Fisheries Survey

**Fisheries Division**

**Northern Lake Michigan Management Unit**

**Brevoort Lake**

**Fall 2023**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | | |
| Water: | Brevoort Lake | | | | | | | |
| T/R/S: | T42N / R05W / Sections: 34 | | | | | | | |
| Primary County: | | | | | | Mackinac | | |
| Watershed: | | | Brevoort River | | | | | |
| Status: | Draft | | | | | | | |
| Survey begin: | | | | | 09/28/2023 | | End: | 09/28/23 |
| Special Regs: | | | | None | | | | |
| Purpose: | | Management Evaluation | | | | | | |

|  |
| --- |
|  |

**Gear Types**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gear Type: Boomshocker | Gear Type: Boomshocker |  | | | | |
| Effort date range: 09/28/23 | Effort date range: 09/28/23 | | |  | | | | |
| No. of gear used: | No. of gear used: | | |  | | | | |
| Effort quantity: 7,876 seconds (5.2 mi) | Effort quantity: 8,573 seconds (5.99 mi) | | | |  | | | | |
| Depth range: 0 to 4 feet | Depth range: 0 to 4 feet | | | | |  | | | | |
| Temperature range: 65.7°F | Temperature range: 64.5°F | |  | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gear Type: Boomshocker | Gear Type: |  | | | | |
| Effort date range: 09/28/23 | Effort date range: | | |  | | | | |
| No. of gear used: | No. of gear used: | | |  | | | | |
| Effort quantity: 11,663 seconds (5.45 mi) | Effort quantity: | | | |  | | | | |
| Depth range: 2 to 11 feet | Depth range: | | | | |  | | | | |
| Temperature range: 63.0°F | Temperature range: | |  | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gear Type: | Gear Type: |  | | | | |
| Effort date range: | Effort date range: | | |  | | | | |
| No. of gear used: | No. of gear used: | | |  | | | | |
| Effort quantity: | Effort quantity: | | | |  | | | | |
| Depth range: | Depth range: | | | | |  | | | | |
| Temperature range: | Temperature range: | |  | | | | |

Collection by: MDNR TCU, Sault Tribe, US Forest Service

Identification by: MDNR TCU, Sault Tribe, US Forest Service

Analysis by: J. Bauman

Date Approved: 00/00/0000

**Introduction**

The Michigan Department of Natural Resources Fisheries Division (MDNR) manages more than 300 inland lakes for Walleye (*Sander vitreus*). Walleye are a high priority species for fisheries management due to their ecological, social, and cultural significance. Through implementation of a management plan (Herbst et al. 2021), MDNR provides guidance to protect, conserve, and adaptively manage populations to maximize ecological benefits and angler satisfaction derived from healthy Walleye populations and fisheries. One important component of this management plan includes monitoring various categories of reproduction for Walley in inland lakes.

Monitoring categories of reproduction of Walleye is important given that costs associated with stocking are substantially higher compared to managing Walleye fisheries supported by natural reproduction. Therefore, inland lakes containing self-sustaining (naturally reproducing) populations are considered a high priority by MDNR and provide a high return per cost for anglers. Approximately 26 percent of Walleye populations statewide have consistent natural reproduction and are rarely stocked, 33 percent have inconsistent natural reproduction and are frequently stocked, and the remainder (41 percent) have no natural reproduction and are maintained exclusively by stocking (Herbst et al. 2021).

In the eastern region of the Northern Lake Michigan Management Unit, MDNR manages several inland lakes for Walleye (Strain: Bays de Noc). Inland lakes managed for Walleye in this region range in size from 60- to 10,000-acres and consist of stocked as well as naturally sustained populations. For example, Brevoort Lake is a 4,001-acre shallow lake that has a long management history for Walleye and other species. Since 1985, fall electrofishing assessments have been conducted to quantify the number of Age-0 (or young-of-year) and Age-1 Walleye captured per mile of electrofishing. These data are used as an index of relative abundance (Serns 1982, Serns 1983) and may be used to predict year-class strength of stocked or naturally produced Walleye (Ziegler and Schneider 2000). In recent years, these data are also used to monitor an ongoing fall fingerling stocking program funded by the Strains Area Sportsman’s Club.

