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. Photo credit: Tammie Paoli.

Lake Michigan Committee
2024 LMTC Summer Meeting
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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 2023. 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 each report section.

2023 Green Bay Brown Trout Management

This report summarizes assessments and management actions for brown trout in Wisconsin waters of Green Bay/Lake Michigan completed in 2023.

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 near-shore and offshore fishery for 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.

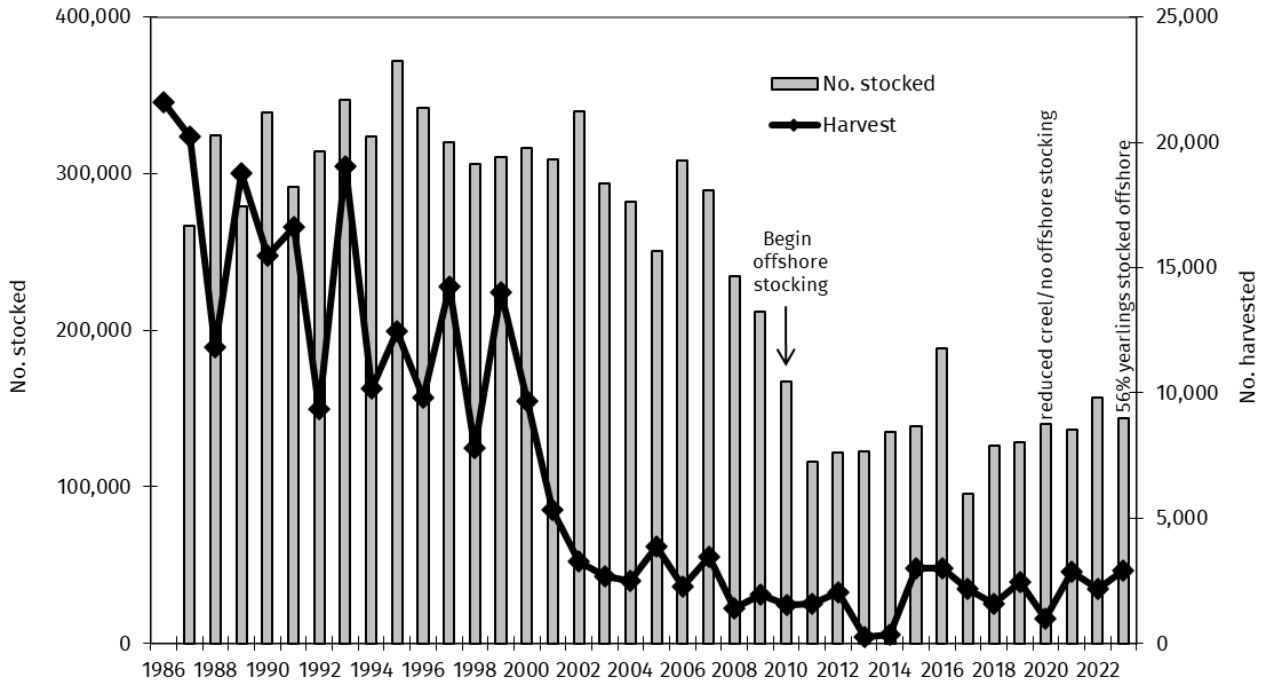

Figure 1. Number of stocked and harvested brown trout (fingerlings & yearlings combined) in Wisconsin waters of Green Bay by year.

Historically, the DNR has stocked several strains and age classes of brown trout into Green Bay and adjacent rivers. To provide a trophy fishery, the Seeforellen (German)

brown trout program was initiated in Wisconsin waters of Lake Michigan in the early 1990s. This strain (*Salmo trutta lacustris*) originated from alpine lakes in Germany and was first brought to a New York state fish hatchery in 1979[1]. The Wisconsin DNR obtained Seeforellen eggs from New York in the winter of 1989-1990. Seeforellen generally live longer and grow faster than other strains, thus adding to the trophy element of the fishery[2]. Currently, Seeforellen brown trout are the only strain that Wisconsin 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[3].

Following the closure of the Thunder River Hatchery in 2017 and the discontinuation of the Wild Rose (domestic) strain of brown trout that were previously stocked into Lake Michigan by Wisconsin, a stocking strategy for Seeforellen brown trout was developed with input from the Lake Michigan Fisheries Forum and several public meetings. The strategy evenly distributes 75% of the entire yearling brown trout quota across each Lake Michigan/Green Bay county.

The remaining 25% are allocated based on brown trout harvest rates and directed effort that were derived from open water creel surveys. Beginning in 2018, an additional 20,000 brown trout were allocated to Green Bay and Milwaukee to further boost the local fisheries. 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. In 2023, a total of 143,510 brown trout were stocked in Green Bay by the DNR (Table 1).

To ensure that known Seeforellen are collected as future brood stock to continue the genetic lineage, Seeforellen stocked into the brood rivers (Kewaunee, Milwaukee and Root) receive a fin clip prior to stocking. The total number of fish clipped annually is approximately 104,000. Brown trout stocked at locations other than the brood rivers do not get fin clipped.

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[1] Garrell, M.H., Strait, L.E. 1982. Seeforellen in New York. New York Fish and Game Journal 29:97-100.

[2] 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.

[3] 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

In 2010 and 2011, the DNR utilized a pontoon barge and the USFWS *RV Spencer Baird* to stock yearling 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 restrictions, 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 and continued into 2022 with fall fingerling quotas being directly stocking into tributaries. In 2023, 56% of the Green Bay brown trout yearlings were stocked offshore on the Door County side. The remainder of the yearlings planned for offshore stocking on the Marinette County side were stocked directly into west shore tributaries (Table 1). Flows in excess of 24,000 cubic feet per second on the lower Menominee River in mid-April 2023 made it unsafe to tie up and depart the wall at Waupaca Foundry with a fully loaded stocking tank on the *RV Coregonus*.

Table 1. DNR brown trout stocking information for Green Bay in 2023.

DATE	COUNTY	LOCATION	STRAIN/SIZE	NUMBER	CLIP	# FISH PER LB	REARING FACILITY
Apr 14, 2023	Door	Offshore Grid 804	Seeforellen yearling	33,046	--	8.2	Wild Rose SFH
Apr 18, 2023	Marinette	Menominee River at Menekaunee Harbor	Seeforellen yearling	9,790	--	7.9	Wild Rose SFH
Apr 18, 2023	Oconto	Oconto River at Stiles	Seeforellen yearling	11,899	--	7.9	Wild Rose SFH
Apr 18, 2023	Marinette	Little River at Krause Road	Seeforellen yearling	11,828	--	7.9	Wild Rose SFH
Apr 19, 2023	Door	Offshore Grid 804	Seeforellen yearling	33,809	--	8.0	Wild Rose SFH
May 11, 2023	Marinette	Little River at Krause Road	Seeforellen yearling	18,218	--	10.2	Brule River SFH
Sept 25, 2023	Marinette	Little River at mouth	Seeforellen large fingerling	11,462	--	28.8	Wild Rose SFH
Sept 25, 2023	Oconto	Oconto River at CTH J	Seeforellen large fingerling	13,458	--	28.8	Wild Rose SFH
			Total yearlings **Total fingerlings**	**118,590** **24,920**			

Creel Results And Discussion

The catch and harvest estimates for open water Green Bay brown trout in 2023 was 3,256 (catch) and 2,896 (harvest) fish from mid-March to mid-November (Figure 1). Green Bay comprised 42% of the total brown trout harvest for Lake Michigan in 2023 (6,963 fish), followed by Milwaukee County (15%) and Kewaunee County (13%). The goal is to have a harvest rate for Green Bay brown trout for anglers targeting salmonids to be at or below 23 hours per fish. In 2023, the brown trout harvest rate

for anglers targeting salmonids in Green Bay was 11.6 hours/fish, a decline from 7 hours/fish in 2022.

