BULLETIN

OF THE

AMERICAN GEOGRAPHICAL SOCIETY

Vol. XLIII 1911 No. 8

PROGRESSIVE DEVELOPMENT OF RESOURCES IN THE LAKE SUPERIOR REGION*

BY

LAWRENCE MARTIN

Assistant Professor of Geology, University of Wisconsin

PHYSIOGRAPHIC FEATURES. The Lake Superior region as here discussed includes over 180,000 square miles in Wisconsin, Michigan, and Minnesota, in the United States, and Ontario, in Canada. This area is shown in Fig. 1.

The area includes parts of three topographic provinces: (a) the Lake Superior Highlands, (b) the Lake Superior Basin and (c) the Belted Plain of portions of Wisconsin, Michigan, and Minnesota. The Lake Superior Highlands are part of a more extensive peneplain which truncates Archean and Algonkian igneous, sedimentary, and metamorphic rocks.

The west part of Lake Superior Basin is a rift valley, produced by *graben* faulting in this peneplain, the remainder of the basin being of undetermined origin.

The Belted Plain consists of alternating cuesta uplands with intervening lowlands, in one of which Lake Michigan lies. These are in the Paleozoic sediments, while in part of the Minnesota area the plain lies on Cretaceous sediments.

The region has been nearly all glaciated, but a small portion in the southwest lies in the Driftless Area. It, therefore, has residual

* Published by permission of the Director of the U. S. Geological Survey.
The author is indebted to Professor R. S. Tarr for suggestions and criticisms.

soils derived from the underlying sandstone, limestone, and igneous and metamorphic rocks.

Another small portion of the area is overlaid by the older drift, its soils being somewhat weathered, transported soils. These two regions are essentially without lakes and have respectively normal, mature drainage and partly-readjusted young drainage.

A third subdivision of the area, comprising the major portion, is covered with the ground moraine, terminal and recessional moraines, drumlins, etc., of the latest (Wisconsin) glaciation, the ice of which came partly from the Labrador and partly from the Keewatin center. Its soils are all transported and are little decomposed. In many places they are stony, sandy, and infertile, although there are large exceptions. Its drainage is youthful and not at all adjusted to the rock structures. Rapids and falls, and lakes and swamps, or muskegs, are most abundant.

The fourth subdivision is the region of lake deposits, especially the clays, silts, and sand laid down in the large marginal glacial lakes, including glacial Lakes Nemadji, Duluth, Chicago, Algonquin, and Nipissing in the Lake Superior and Lake Michigan basins and glacial Lake Agassiz in the valley of the Red River of the North. Here the soils are also transported but they vary greatly in fertility from the somewhat undesirable stiff red clay of parts of the Lake Superior and Lake Michigan borders to the rich silts of the floor of Lake Agassiz in the northwest corner of the area.

The Lake Superior region has an average mean annual temperature of about 45°, 10° to 20° for January and 65° to 75° for July. The annual rainfall is 29 to 34 inches. The climate is affected by the Great Lakes, somewhat modifying a continental climate in the belt of prevailing westerly winds.

Geographical Relations. At present the Lake Superior region constitutes a peninsula of partial wilderness, projecting into adjacent agricultural lands. At first only those resources were developed which were easily removable and were in demand in the neighboring regions. The physiographic influence upon the development of the region has gone hand in hand with historical progress. The furs were thus first sought, then the forests and fish, then the copper and iron ore. All these are associated with stages in the history of the exploration and settlement of America. The utilization of the Great Lakes in relation to resources outside as well as within the area, has been a factor of great importance, as in the case of grain. Agriculture and manufactures are still in early development in the Lake Superior region.

