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REPORT NO. 717

A FISHERIES SURVEY OF LAC LaBELLE, KEWEENAW COUNTY

by

Paul Eschmeyer

I. Introduction

A. Location and Accessibility

Lac LaBelle is a rather large, relatively shallow lake located in the southeast portion of Keweenaw County, about 14 miles west of the eastern tip of the Keweenaw Peninsula. It is situated in Grant Township, in which it covers portions of sections 3, 4, 5 and 6, T. 57 N., R. 29 W., and parts of sections 31, 32, 33 and 34 of T. 58 N. (R. 29 W.).

The lake lies about ½ mile west of Bete Grise Bay, Lake Superior. No towns or villages are located in the immediate vicinity of the water, other than the very small, unincorporated village of Lac LaBelle itself, lying at the northwest end of the lake, at the site of the abandoned Mendota copper mill location. The small village of Eagle Harbor is located about 10 miles distant, along the opposite (northern) shore of the Keweenaw Peninsula.

Lac LaBelle lies near the mouth of the drainage system of the Little Gratiot River, which empties into Bete Grise Bay, Lake Superior.

The lake is easily accessible by a paved road and as a result is much frequented during the summer months. Keweenaw County Road No. 586 branches from U.S.-41 at a point about 5 miles from Lac LaBelle and ex-

tends in a southeasterly direction toward the water. A scenic glimpse of the lake is obtained at the Village of Lac LaBelle, where the road veers sharply to the east, approximately paralleling the north lake shore at a distance of about 1/4 mile. Proceeding to the shore of Lake Superior, the road again turns southward and terminates at the Lake Superior end of the Mendota Canal, a straight, 3/4 mile long, 12 foot deep outlet canal extending from the eastern extremity of the lake to the western end of Bete Grise. The road is kept open for its entire length throughout the winter.

A poor dirt road leads around the south end of Lac LaBelle to Deer Lake, a smaller body of water in the Little Gratiot River drainage system.

The nearest railroad, the Duluth, South Shore and Atlantic Road, stops at Calumet, about 25 miles west of Lac LaBelle. The Calumet - Hecla Line and the Keweenaw Central Railroad from Phoenix to Lac LaBelle have been abandoned.

B. Map and Survey

A physical survey was made of Lac LaBelle by an Institute for Fisheries Research Survey party* during the period of March 10 to March 15, 1941. The lake shoreline and its physical features were mapped, and water depths and bottom soils were determined.

A regular biological survey of the lake was made by an Institute for Fisheries Research Survey party** from September 2 to 7, 1941.

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* The survey party included the writer, leader; Forest Herman and Ted Michelson, assistants.

** The party was composed of Dr. A. S. Hazzard, leader, and the writer, assistant.

C. Past History and Recent Recreational Development.

It is difficult to trace the past history of Lac LaBelle very far back beyond the history of the previously mentioned Mendota Canal. It was with the construction of this channel that the lake itself was put to other than very light recreational use.

The Mendota Canal was first dredged in 1866* by a private corporation. It is said to have been originally cut to facilitate the logging of pine from the surrounding area. Two long piers, both over 600 feet long and somewhat over 100 feet apart formerly extended from the outer entrance of Mendota Canal out into Bete Grise Bay, Lake Superior.

The canal is said to have been first redredged and the docks repaired in 1884, at which time it was 100 feet wide and over 12 feet deep throughout its length. Soon thereafter the canal was abandoned and became partially filled with sand.

In 1905 the canal was again dredged by the Keweenaw Central Railroad Company which had built a road from Calumet to the Delaware Copper Mine and Lac LaBelle. No further work has been done on the canal. By July, 1923, largely as a result of the lack of maintenance on the piers, a bar had formed in Lake Superior, opposite the canal, covered by only 3 feet of water. This effectually closes the canal to all but rowboats and small launches. The original piers are now partially submerged and are unmaintained. A 180 foot pier has been constructed on the south side of

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* This historical discussion is based largely on Bulletin No. 34, Survey of Northern and Northwestern Lakes, "The Great Lakes, their Harbors, Channels and Navigable Tributaries", War Department Corps of Engineers, U. S. Lake Survey Office, Detroit, Michigan, April, 1925. Local residents also provided some information.

the canal and construction of a second has been started on the north side of the canal. They are used and maintained privately by commercial fishing interests operating near Bete Grise Bay, their chief function being the prevention of the formation of a complete sand bar across the canal.

Lac LaBelle and Mendota Canal were last used for running logs about 1915. It is possible that they may be used again at some future date for pulpwood removal. However, reopening of the canal for general navigation cannot at present be foreseen.

The remains of a 156 foot long steamboat wharf can still be seen at Mendota (Village of Lac LaBelle) at the northwest corner of the lake, which was once the terminal station of the Keweenaw Central Railroad.