Since offshore stocking began in 2010, average harvest rate for anglers targeting salmonids has generally improved (27 hours/fish) compared to the previous 10-year average (2000-2009; 35 hours/fish). A difference in 8 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. Offshore stocking did not occur in 2020, so this provides an opportunity to compare harvest rates to years that offshore stocking occurred. Age-2 and age-3 brown trout typically comprise the majority of the angler harvest. Harvest rates from 2021 and 2022 (13 and 7 hours/fish, respectively) remained well within acceptable ranges.

Seeforellen Gamete Collection Summary

Beginning each year in late October or November, DNR crews use electroshocking boats to collect Seeforellen adults (identified by an adipose fin clip) from the three brood rivers. Captured fish are transferred to Besadny Anadromous Fish Facility (BAFF), where they are 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 State Fish 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) 2024-25 stocking quotas for brown trout.

In 2023, the DNR sampled the Kewaunee River on Oct. 30, Nov. 9 and Nov. 16, 2023 using one boat. The Root River was sampled on Nov. 2, Nov. 7 and Nov. 14, 2023 with two boats each day. The DNR also sampled the Milwaukee River and harbor on Nov. 8 and Nov. 15, 2023 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 14 electrofishing boat days.

In 2023, Seeforellen gametes were collected at BAFF during four spawning events between Nov. 15 and Dec. 6. Fertilized, disinfected eggs were transported to the Wild Rose State Fish Hatchery on each spawning date. Sixty fish (30 males; 30 females) were necropsied for fish health on Nov. 15. Virology tests were negative. However, the

bacteria that causes furunculosis (*Aeromonas salmonicida salmonicida*) was isolated from one fish that had a large mass on it and was not used for spawning (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 2023, that trend continued, with the sex ratio at two males for every two and a half females when combining all three locations (Table 2).

A total of 457 brown trout were processed at BAFF in 2023 (Table 2). Gametes were not collected from every fish as some fish were spent or hard (last day), but biological data was collected from all fish. Unique fin clips (adipose + right ventral) were given to brood stock yearlings stocked in 2021. Those age-3 fish comprised 32% of the sample. 24% of the fish sampled were 30 inches or greater (Figure 2). There were no significant differences between the weight of females collected from the three rivers as determined by one-way ANOVA, $F(2,247) = 1.02$, $p = 0.36$.

Table 2. Number of Seeforellen brown trout processed for biological data at BAFF by river source and sex in 2023. 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	
Nov 15, 2023	3	2	26	24	6	9	259,346
Nov 21, 2023	12	16	16	18	10	4	270,200
Nov 29, 2023	17	22	34	37	11	15	421,172
Dec 6, 2023	21	25	33	52	16	28	250,902
TOTAL	**53**	**65**	**109**	**131**	**43**	**56**	**1,201,620**

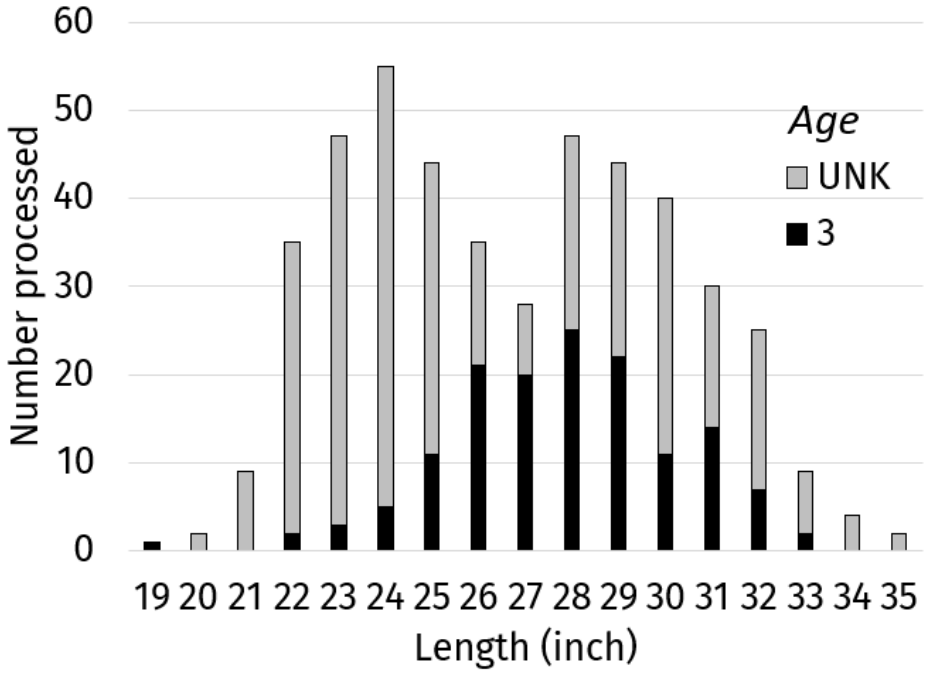

Figure 2. Length frequency by age of Seeforellen *brown trout processed at BAFF in 2023. All rivers combined. Age-three fish are black bars, unknown age fish in grey.*

Summary

The open water harvest estimate for Green Bay brown trout in 2023 was 2,896 fish. Brown trout harvest rate for anglers targeting salmonids in Green Bay was 11.6 hours/fish in 2023. For the last five years, this has been within the acceptable range of the target harvest rate at or below 23 hours/fish.

Seeforellen brood river fish will continue to be hand-clipped with an adipose fin clip prior to stocking so adults can be identified and used for gamete collection when they return to the Milwaukee River and harbor, and the Kewaunee and Root rivers. The DNR planned to continue stocking yearling brown trout offshore into Green Bay in 2024; however, maintenance of the *RV Coregonus* continued into April 2024. Since hatcheries needed to stock out fish, all yearling brown trout were stocked in tributaries and harbors in early April, similar to 2020.

Since offshore stocking began in 2010, the average brown trout harvest rate for anglers targeting salmonids has generally improved (27 hours/fish) compared to the previous 10-year average (2000-2009; 35 hours/fish). The DNR will continue to evaluate the brown trout fishery with the creel survey and assess stocking strategies.