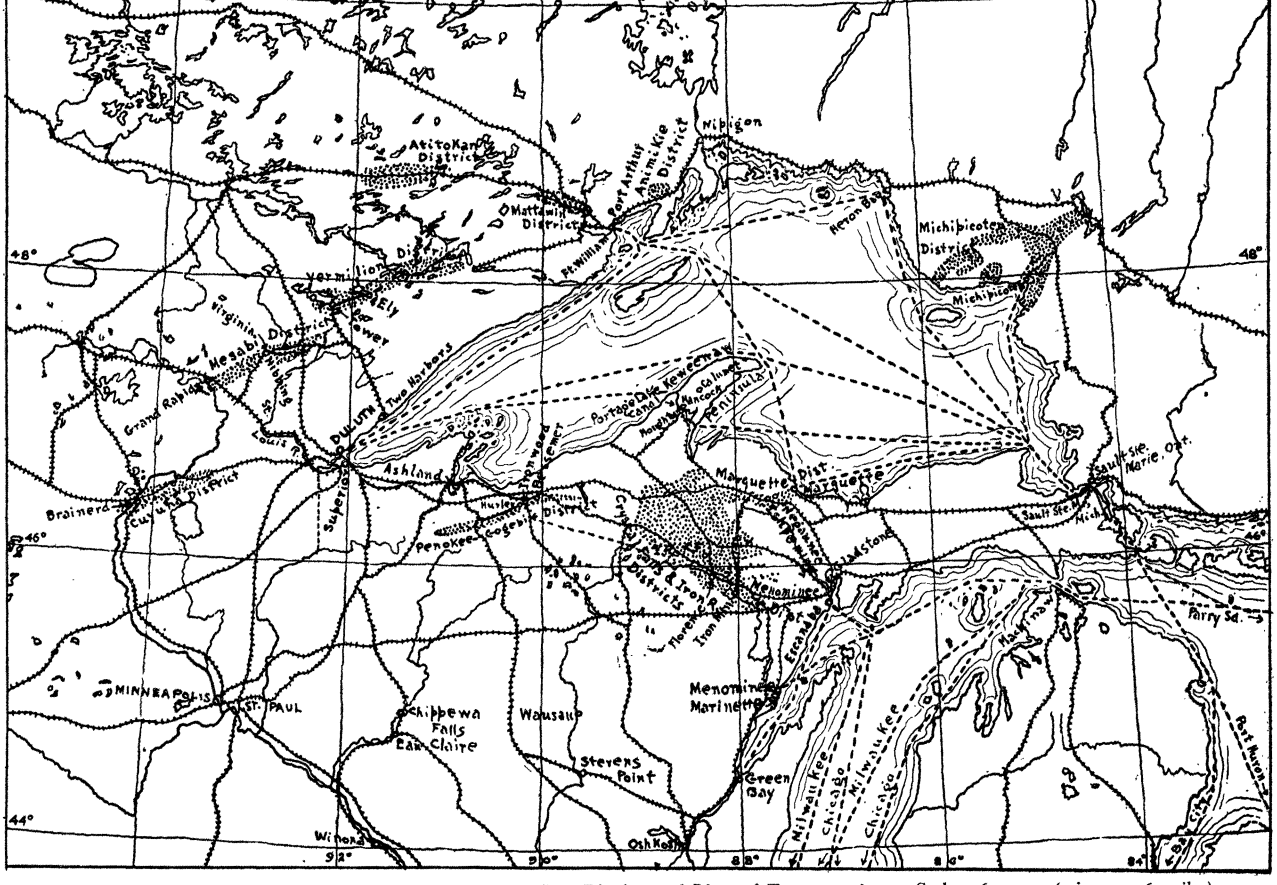

FIG. 1—Sketch Map of the Lake Superior Region showing Iron Districts and Lines of Transportation. Scale 1:6,000,000 (1 in. = 94.69 miles). [Iron districts based on U. S. G. S. Monographs 19, 28, 36, 43, 45, 46; railroad lines on U. S. G. S. base-map of U. S., 1:2,500,000, and on base-map of Canada, 1:2,217,600; transportation routes on Great Lakes on Lake Survey Charts. Compiled by W. L. G. J.]

THE CONTROLLING FACTORS. Of the geographical factors influencing the development of the Lake Superior region none are more notable than its natural resources and its routes of trade. Of these natural resources the iron and copper ores are among the most important, but they are not the only ones, the timber which formerly covered the region having produced millions of dollars worth of lumber, while the land itself has enormous agricultural possibilities, as, for example, on the western border of the region where wheat is raised and flour milled the shipment of which from Lake Superior through the Soo is greater in value than that of the iron ore, though with only one-eleventh the tonnage of the ore. In most areas close to Lake Superior the wheat-raising industry is entirely undeveloped.

