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A FISHERIES SURVEY OF BREVOORT LAKE, MACKINAC COUNTY

by

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Introduction

Location and Drainage

Brevoort Lake is located in Mackinac County (T.41-42N, R.5W.), about 18 miles northwest from St. Ignace. It is easily accessible by gravel roads from old U.S. 2 on the north and new U.S. 2 on the south. The closest village is Moran, which lies  $2\frac{1}{2}$  miles east from the lake.

The lake lies in the Brevoort River drainage system. Brevoort River originates roughly 15 miles northwest of the lake and drains perhaps 30 square miles. Other small streams entering the lake drain about 20 square miles, making the total watershed of Brevoort Lake approximately 50 square miles. Brevoort River, after leaving the lake on the south side, turns rather abruptly to the southeast and parallels the Lake Michigan shore for a distance of 3 miles, then swings around to the south and reverses its course and flows northwest for a mile and a half before turning toward, and flowing into, Lake Michigan. While Brevoort Lake is only  $1\frac{1}{2}$  miles from Lake Michigan, the river covers a distance of about 7 miles in reaching Lake Michigan.

### Acknowledgements

A good map of the lake was prepared in 1938 by the U. S. Forest Service; this map was used for reference in conducting the fisheries survey<sup>√</sup> during July and August, 1942.

We wish to acknowledge the cooperation and help afforded the survey crew by Mr. Alfred Kothhelfer, operator of the Black Point Resort; Mrs. Jean Bassett, operator of Bassett's Resort; and Mr. Highstone from St. Ignace.

### Past and Present Use

Brevoort Lake was used in the lumbering industry for floating logs. Logs were placed in the lake, floated across to the outlet, from which point they were carried by Brevoort River to Lake Michigan.

The present use of the lake is entirely recreational. It lies in a climatic region which is attractive to vacationists from points farther south. The region is rich in scenic beauty, another tourist attraction. In addition to the recreational opportunities provided by the north country, the lake itself offers excellent swimming beaches and good fishing. Brevoort Lake has maintained a reputation as a good fishing lake for many years although, according to local reports, it has suffered a decline in the quality of fishing during the last few years. The muskellunge is the big fishing attraction, although many other game species are taken.

There are nine resorts and boat liveries, and one hotel, in operation on the lake. To accommodate campers, the United States Forest Service has provided a public camping ground on the west end of the lake. The total number of cottages, including those in the resorts and those privately owned, is about 110.

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<sup>√</sup> The fisheries survey party consisted of: H. E. Kilpela, leader; R. D. Van Deusen, S. J. Lievense, and P. Galvin, assistants.

## Physical Characteristics

### Geological Origin

According to Scott,<sup>1</sup> Brevoort Lake was at one time an arm of Lake Michigan but was separated from the main body of the lake by a bar formation. Sand dunes formed on the bar and through a long period of years have developed to such an extent that the two bodies of water are now separated by a mile and a half of low sand dunes through which Brevoort River has maintained its channel. Scott is unable to account for the depression in which Brevoort Lake lies.

### Shape of Basin and Extent of Drainage

The lake is five and one half miles long and has a maximum width of nearly two and one half miles. The maximum depth is 30 feet.

The drainage area includes about 50 square miles. Most of this area is rolling and covered with second-growth hardwoods. A small percentage of the land is cleared and under cultivation, but due to sandy soil and topography, the farm land is decidedly marginal.

### Water Fluctuation

At present the annual water fluctuations in Brevoort Lake is not great. A concrete dam at the outlet, constructed by the U. S. Forest Service, has raised the water level about four feet above its former level. During August, 1942, the lake level was four inches below the top of the dam. It is therefore likely that at present the annual fluctuation in water level does not exceed six or eight inches.

A by-pass has been constructed a short distance from the dam and enters Brevoort River immediately below the concrete dam. A dam containing slash boards has been placed at the point where the by-pass leaves the lake. The lake level can be lowered by removing slash boards from this dam.

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<sup>1</sup>Scott, I. D., 1920, Inland Lakes of Michigan.

Neither dam affords facilities for fish movements.

