WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Lake Michigan Management Reports

WRITTEN BY:
LAKE MICHIGAN FISHERIES TEAM AND DNR STAFF

The Research Vessel Coregonus is an important platform for the DNR sampling program.

Lake Michigan Committee
2022 LMTC Summer Meeting
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TABLE OF CONTENTS

INTRODUCTION

These reports summarize some of the major studies and stock assessment activities by the Wisconsin Department of Natural Resources (DNR) on Lake Michigan and Green Bay in 2021. They provide specific information about the major sport and commercial fisheries and describe trends in some of the major fish populations.

The management of Lake Michigan fisheries is conducted in partnership with other state, federal and tribal agencies and in consultation with sport and commercial fishers. Major issues of shared concern are resolved through the Lake Michigan Committee, which is made up of representatives of Michigan, Indiana, Illinois, Wisconsin and the Chippewa Ottawa Resource Authority. These reports are presented to the Lake Michigan Committee as part of Wisconsin's contribution to that shared management effort.

This compilation is not intended as a comprehensive overview of available information about Lake Michigan fisheries. For additional information, we recommend you visit the DNR's Lake Michigan webpage at dnr.wi.gov/topic/fishing/lakemichigan.

For further information regarding any individual report, contact the author at the address, phone number or email address shown at the end of the report.

GREEN BAY BROWN TROUT MANAGEMENT AND FALL TRIBUTARY SURVEYS, 2021

This report summarizes assessments and management actions for Brown Trout in Wisconsin waters of Green Bay/Lake Michigan completed in 2021. Additional information is included for other salmonid species from the Menominee River.

INTRODUCTION

The Wisconsin DNR has stocked various salmonid species into Green Bay since the 1960s. The initial intent of that stocking effort was to control introduced prey species like Alewives and Rainbow Smelt while providing a quality near-shore and offshore fishery for Green Bay anglers. Creel survey results indicate that harvest and return rates for Green Bay Brown Trout were exceptional throughout the late 1980s and 1990s. Since 2000, Brown Trout harvest has experienced a sharp decline. Stocking numbers for Green Bay have varied somewhat since the 1980s but, in general, have remained fairly consistent until 2010, when fingerling stocking was reduced (Figure 1). Between 2011 and 2015, only yearling Brown Trout were stocked into Green Bay. Both fall fingerlings and yearlings have been stocked since 2016.

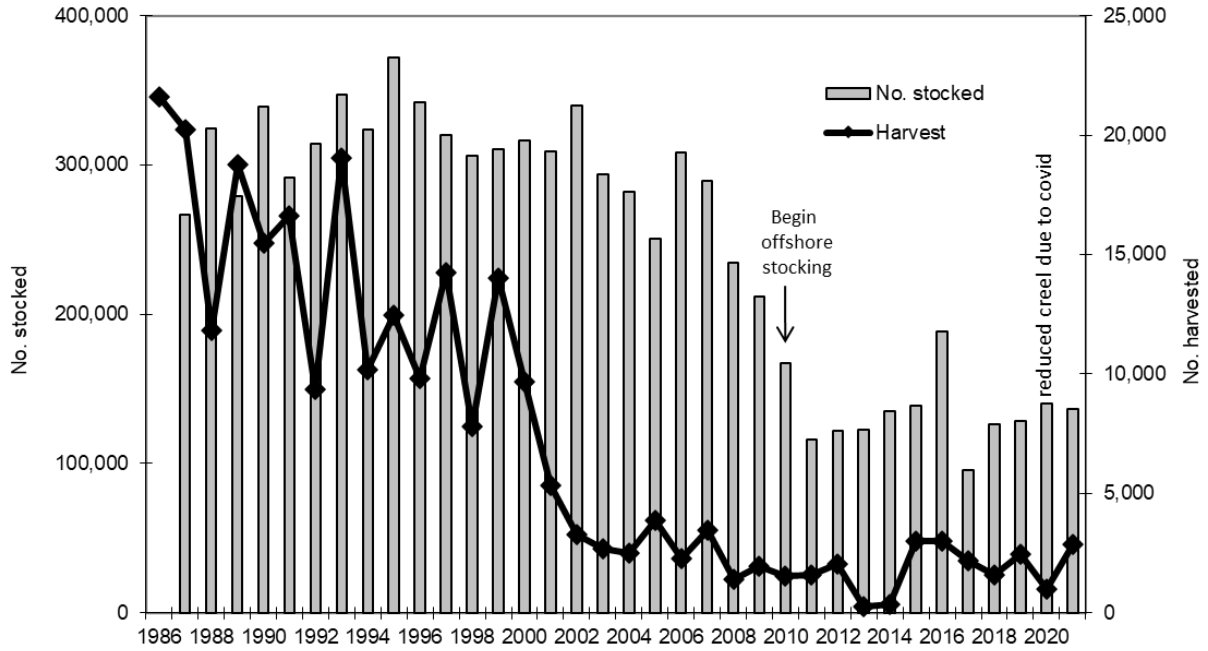


Figure 1. Number of stocked and harvested Brown Trout (fingerlings & yearlings combined) in Wisconsin waters of Green Bay by year.

Historically the DNR has stocked several strains and age classes of Brown Trout into Green Bay and adjacent rivers. To promote an extended trophy fishery, the Seeforellen (German) Brown Trout program was initiated in Wisconsin waters of Lake Michigan in the early 1990s. This strain originated from alpine lakes in Germany. Seeforellen generally live longer and grow faster than other strains, thus adding to the trophy element of the fishery[1]. Currently, Seeforellen Brown Trout are the only strain that Wisconsin routinely stocks into the Great Lakes. Additional background on the Seeforellen strain of Brown Trout and changes in Brown Trout stocking strategies for Wisconsin's Lake Michigan can be found in the 2017 report[2].

Following the closure of the Thunder River Hatchery in 2017 and the discontinuation of the Wild Rose (domestic) strain of Brown Trout that was previously stocked into Lake Michigan by Wisconsin, a stocking allocation strategy for the remaining Seeforellen Brown Trout was developed. The Lake Michigan Fisheries Forum and the general public provided input at several meetings. This strategy evenly distributes 75% of the entire yearling Brown Trout quota across each Lake Michigan/Green Bay County.

Next, the strategy incorporates species-specific harvest rates and directed effort for Brown Trout in each county to allocate the remaining 25% of Brown Trout. Those parameters are derived from open water creel surveys. Beginning in 2018, an additional 20,000 Brown Trout were allocated to Green Bay to boost that local fishery further. Throughout 2019, the DNR conducted an extensive stakeholder outreach and engagement process to inform a management strategy for Lake Michigan stocking. As a result, lake-wide Brown Trout stocking numbers were increased from 376,000 to 450,000 beginning in 2020. A total of 136,549 Brown Trout were stocked in 2021 in Green Bay by the DNR (Table 1).

For four years (2016-2019), staff from U.S. Fish and Wildlife Service Green Bay Fishery Resources office (USFWS-GBFRO) utilized their autotrailer to adipose clip all Seeforellen at the Wild Rose Hatchery. These fish were later stocked into Lake

[1] Belonger, B. 1996. strain evaluation. Pages 55-56 *in* Lake Michigan Management Reports to Great Lakes Fishery Commission, Wisconsin Dept. of Nat. Res., Madison, WI.

[2] Paoli, T. 2018. Green Bay brown trout management and fall tributary surveys, 2017. Lake Michigan Management Reports to Great Lakes Fishery Commission. Wisconsin Dept. of Nat. Res., Madison, WI. https://dnr.wi.gov/topic/fishing/documents/lakemichigan/GreenBayBrownTrout2017.pdf

Michigan, mostly as spring yearlings in 2017-2020 but some as fall fingerlings in the same year as clipping. Marking all Seeforellen with the autotrailer saved considerable staff time and allowed the DNR to evaluate returns of Seeforellen for several year classes. However, in November 2019, USFWS-GBFRO informed the DNR that the mass marking trailer would not be available to clip Brown Trout in 2020 and beyond due to scheduling conflicts with the steelhead mass marking project. To ensure that known Seeforellen are collected as future broodstock, Seeforellen stocked into the brood rivers (Kewaunee, Milwaukee and Root) were hand-clipped by DNR staff at the Wild Rose Hatchery in 2020 and 2021. The total number of fish clipped by hand in 2020 and 2021 is approximately 104,000. Brown Trout stocked at locations other than the brood rivers were not clipped.

In 2010 and 2011, the DNR utilized a pontoon barge and the USFWS *RV Spencer Baird* to stock Brown Trout offshore in Green Bay. From 2012 to 2019, the DNR used the *RV Coregonus* to stock yearling Brown Trout offshore in Green Bay. In 2020, due to COVID-19 concerns, the DNR did not stock Brown Trout offshore; instead, fish were stocked directly into tributaries or harbors. Offshore stocking of yearlings resumed in spring 2021 (Table 1) and plans are to continue to stock yearlings offshore in 2022. The fall fingerling quotas will continue to be stocked directly into tributaries.

Table 1. DNR Brown Trout stocking information for Green Bay in 2021.

DATE	COUNTY	LOCATION	STRAIN/SIZE	NUMBER	CLIP	# FISH PER LB.	REARING FACILITY
16-Mar-2021	Marinette	Little River mouth	Seeforellen yearling	17,415	--	9.2	Wild Rose SFH
12-Apr-2021	Door	Offshore Grid 802	Seeforellen yearling	41,473	--	8.9	Wild Rose SFH
13-Apr-2021	Marinette	Offshore Grid 703	Seeforellen yearling	29,600	--	8.8	Wild Rose SFH
14-Apr-2021	Marinette	Offshore Grid 703	Seeforellen yearling	28,059	--	9.3	Wild Rose SFH
28-Sep-2021	Oconto	Oconto River, Stiles	Seeforellen fingerling	10,001	--	21.1	Wild Rose SFH
28-Sep-2021	Marinette	Little River, Krause Road	Seeforellen fingerling	10,001	--	21.1	Wild Rose SFH
			Total yearlings **Total fingerlings**	**116,547** **20,002**			

CREEL RESULTS AND DISCUSSION

The harvest estimate for open water Green Bay Brown Trout in 2021 was 2,848 fish from April to mid-November (Figure 1). Green Bay comprised 31% of the total Brown Trout harvest for Lake Michigan in 2021 (9,178 fish), followed by Milwaukee County at 23%. The target harvest rate for Green Bay Brown Trout is at or below 23 hours per fish. This target harvest rate was determined by calculating plus or minus one standard deviation of the 1986-1999 mean harvest rate. These years were chosen to reflect a time when Brown Trout fishing was considered at its peak in Green Bay. Brown Trout harvest rate for anglers targeting salmonids in Green Bay was 13 hours/fish in 2021. This is similar to harvest rates in 2015, 2016 and 2019.

Since offshore stocking began in 2010, average harvest rate has generally improved (31 hours/fish) compared to the previous 10-year average (35 hours/fish). A difference in 4 hours/fish may be meaningful, especially since stocking numbers before 2010 were generally twice the number of Brown Trout stocked after 2010. Much of the stocking reductions beginning in 2010 were fall-fingerling Brown Trout that likely have lower survival rates than yearling trout.

MENOMINEE RIVER SURVEY SUMMARY

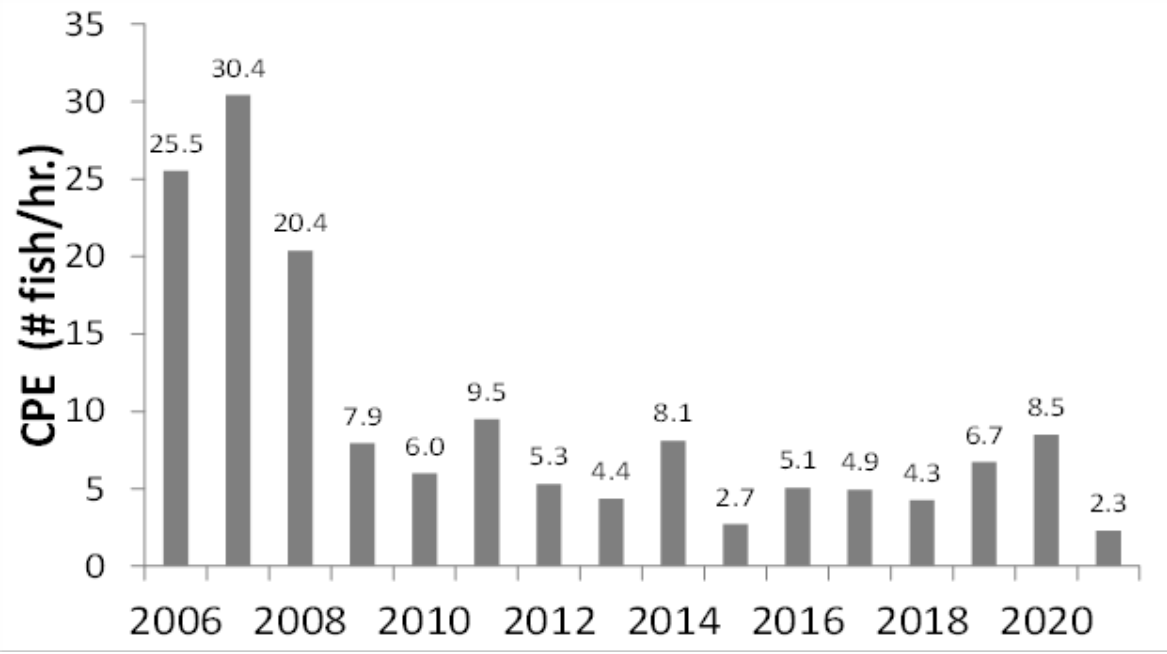


Figure 2. CPUE (# fish/hour) of Brown Trout captured during fall electrofishing surveys on the lower Menominee River, 2006-2021.

Electrofishing surveys targeting trout and salmon on the lower Menominee River were completed weekly beginning on Oct. 4 and ending on Nov. 10, 2021. The effort occurs over a half-mile section of the river from the Stephenson Island boat landing to the Menominee Dam.

A total of 15 Brown Trout were captured (six males; nine females) (Table 2), with a mean length of 28 inches. Twelve Brown Trout had an adipose clip, indicating Seeforellen stocked between 2017-2020. The combined catch per unit of effort (CPUE) for Brown Trout was 2.3 fish/hour, and the lowest in 16 years (Figure 2).

Between 2017-2021, the Michigan Department of Natural Resources (MI DNR) stocked various genetic strains of Brown Trout into the Michigan waters of Green Bay. Those strains include Sturgeon River, Gilchrist Creek and Wild Rose. To investigate whether clipped Seeforellen stocked by the Wisconsin DNR were captured in greater proportions compared to unclipped Brown Trout of various strains stocked by the Michigan DNR, we considered fish stocked from 2017-2020 that would be age 2-5 at the time of the fall surveys. We excluded fall fingerlings stocked in 2020, as those fish would only be age-1 and not likely to make fall spawning runs and used the following equation derived from Kornis et al. (2017)3 to calculate a return index,

$$\textit{Return index} = CPUE_{k,\ age2\text{-}4} \div \frac{y_k}{10{,}000}$$

where the CPUE of clip type *k* for ages 2 - 5 and y_k is the number of fish stocked with clip *k*. The return index for clipped Seeforellen stocked in Green Bay waters in Wisconsin was 0.04, while the return index for unclipped Brown Trout of various strains stocked in Michigan was slightly less, at 0.02. A caveat to this analysis is that not all Brown Trout stocked in Green Bay by either state necessarily return to the Menominee River. Additionally, sample size of Brown Trout captured was low in 2021 (15 fish). We will continue to evaluate the contribution of clipped and unclipped fish in 2022. However, by fall 2022, the Wisconsin age-2 Brown Trout (yearlings stocked in 2021) that were stocked in Green Bay will not be clipped, so that analysis will be limited to ages 3 - 6.

In addition to Brown Trout, other salmonids are also collected during the fall surveys. Nineteen pink salmon were captured during the first week of the surveys, on Oct. 4, 2021 (Table 2). Pink salmon typically spawn in September, and we sometimes see

[3] Kornis, M. S., J. L. Webster, A. A. Lane, K. W. Pankow, K. Mann, S. R. Cressman, and C.R. Bronte. 2017. Recovery rates of stocked and wild Chinook salmon in Lake Michigan, 2011-2015. Report #2017-07, USFWS-Green Bay Fish and Wildlife Conservation Office, New Franken, WI.

some pink salmon near the end stages of life during early October. Thirty Chinook Salmon were observed, the second-highest over the last seven years (Table 4). Each spring from 2014-2019 approximately half of the Menominee River Chinook Salmon quota has been stocked into a net pen as part of a cooperative project with the M&M Great Lakes Sportfishing Club. Net pens were not used in 2020 but resumed in 2021. It is difficult to determine if net-pen use contributed to increased Chinook survival and homing in the 2020 and 2021 surveys.

Only six Rainbow Trout were captured in 2021, the lowest in the last seven years. Three Rainbow Trout had an adipose fin clip. Those fish were collected and heads were delivered to USFWS-GBFRO for coded-wire tag analysis. One of the three fish was stocked by MI DNR (Table 3), but the other two fish did not have a tag-detected. In 2018 and 2019, MI DNR stocked some adipose-clipped fish that were not coded-wire tagged, so those two fish may be from those stockings. Due to low sample sizes from 2021, additional years of data collection are needed to determine better the relative contribution of stocked Rainbow Trout by Michigan and Wisconsin in the lower Menominee River.

Table 2. Number of adult fish captured by species and date on the lower Menominee River, 2021.

DATE	WATER TEMP	FLOW (CFS)	BROWN TROUT	RAINBOW TROUT	CHINOOK SALMON	PINK SALMON
Oct. 4, 2010	65	1,880	1	3	6	19
Oct. 13, 2021	65	2,350	4	0	10	0
Oct. 18, 2021	56	1,850	4	1	6	0
Oct. 27, 2021	49	1,930	0	1	4	0
Nov. 4, 2021	43	1,700	1	0	3	0
Nov. 10, 2021	45	1,760	5	1	1	0
TOTAL			**15**	**6**	**30**	**19**

Table 3. Stocking information from 3 adipose-clipped Rainbow Trout collected in 2021. All fish were collected in the lower Menominee River. Results courtesy of USFWS-GBFRO mass marking program.

CAPTURE DATE	LENGTH (INCH)	WEIGHT (LBS.)	SEX	CODED WIRE TAG #	YEAR STOCKED	AGENCY	LAKE	STOCKING LOCATION
Oct. 4, 2021	27.4	8.6	F	No tag detected				
Oct. 18, 2021	25.5	7.6	M	641164	2019	MI DNR	Michigan	Menominee, Days, E Br Whitefish, Ford, Brevoort Rivers
Oct. 27, 2021	24.8	6.8	M	No tag detected				

Table 4. Number of fish by species caught in 2015-2021 in the Menominee River fall electrofishing surveys.

	MENOMINEE RIVER						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Brown Trout	31	76	51	49	75	112	15
Rainbow Trout	9	29	48	17	34	44	6
Chinook Salmon	8	3	5	10	15	87	30
Pink salmon	0	63	3	42	45	0	19

SEEFORELLEN GAMETE COLLECTION SUMMARY

Beginning each year in late October or November, DNR crews use electroshocking boats to collect Seeforellen adults that are identified by an adipose fin clip from the three brood rivers. Adult Seeforellen are transferred to Besadny Anadromous Fish Facility (BAFF), which is held in ponds. Once a week, from mid-November to early December, propagation staff collect eggs and milt from ripe adults. Fertilized, disinfected eggs are transferred to the Wild Rose Hatchery. Fish that are not yet ripe are returned to the ponds to be spawned later. Enough eggs are collected to fulfill

the Lake Michigan (450,000 fish) and Lake Superior (175,000 fish) 2022-23 stocking quotas for Brown Trout.

In 2021, the DNR sampled the Kewaunee River on Nov. 9 using one boat. The Root River was sampled on Nov. 3, Nov. 9 and Nov. 17, 2021 with two boats each day. The DNR also sampled the Milwaukee Harbor on Nov. 2 with one electrofishing boat and the Milwaukee River and harbor on Nov. 10 with two electrofishing boats. Fish captured at the Root River were given a top caudal clip and fish from the Milwaukee River or harbor were given a bottom caudal clip before being transported to BAFF for data analysis purposes. Kewaunee River fish did not receive a clip during collection. The total effort for all three locations was 10 electrofishing boat days.

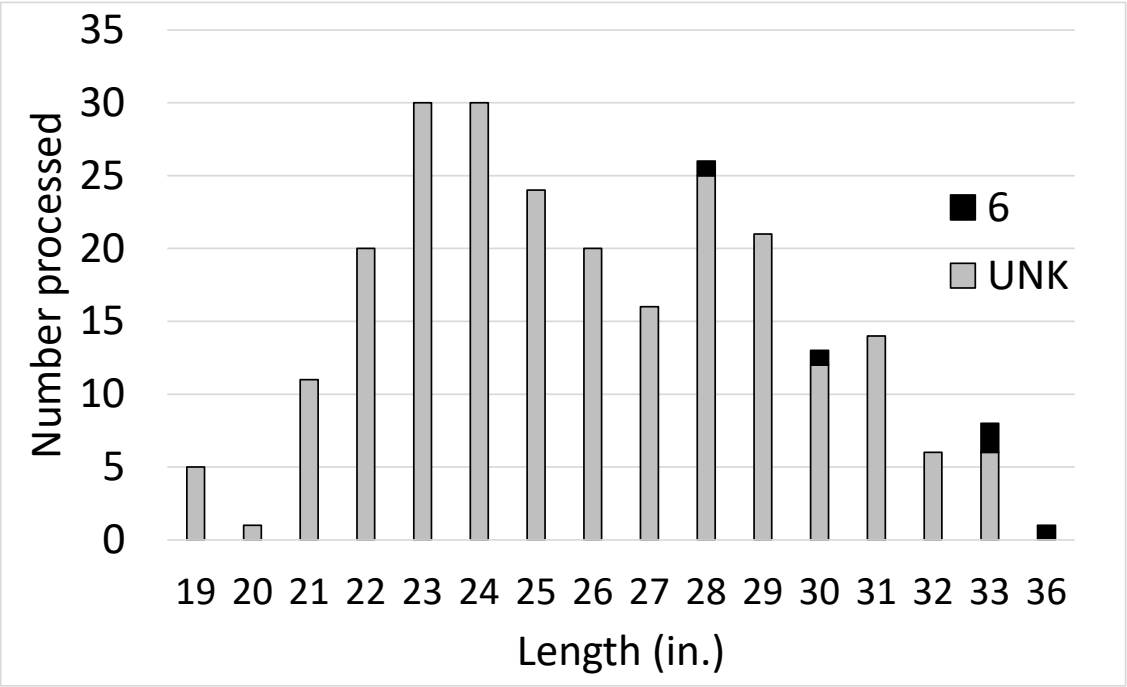


Figure 3. Length frequency by age of Seeforellen processed at BAFF in 2021. All rivers combined. Age-six fish are black bars, unknown age fish in grey.

In 2021, Seeforellen gametes were collected at BAFF during five spawning events between Nov. 17 and Dec. 15. Fertilized, disinfected eggs were transported to the Wild Rose Hatchery on each spawning date (Table 5). Sixty fish (34 males; 26 females) were evaluated for fish health on Nov. 17. Virology tests were negative (Dr. Nicole Nietlisbach, DVM, pers. comm). Fish that were not sacrificed for disease testing were transported via stocking truck below the weir and released in the Kewaunee River either the day of gamete collection or on the last day if still green/hard.

Since 2008, the sex ratio of male to female Brown Trout collected in the Root and Kewaunee Rivers has varied, with fewer males sampled in most years. In 2021, the sex ratio on the Kewaunee and Milwaukee River and harbor were near equal. Still, slightly more males were collected from the Root River (Table 5), even with crews collecting only females on the last day (Nov. 17) of electrofishing.

A total of 246 Brown Trout were processed at BAFF in 2021 (Table 5). Gametes were not collected from every fish as some fish were spent or hard (last day), but biological data was collected from all fish. Age-2 to age-5 fish (adipose clip) dominated the sample, with five fish being age-6 based on unique fin clips (adipose + right pectoral) that were given to brood stock yearlings stocked in 2016. 17% of the fish sampled were 30 inches or greater (Figure 3). There was no significant differences between the weight of females collected from the three rivers as determined by one-way ANOVA, $F(2,113) = 0.12$, $p = 0.89$.

Table 5. Number of Seeforellen Brown Trout processed for biological data at BAFF by river source and gender in 2021. This includes all fish even if no gametes were collected. Mortalities removed from the ponds are not included in this table.

DATE	MILWAUKEE RIVER & HARBOR		ROOT RIVER		KEWAUNEE RIVER		EGGS COLLECTED
	Males	Females	Males	Females	Males	Females	
17-Nov-2021	9	10	23	9	4	6	182,864
23-Nov-2021	8	11	13	12	0	1	151,009
1-Dec-2021	8	12	20	17	1	1	218,715
8-Dec-2021	8	4	10	13	0	1	138,051
15-Dec-2021	7	2	17	16	2	1	101,447
TOTAL	**40**	**39**	**83**	**67**	**7**	**10**	**792,086**

SUMMARY

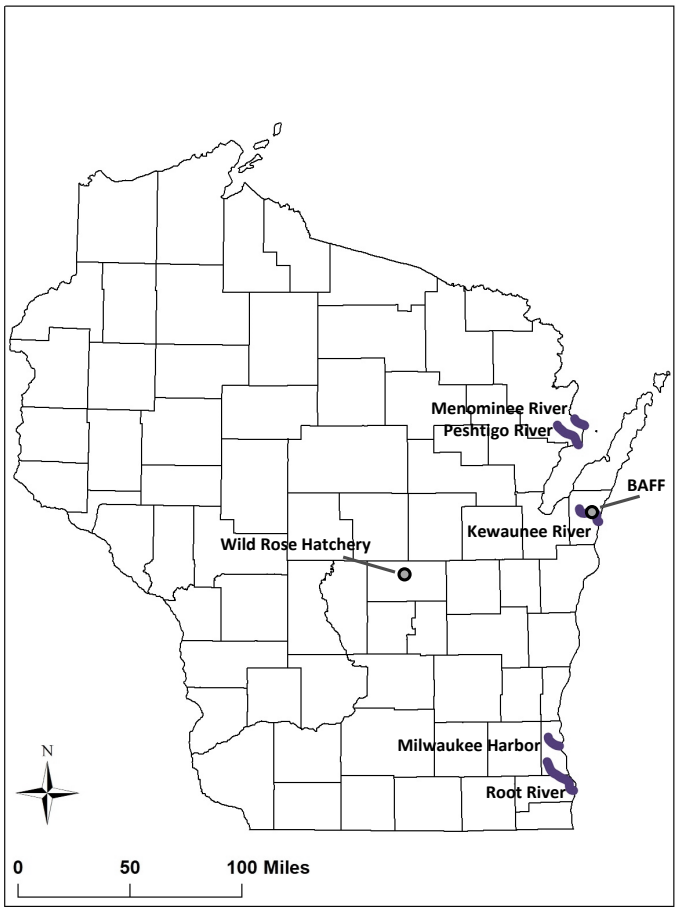
The harvest estimate for open water Green Bay Brown Trout in 2021 was 2,848 fish. Brown Trout harvest rate for anglers targeting salmonids in Green Bay was 13 hours/fish in 2021, which is within the acceptable range of the target harvest rate of 23 hours/fish.

All yearling Brown Trout that the DNR stocked into Lake Michigan from 2017 to 2020 received an adipose fin clip through the efforts of the USFWS-GBFRO mass marking trailer. Brown Trout captured during weekly fall surveys in 2021 were used to evaluate the relative contributions of Wisconsin clipped Brown Trout compared to unclipped Brown Trout stocked by the MI DNR in northern Green Bay. However, the low sample size of fish caught in the 2021 fall Menominee River surveys makes analysis difficult. Results from the 2020 analysis suggest that the return index for clipped Seeforellen stocked in Wisconsin was slightly better than the return index for unclipped Brown Trout of various strains stocked in Michigan.

Seeforellen brood stock will continue to be collected in the Milwaukee River and harbor and the Kewaunee and Root rivers. Fall assessments will continue to be conducted in the Menominee River. After a one-year pause of offshore stocking in 2020, the DNR resumed that activity in 2021 and plans to continue offshore stocking, yearling Brown Trout into Green Bay in 2022. Since offshore stocking began in 2010, the average harvest rate has generally improved (31 hours/fish) compared to the previous 10-year average (35 hours/fish). In 2022, the DNR will continue to stock Brown Trout, conduct index surveys and evaluate their contributions to the Green Bay fishery.

ACKNOWLEDGEMENTS

Dozens of staff across several agencies and offices made this effort possible. DNR fisheries staff from Peshtigo and Sturgeon Bay offices participated in the Menominee River surveys targeting trout and salmon. DNR fisheries staff from Green Bay and Besadny Anadromous Fish Facility collected brood fish on the Kewaunee River. DNR fisheries staff from Milwaukee and Eagle collected and transported brood fish from the Root River and Milwaukee Harbor and river. DNR staff from the Wild Rose Hatchery and BAFF were involved in various aspects of the Seeforellen gamete collection and rearing the fish. DNR fish health staff from Madison collected samples at BAFF. Peshtigo staff collected biological data at BAFF. Data for trout and salmon for all surveys were entered into the DNR Lake Michigan Fish Tracking Database by Peshtigo staff.



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STATUS OF GREAT LAKES MUSKELLUNGE IN WISCONSIN WATERS OF GREEN BAY

BACKGROUND

The Wisconsin DNR, in cooperation with several local Musky clubs and the Musky Clubs Alliance of Wisconsin, initiated a Great Lakes Muskellunge reintroduction program in 1989 for the Green Bay waters of Lake Michigan to diversify the predator population of the bay. Since then, the DNR has been actively managing the Muskellunge population through stocking, population surveys, creel surveys and research projects.

This report aims to summarize data collected for Muskellunge during the 2021 field season on Green Bay and its tributaries and to describe long-term trends in survey results, stocking and angler catch and harvest.