Acknowledgements

Dozens of staff across several agencies and offices made this effort possible. DNR fisheries staff from Asylum Bay (Oshkosh) and BAFF 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 veterinarian Dr. Nicole Nietlisbach and Ryen Kleiser from Madison collected fish health 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 Department of Natural Resources (DNR) in cooperation with several local musky clubs and the Musky Clubs Alliance of Wisconsin initiated a Great Lakes spotted muskellunge reintroduction program in 1989 for the Green Bay waters of Lake Michigan to diversify the predator population of the bay and re-establish a muskellunge fishery. Since that time, the DNR has been actively managing the muskellunge population through a combination of stocking, population surveys, creel surveys, habitat restoration and research projects.

The purpose of this report is to summarize data collected for muskellunge during the 2023 field season on Green Bay and its tributaries and to describe long-term trends in survey results, stocking and angler catch and harvest.

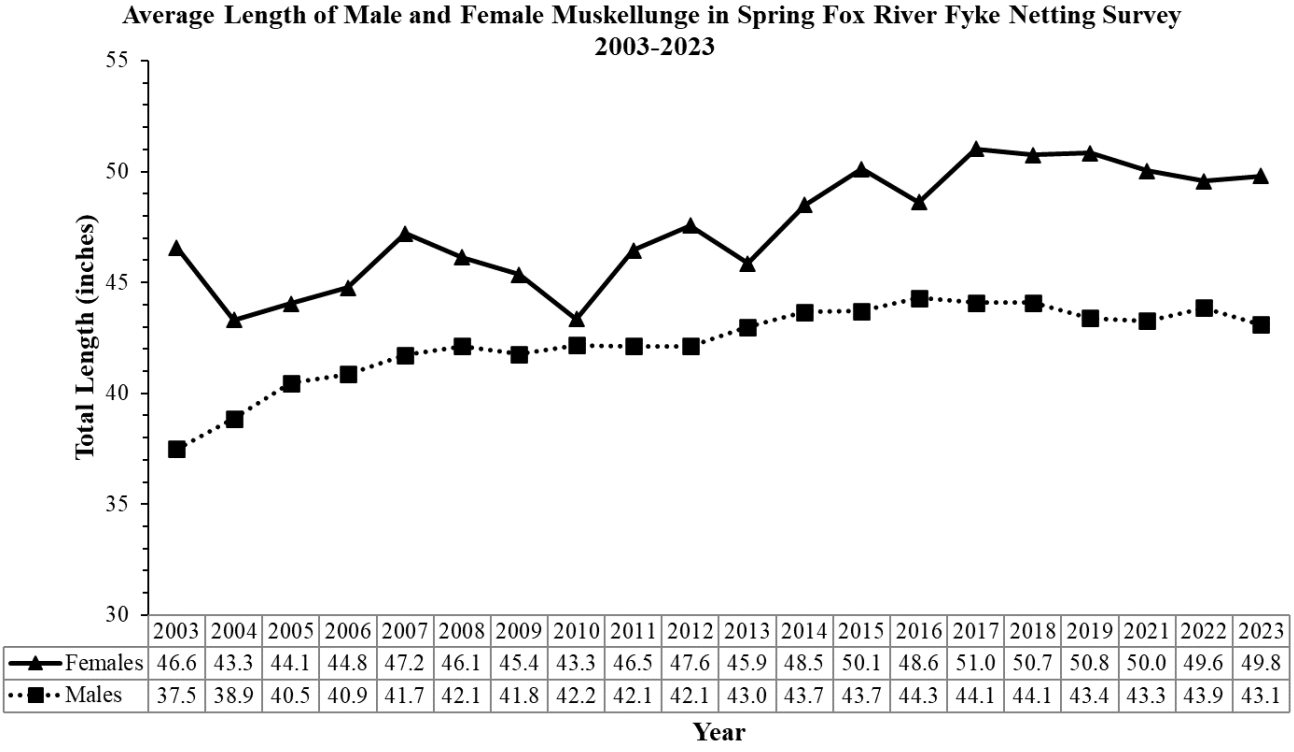
Annual Assessments

Assessments to determine the status of the Green Bay muskellunge population have been conducted using both spring fyke nets and fall electrofishing. 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. Spring surveys were only conducted on the Fox River in 2023.

In 2023, the 59 male muskellunge captured in Fox River fyke nets had an average length of 43.1 inches (1,096 mm), and the 34 female muskellunge captured averaged 49.8 inches (1,264 mm) in length (Figure 1). Furthermore, four female muskellunge >54.0 inches were captured in 2023, including three that were >55.0 inches and one that was >56.0 inches. Also, four male muskellunge that were >49.0 inches were also captured in the spring 2023 fyke netting survey. Between 2003 – 2017, the average length for both male and female muskellunge captured in Fox River netting surveys has steadily increased (Figure 1). Since 2017, the average lengths of male and female muskellunge have been similar across years, with females averaging 50 – 51 inches and males averaging 43 – 44 inches (Figure 1).

In 2023, 19 muskellunge captured in the spring fyke netting survey on the Fox River had previously had a Passive Integrated Transponder (PIT) tag implanted just under their skin. Tables 1 and 2 at the end of this document provide information about the original tagging events for each of these fish as well as any other recaptures in DNR

surveys. Eighteen of the 19 muskellunge were either stocked into the Fox River or were PIT tagged in previous surveys of the Fox River. The other muskellunge was PIT tagged very close to the Fox River in Dead Horse Bay. Four muskellunge had also been recaptured in previous surveys, all of which were on the Fox River. One muskellunge that was originally tagged in a spring 2015 fyke netting survey on the Fox River and was recaptured in the 2023 fyke netting survey was caught by an angler with a PIT tag reader during September of 2023. Recapture data from PIT tagged muskellunge provides information on spawning site fidelity, whether muskellunge return to stocking locations to spawn, their growth rates, survival and longevity. Evidence from PIT tag data from Fox River surveys as well as information from the Peshtigo River PIT tag array suggests that adult muskellunge display strong fidelity to stocking location to spawn. As a result, DNR staff have reprioritized stocking locations and added four new stocking locations with coastal wetland habitat on Green Bay proper to increase the potential of successful natural reproduction.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023
Females	46.6	43.3	44.1	44.8	47.2	46.1	45.4	43.3	46.5	47.6	45.9	48.5	50.1	48.6	51.0	50.7	50.8	50.0	49.6	49.8
Males	37.5	38.9	40.5	40.9	41.7	42.1	41.8	42.2	42.1	42.1	43.0	43.7	43.7	44.3	44.1	44.1	43.4	43.3	43.9	43.1

Figure 1. Average length (inches) of male and female muskellunge captured during annual spring netting surveys of the lower Fox River from 2003-2019, 2021-2023.

Since 2000, nighttime electrofishing surveys have been conducted on the Fox River during September or October to index muskellunge and walleye populations. Between 2000 – 2016, the entire length of the Fox River was surveyed on both banks from the mouth to the dam in De Pere. Starting in 2017, only the upstream half of the Fox River from the railroad bridge north of 172 to the dam in De Pere was electrofished. During the fall 2023 electrofishing survey, only one muskellunge that

was longer than 17.7 inches (i.e., 450 mm) was captured. Furthermore, this muskellunge was also greater than 30 inches (i.e., 760 mm). Catch per unit effort (i.e., number of muskellunge caught per hour of electrofishing) was 0.18 muskellunge per hour for both size classes in 2023 (Figure 2).