Brevoort Lake has three inlets; Brevoort River and Silver Creek on the west end, and Cut River on the north side near the east end. These streams are all relatively short. In addition to these streams, there are two small inlets between Black Point and Cut River.

Some of the physical features of Brevoort Lake are given in the following table.

Table I. Some physical features of Brevoort Lake, Mackinac County.

1. Area 4,230 acres
2. Maximum depth 30 feet
3. Shore development 1.5~~4~~
4. Dominant bottom types
  - a. Shallows (0-15 feet) predominantly sand, grading into pulpy peat.
  - b. Depths (over 15 feet) pulpy peat, traces of muck.
5. Color of water - slightly brown
6. Transparency of water  
(Secchi disc reading) 6 to 8 feet.

∇This means that Brevoort Lake has a shoreline 1.5 times longer than the shoreline of a perfectly round lake of the same size.

#### Discussion of Physical Factors in Relation to Fisheries

As a general rule, small shallow lakes are the most productive lakes. As the depth and size increase, productivity decreases. Deep lakes have a larger percentage of water into which the light does not penetrate than do shallow lakes and plants, depending on light, are absent in deeper waters. Brevoort Lake is considered a shallow lake and a large percentage of the lake is suitable for plant growth, at least from the standpoint of depth.

Large lakes frequently are low in productivity due to wave and ice action. These factors have a definite effect on Brevoort Lake. Much of the shallow area is scoured by waves and ice to such an extent that

vegetation is not able to become established. This means limited cover for forage fish, young game fish, and for many of the fish-food organisms in the depth of water which these small fish naturally inhabit.

The limited transparency, due partially to suspended organic matter stirred up by waves, may account for the lack of vegetation in the deeper waters (over 10 feet).

#### Temperature and Chemical Conditions

##### Temperature

There is no thermal stratification in Brevoort Lake. In other words, there is little difference between the temperature of the surface water and the water on the bottom. At one sampling station in late July, the surface temperature was 74°F. and the bottom (27 feet) temperature was 71°F.

##### Chemical Conditions

Oxygen is plentiful in all parts of the lake during the summer months. This is an aid to continuous production of fish because fish and fish foods can utilize the entire lake. No check has been made of the oxygen content during the winter months but there are no records of winter-kill, so it is safe to assume that oxygen is plentiful.

The methyl orange alkalinity, a measure of hardness, of the water ranged from 78 to 87 parts per million. This means that the water is moderately soft and, while not ideal for the growth of shell forming organisms, many such organisms grow well in waters this soft or softer.

The water is slightly alkaline, the pH ranging from 7.2 to 7.8 (7.0 is neutral).

In general, the temperature and chemical conditions in Brevoort Lake favor good growth of fish and fish foods.

The various temperature and chemical data are summarized in Table II.

Table II. Chemical and temperature data of Brevoort Lake, Mackinac County.

|                           |         |           |
|---------------------------|---------|-----------|
| Date                      | 7/28/42 |           |
| Temperature (°F.)         |         |           |
| Surface                   |         | 72.8      |
| Bottom (27 ft.)           |         | 70.7      |
| Oxygen (p.p.m.)           |         |           |
| Surface                   |         | 7.5       |
| Bottom (27 ft.)           |         | 7.1       |
| M. O. alkalinity (p.p.m.) |         | 78.0      |
| pH range                  |         | 7.1 - 7.2 |

Pollution

No pollution was observed or reported.

Discussion of Temperature and Chemical Factors in Relation to Fisheries

The temperature and chemical conditions in Brevoort Lake are suitable for the growth of warm water fish only. Summer temperatures are too high for trout, but trout from Brevoort River occasionally enter the lake in winter. Oxygen conditions are favorable throughout the year in all parts of the lake.

Biological Characteristics

Vegetation

A list of plants and their relative abundance is given in Table III.

There are 40 different kinds of plants in Brevoort Lake. In spite of the wide variety of plants, however, vegetation is not particularly abundant. The shallow areas support bulrushes and similar emergent plants where there is exposure to wave action, and water lilies where protection is afforded. In general, the shallow areas are only sparsely vegetated and as a result there is a limited amount of cover for fish normally occupying this habitat.