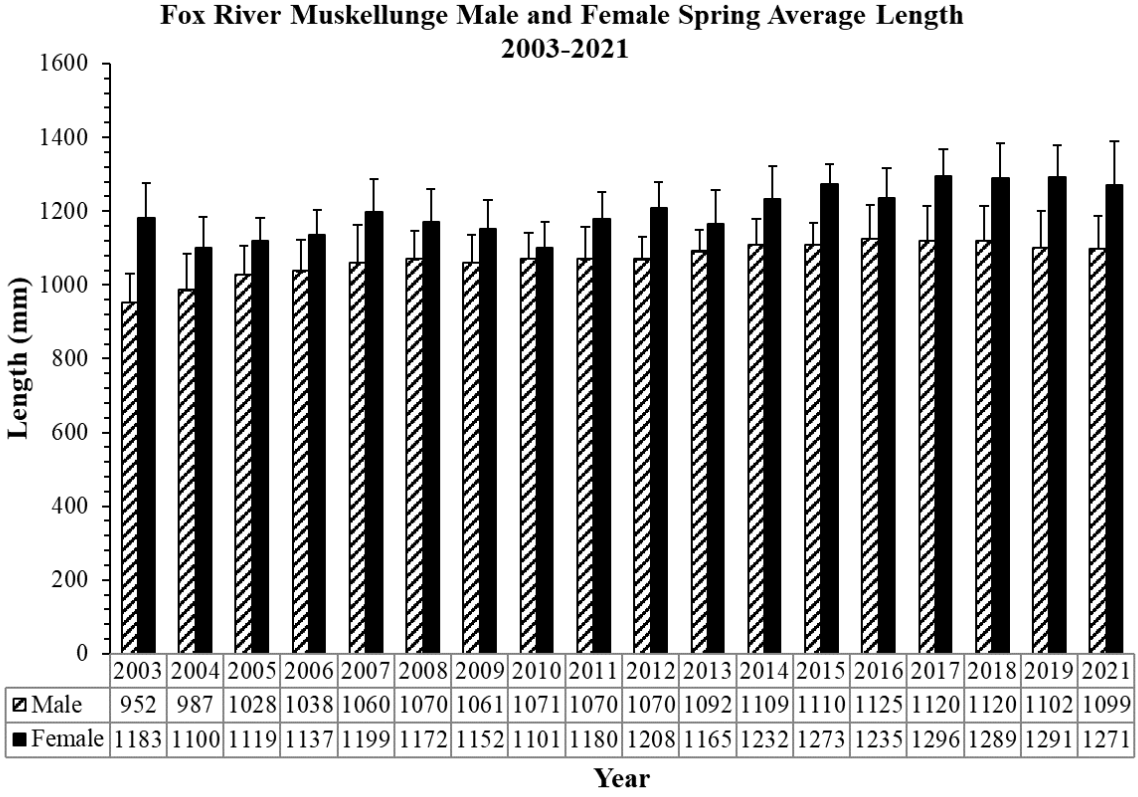
ANNUAL ASSESSMENTS

Assessments to determine the status of the Green Bay Muskellunge population have been conducted using fyke nets and electrofishing in the fall. Spring fyke netting surveys to assess adult spawning populations have been conducted annually on the Fox River since spring 2003 and are also conducted on some of the other major spawning tributaries (i.e., the Menominee River, Oconto River and Peshtigo River) in some years.

In 2021, the 42 male Muskellunge captured in Fox River fyke nets had an average length of 1,099 mm (43.3 in.) and the 15 female Muskellunge captured averaged 1,271 mm (50 in.) in length (Figure 1). Since 2003, the average length for both male and female Muskellunge in Fox River netting surveys has increased steadily in most years between 2012 and 2018 (Figure 1). Average lengths of male and female Muskellunge have been similar over the last 3-4 years, with females averaging 1,270-1,300 mm and males averaging 1,100-1,125 mm.

In 2021, 13 Muskellunge captured in the spring fyke netting survey on the Fox River had a Passive Integrated Transponder (PIT) tag implanted under their skin. Tables 1 and 2 at the end of this document provide information about the original tagging events for each fish and any other DNR surveys recaptures. Twelve of the 13

Muskellunge were either stocked into the Fox River or were PIT-tagged in previous surveys of the Fox River. The other Muskellunge was stocked into Lake Butte des Morts and migrated down to the Lower Fox River. Three Muskellunge had also been recaptured in previous surveys, all of which were on the Fox River in spring. Recapture data from PIT-tagged Muskellunge provides information on spawning site fidelity, evidence of a return to stocking locations to spawn, growth rates and longevity. For example, one of the Muskellunge captured in 2021 was originally tagged as a yearling from the 1998-year class stocked into the Fox River in 1999, meaning this fish was 23 years old.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021
Male	952	987	1028	1038	1060	1070	1061	1071	1070	1070	1092	1109	1110	1125	1120	1120	1102	1099
Female	1183	1100	1119	1137	1199	1172	1152	1101	1180	1208	1165	1232	1273	1235	1296	1289	1291	1271

Figure 1. The yearly average length (mm) of male and female Muskellunge captured during spring netting surveys of the lower Fox River from 2003-2019, 2021. This survey was not conducted in 2020 due to COVID restrictions, which is why this year is missing from the graph. Error bars represent standard deviations.

Since 2000, nighttime electrofishing surveys have been conducted on the Fox River during September or October to index Muskellunge and Walleye populations. Two metrics are used to assess the Muskellunge population in fall electrofishing surveys. Catch rates of Muskellunge >450 mm (17.7 in.) are used as an index of the juvenile and

adult population combined and catch rates of Muskellunge >760 mm (30.0 in.) are used as an index of just the adult population. Muskellunge <450 mm are not included in fall catch rates because large numbers of these small Muskellunge may be encountered in fall electrofishing surveys due to recent stockings of large fingerling Muskellunge in areas where electrofishing surveys take place. During the fall 2021 electrofishing survey, four Muskellunge over 450 mm (17.7 in.) were captured. Furthermore, all four Muskellunge were also greater than 760 mm (30 in.). Catch per unit effort (CPUE) (i.e., number of Muskellunge caught per hour of electrofishing) was 0.74 Muskellunge per hour for both size classes in 2021 (Figure 2).

Since the onset of an earlier electrofishing survey start date in 2009, fall CPUE has been sharply lower in most years (Figure 2). However, other factors such as little to no stocking from 2007-2009 also likely contributed to the very low catch rates of Muskellunge from 2011-2013. Even though catch rates of Muskellunge in fall electrofishing surveys over the last eight years have not been as high as what was observed in the early 2000s, catch rates have been steadily increasing compared to the lows of 2011-2013. Increases in stocking likely drive these increases in catch since 2010, including increased yearling stockings since 2015.

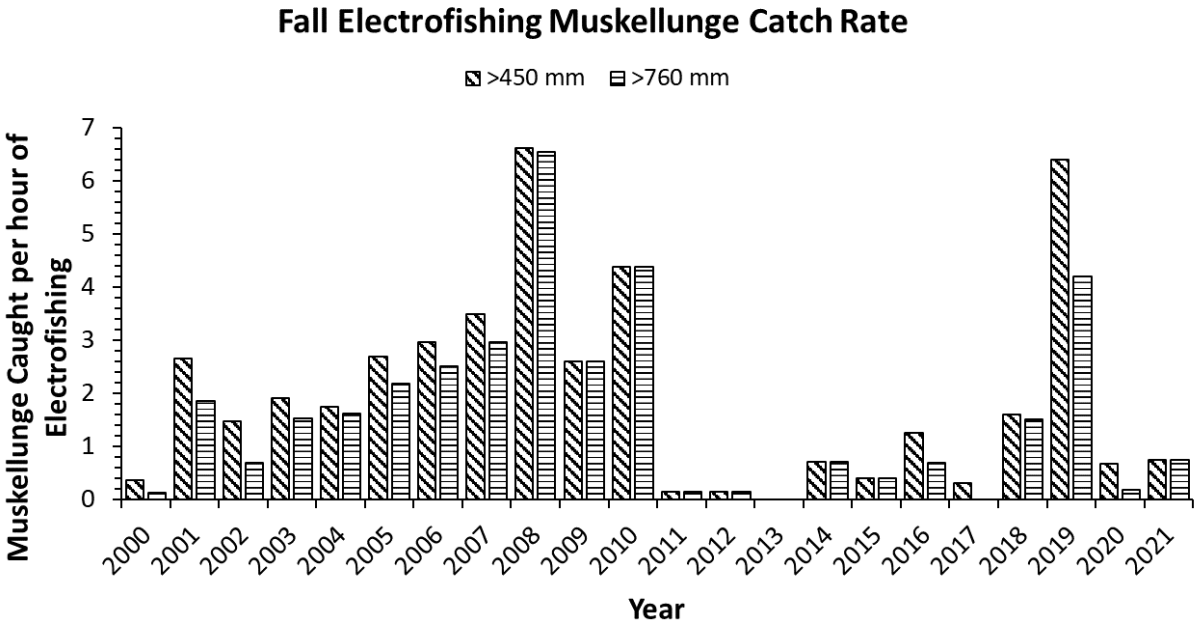


FIGURE 2. Catch per Unit Effort (CPUE) from nighttime electrofishing on the Fox River for Muskellunge greater than 450 mm (17.7 in.) and greater than 760 mm (30 in.) from 2000- 2021.

STOCKING

In 2021, the DNR stocked 15,811 large fingerling Muskellunge into the Wisconsin waters of Green Bay (Figure 3). No yearling Muskellunge were stocked in 2021 due to the inability to collect gametes in the spring of 2020 (Figure 3). Since 1989, a total of 186,403 large fingerlings and 31,622 yearling Muskellunge have been stocked in Green Bay and its tributaries (Figure 3).

Stockings from 2010-2020 consisted of a large fingerling Muskellunge raised at the Besadny Anadromous Fisheries Facility (BAFF) near Kewaunee, WI and yearling Muskellunge reared at Wild Rose State Fish Hatchery. During this time, eggs for Muskellunge raised at BAFF were obtained from wild fish attempting to spawn in the Fox River that were captured during spring fyke net surveys, and yearling Muskellunge raised at Wild Rose were obtained from the Michigan DNR, who collected eggs from adult Muskellunge spawning in the Detroit River. Starting in 2021, large fingerling Muskellunge were also raised at both BAFF and the Wild Rose State Fish Hatchery from eggs that were collected from adult Muskellunge spawning in the Fox River. The impact of raising large fingerling Muskellunge at Wild Rose State Fish Hatchery and BAFF is evident in Figure 3, which shows the increase in large fingerlings stocked in 2021 compared to the previous 10 years. Yearling Muskellunge will continue to be raised at the Wild Rose State Fish Hatchery, with the source of these fish being the Detroit River through a partnership between the Wisconsin DNR and Michigan DNR.

Since 2010, most Muskellunge have been stocked in locations with fingerling habitat and can also support adult Muskellunge. These locations include the Fox River in Brown County, the Menominee River in Marinette County and Sawyer Harbor and Little Sturgeon Bay in Door County. However, since 2010, smaller streams on the west shore of Green Bay, including the Peshtigo River, Oconto River, Pensaukee River and Suamico River, have also been stocked. All stocked fingerling Muskellunge receive a Left Ventral (LV) fin clip, and all yearling stocked Muskellunge receive a Right Ventral (RV) clip, with 20% of the yearling Muskellunge also receiving a PIT tag near the dorsal fin. Results from recent research have shown that adult Muskellunge in Green Bay tend to return to stocking locations to spawn. As a result, future stockings will also focus on areas that have adequate spawning and nursery habitat to increase the likelihood that these stocked Muskellunge will be able to reproduce naturally in future years.

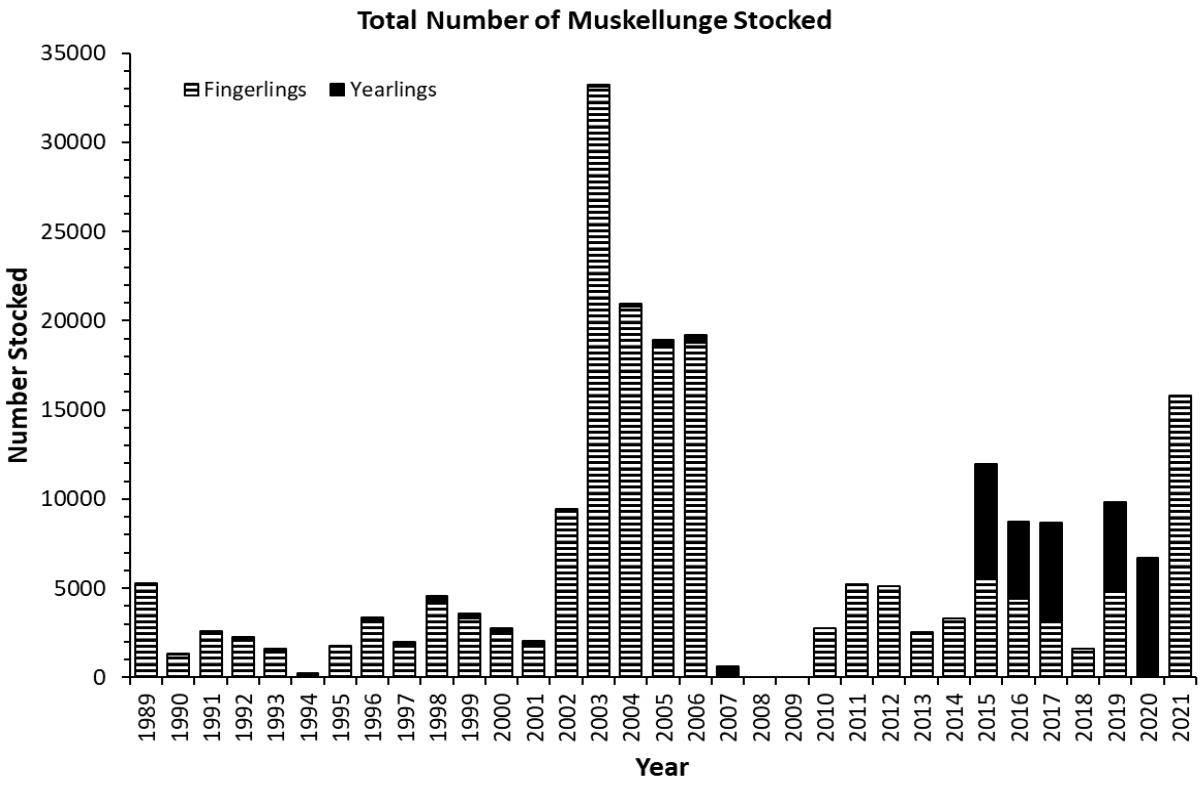


FIGURE 3. Great Lakes Spotted Muskellunge stocking history for fish that were stocked into Green Bay and its tributaries from 1989 – 2021.

FISHERY

The Lake Michigan creel survey estimated that 3,513 Muskellunge were caught by anglers in 2021 (Figure 4). The 2021 catch of Muskellunge was the third-highest estimated catch since 2005 and doubled the average annual catch of 1,750 Muskellunge per year since 2005. It should be noted that DNR staff could not start conducting creel surveys until July 2020, meaning estimates of the number of Muskellunge caught in 2020 are likely low given creel surveys were not conducted from March - June.

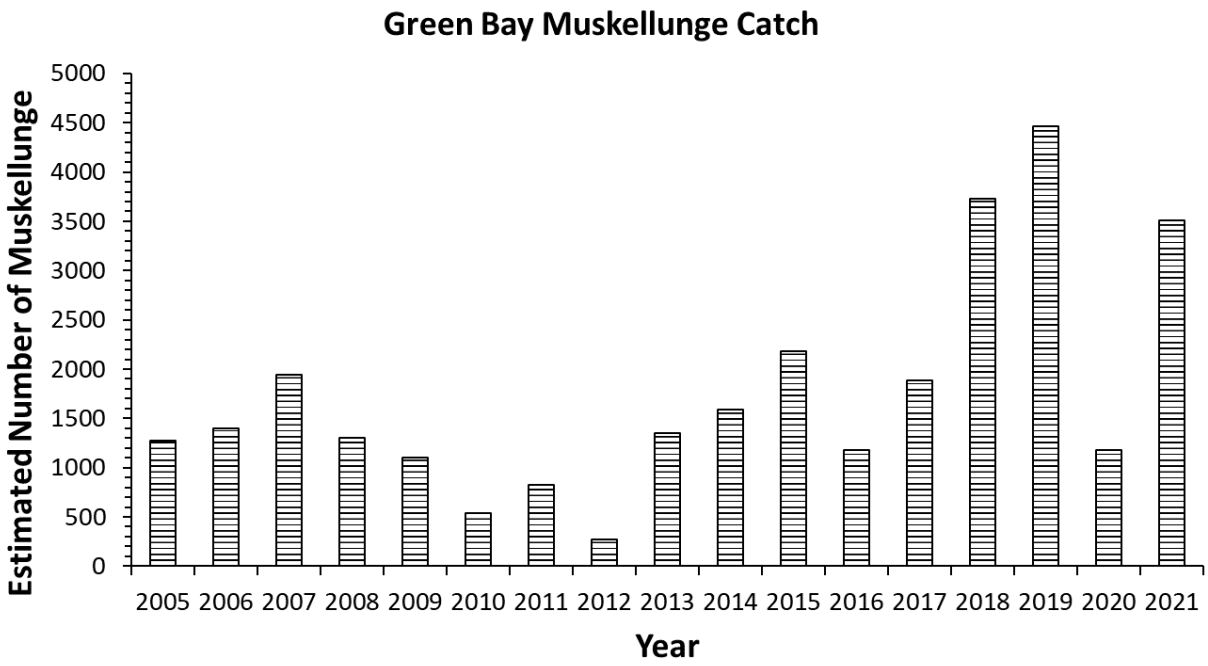


FIGURE 4. The estimated catch of Great Lakes Spotted Muskellunge from Green Bay from 2005 – 2021 during the open water fishing season.

An estimated 68,989 hours of directed effort for Muskellunge occurred on Green Bay and the lower Fox River from March 15 through Nov. 15, 2021 (Figure 5). Fishing effort targeting Muskellunge has increased over the last two years following declines in effort between 2014 and 2019 (Figure 5). The creel survey estimated that angler CPUE was 0.051 fish per hour in 2021 or approximately 19.6 hours spent fishing to catch a Muskellunge (Figure 5).

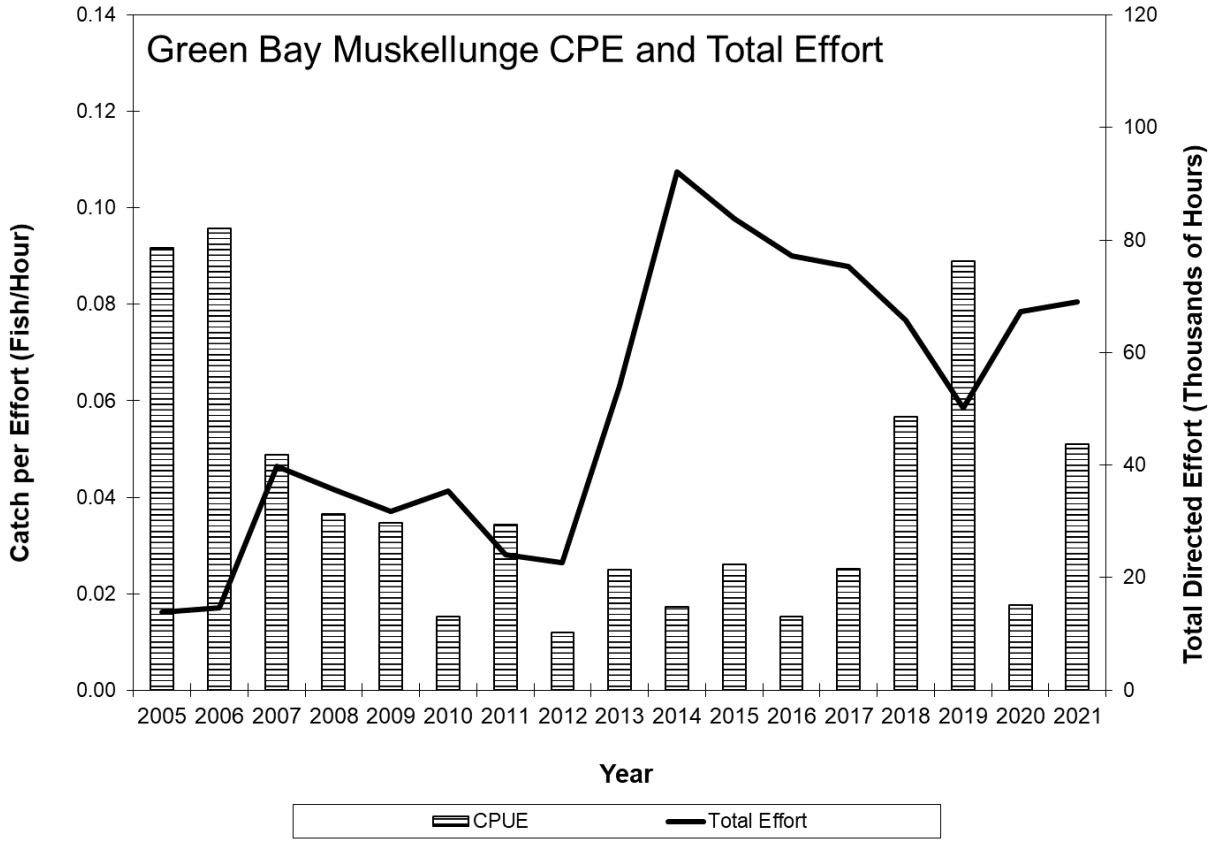


FIGURE 5. The total directed fishing effort for Muskellunge on Green Bay waters of Lake Michigan from 2005-2018 is displayed by the solid black line on the right axis in thousands of hours fished. The left axis shows catch per effort of Muskellunge caught from 2005 through 2021.

THE FUTURE OF THE SPORT FISHERY

Currently, stocking maintains the Green Bay Muskellunge population. Based on DNR surveys and recent research projects with the University of Wisconsin – Stevens Point, it appears that the stocked Muskellunge grow rapidly, reach maturity and attempt to spawn in various tributaries and other locations around Green Bay. Despite attempts by adults Muskellunge to spawn, few natural recruits have been captured over the last 20 years, indicating a bottleneck is likely occurring during egg development or the early larval phase limiting natural recruitment. Future research efforts should attempt to understand where this bottleneck is occurring and provide insight into management options to overcome this bottleneck and create a population sustained through natural reproduction.

Increased stocking since 2010, including large increases in the numbers of yearlings stocked and the addition of raising large fingerling Muskellunge at Wild Rose State Fish Hatchery, should increase the number of Muskellunge available to anglers in Green Bay waters in upcoming years. Creel survey results indicate that the Green Bay Muskellunge fishery remains popular with anglers and that anglers have begun to target Muskellunge throughout Green Bay as the population spreads out from the Fox River and lower Green Bay to more northern waters.

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TABLE 1. Summary of the original tagging information for the 13 Muskellunge captured in the spring 2021 fyke netting survey on the Fox River that were previously PIT tagged. Information provided includes capture date in 2021, PIT tag number, capture size in 2021, sex, observed fin clips, date originally PIT tagged, length when originally PIT-tagged, a location originally PIT tagged, and the gear used to capture the fish when it was originally PIT tagged. Stocking listed in the Survey Gear when Originally Tagged means this fish was PIT Tagged at the time of stocking.

Date Captured	PIT Tag Number	2021 Captured Length (mm)	Sex	Fin Clip	Date PIT Tagged	Tagged Length (mm)	Tagged Location	Survey Gear when Originally Tagged
5/12/2021	985120027250217	1,350	F	LV RV	10/30/2006	945	Fox River	Electrofishing
5/12/2021	985120028921305	1,254	F	NC	8/29/2007	476	Fox River	Stocking
5/11/2021	985121001366707	1,242	F	RV	8/29/2007	518	Fox River	Stocking
5/12/2021	985121001366179	1,055	M	RV	8/29/2007	492	Lake Butte Des Morts	Stocking
5/12/2021	985121001390047	1,385	F	NC	4/28/2010	1,149	Fox River	Fyke Net
5/11/2021	985121013764112	1,071	M	LV	5/13/2011	1,014	Fox River	Fyke Net
5/11/2021	985121014778249	1,136	M	LV	5/11/2016	1,120	Fox River	Fyke Net
5/11/2021	985121014803175	1,119	M	NC	5/21/2014	1,000	Fox River	Fyke Net
5/12/2021	985170001770007	1,100	M	LV	10/14/2018	1,029	Fox River	UWSP Research
5/12/2021	989001003979703	1,067	F	RV	7/28/2015	366	Fox River	Stocking
5/12/2021	43154F777F	1,212	M	RV	9/21/1999	530	Fox River	Stocking
5/11/2021	47046D0405	1,269	M	LV	5/11/2009	1,022	Fox River	Fyke Net
5/11/2021	47057A0E00	1,121	M	LV	5/8/2009	991	Fox River	Fyke Net

TABLE 2. Summary of the recapture information (i.e., events when a Muskellunge was recaptured after it was originally PIT-tagged) for the three Muskellunge captured in the spring 2021 fyke netting survey on the Fox River that were also recaptured in previous surveys. Information provided includes capture date in 2021, PIT tag number, capture size in 2021, sex, observed fin clips, date recaptured, length when recaptured, recapture location and the gear used when the Muskellunge was recaptured. Note that the Muskellunge with PIT tag number 43154777F was recaptured in three previous surveys.

Date Captured	PIT Tag Number	2021 Captured Length (mm)	Sex	Clip	Date Recaptured	Recapture Length (mm)	Recapture Location	Survey Gear when Recaptured
5/11/2021	985121014778249	1,136	M	LV	5/16/2018	1,135	Fox River	Fyke Net
5/11/2021	985121014803175	1,119	M	NC	5/11/2016	1,069	Fox River	Fyke Net
5/12/2021	43154F777F	1,212	M	RV	4/27/2005	1,040	Fox River	Fyke Net
5/12/2021	43154F777F	1,212	M	RV	5/12/2009	1,149	Fox River	Fyke Net
5/12/2021	43154F777F	1,212	M	RV	5/11/2016	1,200	Fox River	Fyke Net

STATUS OF WALLEYE IN SOUTHERN GREEN BAY AND THE FOX RIVER, 2021

BACKGROUND

Walleye stocks in southern Green Bay were decimated during the early to mid-1900s by habitat destruction, pollution, interactions with invasive species and over-exploitation. Following water quality improvements in the early 1970s, the Wisconsin DNR began to stock fry and fingerling fish to rehabilitate the Walleye population. This stocking program successfully re-established natural reproducing Walleye in southern Green Bay and the lower Fox River that stocking was discontinued in Green Bay and the Fox River in 1984 and in the Sturgeon Bay area in 2012. Since 1984, surveys have been conducted to assess adult and young of the year (YOY) Walleye in the Fox River, Green Bay and other tributaries.

This report aims to summarize data collected during the 2021 field season on the southern Green Bay and Fox River Walleye stocks and to describe long-term trends in YOY production and angler catch and harvest.

SPRING ELECTROFISHING SURVEYS

Between 2013 and 2019, the DNR collected data on the adult spawning Walleye population in the Fox River, a tributary to southern Green Bay, using daytime electroshocking. This survey was not conducted in 2020 due to COVID restrictions but resumed in 2021. Each year, electrofishing surveys were conducted just below the dam in De Pere to capture Walleye during the estimated peak of the spring spawning run. The survey's goal is to collect biological data on at least 500 Walleye. Data collected includes total length, sex and a fin spine to estimate the age composition of the adult spawning population.

Electrofishing surveys of the Fox River in 2021 were conducted on March 25 and April 1. Water temperatures ranged from 39-42°F depending on location and date. A total of 4.42 hours of electrofishing effort was expended to capture 555 Walleyes for a catch rate of 125.6 Walleyes per hour of electrofishing. Captured Walleyes ranged in length from 331 to 741 mm (13.0 in. to 29.2 in.) and had an average length of 561 mm (22.1 in.).

Over the two days of electrofishing, 390 female Walleyes were captured, ranging in size from 440 to 741 mm (17.3 in. to 29.2 in.) with an average length of 618 mm (24.3 in.; Figure 1). The vast majority (i.e., 89%) of the female Walleyes that were captured were ≥550 mm (21.7 in.; Figure 1). A total of 149 male Walleyes were captured, ranging in size from 331 to 570 mm (13.0 in. to 22.4 in.) with an average length of 425 mm (16.7 in.; Figure 1). Less than 13% of the males captured were ≥500 mm or 19.7 in. (Figure 1). Only 16 Walleyes of unknown sex were captured, all of which were ≤485 mm (19.1 in.; Figure 1).

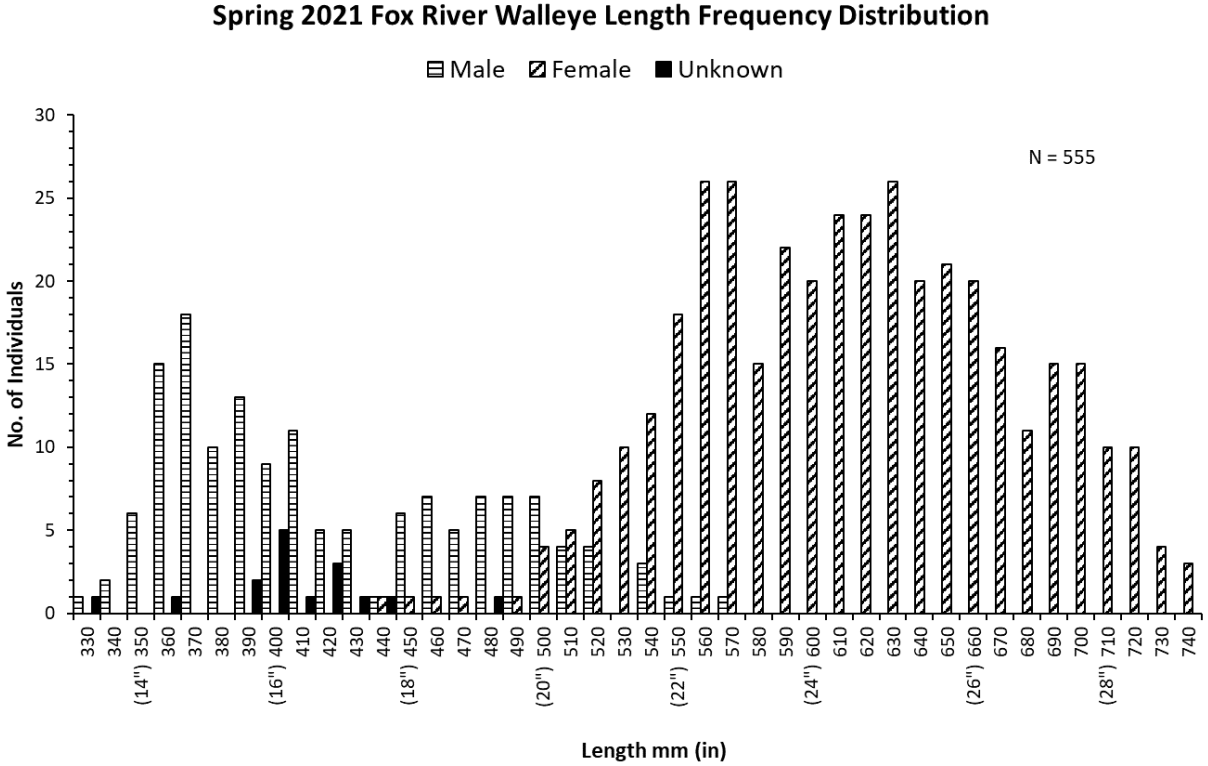

FIGURE 1. The length distribution of Walleyes captured during the 2021 spring electrofishing survey on the Fox River.