Since the onset of an earlier survey date beginning in 2009, fall CPUE has been sharply lower in most years (Figure 2). However, other factors such as substantially reduced stocking from 2007 – 2009 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 10 years have not been as high as what was observed in the early 2000s, they have been higher than what was observed from 2011 – 2013. These increases in catch rates in more recent years are likely driven by increases in stocking since 2010, including increased yearling stockings since 2015.

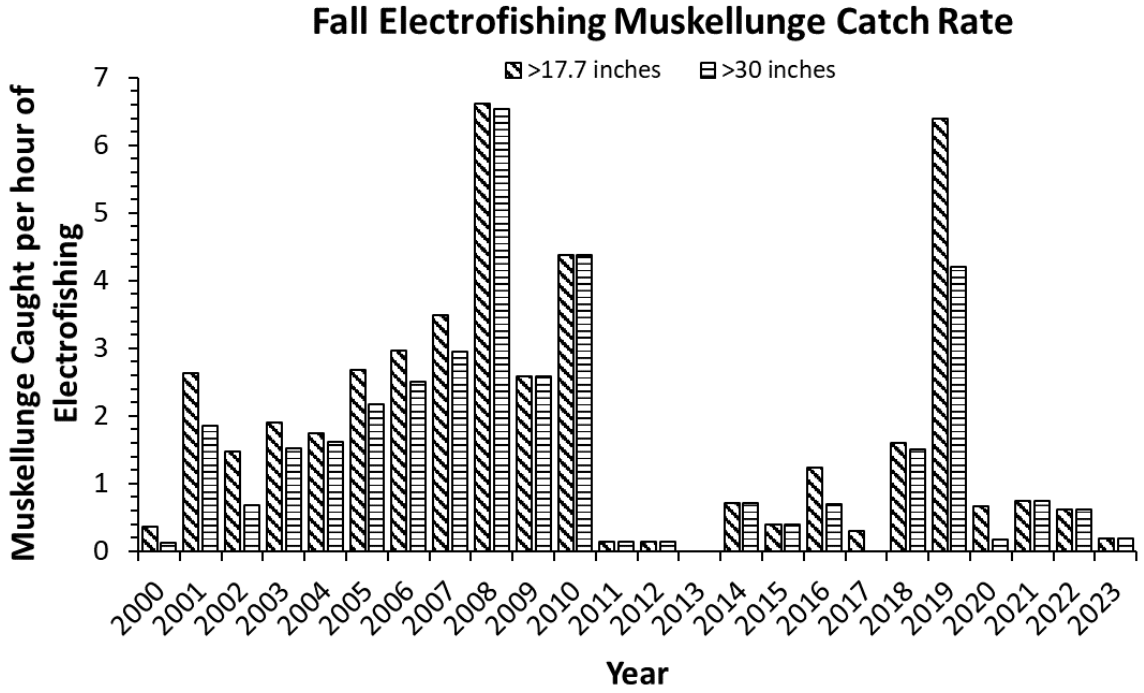


Figure 2. Catch per Unit Effort (CPUE) from nighttime electrofishing on the Fox River for muskellunge greater than 17.7 inches (450mm) and greater than 30.0 inches (760mm) from 2000- 2023.

Stocking

In 2023, the DNR stocked 7,681 yearling muskellunge into the Wisconsin waters of Green Bay (Figure 3). Unfortunately, no large fingerling muskellunge were available for stocking in 2023 due an unknown virus causing a large mortality event among the fingerling muskellunge at the Wild Rose State Fish Hatchery and Besadny Anadromous Fish Facility (BAFF). Since 1989, a total of 189,991 large fingerlings and

41,533 yearling muskellunge have been stocked in Green Bay and its tributaries (Figure 3).

Stockings from 2010 - 2020 consisted of a combination of large fingerling muskellunge raised at the 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, while the 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 raised from eggs that were collected from adult muskellunge spawning in the Fox River at both BAFF and Wild Rose State Fish Hatchery. Raising large fingerling muskellunge at the Wild Rose hatchery in the future should increase the number of large fingerling muskellunge that can be stocked in Green Bay as seen by the large increase in large fingerlings stocked in 2021 compared to the previous 10 years.

Since 2010, most muskellunge have been stocked in locations capable of supporting juvenile and 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.

Results from recent research have shown that adult muskellunge in Green Bay tend to return to stocking locations to spawn[4]. Given this new information, it is important to stock muskellunge in areas with the best spawning and nursery habitat since the goal is to create a self-sustaining population. As a result, four new locations that are thought to have good spawning and nursery habitat have been identified. These include Dead Horse Bay (historical stocking location that had not been stocked in many years), Point Au Sable, Seagull Bar State Natural Area at the mouth of the Menominee River and Egg Harbor. These four stocking locations received stocked muskellunge starting in 2022 or 2023 or will start receiving stocked muskellunge within the next year. Furthermore, Sawyer Harbor in Sturgeon Bay and Little Sturgeon Bay will receive a higher percentage of the muskellunge available for stocking due to high quality wetland habitat in these areas. All historical stocking locations will continue to receive stocked muskellunge; however, numbers stocked in these locations may be lower due to higher prioritization of areas thought to have the best spawning and nursery habitat.

[4] Krebs, J.E. 2020. Movements and Spawning Habitat of Muskellunge Esox masquinongy in Green Bay, Lake Michigan. University of Wisconsin Stevens Point, Thesis.

