CONTRIBUTIONS TO GEOGRAPHY OF MICHIGAN

(Reprinted from NORMAL COLLEGE NEWS)

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The chief material offered is the series of diagrams, to which much attention may be given. The text serves mainly to interpret them and aids to picture conditions prevailing over wide areas. Any teacher should go to the diagrams for the facts of the home locality in which she teaches; to the relief map for her height above sea level and the character of the surface of her neighborhood; to the map of extent of Michigan for other illustrative exercises of the same sort in other directions. The diagrams are capable of being read for any locality in the region or for all localities; how high, how smooth or rough they are, what sort of rocks or soils are probably prevalent there, how cold it is there in winter and how hot in summer, what grows there, how thickly settled, when settled. Whatever things can be shown in their relation to the environment gain an importance for geographic study that may not be intrinsically theirs. Very important characters of Michigan that cannot be shown to be related to configuration, soil or climate have no present value from a geographic point of view. Michigan is truly a group of people and not a portion of North America, yet such is not a geographic point of view. This must concern itself with the part of the earth that Michigan occupies and in how far its life is affected by its home. If this is borne in mind, it will perhaps explain the lack of some things about the state that might be told here.

In connection with the paragraphs on Physiography, students are referred to the admirable report of the state geologist for 1904, just issued, and to Taylor's Short History of the Great Lakes, in "Studies in Indiana Geography," Inland Publishing Co., Terre Haute, Ind.

Authorities for the relief map are: Frank Leverett for the lower peninsula and the country to the southeast; U. S. relief map and Gannett dictionary of altitudes for Minnesota, Wisconsin and upper peninsula; and the Canadian dictionary of altitudes for Canada.

Michigan is a large state with great natural resources, likely in the future to support a population little inferior to the greatest of the United States. Massachusetts has today a population of nearly three millions; Michigan with seven times as much territory, and richer territory, should some day have twenty millions within her boundaries. In a new country like ours the near places are first occupied, the easy things first done. It is for this reason and the great importance that contact with Europe has had for us in the past that the states of the Atlantic seaboard have proceeded so much further in developing their resources than the newer communities of the west. There are today 18 states larger than Michigan, but most of these are west of the 100th meridian and many of them limited for human occupancy by insufficient rainfall. In parts of our state the rainfall is light, but everywhere sufficient for agriculture. If a circle be drawn with its center at the southeastern corner of Michigan large enough to extend across Isle Royale, it will also include New York, Washington, Richmond, Va., and Raleigh, N. C. The radius of the circle would be five hundred miles. No state has so long a coast line. None has a greater variety of valuable resources. Lying far to the north the lakes save it from the rigor of an interior climate, yet is it in that invigorating zone of the spells of weather, now warm, now cold, now wet, now dry, in which are found the most prosperous and progressive peoples, the world over.

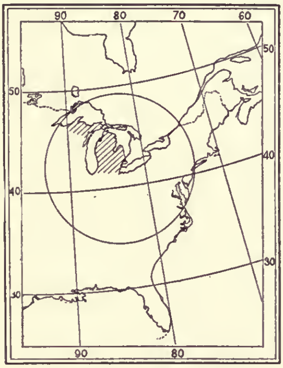


FIG. 1. *Extent of Michigan*

Our state is a part of the physical region of the great lakes. All parts of this area drain to the St. Lawrence river; all parts enjoy the milder climate that comes from the presence of these great bodies of water, loth to heat up under the sun of summer and equally slow in winter to yield up what warmth they have. The great economic distinction of the region lies in the enormous transportation possibilities of broad and deep water ways between the pass over the almost imperceptible divide at Chicago leading to the Mississippi basin and the prairie states and that in the Mohawk valley leading to the Atlantic seaboard and to Europe. It is no coincidence that the growth of the Northwest territory has been parallelled by the expansion of New York, the only Atlantic port connected by an easy pass with the interior of the continent. We observe at once that to study the physical aspects of the state we must consider a wider area than state or country. The political boundaries by no means coincide with the natural ones. This is true from every point of view from which we consider the state. We can never let ourselves be stopped by the state or national boundaries.

There are, however, striking contrasts between the northern and southern parts of the region, and Michigan, like Wisconsin and Ontario, lies in both northern and southern zones. The northern zone is a region of forests in which wild animals still abound, of thin human population, of scattered pockets of thin soil among frequent rocky knobs, a region where rocks are everywhere in evidence, hard and complicated in structure, and abounding in iron and copper. This zone is well shown

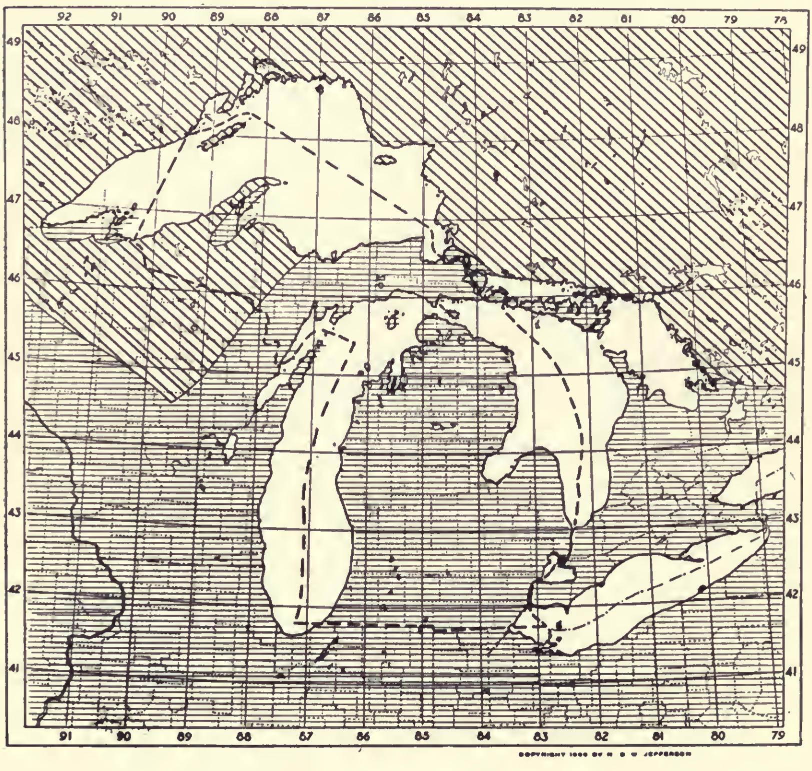


FIG. 2. *Old hard rocks in the north*

on diagram 2 of "Old hard Rocks." It includes northern Ontario, northern Wisconsin, northern Minnesota and the western part of the upper peninsula of Michigan. Of this territory Michigan has about 7,000 square miles, with 150,000 inhabitants.

South of this is a region of deep soils, of agriculture and of denser population. It stretches across peninsular Ontario, southern Michigan and Wisconsin and the northern parts of Ohio, Indiana, and Illinois. This zone is well shown on the diagrams of population and all those representing farm animals and farm products.

The earth is a great ball of rock. When no rock appears at the surface a moderate boring always reaches it beneath and in some countries, like our northern zone and Norway, it forms the greater part of the visible surface. Along the north shore of Georgian Bay the trees in summer are unable to mask with their green leaves the brown of the ledges between. Soils begin with the decay of the rock under the action of the weather. In the mountains this decayed rock may be washed down the slopes by the rains as fast as it forms and the rocks remain bare, but in most places the rocky core of the earth soon becomes buried beneath this coating of decayed rock. If you take up a handful of dirt you find bits of the rock in it, but in the southern lake zone the bits of rock found in the soil are often quite unlike the ledges buried beneath. Many of them are plainly bits broken from the hard rock ledges of the northern zone. So are the common field stones that have afforded so much excellent building material in the southern zone. We learn from this that the northern zone is thin of soil partly because much of its rock waste has gone to the southern region. This was done by the ancient glaciers. In the northern zone only firm rock was left and this often in knobs and ridges, rounded, smoothed and grooved by the passing of the ice. One of these knobs near Marquette is shown in the picture.

These rocks of the upper lake country are among the oldest in the world. They have existed much in the present

FIG. 3. *Knob of Greenstone Schist near Marquette, Mich.*

condition since a period when nothing lived upon the earth, not even the sea weeds and sea creatures that were the earliest forms of life. The landscape must have been barren and brown, dreary and monotonous in the extreme, everywhere naked rock and dirt, without any green thing to rest the eye or moving insect, bird or animal to interrupt the stillness. The great beds of copper and iron ore that are the wealth of this district today are due to the concentrating action of the weather through the enormous length of time that they have been exposed to the elements. (The deep soil of the south has resulted from the addition to its own rock waste of much waste from the north. Naturally the people of these two regions do different things for a living and probably they always will. There are great differences, too, in the rocks that underlie the soils of the two zones. When we call the northern rocks hard rocks we are using a name that covers a great variety of kinds. Hard they all are, and very old, perhaps there are no older rocks on the earth's surface; some are granite like, with large crystal grains of different shapes and colors. These usually have no layers in them. Others are in layers commonly a good deal bent and twisted and others where freshly broken have an appearance not unlike a broken

FIG. 4. *Relief of Lake Region. Height in feet above sea level.*

surface of glass or pottery. But the best way to get an idea of these rocks is to look at them in the field stones. In northwest Michigan they abound in the ledges and in the rest of the state they have been so much used for underpinnings that they are easy to see.

Such ridges are shown on the relief map in the Copper range, backbone of Keweenaw peninsula, the Mesabi range near the 48th parallel west of Lake Superior, where are the greatest iron mines of the world, the Porcupine Mountains on the south shore of the same lake, just east of the 90th meridian and the mountains on the 88th meridian west of Marquette. In all these hills and ridges of the mineral country rock is everywhere in evidence. In the hills of the southern peninsula rock can only be reached by boring, and the boring would be deeper on the hills than in the valleys.

The weathering and wasting of these ancient rocks is

FIG. 5. *Rock Falls, near Harbor Beach*

work that was done long before the time of the glaciers, which merely did the final chiselling and sandpapering.

Under the deep soils of the southern region are other rocks. This picture, fig. 5, of a creek falling into Lake Huron on the eastern side of the thumb of Michigan, with the waters tumbling down over the edges of the rocks shows how they lie in smooth flat layers like the leaves of a book. Here and there they are a little uneven, their edges are usually much frayed and worn, as if the book had been badly handled. One of these layers—the hard Niagara limestone—forms, with its slightly upturned edge, a long line of peninsulas and islands; between Erie and Ontario, where it gets its name from the famous cataract that tumbles over it,—in the high land running across the province of Ontario and ending to the northwest in the peninsula between Lake Huron and Georgian Bay, in Manitoulin and Drummond Islands, in the eastern part of the upper peninsula and the long points that separate Green Bay from Lake Michigan. The great leaf whose edges form this long ridge extends under Lakes Huron and Michigan, passing under lower Michigan perhaps a mile beneath the surface of the lakes, in a shallow basin form, shallow because it is three hundred miles wide to one mile deep. A bit of tin three inches wide and bent down a hundredth of an inch in the middle would represent its shape very well.

Inside the hard Niagara ridge the Monroe rocks came to the surface where are now the basins of Lakes Erie, Huron and Michigan. These lake basins are believed to be due to the softness of these rocks, limestones, themselves easily dissolved by rain water, and containing layers of still more soluble salt and gypsum. Bits of these rocks occur still above water, as Mackinac Island and the mainland of St. Ignace and the shores and islands about the western end of Lake Erie.

The layered rocks of the southern zone were formed as sands and more or less limy muds on the bottom of an ancient sea which opened southward to the Gulf of Mexico, and had the hard rocks of the northern zone for their northern shore, and also for a floor under them. The material worn from the hard rocks in their long exposure to the elements was washed into this ancient sea and went to form the sandy and earthy layers of the southern zone of rocks. This old sea itself lasted a very long time. Its shores were not always in the same place, its waters not always of the same depth. The limy layers must have been formed when the water was clear. Had there been any mud in it this would have settled to the bottom and left earthy matter with the limy stuff of the bottom. Some of the limy layers abound in corals which we may often see in the bits of the rock that we pick up now with impressions of shelled creatures that lived in the sea at that time. Near Alpena and in the Garden Peninsula such corals abound. It is by studying the material of the layers and the remains of the living things found preserved in them that we learn the story of the region. At times the water became shallow and broad stretches of briny marsh alternated with pools where the salt water evaporated in the sun, leaving deposits of rock salt and gypsum that are preserved among the layers of the southern zone. This must have been at times when the climate was as dry here as today in the Southwest. Later the land must have sunk again, for new layers of sandy and limy rock are found above the salt. Again for a long time the sea withdrew, and broad swamps covered the land. The water must have been fresh then, for the swamps were full of plants that could not live in salt water. There were ferns and moss-like plants, but giant in size, quite as big as our forest trees. Our trees, and the plants that flower, did not then exist. From these ferny swamps have come our beds of coal, and in the coal are numberless impressions of the plants that tell us the story. The forests grew old and died, sunk and lie now under layers of slate and sandstone; other similar forests grew later above them, and after a long time all have become buried under thick rock layers which must now be penetrated by shafts to get out the coal. There are many signs in the rocks that each rise in the land and each sinking was very slow, so slow that no one would have noticed it if he had lived through that time, until he saw dry land where before had been water. Just such slow changes are now going on about us. The land at Chicago is sinking at the rate of nine or ten inches a century. Of course that is very little in a year, too little for any one to notice. It is plain that all these layers of rock, with their different conditions and plants and animals, have been a very long while making. Perhaps it is easier now to see that the hard rocks of the north, which were there before, and whose fragments went to form some of the layers, are thought to be so old.

But ages and ages ago, the layered rocks, too, had hardened from the soft mud and ooze to form solid rock and risen out of the old gulf whose waters ran off southward long before there were any men on the earth, before there were even trees or animals even remotely resembling those of today; when the nearest thing to a four-footed animal was probably a huge thing more or less like a frog, at least in his water-loving habits. Ever since then the rocks of this region have remained dry land, and it is a time so long that we cannot measure it at all well. A being who had lived as many centuries as any man is likely to live days would almost certainly not be old enough to remember back to then. Day and night there have been through all the intervening time, and seasons of heat and cold. Rain has fallen, winds blown, and frost followed on sunshine and sunshine on frost, racking, splitting and wasting the rocks as they are wasting today. Have you ever noticed a marble stone in the graveyard? Find one with date fifty years back if you can, and see how rough and cracked it is; how its corners and edges are rounded and crumbled. Marble is a very soft rock, but the hardest rocks must have weathered and crumbled a great deal since the remote period we are thinking of. No wonder soft rocks, some of them softer than the marble of the gravestones and having salt and gypsum among their layers for the rains to wash away, have worn into great valleys like those of Lakes Erie, Huron and Michigan on the Monroe rocks, while the harder Niagara limestone has come to project above the country on either side of it in the long ridge referred to. No wonder, too, that great quantities of that crumbled powder of rock that we call earth or soil have accumulated over the ledges for the plants to grow on and make life possible to us.

In the Lake country the differences in the rocks of the two zones must have made great differences in the landscapes. In the north the long-continued weathering sought out every softer bit of the crumpled, disordered rocks, leaving the harder parts standing in elevated knobs and ridges. In the south the flat layers tend to make the surface level except where the streams had carved their valleys. But after most of the long time elapsed that separates us from the period when warm salt waters reached from the Gulf of Mexico into northern Michigan, another great change befell. The sea waters had now shrunk back to the shape of the present Gulf, North America had much the same outlines on the map as now, except that there were no great lakes,—all sorts of lakes,

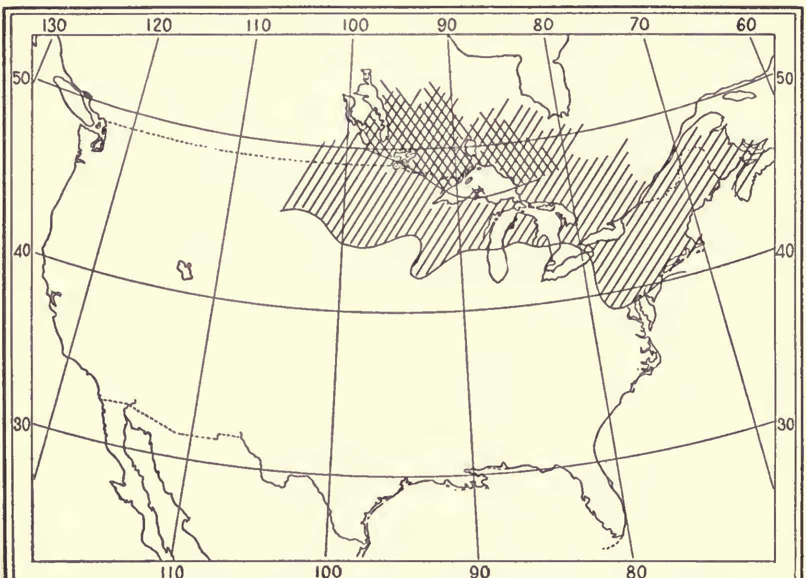


FIG. 6. *Snow on ground December 27, 1904*

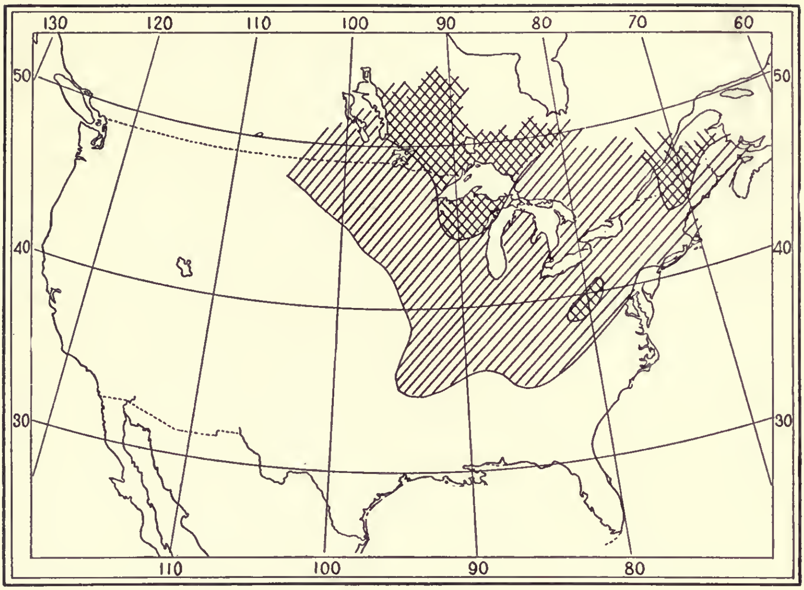


FIG. 7. *Snow on ground January 10, 1905*

indeed, were scarce then, and many rivers ran in courses other than today. Yet it was a long time ago, long before the beginnings of history. The change came in with a great increase of rainfall, causing Great Salt Lake and the neighboring hollows of the great basin of Nevada and Utah to fill and overflow into the Columbia by channels still plain to see among the mountains. Possibly the winter was somewhat colder here than now. It is certain that much increase of winter snowfall occurred. So great was it that summer heats could not melt it all, and accumulation began that grew from year to year. Fig. 6 shows the snow on the ground December 27, 1904. Fig. 7 shows it two weeks later. Where the shading is cross-lined the snow was more than a foot deep. Evidently it snowed in that fortnight. The snow field grew still further. Sometimes it covers even Louisiana for a day. Then it dwindles again and fades away northward until in March or April all the ground is bare. This is a stagnant ice sheet. It lies where it falls until it melts away, snow at the top, but before the winter is over, ice below. In days we call Glacial, however, it failed to melt all summer long, and year after year added a layer, thin or thick we have little idea, until it reached a thickness close north of us of some thousands of feet, thinning to a southern margin along the Ohio river. A curious feature about this huge heap of northern snow is that besides crushing to ice of its own weight the whole mass flattened down, thrusting its edges outward like a mass of pitch. Mr. Willard D. Johnson has imitated this on a small scale by cutting away a wooden barrel from the pitch it contained as it stood on a patch of sand. That pitch did just what we have learned by observation that the ancient ice sheets did,—flattened down and thrust out its edges, scraping and pushing away the sand in every direction. Two hundred years ago when the French Academy was earnestly discussing whether the earth spheroid was oblate or prolate (flattened or pointed), Childrez declared for the latter view because, he said, the long-time accumulations of snow and ice about the poles must amount now to great heaps there that would add notably to the earth's polar diameter. So it would but for the property of ice just described of flowing out sidewise as it flattens down under great pressure. The polar ice caps push out their margins which break off and float away as icebergs toward the equator every summer, and the snow heaps there can probably never reach up more than a mile or two in height. A consequence of the flattening out of the great ice heap north of us was an enormous sweeping away of all decayed or weakened rock from the northern region to accumulate in the south, forming the deep soils of the prairie states in which now lies the center of population of the country. In doing this it blotted out most of the variety of landscape that the weather had wrought in the flat rocks.