Some extensive weed beds are found in water 5 - 10 feet deep, and in this zone there is adequate cover and undoubtedly a generous supply of fish

Table III. List of species<sup>✓</sup> and relative abundance of plants in Brevoort Lake, Mackinac County.

| Common Name            | Scientific Name  | Relative Abundance |
|------------------------|--|--------------------|
| Waterweed              | <u>Anacharis canadensis</u>                            | Few                |
| Sedge                  | <u>Carex rostrata</u>                                  | Few                |
| Coontail               | <u>Ceratophyllum demersum</u>                          | Few                |
| Musk grass             | <u>Chara sp.</u>                                       | Few                |
| Three-way sedge        | <u>Dulichium arundinaceum</u>                          | Few                |
| Spike rush             | <u>Eleocharis Smallii</u>                              | Few                |
| Scouring rush          | <u>Equisetum fluviatile</u>                            | Few                |
| Water star grass       | <u>Heteranthera dubia</u>                              | Few                |
| Mare's tail            | <u>Hippuris vulgaris</u>                               | Few                |
| Blue flag              | <u>Iris versicolor</u>                                 | Few                |
| Duckweed               | <u>Lemna minor</u>                                     | Few                |
| Star duckweed          | <u>Lemna trisulca</u>                                  | Few                |
| Water marigold         | <u>Megalodonta Beckii</u>                              | Few                |
| Water milfoil          | <u>Myriophyllum exalbescens</u>                        | Common             |
| Bushy pondweed         | <u>Najas flexilis</u>                                  | Common             |
| Musk grass             | <u>Nitella sp.</u>                                     | Few                |
| White water lily       | <u>Nymphaea sp.</u>                                    | Few                |
| White water lily       | <u>Nymphaea tuberosa</u>                               | Few                |
| Yellow water lily      | <u>Nuphar variegatum</u>                               | Common             |
| Smartweed              | <u>Polygonum natans</u>                                | Few                |
| Pondweed               | <u>Potamogeton americanus</u>                          | Few                |
| Large-leaf pondweed    | <u>Potamogeton amplifolius</u>                         | Common             |
| Leafy pondweed         | <u>Potamogeton epihydrus</u>                           | Common             |
| Pondweed               | <u>Potamogeton Friesii</u>                             | Common             |
| Variable pondweed      | <u>Potamogeton gramineus</u> var. <u>graminifolius</u> | Abundant           |
| Floating-leaf pondweed | <u>Potamogeton natans</u>                              | Abundant           |
| Sago pondweed          | <u>Potamogeton pectinatus</u>                          | Common             |
| Whitestem pondweed     | <u>Potamogeton praelongus</u>                          | Abundant           |
| Clasping-leaf pondweed | <u>Potamogeton Richardsonii</u>                        | Abundant           |
| Robbins' pondweed      | <u>Potamogeton Robbinsii</u>                           | Few                |
| Flat-stemmed pondweed  | <u>Potamogeton zosteriformis</u>                       | Abundant           |
| Reed grass             | <u>Phragmites communis</u>                             | Few                |
| Duck potato            | <u>Sagittaria latifolia</u>                            | Common             |
| Three-square           | <u>Scirpus americanus</u>                              | Common             |
| Great bulrush          | <u>Scirpus validus</u>                                 | Abundant           |
| Bur reed               | <u>Sparganium eurycarpum</u>                           | Few                |
| Cattail                | <u>Typha latifolia</u>                                 | Few                |
| Bladderwort            | <u>Utricularia vulgaris</u> var. <u>americana</u>      | Few                |
| Wild celery            | <u>Vallisneria americana</u>                           | Few                |
| Wild rice              | <u>Zizania aquatica</u>                                | Few                |

✓ Identifications checked by Mrs. B. Clarke.

food because most submergent weed beds are rich in invertebrate life.

No plants are reported from water deeper than 10 feet. This may be due in part to the limited transparency of the water, as discussed previously.