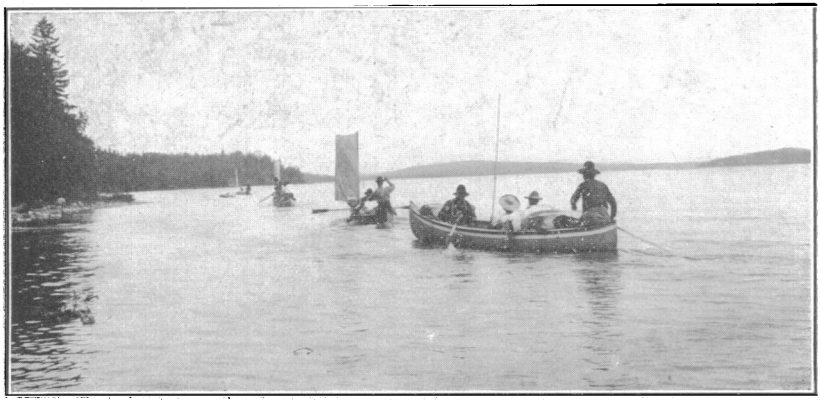

FIG. 2—Lake near Nipigon, Canada. A party starting on a long trip through a chain of lakes and streams produced by glaciation.

Among routes of trade the Great Lakes naturally rank first, but the other waterways and the rather low relief of the whole region, through which railroad building has been comparatively easy, are also important factors, as will be seen later.

INFLUENCE OF GLACIATION. One notable geological factor is the fairly recent covering of the region by a great continental ice sheet. The glacier, it is true, had its detrimental features, especially in the removal of certain of the soft ores, as in the Mesabi Range, and in covering many regions, especially the iron ranges, with a great thickness of glacial drift. This covering is well illustrated on the Mesabi and various other ranges where the ore is removed by steam shovels after stripping the glacial soil covering it. At many mines the drift is so thick as to entail a considerable expense for removal. In the newest of the iron ranges, the Cuyuna Range of

Minnesota, the drift is so thick that open-pit work is impossible and underground mining is necessary, adding considerably to the expense of operating the low-grade ores. More than this, the very heavy drift, covering this and other ranges, is responsible for the obscuring of outcrops and for the necessity for great numbers of test pits or diamond drill holes or magnetic surveys to determine the location of the iron-formation rocks.

These detrimental features are partly compensated by advantages also resulting from the glaciation of the region. Some of these ad-

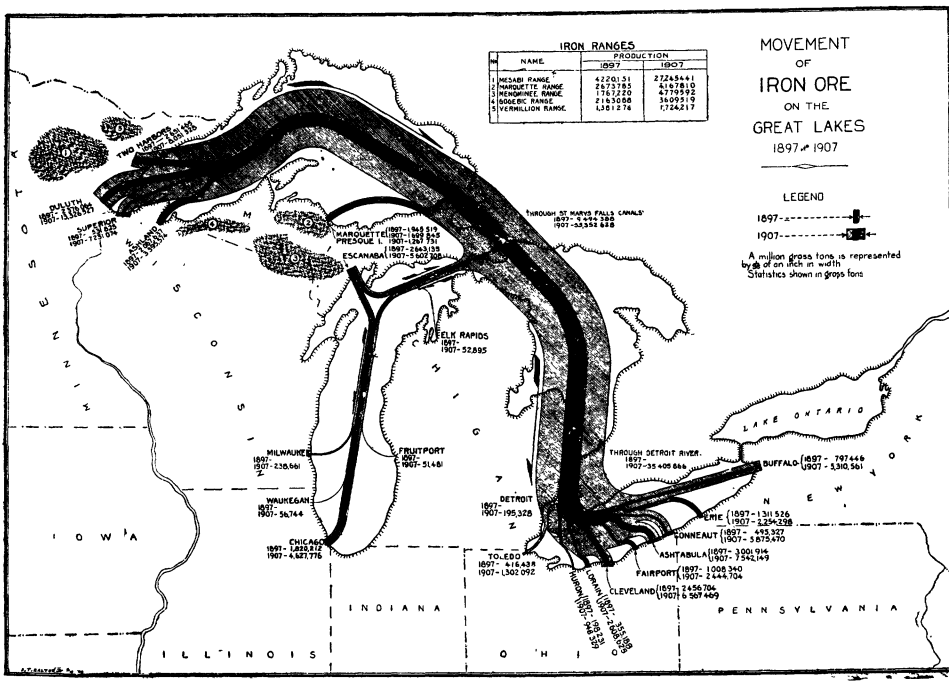

FIG. 3—Increase in Iron Ore Shipments, 1897–1907. (After Commissioner of Corporations.)