Currently, Brevoort Lake is classified as a “Stocked Walleye Lake System” where 50 percent of the adult Walleye population is comprised of stocked Walleye. The objectives of the most recent survey were to: 1) quantify the relative abundance of Age-0 and Age-1 Walleye, and 2) quantify the proportion of stocked fall fingerling Walleye relative to naturally produced cohorts.

**Walleye Stocking History**

Walleye have been stocked in Brevoort Lake sporadically since the late 1800s (Table 1). However, with improvements in propagation and rearing techniques that occurred statewide during the late 1970s and early 1980s, more emphasis was placed on expanding recreational angling opportunities for Walleye. During the early 1980s, Walleye were stocked in Brevoort Lake annually (in 1980, 1981, 1982 and 1983) to establish a few strong year classes, a common practice in fisheries management. Following the initial establishment phase, Walleye were stocked approximately every other year (in 1986, 1988, and 1989) to continue supplementing the current population, without overburdening year-classes already established through natural reproduction.

In 1985, a large 2,000-ft spawning reef was built in Brevoort Lake to increase spawning habitat for Walleye and other gamefish, that was intended to provide additional angling opportunities by bolstering natural reproduction. Surveys conducted during the 1970s had suggested that Brevoort Lake had the potential to provide a greater fishery but was limited by available spawning habitat. Due to increasing costs associated with fish stocking, habitat improvement (i.e., rock reef) was suggested as a prudent alternative to improving fish production. By the late 1980s to early 1990s, the reef was reported to be working properly as several year-classes of naturally produced Walleye were evident and 50 percent of the Walleye captured were reported to be ‘wild’ (versus ‘stocked’). However, by the mid-1990s, additional census estimates suggested that the number of adult Walleye (Table 2) in Brevoort Lake subsequently declined. Despite this decline in adult Walleye abundance, natural reproduction of Walleye continued through this period. As adult Walleye abundance was reportedly declining, stocking resumed, and spring fingerlings were stocked in 1997 and 1998, with a recommendation to continue stocking every three years (triennially) thereafter. Stocking of Walleye every three years was intended to be a conservative supplementation to a modest level of natural reproduction that was being documented in Brevoort Lake at that time.

During the 2000s, anglers provided mixed reviews of the fishery and some requested additional stocking of Walleye, while others including resort owners requested a cessation in stocking. Agency staff also began receiving complaints from anglers regarding the growing number of Cormorants residing in Brevoort Lake. Concerned about the degree to which Cormorants prey upon gamefish species such as Walleye, a Cormorant harassment program began in 2005 in attempt to deter Cormorants from nesting or feeding near Brevoort Lake. In addition to issues related to Cormorant abundance, the presence of Viral Hemorrhagic Septicemia (VHS) resulted in a near statewide moratorium on stocking of Walleye. As a result, Walleye stocking in inland lakes ceased until the moratorium was lifted several years later.

By 2011, the stocking moratorium was lifted, and a prescription was approved to continue stocking Brevoort Lake with spring fingerling Walleye on an ‘every other year’ or biennial basis. Stocking of spring fingerlings continued until 2019, when stakeholder interests shifted towards a request for stocking fall fingerlings, rather than spring fingerlings. Stocking of fall fingerlings occurred in 2018, 2019, 2021, and 2022.

In 2022, a prescription was approved to continue stocking Brevoort Lake with 4,000 to 6,000 fall fingerling Walleye every other year until 2032. All fall fingerlings released as part of this program will receive a unique fin clip (Table 3) to help evaluate the survival of stocked fall fingerlings. As part of the fall fingerling stocking program, inter-agency fall recruitment surveys will be conducted annually to evaluate the success of stocking fall fingerlings. Additionally, fall recruitment or “Serns” surveys will be conducted to determine the extent to which natural reproduction is occurring Brevoort Lake.

**Methods and materials**

On 28 September 2023, a Walleye recruitment survey was conducted at night on Brevoort Lake using three boat electrofishing units. The entire shoreline was sampled for a total effort of 7.8 hours including 16.6 miles of shoreline. Electrofisher settings as well as the transect start and end locations may be found in Table 4. At the start of the survey, surface water temperatures ranged from 63.0 to 65.7°F.