During the 2021 spring Fox River survey, a dorsal fin spine was removed from all captured Walleyes for age analysis and ages were estimated from fin spines for 554 of the 555 Walleyes captured. The percentage of each age class in the adult spawning population is shown in Figure 2. Age three Walleyes were the largest year class in the spring adult spawning population, making up approximately 19% of the Walleyes captured (Figure 2). It is not surprising that age-3 Walleyes were the largest age class in the adult spawning population since age-3 is typically the age when Walleyes begin to mature. The 2018 year class (i.e., the age-3 adults) was the largest year class

recorded in fall young of year (YOY) electrofishing surveys. It is highly likely that not all Walleyes from the 2018 year class were mature by age-3, so this year's class will likely make up a larger percent of the spawning adult population in upcoming years. Ages 6, 7, 8 and 11 were the following largest year classes, with each of these age classes making up just over 10% of the adult spawning Walleye population (Figure 2). All age classes from 3-17 were present except for age-15 Walleyes, meaning at least 14 age classes contribute to the adult spawning population of Walleyes in the Fox River (Figure 2).

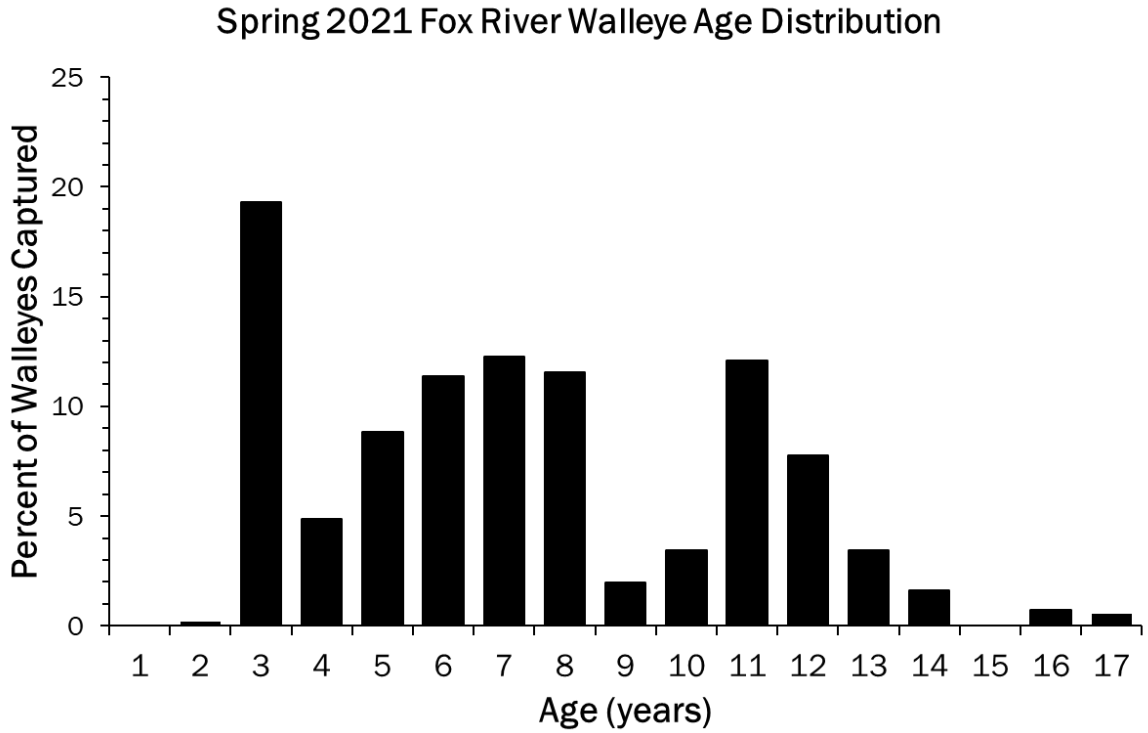

FIGURE 2. Age-frequency distribution of Walleyes captured during the spring spawning run from the Fox River in 2021. Male and female ages are pooled to determine the percentage of the run represented by each year class. The data are presented as the percentage of each age class in the sample.

FALL ELECTROFISHING INDEX SURVEYS

During the fall of 2021, a total of 10 hours was spent electrofishing 17.02 miles of shoreline between lower Green Bay (8.84 miles and 4.6 hours) and the Fox River (8.14 miles and 5.4 hours) as part of the annual fall YOY Walleye index electrofishing survey. A total of 724 Walleyes ranging in size from 198 to 641 mm (7.8 in. to 25.2 in.)

with an average length of 420 mm (16.5 in.) were captured (Figure 3). Twenty-six YOY Walleyes and 698 adults were captured. All but one of the YOY Walleyes were captured in the Fox River.

Dorsal fin spines were collected from up to 10 Walleyes per 10mm length bin to estimate the age composition of the Walleyes sampled. An age-length key was used to assign ages to all Walleyes that did not have a fin spine collected based on an individual Walleye's Length. Walleyes between the age 0-10 were collected in the 2021 fall electrofishing survey (Figure 4). Greater than 80% of the Walleyes captured in Fox River and Lower Green Bay were estimated to be age-3 from the 2018 year class. Catch rates of YOY Walleye in the fall of 2018 were the highest ever recorded in annual fall electrofishing surveys since 1993. The fact that over 80% of the Walleyes captured in the fall 2021 survey were from the 2018 year class shows how strong that year class was and how dominant that year class will likely be in adult surveys in the coming years.

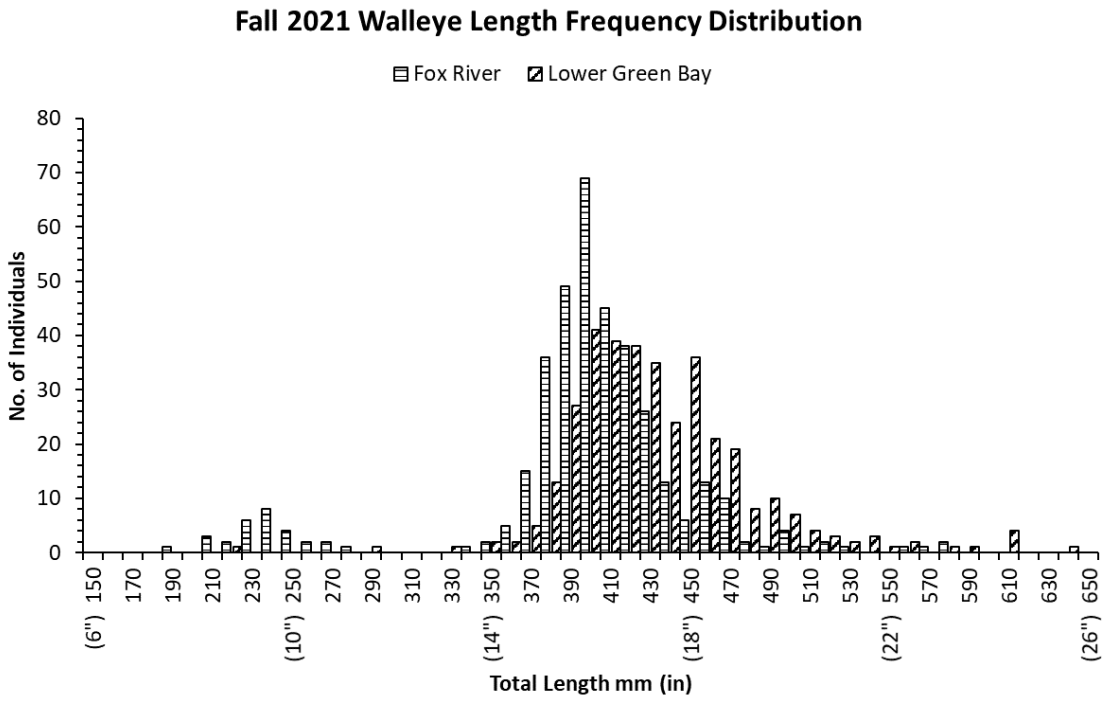

FIGURE 3. Length frequency distribution of Walleyes captured in the fall 2021 electrofishing surveys of Lower Green Bay and the Fox River.

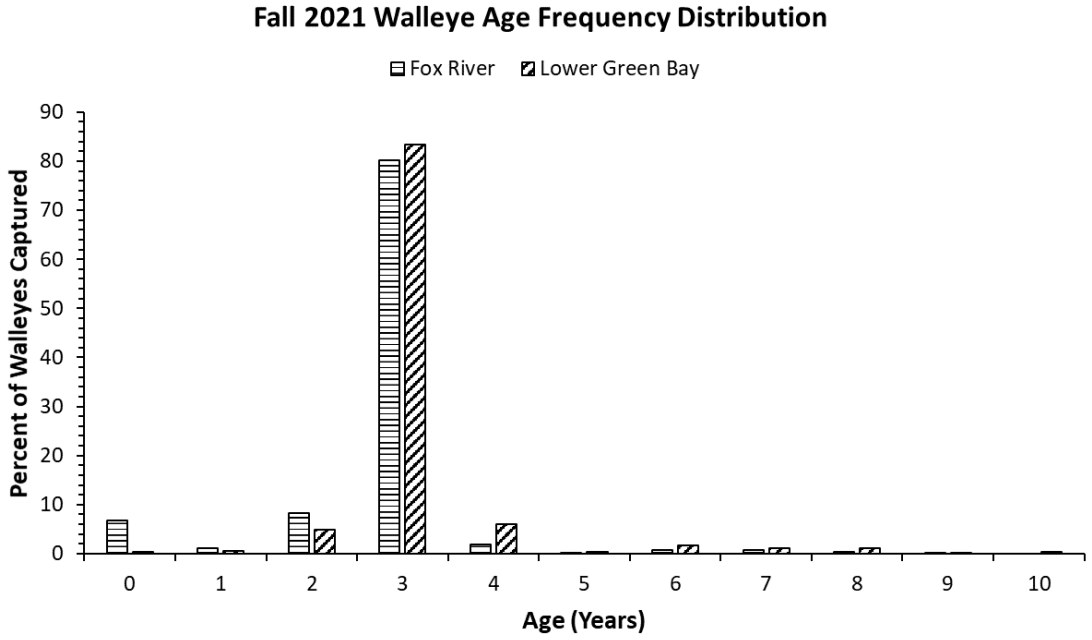

FIGURE 4. Age-frequency distribution (i.e., percent of Walleyes captured) of Walleyes captured in the fall 2021 electrofishing surveys of Lower Green Bay and the Fox River.

Recruitment of YOY Walleye

Results from our 2021 fall electrofishing index surveys indicated that the CPUE of YOY Walleyes captured on the Fox River and lower Green Bay were below average compared to 1993 through 2021 (Figure 5). In 2021, the CPUE of YOY Walleyes in the Fox River was 4.6 per hour shocked, which was well below the 1993-2020 average CPUE of 17.0 YOY per hour. Catch rates of YOY Walleyes in lower Green Bay in 2021 was even lower at 0.2 YOY per hour shocked, which was much lower than the 1993-2020 average of 11.1 YOY per hour of electrofishing (Figure 5). Walleye recruitment tends to be variable, with strong year classes followed by weak year classes in some years, as shown by the variability in catch rates since 1993. It's interesting to note that apparent predictable strong year classes from the fall Fox River surveys occur every five years (i.e., 1993, 1998, 2003, 2008, 2013 and 2018). Trends in catch rates of YOY Walleyes from lower Green Bay fall surveys follow a relatively similar pattern, but catch rates tend to be lower than in the Fox River in most years with really strong year classes.

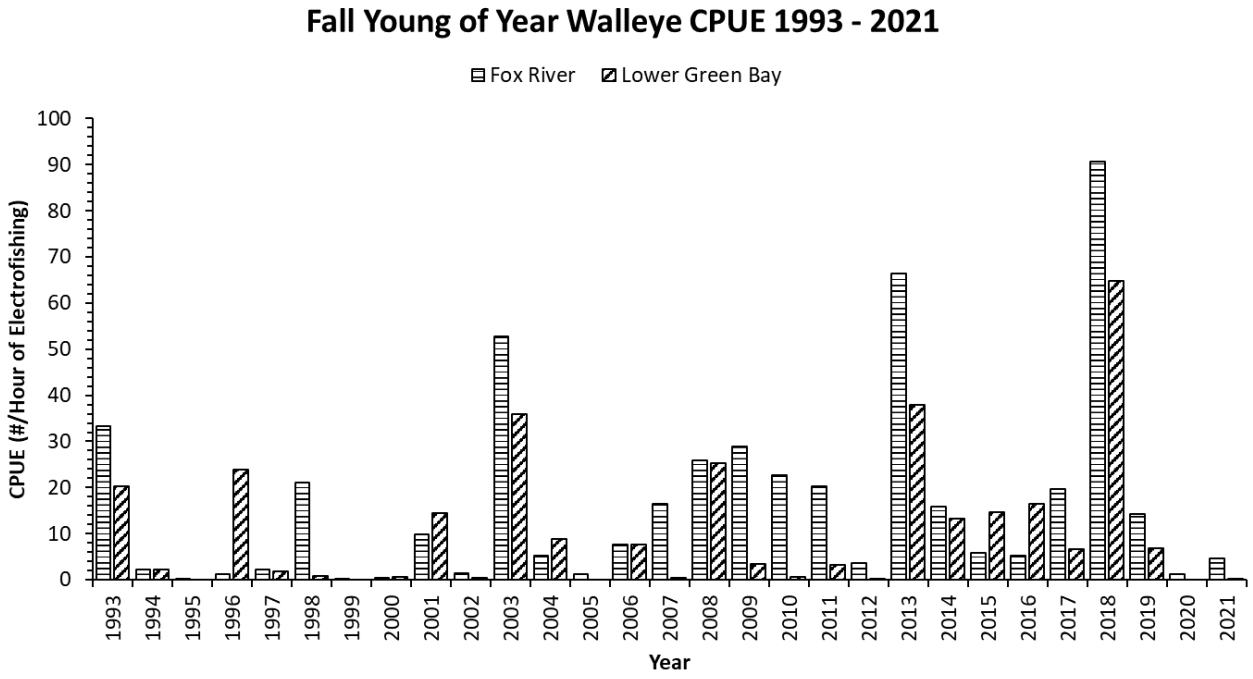

FIGURE 5. Catch per unit effort (CPUE) of young of year (YOY) Walleye in the lower Fox River and lower Green Bay (south of a line drawn from Longtail Point to Point Sable), as measured by CPUE (number per hour) from data collected in electrofishing index surveys during 1993-2021.

CATCH AND HARVEST

Estimates of catch and harvest of Walleyes from Wisconsin waters of Green Bay and its tributaries have been generated from creel survey data collected during the open water season in every year since 1986. From 1986-2012, open water creel surveys were conducted from March 15-Oct. 31. Starting in 2013, the end date of the open water creel was extended to Nov. 15 along the west shore of Green Bay.

The total catch of Walleyes during the 2021 open water season was estimated at 318,101 fish (Figure 6). The total catch of Walleyes in 2021 was 42.7% higher than the estimated average annual total catch of 222,974 Walleyes from 2013-2019. The years 2013-2019 were used because these were the years in which the creel was extended a couple of weeks later in the fall. Total catch from 2020 was not included in the average of total Walleye catch because creel surveys did not start until July of 2020 due to the COVID-19 pandemic, meaning estimates of catch and harvest in 2020 are likely lower than what was caught and harvested during the open water season in that year.

Total open water harvest of Walleyes also increased in 2021 and was estimated to be 153,054 fish (Figure 6). Harvest of Walleyes during the 2021 open water season was 61% higher than the estimated average annual total harvest of 94,675 Walleyes from 2013-2019.

Catch and harvest of Walleyes during the 2021 open water season continued the upward trend that started in the early 2000s and were the highest on record since open water creel surveys started in 1986 (Figure 6). Increases in catch and harvest of Walleyes over the last 20 years are likely driven by increases in the adult Walleye population fueled by consistent recruitment. In particular, increases in catches in more recent years have likely resulted from the really strong 2013 and 2018 year classes, the two strongest year classes documented in fall electrofishing surveys since 1993.

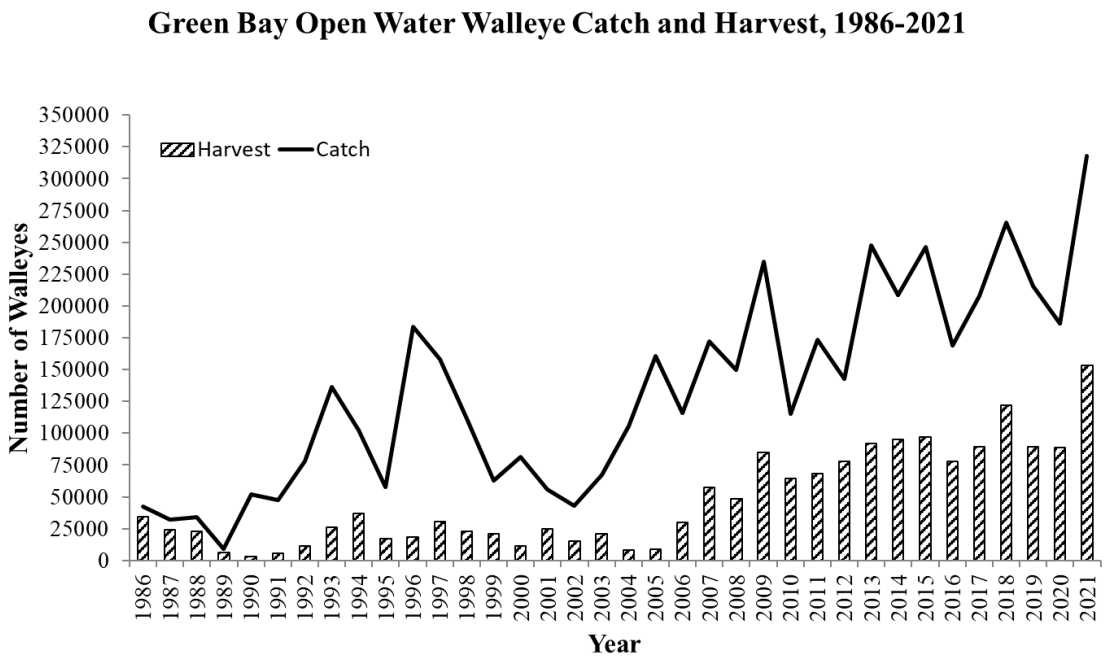

FIGURE 6. Estimated total open water season catch and harvest of Walleyes from Wisconsin waters of Green Bay and the lower Fox River from 1986 through 2021. 2020 data reflects only July-November data because of reduced creel effort due to the COVID-19 pandemic. Starting in 2013, the end date for open water creel was extended from Oct. 31 to Nov. 15.

THE FUTURE OF THE SPORT FISHERY

The future of the southern Green Bay/lower Fox River Walleye stock and sport fishery appears to be very promising. Substantial Walleye year classes have been measured in 11 of the past 14 years during fall electrofishing surveys, with the 2018 cohort being the strongest year class measured since the onset of fall index shocking in 1993. In recent years, anglers have caught much smaller fish, likely due to the dominance of the 2018 year class in the population. As the 2018 year class fully recruits to the fishery and fish from this year class continue to get larger, the size of Walleyes in angler catches will likely increase.

Additionally, as contaminant levels continue to decrease from the Fox River polychlorinated biphenyls (PCB) clean-up, the Walleye harvest will likely continue to show a generally increasing trend. The Green Bay creel survey will continue to play a vital role in managing the Walleye fishery in the future.

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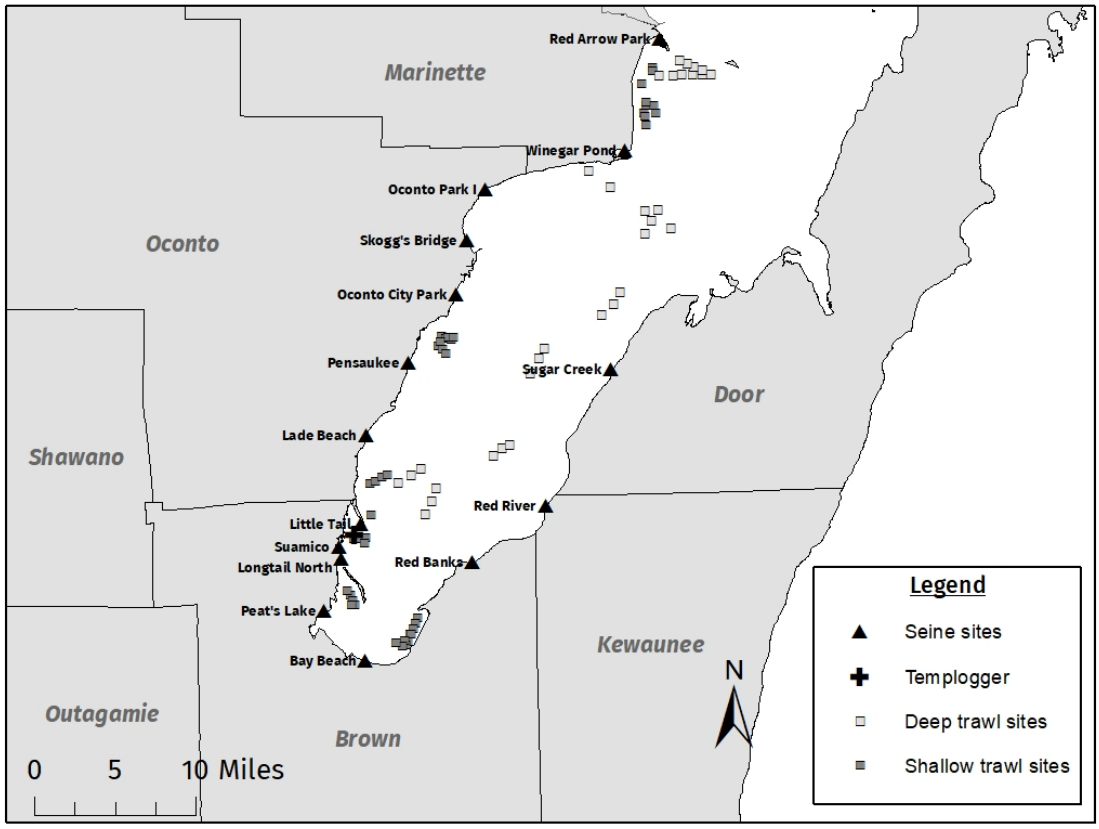
GREEN BAY YELLOW PERCH

This report summarizes assessments and monitoring of Yellow Perch in southern Green Bay completed in 2021 by the Wisconsin DNR. Over the years, data obtained from various surveys have been used as inputs for a statistical catch-at-age model that estimates the abundance of adult Yellow Perch. These surveys include spring fyke netting, water temperature monitoring, shoreline seining, commercial monitoring, bottom trawling and recreational harvest creel surveys. While the target species was always Yellow Perch, several other fish species were captured, and related information as described in this report. Details of methods are described within each survey section.

Yellow Perch abundance in Green Bay increased steadily through the 1980s. The estimated total biomass of yearling and older Yellow Perch rose from under 1 million pounds in 1978 to nearly 9 million pounds in 1987. The population growth was fueled by the production of strong year classes in 1982, 1985, 1986 and 1988. Beginning in the late 1980s, Yellow Perch abundance began to decline, primarily due to poor recruitment. From 1988 to 2002, only two reasonably strong year classes (1991 and 1998) appeared during summer trawling surveys (Figure 1). Since 2002, reasonably strong year classes were measured annually, except for 2014, 2019 and 2020 (Figure 1). The trawling surveys indicated that 2021 produced a moderate year class with the relative abundance of young of the year (YOY) Yellow Perch estimated at 203/hour. The average number of YOY per trawl hour is 880/hours, since deep water trawl sites were added in 1988.

MAP OF 2021 SAMPLING LOCATIONS



SPAWNING ASSESSMENT

The spring spawning assessment inside Little Tail Point is completed every two to three years. Since the survey was completed in 2019, it was not planned for 2021. The survey's primary objective is to collect age at maturity data on spawning Yellow Perch. During that survey, double-ended fyke nets are set at two standard locations offshore in 5 to 8 feet of water after ice-out. Nets are lifted as often as weather conditions allow (every 1-3 days) until most mature females sampled are ripe or spent. Since 1998, the date that 75% of mature female perch were ripe or spent has ranged from as early as April 19 (2012) to as late as May 8 (2014), with a mean date of April 26.

WATER TEMPERATURE

Annual spring and summer temperature monitoring has been ongoing since 2003, except for 2020. A HOBO Water Temp Pro v2® templogger U22 (Onset Computer Corporation) was deployed as soon as ice, weather and staffing conditions allowed (April 12, 2021) near Little Tail Point to record water temperature every 30 minutes until Oct. 28, 2021. The water temperature was 48°F at the time of templogger deployment. May 2021, water temperatures averaged 55.4°F (Table 1). A 23°F drop in water temperature was recorded between Aug. 20 and Aug. 21, 2021. Occasional extreme fluctuations have been recorded on the Little Tail templogger, most often during warm weather with strong west or southwest winds bringing in cooler water.

Table 1. Little Tail Point May water temperature average and date when 50°F was reached. This is considered the temperature at which Yellow Perch will begin to spawn.

YEAR	MAY AVERAGE	50°F REACHED DATE	YEAR	MAY AVERAGE	50°F REACHED DATE
2021	55.4	12-Apr	2011	55.5	26-Apr
2019	52.8	24-Apr	2010	59.4	12-Apr
2018	59.3	Unknown	2009	56.8	18-Apr
2017	55.4	17-Apr	2008	56.7	22-Apr
2016	56.4	17-Apr	2007	61.1	20-Apr
2015	58.8	16-Apr	2006	56.9	12-Apr
2014	55.2	6-May	2005	54.2	19-Apr
2013	56.7	30-Apr	2004	55.7	16-Apr
2012	62.5	4-Apr	2003	56.7	25-Apr

BEACH SEINING

Twelve index sites along the west and east shores of Green Bay were sampled once using a beach seine (25 ft wide x 6 ft high, ¼-inch delta mesh with 6 x 6 x 6ft bag) between June 24-30, 2021. Thirteen sites were sampled between July 13-26, 2021.

A rope tied to a steel rod at each site was driven into the bottom sediment to measure a 50-foot transect perpendicular to the shore. Two people walked alongside the rope and completed two hauls, one on each side of the 50-foot rope. A third person held a tub and supplies. After each 50-foot haul, the number of YOY both retained and escaped from the seine bag when placed in a tub was recorded. Catch

per effort (CPUE) was calculated as the mean number of YOY Yellow Perch per 100-foot seine haul. YOY Yellow Perch were captured at 7 of 12 sites (mean CPUE=50; Table 2) during the June sampling period and at 7 of 13 sites (mean CPUE=6; Table 2) during the July sampling period. The previous 23-year average CPUE is 67. The site with the highest abundance in 2021 was at Peats Lake (CPUE=208).

The mean length of YOY Yellow perch during the late June survey period was 42 mm (range: 22-60 mm), and the mean length of YOY Yellow Perch during the July survey period was 48 mm (range: 29-80). A total of 27 fish species were identified during the survey. Yellow perch YOY dominated the catches, followed by Round Goby, Emerald Shiner and White Perch YOY. Of interest were nine YOY Largemouth Bass and five YOY Smallmouth Bass captured at various sites. No YOY Walleye or Northern Pike were captured.

Table 2. Yellow Perch mean CPUE of June and July sampling periods, 2011-2021.

	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
June CPUE	50	N/A	17	44	163	51	37	46	32	30	115
July CPUE	6	7	7	45	14	12	N/A	7	24	27	38

TRAWLING SURVEY

Annual late summer trawl surveys continued for the 44th year to monitor trends in Yellow Perch abundance. Trawling was conducted at 75 index sites at 12 locations: 43 shallow sites (established in 1978-1980) and 32 deep water sites (added in 1988) using a 25-ft semi-balloon trawl with 1½-inch stretch mesh on the body, 1¼-inch stretch mesh on the cod end and a cod-end liner with ½-inch stretch mesh. The net was towed for five minutes at a speed of 2.8 knots, for a distance of approximately 0.25 miles. Hauls were made during daylight hours on the RV Coregonus.

At each of the 12 locations, 100 YOY Yellow Perch were measured if captured and yearling and older perch were subsampled for age, length and weight. All species were counted, with additional biological data for gamefish and Lake Whitefish.

For all locations, mean length of Yellow Perch YOY was 68 mm (range: 55-110 mm). The average number of Yellow Perch collected per trawl hour was adjusted based on the amount of habitat that standard and deep sites represent, creating a weighted area average value. The trawling surveys indicated that 2021 produced a moderate

year class with the relative abundance of YOY Yellow Perch (203/hour), ranking as 25th out of 33 years since the deep-water sites were added in 1988 (Figure 1). The greatest abundance of YOY Yellow Perch was at Longtail Point (LOT), where 953/hour were captured.