vantages are (a) the removal of what must have been a heavy mantle of soil of residual decay on certain of the iron ranges, thus making prospecting for the ores much easier in some districts because of the abundance of outcrops; (b) the development of the new drainage features which did not exist before the glacial period. The prospector for iron ore and the geologist can well appreciate what the difficulties of exploration in the Lake Superior region would have been had not the country been covered with a net-work of lakes and sluggish streams, separated by rapids and short portages, making it possible to travel for great distances by canoe (Fig. 2). Not one of

the Great Lakes, except possibly Lake Superior, existed before the glacial advance, and the region had not a single one of the tens of thousands of small lakes with which it is covered. In the respect then of a highway being provided over which it was easy to travel and explore, and transport ore, lumber, coal, grain, flour, etc., the glacial invasion was distinctly beneficial.

INFLUENCE OF HARBORS. An enormous tonnage of iron ore is carried eastward over Lake Superior and the other Great Lakes (Fig. 3). Coal and other materials are carried to the iron and

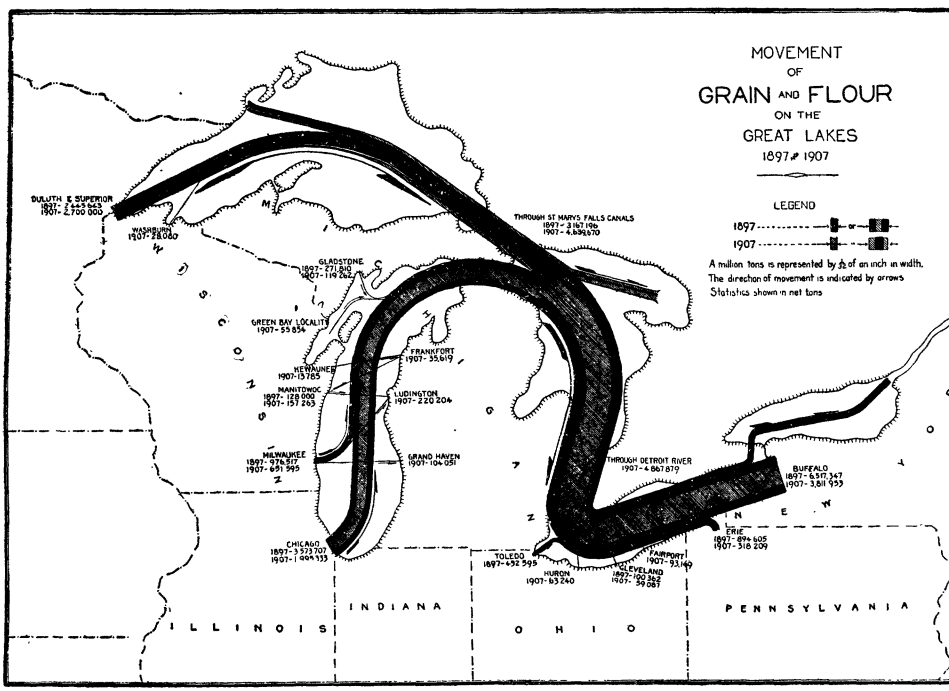

FIG. 4—Increase in Grain and Flour Shipments, 1897–1907. (After Commissioner of Corporations.)

copper country. Naturally, the Great Lakes themselves are far the most important geographical asset in this transportation. A second asset of great value, however, is the series of good harbors which make it possible to load the ore and grain boats with comparative ease and safety. If it were not for the submergence of certain old river valleys, which are thus made into protected landing and loading places, such harbors would not have been available. The harbors at Escanaba, Marquette, and Ashland in Michigan, at Fort William and Port Arthur in Canada and at Two Harbors, Minn. (Fig. 1), have been improved at a comparatively slight expense, so that they

are excellent places for the loading of vessels. The harbor of the Bay of Superior,—at Duluth and Superior,—is one of the best of these ports, furnishing a safe place for loading ore, grain, and lumber and unloading coal, etc., a Haven in time of storms, and a winter refuge for numerous vessels. This harbor exists because the lake waters have been canted into the valley of the St. Louis River, which is even more protected by the building of two sand sits at the head of the lake.