As a result of the drift coating in the southern peninsula, the rocks are not much seen there. Whole counties have no outcropping ledge. The known ledges are almost invariably in the beds of rivers, where they cause falls, and towns grow up with suggestive names like Grand Rapids, Big Rapids, Grand Ledge and Flat Rock, or at the shores of the lakes as at Point aux Barques, on the tip of the "thumb," or in Little Traverse Bay. Deep well borings usually encounter rock at a moderate depth, and we have had to learn much of what we know about it in this way.

The rocky "knobs" of the northern country are shown on the relief map all about the shores of Lake Superior, where the country has been carefully mapped in making charts for ships. Hills that are visible from the lake are important to vessels, as they serve as landmarks for their guidance. Back from the lakes and through all the hard rock country these knob-like hills are seen everywhere, but the country is much of it wilderness, no good maps exist, and we should not know where to put the knobs. Most of them must, therefore, be left out of all maps until the country is better known. The picture of a hill near Marquette (Fig. 3) gives a good idea of them. They should be thought of as dotting the hard-rock area everywhere. The smaller knobs and ridges that the relief map shows in the lower peninsula of Michigan are of sand and gravel, moraines left by the ice sheets as they melted away. Their material, like most of the surface of the south-

FIG. 8. *Morainic hills near Eagle, Wisconsin*

ern zone, is bits of the northern ledges. They are just as characteristic of Wisconsin and southern Ontario as of Michigan, but only in our own state have they been traced out well enough to put them in on the map in their right places.

These knobs and ridges of moraine make most of the steeper hills of the southern landscapes. Fig. 8 shows the appearance of such moraines. All this material that the glaciers brought down from the north is known as the Drift. Parts of it, especially near the hard-rock country, are too sandy for the most successful agriculture. Forests have been the best crop there in the past, and may perhaps be made to abound there again. Something of these forests is still left, as will be shown later. Farther south the land shares the excellent quality for farming of northern Ohio, Indiana and Illinois.

That the land is higher as one goes farther north is seen by the relief map. South of the Saginaw Valley the highest point is a small area over 1300 feet in Oakland county. North of the valley quite a large area exceeds that elevation and a small region on the boundaries of Osceola and Wexford is above 1600 feet. But in the upper peninsula is much land well above that level and 1900 is reached and passed north of Lake Superior. Peninsular Ontario shows the same ascent to the north. The drainage of Lake Superior accordingly goes south into Huron, that of Lake Huron south to Lake Erie by St. Clair, but Michigan and Erie empty to the north against the slope of the land. This is one of the many consequences of the glacier work here. Of old the whole region drained south to the Gulf of Mexico. Lakes Michigan and Erie are now walled off on the south by glacial drift.

II.

OLD BEACHES AND MORAINES.

At the time when great sheets of ice lay on this region, the country south of the Ohio was so warm that the ice all melted before reaching it. The ice here crept forward, pushed by the weight of the mass accumulated mountain high east and west of Hudson Bay. But for a long time there was a region just south of the great lakes where the ice melted and ran off as water as fast as it crept forward. Since the ice dragged quantities of drift in its lower portion, causing all this region to be coated over with the rock fragments from Canadian ledges, all this drift must have dropped at the line where the ice melted. Such is believed to be the origin of a long low ridge, uneven of crest, and following the outline of the lakes at some distance that is traced on the map by the heaviest black line on Fig. 9. It is seen that the front of the ice was uneven; that it pushed furthest south along the hollows now occupied by lakes and bays. Such a ridge of stony detritus at the front of a glacier is called a moraine. Lines of moraine are numerous throughout the lake country. This is one of the plainest.

As the climate grew warmer the front of the ice retreated. That is, it melted back faster than it crept forward. Lakes now began to gather between the moraine and the new front of the ice, filling the basin with water up to the level of the lowest notch in the rim of moraine. There the lakes ran over. As all the country to the north was covered by ice, hundreds of feet thick, this overflow had to go south, where it all found its way, sooner or later, into the Mississippi.

Many such lakes were formed, with shores and outlets that changed as the ice kept melting back and uncovered now and then a new and lower notch in the rim, or allowed two of the water bodies to run together. Duluth, Green Bay, Chicago, Saginaw and Toledo must each have had one of these ice-dammed lakes, draining to the southwest and excavating with its waters the channels in which are the great portages between the great lakes and the Mississippi.

These outlet channels have thus become of great importance from the cities they have fostered. They are still traceable on the ground. The waves of these lakes cut beaches on the slopes of the moraine that held them in. Such beaches are traceable from the outlets for many, many miles. One of

Fig. 9. *Moraines and old lake beaches*

the lakes that has left a very visible beach is traced in outline on Fig. 9 with a black line, the area of the lake that made it by cross-lining over the land. At this time the ice front had melted far enough to the northeast to uncover half of Lake Erie, and the southern third of Lakes Huron and Michigan. Lower land was now uncovered on the "thumb" of Michigan than on the moraine further south, and across this low land the water flowed until its level had fallen to that of the Saginaw lake. This in turn emptied through the valley of the Grand river into the lake at Chicago. The relief map shows how the elevation and shape of the land surface moulded these bodies of water. The water finally escaped to the Mississippi by the valleys of the Desplaines and Illinois. A number of such beach ridges are found one above another, corresponding to various lake levels, with escape at various outlets. The most important line of travel in the United States, the Mohawk valley, was in part excavated by the waters of the great lakes escaping in this way to the Hudson river when the ice had mostly withdrawn from the lakes, but still blocked the St. Lawrence channel.

The waters of the ice-dammed lakes were doubtless kept muddy by the silt from the lower layers of the melting ice. The flat-lying clays about Chicago, Saginaw and Detroit were formed by the slow settling of these sediments to the bottom. The shore ridges and moraines have given the rivers of the lake country a curious arrangement (See Fig. 4). The Maumee, that flows northeastward into Lake Erie at Toledo, receives its headwater tributaries much as the shank of a fish-hook is met by its barb, the St. Joseph from the northeast and the St. Mary from the southeast. Another pair of tributaries lower down the Maumee behave in the same way. So the Cass and Tittabawassee join the Saginaw, and quite similar is the flow of the St. Louis at Duluth, the Wolf river near Green Bay, and the Chicago river at Chicago. The tributaries in each case are obliged to go along behind the ridge to the place where the main stream breaks through before they can begin to approach the lake.

Very different from these are the old shore lines about the northern lakes. Here the beach is a strong feature in the landscape, rising in distinct terraces from the present lake shore, as seen in the picture (Harbor Beach, Fig.10), and at Petoskey and Mackinac island. One of these is indicated on the diagram by a solid black line about the northern shores of the lakes, with numbers giving its elevation above the lake from place to place. The outlet was to the northeast on the 79th meridian just north of the 46th parallel, across the Canadian lake Nipissing to the Ottawa river and the St. Lawrence, which was now free of ice. It will seem strange that the water should find its outlet there where the land is now high above the lake, but it is certain that the land in the north was lower then than now. The shore lines must have been as level as any modern lake shore when made, while now they rise higher and higher as we go to the north. The ele-

FIG. 10. *Elevated beach, Harbor Beach, Mich.*

vations of the beach above the lake surface show this. It seems a very surprising thing, but it cannot be doubted, that the land has risen out of the water in the north without rising so much in the south, pretty much as a trap-door in the floor rises most at the edge away from the hinges. There are many ways of showing that this sort of thing, a rising or sinking of land, is happening in many parts of the world all the time. It is quite as certain as that the earth is turning around on its axis, or that we are swinging around the sun at a tremendous speed, and just as hard to realize. The movement in this case is really very slow and very slight. It sounds a good deal when we say the land has risen 100 feet more in Georgian bay than in Alcona county, but the distance is 150 miles, and the slope of such a tilting only 8 inches to the mile. If you go out and stand on a beach that has a slope of 8 inches to the mile it looks perfectly flat. Moreover, it has been tilting for a good many hundred years before it got so much out of level as that. The movement is neither so great nor so rapid as the ordinary settling of the ground that cracks the walls of our houses. When those old shore lines were bathed by the waves, the basin of our lakes was down to the northeast and the lake waters were high at that side. For the same reason the Nipissing outlet was lower than the St. Clair at Port Huron, and the waters of the upper lakes went to the sea without passing through Erie or Ontario at all. In this channel from Georgian bay to the Ottawa river there is now a low divide between the Nipissing and Ottawa drainage over which the early French explorers made a portage in their trips to the lakes, for Lake Erie was discovered later. Since the day of the old north lakes the basin has been tipping back to the south, the northern shores coming higher and higher out of water, and the water in the south is steadily advancing on the land.

The tiny lakes that dot the surface of Michigan and Wisconsin, thousands in number, are also due to the presence of ancient glaciers here. South of the outer moraines of the ice sheets such lakes are unknown either in America or Europe.

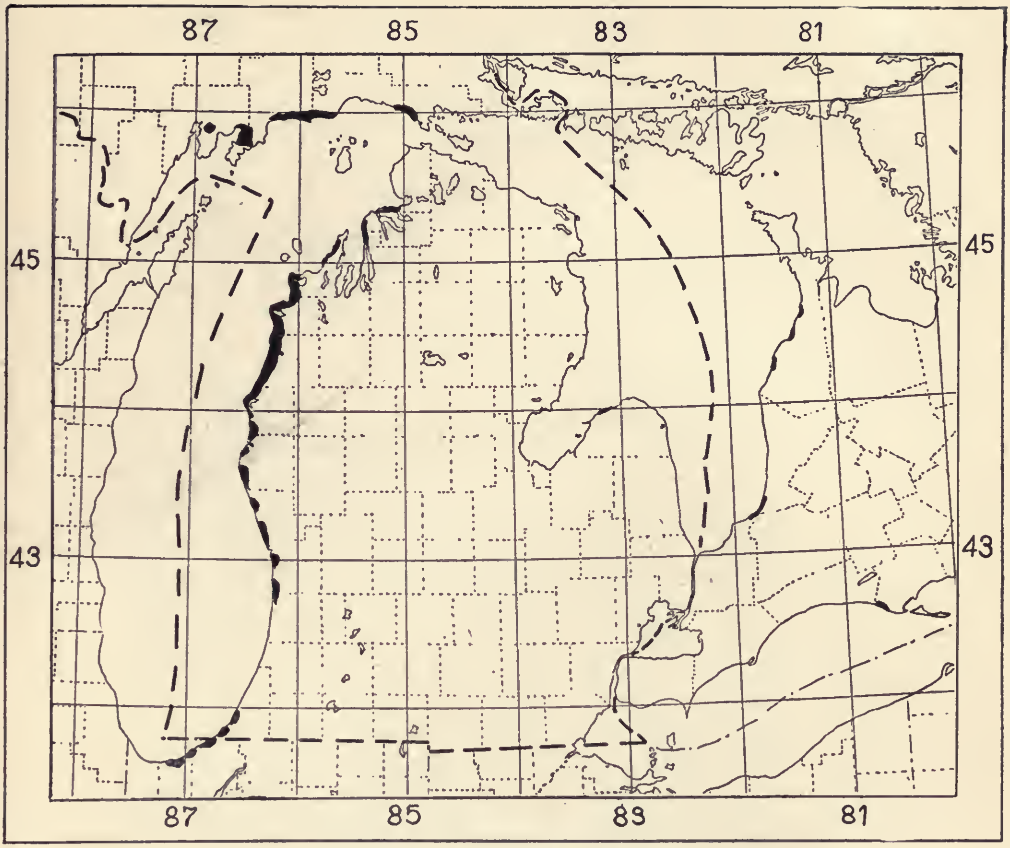


FIG. 11. *Sand dunes about the lakes*

They are due partly to hollows among the irregular heaps of drift left on the surface of the country and partly to the burial in gravel and sand of ice blocks from the glaciers as they at last melted away and covered the country with streams of muddy and sand-laden water.

A feature of the lakes of which Michigan enjoys almost a monopoly is the sand dune coast, best developed on our shore of Lake Michigan between the 44th and 45th parallels (Fig. 11). Ontario's fragment is less well developed for lack of sand. Wherever a shore that is well supplied with sand stands facing the prevalent westerly winds, the sand is flung up on shore by the waves of storms and the winds then pile it up along the coast in long series of sand hills and hummocks. How the wind tends to drive these landward is well shown by a prostrate pine in the dune at Pentwater as it appeared in the summer of 1902 (Fig. 12). The tree grew erect above the spot where the roots are now. The sand in and on which it

FIG. 12. *Dune at Pentwater, Mich.*

grew has long ago been blown to eastward. The tree was first blown over in the same direction, and before the footing was removed by blowing, the tip had become firmly embedded in the position in which we now find it. The chief use men make of the dunes is to build summer homes on them for the coolness of the winds from the lake that piled them up. The picture (Fig. 13) shows both the cottages and the strong wind in the trees. Sand abounds greatly on this eastern shore of

Lake Michigan, building long sweeping borders to the land. The sand is not merely moved landward up the dune, but travels northward along the shore in the play of the waves. In this travel alongshore it has swept across the mouths of the lower peninsula rivers entering this lake and sought to bar them from the lake. Thus each of these rivers has a lake at its mouth inside the line of the dunes, and access to the Big Lake must be maintained by dredging a channel

FIG. 13. *Houses on dune, Pentwater, Mich.*

across the beach. Such lakes are admirably shown on the chart of Lake Michigan published by the U. S. Lake Survey (Campau Building, Detroit, 20c.) characterizing this whole shore line. Ludington has fine examples of the dunes at Epworth Heights, and the bar partly enclosing the Pere Marquette Lake is of this origin.

Figure 14 shows some of the principal ancient outlets of the lakes. Those numbered 1 draining the lakes formed near Duluth, Chicago and Detroit in the southern and western ends of the basins when most of the lake country was still under ice; those numbered 2, leading off the lake waters to the valley of Mohawk and Hudson when the ice had bared most of the lake basins but still blocked the St. Lawrence; and 3, emptying all but Erie at a later period to the great arm of the sea that then occupied the basin of Lake Ontario and the valley of the St. Lawrence. The discharge of the great lakes is considerable enough to wash out a broad, deep channel such as those of the St. Clair and Detroit rivers of today; and all these older channels, now abandoned by the waters that carved them, exerted distinct influence on early lines of exploration and communication and upon subsequent history. Abandoned river channels always drain their rain water off in opposite directions at the two ends with a divide somewhere between. The divide in most of these channels is that separating the basins of the St. Lawrence and Mississippi, represented in the figure by the dotted line. Thus the old channel at the west end of Lake Erie drains northeastward to Lake Erie by the Maumee and southwestward by the Wabash with the divide between these rivers where Ft. Wayne now stands. In early days when travel was by canoe, parties went up the Maumee from Lake Erie, made a portage (or *carry*) across the divide and on down the Wabash. These portages were natural camping spots, which travelers would naturally tend to reach before nightfall. Here parties traveling in opposite directions would often meet and exchange necessities, here the trader would often pitch his camp and defend his precious goods by a stockade or fort, under whose sheltering walls clustered the huts of the half-breed families of the

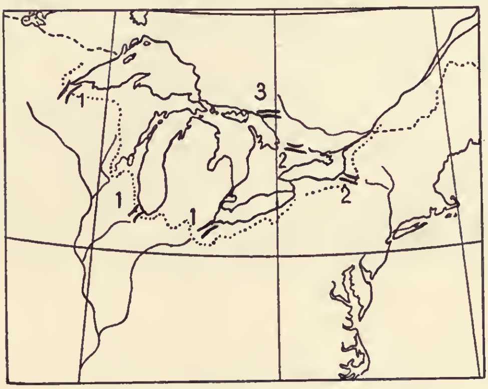


FIG. 14. *Older outlets of the great lakes*

voyageurs; here grew up the earliest important towns of the region. Chicago is the best example of such a history. The easy portage at this point early made it a pathway to the interior of the continent. The French traveled over the lakes to the southwest, looking for a passage to the Pacific. Their settlements were mere forts along this route, utilized later for the highly profitable fur trade, it is true, but without real colonization such as characterized the English settlements along the Atlantic coast.