#### Fish Foods

The food of fish varies considerably with the habits of the different species and also with the age of the same species. Young fish of most species feed on plankton, small plants and animals that float freely in the water. Adult fish vary in their feeding habits. Some feed on plankton, some on insects and other invertebrates, and some on fish. Hence it is important that a lake contain all of these organisms in order to maintain a fish population.

Plankton was abundant at the time of the survey. Algae -- small plants-- were more plentiful than animal forms.

Bottom organisms were not abundant in the main body of the lake, although the bays were quite productive. It is believed, however, that many bottom organisms are unavailable to the fish, and that insects found among weed beds are used more extensively as food.

Forage fish seemed rather limited at the time of the survey. This is probably due to the fact that these species were in deeper water than can be seined. Golden shiners, for example, were reported in the west bay in large numbers in the spring. During mid-summer they undoubtedly take refuge in the weed beds, which in Brevoort Lake lie chiefly between the five- and ten-foot contours. It is therefore probable that forage fish are more plentiful than seining operations indicate.

#### Fish Present

A list of the fish and their relative abundance as recorded by the survey party is given in Table IV. The total numbers of each species stocked during the last five years is included.



Table IV. Kinds and relative abundance of fish in Brevoort Lake, Mackinac County. Stocking Records (1937 - 1941) are included.

| <u>Species</u>    | <u>Abundance</u> | <u>Stocking</u>                       |
|-------------------|------------------|---------------------------------------|
| <u>Game</u>       |                  |                                       |
| Northern pike     | Abundant         | ...                                   |
| Yellow perch      | Abundant         | 11,000 - 7 month                      |
| Pumpkinseed       | Abundant         | 12,060 - 1-5 inches                   |
| Rock bass         | Common           | ...                                   |
| Bluegill          | Common           | 56,000, 3-4 month; 10,500, 1-5 inches |
| Black crappie     | Few              | ...                                   |
| Smallmouth bass   | Few              | 3,975, 3-4 month; 139 adult           |
| Largemouth bass   | Few              | 10,625 fingerlings                    |
| Muskellunge       | Few              | ...                                   |
| Walleyed pike     | Few              | 3,440,000 fry                         |
| Smelt             | Reported         |                                       |
| <u>Forage</u>     |                  |                                       |
| Common shiner     | Common           |                                       |
| Golden shiner     | Common           |                                       |
| Sand shiner       | Few              |                                       |
| Blunt-nose shiner | Few              |                                       |
| Johnny darter     | Few              |                                       |
| Iowa darter       | Few              |                                       |
| Black-nose shiner | Reported         |                                       |
| Muddler           | Reported         |                                       |
| <u>Coarse</u>     |                  |                                       |
| Common sucker     | Abundant         |                                       |
| Black bullhead    | Common           |                                       |
| Brown bullhead    | Common           |                                       |
| <u>Obnoxious</u>  |                  |                                       |
| Carp              | Reported         |                                       |
| Dogfish           | Reported         |                                       |
| Long-nosed gar    | Reported         |                                       |

Brevoort Lake contains nearly every species of game fish common to inland lakes of Upper Michigan, with the exception of trout. Of the game fish, the survey party took more northern pike than any other species. This does not necessarily imply that they are the most abundant species because individuals of this species range farther in search of food than do most species, and are more readily taken in gill nets due to their slender jaws and large teeth. The large number taken, however, does indicate that pike are numerous and should provide good fishing.

Forage fish, while not taken in great numbers by the survey party, are probably fairly numerous.

Coarse fish are limited to suckers, and black and brown bullheads. These fish are believed to have no detrimental influence on the game fish in Brevoort Lake.

No obnoxious fish were taken, but three species have been reported. The relationship between the obnoxious fish and game fish is not clearly understood.

#### Growth Rate of Game Species

The growth rate of the game fish, as determined from scale samples taken during the survey, is given in Table V.

The perch in Brevoort Lake are growing slower than the average for the state, at least during the first several years of life. All other species, for which state averages are available, are making average growth or better. Average northern and walleyed pike reach legal size (14 inches) during their second and third summers respectively, and the Brevoort Lake fish are above average in growth rate.