Lac LaBelle was little fished prior to the development of Keweenaw County as a recreational center. Quality of fishing during recent years in Lac LaBelle appears to have been cyclic in nature, with several poor to average seasons interrupting successive "peaks" of particularly good fishing. This is more or less a typical characteristic of pike lakes in general, and this cyclic phenomenon in various fish populations has been repeatedly demonstrated by fisheries workers. The most recent period of good fishing in Lac LaBelle extended from about 1935 to 1938, when many excellent catches of northern pike and other species were made. A local resident reports that 5 northern pike weighing between 15 and 20 pounds each were caught during the winter of 1935-36. Very few notable catches have been made through the ice in winter since that time.

Fishing in Lac LaBelle is considered poor at present, although occasional fair catches of northern pike and perch are reported. Fishing during the summer is of moderate intensity, while winter fishing is very light.

There are 2 boat liveries on Lac LaBelle where rowboats for use on the lake may be rented, and several motor launches operate out of the lake for deep sea fishing for lake trout in Lake Superior. In addition to fishing and boating, a moderate amount of swimming is done at Lac LaBelle, chiefly at a stamp sand beach at the northwest end of the lake. Some numbers of campers use the available camp sites near the abandoned Mendota copper mill. There are 17 cottages in the Lac LaBelle area, 7 or 8 of which may be rented by the public.

Lac LaBelle lies at the foot of Mount Bohemia and near Mount Houghton and other uplands covered with a dense stand of mixed hardwoods and evergreen. The lake's presence adds much to the scenic beauty of the Bete Grise area of Keweenaw County and it is much visited by tourists. Its popularity with tourists and fishermen will, without doubt, increase in the future.

II. Physical Characters of Lac LaBelle

A. The Lake Basin

Lac LaBelle fills a long, wide, relatively shallow basin, with a surface area of slightly over 1,100 acres. Its longest dimension, extending almost due east-west, is about 2½ miles (13,300 feet). From a width which ranges from 1,000 to 2,000 feet in the eastern ½ mile of the lake, the water broadens out rather gradually until it attains its maximum width of over a mile (5,700 feet) not far from the south shore.

B. Geological Origin

Geologically, Lac LaBelle appears to have been at one time a portion of what is now Bete Grise Bay, and was cut off of this body as a lagoon by continued wave action in the Bay.*

* Information supplied by Dr. George Stanley of the Geology Department of the University of Michigan.

C. Surrounding Country

Lac LaBelle lies at the base of the southern approaches to the Copper Range, which is the rock range forming the backbone of the Keweenaw Peninsula. The area south and west of the lake is relatively flat and slopes gently southward toward Lake Superior. The north shore is dominated by Mount Bohemia and the ridge contiguous with it, extending eastward. The mountain itself is one of the tallest peaks of the range, and has an elevation of 867 feet. It lies about one mile north of the water and is plainly visible from most of the lake. Mt. Houghton, somewhat east of Mt. Bohemia, is also easily visible from most parts of the lake. The quarter mile immediately adjacent to the water (between the lake and County Highway 586) is quite flat and to some degree swampy. Like the other shores of Lac LaBelle, much of it has been burned over in the past, and is covered with a dense tangle of underbrush, logs, and second-growth timber (mostly evergreen). The slope leading up to Mt. Bohemia veers sharply upward on the immediate north side of the road. Almost the entire drainage area of the lake has a sandy soil, a fact which no doubt accounts for the sandy shoreline of the lake itself.

D. Drainage Basin and Inlets

The drainage basin of Lac LaBelle embraces an area which averages 9 miles in length and 4 miles in width and which slightly exceeds 36 square miles in area. The area includes Deer and Gratiot Lakes, two of the other major waters of the Keweenaw Peninsula, which drain into Lac LaBelle through their outlet, the Little Gratiot River. This stream enters the central western portion of Lac LaBelle and constitutes the lake's major inlet. Just before entering the lake the stream divides, so that two separate distributaries each of 15 to 20 feet in width, are present.

The Little Gratiot River is the only sizeable stream directly entering the lake. Several small, un-named streams, some of them intermittent, drain the immediate shore areas. Seven such streams enter from the ~~west~~ north and drain the foothills of the rock range lying north of the lake. The streams are mentioned below, in the order of their occurrence, from west to east, along the north shore of the lake.

Stream number one enters the lake just west of the abandoned stamp mill on the northwest side of the lake. It is about four feet wide at the mouth and is said to be frequented by brook trout during some seasons of the year.

Stream number 2 is a small stream entering the lake about 1,500 feet northwest of the mill-site.

Stream 3 enters the eastern extremity of the small bay which lies at the northwest end of the lake. It is 5 to 6 feet wide at the mouth depending upon the season of the year. Northern pike and perch are said to run the stream in the early spring.

Streams 4 and 5 are very short, more or less intermittent creeks draining swampy areas adjacent to the north lake shore. The first of these is located west centrally and the other east centrally along the north shore of the lake.

Stream 6 is Paddy Creek, a waterway draining Lake Paddy, a small lake about 2 miles north of Lac LeBelle. The stream enters the northwest end of the lake.

Stream 7 is a very small stream draining the swampy area lying between the lake's eastern extremity and Lake Superior.

A single stream, about 10 feet wide, enters the south side of the lake, somewhat east of the center of that shore. This stream probably does not

support trout, but pike are said to run it in season.