While the trawling surveys are designed to assess YOY distribution and abundance, yearling and older Yellow Perch were also measured, weighed, sexed and aged. The abundance of age-one and older fish was 43/hour in 2021 compared to the 34-year average of 400/hour. A majority (80%) of the age-1 and older fish captured were yearlings (2020 year class) with a mean length of 134 mm (range: 99-168 mm) followed by age-2 (17%) with a mean length of 188 mm (range: 124-230 mm). White Perch YOY were the dominant species captured at shallow sites, followed by Gizzard Shad, Spottail Shiners, Yellow Perch YOY and Round Goby. At deep sites, Rainbow Smelt adults were the most abundant species sampled. Other common species in decreasing order of abundance captured at deep sites were Alewife adults, Lake Whitefish juveniles, Lake Whitefish YOY and Rainbow Smelt YOY.

At each of the 12 locations, a temperature and dissolved oxygen profile was taken along with a secchi disk reading. The hot, calm weather throughout the 2021 survey period likely contributed to the “Dead Zone,” which we encountered during parts of the survey and undoubtedly affected the catches. This “Dead Zone” is a layer of cold water on the bottom with low oxygen. Dissolved oxygen levels were near or below 3 mg/L in the bottom 5 feet of water at sites 20 feet deep off of Little Suamico River (OLSR) and to the north near Pensaukee (PEN). This layer of anoxic water was persistent over several days of the survey, and low catches of fish were noted at locations with good numbers of YOY Yellow Perch. In 2018 and 2019, the “Green Bay Dead Zone,” an area of hypoxic water in the bottom layer, was first recorded during trawling surveys. Oxygen readings were sufficient at all locations in 2020.

Water clarity was highest at the northernmost locations and decreased farther to the south, ranging from 1.9 m at Little River Deep (LRD) off Marinette to 0.6 m at Point Sable (LOT) in the southern bay. Nonetheless, the water clarity reading at LRD was recorded lowest in at least the last 20 years.

Dreissenid mussels incidentally caught in the trawl are weighed to the nearest pound and are visually inspected for the relative composition of zebra and quagga mussels. From 1999 to 2011, zebra mussels comprised most of the dreissenid mussels incidentally caught in the trawling survey. However, since 2012, quagga mussels have dominated the dreissenid mussels caught. A total of 81 pounds of mussels were

collected in 2021. The highest weight of dreissenid mussels recorded was 778 pounds in 2005.

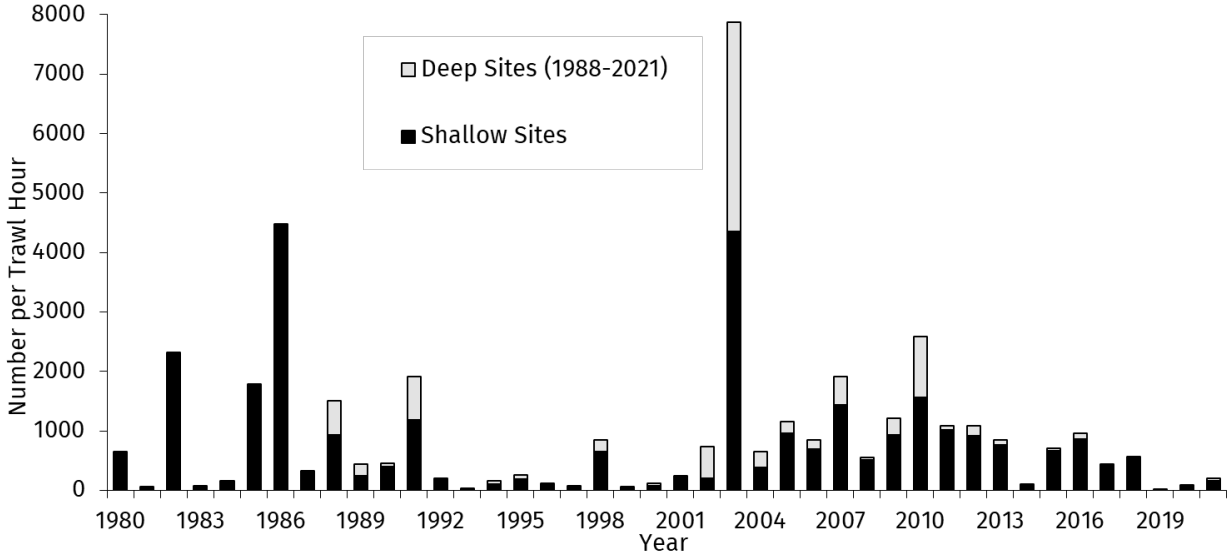


Figure 1. Relative abundance (weighted area average) of young-of-year Yellow Perch collected during late summer index trawling surveys in Green Bay from 1980 to 2021.

RECREATIONAL HARVEST

Since 2006, recreational fishing regulations for Yellow Perch in Wisconsin waters of Green Bay include a 15 fish daily bag limit during the open season from May 20 to March 15. Recreational harvest is estimated from an annual creel survey. Winter harvest is influenced largely by ice conditions, daily bag limits, angler effort and abundance of adult perch. An estimated 172,572 perch were harvested between January and March 15, 2021. The 2021 ice harvest was significantly higher than the previous 20-year winter (2001-2020) average of 34,035 perch and was the highest ice harvest recorded since 1995 (Figure 2).

The ice harvest increase for 2021 of Yellow Perch followed a sharp increase in the 2020 open water harvest when an estimated 248,485 Yellow Perch were harvested (Figure 2). The 2020 estimates do not include harvest from the May 20 opener to July when creel was not conducted due to COVID-19 restrictions, so the true harvest was even higher in 2020. Higher harvests continued into the 2021 open water fishing season when an estimated 258,025 Yellow Perch were harvested by anglers between May 20 and Nov. 15 (end of open water creel). Most of the open water harvest was by boat anglers launching at ramps in Brown County (25%) or Door/Kewaunee counties

(23%). Oconto County and Marinette County ramps accounted for 21% and 17% of the Yellow Perch harvest, respectively. The remaining 14% of the harvest was from anglers fishing along a pier, shore or stream or from moored boat surveys. The mean length of open water harvested Yellow Perch was 9.2 inches (n=354). The majority of the fish harvested were age-2 (2019 year class; 37%) or age-3 (2018 year class); 47%), but ages 1-8 were represented.

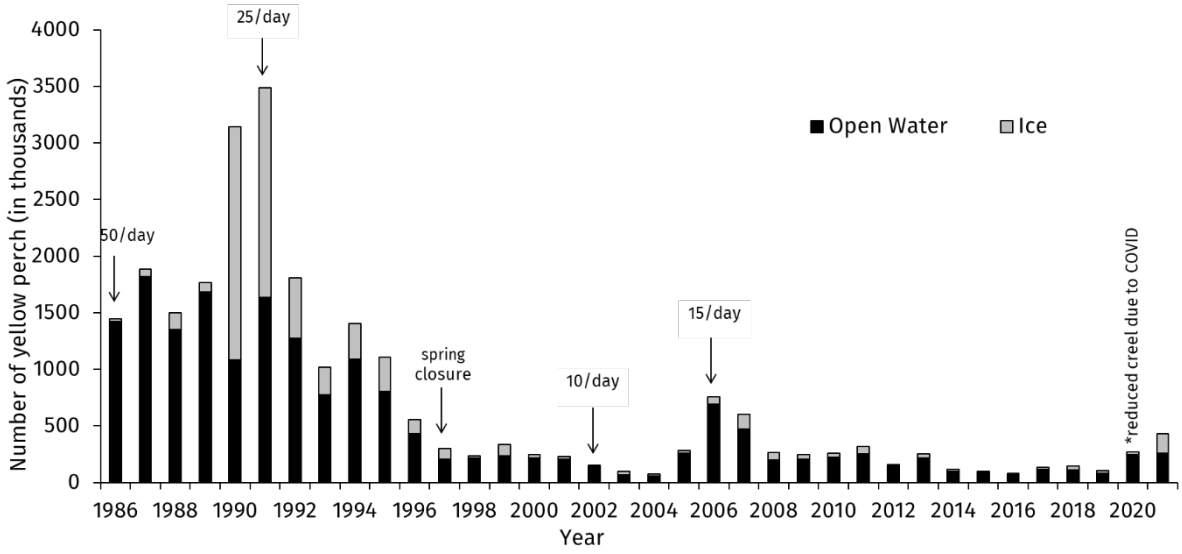


Figure 2. Estimated recreational harvest of Yellow Perch in Green Bay from 1986 to 2021. Regulation changes are indicated by arrows. Open water creel estimates for 2020 are from July-November only.

COMMERCIAL HARVEST

The annual commercial harvest was reported by commercial fishers, who are required to weigh and report their harvest daily. Fish sampled by the DNR at commercial landings were used to describe the age and size composition of the catch. Since 1983, the Yellow Perch commercial harvest in Green Bay has been managed under a quota system. The Zone 1 (Green Bay) quota has ranged from 20,000 pounds to a high of 475,000 pounds. The total allowable commercial harvest has remained at 100,000 pounds since 2008.

In 2021, commercial fishers harvested 79,781 pounds of Yellow Perch (an estimated 243,991 fish), compared to 41,812 pounds in 2020. Most commercial harvests was with gill nets (84%), while drop nets comprised 16% of the total harvest in 2021. The average harvest rate (CPUE) for gill nets in 2021 was 52 pounds per 1000 ft fished, up

from 34 pounds per 1,000 feet fished in 2020. Drop net CPUE was 40 pounds per lift in 2021, up from 8 pounds per lift in 2020. Age-3 perch (2018 year class) comprised 60% of the total commercial harvest in 2021, while age-2 comprised 38%.

POPULATION MODELING

Data collected in 2021 was incorporated into the statistical-catch-at-age model for Yellow Perch in Wisconsin waters of Green Bay. The model was updated and ran during the spring of 2022. Those inputs included harvest, effort and age composition from commercial and sport fisheries and YOY data from trawling surveys. Outputs of that model estimate that the adult (age-1 and older) Yellow Perch population has ranged between 1.1 million and 2.1 million fish from 2013 to 2021. The Yellow Perch (age-1 and older) abundance was estimated at around 1.3 million fish in 2021. The model estimates are retrospective, therefore, the higher proportion of the 2018 year class evident in the fishery resulted in modest increases in the population estimates for 2019 and 2020. For example, the adult Yellow Perch abundance for 2020 was previously estimated at 1 million fish and was adjusted to 1.4 million after the 2021 data input.

DISCUSSION

Open water harvest of Yellow Perch by sport anglers in Green Bay increased in 2020 and 2021 to levels not recorded since 2010-2011. The 2021 ice harvest was the highest ice harvest recorded since 1995. Higher harvest by sport anglers was likely related to higher angler effort. Total angler effort for all species in winter 2021 was estimated at 330,000 angler hours. This was the highest effort recorded in winter creel in nearly two decades. As a comparison, the previous 10-year average effort for winter creel is 259,000 angler hours. The 2021 sport angler effort for open water (all species) was also very high, at 1.3 million angler hours, and was the highest effort recorded during open water creel in over 30 years. The previous 10-year average effort for open water creel is 986,000 angler hours.

Total commercial harvest in 2021 increased by 52%, and the harvest rate improved to 52 pounds per 1000 feet of gill nets compared to 34 pounds in 2020. Drop net harvest rate increased significantly in 2021. Age-2 and age-3 yellow perch continue to provide most of the harvest opportunities for sport and commercial fishers. In particular, the 2018 year class (age-3) were well represented in the aging samples.

The trawling surveys indicated that 2021 produced a moderate year class with the relative abundance of YOY Yellow Perch estimated at 203/hour. In recent years, Yellow Perch recruitment may be higher than measured by the trawling surveys. The long-term shallow water trawling sites were established when water levels were near the long-term average of 579 feet above sea level. Higher than average water levels in Green Bay and Lake Michigan from 2015 to 2021 provide additional shallow water habitat for Yellow Perch. From 1999 to 2014, Green Bay and Lake Michigan water levels were below average.

The DNR will continue monitoring the Yellow Perch fishery's status and adjust commercial harvest and sport bag limits as needed.

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SPORTFISHING EFFORT AND HARVEST

Wisconsin's Lake Michigan open water fishing effort was 2,734,359 hours during 2021, which was 13% above the five-year average of 2,413,458 hours (Table 1). The most notable changes in the effort were in the ramp, charter and stream fisheries, which was up considerably from the five-year average (18.81%, 10.99%, and 20.03%, respectively). The moored boat effort was only slightly below the five-year average and up from 2020 (249,525 hours in 2021 and 227,887 hours in 2020).

The 2021 season was more successful for Wisconsin's Lake Michigan trout and salmon anglers than the 2020 season. Overall harvest was higher, with 288,252 salmonids harvested (Table 4). Although the harvest rate decreased from 2020 to 0.1054 fish, this was about the same as the five-year average harvest rate. The total harvest for all salmonid species was up from the 2020 harvest numbers. Harvest for Brown Trout remained below the five-year average, but harvest for all other salmonids was above the five-year average. The 2021 lake trout harvest of 40,145 fish (Table 2) was almost 26% above the five-year average and the highest harvest on record since 2001. The 2021 Chinook harvest of 100,323 fish was almost 22% above the five-year average and the highest harvest since 2016. The standard weights for harvested Rainbow Trout, Chinook and Coho salmon were above the five-year average (Table 5), while the standard weights for Brown Trout and Lake Trout were slightly below the five-year average.

The open-water Yellow Perch harvest in 2021 was 261,701 fish (Table 2). This was an increase in harvest from 2020 and the highest harvest on record since 2013. Lake Michigan Yellow Perch harvest was 3,676 fish and the Green Bay harvest was 258,025 fish.

Table 1. Fishing effort (angler hours) by various angler groups in Wisconsin waters of Lake Michigan and Green Bay during 2021 and percent change from the 5-year average (2017-21).

YEAR	RAMP	MOORED	CHARTER	PIER	SHORE	STREAM	TOTAL
2021	1,695,163	249,525	336,413	87,558	93,710	271,990	2,734,359
% change	18.81%	-0.41%	10.99%	-15.03%	-9.41%	20.03%	13.30%

Table 2. Sport harvest by fishery type and species for Wisconsin waters of Lake Michigan and Green Bay during 2021.

SPECIES	RAMP	MOORED	CHARTER	PIER	SHORE	STREAM	**TOTAL**
Coho Salmon	31,450	17,960	27,721	1,321	713	844	**80,009**
Chinook Salmon	31,192	22,990	35,483	959	987	8,712	**100,323**
Rainbow Trout	17,428	15,398	20,903	79	150	4,639	**58,597**
Brown Trout	6,112	1,274	562	37	793	400	**9,178**
Brook Trout	0	0	0	0	0	0	**0**
Lake Trout	9,012	9,451	21,682	0	0	0	**40,145**
Northern Pike	4,006	0	0	160	205	300	**4,671**
Smallmouth Bass	3,155	5,365	0	198	204	1,007	**9,929**
Yellow Perch	222,437	27,042	0	1,310	2,135	8,777	**261,701**
Walleye	127,328	15,925	0	30	0	18,190	**161,473**
TOTAL	**452,120**	**115,405**	**106,351**	**4,094**	**5,187**	**42,869**	**726,026**

Table 3. *Total number of fish harvested by species across all angler groups in Wisconsin waters of Lake Michigan, 2012-2021.*

SPECIES	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021	TOTAL (SINCE 1986)
Brook Trout	18	0	0	0	0	0	0	0	0	0	39,040
Brown Trout	21,337	17,052	23,511	20,335	23,885	20,404	12,625	8,013	3,317	9,178	1,186,479
Rainbow Trout	75,981	58,429	72,724	59,127	77,004	66,599	57,141	50,258	54,430	58,597	2,429,140
Chinook Salmon	390,385	144,807	130,231	114,528	138,110	84,163	84,228	63,043	80,890	100,323	7,248,871
Coho Salmon	73,395	88,933	52,297	41,067	125,748	119,788	85,459	32,197	40,349	80,009	2,852,005
Lake Trout	29,094	27,246	25,424	35,778	19,046	20,345	26,747	34,197	38,271	40,145	1,562,658
TOTAL	590,210	336,467	304,849	270,835	383,793	311,299	266,200	187,708	217,257	288,252	15,318,193
Harvest Per Hour	0.2337	0.1210	0.1163	0.0989	0.1464	0.1222	0.1086	0.0795	0.1111	0.1054	0.1402

Table 4. *Total number of salmonids harvested by year by angler group in Wisconsin waters of Lake Michigan, 2012-2021.*

FISHERIES TYPE	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021	TOTAL (SINCE 1986)
Ramp	261,944	112,092	114,649	103,602	163,103	135,785	103,356	59,786	51,777	95,194	5,882,898
Moored	122,008	77,929	57,004	53,182	74,000	46,638	50,785	43,816	47,463	67,073	3,881,112
Charter	174,776	105,427	97,186	91,255	112,150	100,333	89,446	73,521	92,845	106,351	3,813,693
Pier	9,023	5,978	7,898	8,197	10,153	4,963	2,493	695	1,066	2,396	367,110
Shore	6,900	10,146	10,001	4,935	9,446	7,119	4,242	2,946	4,460	2,643	461,421
Stream	15,559	24,895	17,449	9,664	14,941	16,461	15,878	6,944	19,646	14,595	911,959
TOTAL	**590,210**	**336,467**	**304,187**	**270,835**	**383,793**	**311,299**	**266,200**	**187,708**	**217,257**	**288,252**	**15,318,193**

**Note: Creel estimates for 2020 are from May-November only. Final column in Tables 3 and 4 represents total number of salmonids harvested from 1986-2021.*

Table 5. Standard weight (lbs) for salmonids from Wisconsin waters of Lake Michigan and Green Bay from 2015-2021 and percent change from the 5-year average.

SPECIES	2015	2016	2017	2018	2019	% CHANGE
Brook Trout	-	-	-	-	-	-
Brown Trout	3.86	3.96	3.97	3.45	5.48	32.34%
Rainbow Trout	3.90	4.29	4.05	3.74	4.35	7.10%
Chinook Salmon	9.19	10.31	10.41	10.01	10.94	7.53%
Coho Salmon	3.85	3.93	3.65	4.29	4.45	10.40%
Lake Trout	5.61	5.83	5.67	6.08	6.35	7.46%

SPECIES	2015	2016	2017	2018	2019	2021	% change
Brook Trout	-	-	-	-	-	-	-
Brown Trout	3.86	3.96	3.97	3.45	5.48	3.93	-5.40%
Rainbow Trout	3.90	4.29	4.05	3.74	4.35	4.41	5.81%
Chinook Salmon	9.19	10.31	10.41	10.01	10.94	10.63	1.64%
Coho Salmon	3.85	3.93	3.65	4.29	4.45	4.26	3.40%
Lake Trout	5.61	5.83	5.67	6.08	6.35	5.89	-1.26%

** Note – No brook trout were harvested during this time period.*
*** Note – No biological data was collected from sport-caught fish in 2020.*

Walleye, Northern Pike and Smallmouth Bass harvest increased from 2020. The 2021 Walleye harvest was estimated at 161,473 fish, Northern Pike harvest was estimated at 4,671 fish, and Smallmouth Bass harvest was estimated at 9,929 fish.

For more summaries, check out Wisconsin's Lake Michigan website at:

http://dnr.wi.gov/topic/fishing/lakemichigan/ManagementReports.html

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THE STATUS OF THE COMMERCIAL CHUB FISHERY AND CHUB STOCKS IN WISCONSIN WATERS OF LAKE MICHIGAN, 2021

The total Bloater Chub harvest from commercial gill nets was 3,359 pounds for the calendar year 2021. This was an increase from last year in the southern zone. Although there were 16 permits in the northern zone and 25 in the southern zone, only one fisher reported fishing for chubs in the North and only two in the South (Tables 1 and 2). There was no reported chub harvest in the commercial Smelt trawlers as incidental to the targeted Smelt harvest.

Table 1. Harvest, quota, number of fishers and effort (feet) for the Wisconsin Southern Zone gill net chub fishery, 1983-2021.

YEAR	HARVEST	QUOTA	FISHERS	EFFORT (1,000 ft)	CPUE
1983	1,730,281	1,850,000		19,490.0	88.8
1984	1,697,787	2,400,000		30,868.7	55
1985	1,625,018	2,550,000		32,791.1	49.6
1986	1,610,834	2,700,000		34,606.1	46.5
1987	1,411,742	3,000,000	59	32,373.9	43.6
1988	1,381,693	3,000,000	60	58,439.0	23.6
1989	1,368,945	3,000,000	64	48,218.1	27.6
1990	1,709,109	3,000,000	54	41,397.4	41.3
1991	1,946,793	3,000,000	58	45,288.3	43
1992	1,636,113	3,000,000	53	40,483.7	40.4
1993	1,520,923	3,000,000	58	42,669.8	35.6
1994	1,698,757	3,000,000	65	35,085.5	48.4

1995	1,810,953	3,000,000	59	28,844.9	62.8
1996	1,642,722	3,000,000	56	27,616.6	59.5
1997	2,094,397	3,000,000	53	28,441.8	73.6
1998	1,665,286	3,000,000	49	23,921.1	69.6
1999	1,192,590	3,000,000	46	25,253.2	47.2
2000	878,066	3,000,000	41	22,394.7	39.2
2001	1,041,066	3,000,000	44	26,922.8	38.7
2002	1,270,456	3,000,000	47	24,940.5	50.9
2003	1,069,148	3,000,000	43	22,613.0	47.3
2004	1,057,905	3,000,000	43	21,468.9	49.3
2005	1,213,345	3,000,000	43	24,119.8	50.3
2006	807,031	3,000,000	40	19,110.4	42.2
2007	410,025	3,000,000	43	13,837.4	29.6
2008	227,026	3,000,000	39	9,823.2	23.1
2009	165,158	3,000,000	37	7,960.8	20.7
2010	90,879	3,000,000	38	5,645.6	16.1
2011	34,262	3,000,000	35	2,169.6	15.8
2012	8,583	3,000,000	32	784.0	11
2013	10,146	3,000,000	31	867.0	11.7
2014	25,436	3,000,000	31	1,267.0	20.08
2015	51,351	3,000,000	29	2,722.0	18.86
2016	32,140	3,000,000	31	1,944.0	16.53
2017	9,644	3,000,000	28	688.9	14

2018	7,301	3,000,000	25	424.0	17.2
2019	742	3,000,000	25	83.0	8.9
2020	2,393	3,000,000	25	167.0	14.3
2021	3,272	3,000,000	25	234.8	13.9

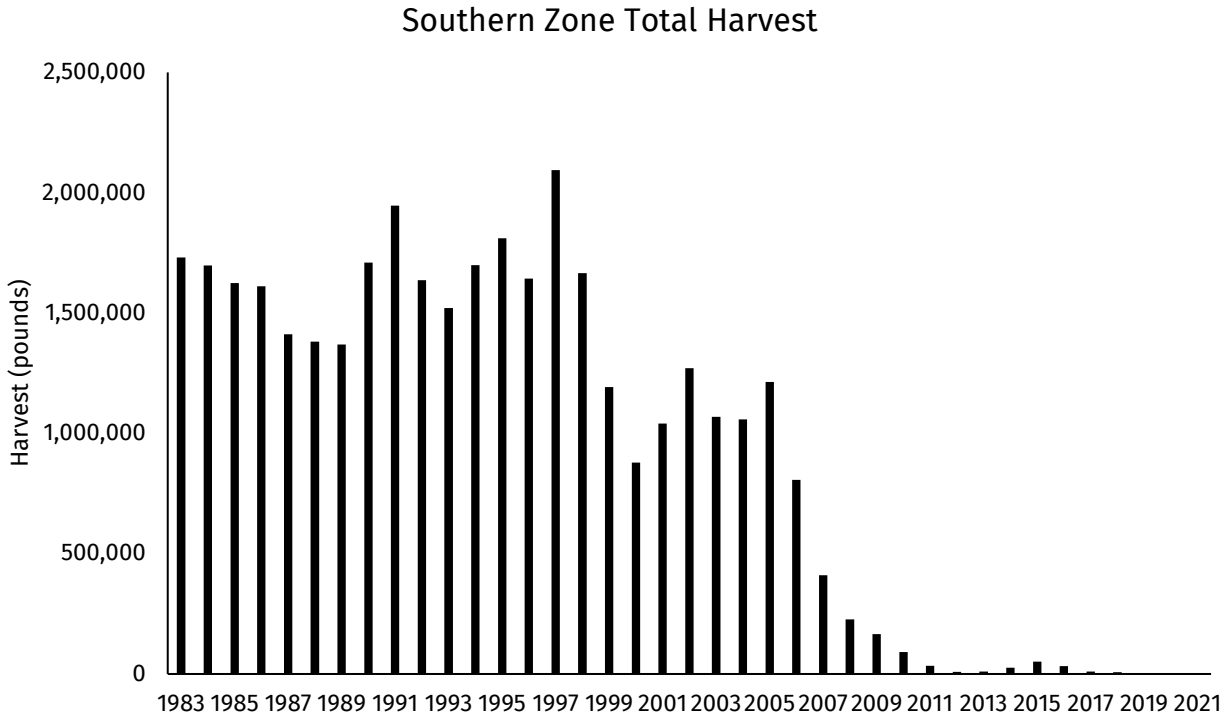
Table 2. Harvest, quota, number of fishers and effort (feet) for the Wisconsin Northern Zone gill net chub fishery, 1983-2021.

YEAR	HARVEST	QUOTA	FISHERS	EFFORT (x 1,000 ft)	CPUE
1983	342,627	300,000		6,924.70	49.5
1984	192,149	350,000		6,148.40	31.2
1985	183,587	350,000		3,210.00	57.2
1986	360,118	400,000		7,037.20	51.2[b]
1987	400,663	400,000	23	6,968.60	57.5
1988	412,493	400,000	23	8,382.30	49.2
1989	329,058	400,000	25	8,280.80	39.7
1990	440,818	400,000	23	8,226.40	53.6
1991	526,312	400,000	22	9,453.50	55.7
1992	594,544	500,000	24	11,453.10	51.9
1993	533,709	500,000	24	15,973.60	33.4
1994	342,137	500,000	24	8,176.20	41.8
1995	350,435	600,000	24	5,326.40	65.8
1996	332,757	600,000	24	4,589.70	72.5
1997	315,375	600,000	23	4,365.60	72.2
1998	266,119	600,000	23	3,029.00	87.9
1999	134,139	600,000	23	1,669.70	80.3
2000	77,811	600,000	21	2,199.50	35.4

2001	36,637	600,000	21	972.4	37.7
2002	63,846	600,000	21	1,098.60	58.1
2003	102,692	600,000	21	2,326.50	44.1
2004	50,029	600,000	21	1,354.00	36.9
2005	50,831	600,000	21	1,376.80	36.9
2006	36,285	600,000	19	1,011.10	35.9
2007	6,590	600,000	18	216	30.5
2008	23,942	600,000	18	845	28.3
2009	17,091	600,000	18	831.4	20.6
2010	5,551	600,000	18	474.2	11.7
2011	5,368	600,000	17	313	17.1
2012	6,633	600,000	16	497	13.3
2013	8,813	600,000	17	492.5	17.89
2014	6,807	600,000	17	393	17.32
2015	3,163	600,000	14	171	18.49
2016	7,850	600,000	17	159	49.37
2017	828	600,000	17	72	11.5
2018	200	600,000	17	12	16.7
2019	0	600,000	16	0	0
2020	0	600,000	16	0	0
2021	87	600,000	16	2.4	36.6

[a] *for the years 81-85, 90 & 91, 98-17 totals were by calendar year.*
[b] *for the years 86-89 & 92-97 the totals were through Jan. 15 of the following year.*

Harvest in the southern zone, including waters from Algoma south to Illinois, was 3,272 pounds in 2021. The total catch in the southern zone was up from 2020 but remains at less than 1% of the allowed quota of 3 million pounds for the southern zone. In the northern zone, essentially waters from Baileys Harbor to Michigan, 87 pounds were reported. The southern zone CPUE was slightly down compared to 2020. Total gill net effort was up slightly in the southern zone compared to 2020. In the south, 25 permits were issued, with 2 reporting harvesting chubs in 2021, while 1 of 16 permit holders reported harvesting chubs in the north.



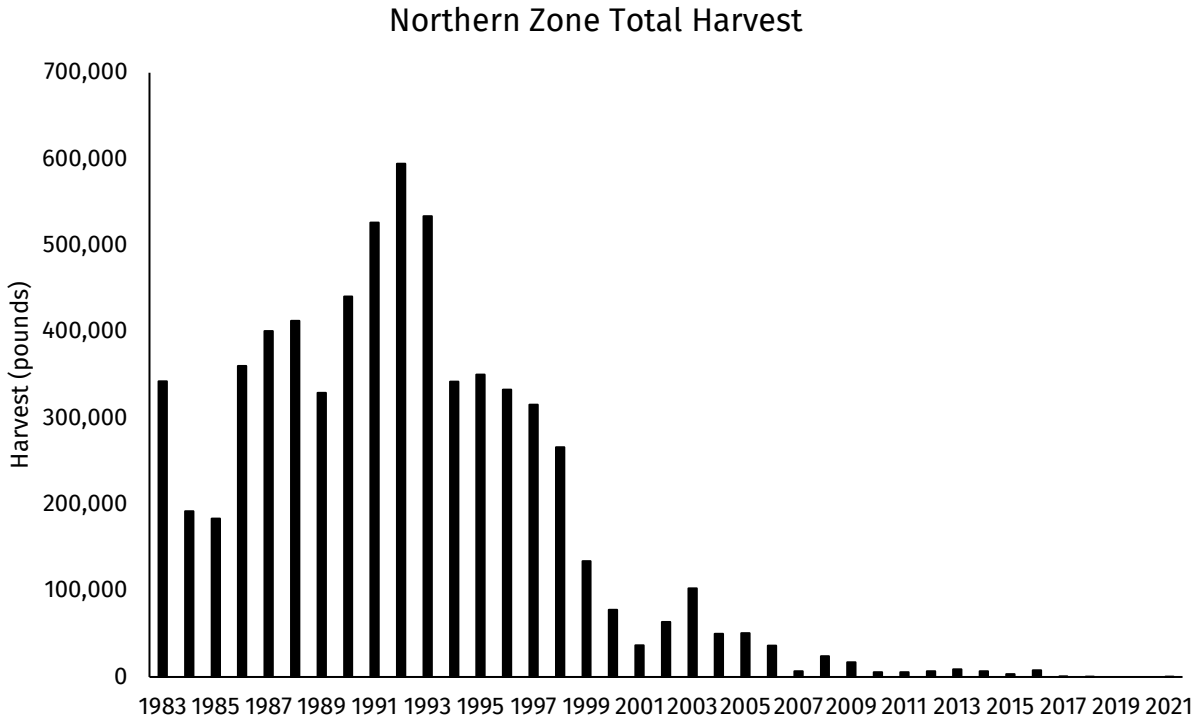


Figure 1. Total harvest (pounds) by year and zone for the Wisconsin gill net chub fishery, 1983-2021.