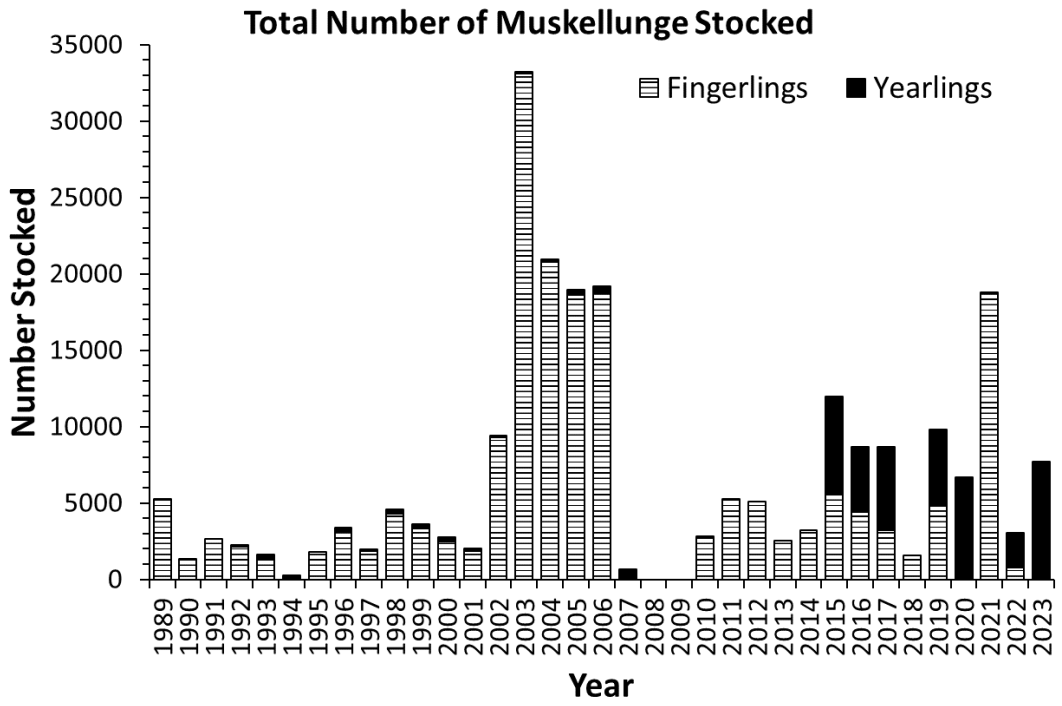


Figure 3. Great Lakes spotted muskellunge stocking history for fish that were stocked into Green Bay and its tributaries from 1989 – 2023.

Fishery

The Lake Michigan creel survey estimated that a total of 5,358 muskellunge were caught by anglers in 2023 (Figure 4). The catch of muskellunge in 2023 was the highest in any going back to 2005 and nearly double the number of muskellunge that were estimated to be caught in 2022. The estimated 5,358 muskellunge that were caught in 2023 is nearly 3X higher that than the average annual catch of 1,856 muskellunge per year since 2005 (Figure 4). It should be noted that WDNR staff were unable to start conducting creel surveys until July of 2020, meaning estimates of the number of muskellunge caught in 2020 are likely low given creel surveys were not conducted from March – June.

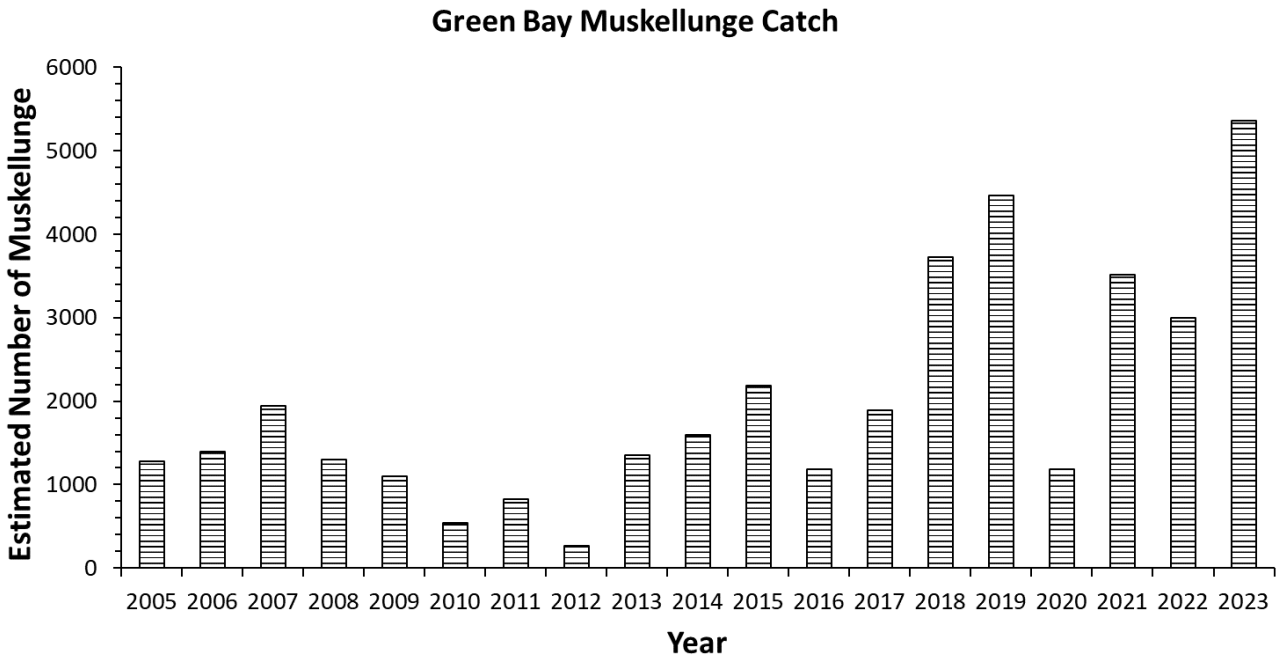


Figure 4. The estimated catch of Great Lakes Spotted muskellunge from Green Bay from 2005 – 2023 during the open water fishing season.

An estimated total of 94,993 hours of directed effort targeting muskellunge occurred on Green Bay and its tributaries from March 15 through November 15, 2023 (Figure 5). The 94,993 hours of effort is the highest amount of effort spent targeting muskies over the last 19 years and speaks to the growing popularity of the muskellunge fishery on Green Bay (Figure 5). Results from the 2023 creel survey showed that angler catch per unit effort was 0.038 muskellunge per hour of directed fishing effort in 2023 or approximately 26.3 hours spent fishing to catch a muskellunge on Green Bay and its tributaries (Figure 5). 2023 marks the fourth year in a row where catch rates muskellunge catch rates have been increasing among anglers targeting muskellunge. Furthermore, catch rates by anglers targeting muskellunge in 2023 were the second highest they have been in any year since 2007, behind only 2019 when anglers had to spend only 17.2 hours fishing to catch a muskellunge in Green Bay and its tributaries (Figure 5).