Two streams, each about 5 feet wide, enter the Gratiot River outlet of Lac LaBelle. The most easterly of these is said to support brook trout.

The Lac LaBelle drainage system is bounded by that of the Tobacco River and its tributaries to the west and by the Montreal River drainage to the north. Short streams with direct entry into Lake Superior drain a portion of the area lying between Lac LaBelle and Lake Superior.

E. Outlet

There are at present two outlets to Lac LaBelle. The first of these is the Gratiot River, which leaves the southeast corner of the lake and pursues a widely meandering course into Lake Superior. It is from 100 to 150 feet wide as it leaves the lake, and is bounded by swampy margins throughout much of its course. It is somewhat silted-in at some points, and supports a rich growth of vegetation.

The second outlet is the previously mentioned artificial waterway, the Mendota Canal, which is straight, 3/4 mile long, 10 to 12 feet deep, 100 feet wide, and cut from the eastern extremity of the lake to the nearest shore of Lake Superior. The Gratiot River outlet leaves the lake south of the Mendota Canal exit, meanders across it and enters Lake Superior about 3/4 mile north of the Lake Superior end of the canal.

F. Water Fluctuation

Since Lac LaBelle has free and unobstructed access to Lake Superior, water fluctuation during the year is very slight. Such slight, temporary variations in level as may occur have insufficient bearing on the fishery there to warrant further mention.

G. Area and Shoreline Development

Lac LaBelle has a total surface area of 1,146 acres, or about 1.8 square miles, and a shoreline which is 40,320 feet, or 7.6 miles, in length.

The lake has a shoreline development of 1.61, which means that the lake has a shoreline over 1.6 times as long as would have a perfectly circular lake of the same area. Other factors being equal, the greater the amount of shoreline which a lake has in relation to its area, the higher is its biological productivity.

H. Depth

The maximum depth of Lac LaBelle is 39 feet. This depression is located at the center of the lake, with respect to its north and south shores, and about a half mile from its eastern extremity. The narrowest part of the lake is thus seen to be also the deepest. A second depression exceeding 35 feet in depth lies near the geographical center of the lake. Almost all of the lake area more than 800 to 1,000 feet from shore is over 25 feet in depth.

I. Shoals and Bottom Types

The slope from shore to the depths is quite gradual and regular along most of the south and west shores. Steeper slopes characterize the north portion of the lake, with the steepest declivity occurring at the narrowest (and deepest) portion of the lake, about $\frac{1}{8}$ mile from the east shore. About 15 per cent of the lake's surface area may be considered as shoal area. Wide, sandy shoals in the southeast, south central and northeast sections of the lake contribute heavily to this percentage.

Finely divided sand is typical of the bottom of almost all of the shoreward areas of Lac LaBelle, and dominates the bottom soil of about 25 per cent of the lake. Sandy soils extend out into the water for a distance of less than 50 feet in the northwest portion of the lake to almost 1,500 feet along some portions of the east shore, and encroach to depths of up to 25 feet. The uniform regularity of the lake basin is interrupted by a

narrow sand bar, covered by from 19 to 20 feet of water, and lying about 1,600 feet from the south central shore, which it parallels. Moderately soft muck soils dominate the remainder of the bottom soil, and cover all of the deeper parts of the lake basin. The transitional zone from sand to muck is very broad throughout most of the lake, leaving a band of 300 to 700 feet of the lake bottom covered with varying mixtures of muck and sand. Very small quantities of pulpy and fibrous peat are mixed with the muck and sand at the extreme eastern end of the lake, near the Mendota Canal outlet of the lake. A restricted portion of the northwest section of the lake has a bottom soil composed of stamp sand, which dates back to the days when the stamp mill was still operating.

There is adequate shoal area in Lac LaBelle to meet the needs of all shoal-spawning fish present.

J. Color of the Water

The water of Lac LaBelle is relatively clear, with a slightly brownish bog-stained cast. A Secchi disk (a white metal disk about 6 inches in diameter) when lowered into the water disappears from view at depths of 8 to 10 feet. This reading serves as a criterion of the depth to which light penetrates given waters. The degree of transparency in the case of Lac LaBelle is about average for northern Michigan lakes. The extent of light penetration is closely correlated with the depth at which aquatic plants will grow, since the higher plants cannot exist in the absence of all light.

III. Temperature and Chemical Characters of Lac LaBelle

A. Significance of Temperature and Chemical Data.

As a part of the survey conducted at the lake, various physical and chemical data concerning the lake water itself were collected. Temperature of the water at various depths was observed, and pertinent information con-

cerning the chemical composition of the water was obtained. Such data are very important in assisting to determine the degree of adaptability of a lake to the various fish species. All fish have certain ranges of temperature and dissolved oxygen content which they will tolerate, and within these ranges are optima. Not only the ranges, but particularly the optima, vary among the different fish species, as well as among food organisms and other organic life in the waters.