Population assessments off Baileys Harbor were not conducted in 2021 due to budget constraints.

Population assessments with graded-mesh gill nets (1,300 ft. per box) were conducted off Sheboygan in January and February 2022 for the 2021 assessment year. One box per lift was set along with standard mesh 2-3/8-inch gill nets. In this year's assessment, we conducted two lifts off Sheboygan. Net nights totaled eight for all sites combined. Biological samples were collected out of standard and graded mesh gear.

Catches from graded-mesh gill nets were comparable to 2017, the last time Sheboygan was sampled. Chubs from ages 6 to 21 were collected (Figure 2), and the mean age was 9.9 years. In addition, the sex ratio was relatively even (52% male and 48% female).

We collected samples from two lifts of our commercial fisher's standard mesh catch out of Sheboygan. Samples were taken from his 2 3/8-inch mesh show chubs ranging

from 6 to 19 years (Figure 3). Sex ratios were heavily skewed towards females (21% male and 79% female).

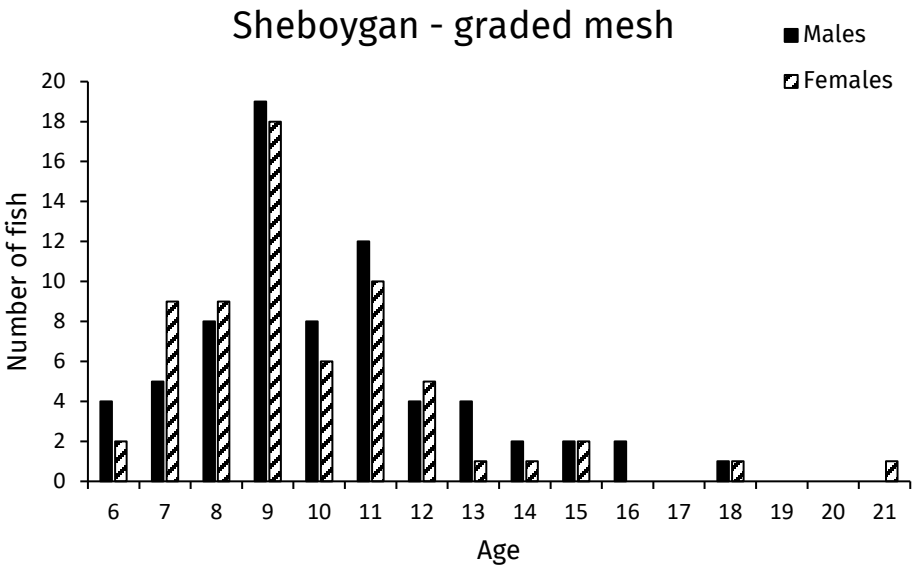


Figure 2. Age composition by sex of chubs captured during graded-mesh assessments off Sheboygan, Wisconsin in 2022.

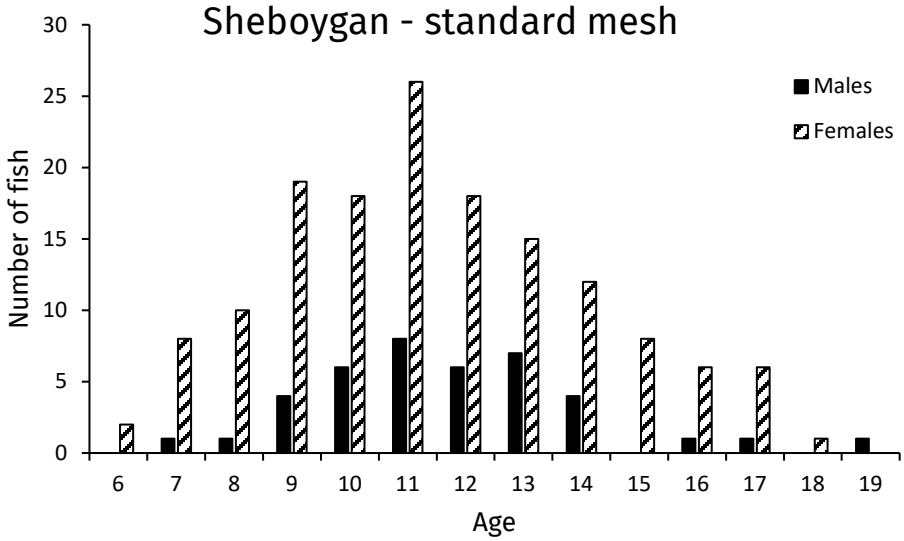


Figure 3. Age composition by sex of chubs sampled from standard-mesh gill nets off Sheboygan, Wisconsin in 2022.

We are grateful to Mark Nelson, a commercial fisher out of Sheboygan, for the setting and lifting of assessment nets off Sheboygan that was essential to the completion of this project.

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STATUS OF LAKE STURGEON IN LAKE MICHIGAN WATERS

INTRODUCTION

Overfishing by commercial fishers was a major cause of the decimation of Lake Sturgeon populations the early 1900s. Additionally, altered stream flows, interruption of migration routes with dams and water quality degradation in Wisconsin's Lake Michigan's major rivers (Milwaukee, Manitowoc, Kewaunee, Menominee, Peshtigo, Oconto and Fox) also played a role.

The passage of the Clean Water Act with associated permits for industry and implementation of new Federal Energy Regulatory Commission licenses have improved conditions for fisheries in general. Lake Sturgeon populations have also benefited in the last 25 years and natural reproduction currently occurs on the Menominee, Peshtigo, Oconto and Fox Rivers. These populations are self-sustaining without the benefit of stocking. Tagging studies and genetic analysis results indicate a distinction between four populations (Fox-Wolf, Peshtigo-Oconto, Menominee and Manistee rivers) that reside in Green Bay. The Menominee River contains the largest population in Lake Michigan waters, with a majority of those fish (69%) genetically assigned to the Menominee River population and also having representation from the other three population stocks. The lower Menominee River supported a hook and line fishery from 1946-2005. The exploitation rate (16%) was highest in 2005 when the harvest was 136 fish. That hook and line fishery has been a catch and release fishery since 2006. Lake Sturgeon stocking occurs on the Milwaukee and Kewaunee rivers and recovery is dependent on the survival and growth of those stocked sturgeon and continued habitat improvements.

GREEN BAY POPULATIONS

From 2015-2021, data collected from Lake Sturgeon stemmed from fish passage efforts at the Menominee and Park Mill dams on the Menominee River. Those efforts produced data from 784 Lake Sturgeon in the fish lift, and 601 of those fish were passed upstream of the lower two dams. These efforts aim to provide Green Bay adult sturgeon access to better spawning and rearing habitat, increase the spawning and recruitment success of Menominee River adult sturgeon and increase the overall population size in the lower river and Green Bay. To date, over 90% of the passed

upstream sturgeon remained upstream in good spawning habitat for at least one spawning opportunity and nearly all of those fish return downstream to Green Bay. A recent parentage study initiated by Michigan State University indicated that adult sturgeon passing above the lower two dams on the Menominee River contribute to recruitment.

We continued our movement study with acoustic transmitters implanted in Lake Sturgeon from the Menominee, Peshtigo, Oconto and Fox rivers. From 2011-2021, we have surgically inserted acoustic tags into 358 adults (Menominee (71%), Peshtigo (10%), Oconto (11%) and Fox (8%)). Their movements are monitored continuously with 3-6 stationery receivers in each of those four rivers and several receivers in Green Bay. Recent movement information supports genetic analyses which describe a mixed population. Southern Green Bay tagged sturgeon have also been documented at receivers in northern Green Bay, and a few strays were detected on non-Green Bay, Lake Michigan receivers. The sex distribution from all project sturgeon was 33% female and 67% male. The average length of the females was 156.5 cm, and males were 140.1 cm. The movements will be documented in Green Bay until 2024 and between the four major Green Bay rivers through 2025.

In August 2021, we completed the installation of two passive integrated transponders (PIT) tag antenna arrays in the Peshtigo River about ½ mile downstream of the Peshtigo Dam. Our objective is to determine if these arrays will detect previously PIT-tagged sturgeon, including PIT-tagged sturgeon that may have strayed from other rivers. The antennas were functional through December 2021 and detected over 160 sturgeon, with most of those detections occurring during spring spawning migration from April 10 through May 26, 2021.

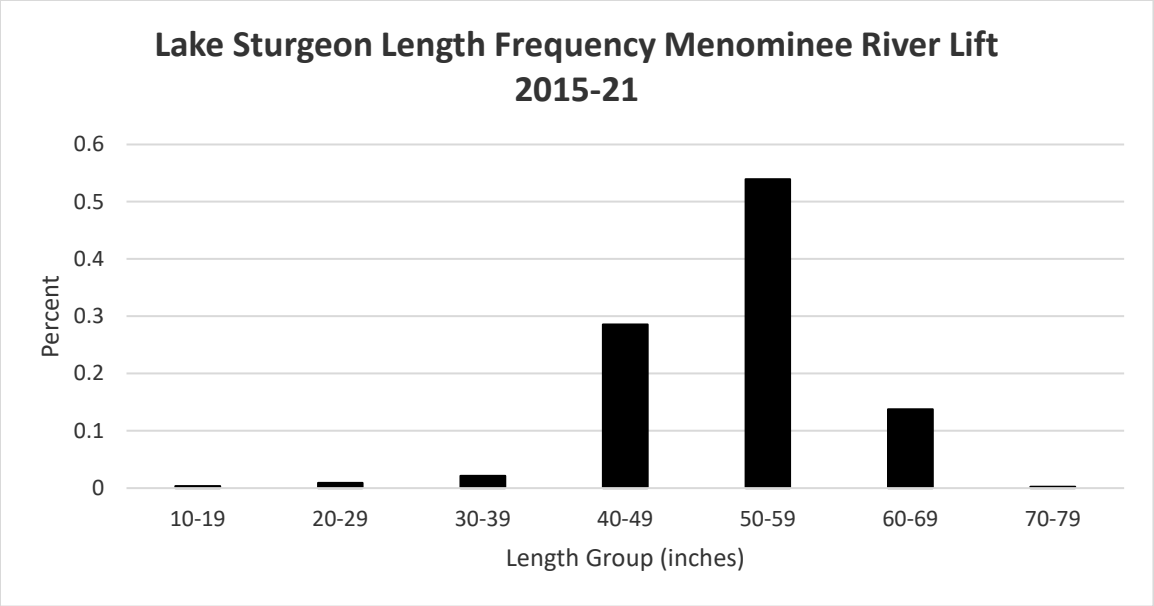


Figure 1. Length frequency of lake sturgeon captured in the Menominee River fish lift 2015-2021.

MILWAUKEE UPDATE

Milwaukee River Streamside Rearing Facility

The Milwaukee River streamside rearing facility (SRF) was deployed the week of April 5 and put into service on April 9, 2021. Wisconsin DNR personnel artificially spawned eight females and 40 males from the Wolf River and transferred those fertilized eggs to the SRF trailer on April 9, 2021. Approximately 80,000 eggs from eight females were transferred to the trailer. Eggs from each female were placed into a separate hatching jars.

By April 20, Lake Sturgeon larvae began to hatch and could be seen in the incubation jars. Over the next five days, hatching continued until all larvae were hatched and moved to the smaller fry tanks. During June, sturgeon were fed brine shrimp followed by chopped blood worms, then whole blood worms. By the end of July, the sturgeon were fed whole Krill.

Testing for VHS virus in conjunction with our normal fish health screening process was conducted in June, and then we stocked 440 small fingerlings on Aug. 5, 2021, below the Thiensville Dam. These fish all received a right ventral fin clip but were too

small to PIT tag, averaging three and a half inches in total length. On Sept. 19, 2021, 1,048 large fingerlings and 6 juveniles (age-2) were stocked at Lakeshore State Park. All fish released in September received a right ventral fin clip and a PIT tag. The large fingerlings averaged six inches in total length and weighed an average of 14.9 g.

Milwaukee Juvenile Sampling

Each year a summer gill net survey targeting juvenile Lake Sturgeon in the Milwaukee Harbor area is conducted. This survey began in 2013 and is designed to evaluate the survival of stocked Lake Sturgeon and monitor the retention of marks, both PIT tags and fin clips. It also establishes an index of relative abundance for juvenile Lake Sturgeon in the Milwaukee estuary under the current stocking plan. Two gangs of gill nets are tied together to create a 1,000-foot set, including 600 feet of 4-inch mesh, 200 feet of 8-inch mesh, and 200 feet of 10-inch stretch mesh panels. One net gang per day is set in a random location within or just outside of the Milwaukee Harbor and soaked for less than 24 hours. Nets are set opportunistically, with the target of at least one set per week beginning in June and ending in September. When a juvenile sturgeon is captured, the fish is scanned for tags and checked for fin clips. If it does not have a PIT tag, new one is implanted underneath the second scute. The weight, length and girth are recorded, a genetic sample is taken, and some pictures are often snapped before release. Bycatch species are identified and numbers of each species are recorded.

Since 2013, 112 Lake Sturgeon from the Milwaukee River SRF have been captured during this survey. The Milwaukee juvenile survey has also captured six more from the Kewaunee SRF. 2021 was a banner year for this survey as 21 juvenile sturgeon were captured. The age of the recaptured sturgeon ranged from 1-6 years old, and the size ranged from 12-34.3 inches. On average, the Lake Sturgeon from the Milwaukee SRF are growing more than 4.5 inches annually for the first six years following release.

Milwaukee River Adult Monitoring

Adult Lake Sturgeon have been observed in the Milwaukee River in 2018, 2019, 2020 and 2021. In 2020, about a dozen sturgeon were observed in one location all at the same time. Fisheries staff were unable to sample these fish in 2020. In 2021, a handful of sightings were reported, and fisheries staff netted four adult Lake Sturgeon from the Milwaukee River. Three of those fish had right ventral clips and PIT tags. The first

was from a Wild Rose stocking in 2005 and was 55 inches. The second two originated from the Milwaukee SRF 2007 and 2010 cohorts and were 47.5 and 50.5 inches, respectively. The fourth fish netted was 60 inches long and had no clips or tags, so its origin is unknown.

In the summer of 2021, two PIT tag antennas were installed in the lower Milwaukee River. The objective of these antennas is to monitor for tagged Lake Sturgeon returning to spawn or utilize the river. No sturgeon were detected in fall or winter of 2021. The antenna was operating as designed as it detected many other species tagged for other projects.

KEWAUNEE UPDATE

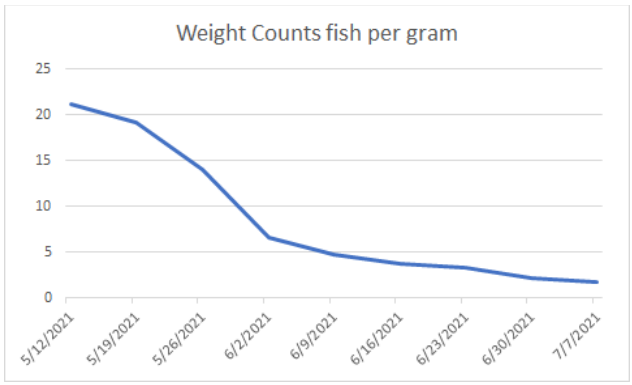
Kewaunee River Streamside Rearing Facility

The SRF originally located on the Manitowoc River, was moved to the Kewaunee River at the Besadny Anadromous Fishery Facility (BAFF) beginning in 2009. Approximately 96,000 sturgeon eggs were collected from eight separate females, fertilized with 40 males on the Wolf River at Shawano, and transported to eight separate McDonald jars onsite with river water temperatures of 10.5° C (51° F). After little development in the eggs at 314 Daily Temperature Units (DTU), a failed hatch was concluded. DTU are a mechanism for tracking and predicting larval development,

$$DTU = \sum_d (T_d - 32),$$

where *T* is the temperature of the rearing water for day *d* (in degrees Fahrenheit) and summed over all days since egg fertilization. A fry transfer of 4,000 fish from Wild Rose occurred on April 23, 2021. These fish were of mixed genetics from the original eight females. The fry was split between four tanks at 1,000 fry per tank.

The fry displayed active feeding behavior of brine shrimp on April 30. Fry responded favorably to chopped bloodworms on April 31, then proceeded to whole blood worms on June 15 and krill on July 20. Weekly weight counts were performed to track performance and growth rates. The average growth rate was 40% per week. Their growth over time is shown in Figure 2.



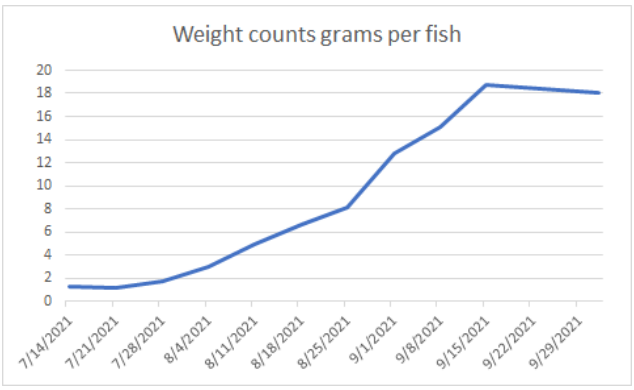


Figure 2. Sturgeon weight count fish per gram (top panel) and weight count grams per fish (bottom panel).

Table 1 shows the fish clipped, PIT-tagged, and then stocked into the river below the BAFF dam from 2009 to 2021. The cause of this difference in performance is unclear since it seems that all tanks are treated similarly with water, feeding and cleaning activities. Steps are being implemented to level these factors to help achieve more consistent growth. Fish health inspected the sturgeon on July 7 and received a clean bill of health on Aug. 9. The sturgeon were left vent clipped and PIT-tagged on Sept. 21. A total of 1,077 clipped and tagged Lake Sturgeon were stocked into the Kewaunee River in 2021.

Table 1 Kewaunee Lakeside Rearing Station 2009-2021					
YEAR	SPAWN DATE	# STOCKED	# KEPT/FEMALE	AVE. WGT (G)	AVE. L(MM)
2009	4/25	1035	unknown	26.9	191
2010	4/19	17	unknown	36.4	208
2011	5/4	461	1,000	14.4	151
2012	4/19	964	1,000	29.3	187
2013	5/2	887	900	30.1	195
2014	5/7	510	800	11.74	146
2015	4/18	1,000	800	18.1	166
2016	4/20	1,001	800	32.6	204
2017	4/19	1,038	520	25.6	189
2018	5/4	1,036	620	25.4	186
2019	4/27, 4/28	1,055	660	16.4	164
2020					
2021	4/9	1,077	unknown	18.1	180
Notes- Number stocked only reflects fish released in October, and not early release fish					

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2021 STATUS OF LAKE TROUT IN SOUTHERN LAKE MICHIGAN

BACKGROUND

The purpose of this report is to summarize data collected during the 2021 field season and to describe long-term trends in relative abundance, catch-at-age, natural recruitment and spawning populations of Lake Trout in the southern Wisconsin waters of Lake Michigan. Please refer to the Sportfishing Effort and Harvest report for changes in sport harvest.

The rehabilitation goals and objectives referenced in this report are outlined in more detail in “A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan” (Dexter et al. 2011; referred to in this document as “Strategy”).

SPRING LAKEWIDE ASSESSMENT SURVEYS

The Lakewide Assessment Plan for Lake Michigan Fish Communities was developed in 1998 as a multi-agency effort to assess fish communities in a standardized and coordinated effort. The primary objective is to assess the relative abundance of Lake Trout.

In 2021, the Wisconsin DNR surveyed two reefs within the Southern Refuge (the Northeast and Sheboygan Reefs) between May 24 and June 4. Per the protocols, twelve nets are set per reef. Each set consists of two 800-foot gangs of graded-mesh multifilament net, with 100 ft panels each of 2.5 in, 3.0 in, 3.5 in, 4.0 in, 4.5 in, 5.0 in, 5.5 in and 6.0 in mesh. Gillnets are set for 24 hours at three depth strata (shallow, mid and deep). Bycatch is typically minimal; out of 880 fish caught between the two reefs, one burbot caught on the Northeast Reef was the only bycatch.

Catch-per-unit-effort (CPUE) on the two reefs sampled has increased annually since 2014 (Figure 1). In 2021, spring CPUE was 69 fish/1,000 feet of net on the Northeast Reef and 24 fish/1,000 feet of net on the Sheboygan Reef.

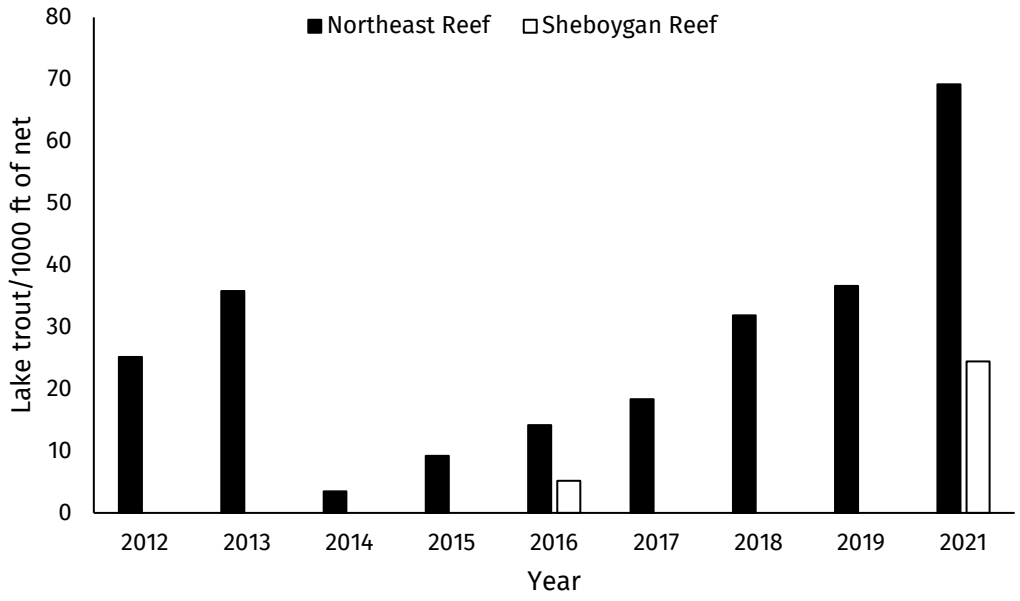

Figure 1. Spring catch-per-unit effort of Lake Trout by year for offshore reefs.

Objective 1 outlined in the Strategy for Lake Trout rehabilitation is to increase the average CPUE in spring assessments of targeted rehabilitation areas to 25 or more Lake Trout per 1,000 feet of graded-mesh gill net. This objective has been met on the Northeast Reef since 2017 (Figure 1).

Lake Trout stocked in Lake Michigan have been tagged with coded-wire tags (CWT) by the U.S. Fish and Wildlife Service every year since 2011. Before 2011, only a subset of the 1985 and 1988-2003 year classes were tagged. Snouts were collected from adipose-clipped Lake Trout for CWT extraction for age determination.

The age structure of stocked lake trout caught during spring assessments on the offshore reefs was relatively young, with a mean age of 8.3 years in 2021 (Figure 2). Although the ages shown in Figure 2 are only from CWT Lake Trout, it is worth noting that 93.5% of Lake Trout caught during spring assessments in 2021 were adipose-clipped. Of the 404 Lake Trout collected for CWT, 376 (93%) were Klondike Reef strain (Figure 3). The remaining Lake Trout were either Seneca Lake (25 fish) or Lewis Lake strains (3 fish). The Klondike Reef strain is a deep-water strain stocked only on the Southern Refuge, and these fish are likely to remain on the offshore reefs, while other strains stocked into Lake Michigan make use of a variety of habitat. Klondike Reef fish have been stocked on the Southern Refuge since 2012.

Every Lake Trout caught was examined for the presence of fin clips. Unclipped Lake Trout were presumed to be wild fish. In 2021, only 2% of Lake Trout caught on the Northeast Reef and 12.6% caught on the Sheboygan Reef were unclipped (Figure 4). The proportion of wild Lake Trout encountered on the Sheboygan Reef is about the same as when the reef was last sampled in 2016. The low proportion of wild Lake Trout encountered on the Northeast Reef could be influenced by the high number of Klondike Reef fish encountered in 2021, as the Northeast Reef was the primary stocking location for this strain.

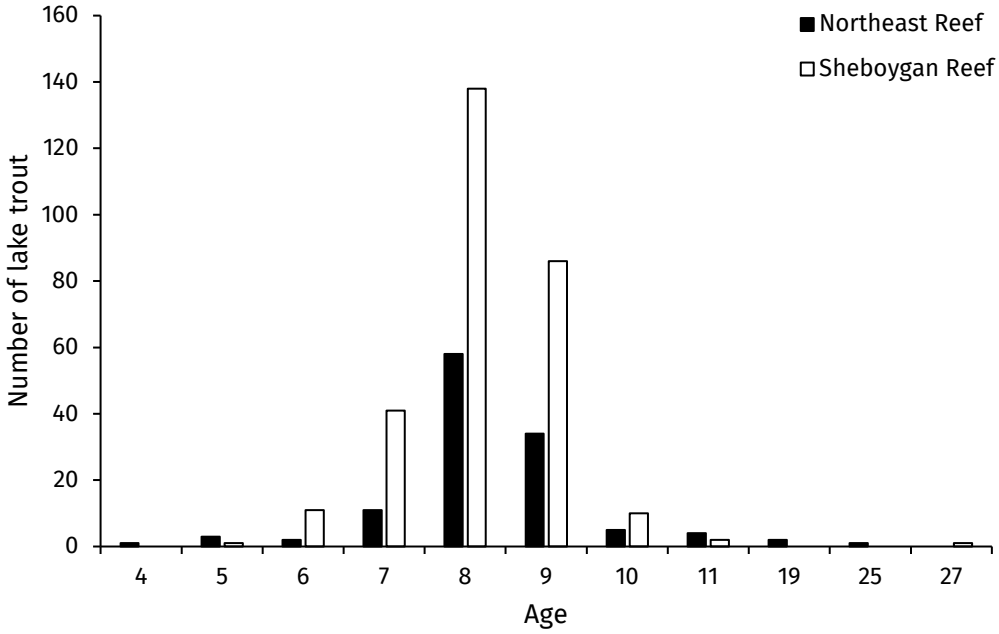

Figure 2. Age distribution of stocked Lake Trout caught on offshore reefs in spring 2021.

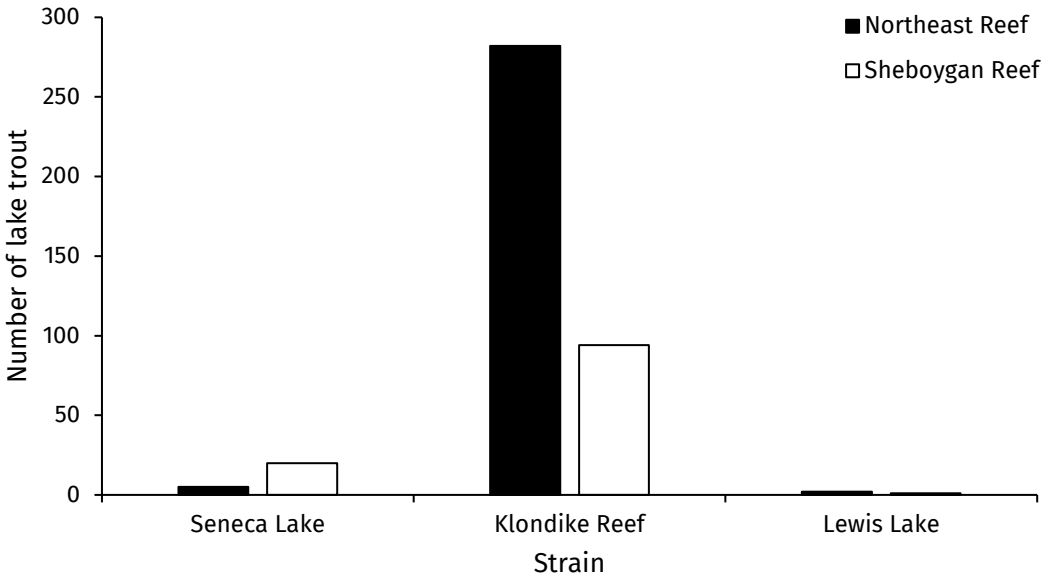

Figure 3. Strain composition of coded-wire tagged Lake Trout caught on offshore reefs in spring 2021.