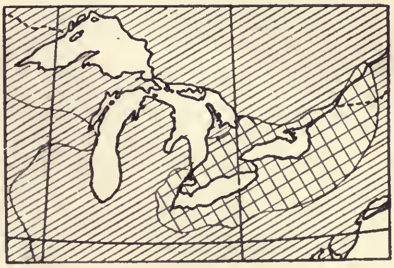


FIG 15. *The Hurons (Iroquois) about Lakes Erie and Ontario with friendly Alonquin tribes in most of the lake country*

The French first entered the lake country by the portage from the Ottawa to Lake Nipissing along the line of the old northern outlet. There is no doubt they were guided in their choice of this northern route by the possession of the lands about Lake Ontario and Lake Erie by the redoubtable Huron tribes (Fig. 15), while the upper route was through the country of friendly tribes of the great Algonquin family. To these facts is due the importance of Mackinac and the Sault Ste. Marie in the early history of Michigan. Mackinac, Sault Ste. Marie, Green Bay, Chicago and St. Joseph were reached by the whites long before Detroit. LaSalle did not make his first trip up Lake Erie until 1679. The settlement of Detroit, 22 years later, seems to have come of a desire to cut off the English of the New York colony from the fur trade of the northern lakes. Nicollet made the first post at the Sault and coasted as far as Green Bay in 1635. Marquette 38 years later passed over the same route and on to Lake Winnebago, up the Fox river to the Wisconsin by the portage where the town of Portage, Wis., now stands. This is a region of lakes. In times of heavy rain the Wisconsin sent surplus waters down the Fox river to Green Bay. On his return from the Mississippi in 1674 Marquette ascended the Illinois and

Desplaines to the Chicago portage. Here, too, the land is very flat and in wet seasons loaded boats floated from Lake Michigan to the Mississippi. In dry weather they must be carried thirty miles In 1679 we find LaSalle at St. Joseph, probably making the portage to the Kankakee from South Bend and getting to the Mississippi by the Illinois. It was an explorer's trip. He had no map to show how far he was going out of his way. As the divide lies just beyond Michigan territory none of these old portage towns are included in the present state of Michigan.

Traffic on the lakes then as now largely passed *through* Michigan waters between outside points on either hand. The portage at Sault Ste. Marie differs from the others in not standing on a divide but at the rapids in which the waters of Lake Superior descend to the eighteen feet lower waters of Lake Huron.

III.

CLIMATE

Michigan and southwest Ontario consist of peninsulas projecting into lakes. A result of this position is to mitigate extremes of temperature. Water is slower to heat up than land, so a hot day in summer is hotter on shore than over the lakes. One of the hottest days of the year 1904 was the 24th of August. Fig. 16 shows diagramatically all the highest temperatures observed in the region that day. The greatest heat was, of course, south of the Lakes, where the thermometers rose above 90°. Next north of this comes a belt which has been shaded with rulings in the diagram, where temperatures between 80° and 90° were noted. Two outlying islands of this shading are seen in southern Michigan, and three in peninsular Ontario. These isolated warm spots lie a little back from the lake shores, or touch them only to eastward. West-facing shores on both Huron and Michigan are seen to be cooled by the winds that prevail here from the west. Erie, too, shows something of the same sort. This has brought us across the blank to the dotted area of temperatures under 70°, perhaps the greater part of the coast country on the upper lakes. In this again lie islands of more than 70°, in Wisconsin, a little back from the lake, and in Upper Michigan, where it only touches the lake shore to eastward as before. It would be hard to find a shore on the map where a trip straight inland would not bring us to higher temperature. I have no doubt this would have been true in the Canadian country east of Lake Superior, though the country is little settled, and we have no knowledge of thermometers there. The cooling effect of the lakes is apparent in every part of the diagram. Lake Erie, which is barely 60 feet deep, does not cool its shores so effectively as the other lakes, which are much deeper. In each of the lakes the water is observed to be coldest where it is deepest. Out on mid Lake Michigan, near the 45th parallel, there is a patch of cold water, so well

FIG. 16. *Maximum temperatures of the afternoon of Aug. 24, 1904, a very hot day showing less heat on the shores*

known to masters of vessels that they fill their water casks there. This "Cold Island" is over the greatest depth of the lake. Out on Lake Superior, far the deepest of all, the water keeps a temperature of 39° to 41° in midsummer. Only near the shores, where the sun penetrates to the sandy bottom, is the water warm. Not only is the effect of these cool waters borne to eastward on the prevailing west winds, but they extend their influence shoreward on hot summer days with the landward breathing of the lake breezes that then prevail.

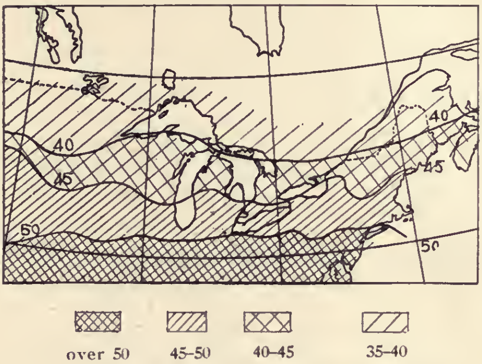


FIG. 17. *Mean annual temperature, 1871-1896*

This tempering of summer heat by the lakes must not be supposed to make Michigan cooler than places east and west of it. On an average it has about the same temperature as places in the same latitude further from the lakes. Fig. 17 will make this clear. It records the average temperatures of the period 1871-1896 as recorded by observers of the U. S. Weather Bureau. Neither does it mean that our summers are cool. One time or another Michigan has known as high temperatures as southern Louisiana. The reader should make this out on Fig. 18, which shows the distribution of the highest temperatures recorded in eastern North America, from 1871 to 1896. It appears by

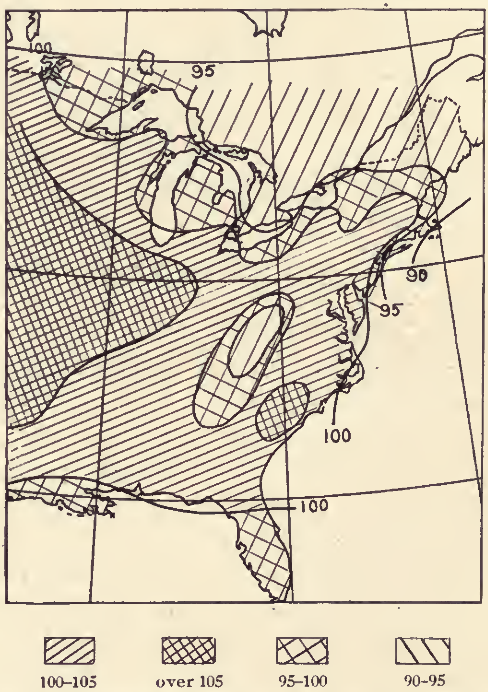


FIG. 18. *The highest temperatures recorded from 1871 to 1896*

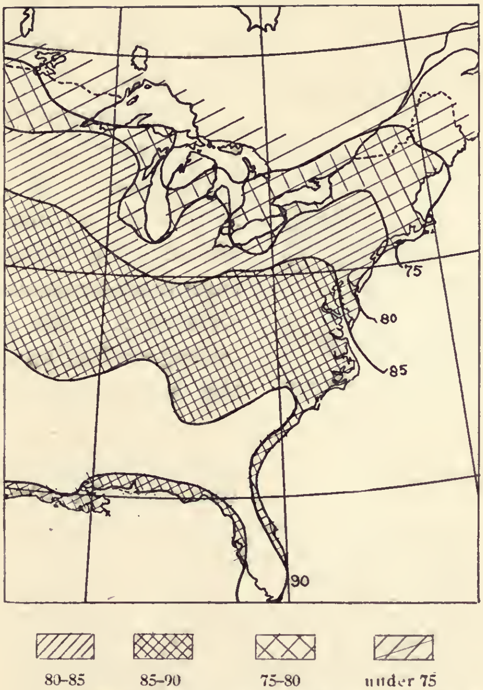


FIG. 19. *Mean of the hottest temperatures observed on July days, 1871-1896*

this that neither southern Louisiana nor Michigan north of the southernmost counties have experienced greater heats than 100° during that period. Usually, of course, Louisiana is the warmer of the two, yet not greatly. Fig. 19 shows the average of the highest temperatures reached each July day in the 25 years. From this we may say that the region west of Saginaw Bay is likely to have a temperature of 75° to 80° any July afternoon, Louisiana more than 90°. On January mornings, Louisiana's average is 45°, lower Michigan's 15°(Fig. 20). For its coldest moments, Louisiana has known temperatures from zero to ten degrees above; lower Michigan from twenty-five to thirty degrees below. (Fig. 21). In a word, Michigan reaches summer heats on any day in July almost as great as those of Louisiana, and the hottest record is the same for both places, but January sends down our thermometers thirty degrees lower than Louisiana's.

Cold winters and hot summers characterize our climate, but as Fig. 16 showed us the great lakes mitigate the greatest summer heats along their actual shores. Facts for particular localities may be read from the diagrams in the same way.

In winter the effect of the lakes is reversed. Water cannot cool below 32°. Air below that temperature must, when near the lakes, be warmed by radiation from the water. The winds should distribute this mitigating effect a moderate distance inland from the lake shore. Let us look over, in this connection, the diagram of the lowest temperatures observed

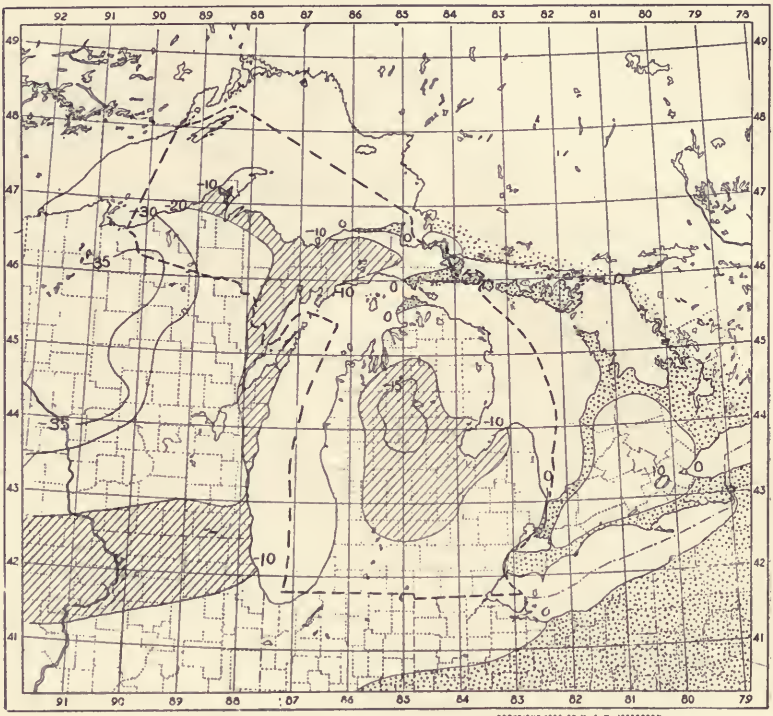


FIG. 22. *Minimum temperature of the morning of Jan. 24, 1904, showing less cold near the shore*

in January 24, 1904, when a cold wave was central in northwest Wisconsin. Its effects reached into Ontario, but were notably lessened at every lake shore, while the interior of Ontario has 10° below, inland parts of the lower peninsula of Michigan 15° below, with 35° below on the Wisconsin highlands. These mitigating effects do not indeed reach far from the water, but the shore counties have extremes of temperature much moderated by them. It is on such days as August

24, that Chicago people become eager to flit across the lake to Michigan shore resorts. Such summer coolness constitutes an asset of singular value in that its continued use and enjoyment does not involve any diminution of future availability. In this it surpasses mines, lands, forests, or fisheries, and is to be classed rather with beautiful scenery, good institutions, and a reputation of citizens for good character.

In the main our temperatures are of the class usually

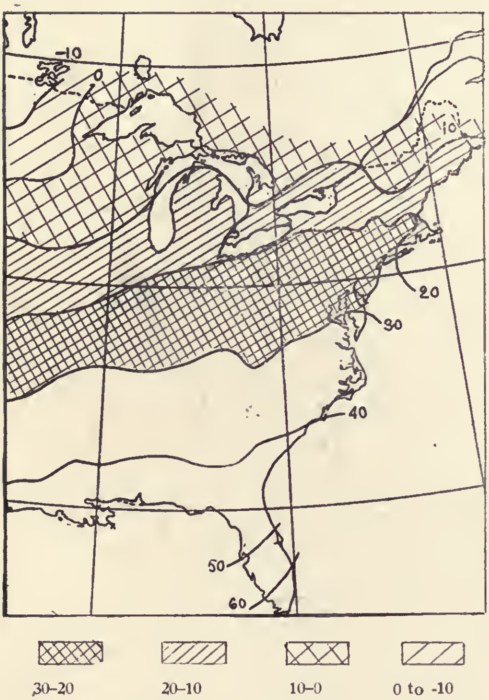


Fig. 20. *Mean of the coldest temperatures observed on January days 1871-1896*

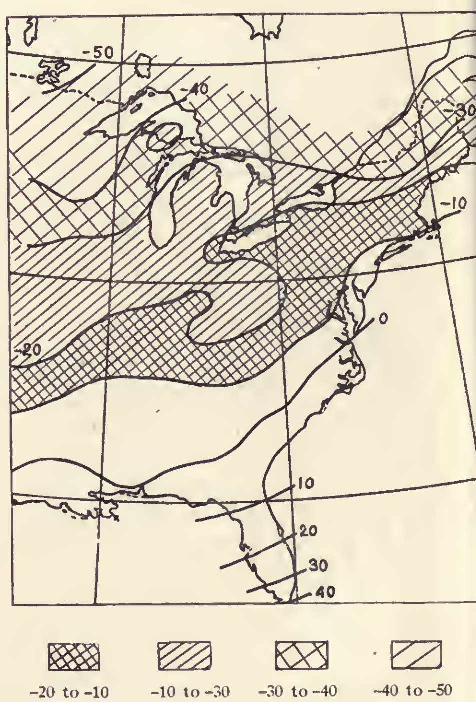


Fig. 21. *The lowest temperature recorded 1871 to 1896*

grouped as temperate, because their average values are moderate, but their ranging through extremes is their most striking character. These extremes occur not merely in the transition from day to night, and from summer to winter, but also in the spells of weather that sweep in unending procession from the Pacific to the Atlantic, and distinguish our weather from the experiences of regions nearer the equator. The columns of numbers at the side of this page are the averages of the thermometer readings for each of the twenty-four hours every day in January and July at Ypsilanti and at Havana, Cuba, in 1904. As the eye runs down the January values for Ypsilanti, it is struck by the great changes. In fact, if we group the days as cold or warm, according as their temperatures are below or above 17°, the mean of the whole month, it appears to have consisted of four cold spells and four warm spells; cold: 2 to 5, 10, 17 and 18, and 24 to 29; warm: 6 to 9, 11 to 16, 19 to 23, and 30 and 31. The difference from warm spell to cold is often greater than from day to night. A glance shows that Havana lacks such spells in summer and winter, while our summer shows them much diminished. This is seen again by comparing the highest and lowest temperatures of the month, Ypsilanti showing a difference in winter of 34°, in summer of 27°, and Havana 9° and 4°. The same thing is true of the individual days. To show this I have selected the coldest and warmest dates at each place in the two months, and give now the temperatures for every two hours those days, with the somewhat surprising showing that not merely is our cold day nearly 65°

MEAN DAILY TEMPERATURES, 1904

	Ypsilanti.		Havana.	
Day	Jan.	July	Jan.	July
1	19°	58°	67°	80°
2	7	62	69	80
3	1	65	71	77
4	3	73	71	78
5	7	73	68	80
6	21	67	69	79
7	26	66	68	80
8	32	70	70	81
9	22	69	66	80
10	15	72	68	80
11	18	75	73	80
12	23	67	73	80
13	24	69	71	80
14	22	73	65	80
15	21	76	65	79
16	22	76	67	80
17	12	82	68	80
18	6	85	68	80
19	21	81	71	78
20	34	75	71	79
21	32	72	71	79
22	31	67	73	80
23	23	65	74	81
24	0	65	66	79
25	1	68	72	80
26	8	71	72	80
27	5	71	72	80
28	8	67	72	77
29	10	66	74	78
30	18	73	72	78
31	23	75	74	77
Mean	17	71	70	79
Lowest	0	58	65	77
Highest	34	85	74	81

colder than their's, but our hot one considerably warmer. This would not always happen, however. The July of 1904 was 2° or 3° cooler than usual at Havana, and a little warmer than usual at Ypsilanti, while the day cited was an exceptionally warm one. But all the data given serve to justify the statement that our climate is one of hot summers and cold winters, mitigated on the lake shores by the more constant temperatures of the lakes. But these spells of weather have more in them than heat and cold. The warm ones bring most of our rain and snow, while the cold ones give us fine bracing days, under a sky unsurpassed even in Italy. And though the lowering skies of the warm ones are less agreeable, they alone make life possible here. As they swing eastward across the continent the winds blow in toward them in every direction, forming a great eddy often a thousand miles across. Thus it happens that it is preceded as it draws near us by easterly and southeasterly winds that bring moisture from the Atlantic, and then, if it pass by on the north, by southerly winds from the Gulf of Mexico. From these most of our rainfall is obtained. All of southeastern North America is well watered for the same reason, and the lake country lies near the northwest margin of this region of sufficient rain. North of Lake Superior the annual rainfall soon falls away to 25 inches, a scanty amount. South of that lake the whole region of our study has an annual fall of rain and melted snow of 33 or 34 inches, abundant for successful agriculture. The great lakes are to be regarded as mighty pools of this rainwater, standing

Hourly Temperatures, 1904.