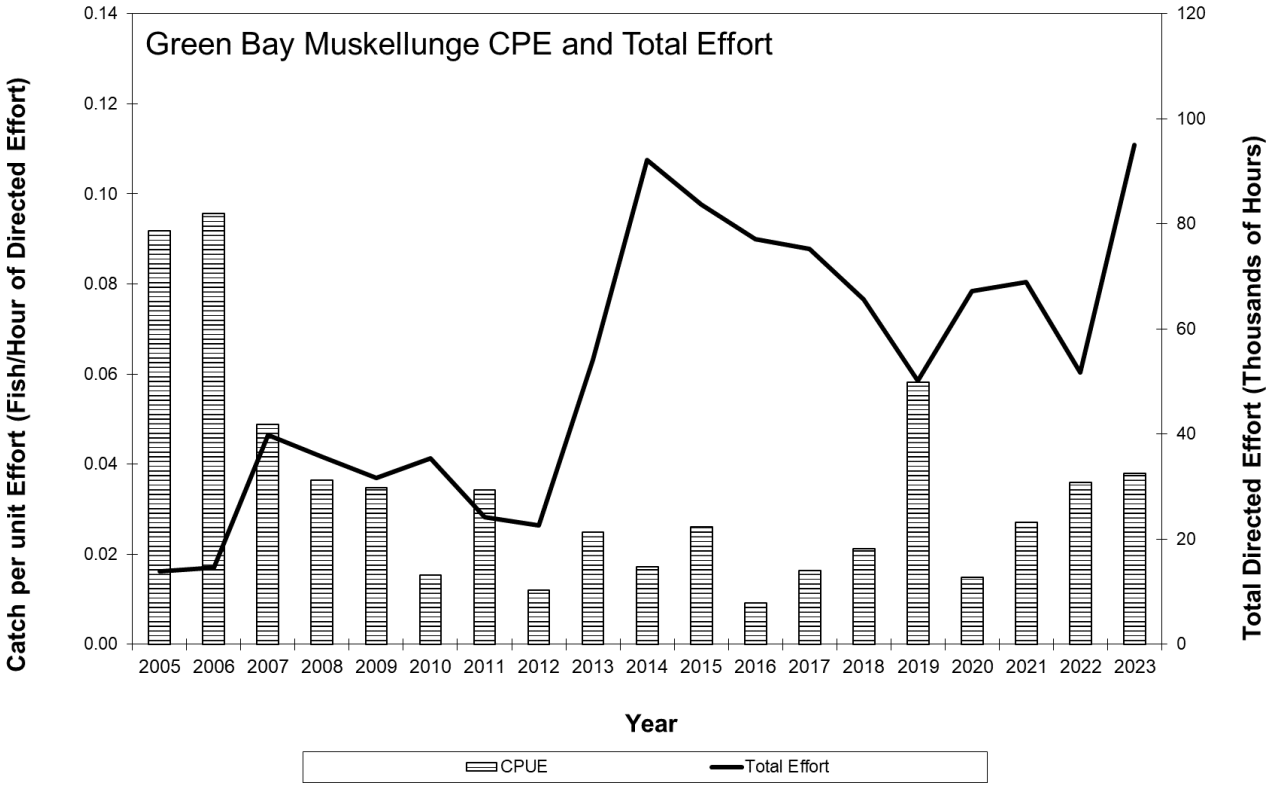


Figure 5. Total directed fishing effort for muskellunge on Green Bay waters of Lake Michigan from 2005-2023 is displayed by the solid black line on the right axis in thousands of hours fished. The left axis shows catch per unit effort (number of muskies caught per hour of directed effort) of muskellunge caught from 2005-2023.

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 stocked muskellunge grow rapidly, reach maturity, and attempt to spawn in various tributaries and in other locations around Green Bay. Despite attempts by adult 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 that is 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 19 muskellunge captured in the spring 2023 fyke netting survey on the Fox River that were previously PIT tagged. Information provided includes capture date in 2023, PIT tag number, capture size in 2023, sex, observed fin clips, date originally PIT tagged, length when originally PIT tagged, 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 Tagging means this fish was PIT Tagged at the time of stocking.

DATE CAPTURED	PIT TAG NUMBER	2023 CAPTURED LENGTH (INCHES)	SEX	FIN CLIP	DATE TAGGED	TAGGING LENGTH (INCHES)	TAGGING LOCATION	SURVEY GEAR WHEN TAGGING
5/9/2023	985121014799499	45.3	M	LV	5/5/2015	41.5	Fox River	Fyke Net
5/9/2023	985121014784070	51.1	F	LV	5/5/2015	47.6	Fox River	Fyke Net
5/9/2023	4703532D6B	49.1	M	LV	10/28/2008	41.0	Fox River	Electrofishing
5/9/2023	956000003142857	39.3	M	RV	7/28/2015	16.0	Fox River	Stocking
5/9/2023	985121014819665	43.4	M	LV	5/12/2021	43.6	Fox River	Fyke Net
5/10/2023	989001003982122	46.7	M	LV	5/11/2021	45.7	Fox River	Fyke Net
5/10/2023	989001003979778	41.9	M	RV	7/28/2015	13.6	Fox River	Stocking
5/10/2023	985121001325532	53.2	F	RV	8/29/2007	19.0	Fox River	Stocking
5/10/2023	985121015359350	44.2	M	LV	5/12/2021	44.3	Fox River	Fyke Net
5/10/2023	985121014802201	44.9	M	LV	5/12/2021	44.1	Fox River	Fyke Net
5/10/2023	956000002923577	50.6	F	LV	5/11/2022	50.2	Fox River	Fyke Net
5/10/2023	956000002909470	47.6	M	LV	5/16/2018	45.5	Fox River	Fyke Net
5/10/2023	985121001367298	50.5	F	BV	8/29/2007	20.2	Fox River	Stocking
5/10/2023	985121001368300	49.9	M	NONE	5/5/2008	43.9	Fox River	Fyke Net
5/10/2023	956000002908876	44.9	M	LV	5/9/2018	43.5	Fox River	Fyke Net
5/10/2023	989001003975987	44.3	M	LV	5/11/2022	43.3	Fox River	Fyke Net
5/10/2023	985121014777297	46.6	M	LV	5/16/2013	42.8	Fox River	Fyke Net
5/10/2023	989001003982087	40.6	M	LV	5/11/2021	37.6	Fox River	Fyke Net
5/10/2023	985121015085084	47.5	M	LV	5/5/2009	39.3	Dead Horse Bay	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 five muskellunge captured in the spring 2023 fyke netting survey on the Fox River that were also recaptured in previous DNR surveys or by anglers with PIT tag readers. Information provided includes capture date in 2023, PIT tag number, capture size in 2023, sex, observed fin clips, date recaptured, length when recaptured, recapture location, and the gear used when the muskellunge was recaptured. Note that one muskellunge was recaptured in multiple surveys.

DATE CAPTURED	PIT TAG NUMBER	2022 CAPTURED LENGTH (INCHES)	SEX	FIN CLIP	DATE RECAPTURED	RECAPTURE LENGTH (INCHES)	RECAPTURE LOCATION	SURVEY GEAR WHEN RECAPTURED
5/9/2023	985121014799499	45.3	M	LV	9/19/2023	45.9	Green Bay	Angler Caught
5/10/2023	989001003982122	46.7	M	LV	5/11/2022	46.3	Fox River	Fyke Net
5/10/2023	985121001368300	49.9	M	NONE	10/26/2009	46.0	Fox River	Electrofishing
5/10/2023	985121014777297	46.6	M	LV	5/16/2019	45.9	Fox River	Fyke Net
5/10/2023	985121014777297	46.6	M	LV	5/11/2022	46.3	Fox River	Fyke Net
5/10/2023	985121015085084	47.5	M	LV	5/11/2022	47.6	Fox River	Fyke Net

Green Bay Northern Pike

Background

Northern pike are a native top predator and important game fish in Green Bay with a unique life history. Each spring, adult pike migrate migrate up tributaries and ditches of Green Bay as they seek shallow wetlands to spawn in. However, approximately 70% of Green Bay's west shore wetlands have been lost due to a combination of human and non-human factors[5].

In the early 1990s, DNR began conducting young-of-year (YOY) northern pike trapping surveys along small and medium wadable waterways of Green Bay's west shore. These surveys were done with specially designed box traps that capture YOY pike as they are passively migrating downstream towards Green Bay. In the mid-2000s, DNR discontinued this work due to staffing and budget reductions. During that time, several local partners such as UW-Green Bay, UW-Madison, and the Oneida Tribe stepped in to continue sampling northern pike in the spring. Currently, three county land and water conservation departments (Brown, Oconto, and Marinette) utilize box traps and modified fyke nets to survey adult pike use and reproduction in various inland waterways along the west shore of Green Bay.