Aging structures (10 per inch group) were collected from all Walleye for age analysis. Scale samples were collected from all Walleye less than 10.0 inches. The first three dorsal spines were collected from all Walleye captured.

Captures of Walleye are reported as the number of Age-0 (young-of-year) and Age-1 Walleye per mile of shoreline sampled. Capture rates were then compared using qualitative indices used by Michigan and Wisconsin. Based upon catch rates of Age-0 and Age-1 Walleye, relative abundance estimates were generated for an entire lake for Age-0 and Age-1 Walleye. Historical survey results (1985 to 2022) are also referenced in the results section.

***Michigan***

To assess the relative strength of Age-0 (young-of-year) classes in lakes with good Walleye abundance the following table was used for reference (Ziegler and Schneider 2000):

|  |  |  |
| --- | --- | --- |
| Age-0 Captured per Mile | Year-class Strength | Calculated Number/Acre |
| <45 | Poor | <11 |
| 45 to 130 | Average | 11 to 30 |
| >130 | Strong | >30 |

To assess the relative strength of Age-1 classes in lakes with good Walleye abundance the following table was used for reference (Ziegler and Schneider 2000):

|  |  |  |
| --- | --- | --- |
| Age-1 Captured per Mile | Year-class Strength | Calculated Number/Acre |
| <20 | Poor | <4 |
| 20 to 90 | Average | 4 to 18 |
| >90 | Strong | >18 |

The following equation was used calculate the number of Age-0 (young-of-year) Walleye for an entire lake (Serns 1982, Ziegler and Schneider 2000):

The following equation was used to calculate the number of Age-1 Walleye for an entire lake (Serns 1983, Ziegler and Schneider 2000):

***Wisconsin***

To assess the status of Age-0 year-class strength, the following was used for reference (Gilbert and Hennessy 2014).

|  |  |
| --- | --- |
| Age-0 Captured per Mile | Year-class Strength |
| <5 | Poor |
| 5 to 9.9 | Low |
| 10 to 19.9 | Average |
| 20 to 39.9 | Good |
| 40 to 69.9 | High |
| 70 to 140 | Very High |
| >140 | Excessive |

**Results**

During the 2023 fall Walleye recruitment survey, a total of 137 Walleye were captured ranging in size from 5.0 to 25.0 inches in total length (Table 5). The average size of Walleye captured was 11.5 inches and approximately 26 percent of fish captured exceeded the minimum size for harvest (i.e., 15.0 inches). Based on the length distribution, the number of Age-0 (young-of-year) and Age-1 Walleye captured was 62 and 30, respectively.

The number of Age-0 and Age-1 Walleye captured per mile of shoreline sampled was 3.73 and 1.80, respectively (Tables 6 & 7). The estimated number of Age-0 Walleye (naturally produced) increased in 2023 by 48 percent compared to 2022 (Table 6). The estimated number of Age-1 Walleye, both naturally reproduced and stocked, increased in 2023 by 227 percent compared to 2022 (Table 7). Approximately 14 percent of Walleye captured, ranging in size from 6 to 19 inches were observed to have pectoral fin clips. Approximately 40 percent of Walleye captured, ranging in size from 10 to 13 inches were observed to have pectoral fin clips.

**Discussion**

A total of 17 fall Walleye recruitment assessments have been conducted in Brevoort Lake over the past 38 years. Results suggest that year-class strength of Age-0 and Age-1 Walleye in Brevoort Lake remains poor by Michigan and Wisconsin standards. However, in recent years (since 2021) number of naturally produced Age-0 as well Age-1 (origin unknown) appear to be increasing.