Fort William and Port Arthur, on Thunder Bay, are harbors of importance; Duluth and Superior are also busy ports. From the former two Canadian ports hardly any iron ore is transported at the present time, but grain and flour are shipped eastward from them over the Great Lakes route. The Great Lakes are thus seen to be of importance, a commercial asset in an entirely different industry

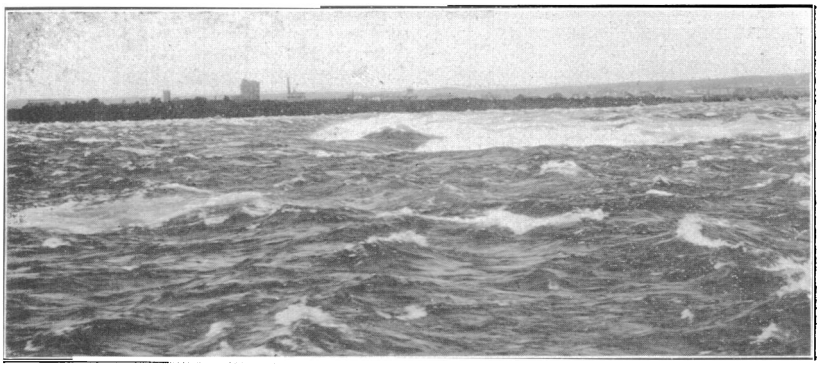

FIG. 5—The Rapids at the Soo. Sault Ste. Marie, Canada, in the background.

(Fig. 4). The shipping from Fort William and Port Arthur, which was a little over half that from Duluth and Superior in wheat, other grain, and flour in 1906, surpassed these American ports in 1907 in both wheat and other grains, though not equalling Duluth and Superior in flour shipments. This is due to the increased development of the Canadian Northwest. Most of this grain from Lake Superior ports goes to Buffalo and by the Erie Canal and railways to the Atlantic Coast. Some, however, goes by the Welland and St. Lawrence canals to the Canadian seaboard.

INFLUENCE OF SAULT CANALS. Still another factor in the development of this great trade route from Lake Superior to the other Great Lakes and to the Atlantic, is the original connection of all the Upper Great Lakes except Superior by navigable waterways. Lake Superior iteslf is separated from this great chain of highways by

a navigable river with a short rapid at Sault Ste. Marie (St. Marys Falls, Fig. 5). The descent from Lake Superior to the level of Lake Michigan and Huron is about twenty feet, and the length of the rapids is only about a mile. Accordingly, it was possible to construct a short canal, with locks, at Sault Ste. Marie (the Soo), which would take the vessels past this obstacle. In the infancy of transportation on the Great Lakes, it was necessary to unload the vessels at the Soo, and to reload vessels on the other side.

The Hudson's Bay Company built the first canal, which was on the Canadian side, in 1798. It admitted only batteaux and canoes. The efforts to induce the American government to build a canal at this point were at first unsuccessful, largely through the opposition of Henry Clay, it is said, who could think of no resources of the Lake Superior region the transportation of which would ever warrant the enormous expense of the canal.

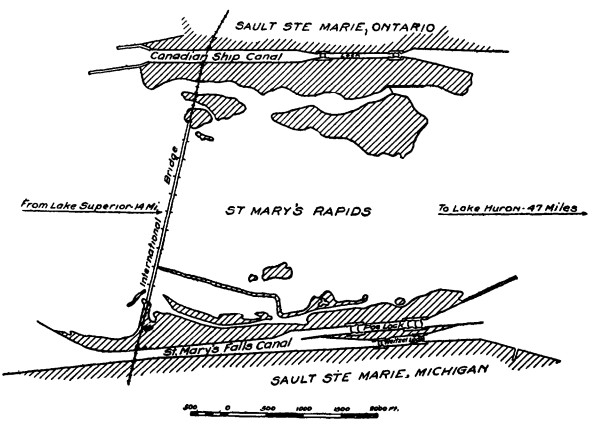

FIG. 6—The Rapids, Canals and Locks at the Soo.