B. Temperature of the Water

Temperatures were taken and water analyses were made on September 3, at two points in the lake, the east and west depressions. The results are shown in Table I. There appeared a variation of only 1.2°C. in the waters

Table I
Summary of Chemical and Temperature Conditions
at Lac LaBelle, September 3, 1941

Station	1		2	
Location	Depression near east end of lake		Depression near west end of lake	
Surface temperature		65.1°F.		65.5°F.
Bottom temperature	(36 feet)	63.3°F.	(27 feet)	63.5°F.
Oxygen, near bottom of lake, in p.p.m.	(35 feet)	8.3	(27 feet)	8.0
Methyl Orange Alkalinity				
Surface		26		...
Bottom	(36 feet)	27	(27 feet)	26
pH				
Surface		6.8		...
Bottom	(36 feet)	6.8	(27 feet)	7.0

of the lake, both surface and bottom. Surface temperatures ranged from 65.1°F. (18.4°C.) to 65.5°F. (18.6°C.) while bottom temperatures showed little change, ranging only from 63.3°F. (17.4°C.) to 63.5°F. (17.5°C.) This temperature series offers somewhat of a surprise to the fisheries investigator. In a northern Michigan lake with a basin such as that of Lac LaBelle, there would be expected, even in early September, as well as during the earlier summer, a stratification of the water into 3 zones,

an epilimnion (zone of warm circulating water), a thermocline (zone of rapid change in temperature, e.g., at least one degree centigrade per meter of depth) and a hypolimnion (zone of cold, non-circulating water below the thermocline). Apparently such stratification is present in Lac LaBelle only during some years, or is present only during the height of the summer. The late Dr. John N. Lowe, in July, 1926, found a thermocline existing at levels below 20 feet. He found a surface temperature of 73.4°F., a temperature of 71°F. at 20 feet, and a bottom temperature (at 26 feet) of 67°F.

The absence or instability of the thermocline in Lac LaBelle may probably be largely attributed to the large surface area of the lake and its relatively shallow depth, which exposes it to violent wind action and thus facilitates extensive water circulation. In addition, there was gathered during the survey some evidence to indicate that there may be a current present in Lac LaBelle, presumably resulting from its direct connection with Lake Superior. Gill nets set at depths of over 20 feet collected considerable amounts of aquatic vegetation and debris, suggesting that a water current had passed through them, since no vegetation was growing at the depths at which the nets were set. A possibility, however, is that violent wind action preceding the observation (of vegetation in the gill nets) had caused a complete circulation of the almost iso-thermal waters of the lake. The finding of a thermocline in the lake by Dr. Lowe in 1926 gives weight to this latter possibility.

The instability or absence of the thermocline in Lac LaBelle probably serves to prevent any stagnation or dangerous depletion of the oxygen supply in the greater depths of the lake, since the period during which no water circulation takes place in this area is either very short or absent. The productive volume and the total water volume in the lake are

thus probably identical. Aquatic life of all kinds can survive at depths from which it might be restricted under otherwise similar conditions, if a thermocline were more permanently present. The instability of the thermocline (and hence thermal stratification) frequently results also in the warming of the water of the entire lake, and so eliminates the continuous preservation of a cold water area below the thermocline for fish of low temperature requirements (e.g. trout). However, the water temperatures at the time of the survey (17.4° to 18.6°C., or about 63° to 65°F.) as well as those taken by Dr. Lowe are sufficiently low for trout. If temperatures became no higher than they were at the time of the survey, throughout the year, Lac LaBelle could support, from the standpoint of temperature, any fish species native to Michigan. However, it is quite certain that higher temperatures unsuitable for trout occur during the warmer part of the summer.

C. Oxygen and Carbon Dioxide

Chemical stratification, like thermal stratification discussed above, does not occur in Lac LaBelle. At both stations where water analyses were made, ample oxygen for all forms of aquatic life was found in the water even near the bottom of the lake. At station 1, near the east end of the lake, at a depth of 35 feet, 8.3 parts per million of oxygen were present, while at station 2, near the west end of the lake, 8 parts per million were found at 27 feet. These are more than double the requirements for survival of the species indigenous to the lake. This much or more oxygen is assuredly present at lesser depths.

Almost no carbon dioxide was found in the lake, the amounts present having no significant bearing on the fishery there.

D. Hardness of the Water

The water in Lac LaBelle is quite "soft", as indicated by Methyl Orange Alkalinity tests, designed to show the degree of hardness of the water resulting from the presence of certain minerals and buffer salts. Methyl Orange Alkalinity ranged from 26 to 27 parts per million. Soft waters are almost without exception much less fertile (productive) than are moderately hard waters. Water of Lac LaBelle falls far short of the 100 to 200 parts per million Methyl Orange Alkalinity generally considered necessary for maximum productivity.

E. pH

The hydrogen ion concentration, or pH, (an expression of intensity of acidity or alkalinity of the water) of Lac LaBelle ranges from 6.8 to 7.2. Seven is the neutral point as regards hydrogen ion concentration and waters which are neutral or slightly to moderately alkaline are normally more productive than are acid waters.