Low or poor year-class strength is surprising given that adult relative abundance, calculated during the 2018 Status and Trends assessment, found the catch rate of adult Walley in Brevoort Lake to be moderate to high, relative to other inland lakes in Michigan (Wehrly et al. 2015). For example, inland lakes in the western Upper Peninsula have the highest average catch rates of Walleye in fyke and trap nets across the state (1.17 fish per net lift, Herbst et al. 2021). In 2018, Brevoort Lake recorded a catch rate of Walleye of 0.98 fish per net lift. Results from the 2018 Status and Trends survey suggest that the relative abundance of adult Walleye in Brevoort Lake is moderate to high. However, natural recruitment assessments conducted more recently indicate that successful natural reproduction by adults is limited but has increased since 2021.

The success of stocking clipped fall fingerling Walleye is still being evaluated. A reasonable portion of fish captured, within a size range consistent with having fin clips, suggesting these stocked fish are surviving from one year to the next. However, additional data are needed (through 2032) to fully evaluate the inter-annual contribution of these marked individuals compared those produced naturally. Therefore, additional fall recruitment surveys will be scheduled to continue monitoring natural reproduction and evaluate stocking of fall fingerling Walleye.

An adult census estimate used to determine the density of adult Walleye in Brevoort Lake is scheduled for spring of 2029. A spring adult census estimate will also provide useful information relative to the number of clipped/stocked Walleye that survived during the prescribed stocking period (2022 to 2032).

**Management recommendations**

1). Continue to annually conduct fall recruitment assessments in Brevoort Lake to quantify the relative abundance of Age-0 and Age-1 Walleye. Managers are encouraged to collaborate private stocking events with MDNR survey staff to ensure stocked fall fingerlings are distinguishable from their wild cohorts (e.g., fin clipping).

2). Conducted a spring netting survey by 2029 to quantify the abundance of adult Walleye in Brevoort Lake.

**Bibliography of literature cited**

Gilbert, S., and J. Hennessy. 2014. Guidelines to Evaluate Walleye Stocking Success in Inland Lakes.

Herbst, S. J, D. B. Hayes, K. Wehrly, C. LeSage, D. Clapp, J. Johnson, P. Hanchin, E. Martin, F. Lupi, and T. Cwalinski. 2021. Management Plan for Walleye in Michigan’s Inland Waters. Michigan Department of Natural Resources, Lansing, Michigan.

Serns, S. L. 1982. Relationship of Walleye Fingerling Density and Electrofishing Catch Per Effort in Northern Wisconsin Lakes. North American Journal of Fisheries Management 2:38-44.

Serns, S. L. 1983. Relationship between electrofishing catch per unit effort and density of walleye yearlings. North American Journal of Fisheries Management 3:451-452.

Wehrly, K. E., D. B. Hayes, and T. C. Wills. 2015. Status and Trends of Michigan Inland Lake Resources, 2002-2007. Michigan Department of Natural Resources, Fisheries Report 08, Lansing.

Ziegler, W., and J. C. Schneider. 2000. Guidelines for evaluating Walleye and Muskie Recruitment. Chapter 23 *in* Manual of Fisheries Survey Methods. Michigan Department of Natural Resources, Fisheries internal document, Ann Arbor.