	Ypsilanti.		Havana.	
Hour	Jan. 24.	July 18.	Jan. 15	July 8
2	5°	76°	61°	77°
4	3	76	60	76
6	0	76	61	74
8	1	86	65	76
10	2	90	67	84
Noon	5	95	68	87
2	5	95	70	87
4	2	95	69	86
6	3	90	68	85
8	5	86	65	82
10	6	83	63	82
12	6	80	60	80

awaiting its chance to run off by Niagara to the sea. From their surface it is believed that as much as 20 to 30 inches are evaporated annually, and of this there is reason to believe some 4 or 5 inches fall a second time on the lake country. The lakes do not cause the rainfall on their shores, but they may well increase it by a few inches as explained above. For this reason rainfall maps of the whole continent show a distinct widening of the rainy eastern area toward and over the great lakes, which seem to possess the beneficient power of enabling us to receive as rain twice over a portion of the moisture brought us on the winds from the Atlantic and the Gulf. We should now turn to Fig. 23, the diagram of our annual precipitation. The data cover the last 25 years, and though still imperfect in some parts of the area, the main facts are doubtless as represented here. Perhaps the most conspicuous feature of the map is the general increase of the rainfall to the south, of which we have just spoken. Next to that in interest come the patches of increased rainfall on every distinct elevation that stands to southeast of one of the lakes. The relief map in the November issue (Fig. 4) must be referred to. The Ontario highland has 40″ of rain between its crest and Lake Huron. This is some of the water reprecipitated from the lakes as is shown by rains at Saugeen and Parry Sound, with northwest winds. In our lower peninsula, the highlands north and south of the Saginaw-Grand Valley are similarly favored on their northwest slopes; the highest point of the whole peninsula, in Osceola county, having 40″ to windward like the slope in the south from Berrien up through Cass and St. Joseph, to Branch. Ball Mt., the highest part of the southern highland, has a similar increase over neighboring counties. Similarly, the highland of northern Wisconsin has an area of 35″, while the Mesabi Range, northwest of Lake Superior, will probably be found to have larger precipitation than the country about, as soon as gauges are set up there, thanks to its considerable elevation. To leeward of these elevations are noted the scantier records—under 30″—on the thumb of the lower peninsula, and other patches southward from there to the west end of Lake Erie, as well as the west shore of Lake Michigan, from Milwaukee to Manitowoc. The most curious adjustment of the precipitation to the topography will be found south of Lake Erie, where the rapid rise of the land sends up the precipitation as suddenly from 35″ to

FIG. 23. *Rain and snow. Blank areas have from 30 to 35 inches, dotted areas less than 30, lined areas from 35 to 40, and cross-lined areas over 40 inches for the average year between 1880 and 1904*

40. The dryer belt extending into Pennsylvani a between the 80th and 81st meridians, coincides with a long valley in the upland, an ancient drainage line that is easy to make out on the relief map. Newcastle and Pittsburg are the two stations in the valley. Further adjustments will be found if explanations are sought on the relief map for the 40″ close east of

the 80th meridian in the same region and the 44″ near 82 30′ west longitude.

The rain usually comes rather heavier in the growing season than at other times, as the diagrams of Fig. 24 show. In occasional years this does not happen, and it is probably less pronounced in the patches to windward of the chief elevations.

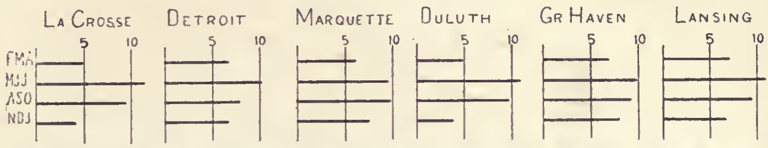


Fig. 24. *Inches of rain and melted snow that fall in February, March, April, May, June July, and so forth, showing that our heavier rains come in summer*

Thunderstorms are the occasion of much of the summer rainfall, but are much less frequent than in the prairie states to the southwest. Tornadoes, the cyclones of the newspapers, rarely come into our territory. The windfalls of the older forests were silent evidences of their occasional passage, and a few have been since recorded.

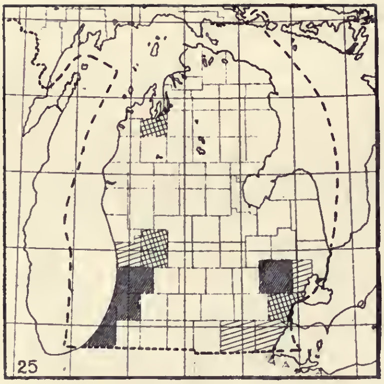


FIG 25. *Pears in 1902*
Dark lining over 20, cross lines over 10 and light lines over 5 bushels per square mile

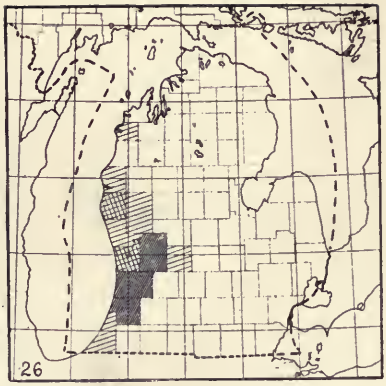


FIG. 26 *Peaches in 1902*
Dark lining over 500, cross lines over 100 bushels per square mile

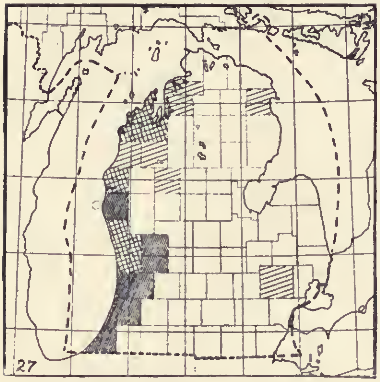


FIG. 27. *Plums in 1902*
Dark lining over 10, cross lining over 3 and light lines over 1 bushel per square mile

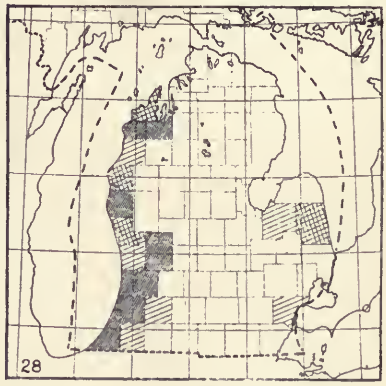


FIG. 28. *Cherries in 1902*
Dark lining over 5, cross lining over 2, light lines over 1 bushel per square mile

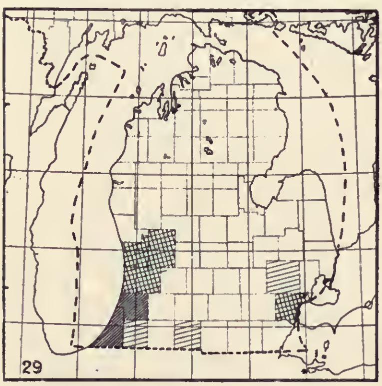


FIG 29. *Strawberries in 1902*
Dark lining over 50, cross lining over 20 light lines over 10 bushels per square mile

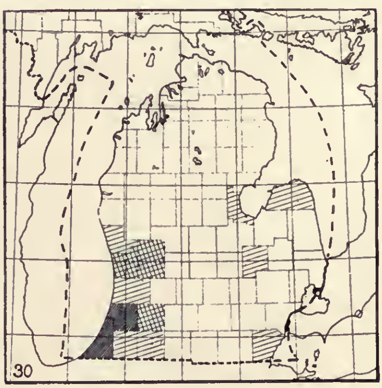


FIG. 30 *Grapes in 1902*
Dark lining over 10,000 lbs., cross lines over 1,000 lbs., light lines over 200 lbs. per square mile

IV.

THE FRUIT BELT

The prevalent west winds from Lake Michigan, with their mild, moist air have doubtless made the southwestern counties of our state the fruit belt of the region. Perhaps the simplest presentation of this fact is in the group of diagrams, Figs. 25 to 30, showing the crop of pears, peaches, plums, cherries, strawberries and grapes in Michigan in 1902. Raspberries and blackberries show the same distribution. Three-quarters of our fruit, other than apples, comes from the shore counties between Grand Traverse Bay and the Indiana boundary (see Fig. 31) and two-thirds from the four southern

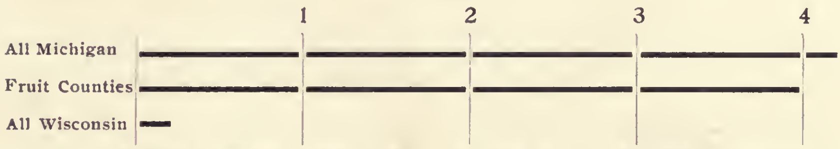


FIG. 31. *Millions of bushels of fruit, 1902. The fruits are, for Michigan—strawberries, blackberries, raspberries, peaches, pears, plums and cherries; for Wisconsin—Strawberries, blackberries, raspberries, currants and grapes, the only ones reported. Michigan grapes are omitted, being only known in pounds*

counties—Kent, Allegan, Van Buren and Berrien. Not merely are May frosts prevented from injuring the fruit by mild airs from the Lake, but a too early swelling of the buds in March warm spells is likewise avoided. Lake Michigan literally blows hot and cold or rather warm and cool; the fact being that the lake water changes much less in temperature than the land and so moderates extreme temperatures on shore, either of heat or cold. Nearness to Chicago markets must exercise a very stimulating effect on the crop of the southern counties, but the Lake counties of Indiana, Illinois and Wisconsin have no share in the business, although still nearer. This appears more clearly in Fig. 32 which gives in thousands of bushels the peach crop of the region. Only Michigan and Ohio give the data by counties. Indiana, however, reports the number of bearing trees, which are noted here for the Lake country, also in thousands. Call it a tree bears two bushels or even three or four, and the inferred yield is still far from great. The whole state of Illinois only produces as much as the tenth among Michigan counties; Wisconsin not enough to report at all. From statements made to me there I judge that Ontario produces considerable quantities of peaches. It certainly is situated as well as our fruit counties, but no statistics are available on this point. The Ohio figures show an especially large yield from Ottawa county and this again illustrates the advantage of position to leeward of the Lake, as Ottawa peaches come mostly from the peninsula north of Sandusky and the American islands in Lake Erie. All the facts go to show the importance of the west winds from the Lake for fruit raising rather than nearness to the Lake or the market. Fig. 30 shows that Van Buren and Berrien lead the state in producing grapes; as a matter of fact they produce twenty-seven million of the state's thirty-four million pounds (see Fig. 33). So California, under the west winds from the

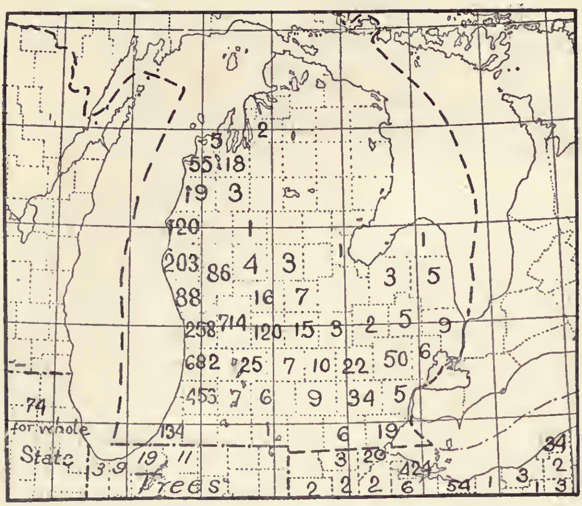


Fig. 32. *Thousands of bushels of peaches, 1902*

Pacific, is far in the lead of American states as grape and wine producer. Similarly situated are Chile and Peru, the finest grape countries in South America, and Portugal and the Bor-

FIG. 33. *Millions of pounds of grapes, 1902*

deaux country in Europe. It is not the least interesting feature of the study of the home country that it quickly leads us to see things abroad in a clearer light. Our fruit industry has had great developments in the last few years and its adjustment to geographic features seems to assure its future as long as the central states are the seat of a great population. The imperative need of the present is prompt and economical refrigerator car service to the markets. From an examination of Detroit market prices it is certain that this crop was worth on the farm from three to four million dollars in 1902.

The apple crop, worth over five millions, was much more scattered. Apples are raised with us wherever men live, their keeping quality making them a significant item of food for home consumption as well as for marketing. The principal sources of the crop are shown in Fig. 34. The fruit belt produced but sixteen percent of the whole.

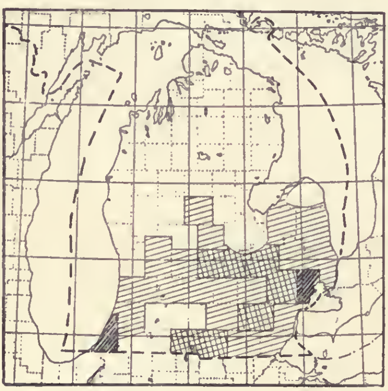


FIG. 34. *Apples in 1902. Dark lining, more than 900, cross lines more than 600, and light lines over 300 bushels per square mile*

SUGAR BEETS

Not a little of the hundred and fifty million dollars worth of vegetable products of Michigan enters into manufacturing processes, which add another hundred and thirty million of dollars to their value. Usually these manufacturing processes have followed on the farm and forest occupations and have been located near the supplies of raw material. The diagram of wheat production shows that the breakfast food factories of Battle Creek are in the heart of the wheat country. Grand Rapids, too, grew into eminence as a furniture center while still in the belt of abundant hardwood lumber. The lumber is now mostly cut off and large supplies are imported from outside the state.

The beet sugar industry differs from these in that the beets are raised to ship to some factory rather than the factory placed where beets are raised. This tends to concentrate the sugar beet farming as no other agricultural product is concentrated. The diagram (Fig. 35) shows the large production of

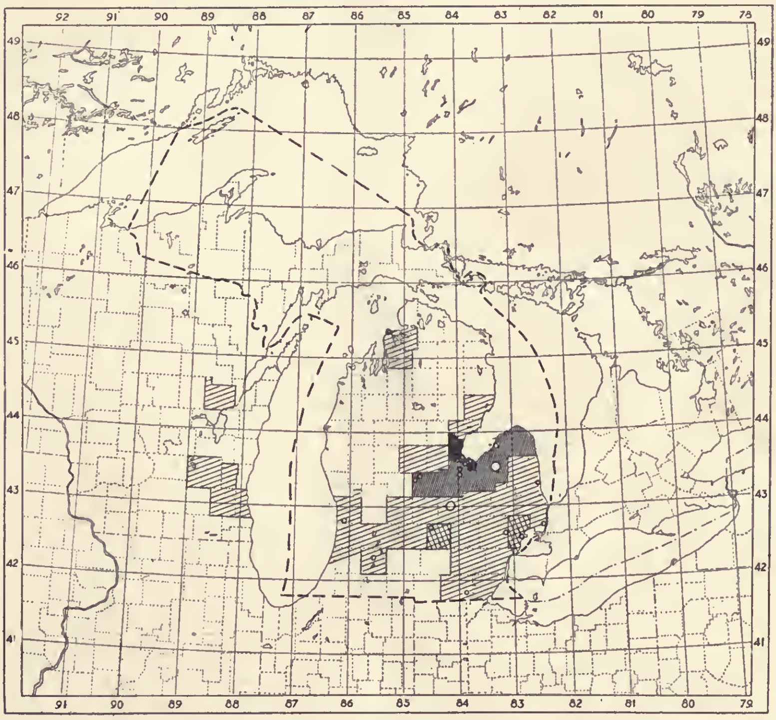


FIG. 35. *Sugar beet crop of 1903. Darkest shade is 140 tons to a square mile, then 60, 20, and 2 tons. Circles are factories*

the Saginaw valley along a line of dense population, and a diminishing production as one recedes from Bay county in any direction. Bay county, where the industry now centers, is rather north of the best farming country for other products, as the other diagrams show. For the present, beet raising is largely centered about the larger factories. This is because of the newness of the industry in the state. Only California up to 1904 and Colorado in that year produced more beet sugar

FIG. 36. *Sugar crop in thousands of tons in 1903-4, Michigan's banner year*

than Michigan, which makes about a quarter of the total quantity produced in the United States. Even including the cane sugar of Louisiana, Michigan is the third producer in the Union, and cane sugar is rapidly losing in importance the world over. In 1854 there were but 182,000 tons of beet sugar produced in the world. In 1904-5, of a total world-production of nine and a half million tons of sugar, five million were made from beets. Michigan built her first sugar factory in 1897. In 1903 she produced 57,064 tons of beet sugar in twenty factories; in 1904, 46,659. All the world has benefitted by the substitution of the beet for cane as a source of sugar, as it has reduced the price to one-half that formerly paid. The mitigating effect of the Lakes makes Michigan favored territory for the beet, from the sensitiveness of the plant to the frost. A mean summer temperature of 70° seems to be about what it demands. California has its climate tempered by the winds that prevail from the Pacific. It may be that the western counties along Lake Michigan would prove as favorable to this cultivation as the Saginaw Valley.

AGRICULTURE

The dominant geographic note that appears in all the following diagrams, as in those of fruit, is their strict limitation to the southern two-thirds of the area. We see here a result of the twofold geography described in the earliest pages of these Materials. Nevertheless, Wisconsin, southern Michigan and southwest Ontario are great agricultural regions. Not quite a quarter of the states of the Union excel ours in the total value of their agricultural products. Most of these have their whole extent available for farming.

Fig. 37 gives the relative values of our main farm pro-

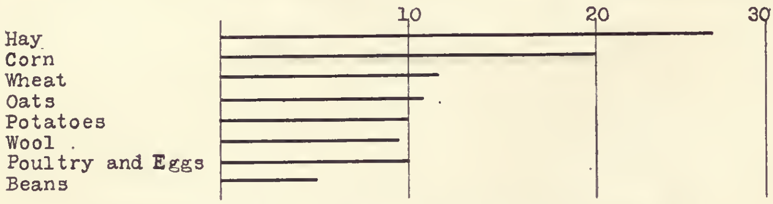


FIG. 37. *Value of Michigan farm products, millions of dollars, 1903*

ducts. Fruits, it will be remembered, amount to ten millions more and milk and meat to other large items of which the

FIG. 38. *Corn in 1902. Darkest shade, 3200 bushels to 1 square mile, then 640 and 64 bushels*

value cannot be ascertained. Beans are produced here in greater quantity than anywhere in the country. The peppermint produced from some of the western bogs is of very moderate total value.

Perhaps the most instructive of the distributive diagrams is that for corn, Fig. 38, in respect to the sharp limits to the agricultural country on the north. The sensitiveness of the corn to sunshine seems to account for the fairly even east and

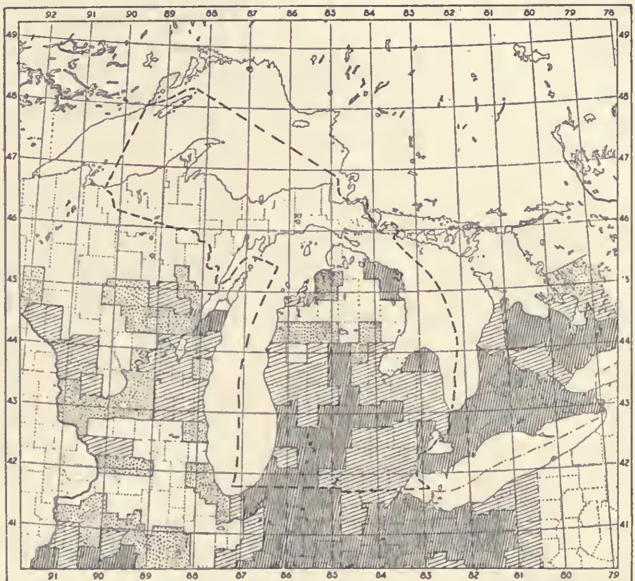


FIG. 39. *Wheat in 1902. Darkest shade, 640 bushels to ~~an acre~~ Sq mile, then 160 and 64 bushels*

west lines that separate the grades of production roughly along the 42nd and 44th parallels of latitude. The wheat crop, Fig. 39, is much more scattered as well as much less important. Here Ontario is seen to excel American territory, latitude for latitude as well as in its oat crop, Fig. 42.