The State of Michigan undertook the building of the first ship canal* as early as 1837, although the canal was not completed until 1855, because of lack of support by the national government. It cost $1,000,000.

The American government started to rebuild this canal and lock in 1869, completing the work in 1881. A second lock (Fig. 6) was started in 1887 and completed in 1896. The cost of these two locks and improving the canal and river was $10,000,000. The Canadian canal and lock were built between 1892 and 1894 at a cost of $4,000,000. The construction of still another and longer lock is said to be contemplated on the American side.

The increase of traffic through the Soo is indicated by the fact that these three new locks (two in the United States and one in

* This and many other statistics on the Sault Ste. Marie canals are from the annual report of the Chief of Engineers of the United States Army; the Blue Book of American Shipping, 13th Annual Report, 1908, 423; and from an article by E. E. Ferguson, *Bull. Amer. Bureau of Geogr.*, II, 1901, 74–88.

Canada) have already been necessary since the first one, while the increase in the size of vessels is shown by the relative dimensions of the various locks:

	LENGTH.	WIDTH.	DEPTH.
Two Michigan Locks, each....	250 ft.	70 ft.	11½ ft.
Weitzel Lock.....	515	60	17
Poe Lock.....	800	100	22
Canadian Lock.....	900	60	22

THE SAULT CANALS AND THE DEVELOPMENT OF LAKE SUPERIOR IRON MINING. This increase in the size of the canals is partly due to the increasing wheat shipments, but almost entirely to the iron ore transportation, due to the wonderfully rapid increase in iron mining in the Lake Superior region. The vessels have increased to a length of 605 feet,* 60 foot beam, depth of 32 feet and a capacity of 13,000 and even 14,000 tons. Sailing vessels are fast going out of the lake traffic. They carried 30 per cent. of the tonnage at the Soo in 1895, 15 per cent. in 1905.

With the increased saving in time of loading iron ore (a cargo of 9,277 tons has been loaded at Duluth, for example, in 70 minutes) and of unloading (10,346 tons being unloaded at Cleveland in 4 hours and 10 minutes) and the saving of delay in the Soo locks (normally the only place of delay in the whole route), it is possible for one boat to make many trips from the head of the lakes or from other ore ports to the Lake Erie ports in a season. This is why several large and fast-working locks are necessary. It was estimated that the five days' delay incidental to the sinking of a vessel in the St. Marys River below the canal in 1900, holding back only the vessels drawing over 13 feet, resulted in a loss of $500,000 to the various operators of vessels. With delays eliminated, many and fast trips can be made. The *W. E. Corey* made thirty trips from Duluth to the Lake Erie ports in 1906, carrying 302,000 tons of iron ore. The more trips made the cheaper the rate of transportation. In 1907 the rate varied from seventy-five cents (Duluth to Lake Erie ports) to seventy cents from Marquette and sixty cents from Escanaba, which is much less (about one-fifth) than the minimum railway rate or the rate if vessels had to be unloaded and loaded again at the Soo. Contrast this with one and eight-tenths cents a bushel, the 1907 rate on wheat, which is bulkier but not so heavy, from Duluth to Buffalo, by lake, and with the rate on coal, the only bulky commodity going west (Fig. 7), on which the rate from Lake Erie ports to Duluth, by lake, was only thirty cents per ton in 1907.

The cost of the Soo canals, even without tolls, is paid over and

* The Atlantic liner "Lusitania" is 785 feet long.

over again in this cheapness of transportation. The expenditures involved in their building have been more than warranted by the enormous traffic which goes through the canals at Sault Ste. Marie. Although the season for lake transportation is limited to less than eight months, the canals at Sault Ste. Marie carry a greater tonnage than any other canals or other waterways in the world, surpassing even the Suez Canal, which has been and is still the great route of trade between Europe and Asia and is open the year round, as is the Kiel, or Kaiser Wilhelm, Canal between the Baltic and North