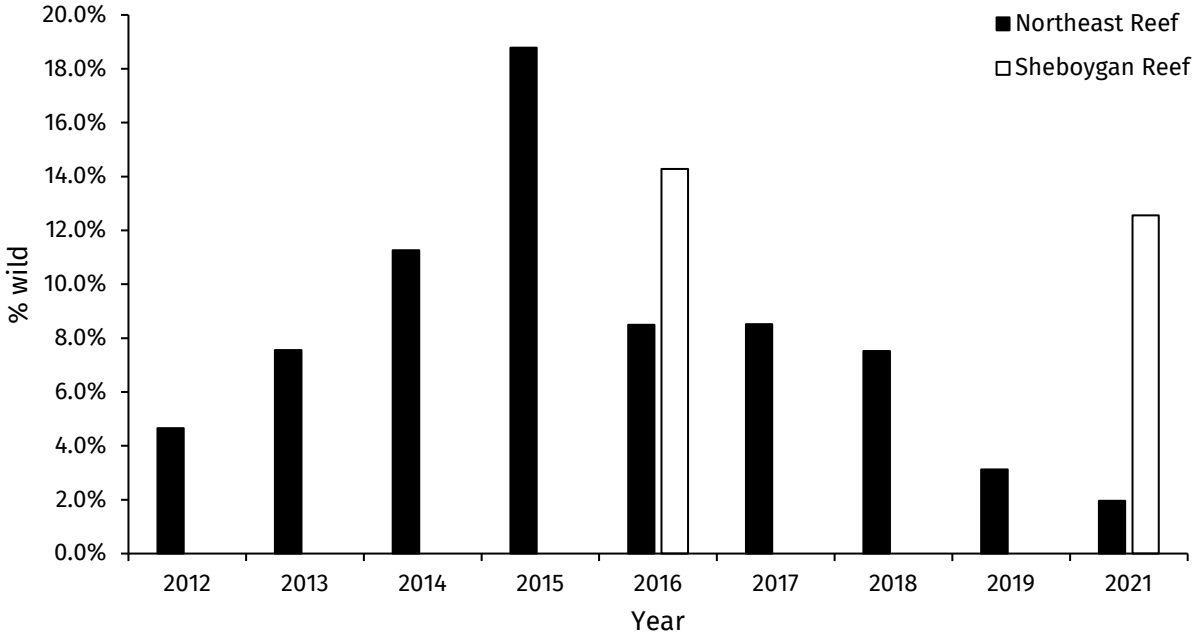

Figure 4. Proportion of wild Lake Trout captured in spring assessments on offshore reefs from 2012-2021.

FALL SPAWNING ASSESSMENT

The DNR annually conducts Lake Trout spawning surveys on nearshore and offshore reefs. Two nearshore reefs off Milwaukee (Green Can Reef and South Milwaukee Reef) have been sampled annually since the late 1980s. The Northeast Reef within the Southern Refuge has been sampled annually since 2009.

Both nearshore reefs were sampled on Nov. 2, 2021. The Northeast Reef was sampled on Nov. 4. Each nearshore reef was set with two 800-foot gangs of graded-mesh gill net with 200-foot panels each of 4.5 inch, 5.0 inch, 5.5 inch and 6.0 inch mesh. The Northeast Reef was set with three 800-foot gangs. Of the 168 fish caught on the nearshore reefs, 27 were species other than Lake Trout (17 Longnose Sucker, eight White Sucker, one Channel Catfish and one Round Whitefish). No bycatch occurred on the Northeast Reef.

Overall catch-per-unit effort (CPUE) on the nearshore reefs has remained relatively consistent since 2012 (Figure 5). In 2021, the CPUE of Lake Trout on the South Milwaukee Reef was 41.3 Lake Trout/1,000 feet of net, while CPUE on the Green Can Reef was 46.9 Lake Trout/1,000 feet of net. Catch in 2021 was below the 10-year average CPUE of approximately 69 Lake Trout/1,000 feet of net for both reefs.

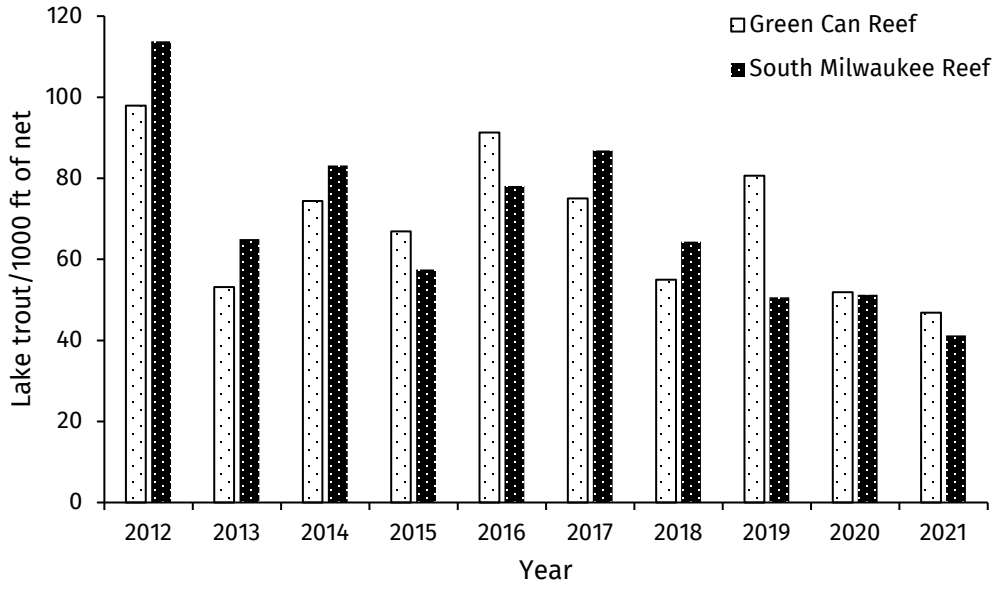

Figure 5. Fall catch-per-unit effort of Lake Trout by year for nearshore reefs.

Overall CPUE on the Northeast Reef has remained relatively consistent since 2012 (Figure 6). In addition, the catch has consistently been higher than on the nearshore reefs. In 2021, CPUE on the Northeast Reef was 126 Lake Trout/1,000 feet of net, about the same as the 10-year average CPUE of 123 Lake Trout/1,000 feet of net and a slight increase from 2020.

Objective 2 outlined in the Strategy is to increase the abundance of adults in fall surveys to a minimum CPUE of 50 Lake Trout/1,000 feet of graded-mesh gillnet in targeted rehabilitation areas, including the Northeast Reef. This objective has been met consistently since 2012 (Figure 6).

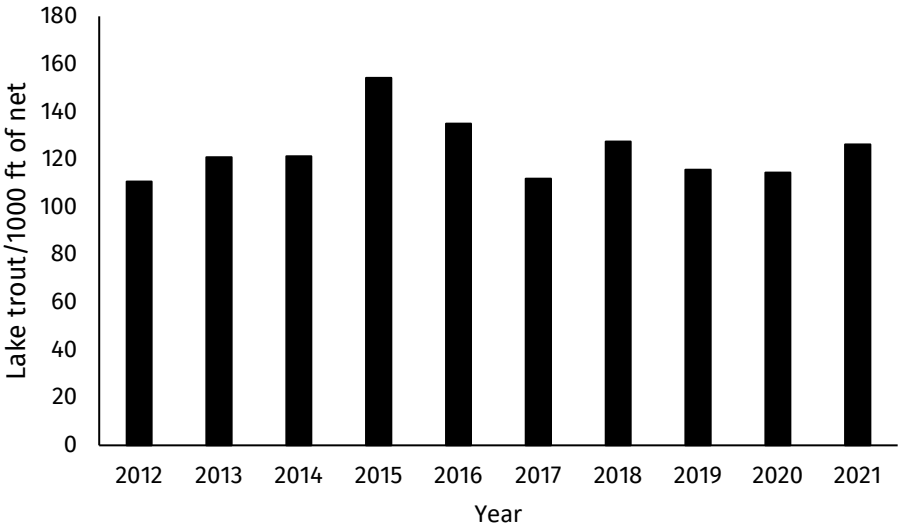

Figure 6. Fall catch-per-unit effort of Lake Trout by year for the Northeast Reef.

The age structure of Lake Trout captured during fall assessments is shown in Figures 7 and 8. The mean age of Lake Trout captured on the nearshore reefs for 2021 was 10.8 years (Figure 7). The mean age of Lake Trout captured on Northeast Reef in 2021 was 9 years (Figure 8). This is a younger mean age than what was seen on offshore reefs in previous years and could be a result of the Klondike Reef fish maturing and showing up on spawning reefs. Ages shown in Figures 7 and 8 are only from CWT Lake Trout, and there are likely older Lake Trout in the population not represented here.

Collecting otoliths from non-CWT Lake Trout (including wild and fin-clipped fish) in future years should provide further insight into age structure.

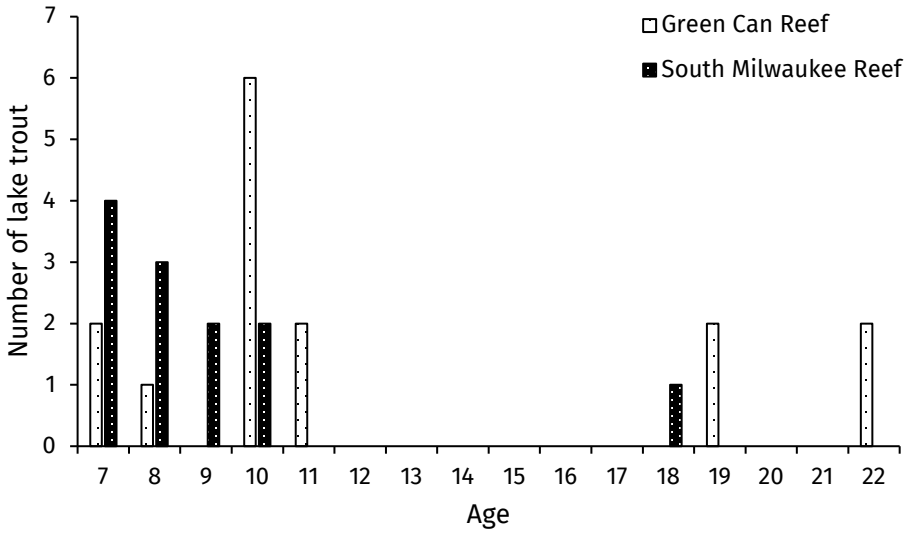

Figure 7. Age distribution of stocked Lake Trout caught in the 2021 fall assessment survey on nearshore reefs.

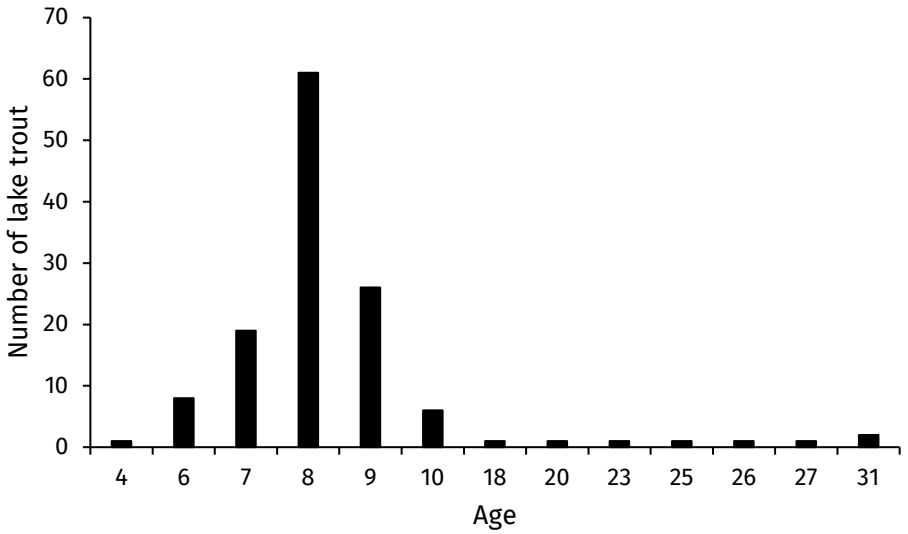

Figure 8. Age distribution of stocked lake Trout caught in the 2021 fall assessment survey on offshore reefs.

The strain composition of CWT fish caught in fall assessments is shown in Figure 9. The Seneca Lake strain made up the majority of returns nearshore, while the offshore returns were overwhelmingly dominated by the Klondike Reef strain (92% of CWT fish).

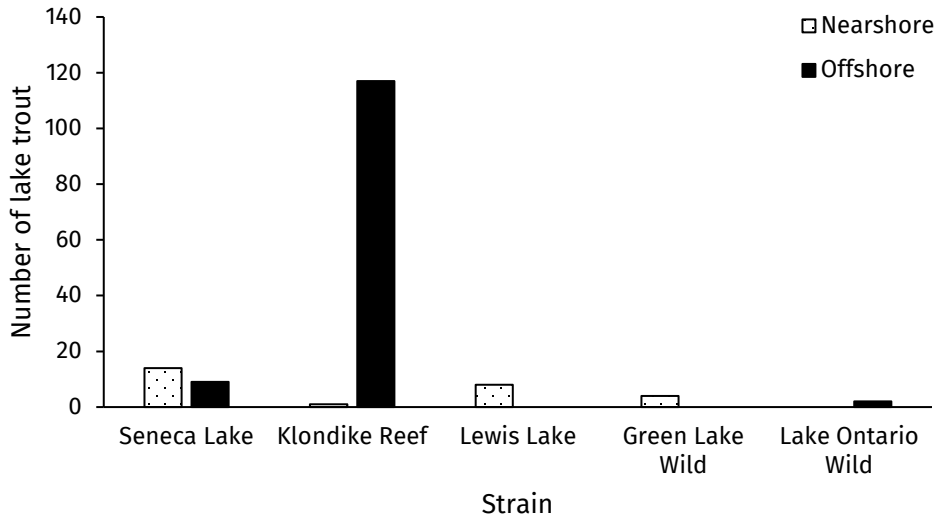

Figure 9. Strain composition of coded-wire tagged Lake Trout caught in fall assessment surveys in 2021.

In 2021, 12% of Lake Trout caught on the Green Can Reef and 9% of Lake Trout caught on the South Milwaukee Reef were wild (Figure 10). This was lower than 2020 but in line with the 10-year average (9% on the Green Can Reef and 7% on the South Milwaukee Reef).

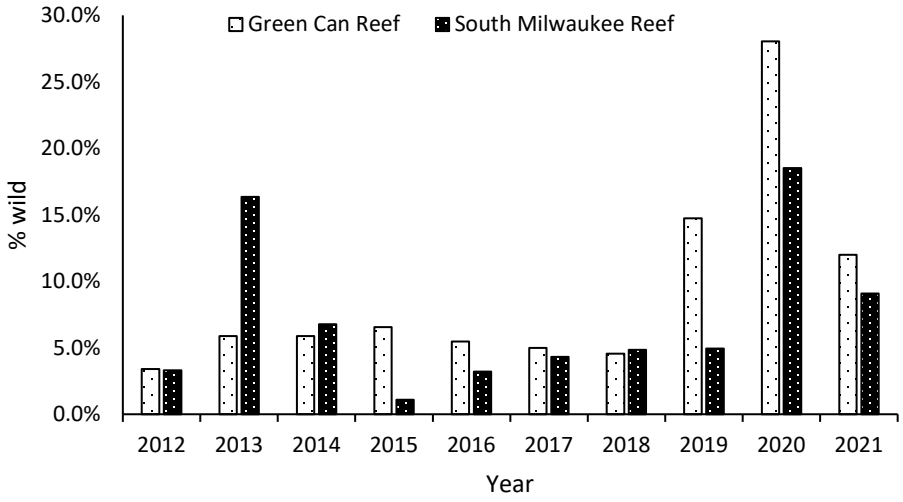

Figure 10. Proportion of wild Lake Trout captured in fall assessment surveys on nearshore reefs from 2012-2021.

Overall, the proportion of wild Lake Trout caught on the offshore reefs is generally higher than on the nearshore reefs. However, in 2021, only 5.0% of Lake Trout caught on the Northeast Reef were presumed to be wild (Figure 11). It is important to note that this is only based off one lift on the Northeast Reef and was likely influenced by the high numbers of Klondike Reef fish captured (Figure 9).

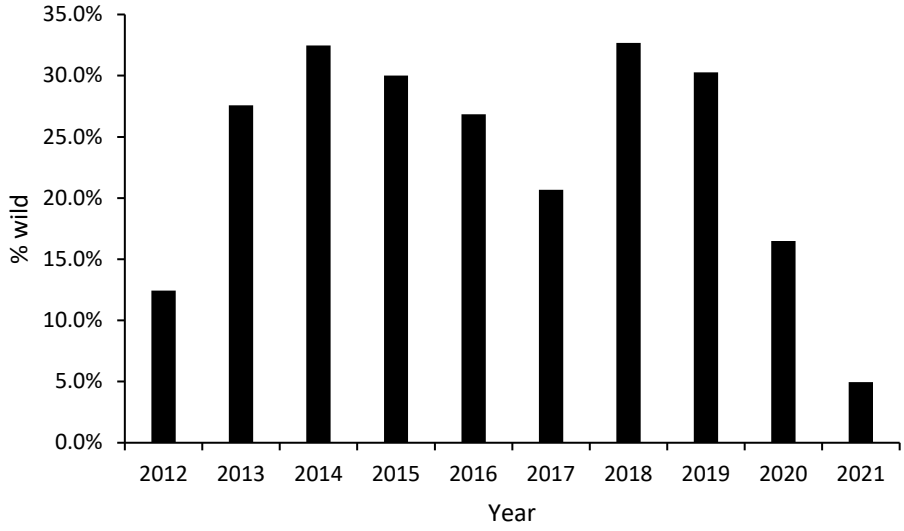

Figure 11. Proportion of wild Lake Trout captured in fall assessment surveys on offshore reefs from 2012-2021.

Objective 3 outlined in the Strategy, addresses achieving progress towards attaining spawning populations; specifically, spawning populations in targeted rehabilitation areas should be at least 25% female and contain 10 or more age groups older than age-7. Although we observe 10 or more age groups older than age-7 on the Northeast Reef (Figure 8), we are not consistently observing spawning populations that are at least 25% female in the Southern Refuge. In 2021, the proportion of female Lake Trout caught in the fall was 14.7% on the Green Can Reef, 16.7% on the South Milwaukee Reef and 20.1% on the Northeast Reef (Figure 12).

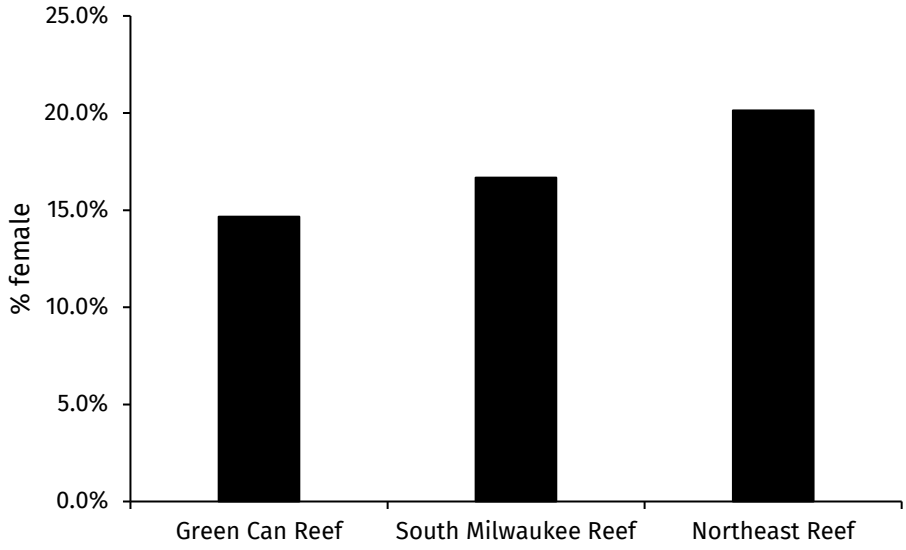

Figure 12. Proportion of female lake trout caught in 2021 fall assessment surveys.

Not every objective outlined in the Strategy was addressed in this report.

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LAKE WHITEFISH

COMMERCIAL HARVEST

Lake Whitefish *Coregonus clupeaformis* harvest in Wisconsin waters of Lake Michigan and Green Bay was approximately 892,000 pounds in 2021, a decrease of approximately 44,000 pounds from 2020 (Figure 1). Harvest in 2021 was the lowest since the quotas were established in 1989-90.

The commercial whitefish harvest in Wisconsin was previously regulated on a “quota year” basis beginning in July and running through June of the following year, with a closed period during spawning in November. In 2012, the quota season began operating on a “calendar year” with the same November closed period. The initial quota established in 1989-90 was 1.15 million pounds. It increased several times and reached 2.47 million pounds during the 1998-99 quota year. The quota was again increased during the 2009-10 quota year resulting in the current total allowable catch limit of 2.88 million pounds. The Wisconsin quota is allocated to three zones at roughly 9% of the quota for zones 1 and 3 and 82% for zone 2. However, the 2009-10 quota increase of approximately 410,000 pounds was treated as a “Special Increase” and split equally among the zones. Beginning May 21, 2021, an additional 200,000 pounds was added to the Zone 1 commercial quota as part of an “Emergency Increase” (Table 1).

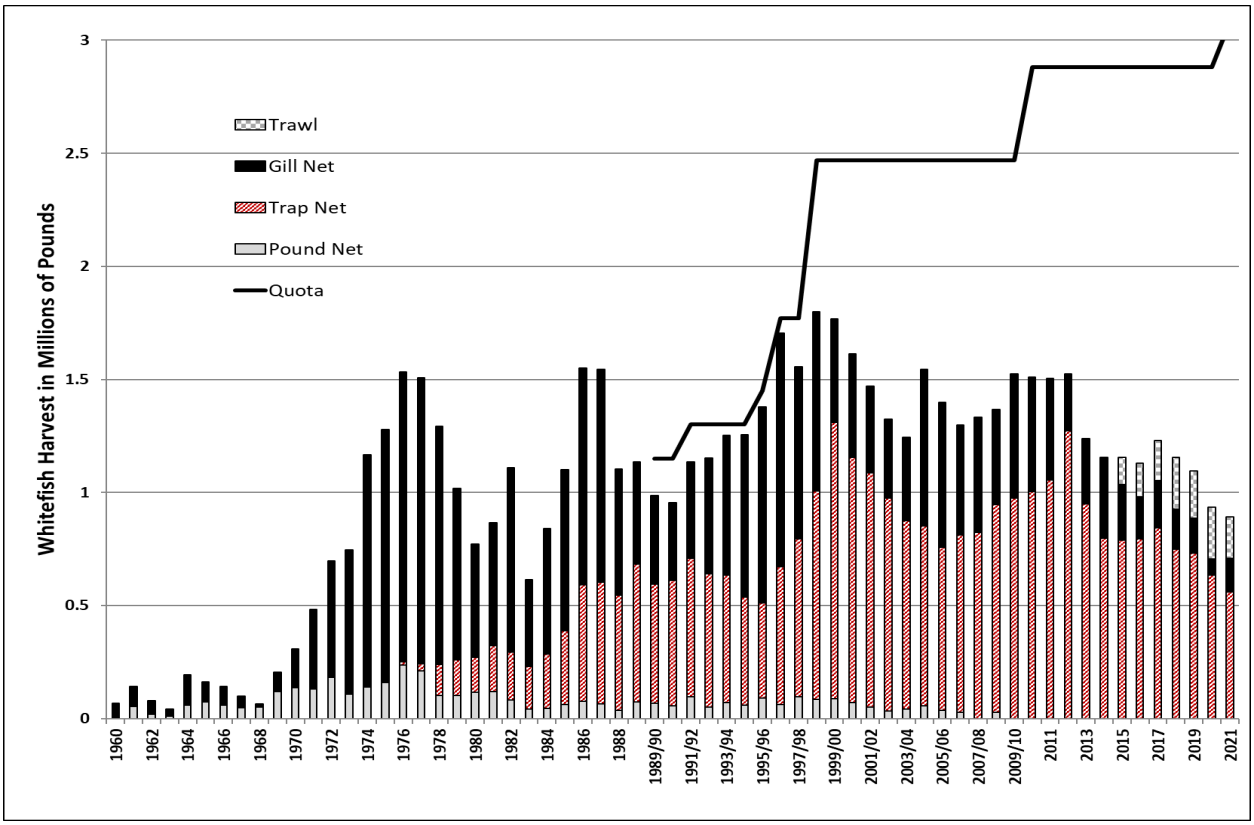

Figure 1. Lake Whitefish reported commercial harvest by gear in pounds (dressed weight) from Wisconsin waters of Lake Michigan including Green Bay, from 1960 through 2021. (Calendar years 1949 through 1989 and 2010-2021; quota years 1989-90 through 2008-09). Years in which there was a transition (1989, 2010) are reported both in quota and calendar year harvest.

Trap and gill nets have been the primary gear types used to harvest Lake Whitefish in Wisconsin waters of Lake Michigan. Pound nets were used historically but have not been employed since 2009. In 2019, a bottom trawl fishery for Lake Whitefish was implemented; but it is restricted to only the Manitowoc/Two Rivers area of Lake Michigan. Commercial fishers have used trap nets as a legal gear to harvest Lake Whitefish from Lake Michigan since 1976 and have long been the primary gear for Lake Whitefish (Figure 1).

Table 1. Lake Whitefish harvest by zone in dressed weight in Wisconsin since the quota increase to 2.47 million pounds. Data are presented by quota year through mid-2011 and by calendar year between 2012-2021.

QUOTA YEAR [A,B]	ZONE 1 HARVEST	ZONE 2 HARVEST	ZONE 3 HARVEST	TOTAL HARVEST
1998-99	143,225	1,474,605	182,486	1,800,316
1999-00	57,659	1,516,187	193,592	1,767,438
2000-01	72,496	1,330,107	210,604	1,613,207
2001-02	39,333	1,301,209	129,084	1,469,626
2002-03	107,827	1,085,599	131,344	1,324,770
2003-04	81,525	1,050,697	111,389	1,243,611
2004-05	129,081	1,248,689	166,319	1,544,089
2005-06	173,563	1,104,843	118,823	1,397,229
2006-07	181,289	901,935	214,909	1,298,133
2007-08	180,835	938,005	215,228	1,334,068
2008-09	182,614	944,580	211,614	1,338,808
2009-10	317,140	922,533	286,066	1,525,739
2010-11	263,389	1,030,042	270,370	1,563,801
2012[c]	205,244	985,408	333,209	1,523,861
2013	338,563	630,764	270,204	1,239,531
2014	336,564	543,256	276,034	1,155,854
2015	314,003	586,115	253,858	1,153,976
2016	254,685	610,191	264,521	1,129,397
2017	283,784	711,130	234,891	1,229,755
2018	352,470	535,907	265,632	1,154,009

2019	330,209	494,987	269,251	1,094,447
2020	349,054	327,542	255,694	932,290
2021[d]	448,819	244,122	198,855	891,796

[a] Between quota years 1998/99 and 2008/09 the quota was 2.47 million pounds and quotas for zones 1 through 3 were 225,518, 2,029,662, and 214,820, respectively. [b] Beginning April 2010, the WI quota was increased to 2.88 million pounds and quotas for zones 1 through 3 were changed to 362,185, 2,166,629, and 351,487 pounds respectively. [c] Beginning in January 2012, the Wisconsin commercial whitefish fishery began quota administration on a calendar year basis. [d] Beginning May 21, 2021, an additional 200,000 pounds was added to the Zone 1 commercial quota as part of an "Emergency Increase" resulting in a quota of 562,185 pounds.

Trap net effort changed very little between 2020 and 2021 and continues at a relatively low level compared to the most recent peak in 2010 (Figure 2). Gill net effort has followed a longer-term decline and remains at historic lows. However, gill net effort did increase considerably from 1.74 million feet of gill net fished in 2020 to 2.26 million feet fished in 2021. Preference for trap net caught fish is largely responsible for the overall decline in gill net use, although the decline in gill net efficiency brought on by ecological perturbations from invasive species is also a major contributor (increased water clarity, algal fouling). Commercial trawl effort declined by around 100 hours between 2020 and 2021. However, because the trawl fishery is still relatively new, it's difficult to interpret any effort trend data at this time.

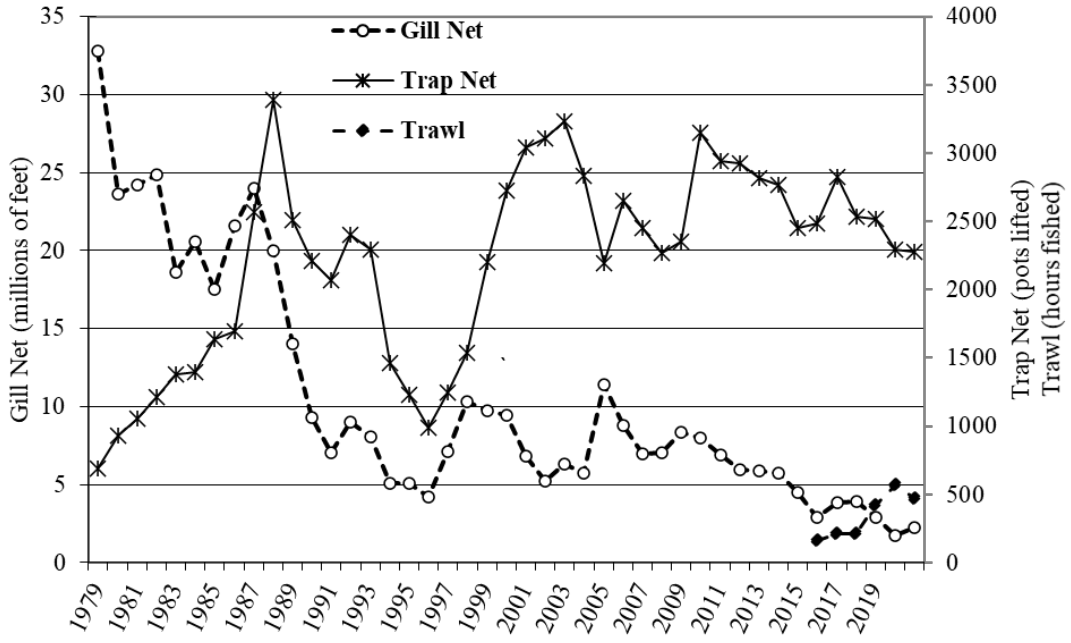

Figure 2. Trends in commercial fishing effort for Lake Whitefish in Wisconsin waters of Lake Michigan including Green Bay, 1979 – 2021. The first three years of data from the trawl fishery.