Figs. 35 to 46 are original diagrams made on the basis of farm and agricultural statistics published by Ontario, Michigan, Ohio, Indiana and Illinois for 1902-3. New York, Minnesota and Pennsylvania appear to publish no such data and Michigan has suspended their publication with the year 1902-3. All similar diagrams in the current text-books are copies of diagrams taken from the Statistical Atlas of the U. S. Census. Most of these date from the year 1890 and the rest, though often dishonestly supplied with later dates, from 1900, and will until about 1912. None of them include Canadian data.

Michigan's wheat crop has fallen off steadily since 1880, if we make exception of single, unusual years. The acreage in wheat in the state in 1903 was little more than half that of

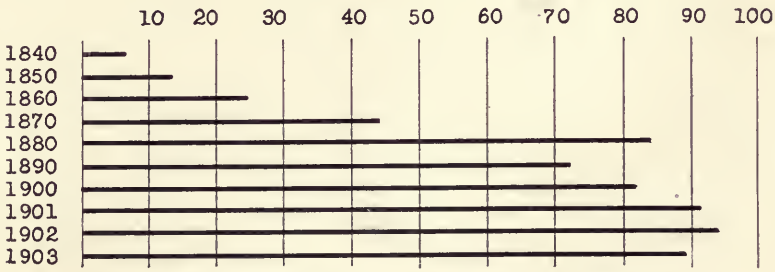


FIG 40. *Michigan Cereals (wheat, oats and corn), millions of bushels*

1880. This falling off is very likely the cause of the rather irregular distribution of the crop with us. In that case Ontario is not having the same experience, as the yield there is more evenly distributed. How much of this falling off is due to diversion of interest, to fruit and stock raising, how much to the development of manufacturing industries is a subject of inquiry for agriculturist and economist rather than for the geographer. It is not due to a falling off in the pop-

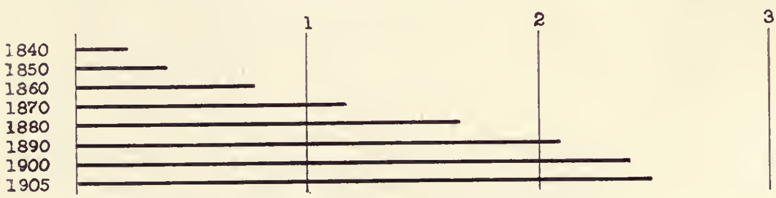


FIG. 41. *Population Michigan in millions since 1840*

ulation. The great cereals, corn, wheat and oats are still produced in quantities roughly corresponding to the density of the population. There seems good geographic ground for expecting that considerable crops of grain will always be produced here. The market is near, means of transportation good, and much soil seems entirely suitable with proper methods of agriculture. The demand for grain is permanent and bound to increase. Fig. 40 illustrates the combined crops of corn, wheat and oats since the state was settled. Fig. 41 shows for the same period the number of citizens that produced the crops. Except for the year 1880, there is much similarity between the two diagrams; 1880 may have been an unusually

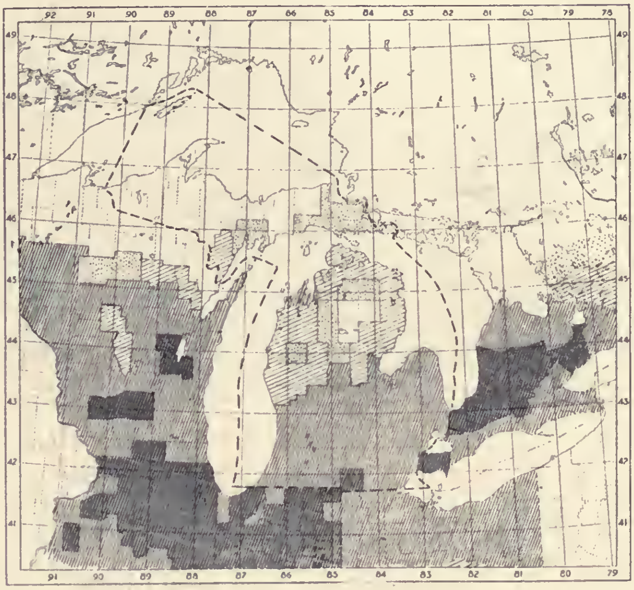


Fig. 42. *Oats in 1902. Darkest shade is 3200 bushels to a square mile, then 640, 160 and 64 bushels*

favorable year and 1903 an unfavorable one. All such data collected and compiled for the single year of the census are liable to such accidental influences on their values that make them not wholly suitable to use. An average value for each ten years would be much preferable. Yet it is clear enough from the figures that there has been little increase of cereal crops within Michigan territory for many years. Ontario is as notable for its oat crop, Fig. 42, as northern Illinois. One wonders if the frequent derivation of its citizens from Scotland has influenced this crop.

Potatoes, Fig. 43, are widely grown, none the less probably because they enter so directly into the food of all the peo-

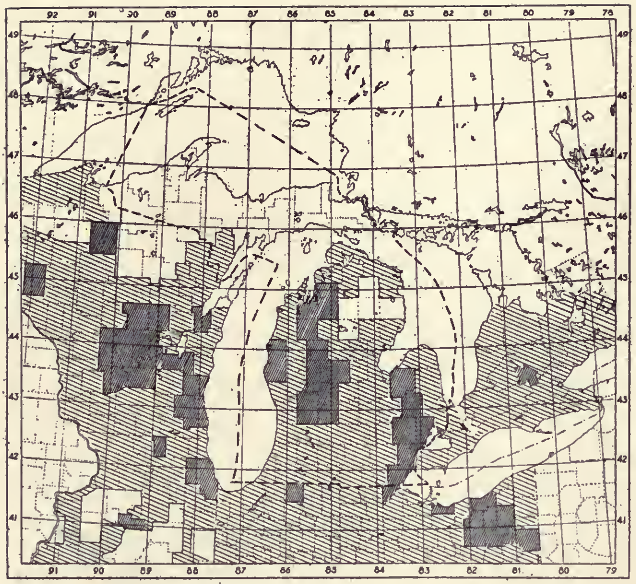


FIG. 43. *Potatoes in 1902. Darkest shade, 500 bushels to a square mile, then 100*

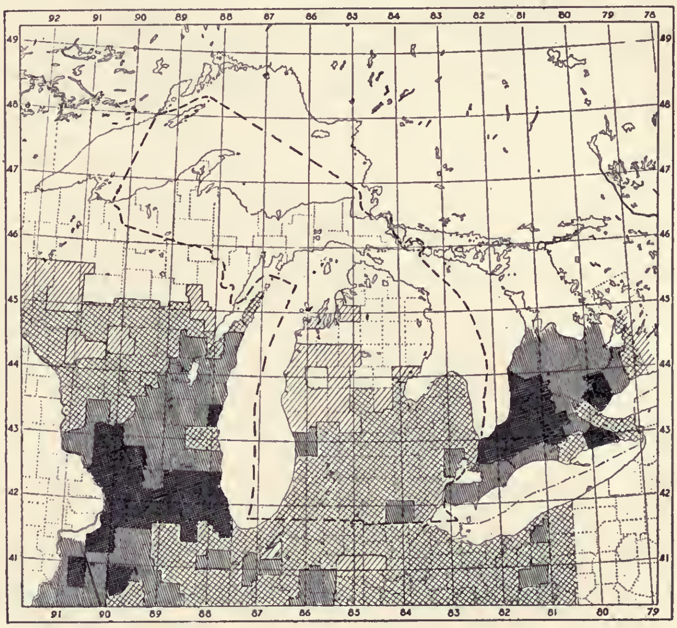


FIG. 44. *Cattle in 1902. Darkest shade is 75 to a square mile, then 50, 25 and 10*

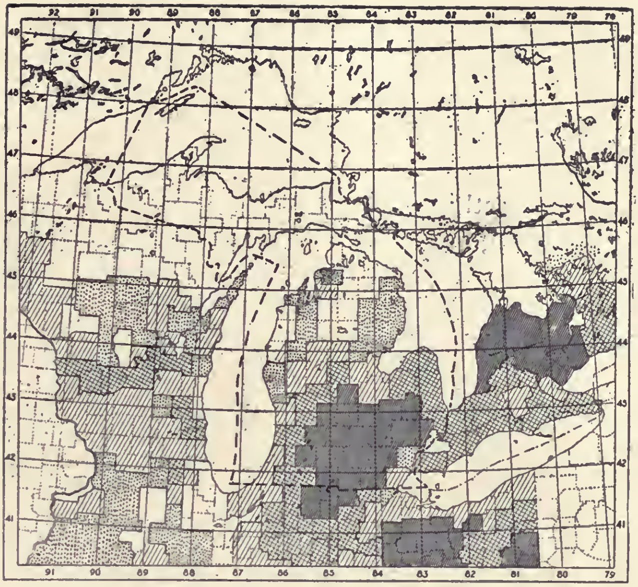


FIG. 45. *Sheep in 1902. Darkest shade 50 to a square mile, then 25 and 10*

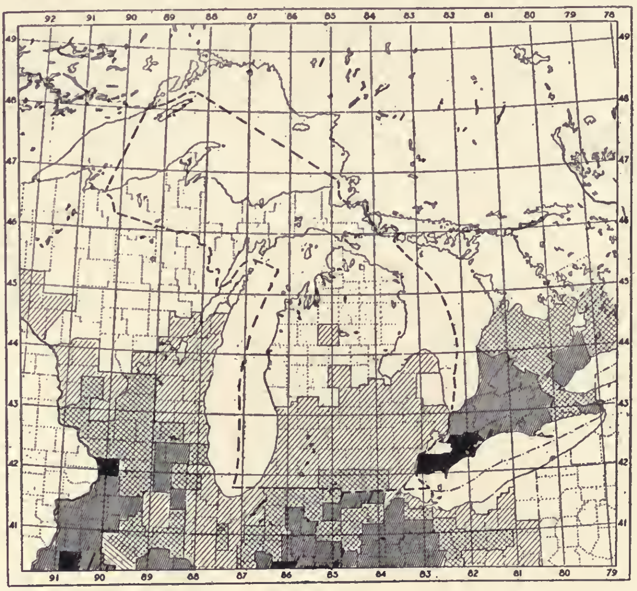


FIG. 46. *Swine in 1902. Darkest shade 100 to a square mile, then 50 and 25*

ple that an effort is likely to be made to supply at least home demands on every farm. The best potato yield seems to occur well to the north of the regions favored by grain.

Cattle, sheep and hogs, Figs. 44, 45 and 46, are raised about where the cereals are cultivated. Ontario is seen to be as successful in stock raising as in raising cereals. There seems to be distinctly more sheep raising on the uplands of Ontario, of Michigan south of Saginaw Bay, and of Ohio south of Lake Erie. Perhaps there will be a future development of this industry in the other uplands, in Michigan southwest of Grand Traverse Bay and of northern Wisconsin.

The foregoing should be regarded as a review, not of agriculture in this region, but of the geographic distribution of its great agricultural staples. They with the kindred lumber crop of the northern country represent an annual value of from 150 to 175 million dollars, now and probably always the main natural productions of the state and the basis of industries that create the still larger manufactured values.

IV.

FORESTS

When Michigan was first settled it was covered by a superb growth of hardwood in the southern three or four tiers of counties, broken only by lakes and occasional openings, while northward from this line and across Ontario and Wisconsin stretched the finest forests of pine and mixed pine and hardwood on the continent. There were splendid trees, hemlocks twelve feet around and white pines thirteen to fifteen about, three feet above the ground and rearing their summits sometimes 150 feet in the air. Great groves of solid pine or mingled growth of elm, maple, sycamore, poplar and hemlock darkening the soil beneath and keeping it free from undergrowth, alternated here and there with dense wet growths of tamarack and cedar, the forest dark but passable, the swamps light but trackless, like the occasional windfalls marking the passing of storm winds that were fortunately rare, but each one recorded in an overthrown part of the forest. Of this great forest the pine is mostly gone. Probably the Ward estate in northwestern Crawford county has the only untouched pine wood in the southern peninsula. Of mixed growth, culled over for the little pine it once contained, there can be few areas in the lower peninsula finer than the forests of southern Cheboygan, eastern Otsego and western Montmorency counties. Lumbering began at Port Huron in 1833. The output of St. Clair county for that year was four million feet. The industry crept along the shore into Saginaw Bay to the Saginaw Valley that was long the seat of an enormous lumbering activity. In 1888, the great year of the business, Michigan produced nearly four billion three hundred million

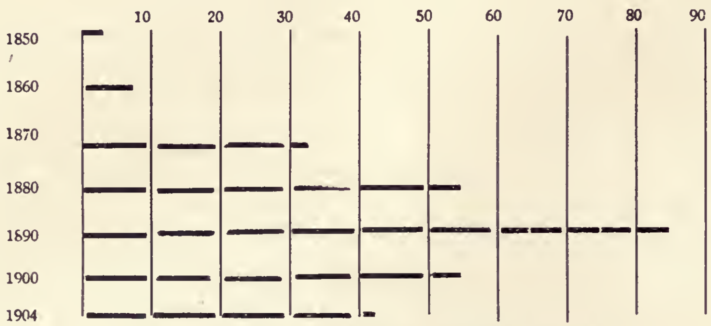


FIG. 47. *Lumber cut in Michigan, millions of dollars*

feet of lumber, in large part white pine. Since that time the product has steadily diminished as the forests have vanished before the lumberman's axe. In 1904, over one billion six hundred million feet were cut, but of this three-quarters was hemlock and hardwood. This product is estimated to be worth fifty-four million dollars, but a portion of this value has been given in the various processes of sawing, planing and finishing the logs into manufactured lumber. Since 1884, more than fifty-six billion feet of lumber have been made in the state, and thirty-six billion shingles. A better conception of the meaning of these numbers will be had when we think that Michigan is said to consume two billion feet of lumber a year at present. Vast as the cut has been, Michigan is still second only to Wisconsin in this industry. The timber diagram attempts to show where well informed men believe there is now in 1905 the best standing timber in the Great Lake region. It is only an estimate. No forest survey has been made, except for Wisconsin. The black areas in Ontario and Roscommon and Crawford counties, Michigan, are forest reserves, where old trees are preserved or new plantations attempted. Comparison with the diagrams of population and farm products shows how widely in the north forests take the place of the southern farms. In Ontario, the complete removal of forests in the lake peninsula corresponds well with the large farm returns from the same district, while the dense forests towards Hudson Bay are in the same region

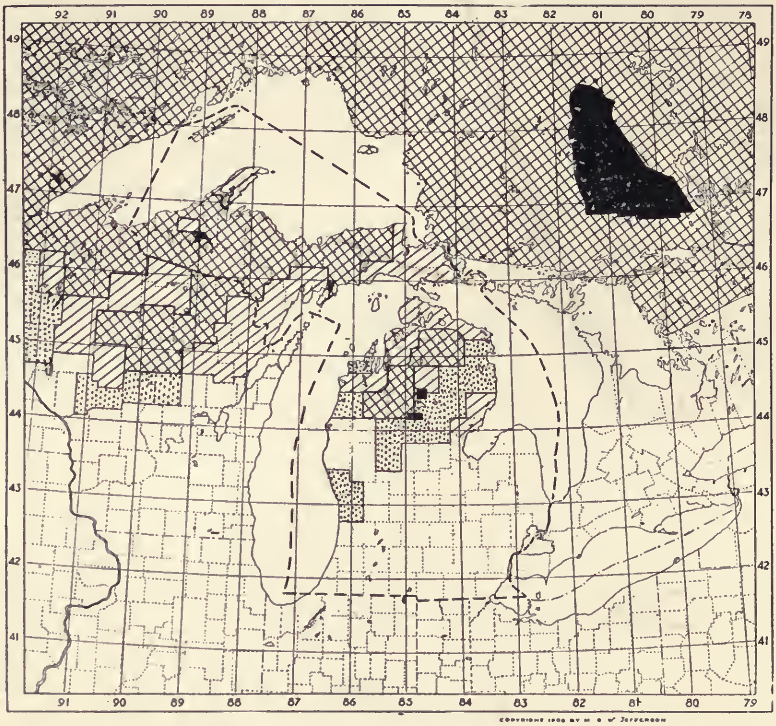


FIG. 48. *Standing timber in 1905. Cross lined areas have much good lumber, single lined and dotted areas have less and less. Forest reserves in black. Not based on any survey, but the estimate of competent men*

where population and agriculture are alike wanting. The lumber diagram shows where the lumber of 1904 has been manufactured. The reports being from sawmills, the lumber is often reported a long way down stream from the forests where it grew, as along the Mississippi river down which the logs were rafted as far as Rock Island, Illinois. All show clearly the transference of the great undertakings of the Great

Lake country from the lower peninsula of Michigan to Georgian Bay and Wisconsin. It is readily understood that unimproved lands predominate in the north, often more than 90 per cent of all the area. It is beginning to be realized now

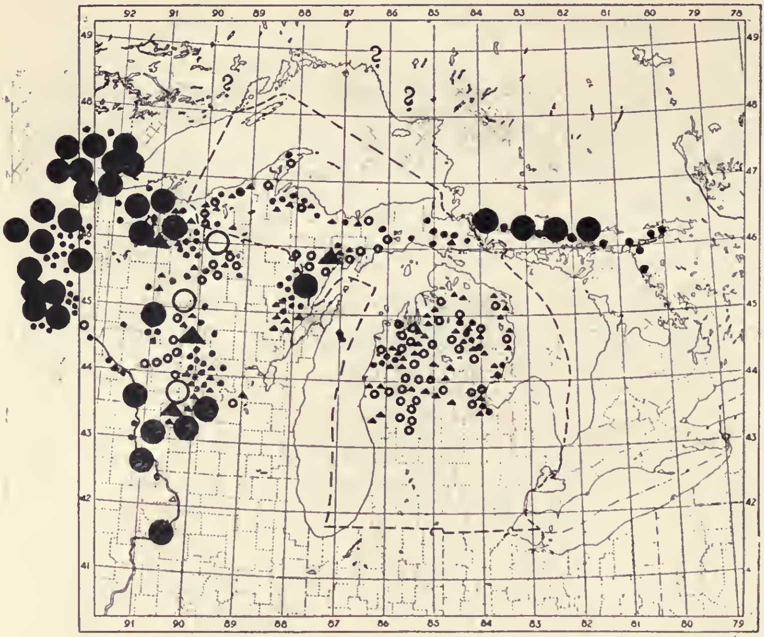


FIG. 49. *Lumber made in 1905, Solid circles are Pine, open circles Hardwood, and triangles Hemlock. Large marks indicate a hundred million feet each, small ones ten million feet. Data from American Lumberman, Jan. 21, 1904*

that much of this land ought to remain unimproved here as in the older states and in Europe, that it is not good farm land, while it will yield a continuous crop of timber for all time if protected from fire and trespass and cut over as the timber matures, without waste.