Since 2015, Brown County Land and Water Conservation Department deploys smaller custom built fyke nets with wings to capture adult pike as they are migrating up small streams and ditches each spring. In 2018, Oconto County LWCD began a similar effort to assess adult pike during spawning runs and in 2022, Marinette County LWCD followed suit. The three county agencies deploy fyke nets in two to four locations each spring. DNR provides numbered floy tags and tagging equipment to county staff, provides guidance on net locations and completes data entry into a statewide SWIMS database. Some of the fyke net locations are new sites where the county LWCD is considering a future pike spawning or road crossing project, while some of the locations are established areas that adult pike typically use. After each field season, DNR compiles data from partner agencies and enters it into the DNR SWIMS database.

Through the years, adult and YOY pike surveys have identified many important areas that pike utilize to spawn. As a result, spawning marshes were created or enhanced by DNR or partner agencies over the last three decades along the west shores of Green Bay using various funding sources such as Great Lakes Restoration Initiative or Fox River Natural Resources Damage Assessment. In some cases, DNR acquisition of

[5] Bosely, T.R. 1978. Loss of wetlands on the west shore of Green Bay. Wisconsin Academy of Sci. Arts and Letter 66: 235-244.

high value fisheries property was pursued as part of the Green Bay West Shores Wildlife Area or under the Scattered Fisheries Habitat Program.

Other previous survey work focusing on adult northern pike along the west shores of Green Bay includes a telemetry study in the Pensaukee River watershed[6]. In that study, 21 adult pike were captured in a fyke net in February and March 1998 near the mouth of the Pensaukee River. Fish were surgically implanted with external radio transmitters and movement was monitored during spring spawning using a truck, boat, or airplane. Travel distance varied but two of the pike traveled 15 river miles to inland spawning grounds.

In addition to spring tributary surveys where adult northern pike are targeted by partner agencies, pike are sometimes caught incidentally in DNR surveys such as yellow perch fyke netting or tributary electrofishing surveys while targeting other gamefish species such as walleye or trout. However, a large scale adult northern pike survey across the entire west shore of Green Bay had not been done by DNR until the spring of 2023. The purpose of the 2023 survey was to collect catch per effort data, length and age information, and to determine if a mark-recapture population estimate for localized populations was feasible.

A creel survey on Wisconsin waters of Green Bay is run annually from January until mid-November. Catch and harvest estimates for pike and other species of interest are generated from that survey. The Wisconsin waters of Green Bay and major tributaries are open all year for northern pike fishing. Other tributaries and ditches along Green Bay have a closed season for pike from the first Sunday in March to the first Saturday in May. The lower Menominee River (Wisconsin/Michigan boundary waters) has a closed season from March 1 to the first Saturday in May. There is a 5 daily bag limit with no minimum size limit on the above mentioned waters. The Michigan waters of Green Bay have a closed season from March 15 to May 15, with a 2 daily bag limit and 24 inch minimum size for northern pike.

Spring Fyke Netting Survey Methods

For the purposes of the 2023 spring survey, the west shore of Green Bay was divided up into three areas by county: Marinette, Oconto, and Brown, with one crew assigned to each county (Figure 1). A portion of nets in each county were set on April 3, 2023 and were run for approximately one week. Exact dates of setting and removal is listed in each section below. The Marinette and Brown county nets were 3’ x 6’ hoop fyke nets with ¾” bar, 1.5” stretch mesh (Peshtigo DNR nets), while the Oconto county nets were 4’ x 6’ with ¾” bar, 1.5” stretch mesh (Florence DNR nets). Northern pike were measured (total length), sexed and given a top caudal mark indicating capture. Recaptures were identified following the first day of netting. A pelvic fin ray from

[6] Schuette, P. A., and R. A. Rost. 1998. Wetlands used by spawning northern pike (Esox lucius L.) in the Pensaukee River watershed, 1996 and 1998. Report for Wisconsin Coastal Management Program.

northern pike was collected from 5 fish per 0.5 inch group for males, females and unknown sex[7]. For the length and age analysis, data was combined for all nets.

MARINETTE COUNTY

Five nets were set in the lower Peshtigo River and two nets were set in the protected area behind Seagull Bar (Red Arrow Park "pocket") on April 3 (Figures 2 and 3). An additional net (#8) was set in the lower Peshtigo River on April 4. Nets were lifted daily through April 8, 2023. Water temperature ranged from 33-38F.

OCONTO COUNTY

Eight nets were set in the lower Oconto River on April 3. Two nets (#3, #6) were moved to more protected areas within the Oconto River (#3A, 6A) on April 4 and 5, respectively. On April 5, five of eight nets were removed from the river and set in Green Bay proper east of the Oconto Sportsman's Club. The remaining three nets (#7, 3A, 6A) were removed from the river on April 6. Two of the five nets on Green Bay proper were double-ended fyke nets. Nets were checked daily except for Green Bay nets #4 and 5 which were not checked on April 6 due to gale winds. Nets were removed from Green Bay on April 7. Water temperature ranged from 36-38F. See Figure 4 for net locations.

Four nets were set in the lower Pensaukee River on April 4 and were removed on April 7. Water temperature ranged from 36-40F. See Figure 5 for net locations.

BROWN COUNTY

Six nets were set as double-ended fyke nets on April 3, 2023 in Peats Lake, Green Bay, west of the Cat Island chain. Six nets were set as double-ended fyke nets on April 3 in Deadhorse Bay on the north side of the Cat Island chain. Peats Lake nets were lifted on April 5 and April 7, when they were removed. Four of the six Deadhorse Bay nets were checked and removed on April 6 using the Lineville boat landing. The remaining two nets (#9, 10) were collapsed and covered by an ice shove and were later removed on April 11. Water temperature ranged from 33-39F. See Figure 6 for net locations.

[7] Dembkowski, D. et al. 2020. Sampling Protocols for Estimation of Age-Based Northern Pike Population Metrics in Wisconsin. Wisconsin DNR Fish Age Task Group, unpublished.