Table V. Growth rate of game fish in Brevoort Lake, Mackinac County

| Species         | Age Group <sup>√</sup> | Number | Average Length<br>(inches) | Average for<br>State (inches) |     |
|-----------------|------------------------|--------|----------------------------|-------------------------------|-----|
| Northern pike   | I                      | 25     | 17.1                       | ...                           |     |
|                 | II                     | 20     | 21.0                       | ...                           |     |
|                 | III                    | 9      | 23.9                       | ...                           |     |
|                 | IV                     | 5      | 27.7                       | ...                           |     |
|                 | V                      | 4      | 26.4                       | ...                           |     |
|                 | VI                     | 2      | 33.0                       | ...                           |     |
| Muskellunge     | III (?)                | 1      | 25.5                       | ...                           |     |
|                 | XII (?)                | 1      | 50.5                       | ...                           |     |
| Largemouth bass | II                     | 1      | 9.8                        | 8.4                           |     |
|                 | VIII                   | 1      | 18.4                       | ?                             |     |
| Smallmouth bass | I                      | 1      | 6.4                        | 6.0                           |     |
|                 | II                     | 3      | 9.4                        | 8.8                           |     |
|                 | III                    | 1      | 13.6                       | 10.7                          |     |
|                 | IV                     | 3      | 14.2                       | 13.3                          |     |
|                 | VI                     | 1      | 17.2                       | 15.2                          |     |
|                 | Bluegill               | III    | 3                          | 6.9                           | 5.6 |
| Bluegill        | IV                     | 5      | 8.1                        | 6.7                           |     |
|                 | V                      | 2      | 8.9                        | 7.4                           |     |
|                 | VI                     | 8      | 9.0                        | 7.8                           |     |
|                 | VII                    | 2      | 9.8                        | 7.9                           |     |
|                 | Pumpkinseed            | III    | 32                         | 5.3                           | 5.8 |
|                 | IV                     | 7      | 6.9                        | 6.4                           |     |
|                 | V                      | 2      | 7.4                        | 6.8                           |     |
| Pumpkinseed     | VI                     | 13     | 8.1                        | 7.1                           |     |
|                 | VII                    | 2      | 8.3                        | 7.8                           |     |
|                 | Perch                  | II     | 2                          | 4.5                           | 6.2 |
|                 | III                    | 8      | 5.6                        | 7.1                           |     |
|                 | IV                     | 11     | 6.2                        | 7.8                           |     |
|                 | V                      | 8      | 7.5                        | 9.4                           |     |
|                 | VI                     | 5      | 8.7                        | 10.2                          |     |
| Perch           | VII                    | 3      | 10.4                       | 10.4                          |     |
|                 | VIII                   | 1      | 12.5                       | 11.3                          |     |
|                 | Black crappie          | I      | 5                          | 4.4                           | 5.3 |
|                 | II                     | 1      | 6.6                        | 5.9                           |     |
| Black crappie   | V                      | 1      | 11.5                       | 9.7                           |     |
|                 | VI                     | 2      | 12.1                       | 10.1                          |     |
|                 | Rock bass              | III    | 9                          | 5.1                           | 4.9 |
|                 | IV                     | 21     | 6.3                        | 5.6                           |     |
|                 | V                      | 12     | 7.4                        | 6.6                           |     |
|                 | VI                     | 2      | 8.4                        | 8.3                           |     |
| Rock bass       | VII                    | 2      | 9.7                        | 8.7                           |     |
|                 | VIII                   | 2      | 10.8                       | 9.6                           |     |
|                 | Walleyed pike          | III    | 3                          | 18.3                          | ?   |
| Walleyed pike   | IV                     | 1      | 21.1                       | ?                             |     |

<sup>√</sup> Indicates number of year-marks (annuli). To find number of summers of growth, add 1 to the Age Group. For example a fish caught in August having 2 annuli has completed most of -3 summers of growth.