Of delinquent tax lands, the state has some six million acres left on its hands, much of it thin, sandy soil where pine grew, where fire followed the lumberman and where agriculture will never yield a crop of such value as the lumber that may be grown on it. It is three townships of this land that have been set aside under the protection of the state Forestry

Commission as the state's first forest reserve. Ontario's liberal reserve will be noticed.

MINERAL PRODUCTS OF MICHIGAN

In 1903 Michigan's mines yielded a value of fifty-six million dollars, much the greater part of which consisted of iron and copper.

One-tenth of the world's iron ore and one-sixth of the

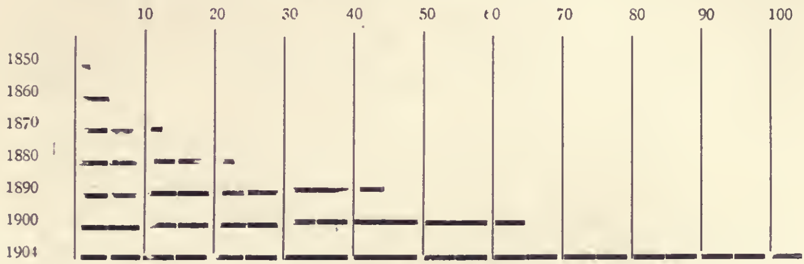


FIG. 50. *Copper mined in Michigan, thousands of tons*

world's copper was produced that year in this state; ten million tons of iron ore, worth over twenty-five million dollars, and ninety-six thousand tons of copper, valued at another twenty-five millions. Both minerals come from the Hard Rocks of the northern region, where mining is the predominant industry. The copper comes from the Keweenaw peninsula that projects into Lake Superior near the middle of its southern coast. The so-called Copper Range is easily recognized here on the relief map.

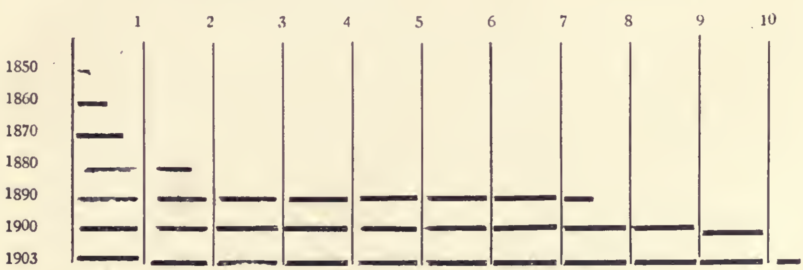


FIG. 51. *Iron ore mined in Michigan, millions of tons*

The iron is mined a little further south toward the Wisconsin boundary. Both metals are won in steadily increasing quantities. At the beginning of 1905, nearly $500,000,000 worth of copper and more than $200,000,000 worth of iron ore had been produced within the state. Up to 1887, Michigan was the leading producer of copper in the United States as also of iron ore up to 1902. Since those dates she is second to Montana in copper and Minnesota in iron, not that her own production shows any sign of falling off, but that of the other two states has had an enormous increase. Michigan has increased her copper output two and a half times since 1886, but Montana five times. So our state is mining twice as much iron as she did ten years ago, but Minnesota ten times as much.

The Minnesota ranges also belong to the hard rocks of the northern Lake region, west of Lake Superior. The deposits have the advantage of lying near the surface in great dirt-like beds, so soft that it can be taken out by steam shovels directly into railroad cars as soon as the surface gravels are taken off. Such mining goes faster and is much cheaper than the usual process of constructing deep shafts and blasting out hard ore. There are still vast quantities of this soft ore in the Minnesota ranges, but the quality is not equal to that of Michigan ore. The ten million tons of Michigan ore taken out in 1903 were valued at over twenty-five million dollars, while the fifteen million tons of Minnesota ore were worth less than twenty-seven million dollars. Copper and iron centers are all shown on the diagram of mineral resources as well as the lines over which the iron ores are sent to the coal fields of Pennsylvania, where coal and limestone are at hand to smelt it. The whole product passes through the canals about the rapids at Sault Ste. Marie and down the lakes to Erie ports in lanes as well defined as a path upon land. Commonly enough in the season one may see these vessels stretching out in a long line to the horizon where patches of smoke indicate that still others are beyond. The shipping ports, Duluth, Two Harbors, Superior, Ashland, Marquette and Escanaba have developed great facilities for handling this commodity. The ore is stored in great cribs along the dock, from which it falls by its own weight to the steamers below. These are built especially to carry ore, and are of a type of their own, quite unlike the ocean steamers that carry all sorts of cargo. Figure 53 shows this well. The engines are well back in the stern, leaving the middle of the vessel clear free for the ore that is poured in through long

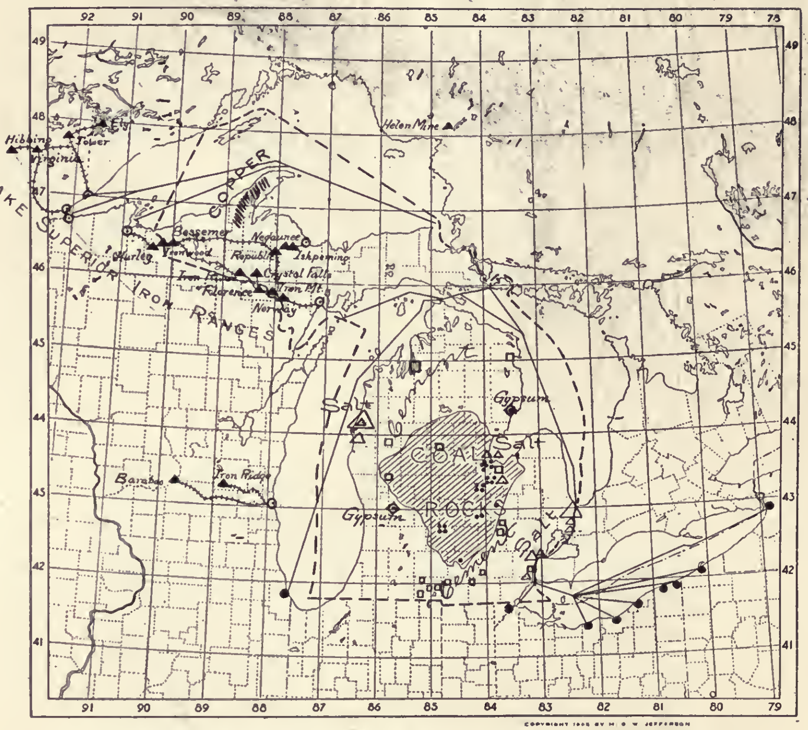


FIG. 52. *Minerals in the Lake country 1904 Solid triangles show iron mining points, solid circles smelting cities. Dots in circles are principal shipping points. Open triangles show salt production, and size indicates importance. The large dots in the coal rocks are active mines. Gypsum and cement are indicated by name where they occur*

rows of hatches into the hull of the ship which is quite without the many room-like subdivisions of ocean steamers. This enables great scoops, operated by steam, to take out the cargo almost as rapidly as they were loaded. Anyone who will figure it out how many loads for a 5000-ton vessel there are in the twenty-five million tons of Lake Superior ore, will have a better idea of the commercial activity of the lakes, especially when he adds mentally some thought of the movement of grain and lumber. Of course the ores might be carried by rail, but at greatly increased cost and the presence of the great Lakes between the coal fields of Pennsylvania and the

FIG. 53. *Lake Steamer—St. Clair River, May, 1902*

iron deposits of the northern lakes is a vast advantage to the people of this country, who use immense quantities of iron and make a use of copper that is rapidly increasing with the increasing use of electricity.

The last ten years have seen a cement industry spring up in Michigan in which the state is already third among the United States and the business grows rapidly. Nearly three million dollars' worth was made in 1903, not a little of which went into the construction of admirable walks in many a Michigan town and village. The uses of cement have multiplied of late years, especially in bridge and building construc-

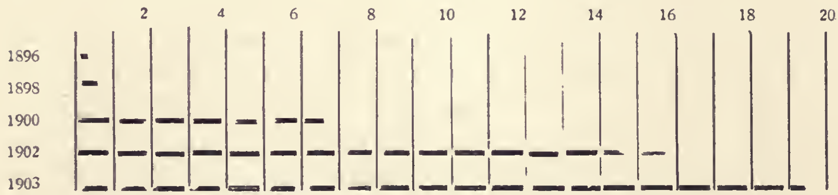


Fig. 54. *Cement made in Michigan, hundreds of thousands of barrels*

tion. There are materials in the marls of the countless lakelets and in the extensive limestone deposits of the state for a great future output, and the market is increasing.

Salt was recognized here from the earliest times. When the state was admitted to the Union in 1837, seventy-two sections of salt spring land were granted to the new state from the National land, providing that they were selected before 1840. The selection of these lands and the study of their possibilities was the first undertaking of Douglas Houghton, the first state geologist. This remarkable man recognized all the chief mineral resources of the state and pointed out the lines for their development. In almost every case, experience has proved the wisdom of his plans. The salt springs have

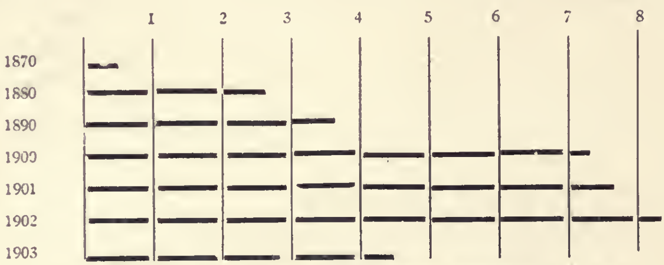


Fig. 55. *Salt manufactured in Michigan, millions of barrels*

their origin in the layers of salt among the rocks that underlie the state. The rainwater, percolating through the soil and rocks, dissolves the salt and brings it to the surface in occasional springs. The process of manufacturing the salt is mainly one of getting rid of the water again from brine pumped up from wells and the great item of expense that of the fuel needed to evaporate it. For many years Michigan led the country in this industry, but since 1902 she has been second to New York. The business has here been growing less and less profitable to the manufacturers, being now regarded as hardly more than an inexpensive way of disposing of the waste wood or lumber mills. In 1903 the product fell off from eight to four million barrels and the lead in the business went from the Saginaw Valley to Ludington and Manistee on Lake Michigan. It is significant that the decline in the business of salt manufacturing has closely followed the decline of lumbering, just as the salt block and the lumber mill have been associated in their activities. While the decline in price has diminished the profits to the manufacturers, the people are getting salt for 26 cents a barrel that cost them three dollars in 1840. If a mine can be sunk 800 or 1000 feet, layers of clear rock salt will be reached that may be taken out without dissolving in water and the subsequent expensive evaporation. An attempt to do this is now being made near Detroit.

Coal is a product that is only moderately developed as yet. Michigan is the fifteenth state in the Union. But the industry is growing vigorously, and may be considered in some measure as a reaction of the Saginaw Valley against the decline in its lumbering activity. Up to 1895 barely 100,000 tons a year were mined. At present it is chiefly centered in Bay and Saginaw counties, but the coal rocks extend almost across the central part of the state, as seen on the diagram.

FIG. 56. *Coal mined in Michigan, hundreds of thousands of tons*

It is all soft or bituminous coal, lying in flat layers among the slates and sandstones. These coal layers are believed to be the remnant from marsh plants of which fossils abound in it. The product in 1903 was 1,367,000 tons worth $2,707,527. This is a million dollars more than was mined in any previous year.

Of gypsum, more is produced here than in any other state. In total value it is the least significant of our minerals, though rapidly increasing. It is quarried or mined at two points, near Grand Rapids and at Alabaster near Tawas City,

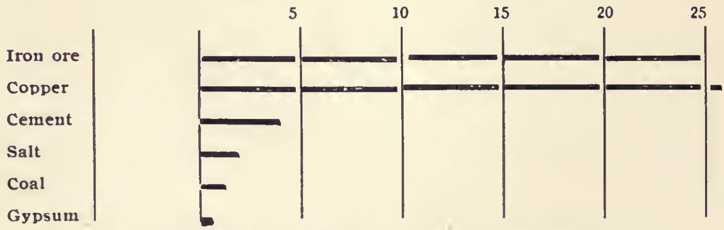


FIG. 57. *Value of Michigan mineral products, millions of dollars. 1903*

as the name indicates. Brick clays are widely distributed over the state.

Great as are these mineral resources, none of them come up to the value of the annual hay crop, twenty-seven million dollars, while the total agricultural product is much more than twice as great in value as the whole output of minerals. The lumber, too, even in these declining times, is worth more than the product of all the mines. The people of the state have a more general participation in its agriculture than in the mines, which are almost necessarily worked by companies using capital from many lands. It is said to be common enough among the Lake Superior copper miners to have holdings in the mines where they are employed, an advantageous arrangement, but not common in mining life. The greatest gain the mines bring to the people of the state is the one they share with all the people of the nation, the increased availability of these useful substances from increase in output and lowering of price.

MANUFACTURES

The manufactures of Michigan have depended largely on her product of lumber and minerals. Though the lumber is now rapidly declining, it still is the basis of the great industry of the state. Lumber and planing mill products were worth $55,000,000 in 1904. Based on the great iron mines is the foundry and machine shop output, in which we include Detroit's large business in stoves and furnaces, in all $37,000,000. Flouring mills in the state in the same period yielded a product worth $26,500,000, and copper smelting $21,000,000. Other great industries are the manufacture of carriages, wagons and automobiles, valued at $20,000,000. Detroit has seen the making of automobiles grow from nothing in 1900 to a sale of 9,000 machines in 1904, a third of the output of the whole country. Lansing and Grand Rapids also have active automobile industries. Lansing is reputed to make more automobiles than any other city of its size in the world. It is the home of the well-known Oldsmobile machine. It is said that Lansing has an automobile on its streets for every 150 inhabitants. The central position of the state, its abundant raw materials, and sufficient supply of skilled mechanics makes the future of the automobile industry in Michigan look very promising.

An application of the state's lumber product is in furniture making, in which the state is third in the Union. Grand Rapids is the great center in the state, formerly getting its hardwoods from the country around, but now going out of the state for much of it. The Grand Rapids product is very widely and favorably known for its quality. The furniture made in the state in 1904 was valued at $18,400,000.

Apart from the iron ores which go to Lake Erie and Pennsylvania, Michigan finishes much of her raw materials within her own borders. Her industries are well diversified. The four chief industries of Detroit in lumber, iron, chemicals, and vehicles produce among them barely a quarter of the whole manufacturing output of the city. There are then a great number of small establishments in many different branches of industry whose aggregate product is the bulk of the whole product. No state indeed produces and manufactures things more essential to modern life and modern civilization or a greater variety of them than Michigan. Grand Rapids produces more furniture than of any one other product, yet the aggregate of the other industries amounts to more than twice the value of the furniture. Furniture making may be the greatest one business in Grand Rapids, but it figured in 1900 for only seven and one-half million dollars in a total manufactured product of nearly twenty-five millions.

Battle Creek makes a specialty of breakfast foods, but in a total manufactured product of $12,000,000 they represented but $5,000,000.

Saginaw and Bay City have been at one time more nearly dependent on a single industry—lumbering. They grew phenominally from 1880 to 1890, through the culminating period of that business. In the next decade they barely held their own. Yet the great developments of coal mining and beet sugar manufacturing have done much to make up for the decline of lumbering and are ample proofs of the vitality of the Saginaw Valley. Both cities are now growing again on a basis of prosperity more solid than ever before because more varied. Manufacturing is city business. Three-quarters of the manufactures of the country are made in cities and towns. In Michigan population is well distributed through the area and so is manufacturing industry. The output is greatest in the south where cities and towns are more numerous. Detroit is the greatest producer, Grand Rapids second, followed by Kalamazoo and Battle Creek, but all four together produce only $185,000,000 of a total for the state of $429,000,000, considerably less than half. How different from Chicago which makes three-quarters of the goods manufactured in Illinois!

The six chief manufacturing states of the country are New York, Pennsylvania, Illinois, Massachusetts, Ohio and New Jersey, after which comes a group of five states differing little among themselves. Of these five Michigan is one. In almost every one of the six leading states more or less specialized industries are found centered in huge groups of population like that at the mouth of the Hudson, which gives

New York and New Jersey their leading position. The distribution of Michigan industry through the state may pass with time, but it is an advantage to the people of the state while it lasts, for it allows the numerous people who seek industrial employment to find it in small communities that are large enough to offer social opportunities and small enough to make possible a style of life and a freedom that is denied to many of those who dwell in large cities. The last ten years of the nineteenth century saw a distinct tendency all over the United States for industries to grow more away from the larger cities than in the preceding decades. As Michigan is wholly young in history and development she may never see her people concentrated in cities that contain a large part of all her people.

V.

COMMERCE OF THE GREAT LAKES

The commerce of the Great Lakes has now reached very great proportions. It is mostly grain from the head of Lake Superior or Chicago for Buffalo, lumber and iron from Lake Superior to Lake Erie ports from which much smaller return shipments of coal are made. The routes are all marked on the diagram of mineral resources. They are unlike ocean lines of travel in all following the length of the lakes. Travel here is more along than across. The single exception is the railroad ferry across Lake Michigan between Milwaukee and Ludington, the only service on the lakes that is maintained all the year around. This is operated by the railroads as a part of their lines between Wisconsin and the east.

The water route of the lakes offers cheap carriage of goods from the producing west to eastern markets. Minnesota and Dakota grain and Lake Superior iron ores have been rendered immensely more available by the opening up of the passages between the lower lakes and Lake Superior. In 1895 a ton of iron ore was carried from Duluth to Cleveland by lake for 80 cents. The lowest freight by rail was $2.59. The ore itself was only worth on the dock at Cleveland $2.80 Everyone that uses iron is a gainer by lake transportation.