Table 1. Year, number stocked, size at stocking in inches (in.), age at stocking, and unique mark types (OTC: oxytetracycline, LPC: left pectoral clip) for Walleye stocked in Brevoort Lake, Mackinac County, Michigan.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Number Stocked | Size at Stocking (in.) | Age at Stocking | Mark Type |
| 1889 | 2,220,000 |  | Spring Fry |  |
| 1905 | 350,000 |  | Spring Fry |  |
| 1933 | 300,000 |  | Spring Fry |  |
| 1935 | 300,000 |  | Spring Fry |  |
| 1936 | 300,000 |  | Spring Fry |  |
| 1937 | 630,000 |  | Spring Fry |  |
| 1938 | 500,000 |  | Spring Fry |  |
| 1939 | 1,200,000 |  | Spring Fry |  |
| 1940 | 750,000 |  | Spring Fry |  |
| 1941 | 360,000 |  | Spring Fry |  |
| 1978 | 32,613 |  | Fall Fingerling |  |
| 1979 | 39,817 |  | Spring Fingerling | None |
| 1980 | 50,029 |  | Spring Fingerling | None |
| 1981 | 5,394 |  | Spring Fingerling | None |
| 1982 | 2,081,300 | 0.35 | Spring Fry | None |
| 1982 | 10,581 |  | Spring Fingerling | None |
| 1983 | 22,139 |  | Spring Fingerling | None |
| 1986 | 100,081 | 1.84 | Spring Fingerling | None |
| 1988 | 43,768 | 1.50 | Spring Fingerling | None |
| 1989 | 10,155 | 2.05 | Spring Fingerling | None |
| 1997 | 20,534 | 2.13 | Spring Fingerling | None |
| 1998 | 8,160 | 1.73 | Spring Fingerling | OTC |
| 2000 | 22,665 | 1.89 | Spring Fingerling | None |
| 2003 | 19,433 | 1.72 | Spring Fingerling | None |
| 2006 | 21,945 | 1.44 | Spring Fingerling | None |
| 2011 | 22,000 | 1.42 | Spring Fingerling | OTC |
| 2013 | 38,135 | 1.85 | Spring Fingerling | OTC |
| 2014 | 10,000 | 1.50 | Spring Fingerling | OTC |
| 2015 | 51,262 | 1.80 | Spring Fingerling | OTC |
| 2017 | 50,250 | 1.91 | Spring Fingerling | OTC |
| 2018 | 3,000 | 7.50 | Fall Fingerling | None |
| 2019 | 46,644 | 1.59 | Spring Fingerling | OTC |
| 2019 | 3,000 | 6.00 | Fall Fingerling | LP Clip |
| 2021 | 400 | 10.00 | Fall Fingerling | None |
| 2022 | 4,603 | 6.61 | Fall Fingerling | LP Clip |

Table 2. Brevoort Lake adult Walleye (age three and older) density, number (N) of adults per acre, and 95% confidence limit estimates collected by USFS, MDNR, and Tribal staff.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Adult Walleye | N Adults per Acre | LCI | HCI |
| 1985 | 5,775 | 1.44 | 1.14 | 1.97 |
| 1986 | 8,518 | 2.13 | 1.78 | 2.66 |
| 1989 | 5,532 | 1.38 | 1.02 | 1.68 |
| 1991 | 5,049 | 1.26 | 0.95 | 1.86 |
| 1994 | 2,900 | 0.72 | 0.58 | 0.98 |
| 1996 | 2,097 | 0.52 | 0.42 | 0.71 |
| 1998 | 1,702 | 0.43 | 0.30 | 0.71 |
| 2001 | 1,759 | 0.44 | 0.34 | 0.63 |
| 2005 | 1,233 | 0.31 | 0.25 | 0.39 |
| 2008 | 7,780 | 1.94 | 1.66 | 2.35 |
| 2011 | 4,251 | 1.06 | - | - |
| 2015 | 5,773 | 1.44 | 1.27 | 1.63 |
| **AVG** | **4,364** | **1.09** | **0.88** | **1.42** |

Table 3. Prescribed year for stocking fall fingerling Walleye in Brevoort Lake and the intended unique fin clip prescribed for that stocking year.

|  |  |
| --- | --- |
| Prescribed Stocking Year | Planned Clip |
| 2022 | Left Pectoral Fin |
| 2024 | Right Pectoral Fin |
| 2026 | Left Pelvic Fin |
| 2028 | Right Pelvic Fin |
| 2030 | Left Pectoral Fin |
| 2032 | Right Pectoral Fin |

Table 4. Boat electrofishing settings and start/end locations for transects surveyed on Brevoort Lake, Mackinac County 28 September 2023.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Boat | Type | Duty | Pulse | Amps | Start | End |
| Blue | DC | 30.0 | 60.0 | 20.0 | 46.017500 -84.96692 | 45.99065 -84.94083 |
| Red | DC | 30.0 | 60.0 | 20.0 | 46.009450 -84.96486 | 45.99106 -84.87831 |
| Green | DC | 0.0 | 120.0 | 6.5 | 45.990863 -84.93820 | 45.99106 -84.87831 |

Table 5. Length distribution of Walleye captured in Brevoort Lake, Mackinac County, Michigan 28 September 2023. Number (No.) of Walleye captured in top box indicates Age-0 (young-of-year), and bottom box indicates Age-1.