Trap net catch per unit of effort (CPUE) show a steady decline in recent years (Figure 3). Catch decreased by another 30 pounds per lift between 2020 and 2021. Gillnet CPUE has remained relatively steady over the past 15-20 years and increased by 16 pounds per 1,000 feet fished between 2020 and 2021, reaching its highest level since 2007. Trawl CPUE continued to decline, falling slightly by 11 pounds per hour fished. However, because the trawl fishery is still relatively new, it's difficult to interpret any CPUE trend data at this time.

The implications of the COVID-19 pandemic likely had a negative impact on commercial fishing effort, and potentially CPUE, at least in the first half of 2020. However, the generally steady drop in CPUE for all gears suggests a declining overall Lake Whitefish population in Wisconsin waters; most likely driven by catch data from areas primarily harvesting fish from the Lake Michigan stock(s). Most Lake Michigan stocks have been in decline for the past 5-10 years, and future safe harvest levels for the commercial fishery will reflect this trend.

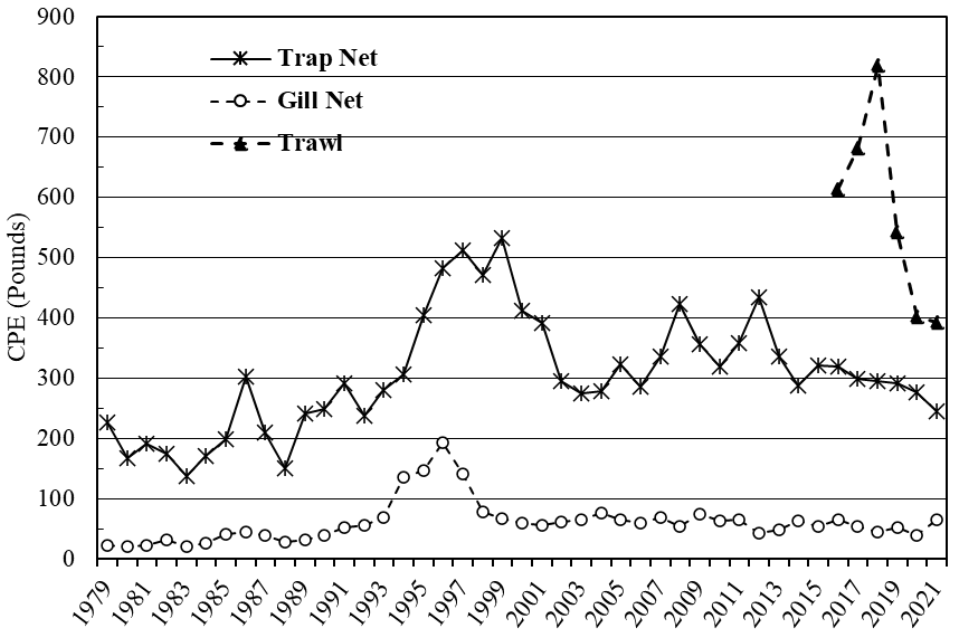

Figure 3. Trends in commercial dressed weight catch per unit of effort (CPUE) for Lake Whitefish in Wisconsin waters of Lake Michigan, including Green Bay, 1979 – 2021. Gill net is pounds harvested per 1,000 feet lifted, trap net is pounds harvested per pot lifted, and trawl is in pounds harvested

per hour fished. The first three years of data from the trawl fishery should be interpreted with caution as they were part of an experimental study.

SPORT ANGLER HARVEST

The winter creel season of 2007 recorded the first significant Lake Whitefish harvest of an estimated 1,559 fish. The harvest increased substantially during the winter of 2008 and has remained relatively high. The advent of whitefish fishing is largely responsible for the resurgence of the overall ice fishing effort on Wisconsin waters of Green Bay (Figure 4). Efforts for Lake Whitefish made up 74% of the total ice fishing effort on Green Bay in 2020. A formal Guide Reporting Program was implemented in 2017, although a portion of the guided trip harvest is still estimated because of cases of non-reporting. Previous to the reporting program, guide harvest was included as part of standard creel interviews though it was likely underestimated.

Winter creel surveys for Green Bay are conducted during January, February and March. For winter 2021, the estimated whitefish harvest was 76,601 fish, a decrease of nearly 25,000 from the previous year (Figure 4). Fishing effort data submitted in the formal Guide Reports are not directly included in the direct effort estimates for the overall creel harvest, so the effort is likely underestimated somewhat. However, some effort data are likely collected from guided trips incidentally during creel surveys. CPUE, measured in Lake Whitefish caught per hour of fishing specifically for that species, has been considerably lower during the last three ice seasons than in previous years (Figure 5). The catch rate for 2021 decreased substantially from that of 2020.

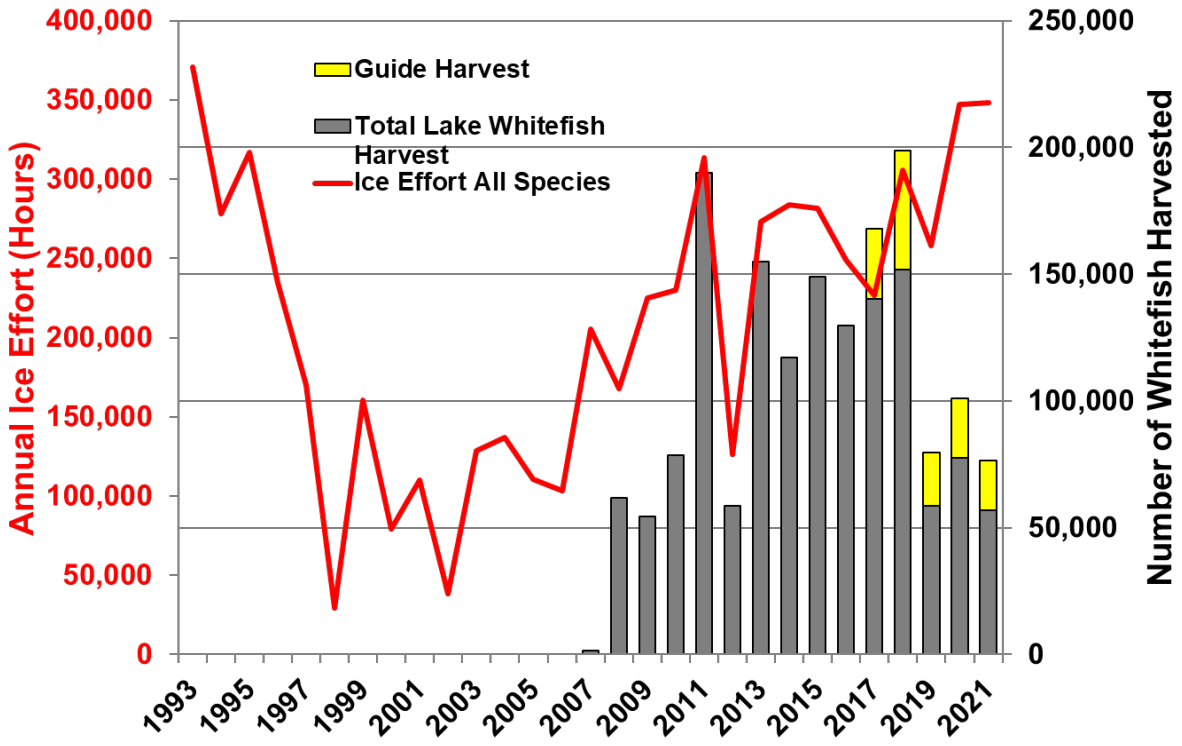

Figure 4. Estimated number of Lake Whitefish harvested and total effort for all species in Wisconsin waters of Green Bay during the winter creel season (January- March) for 2007-2021.

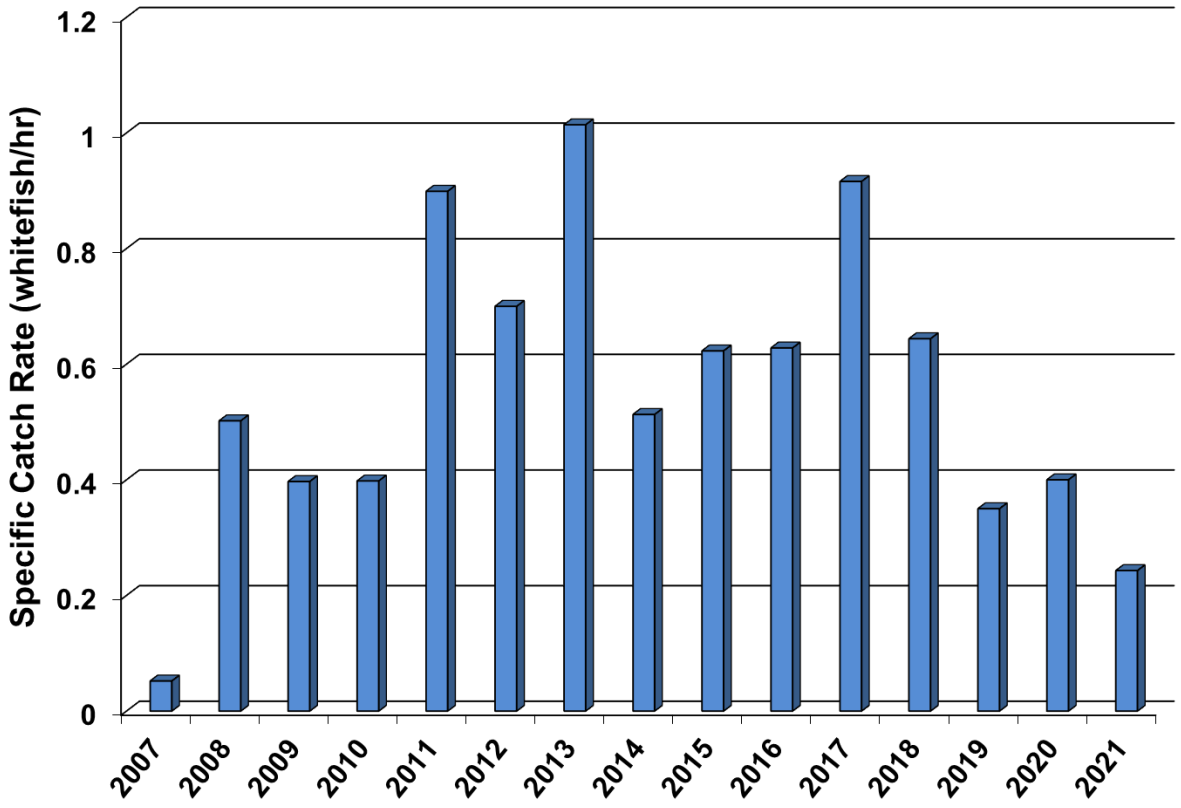

Figure 5. Specific catch rates of Lake Whitefish caught per hour for anglers targeting Lake Whitefish in Wisconsin waters of Green Bay during the winter creel season (January-March) for 2007-2021.

WEST SHORE GREEN BAY TRIBUTARY POPULATIONS

During the mid-1990s, Lake Whitefish began a recolonization of the Menominee River (Belonger, 1995). The whitefish population gradually increased, and by the mid-2000s, the number during the November spawning period was estimated to be in the thousands. Formal surveys to collect biological data from Lake Whitefish in the Menominee River during the November spawning period began in 2009. Starting in 2013, Wisconsin DNR staff began assessing other major west shore Wisconsin rivers in Green Bay for Lake Whitefish during November. These surveys revealed that Lake Whitefish were also making spawning migrations into the Fox, Peshtigo and Oconto rivers to varying degrees of relative abundance. The ability to accurately estimate these individual populations has been confounded by the influence of the dams

artificially concentrating fish on most rivers. Therefore, sampling efforts, particularly in earlier years, have typically been restricted to collecting a viable sample to assess the size and age composition of the spawning population. While several tagging studies have occurred, the relatively low number of recaptured fish relative to the total number tagged constrains accurate population estimates as well.

Strong young-of-year recruitment events have been measured for some time in the waters of southern Green Bay. Bottom trawling assessments, conducted annually during August targeting juvenile Yellow Perch, have captured Lake Whitefish in increasing numbers beginning in the mid-1990s (Figure 7). This survey is particularly successful at catching the young-of-year and yearling stages of Lake Whitefish, while adult catches are likely limited due to gear avoidance. Initial occurrence of large year classes of young-of-year whitefish generally follows trends of adults colonizing the tributaries suggesting these river populations are major sources for Lake Whitefish recruitment into the Green Bay fishery. However, emerging evidence suggests that some Lake Whitefish recruitment is occurring in Green Bay's open waters. After some relatively strong recruitment events between 2012 and 2018, recruitment was measured to be relatively low over the last few years.

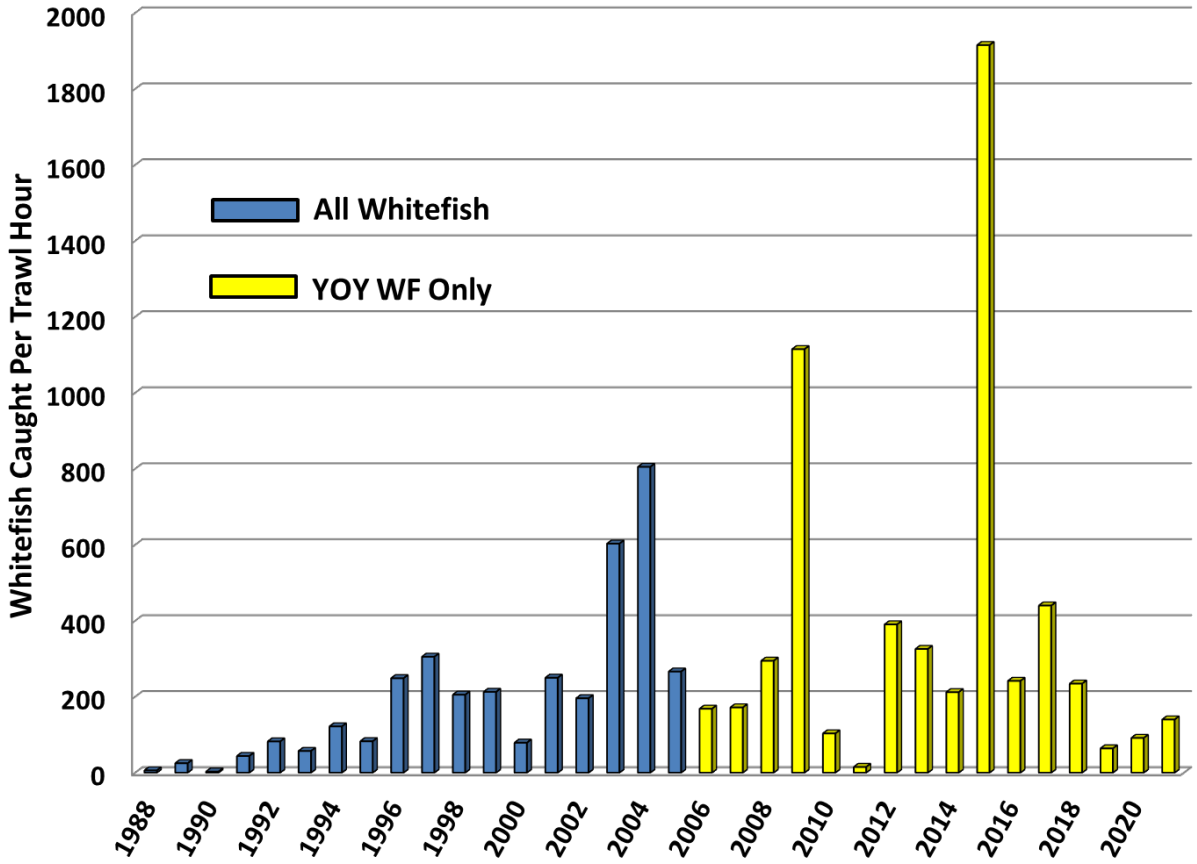

Figure 7. Lake Whitefish captured during August bottom trawling assessments in Green Bay between 1988 and 2021. Young-of-year (YOY) whitefish were not separated in counts until 2006; therefore, blue bars represent all whitefish combined in the catch while yellow bars represent only YOY whitefish.

References

Belonger, B. 1995. Documentation of a Menominee River Whitefish Run. Wisconsin Department of Natural Resources Correspondence/Memorandum. 4 pgs.

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2021 LAKE MICHIGAN WEIR REPORT

GENERAL WEIR OVERVIEW

The Wisconsin DNR operates three salmon and trout egg collection facilities on Lake Michigan tributaries. The Strawberry Creek Salmon Spawning Facility or weir (SCW) is located in Sturgeon Bay, WI, in Door County and has operated since the early 1970s. SCW is the DNR's primary egg collection facility for Chinook Salmon (*Oncorhynchus tshawytscha*). It typically provides the entire egg supply needed by the DNR to produce Chinook Salmon for stocking into Lake Michigan. The Besadny Anadromous Fisheries Facility (BAFF) has been operated since 1990 and is located on the Kewaunee River in Kewaunee County. BAFF is a co-primary egg collection facility for steelhead (*Oncorhynchus mykiss),* Coho Salmon (*Oncorhynchus kisutch*) and Brown Trout (*Salmo trutta*). The Root River Steelhead Facility (RRSF), operated since 1994, is located on the Root River in Racine County. RRSF is also a co-primary egg collection facility for steelhead, Coho Salmon and Brown Trout. BAFF and RRSF both serve as backup egg collection facilities for Chinook Salmon.

This report summarizes the numbers of fish processed at each weir during 2021, but please note that reported values are not absolute numbers of fish returned to each river. Many variables impact spawning runs, including stream flow, lake level, water temperature, stocking numbers, survival, harvest, dates of operation for each weir, etc. These factors vary yearly and impact the numbers of fish available and processed at each egg collection facility. Egg collection goals also vary yearly, depending on projected stocking quotas, DNR production needs and egg requests from other states or agencies.

Overall for 2021, anticipated egg collection goals were met for salmon and trout to meet planned future stocking levels by the DNR for Wisconsin waters of Lake Michigan.

Strawberry Creek Salmon Spawning Facility

Autumn 2021 Strawberry Creek Summary

The SCW and pond were operated for Chinook Salmon spawning for 18 days from Oct. 1 to Oct. 18, 2021. The weir was open and fished for 15 nights. The weir or access to

the pond was temporarily closed on Oct. 3 and 10 to prevent overcrowding in the holding pond and was then shut down for the season on Oct. 18. Specific work dates for egg and data collections were Oct. 4, 7, 11, 14 and 18. The numbers of Chinook Salmon processed for data each day respectively were 630, 1,054, 678, 616 and 473 (a total 3,451). Overall, 474 female Chinooks were spawned, and over 2.3 million eggs were collected. These Chinook eggs were transferred to the Wild Rose State Fish Hatchery, where they were incubated, hatched, and raised until the following spring for stocking into several Lake Michigan tributaries.

A water pump powered by a diesel engine to supplement stream flow at SCW was operated continuously from Oct. 1-18, 2021. Even without operating the pump during 2021, plenty of standing water was available in Strawberry Creek for Chinook Salmon to easily swim upstream. This relatively high stream water level was due in part to a high lake level and a similar elevation with the close proximity of SCW to the lake (< 0.5 stream miles downstream). Even with high water, operating the pump still seemed to help the Chinook run by providing even more water and flow.

In addition to the 3,451 spawning Chinook Salmon processed for data, another 832 mortalities were removed from the pond and tallied at SCW during 2021 (total 4,283). A total of 474 female Chinooks were spawned and over 2.3 million eggs were collected (Table 1). This number of Chinook (4,283) is close to the long-term average of 4,630 (Figure 1).

Almost all Chinook Salmon at SCW were processed for data including length (mm), weight (kg), sex, lamprey scars and fin clips. Fish health samples were also collected from a subsample. The total length for male Chinooks ranged from 20.0 to 45.1 inches (total length) and averaged 34.8 inches. Females ranged from 23.1 to 42.8 inches and averaged 36.2 inches. The average weight of age-3 female Chinook Salmon in 2021 was 19.0 pounds (N=249) based on known age-3 fish from fin clips at Strawberry Creek (Figure 2).

Table 1. Numbers of Chinook Salmon processed for data; females spawned, eggs collected and the average number of eggs per female at Strawberry Creek weir during autumn 2021. (Note: Every fish was not always removed from the pond each day, and instead unprocessed fish were sometimes saved for subsequent egg collections.)

DATE	CHINOOKS PROCESSED	FEMALES SPAWNED	EGGS COLLECTED	AVERAGE EGGS PER FEMALE
Oct 4, 2021	630	96	532,763	5,550
Oct 7, 2021	1,054	108	557,508	5,162
Oct 11, 2021	678	120	646,654	5,389
Oct 14, 2021	616	90	310,342	3,931
Oct 18, 2021	473	60	334,488	5,575
TOTALS	**3,451***	**474**	**2,381,755**	**5,121**

**An additional 832 Chinooks were removed from the pond and stream and were just tallied from September 23 to December 2 (3,451 processed + 832 tallied = 4,283 total).*
***Some Chinook got into the pond after being closed too, so an additional 82 were removed from the pond and processed for data on October 25.*

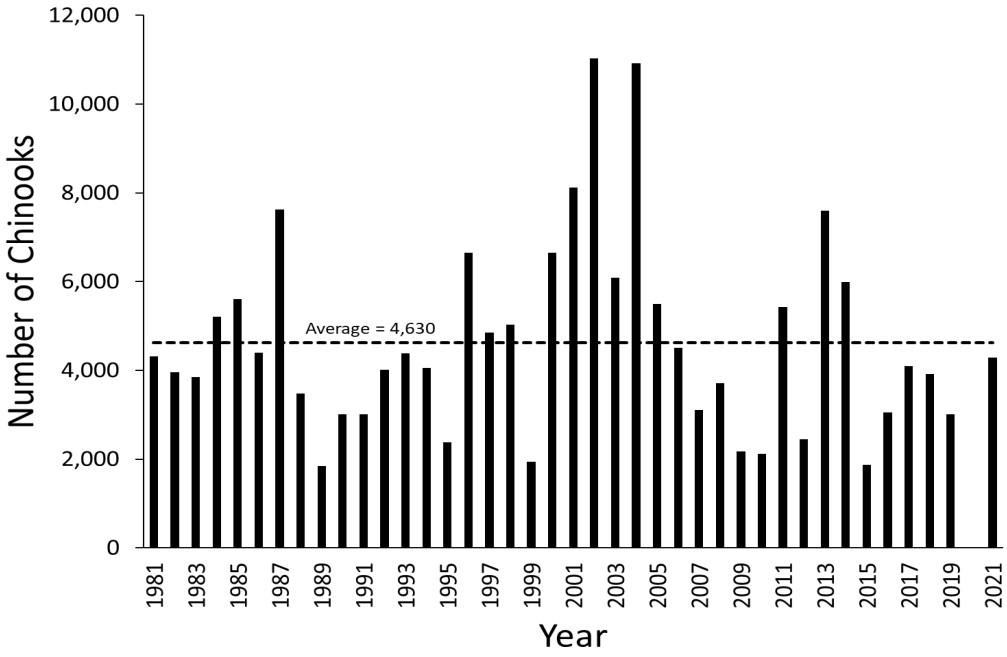

Figure 1. Numbers of Chinook Salmon handled during autumn spawning operations at Strawberry Creek weir per year from 1981-2021 (2020 data not available). The long-term average is 4,630 (dotted line). Several factors impact these numbers, including stream flow from rainfall and supplemental water pumping, lake level, water temperature, stocking numbers, survival rates, dates of operation for the weir, etc.

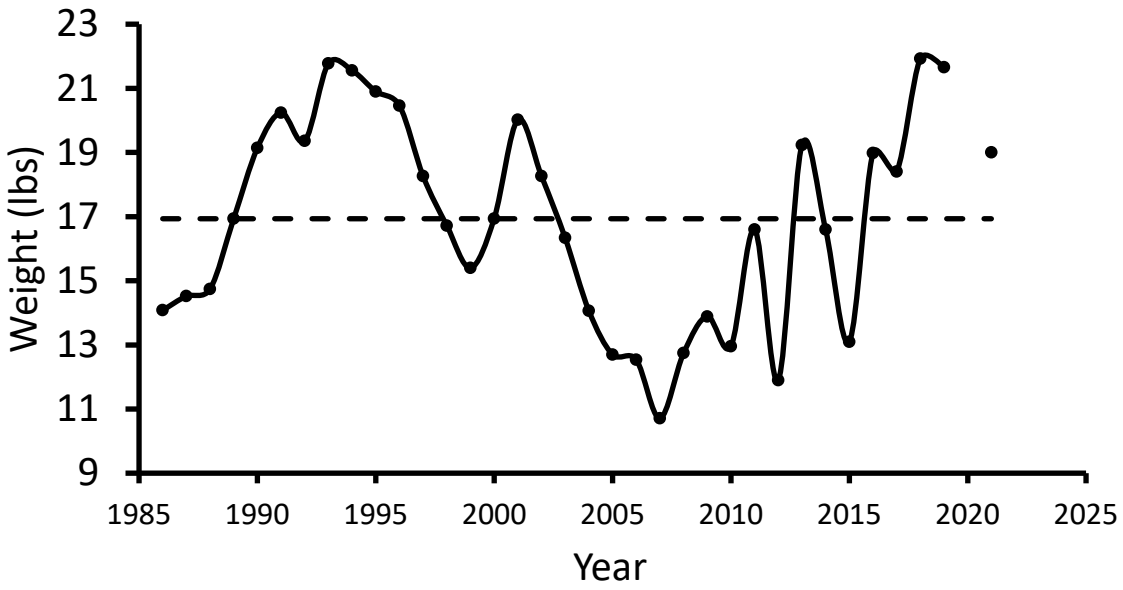

Figure 2. The average weight of age-3 female Chinook Salmon processed at the Strawberry Creek weir per year from 1986-2021 (2020 data not available). The long-term average is 16.9 pounds (dotted line). Many factors impact Chinook size, including alewife biomass, Chinook abundance and the ratio of predator/prey (etc.).

Besadny Anadromous Fisheries Facility (BAFF)

Spring 2021 BAFF Summary

Six steelhead processing days occurred at the BAFF on the Kewaunee River during 2021 on March 31 and April 5, 7, 12, 14 and 21. The numbers of new steelhead processed for data each day respectively were 81, 63, 117, 48, 58 and 19 (total 386). These steelhead were processed for data including length (mm), weight (kg), fin clips, gender, spawning condition, lamprey wounds and coded wire tags. Fish health samples were also collected from a subsample. Over 700,000 eggs were collected from 386 female steelhead. Numbers of steelhead processed annually at BAFF during recent years include 386 (2021), 677 (2019), 710 (2018), 708 (2017), 535 (2016), 429 (2015), about 1,500 (2014) and 878 (2013) with an average of 728.

Autumn 2021 BAFF Summary

A total of 550 Chinook and 701 Coho salmon were processed for data at BAFF during autumn 2021 from Oct. 2 to Nov. 18 (Table 2). These salmon were sacrificed and processed for data including length (mm), weight (kg), gender, lamprey wounds and

fin clips. CWTs were also collected from Chinooks. Eggs and fish health samples were collected from both Chinook and Coho. Below is a summary of Chinooks processed at BAFF by year from 1990-2021 (Figures 3 and 4). Coho processed at BAFF during recent years include: 1,298 (2012), 2,286 (2013), 786 (2014), 689 (2015), 861 (2016), 1,044 (2017), 1,480 (2018), 602 (2019), 1,857 (2020) and 701 (2021) with an average of 1,160.

Table 2. Numbers of Chinook and Coho salmon processed for data and removed from ponds each day at the Besadny Anadromous Fisheries Facility (BAFF) during autumn 2021. Tallies of dead fish routinely removed from holding ponds are not included in this table.

DATE	CHINOOK PROCESSED FOR DATA	FEMALE CHINOOK SPAWNED	CHINOOK EGGS COLLECTED	COHO PROCESSED FOR DATA	FEMALE COHO SPAWNED	COHO EGGS COLLECTED
Oct. 2, 2021	34			5		
Oct. 5, 2021	209			52		
Oct. 13, 2021	160	36		127		
Oct. 20, 2021	103			51		
Oct. 27, 2021	29			224	98	164,104
Nov. 3, 2021	15			151	67	139,767
Nov. 18, 2021				91	17	37,985
TOTALS	**550**	**36**		**701**	**182**	**341,856**

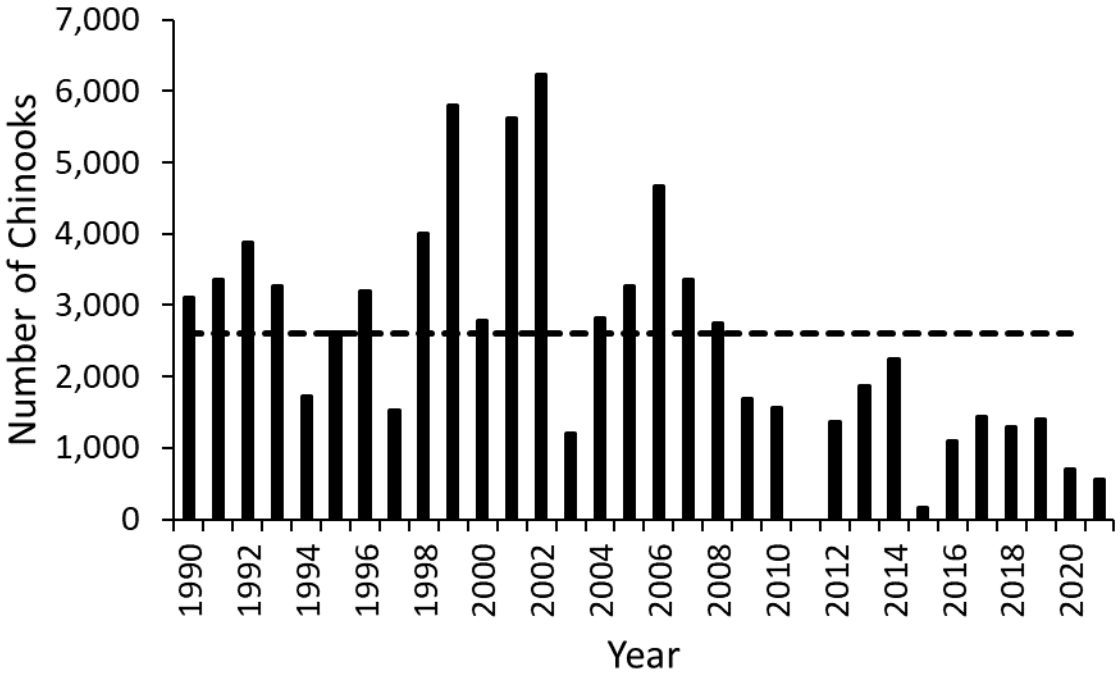

Figure 3. Number of Chinook Salmon handled during autumn spawning operations at the Besadny Anadromous Fisheries Facility (BAFF) per year from 1990-2021. The long-term average is 2,596 (dotted line). Several factors impact these numbers including stream flow, water temperature, stocking numbers, survival rates, dates of operation for the weir, etc.