The surface of Lake Superior is 18 feet higher than Lake Huron and Lake Michigan. This fall of 18 feet in the St. Mary's River causes the rapids called in French *Sault* (leap or fall) *Ste. Marie*. Here the early missionary explorers had to land to carry their canoes around the rapids. Here they naturally encamped and here grew up a fort and trading station of much importance. Great canals have been built on each bank passing around the rapids and provided with locks to enable vessels to overcome the difference in level. One of these locks is shown in the picture (Fig. 58). It is a part

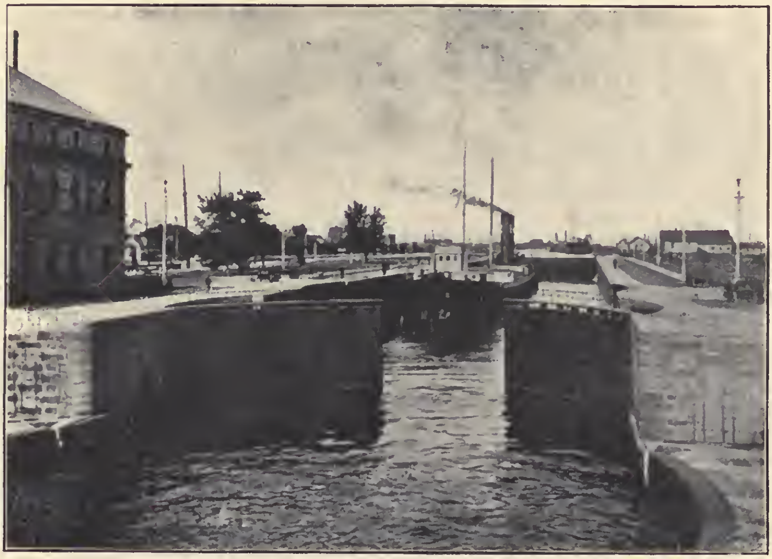
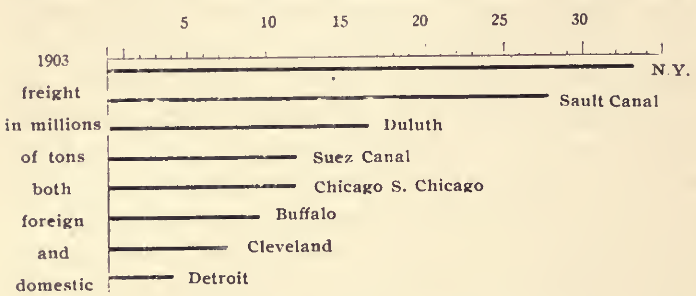


FIG. 58. *The American Locks at the Sault Ste Marie. The ship has come from Lake Superior as now she has come down to the level of the river below the rapids, the gates are being opened to let her proceed southward*

of the canal 800 feet long and 100 feet wide, fitted with strong water-tight gates at each end. The upper gates are now closed and the boats above it float as always at the level of Lake Superior. The gates below are just opening to let out the steamer. When they are wide open the gates will fold back into the hollows seen in the side of the canal, quite out of the way. Half an hour ago the lower gates were shut and the upper ones open. At that time, of course, the water on which the steamer floats in the lock was as high as in the canal above and in Lake Superior. The steamer entered the lock and the upper gates were closed behind her. The engineers in the building at the left then opened valves in a great number of pipes in the bottom of the lock which allowed the water to run out into the part of the canal below. The steamer was gently lowered on the surface of the sinking water until the level of the lower reach of the canal was attained. As soon as the gates are wide open the vessel will steam off for Lake Huron or Lake Michigan, some other waiting ship will enter the lock, the lower gates will be closed, the water allowed to enter gently from above through pipes in the floor, until the ship is lifted by the rising water to the upper level. Then the upper gates will be opened and the ship will pass on to Lake Superior. Two such locks in the American canal and another on the Canadian side have been constructed at an expense of six and four million dollars respectively.

During the nine months of navigation there is an immense activity at these locks. In 1904 there were carried eastward on these waters between American ports 130,000,000 bushels of grain, 21,000,000 tons of iron ore, 1,770,000,000 feet of lumber, and 1,000,000 tons of flour; and westward, 14,000,000 tons of coal. This is estimated to amount to fifty-one million tons of freight, of which thirty-one million and a half passed through the Sault canals. This is not very different from the foreign and domestic trade of the great port of New York and three times greater than the tonnage that passes through the



Suez canal. The figures apply only to the *bulk* of the goods; coal, iron and grain are all bulky commodities and of little cost. Imports to this country from abroad include many materials like silk, coffee, tea and spice, the value of which by the ton would be enormous. Thus the New York freight is three or four times as valuable as all that passes along the lakes. The same thing is true of the Suez canal. Think of a shipload of tea. Can you reckon the value of 5,000 tons of tea? The charge that the owners of the Suez canal make for the passing of steamers is itself about two dollars a ton. The canals at the Sault are free to all. The money expended on them represents but a small part of the outlay of the government on navigation on the Lakes. The United States, and in much smaller degree also Canada, has been constantly occupied for many years deepening connecting channels, constructing harbors of refuge, mapping the lakes and rivers and marking the safe passages by buoys in the water and lighthouses and range-marks ashore. The harbor building that has been done by the national government on the Great Lakes is a vast work in itself. Except on Lake Superior the American shores of the Lakes are mostly of sands that work along shore incessantly in wind-driven currents. Where the wind gets hold of such sands, dunes are built, as described at pages 23 and 24. The harbors on these sandy shores are mostly river mouths where land waters have always maintained an uncertain channel across the beach, rarely more than five or six feet deep at the most favorable seasons and liable to constant changes of place and depth with the continuous shifting of the sands. The general plan of improvement at these river mouths has been similar to that used in the Eads Jetties at the Mississippi mouth, which confine the waters of one of the river mouths between narrowing walls and cause the current to scour out its own bed. So on the Lakes, piers have been built on each side of the natural stream entrances at a moderate distance apart and extending well out from the shore line, as shown in the picture. This always improved the entrance, but a difficulty not found at the mouth of the Mississippi exists in the Lakes in the shallowness of their waters. The piers across the beach compel the streaming shore sands to go out around their ends, soon shallowing the water there. In the deep waters of the Gulf of Mexico this is an immensely slow process, but on the Lakes a few years suffice to fill up the angles on either side of the piers and shallow its entrance with a bar. The obvious remedy has been applied of extending the piers further into the Lake and many of them have now become so long as to involve heavy expense for repairs, the material being invariably wooden piling. Sheboygan, Wis., has piers that extend 2500 feet beyond the shore line, Menominee 2150, St. Joseph 2040, Milwaukee 1650 and Muskegon 1550. The relief afforded,

FIG. 60. *Piers of Kincardine Harbor, Ontario, looking out.*

moreover, is only temporary. Dredging had finally to be resorted to and if continuously applied is an effective remedy. Dredging is further necessitated by the demands of modern navigation for channels eighteen to twenty feet deep, which are not attainable by the unaided scour of any streams that flow into the lakes. Besides improving a large number of harbors of the sort, the national government has undertaken even greater works in some of the connecting rivers, in the Sault canal, the channels leading thence to Lake Huron and in the St. Clair and Detroit rivers. A continuous channel of twenty feet depth is in process of construction throughout the course, from Buffalo to Duluth. A most difficult part of this work is the excavation of the bed rock that underlies the Detroit river at the Limekiln Crossing near Amherstburg, where drilling, blasting and removal of fragments has been going on for many years. The maintenance of the desired depth at this point is rendered more difficult by the oscillation of Lake Erie in the wind. An east wind raises the water at the mouth of the Detroit river and lowers it at Buffalo and the much commoner west winds produce the opposite effects. Thus the violent west wind of Nov. 21, 1900, raised the lake at Buffalo over seven feet and lowered it at the Limekilns nearly three. At such times a number of north-bound freighters may usually be seen tied up below Amherstburg waiting for depth of water sufficient to let them pass the Limekilns. An automatic gage at this point indicates day and night the depth on the crossing in feet and tenths of feet. An important part of the government's activity on the lakes has resulted in the preparation of admirable charts of all the shores and waterways.*

With all this activity of the United States, it remains a dangerous navigation. No day in the lake voyage is free from that greatest of all sea hazards, the approach to land, which threatens ocean ships only at the end and beginning of a voyage. On the lakes the land is rarely out of sight and for hundreds of miles navigation is within a few rods or even feet of dangers that menace the safety of the ship.

Over the deeper, colder waters fogs are frequent as a result of the chilling of the moisture laden air below its dew-point. This, of course, happens oftenest on Lake Superior. The U. S. Weather Bureau has pointed out that fogs are less usual on the southern route from the Sault to Duluth, that crosses Keweenaw peninsula by the passages and canal at Portage Entry, in warmer waters. This route is, however, little used, perhaps from the added danger of coming nearer land. At the west end of Lake Superior lurks yet a greater danger in the great and irregular attraction of the country rocks for the needle of the compass.

It has been well known since the first voyage of Columbus that the compass needle does not in most parts of the world point to the true north. An accurate map of the variation of

* The admirable colored maps of the separate lakes deserve to be in every Michigan schoolroom. They may be obtained at the Lake Survey office, Campau Building, Detroit, for 15 cents each.

the compass for the lakes has recently been prepared by the Lake Survey and is here reproduced. All places through

FIG 61 *Lines of equal magnetic variation for 1905 giving the number of degrees that the compass points east and west of true north by the solid lines and the change in this variation per year by the dotted line, west variation increasing, east diminishing*

which passes the heavy line numbered 0° have no variation, i. e. the compass at those places does point to the north. At a point like Chicago on the line marked 3° e. the compass points three degrees east of north, and so of other places on the map. The broken lines indicate the number of minutes by which the variation is changing per year, westerly variation increasing and easterly variation diminishing. Thus at Sault Ste. Marie where the variation was in 1905 4° west, the annual change is 6 minutes which by 1915 will have amounted to another degree. The variation will be then 5° west. At some localities near the Lake Superior coast of Minnesota variations are as great as 26° east and within *650 feet* change to 6° east. This cannot be shown on a map and, of course, is only noted very near shore. Along such a shore the compass cannot be relied upon.

It is possible for vessels drawing less than fourteen feet of water to pass from the lakes to the St. Lawrence and Europe by making use of the Welland canal around Niagara through Canadian territory. The passages both in the canal and the river are narrow, difficult and dangerous and accidents are so common that insurance for ships going over this route is very high and the traffic does not pay. The small size of the vessels that can be used in it is another difficulty. The largest ships that can pass the Welland canal are of about 3,000 tons, and a 3,000 ton ship can never carry goods so cheaply as the great ships built for the ocean freight, some of which are now of 23,000 tons.

But it is perfectly feasible to deepen the Welland canal and the channel of the St. Lawrence so that the largest vessels can pass. If that is ever done the lake ports will be put in direct communication with the sea, at least in the open season. The dangers of this long course of inland navigation must always, however, far exceed those of the open ocean. Perhaps this extra hazard will always offset the cost of an extra handling involved in shipments of western goods from Atlantic ports.

Great as the carriage of Michigan lumber and iron on the lakes is, most of the lake-carried goods move between points beyond the territory of the state. But the existence of this vast and ceaseless traffic gives the state facilities of transportation that encourage the growth of her industries and she shares with her sister states in the development and cheapening of these great natural resources for feeding and housing the people of the land.

LAKE NAVIGATION IN WINTER

Through navigation on the Great Lakes is usually suspended in January, February and March, on account of ice in the connecting rivers. Probably none of the lakes freeze over solid, but the bays do and St. Mary's river at the Sault is generally crossed on foot in January and February over the ice. Put-in Bay and Kelley's Island in Lake Erie usually have team connection with the Ohio shore for a longer or shorter period in February and so does Mackinac Island with St. Ignace.

Communication between St. Ignace and Mackinaw City is kept up by train ferries through the winter across the Straits

FIG. 62. *A Lake Michigan car ferry battling with the ice*

of Mackinac. Detroit and Port Huron maintain a hardly interrupted service across the Detroit and St. Clair rivers by train and other ferries. Lake Michigan, too, is crossed throughout the year by powerful train ferries between Ludington, Frankfort, Grand Haven and Wisconsin ports, but passengers are not much carried by this route, the service being a good deal interrupted by the drifting of ice floes on the westerly winds against the Michigan shores, as shown in Fig. 62. For great fields of ice form along the shores in quiet weather, which are driven out into the lakes when the wind rises. At times these fields are so extensive that no open water can be seen from the shore. In the bays the ice remains firm most of the cold season. In Green Bay, Grand and Little Traverse Bays and Saginaw Bay the ice cover enables much fishing to be carried on through the ice. Shanties are built and little villages of the fishermen occupied on the ice all winter long. Occasionally these men stay too long in the spring and the warm south winds melt the shore ice and leave them drifting on a more or less rotten ice floe. Many lives are thus endangered every year and occasionally some are lost.

PEOPLING THE LAKE COUNTRY

Michigan is a part of the earliest addition to the territory of the original thirteen states. The region was known as the Territory northwest of the Ohio river. It was ceded by England in 1783 at the close of the Revolutionary war, but had been British ground barely twenty years. For this reason the old English place names that abound in New England are wholly absent here, their place being taken by French words. The French trails that crossed it in many directions between the St. Lawrence and the Gulf of Mexico were protected here and there by forts from the savage Indians who were the real inhabitants. Of Europeans there were barely 4,000 in the whole territory, between French and half-breeds. These were grouped in three settlements; one at Detroit, where a fort had been built by the French to keep the English in New York from ascending the lakes in the pursuit of the fur trade, in which they were serious rivals, and the other two at the Illinois towns near St. Louis and at Vincennes on the Wabash. The British had put an officer and a few troops in each of these posts at the close of the French and Indian war, in 1763, and from them fitted out foraging parties of Indians against the frontier settlements of Pennsylvania and Kentucky through the Revolution till Captain George Rogers Clark invaded the territory from Kentucky, capturing the Illinois towns and Vincennes in 1778-9. The Americans held them from that time on, but though the whole territory became American by treaty in 1783, the British were able to put off giving possession at Detroit till 1796 by reason of the distance from the principal seats of population of the young nation and its weakness. Congress planned to divide the territory into three

FIG 63. *The Northwest Territory. Heavy north and south lines divide it into three states as suggested by Congress. The heavy lines across through the foot of Lake Michigan the northern boundary suggested for those three states if two were made to the north*

states as indicated by the black lines on the map. Power was reserved, however, to make two or more states out of that part of the Territory north of an east and west line through the southern point of Lake Michigan, drawn heavy on our map. Had this division line been actually held to, Illinois and Indiana must have been left without frontage on Lake Michigan, and a glance at the map shows that, as the site of Chicago would have been withheld from the western state, so Ohio would have lost Toledo and the much-prized Maumee Bay, though this was not then certainly known, since such maps as existed at that time made the line pass well north of Toledo. It is not strange that the three southern states should have wanted to change the boundaries thus set for them when they came to seek admission to the Union. Ohio added a little on the north in her own constitution of 1802, but failed to get it specifically described anew by Congress, Indiana added rather more when she was admitted in 1816, and Illinois still more on her admission in 1818. The feeling was strong that Michigan had an enormous coast line from which she could easily spare a little to them. Yet their action was in plain violation of the Ordinance of 1787, laying out the original lines, as well as of subsequent acts of Congress. In 1837, when Michigan was seeking admission to statehood, the dispute over the boundary with Ohio led to much anxiety and the period of excitement exaggeratedly called the Toledo War.

The way in which little communities of men with organized local government spread over this region may be seen on Fig. 64. The counties colored darkest were organized before 1810. Of Michigan there was at that time only Wayne County. Of course that meant that governmental affairs for the whole region had to be transacted at Detroit, the only considerable settlement. By 1830 Chippewa and Mackinac were added and the counties adjoining Wayne. Between 1830 and 1850 the state was admitted to the Union and a considerable movement of people took place into the country between Detroit and the Saginaw Valley and the extraction of copper was begun in Houghton county. Can you see evidences of these things in the diagram? It was at this same period that Wisconsin, too, had its greatest expansion. In Ontario settlement was earlier but slower to spread. In the years from 1850 to 1870 people spread along the shores of the lower peninsula and iron in Marquette and lumber in Menominee began to be sought for actively. In 1890 there remained unorgan-

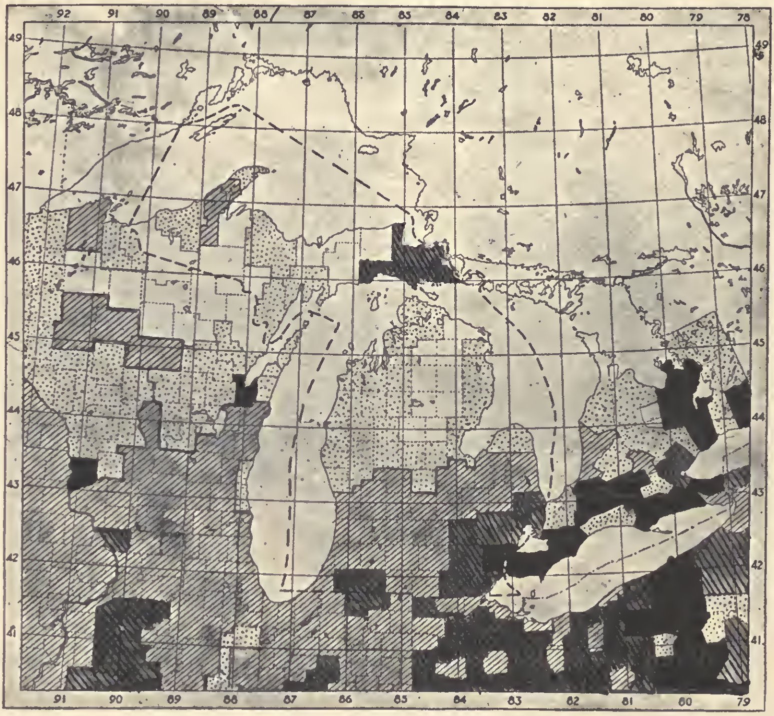


FIG. 64. *Date of organizing county government; black, organized before 1810, heavy lines before 1830, light lines before 1840, dotted before 1870.*

ized only Oscoda and Ogemaw in the lower peninsula and Iron in the upper. This was added in 1891, the last county in the state. North of Lake Superior and Georgian Bay Ontario has all its territory still governed as territorial districts.

Nearly a quarter of the people of Michigan were born in foreign countries, nearly half of them in some British territory and a quarter more in Germany. Six per cent of our people came from New York and two per cent each from Pennsylvania and Indiana. The distribution of population in the region in 1900 is shown on the map. (Fig. 65).