|  |  |
| --- | --- |
| Inch Group | No. of Walleye Captured |
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0 |
| 5 | 1 |
| 6 | 23 |
| 7 | 46 |
| 8 | 2 |
| 9 | 0 |
| 10 | 4 |
| 11 | 14 |
| 12 | 11 |
| 13 | 1 |
| 14 | 0 |
| 15 | 0 |
| 16 | 1 |
| 17 | 6 |
| 18 | 7 |
| 19 | 9 |
| 20 | 6 |
| 21 | 4 |
| 22 | 0 |
| 23 | 0 |
| 24 | 1 |
| 25 | 1 |
| TOTAL | 137 |

Table 6. Survey year, number (No.) of Age-0 (young-of-year) Walleye per mile, Michigan (MI) year-class strength rating, Wisconsin (WI) year-class rating, estimated Age-0 per acre, and the estimated number of Age-0 in Brevoort Lake, Mackinac County, Michigan from 1985 to 2023.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Survey Year | No. Age-0/mile | MI-Rating | WI-Rating | Estimated Age-0 per acre | Estimated No. YOY |
| 1985 | - | Poor |  | - | - |
| 1986 | 6.23 | Poor | Low | 1.46 | 5,837 |
| 1987 | 1.93 | Poor | Poor | 0.45 | 1,805 |
| 1988 | 24.09 | Poor | Good | 5.64 | 22,552 |
| 1989 | 26.10 | Poor | Good | 6.11 | 24,437 |
| 1991 | 9.79 | Poor | Low | 2.29 | 9,163 |
| 1992 | 15.64 | Poor | Average | 3.66 | 14,644 |
| 1995 | 33.25 | Poor | Good | 7.78 | 31,130 |
| 1997 | 3.41 | Poor | Poor | 0.80 | 3,197 |
| 2006 | 0.00 | Failed | Failed | 0.00 | 0 |
| 2008 | 2.06 | Poor | Poor | 0.48 | 1,928 |
| 2009 | 0.28 | Poor | Poor | 0.07 | 260 |
| 2013 | 0.00 | Failed | Failed | 0.00 | 0 |
| 2019 | 0.49 | Poor | Poor | 0.12 | 463 |
| 2021 | 0.10 | Poor | Poor | 0.02 | 97 |
| 2022 | 2.52 | Poor | Poor | 0.59 | 2,359 |
| 2023 | 3.73 | Poor | Poor | 0.87 | 3,488 |
| AVG | 8.10 |  |  | 1.90 | 7,585 |

Table 7. Survey year, number (No.) of Age-1 Walleye per mile, Michigan (MI) year-class strength rating, estimated Age-1 per acre, and the estimated number of Age-1 in Brevoort Lake, Mackinac County, Michigan from 1985 to 2023.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Survey Year** | No. Age-1/mile | MI-Rating | Estimated Age-1 per acre | Estimated No. Age-1 |
| 1985 | - |  | - | - |
| 1986 | 0.50 | Poor | 0.10 | 387 |
| 1987 | 0.00 | Poor | 0.00 | 0 |
| 1988 | 1.02 | Poor | 0.20 | 790 |
| 1989 | 0.85 | Poor | 0.16 | 658 |
| 1991 | 0.00 | Poor | 0.00 | 0 |
| 1992 | 5.90 | Poor | 1.14 | 4,578 |
| 1995 | 8.50 | Poor | 1.65 | 6,598 |
| 1997 | 4.15 | Poor | 0.80 | 3,218 |
| 2006 | 31.05 | Average | 6.02 | 24,103 |
| 2008 | 2.35 | Poor | 0.46 | 1,826 |
| 2009 | 2.22 | Poor | 0.43 | 1,725 |
| 2013 | 0.00 | Poor | 0.00 | 0 |
| 2019 | 8.90 | Poor | 1.73 | 6,905 |
| 2021 | 0.00 | Poor | 0.00 | 0 |
| 2022 | 0.55 | Poor | 0.11 | 428 |
| 2023 | 1.80 | Poor | 0.35 | 1,399 |
| AVG | 4.24 |  | 0.82 | 3,288 |