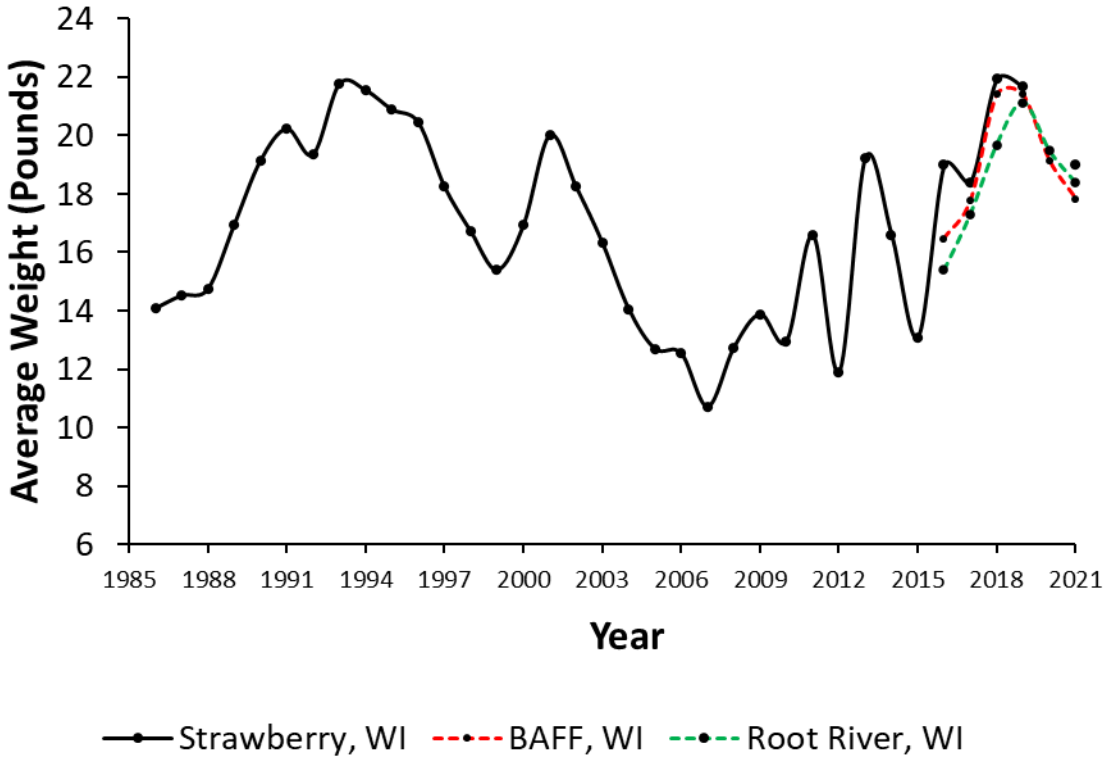

Figure 4. The average weight of age-3 female Chinook Salmon processed at the Strawberry Creek weir per year from 1986-2021 (black), the Besadny Anadromous Fisheries Facility from 2016-2021 (red), and the Root River from 2016-2021 (green). Many factors impact Chinook size, including alewife biomass, Chinook abundance and the ratio of predator/prey (etc.).

Root River Steelhead Facility (RRSF)

Spring 2021 Root River Summary

The RRSF was operating for five processing dates during the spring 2021 migration, and we captured 596 steelhead between March 22 and April 19. Our biological sampling goals were met, and fish health inspections were conducted.

The number of fish captured at RRSF is a subset of the 2021 steelhead run in the Root River. We do not stop every fish in the river, as they can move upstream past the facility before it is operational in early spring. Some fish also bypass the facility during the sampling season when the river is at high flows. Therefore, any comparison to past years' processing numbers will not provide a meaningful measure

of the overall return of steelhead back to the Root River. In 2021, high flows on the Root River for much of the early spring, as a result of snow melt and heavy rain, delayed the start-up of the facility, and it is probable that steelhead were moving upstream before the facility was running.

The spring 2021 RRSF steelhead effort is summarized below.

CAPTURED	SPAWNED	EGGS TAKEN	PASSED UPSTREAM
596	236 total (111 Chambers, 120 Ganaraska and 5 Unspecified)	209,783 Chambers 223,961 Ganaraska 9,723 Unspecified	429

The unspecified strain of steelhead will be stocked into rivers other than other brood rivers (the Root River and the Kewaunee River).

Throughout the spring season, steelhead were sampled as part of an ongoing multi-agency, lake-wide study on natural reproduction and movement. Stocked steelhead were implanted with small coded wire tags before release, and tags were recovered from 167 fish at RRSF. Analysis of the tags will provide fish managers with more information on movement patterns of steelhead in the lake, growth rates and the occurrence of "straying," when a mature fish returns to a stream other than the one where it was originally stocked.

Autumn 2021 Root River Summary

The Root River Steelhead Facility in Racine County was in operation for eleven processing days during the fall 2021 migration. Between Oct. 4 and Nov. 15, 4,581 fish were captured and processed. Biological sampling goals were met, and fish health inspections were conducted on Coho Salmon.

The Wisconsin DNR's fall 2021 Root River effort is summarized below.

	CAPTURED	SPAWNED	EGGS TAKEN	PASSED UPSTREAM
Chinook	2,174	0	0	1,634
Coho	2,340	608	325,000	2,263
Steelhead	55	0	0	15
Brown Trout	12	0	0	12
Totals	4,581	608	325,000	3,924

Due to a lack of precipitation, water levels in the Root River were low for much of the fall season. Despite the low water levels, both Coho and Chinook salmon moved upstream in large numbers throughout October.

Chinooks were sampled throughout the fall season as part of the DNR's ongoing net-pen study. Chinook Salmon in the Kewaunee and Root rivers were differentially marked with coded wire tags from 2015-2018. Chinook stocked directly into the rivers and net pens received different coded wire tag numbers. Analysis of these tags will help evaluate whether Wisconsin's collaborative net pen projects positively impacted post stocking survival. Tags were recovered from 418 Chinook Salmon at the RRSF in 2021.

In addition, steelhead were sampled as part of an ongoing multi-agency, lake-wide study on natural reproduction and movement. Stocked steelhead were implanted with small coded wire tags before release, and tags were recovered from 40 fish at the RRSF. Analysis of the tags will provide fish managers with more information on movement patterns of steelhead, growth rates, and the occurrence of "straying," which is when a mature fish returns to a different stream than the one it was originally stocked in.

The DNR would like to acknowledge the support of Salmon Unlimited in keeping the RRSF operational. In addition, a special thank you to the volunteers for daily opening and closing the facility's viewing window.

For additional Lake Michigan fisheries information, please visit:
dnr.wi.gov/topic/fishing/lakemichigan

For fishing information, please visit:
dnr.wi.gov/topic/fishing/lakemichigan/OutdoorReport

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YELLOW PERCH ASSESSMENTS IN WISCONSIN WATERS OF LAKE MICHIGAN 2021

2021 SPAWNING SURVEY

Survey Dates (May 26, 2021 – June 11, 2021)

The Wisconsin DNR's 2021 Yellow Perch spawning survey was conducted near the Green Can Reef outside of the Milwaukee Harbor using gillnets containing one 100-foot panel of each 2.0 inch, 2.5 inch, 2.75 inch, 3.0 inch and 3.25 inch mesh.

The Green Can Reef area off Milwaukee is the established index site for our annual Yellow Perch spawning assessment. Protocols for this survey are more clearly defined in the Standard Operating Procedures for the Southern Lake Michigan Fisheries Work Unit (LMWU) (DNR 2014). Two gillnets tied together create one 1,000-foot-long gang. Two gangs were set on three different days from May 26, 2021, to June 11, 2021, at depths of 26 to 54 feet of water. Water temperature on the bottom of the lake ranged from 46°F to 51°F during the survey. The total effort for the 2021 survey was 6,000 feet of gillnet set for one night. All nets were set and lifted from the LMWU 20-foot Lake Sturgeon work boat.

In total, 21 Yellow Perch were captured, including 14 ripe males and seven females. Aging structures were collected from all individuals. Eighteen of the perch were from the 2016 cohort (five years old), one fish was from the 2017 cohort (four years old) and two fish were from the 2018 cohort (three years old). The number of Yellow Perch captured remained extremely low, however, the 2016 year-class was dominant in the 2021 spawning survey.

In addition to Yellow Perch, we also captured Round Whitefish, Alewife, Burbot, Lake Trout, Longnose Sucker, a Rock Bass and a Round Goby.

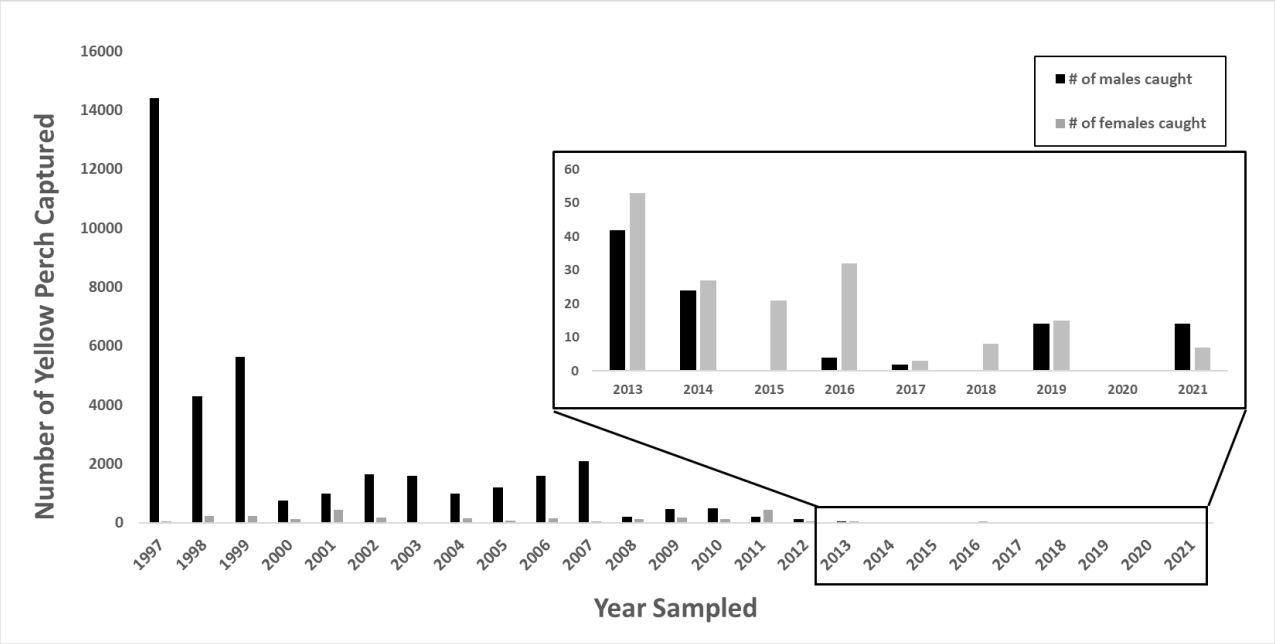

*Figure 1. Yellow Perch Spawning Assessment Green Can Reef, Lake Michigan, Milwaukee, DNR 1997-2021. *No spawning survey was conducted in 2020**

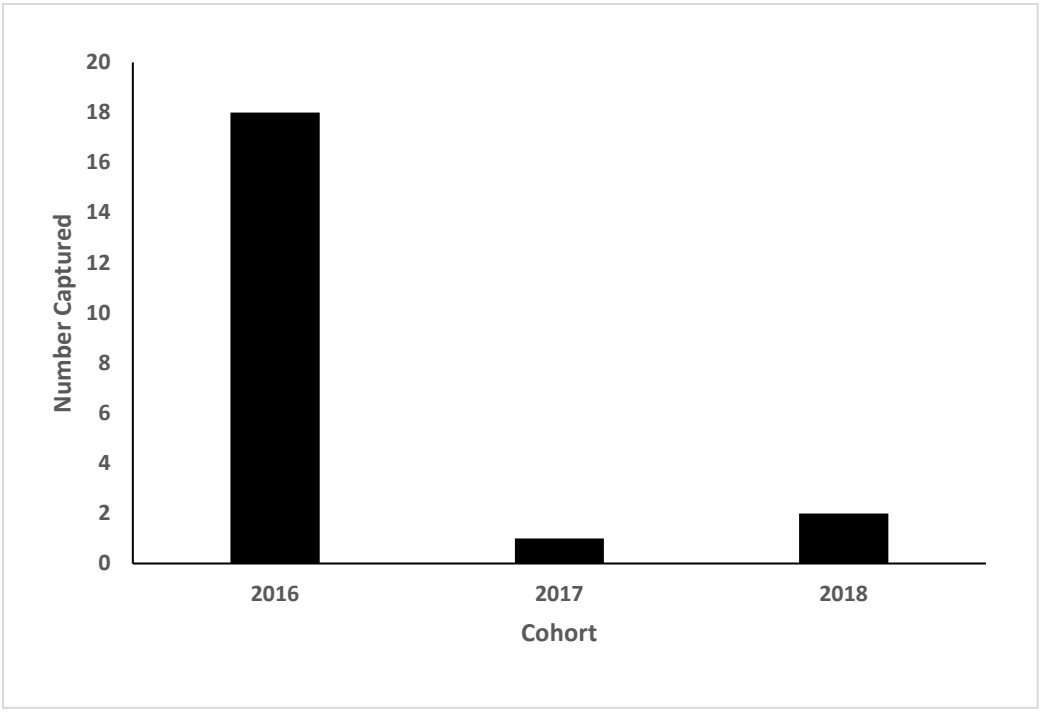

Figure 2. Cohorts of Yellow Perch captured during annual spawning assessments on Green Can Reef, Lake Michigan, Milwaukee, DNR 2021.

YOUNG OF YEAR SURVEY

Survey Dates (Sept. 15, 2021-Sept. 16, 2021)

An annual survey of young-of-the-year (YOY) Yellow Perch along the Lake Michigan shoreline typically consists of seining and micromesh gill netting efforts encompassing sampling sites from Sheboygan to Kenosha. In 2021, an abbreviated micromesh survey was completed. Due to budget constraints, seining occurs every other year. Still, weather conditions were not favorable for micromesh during the traditional sampling time in 2021, resulting in only one day of effort out of the Milwaukee Harbor near Bradford Beach.

Two hundred feet of micromesh gill net was set out for an overnight set. Nine perch were captured, four were hatched in 2021, and five were hatched in 2020. Since this was a limited survey, it is difficult to make inferences about regional trends for the 2021-year class. However, we saw higher numbers in this net than the recent years. Micromesh surveys in 2022 and spawning and graded mesh assessments in future years should indicate a stronger year class if recruitment was up slightly in 2021. The most recent significant recruitment we have noticed was from the 2016 cohort, which has also been observed in spawning surveys.

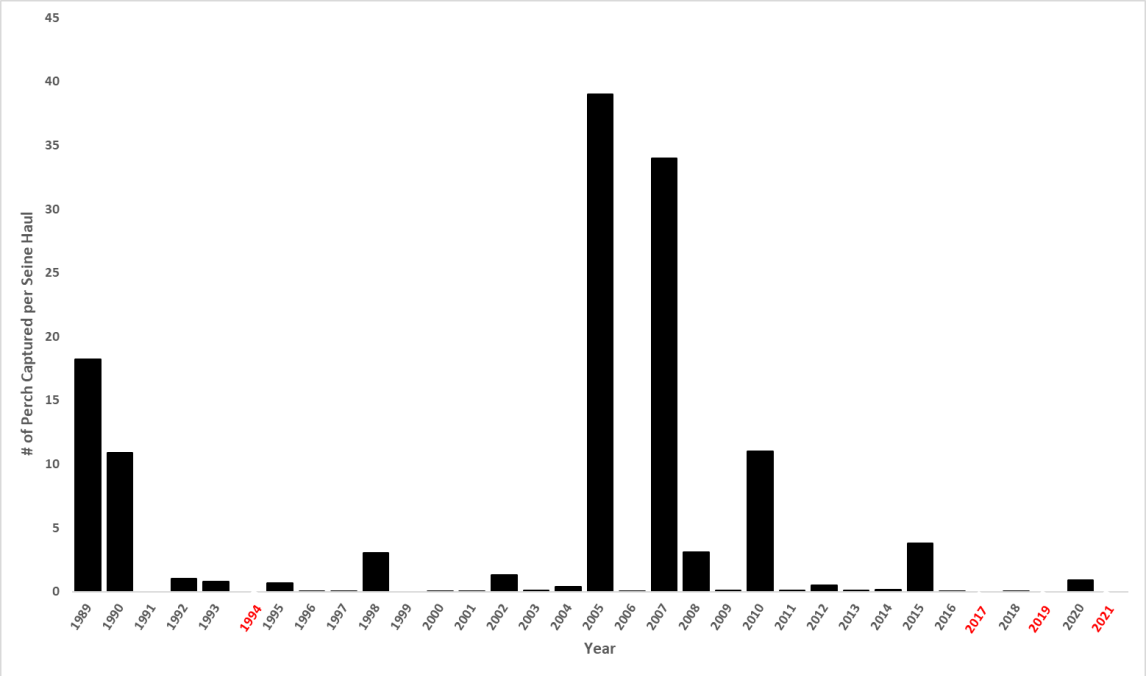

Figure 3. Number of Yellow Perch captured per seine haul in annual beach seining surveys at index sites from Kenosha to Sheboygan on Lake Michigan from 2004-2020. Surveys were not conducted in 1994, 2017, 2019 or 2021.

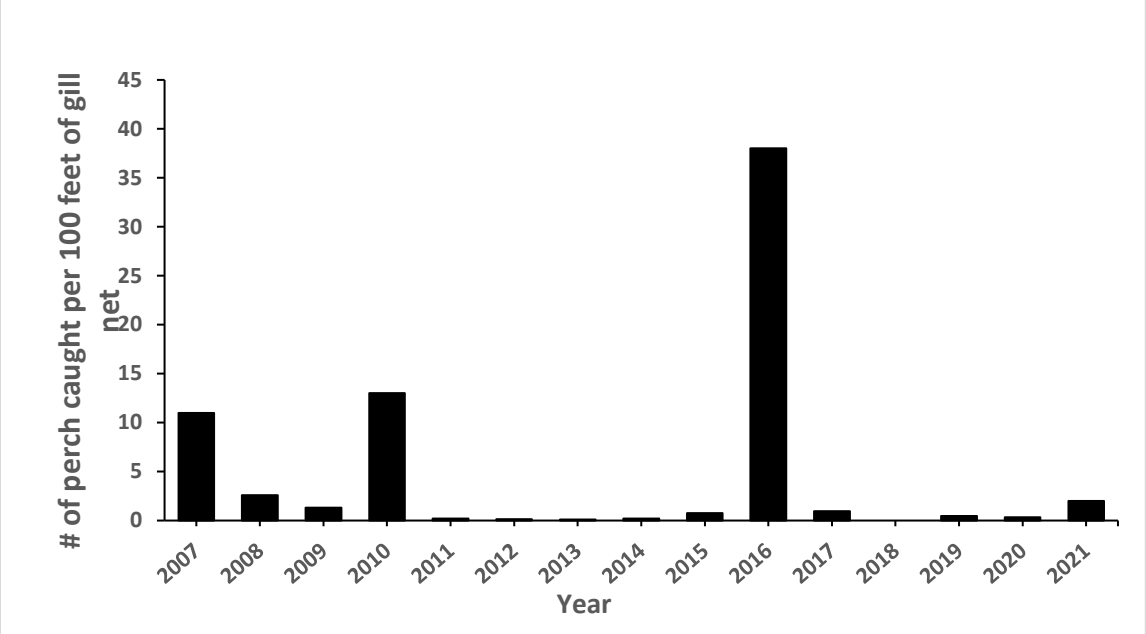

Figure 4. Micromesh gill net CPUE of young-of-the-year Yellow Perch in the nearshore waters of Lake Michigan, DNR 2004-2021.

WINTER GRADED MESH ASSESSMENT

Survey Dates (Dec. 3 – Dec. 8, 2021)

Our annual winter graded mesh assessment of the Yellow Perch population in Lake Michigan was conducted between Dec. 3 and Dec. 8, 2021. Historically, this survey would be conducted in January 2022 and labeled as the winter of 2022 survey; however, due to the availability of the boat and marina space, this survey was conducted in December when Yellow Perch should be schooled in similar locations. This survey will be conducted in early December or late November for the foreseeable future.

For the winter graded mesh survey, we try to set 20 boxes of net. Each box of gill net contains one 50-foot panel of each 1.0 inch, 1.25 inch, 1.5 inch, 1.75 inch and one 100-foot panel of each 2.0 inch, 2.25 inch, 2.5 inch, 2.75 inch, 3.0 inch and 3.25 inch stretch monofilament mesh, totaling 800 feet per box. Two or three boxes of net are then attached at the ends to create a gang. The survey was conducted off the nearshore waters of Milwaukee to the north and south using the DNR research vessel *R/V Coregonus*.

In recent years, the catch has been extremely low. We tested setting nets in different depths in 2020 and caught all four of our perch in one lift on the shallow end of Green Can Reef, in waters slightly shallower than we had been fishing. For 2021, we set the nets into shallower water than we had historically sampled and found more perch. We lifted three 1600-foot gangs on Dec. 3, 2021, to the north of the harbor at depths ranging from 18 to 72 feet. This set captured a total of 16 Yellow Perch. Five days later, we set two 1600-foot gangs and one 2400-foot gang around the Green Can Reef, ranging from 33 to 65 feet. The gangs were lifted on Dec. 8, 2021, capturing another 13 perch. Due to consistent high winds, we could not reset for a third lift. With the two lifts combined, we could lift 10,400 feet of gill net effort (13 boxes) over two nights.

The surface water temperature during the sampling period was 48-52^{0}F, slightly higher than in previous years of sampling. Our catch totaled 29 Yellow Perch and consisted of 17 females, nine males and three perch of unknown sex. Ages ranged from 2-10-years-old (Table 2), and sizes ranged from 4.4 to 14 inches. For standardization purposes, graded mesh assessment data is often reported as the catch rate per 10,000 feet of equal-length mesh panels. In these terms, our adjusted

catch was 24 Yellow Perch per 10,000 feet of a standardized mesh gill net in the December 2021 graded mesh assessment.

Table 1. Number of Yellow Perch caught by mesh size in the December 2021 graded mesh assessment.

Mesh Size (in)	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25
# of yellow perch	1	0	2	2	9	1	5	2	4	3

Table 2. Number of Yellow Perch caught by age in the December 2021 graded mesh assessment.

Age	1	2	3	4	5	6	7	8	9	10
# of yellow perch	0	1	8	7	3	1	3	2	2	2
Average Length	-	205	196	228	232	278	273	268	329	358

We maintained our Yellow Perch graded mesh standard protocol but could not reach the goal of 20 boxes of effort. We did, however, capitalize on the nets that we were able to set when we moved into slightly shallower waters. The perch may have been slightly shallower than most of our sets in previous years. Other states surrounding Lake Michigan have noticed similar movements into the shallows as we did.

These catch rates remain historically low but are higher than those in recent years. We did see more cohorts (ages 2-10) than we have in recent years; some represented stronger than others (Figure 5). This was the highest catch we have encountered since 2013 and 2015. We did capture a wide range of ages suggesting that we may have been missing those fish in previous surveys. Although the catch was higher than in previous years, it remains historically low. Before 2013, capturing hundreds of fish per 10,000 feet of net was uncommon. Other species caught included good numbers of Round Whitefish (332), Lake Trout (11), Burbot, White Sucker, Longnose Sucker, Round Goby, Rock bass and Smelt. The nets were not clogged by Cladophora which occasionally occurs in shallower waters. We plan to continue to set in the shallower water for the graded mesh assessments, and we will continue comparing our catch rates to other agencies within Lake Michigan.

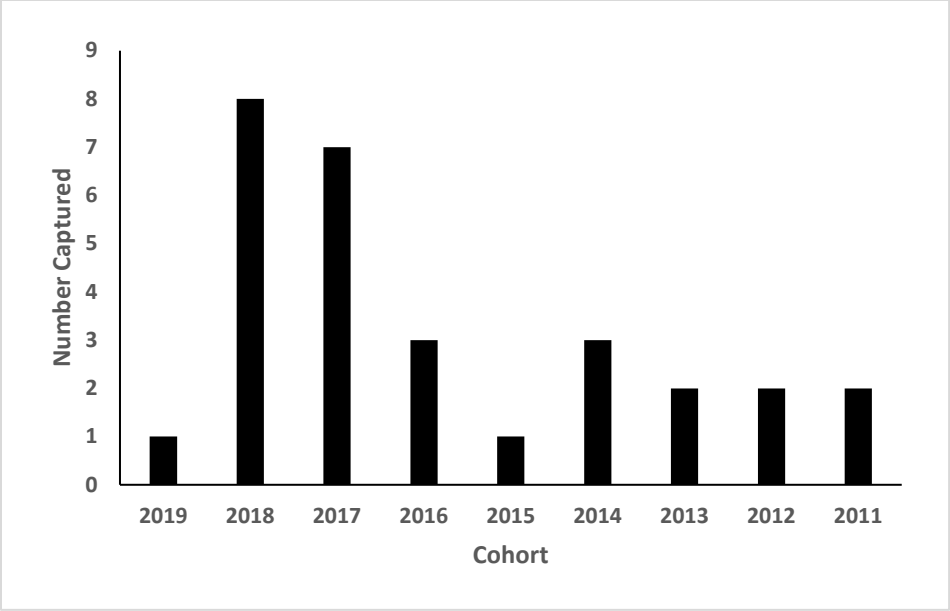

Figure 5. Cohorts of Yellow Perch captured during annual graded mesh assessment in Milwaukee, WI, 2021.

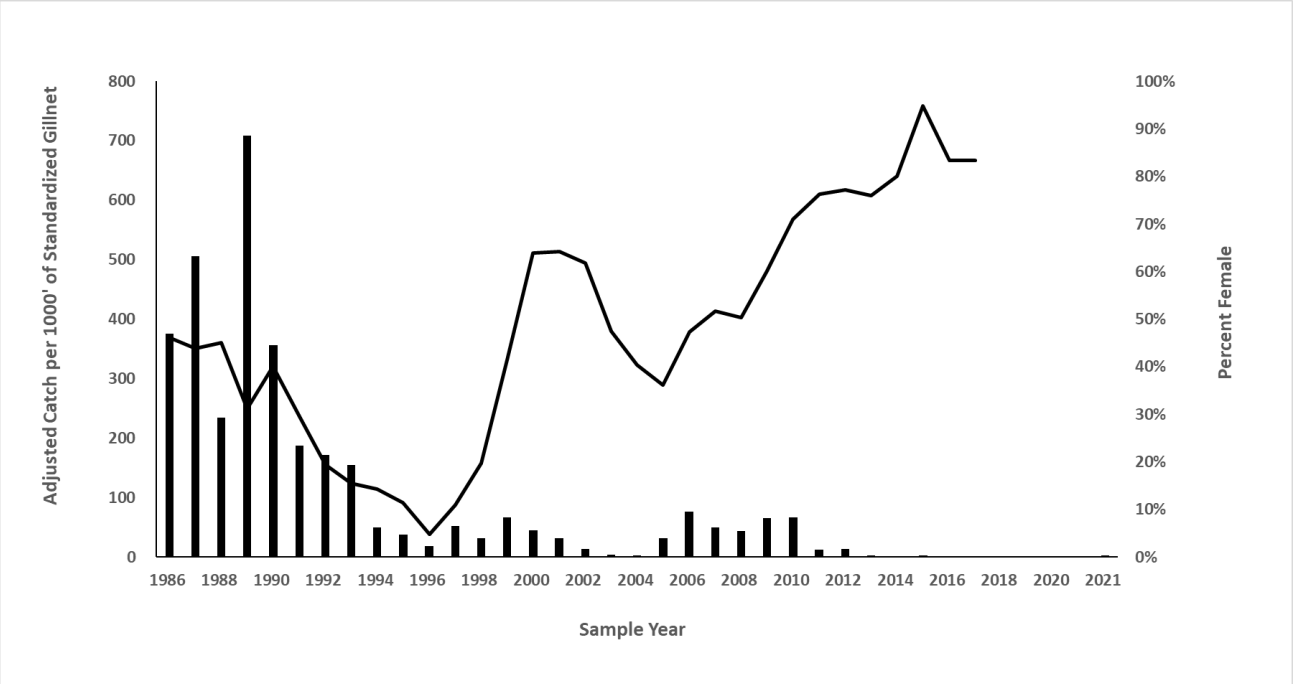

Figure 6. Adult Yellow Perch standardized CPUE (bars) and percent female (line) in the Wisconsin waters of Lake Michigan winter gill net assessment, Milwaukee, WI, 1986-2021. Percent female calculation ends in 2018 due to insufficient sample size.

2021 SURVEY YEAR SUMMARY

Yellow Perch populations remain low and struggle to produce significant year classes. Yellow Perch from the 2016 cohort were captured during the spawning survey in 2021 and in the graded mesh assessment in December 2021 and are also showing up in the creel surveys. Although the total catch is low, the 2016 cohort is the most recent successful cohort in the last 10 years. They have been detected in multiple years of spawning surveys and hopefully will be able to contribute to the next significant cohort. Our YOY surveys for 2021 were extremely limited but did detect some Yellow Perch. Further evaluation of the strength of the 2021 cohort will be needed. The strength of the 2021 cohort will be evident in later years if they show up in other surveys. Overall, catch remains low, and the population relies heavily on one or two years of successful recruitment.

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