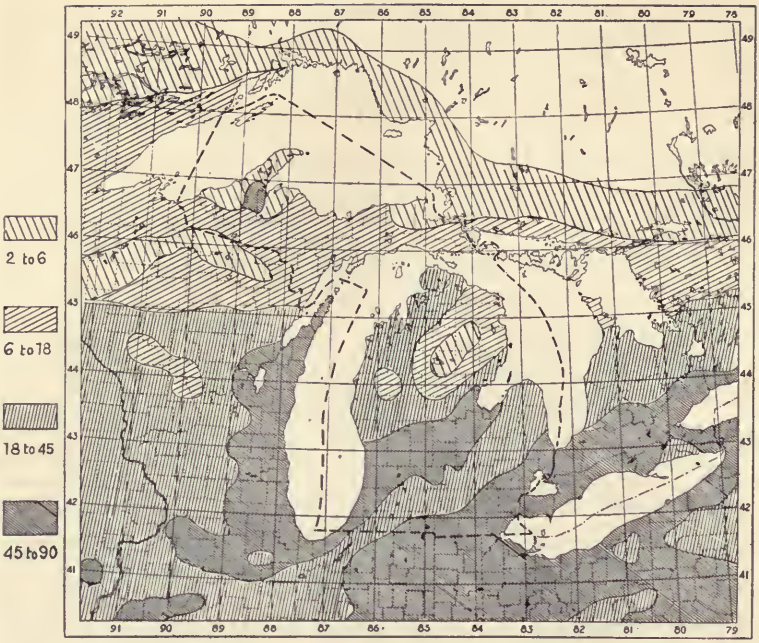


FIG. 65. *Population of the Lake Country in 1900. Scheme to left gives number of inhabitants to one square mile*

FISHERIES

When the white man first came to Michigan it is the testimony of all the early writers that the Great Lakes teemed with valuable food fish—whitefish, lake herring, lake trout and sturgeon. Brook trout abounded in the upper peninsula and in the coast streams of the lower peninsula from Mackinaw to Traverse City in Lake Michigan and to Rogers City on the Lake Huron shore. Grayling were common in streams still further south.

The excellence and abundance of the native fish is a frequent theme in early days. The store was indeed inexhaustible for the first thin population. Following Michigan's admission to statehood, however, settlers came steadily pouring in, and so in all the lake states. There has been no interruption to this growth of population from that day to this.

The ease of capture joined with the excellent quality and abundance of the fish exposed this resource of the lakes to heavy inroads. Before 1880 trout and grayling were driven from many streams by lumbering operations, the discharge of sawdust alone rendering many rivers unfit for fish and spoiling not a few fishing grounds on the Great Lakes themselves. Of the Great Lake fisheries in general they were getting "played out" in 1878. About the year 1850 the pound or trap net was introduced, a device consisting of a fence or wall-like net, reaching out from the shore sometimes two or three miles into the lakes, that intercepted the fish as they swam along parallel to the shore, guided them outward to a pound or trap whence they were lifted by the fisherman at his leisure. This proved the most destructive of fishing devices and has been held largely responsible for the rapid decline of the fisheries. The rough estimates available for the earlier years put the catch of 1830, seven years before Michigan became a state, at 8,000 barrels; of 1857, at 13,500 barrels; of 1857, at over 80,000 barrels, valued at $640,000. In 1885 the value of the catch had passed one and a half million dollars. The same thing was going on in the waters of other American states and of Canada. It has been well said that the commercial fish never had a chance. In 1878 the fishermen had to set their nets twenty, thirty and even forty miles from shore and not so good lifts were had even at those distances as were had a few years earlier five or ten miles from shore right in sight from city harbors. In 1842 the discovery was made in Europe that brook trout could be propagated artifically. Protection of the fry during their helpless stage of infancy made it possible to place in the streams a new generation vastly outnumbering those that nature reared. In 1873 the Michigan Fish Commission was created for the "propagation and cultivation of whitefish and such other kinds of the better class of food fishes as they may direct." They were given an appropriation of $7500 which has now increased to $33,000. They at once began their attempt to restock the lakes with whitefish, with the theory embodied in the following statement: In a state of nature from a thousand whitefish eggs not more than one survives; artificially 940 may be obtained. As one fish yields about 25,000 eggs, fish culture gives a whitefish 24,000 descendants where nature gives her 25. Already in 1874 a million and a half young whitefish were "planted," twelve and a half million in 1878, fifty million in 1886, a hundred million in 1890 and two hundred million in 1892. The results of this vast fish nursery were somewhat disappointing, yet in 1885 small whitefish were becoming abundant in the Lakes, presumably the result of the Fish Commission's "plantings," especially as they were not observed at unplanted places. But the catch of whitefish declined from eight million pounds in 1891, the first year of statistics that the Commission regards as reliable, to six, five, four and little more than three million pounds in the four years that followed. Meanwhile the Commission had taken other fish in hand; great numbers of eels were brought from the Hudson river at Albany and released in the lakes, where they were observed to thrive and grow large. But the little eels that had been hoped for never appeared; it was evident they reared no families. Presently naturalists learned that the eel has to go to salt water to spawn and indeed passes the earliest stage of its life in the deep ocean waters in a form as little like an eel as a tadpole is to a frog.

Sturgeon, salmon, brook trout and bass of various kinds were successfully reared and planted in lakes and inland waters. Here success was as marked as failure had been on the lakes. Trout were not only restored to streams once completely fished out but introduced to streams all over the lower peninsula, which was reported changed (1892) "from a land barren in brook trout to one in which good trout fishing is abundant, giving farmers food and attracting thousands of tourists." Attempts were repeatedly made to domesticate and propagate the grayling which was fast disappearing as lumbering operations advanced in the northern part of the lower peninsula. In this there was no success either in finding them spawning in the wild state to obtain eggs to rear or in persuading them to spawn in captivity.

Attention was given to the food supply on which the whitefish fed to solve the doubt whether the small fish released so numerously were able to find a sufficient supply of their natural sustenance. From the toothless, sucker-like, downturned jaw of the mature whitefish it was inferred to be a bottom feeder, as well as from the presence of numerous stones in its stomach, supposed to have been caught up hastily as it took its food. Two-thirds of its food in cases examined in the Charlevoix region consisted of two forms of minute life of the lakes known as the *plankton*. These are pontoporeia hoyi

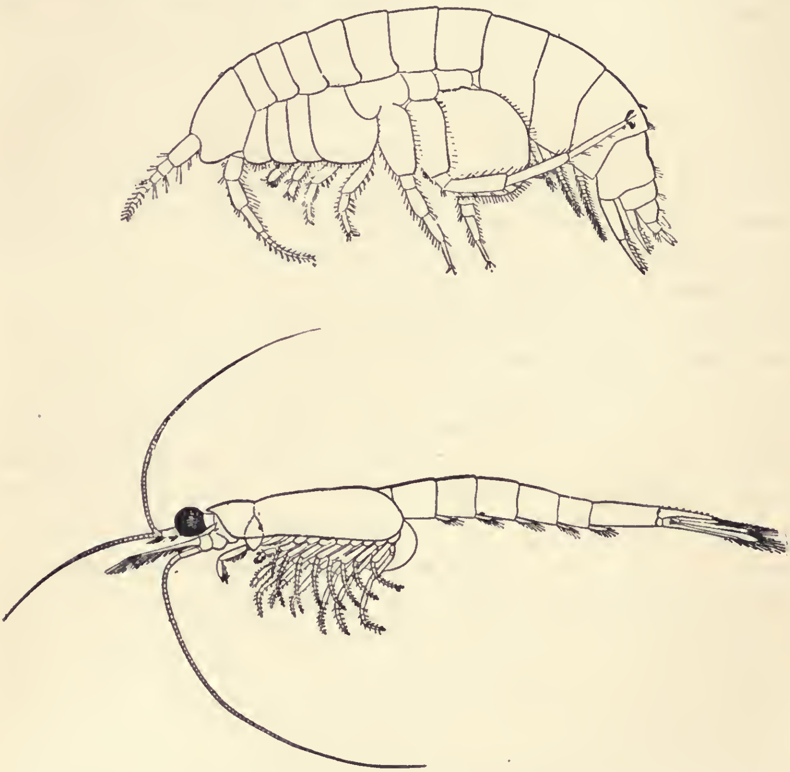


FIG. 66. *Plankton of great lakes on which the whitefish probably feeds—much enlarged*

and mysis relicta, 43 and 20 per cent respectively. Of these forms of life there was found a great abundance. There was certainly food enough to maintain again today the teeming multitudes with which the lakes had one time swarmed. "If one draws through the water a net of finest gauze and collects its gleanings into a small glass there will be seen a myriad of minute forms almost or quite invisible to the eye. The mass of material obtained depends not only upon the length of the haul and size of the net, but upon numerous other conditions as well. Under no probable circumstances, however, will the net fail to collect a certain amount of material which the microscope shows to be composed of living organisms of varied character. Among these are both plants and animals, the latter so insignificant that their own motion does not suffice to carry them over any considerable distance, and hence both plants and animals are dependent upon waves, currents and winds for their wide distribution. Their entire existence is passed floating freely in the water and both plants and animals possess characters of form or structure fitting them for maintaining their position. This mass of living forms is known as the *plankton*. One may justly call it *the primitive food supply* of the water, and as such it is of course the origin of fish food." There is much less plankton it appears in the Great Lakes than in the ocean, but abundance to maintain a fish life much greater than now exists. Not merely is there plenty of the two forms mysis and pontoporeia, and the others on which whitefish feed, but the still lower forms in the plankton on which these feed. Of the fry it is only known that as soon as they absorb the food sac with which they are hatched from the egg they are unlike the mature whitefish in having "raptatorial" teeth with which they dart upon their prey, not on the bottom, but free swimming through the water. Just what these are is not certainly known, but the fact that captive fry greedily chased and ate two copepods, cyclops thomasi and diaptomus cicilis suggests at least that their natural food resembles these crustaceans. These, too, abound in the Great Lake waters.

It could no longer be doubted that the greater success in peopling the streams with trout than the lakes with whitefish was due to the protection enjoyed by the former of a close season and a legal size below which they might not be caught under penalty. The lakes were overfished. While the hatcheries were doing all their capacity would admit to replenish the waters, their work was to a great extent neutralized by the persistent catches of immature fish by the fishermen. The substitution of steam vessels for sail boats and the introduction of large capital had resulted in hastening the destruction of the whitefish enormously. The establishment of depots where the fish might be frozen and preserved for future use had offered a temptation to those engaged in the business to prosecute their work at all seasons of the year. Many localities formerly known as good whitefish grounds had by the multiplication of methods of capture, been fished to death and now made poor return, while many other grounds had been wholly abandoned because of their unproductiveness. Still more serious was the nature of the catch. It was reported from Alpena in 1892 that "tons of immature whitefish were taken in the pound nets there, many of them so small that they could not be salted, neither could they be put upon the market and sold fresh, and as a last resort they were smoked. In other cases the fish caught were so small that they could only be disposed of to grind up for fertilizers.' It was felt that if the millions of small fish put in the lakes could escape this shameful manner of fishing until they attained a spawning age and a commercial size, the fruits of artificial propagation might be realized. A detail that was noted in Charlevoix waters throws light on what was going on:—The fishermen, highly skilled in the practice of their art and easily distinguishing varieties among the fish they handled that seem quite identical to the uninitiated, looked with little tolerance on the early labors of the Fish Commission and maintained entire incredulity as to the validity of their conclusions. When the whitefish, coregonus clupeiformis, began their rapid disappearance from Charlevoix waters in the years following 1880 the fishermen held the fact to be simply that the fish had gone away to some other locality. The increasing presence in the lake of sawdust from the lumber mills was regarded as a sufficient cause. But coincident with the ''going'' of the true whitefish arrived another, sold commonly as a whitefish but well known to the fishermen as distinct and named by them ''longjaw'' (coregonus prognathus) (Fig. 67). The longjaw had not been unknown before, it merely became now a greater part of the total whitefish catch. Now the true whitefish yields the best catches at depths of twelve fathoms or less while they are not found at depths of twenty to twenty-five fathoms where the longjaws are most abundant. There is no evidence that the habits of the two species have changed in the period of time considered. The simplest explanation of what has occurred would seem to be that as scarcity of the whitefish drove the fishermen to set their nets further from

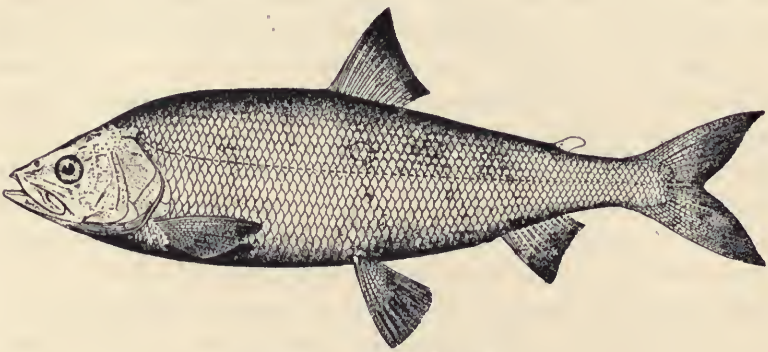


FIG. 67. *Longjaw Whitefish*

shore it necessarily drove them into deeper and deeper waters. The whitefish had been exhausted, not driven away, and the longjaws had not come in, but were being caught more because the nets were invading the deeper waters where they lived. A singular confirmation of this explanation was afforded by subsequent experience in the same waters. As the fishermen worked further and further away from shore the longjaws in turn began to ''go away'' and give place to another form, the ''blackfin'' (coregonus nigripinnis). The black-fin is rarely found in depths less than forty fathoms. There is no ground to doubt that he has always lived there and is caught now first in growing numbers because the nets have again pushed out into deeper waters.

The writer was present on a fishing trip in 1905 from a Canadian port into Lake Huron that gave an idea of how strenuous an assault is being made on fish life. It is probably a fair example of legal lake fisheries. The little tug steamed out at sunrise to a buoy some sixteen miles offshore, marked by a red and white flag. It seemed a very obscure object but was easily made out by the experienced fishermen. The buoy was taken in and its line lifted until the ends of the nets came over the rail at 9:30 a. m. From that time till noon the tug steamed slowly along, taking up seven miles of net which was lifted inboard, net, fish, and all, by a steam-winch patented from Charlevoix, Mich. A rod was run through the rear wall of the pilot house to the engine room by which the engines of the boat and the fish lifter could be stopped and started from the pilot house. Here at the door stood one of the crew of five with a gaff to help heavy fish over the side but ready to stop the engines when needed. Another pulled the net hand over hand from the fish lifter and laid it, fish and all, in the net boxes as evenly as possible. The rest busied themselves freeing fish from the meshes of the net in which they were tightly entangled, carrying off boxes filled with fish and net and bringing empty ones. There were 56 nets, each 800 feet long and eight feet wide, with lead sinkers all along one edge and wooden floats along the other. The sinkers were altogether too heavy for the floats to lift, but the floats were able to make the net stand up on the bottom like a fence, seven miles long and eight feet high. Two hundred and thirty-eight fish were taken, a third of them whitefish fifteen or twenty inches long and weighing from three to six pounds. The fish were literally pumped on board by steam, coming over the side from one to two a minute, an average of one to every 150 feet of net. To take these from the nets, straighten the net, untie the nets from each other as a joint came up and lay them and the fish in their boxes, called for the incessant activity of all hands. Even then the engines had frequently to be stopped.

Quite as many stones as fish were lifted, mostly jagged bits of limestone greatly honeycombed by the solvent action of the water and weighing up to ten pounds. These are probably entangled in the net by the fish in their struggles to escape from the meshes, struggles which are further evidenced by the way the net strands are forced into their bodies. A depth of sixteen fathoms had been carefully selected by sounding as the net was laid. At the end of the line the rush was followed by a twenty-minute rest for lunch. Then the tug steamed over her course again at a three-mile pace that kept all hands on the jump to lay out the net straight and clear so that it would stand upright on the bottom. When a "foul" comes the engines are stopped and all hands go to work at it till the net is clear. At the end of the line, as at the beginning, a heavy stone anchors a cedar buoy with pole and flag and the net is set. Two other similar lines will keep the tug busy tomorrow and the day after. On the third day this will be again taken up. From the stake in, all hands clean fish, with an occasional turn at engine and wheel. When the landing is made the catch is ready for the ice or for sale.

The hope of the Fish Commission, to maintain a constant supply of food fish to the lakes by securing the growth from the egg to maturity of as many fish as were annually caught, had failed of realization. Much has been said when we state that fishing paid so good a return on the capital it employed that its appliances improved and the zeal with which it was prosecuted increased much too fast for the fish introduced into the lakes by the Commission ever to have a chance to grow up unless their capture in infancy were legally prevented. The Commission is satisfied that a whitefish does not spawn before attaining a weight of at least two pounds, yet a million pounds of the total of three million pounds caught in 1895 were individuals weighing less than one and a quarter pounds. As a specific example a firm in Grand Haven shipped a barrel of whitefish to Detroit which was found to contain between twenty-five hundred and 3000 individuals. The shippers offered a similar lot every day in the season. The diminishing size of the mesh of the nets used contributed much to this result. The legal mesh in 1870 had already contracted some since earliest days. It was then 4¼ inches, not open as in use, but stretched out to its greatest extent. In 1896 it had diminished to 2¼ inches and illegally nets were doubtless used even smaller than this. In 1894 an attempt to pass a law enforcing penalty for having in possession whitefish under a standard size, met defeat at the hands of the fishermen who saw in it rather the present limitation of their catch than the protection of their future interests. In 1894 Lake Ontario was declared "fished out," while from Lake Erie fishing firms were moving to Lake of the Woods at least for summer work. The U. S. Fish Commission that year suspended work in Lake Erie for lack of whitefish from which spawn could be obtained. In 1897 a protective law was at last obtained. It was now illegal to use pound nets with meshes of less than 3½ inches in the pockets, to have the following fish in possession of less weight than—sturgeon, 15 pounds; whitefish, 2 pounds; lake trout, ½ pound; walled-eyed pike or pickerel, 1 pound; catfish, 1 pound; perch, 4 ounces; all in the round, to net fish between October 13 and December 15, when the whitefish are spawning, to take trout, salmon or grayling between September 1 and May 1, to kill them at any time in any other way than by fishing with hook and line, to have them in possession under 7 inches long, or to have trout or grayling for sale. The results are regarded as distinctly satisfactory, yet the period during which protection has been had is brief and the whitefish, to which most attention has been given, shows only moderate increase. The average value of the whitefish, however, has risen from less than 4 cents per pound in 1892 to nearly six cents in 1902. If this result from the elimination of the smaller, immature fish it is a great gain. It may merely point to an increased demand for the same qualities that were formerly cheaper. The herring catch is known to have increased with increasing demand. Early statistics are not relied on but it is not questioned that whitefish and trout formerly made up much the greater part of the total catch. Kinds of fish are now caught and sold for which there was then no market. The total value of the Great Lake fisheries in 1900 was over five million dollars, of which one and a half were reported for Michigan. Michigan and Ontario led in value of the catch among all the neighboring states.