F. Pollution

Any pollution occurring in Lac LaBelle would be restricted to occasional domestic wastes of lakeside cottage owners. The stamp sand at the northwest end of the lake has hardened and is no longer a factor in pollution of the lake. At the present time no pollution is occurring at Lac LaBelle which might be said to be significant in the consideration of the fishery there.

IV. Biological Character of Lac LaBelle

A. Vegetation

Considering the sandy soil covering almost all of the shoal area of the lake, aquatic vegetation in Lac LaBelle is surprisingly abundant, being above average in amount for similar soft water lakes of upper Michigan.

Emergent reeds cover the shallower portions of almost the entire shoreline, and a band of submerged pondweeds lies along the shallower portions of the declivity, beyond the reeds, in much of the lake. While some wave-washed sandy shoals are relatively barren of aquatic plants, vegetation is particularly varied and abundant in a few shallow, protected bays at the west end of the lake. The water is insufficiently transparent to permit the growth of submerged vegetation at depths over about 12 feet. Plants in Lac LaBelle contribute almost all of the shelter present in the lake, except for occasional large deadheads and isolated boulders. A list of the aquatic plants found in Lac LaBelle is shown in Table II.

Table II
Aquatic Plants of Lac LaBelle*

Species	Abundance
Waterweed (Anacharis canadensis)	Common
Water marigold (Megalodonta Beckii)	Sparse
Sedge (Carex sp.)	Abundant
Spike rush (Eleocharis acicularis)	Common
Quillwort (Isoetes Braunii)	Abundant
Bushy pondweed (Najas flexilis)	Common
Yellow Water Lily (Nuphar variegatum)	Common
Reed grass (Phragmites communis)	Abundant
Pondweeds:	
(Potamogeton amplifolius)	Abundant
(Potamogeton gramineus var. graminifolius)	Common
(Potamogeton panormitanus var. minor)	Common
(Potamogeton Richardsonii)	Common
(Potamogeton Robbinsii)	Common
(Potamogeton Spirillus)	Common
Sedge (Scirpus acutus)	Abundant
Wild Celery (Valisneria americana)	Common

* Identifications by B. M. Robertson, Department of Botany, University of Michigan.

B. Plankton

Judging by the samples collected at the time of the survey, plankton (microscopic, free-swimming plants and animals) is quite abundant in Lac LaBelle. Animal plankton is the prevalent type, with crustaceans being the dominant organisms. While extensive seasonal variations in plankton

occur, and although a single group of samples is hardly adequate for making a generalized statement, it appears likely that plankton is present in sufficient quantity to meet the needs of plankton consuming fish species in the lake (e.g. cisco), and of young fish of other species during their early stages of development.

C. Bottom Foods

Invertebrate bottom food is relatively scarce in Lac LaBelle. The sand covering much of the shoal area of the lake is quite barren of aquatic organisms. Dragonfly larvae are the dominant type of organism on the shoals, and form an important food item for fish of several species in the lake. Limited numbers of mayfly nymphs are also present on the shoal areas. Crayfish are quite abundant, particularly toward the west end of the lake. Midge larvae are present in the bottom soils in the deeper areas of the lake. In general, bottom organisms are as abundant as could be expected in a lake with the limited fertility of Lac LaBelle.

D. Fish Present in Lac LaBelle

Species of fish present in Lac LaBelle and their relative abundance, as judged by their occurrence in survey collections, are shown in Table III. Stocking for the 4 years preceding the survey is included. Thirteen separate collections were made with bag seines and gill nets. The number of collections in which the given species occurred is shown in the table. The indicated abundance of game and coarse fish species is derived from consideration of both the total number of individuals taken and the number of samples in which they occurred. Occurrence and abundance of forage fish is based on 3 samples taken with a bag seine.

Table III
List of Fishes Collected in Lac LaBelle With An
Indication of Their Abundance and Artificial Stocking

Species	No. of samples in which species occurred	Abundance	Stocking
GAME FISH			
Perch	11	Abundant	...
Sauger	7	Very common	...
Northern pike	5	Very common	...
Walleye	3	Common	2,130,000
Cisco	3	Common	...
Rock bass	2	Scarce	...
Smallmouth bass	1	Rare	...
Pumpkinseed	1	Rare	...
FORAGE FISH			
Spot-tailed shiner	2	Common	...
Johnny darter	2	Common	...
Iowa darter	2	Common	...
Log perch	1	Common	...
Muddler	1	Rare	...
COARSE FISH			
Suckers	7	Common	...

As shown in the table, perch, ranging in size up to 11 inches, were caught more frequently and in greater numbers than any other game species, with sauger, up to 16 inches, and northern pike, up to $2\frac{1}{2}$ pounds well represented in the catch. Somewhat fewer walleyes, up to $4\frac{1}{2}$ pounds, and ciscoes ranging up to 13 inches in length, were taken, with other fish species very much in the minority. Largemouth bass, not collected during the survey, have been reported by anglers on rare occasions.