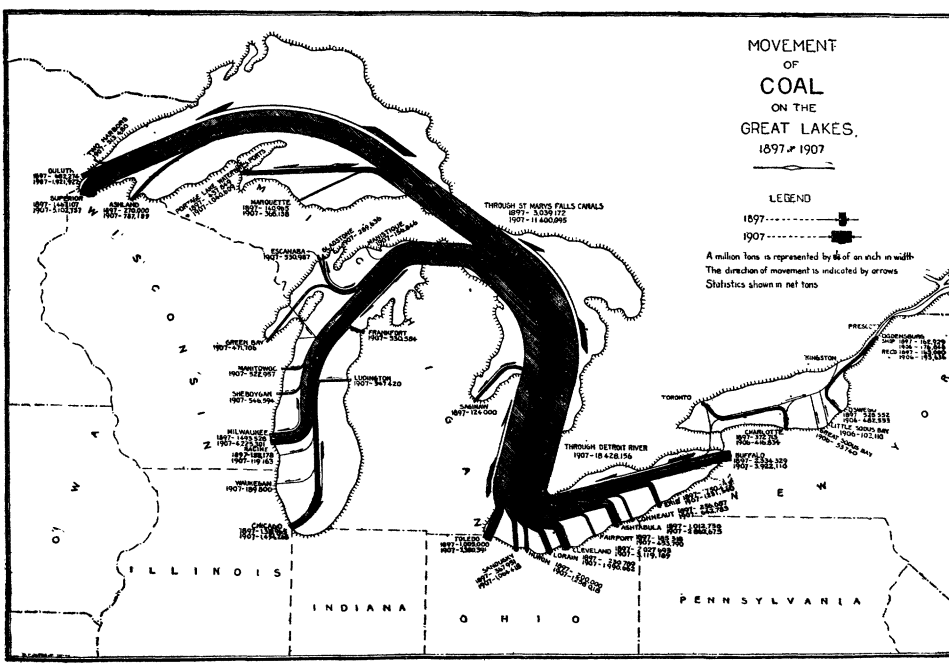

FIG. 7—Increase in Coal Shipments, 1897–1907. (After Commissioner of Corporations.)

Seas in Germany. The net tonnage at the Soo* was three times that of the Suez Canal in 1906 and seven times that of the Kiel Canal. It increased between 1906 and 1907 by a tonnage nearly equal to the combined tonnage of the Suez and Kiel Canals in 1906, as the following table shows:

SOO.	SUEZ.	KIEL.
1895....16,806,781 tons net	8,448,383 tons net	(not open)
1900... 22,315,834 " "	9,738,152 " "	3,488,767 tons net
1905....36,617,699 " "	13,132,694 " "	5,270,477 " "
1906... 41,098,324 " "	13,443,392 " "	5,796,949 " "
1907....58,217,214 " "	.....	.....

* Transportation by Water, United States, 1906, Bureau of the Census, *Bull.* 91, 1908, p. 46.

This comparison of the traffic at the Soo, Suez and Kiel Canals shows a large yearly increase in the case of the Soo Canals. This is related partly to the great growth of production of wheat farther west, both in United States and Canada, but mainly to the increase in the iron production (24 per cent. 1903-1905) largely in the region tributary to Lake Superior (and not including Lake Michigan) and especially on the Mesabi Range (which had five-fold increase of tonnage shipped, 1902-1905). These figures give no account of the shipments by the Great Lakes from the Menominee and Crystal Falls districts, whose chief ports are Escanaba and Gladstone (Fig. 1), and whose vessels do not pass through the Soo canals.

The traffic past Detroit, which would include this and other Lake Michigan and Lake Huron traffic, amounted in 1906 to over 70,000,000 tons, carried in 25,000 vessels. This includes a season of 230 days and a different proportion of west-bound as well as east-bound traffic, for example, part of the commerce of Chicago.

The greater part of the iron ore is carried in vessels belonging to the iron and steel companies which own or operate many of the mines. In 1906 the United States Steel Corporation (Pittsburg Steamship Company) had 101 vessels with 368,165 aggregate gross tonnage, 16 per cent. of the total gross tonnage of the Great Lakes.* The Gilchrist Transportation Company had 62 vessels with 190,890 tons gross register. The latter are not allied directly to any of the iron or steel interests, as are the various other steamship operators who handle ore and coal. The package freight service, carrying goods readily transferred from cars to boats, are practically all owned or run in connection with the great trunk line railways like the Pennsylvania Railroad, the New York Central, the Canadian Pacific Railway, etc.