### Natural Propagation

Young of the year of all species, except the northern pike, walleyed pike, and muskellunge, were taken in large numbers. (The young of these three species are seldom taken by seining.) This indicates that spawning facilities are adequate and that these species are able to maintain their numbers by natural propagation. The large number of northern pike in the lake is proof of their successful propagation. Whether or not walleyes spawn in the lake is not known.

Spawning facilities are adequate for all species except perhaps the walleye.

### Management Proposals

#### Designation of the Lake

Brevoort Lake is at present in the "all other" lakes classification, having been changed from a "pike" lake in 1938. The reason for the change was the reported decline in the pike fishing, and it was hoped that the added protection resulting from this change would allow the pike to increase.

The present classification protects the pike during the early summer when they are more readily taken. (Pike lakes are open to fishing on May 15; "all other" lakes are opened on June 25.) It also protects the bass during the same time. They are legally protected in pike lakes until June 25, but it is frequently reported that on large lakes such as Brevoort Lake quite a few bass are killed or taken prior to June 25 in spite of the best law enforcement possible.

Protection of the pike may allow them to increase to such an extent that the bass population may suffer more by predation of the pike than by the illegal kill in a pike lake classification. Too, the pike might interfere with the muskellunge if the former were to become too numerous.

It is evident that there is a fairly large pike population in the lake

and it is difficult to understand why pike fishing is not better than it is. However, since the change in designation has been made quite recently, it is considered advisable to see what effect the change will have over a period of a few more years. It may be that the present population of pike has resulted from the change, since the majority of the pike taken were relatively young (Age Groups I and II). If this is the case, fishing should be much better in 1943 and 1944. However, the present designation should be maintained until such time as pike fishing is improved or until it becomes evident that the pike population is increasing to the point of becoming detrimental to the bass or muskellunge. The present designation also affords protection to the pan fish and they should act as "buffer populations," meaning that the pike may feed more heavily on them and to a lesser extent on the bass.

The lake was closed to spearing in 1941, and should remain closed, at least for the time being.

#### Stocking

In view of the fact that Brevoort Lake contains large numbers of game fish, and all species except perhaps the walleyed pike are reproducing successfully, it is recommended that all stocking be discontinued for the present.

Several requests have been made for the introduction of adult walleyes. This is believed to be undesirable because of the effect it might have on the muskellunge. There are several fish-eating species in the lake at present and it is felt that the increase in number of such species should not be encouraged.

Requests have also been made for adult northern pike, but the large present population indicates that there is no need for planting. Similar requests have been made for bass, but the number of young bass found by the

party indicate adequate natural propagation.

#### Predators and Parasites

No parasites or predators were found to be present in sufficient numbers to warrant concern. Perch and pike were found to be lightly infested with black spot (*Neascus*) and yellow grub (*Clinostomum*), and smallmouth bass contain the bass tapeworm (*Proteocephalus*) common to many inland lakes. No serious infestations have been reported, and these parasites are not harmful to man.

#### Shelter

Shelter is scarce in the shallow water, but is generally adequate in the deeper water (5-10 feet). Due to the tremendous amount of wave and ice action, it would be very difficult to maintain artificial cover devices except beyond the five-foot depth, although their construction would undoubtedly tend to concentrate certain game species and improve fishing.

#### Regulation of Water Level

The present dam regulates the high water level, and as far as is known, the low level in late summer is 4-6 inches from the top of the dam. This arrangement is believed to be suitable in so far as the fishing of the lake is concerned. The dam should be kept in operation and repair.

#### Spawning Facilities

As pointed out previously, spawning facilities are adequate for all desirable species.

#### Other Recommendations

Requests have been made for a screening device at the mouth of the Cut River to prevent pike from running up to spawn. These requests have been made on the basis that the rapid drop in water levels prevents the young pike from reaching the lake. Studies on this subject on other lakes indicate that in most years many more young pike reach the lake than is realized, and it is

perhaps better to lose a small percentage of young than to keep the pike from going upstream, since they are not known to reproduce in any quantity in lakes not having marshes available on inlet or outlet streams. Another objection to screens is that they require constant attention.

INSTITUTE FOR FISHERIES RESEARCH

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