The occurrence and abundance of game fish in Lac LaBelle agrees quite well with observations made by the late Dr. John N. Lowe in July, 1926, although he listed sauger as being rare at that time. Dr. Lowe also reported that sturgeons were once present in the lake, but were thought to be extinct by 1926. Although only a single fingerling smallmouth bass appeared in the 1941 collections, Dr. Lowe reported that smallmouth bass were found on the east shore of the lake, although "not overly abundant". An entry in the Detroit Free Press Fishing Contest for 1934 lists the capture

by angling of a 5 pound, 20½ inch long smallmouth bass by a resident of Laurium, Michigan. Other catches of smallmouth bass have been reported from time to time by anglers (as shown in Table IV), but by and large this species is quite rare in the lake.

Among the forage fish, spot-tailed shiners were found to be quite common in localized areas, with darters and log perch occurring quite frequently along much of the shoreline. Many young-of-the-year perch were taken in the seining near shore and this species is without doubt the most important forage fish in the lake.

Common suckers ranging up to 16 inches in length are the dominant coarse fish in the lake. Two bullheads were reported caught in 1931. No obnoxious species were collected and none have been reported in recent years.

E. Creel Census

As a part of the Michigan general creel census, conservation officers have taken occasional creel records at Lac LaBelle since 1928. Although the numbers of records taken are insufficient in number to represent a random cross-section of the fishing, they are summarized in Table IV, below. The records indicate that northern pike, walleyes and perch were most frequently taken by the anglers questioned. Average sizes are not available for some of the individual species of fish caught, and so are omitted from the table. If the records were representative of the quality of fishing in the lake, it would be indicated that the catch per hour in Lac LaBelle has been below the average for the state as a whole during the period covered, but about equal to the other pike lakes of the Upper Peninsula.

F. Growth Rate of Fishes of Lac LaBelle

In Table V is shown the rate of growth of several of the more important game fish species in Lac LaBelle. The average length of fish of a given age

Table IV
Creel Census Data for Lac LaBelle

Year	Number of fishermen	Taking No. Fish		Total hours fished	Legal fish caught	Catch per hour	Catch per fisherman	Ave. size of fish (inches)	Illegal fish caught	No. hours per fisherman day
		Number	Per cent							
1928	3	0	0	16	6	0.37	2.0	19.7	1	5.3
1929	27	7	26	114	60	0.53	2.2	18.0	1	4.2
1930	92	33	36	170½	54	0.32	0.6	15.4	14	1.9
1931	133	43	32	331½	148	0.45	1.1	19.0	27	2.5
1935	2	0	0	14	11	0.79	5.5	14.0	3	7.0
1938	4	2	50	8½	2	0.24	0.5	19.5	0	2.1

Number and Average Size of Each Species

Year	Brook Trout		Smallmouth Bass		Yellow Perch		Walleyes		Northern Pike		Bullhead		Common Sucker	
	No.	Size in inches	No.	Size in inches	No.	Size in inches	No.	Size in inches	No.	Size in inches	No.	Size in inches	No.	Size in inches
1928	...	...	3	15	...	...	1	...	2	...	...	...	...	...
1929	...	...	1	...	4	...	25	...	25	...	...	...	5	...
1930	...	...	1	11	13	...	5	18	34	...	...	...	...	...
1931	3	...	...	...	16	...	28	...	98	...	2	...	1	20
1935	...	...	...	...	3	...	8	...	...	...	...	...	...	...
1938	...	...	...	...	...	...	...	...	2	19.5	...	...	...	...

and species is shown together with an indication of the numbers of individuals upon which the average is based. Averages derived from only one or a few individuals are not significant due to the fluctuation in size within the age groups. The ages shown represent the summers of growth which the fish have completed, which does not include the summer of 1941. Since the fish were collected in September, they were in every case almost a full growing season older than shown in the table.

The table shows that northern pike have a very good growth rate, reaching legal size during the second summer of life. Walleyes apparently reach legal size during their 4th summer of life, which is about average for the species in upper Michigan. Growth of perch is only fair, since slightly over 3 full summers is probably required before "keeper" size of 6 inches is reached. Inadequate data suggest that rock bass may be creeled only after they are well along into their 5th summer of growth. Sauger are not protected by minimum size or bag limit restrictions. They reach fair food fish size during their third summer of growth.

Table V
Growth Rate of Fishes of Lac LaBelle

Age Group	Perch		Northern pike		Sauger		Walleye		Cisco		Rock bass		Common sunfish	
	No.	Ave. size (inches)	No.	Ave. size (inches)	No.	Ave. size (inches)	No.	Ave. size (inches)	No.	Ave. size (inches)	No.	Ave. size (inches)	No.	Ave. size (inches)
I	1	4 3/8	3	14 5/8	...	...	...	...	...	...	...	...	1	3 1/2
II	1	6	3	18 7/8	3	11 1/2	2	13	...	...	1	4 1/2	...	...
III	14	6 5/8	4	21 7/8	2	11 7/8	...	...	...	...	...	...	...	...
IV	9	7 3/8	...	...	1	13 1/2	1	16 3/4	6	10	1	6	...	...
V	6	8 1/4	...	...	3	14 1/8	1	18 3/4	1	9 3/4	1	7 5/8	...	...
VI	11	8 7/8	...	...	3	14 1/4	...	...	...	...	...	...	...	...
VII	1	9 1/4	...	...	...	...	...	...	...	...	...	...	...	...
VIII	2	9 1/8	...	...	...	...	...	...	...	...	...	...	...	...