The freight tonnage carried through the Soo canals in 1888, 1890, 1895, 1900, 1906 and 1907 follows, comparative analytical figures for 1900 and 1907 being given for the sake of showing the preponderance of the iron ore traffic and its great increase. The other products shipped are of notable bulk and value and show large increases as well, except the yearly fluctuations of grain, and the diminution in lumber shipments. They come nowhere near the iron ore traffic in tonnage,† the iron ore making 89 per cent. of

* From statistics by Walter Thayer, "Transportation on the Great Lakes," in American Waterways, *Annuals Amer. Acad. Polit. and Soc. Science*, XXXI, 1908, 126-138.

† 1900 figures quoted from *Bull. Amer. Bureau of Geogr.*, II, 1901, 87-88; 1907 figures and general data for 1888-1906 from Monthly Summary of the Internal Commerce of the United States, December, 1907, Bureau of Statistics, Department of Commerce and Labor, 1908, 631-632; and from Transportation by Water, 1906, United States, *Bull* 91, Bureau of Census, 1908, 46.

the east-bound traffic by tonnage. The west-bound traffic is not quite a quarter of the east-bound, ninety per cent. of it being coal.

1855.....	——	vessels,	carrying	14,503	tons	worth	$ ——
1880.....	3,503	"	"	1,244,279	"	"	——
1888.....	7,803	"	"	6,411,423	"	"	82,156,019
1890.....	10,557	"	"	9,041,213	"	"	102,214,948
1895.....	17,956	"	"	15,062,580	"	"	159,575,129
1900.....	19,452	"	"	25,643,073	"	"	267,041,959
1906.....	22,155	"	"	51,751,080	"	"	537,463,454
1907.....	20,437	"	"	58,217,214	"	"	569,830,188

(16,475 vessels in 1906 by the United States canal and locks,
5,680 " " " " " Canadian " " lock.)

Tonnage shipped via Soo canal 1855–1895: 101,244,462 tons.
" " " " " 1895–1907: 427,148,680 "

Total shipments via Sault Ste. Marie, 1855–1907, 528,393,142 tons.

Total iron ore shipments, 1854–1907, except Menominee (*i.e.*, practically ore shipment via Soo), 464,751,429 tons; iron ore 81 per cent. of total Soo tonnage.

	1900		1907	
Eastbound:	TONS.		TONS.	
Iron Ore.....	16,443,568	.....	39,594,944	
Pig Iron.....	....	.....	20,406	
Copper.....	131,066	.....	89,959	
Wheat.....	....	(40,489,302 bu.)	....	(98,135,775 bu.)
Other grain.....	....	(16,064,225 bu.)	....	(43,461,186 bu.)
Flour	....	(6,754,876 bbls.)	....	(6,524,520 bbls.)
Lumber.....	....	(909,651,000 feet)	....	(649,320,000 feet.)
Building stone.....	48,902	.....	898	
General Merchandise	....	.....	106,075	
Passengers.....	....	.....	....	(31,710 persons)
Total Eastbound Freight.....	....	.....	45,544,319	
Westbound:				
Hard Coal }			{ 1,506,668	
Soft Coal }	4,486,977	. . ..	{ 9,893,427	
Manufactured Iron..	....		287,535	
Flour	....	.....	....	(250 bbls.)
Grain.....	....	.....	....	(2,152 bu.)
Salt.....	....	.....	....	(460,802 bbls.)
General Merchandise	....	.....	916,579	
Passengers.....	....	.....	....	(31,048 persons)
Total Westbound Freight.....	....	.....	12,672,895	
Total freight tonnage.....	25,643,073 tons	.....	58,217,214 tons.	

The proportional value of the products carried through the Soo canals in 1906, was:

	VALUATION.		PER CENT. OF TOTAL VALUATION.
Iron ore.....	$121,981,795	Iron ore.....	23 1/5%
Wheat, other grain and flour...	133,281,196	Cereals	24 3/5%
Copper	36,595,220	Copper	6 4/5%
Coal	25,136,044	Coal	4 3/5%
Lumber	19,813,882	Lumber	3 3/5%
Manufactured iron, pig iron, salt, and building stone.....	30,427,667	Mfg'd iron, etc...	5 3/5%
Unclassified	170,227,650	Unclassified	31 3/5%

(To be concluded.)