G. Food Habits of Fishes of Lac LaBelle

Study of the food habits of the dominant fish species of Lac LaBelle was restricted to field analyses of the stomach contents of fish taken during the survey. It seemed convincingly established that the yellow perch is the outstanding food fish in Lac LaBelle, particularly during its first summer of life. Perch were found in the stomachs of sauger, northern pike, walleyes, rock bass and perch, and appeared in 11 out of 18 stomachs examined which contained any food at all. Fifteen perch fingerlings were found in the stomach of a 16 3/4 inch walleye and 11 were found in the stomach of a northern pike. A two-summer old, $4\frac{1}{2}$ inch perch was caught by the writer while fishing experimentally with a perch fingerling for bait. In addition to the young-of-the-year perch, juvenile and adult perch are common items on the menus of the larger pisciverous fish in the lake. An 8 inch perch was found in the stomach of a $23\frac{1}{2}$ inch northern pike, while another (24 inch) pike was found to have consumed a 10 1/4 inch perch.

Large dragonfly nymphs, but no other insects, were found in 6 out of 8 perch stomachs examined, while a crayfish was found in another stomach of a perch. Crayfish are surprisingly common in the lake (considering the low alkalinity) and are no doubt frequently eaten by many of the fish species.

H. Natural Propagation

Spawning facilities for all the important species in Lac LaBelle, with the possible exception of the walleyed pike, are apparently quite adequate.

Ample vegetation is present for spawning of yellow perch, as shown by the large numbers of young-of-the-year perch which can be seen near shore in all parts of the lake.

Northern pike have maintained their numbers in the lake for years without artificial stocking, and probably spawn in the shallow, somewhat flooded, marshy areas adjacent to the Gratiot River outlet into Lake Superior. In addition, they are known to run up the Little Gratiot River in the very early spring, presumably for spawning.

While little is known concerning the spawning behavior of saugers under inland lake conditions, the fact that this species is abundant now, although classified as rare by Dr. Lowe in 1926, permits the assumption that spawning facilities are adequate. The apparent rise in population has not been due to artificial stocking.

Cisco require no specialized facilities for spawning, but spawn in shallow water over shoal areas in late fall. There can be no question of adequate habitat in the lake for the natural reproduction of this species.

The presence of 4 age groups of rock bass, including young fingerlings, constitutes ample evidence that this species is reproducing naturally in Lac LaBelle. The presence of young-of-the-year smallmouth bass makes the same statement true in the case of this species. Although little gravel was seen along the shoreline at the time of the survey, there are localized areas where fine gravel is mixed with the sand on shoal areas, which should be suitable for the construction of the nests of these fish. The absence of large numbers of smallmouth bass and rock bass in the lake at the present time is no doubt due to annual decimation of numbers of young by the piscivorous species of fish which are prevalent in the lake rather than to inadequacy of spawning facilities. None of Michigan's pike lakes support good populations of pan fish other than perch during periods when the pike population is high.

Natural reproduction of walleyes in Lac LaBelle might be questioned. There are at present no shoal areas with a rubble or coarse gravel bottom

type, on the lee shore of the lake. It has not yet been established that this is the only kind of habitat which encourages walleye spawning, however, and natural reproduction might occur under somewhat different conditions. Continued heavy stocking of the lake with walleye fry in the past makes it difficult to judge the success of natural reproduction by reference to numbers of adult fish present.

Several inlet streams provide ample habitat for the spawning of common suckers indigenous to the lake.

V. Management Suggestions

A. Designation of Lake

Lac LaBelle is at the present time designated as a pike lake and the foregoing discussion supports this designation. There is no reason for changing the lake to a different classification at the present time, and it is highly unlikely that a change in designation could be justified at any time in the near future.

B. Stocking

As has been stated, artificial stocking in Lac LaBelle during recent years has been restricted to the planting of large numbers of walleye fry each year. It does not seem that any advantage could be gained by stocking any other species and even the stocking of walleyes might be questioned. If it can be shown that walleyes reproduce naturally in the lake, stocking of this species might be superfluous or harmful. On the other hand, if artificial stocking is responsible for the present population of walleyes in the lake, its continuation might be justified. The matter of whether or not natural reproduction does occur might be determined in several ways, as follows: (1) By observations conducted with a spotlight from a boat at night along the south and southwest shores of the lake, to determine whether or not adults are spawning. Observations should be made soon after the ice cover leaves the lake in the spring, after the water has reached

a temperature of between 40 and 50°F. on the shoals. (2) By examination of the bottom on shoal areas during the first two weeks in May to determine whether eggs are present. (3) By use of a 3/4 inch mesh gill net during September or October to capture young-of-the-year walleyes (applicable only if walleyes have not been artificially stocked during the previous spring). (4) By setting experimental gill nets during 1943 or 1944 to attempt to capture walleyes of a year class such that their hatching would date back to the spring of 1941, when no walleyes were stocked. (Possibility of influx of foreign fish from Lake Superior would need to be considered, however, although walleyes are very rare at this point in Lake Superior.)

In the absence of adequate information concerning the various ramifications of spawning behavior of walleyes, and in view of the absence in the lake of habitat which is known to be suitable for their spawning, it is recommended that walleye stocking be continued during alternate years (starting again in 1942) until further information can be obtained at the lake.

C. Predators

Predators at Lac LaBelle are limited to considerable numbers of mergansers, limited numbers of kingfishers, and occasional loons and otters. Predators are insufficient in number to cause significant harm to the fishery at Lac LaBelle, and control measures cannot be justified.

D. Parasites

A moderate amount of parasitation was found in perch, sauger and northern pike, with a single observation of an adult tapeworm in the stomach of a walleyed pike. In the former 3 species, the skin and liver were the parts most frequently affected. Seven perch and 2 sauger were found during the survey which had livers which were encysted to a greater

or less degree, and the skins of 3 perch, 2 sauger and 2 northern pike were infected with the common black spot parasite. Both types of parasites have water birds as alternate hosts and are difficult or impossible to control. In view of the fact that neither appreciably affects the quality of the flesh, or, insofar as is known, adversely affects the growth and development of the infected fish, no control measures are here recommended.

E. Cover

Cover now present at Lac LaBelle includes the zone of vegetation which follows the periphery of almost the entire lake, extending out into the water to varying distances, and a considerable number of deadheads scattered along the south and west shores. This amount of cover is adequate during the period of the year when all of it is present, i.e., during the growing season of the vegetation. During the summer and fall, young-of-the-year fry and fingerlings are given a sufficiently good opportunity to escape predation to more than insure the perpetuation of the original numbers of their species. In considering the management of a pike lake, however, we are dealing with species of fish (particularly northern pike) which feed voraciously throughout the winter. Many other species (such as Centrarchids and some forage fishes) are less active. In a lake such as Lac LaBelle, after the vegetation has died off in late fall, the almost undiminished activity of the pike, the decreased activity of other species, and the absence of protective shelter combine to place many of the forage fishes and fingerling game fishes at a distinct disadvantage with respect to their predators. This situation is probably largely responsible for the fact that the numbers and species of forage fish in Lac LaBelle, as revealed by the survey, are anything but impressive. Spot-tailed shiners, present in some numbers in very localized areas, log perch, and a few darters appear to

be the only purely forage fish in the lake.

Considering the foregoing discussion, it appears logical to here recommend that additional shelter, available to young fish during the winter months, be placed in Lac LaBelle. A sufficient quantity of the usual type of brush shelters, not too large in size, would, it is believed, provide sufficient protection during the winter to assist in carrying over a larger brood stock of forage fish each year for spawning in the spring, than would otherwise be possible. The ultimate objective of the addition of brush shelters would of course be an increase in the numbers and growth of game fish as a result of the eventual net increase in available forage fish. In addition, fishing in Lac LaBelle during at least the early part of the season, before vegetation becomes established, might improve as a result of an expected concentration of game fish in the vicinity of the brush shelters due to the presence of forage fish there. This concentration of game fish has some importance in a lake of the relatively low productivity, and hence relatively limited, widely scattered fish population, of Lac LaBelle, as it improves the angler's possibility of success.

Shelters should be placed at depths of from 8 to 15 feet to be most effective. The gradual contours of the south and west shorelines would adapt themselves better to the installation of such shelters than would the steeper declivities of the north shore. Shelters might best be placed at intervals of from 200 to 300 feet, and more or less paralleling the 10-foot contour line. Between 75 and 100 shelters should be adequate to produce effective results.

F. Regulation of the Water Level

Water fluctuation at Lac LaBelle is minimal, being limited more or less to the amount of fluctuation in Lake Superior. There is no indication

that a higher or lower water level would be of benefit to the fishery there. Although a rise of one or two feet in level would flood considerable areas which would be ideal for spawning of northern pike, there is no indication that the spawning habitat now available to this species is inadequate to sustain the maximum possible population. In view of this, no regulation of the water level seems required.

G. Improvement of Spawning Facilities

As has been mentioned above, spawning facilities in Lac LaBelle at the present time appear to be entirely adequate for all species indigenous to the lake, with the possible exception of walleyed pike. Until more information is obtained concerning the spawning habits of this species, no improvements in spawning facilities can be recommended.

H. Further Observations

Observations should be made at Lac LaBelle in the manner outlined earlier in this report to determine whether or not walleyed pike reproduce under the conditions extant there.

Lac LaBelle gives the impression of carrying just about the maximum fish population of which a lake of its limited basic fertility is capable. Due to the prohibitive cost, the lake's production of game fish could not justifiably be increased by known improvement methods (e.g., fertilization) under existing fishing pressures.

Should further data be desired concerning anglers' catches in typical Michigan pike lakes, Lac LaBelle offers a good opportunity for an intensive creel census as there are only two points--Bete Grise and Lac LaBelle Village--where fishermen can enter and leave the lake.

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