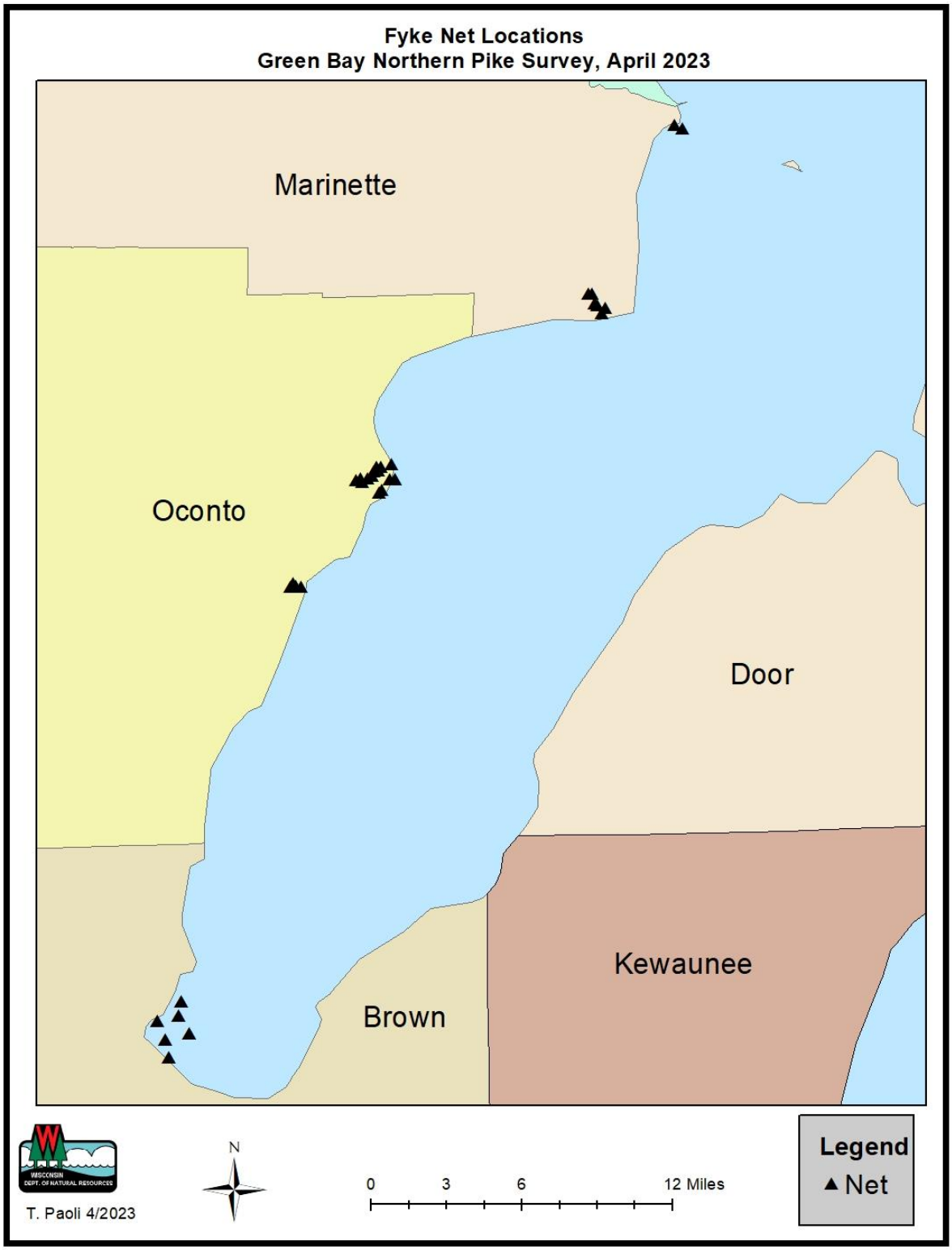

Figure 1. Map of all fyke net locations on Green Bay and tributaries.

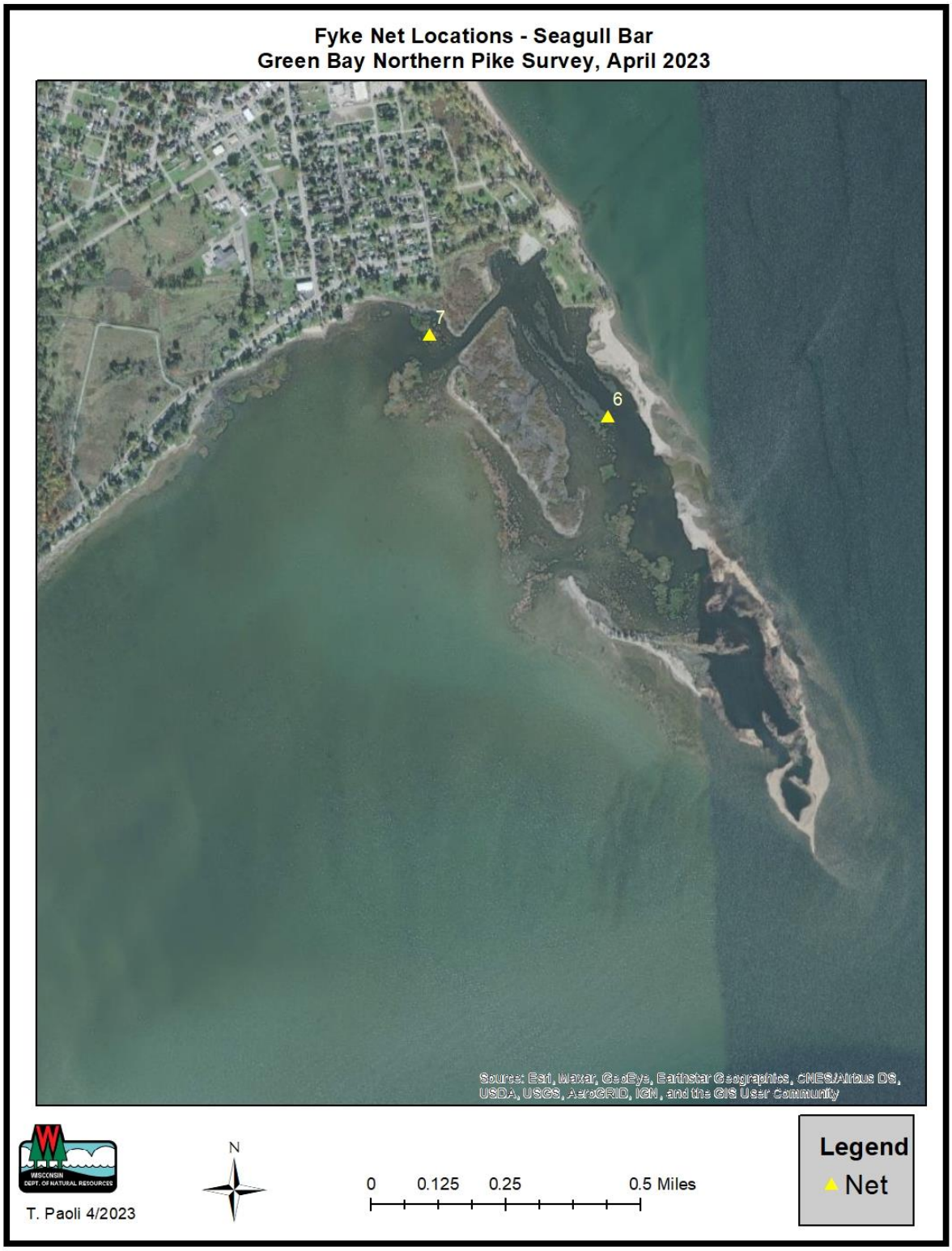

Figure 2. Map of fyke net locations near Seagull Bar.

Figure 3. Map of fyke net locations in the lower Peshtigo River.

Figure 4. Map of fyke net locations in the lower Oconto River.

Figure 5. Map of fyke net locations in the lower Pensaukee River.

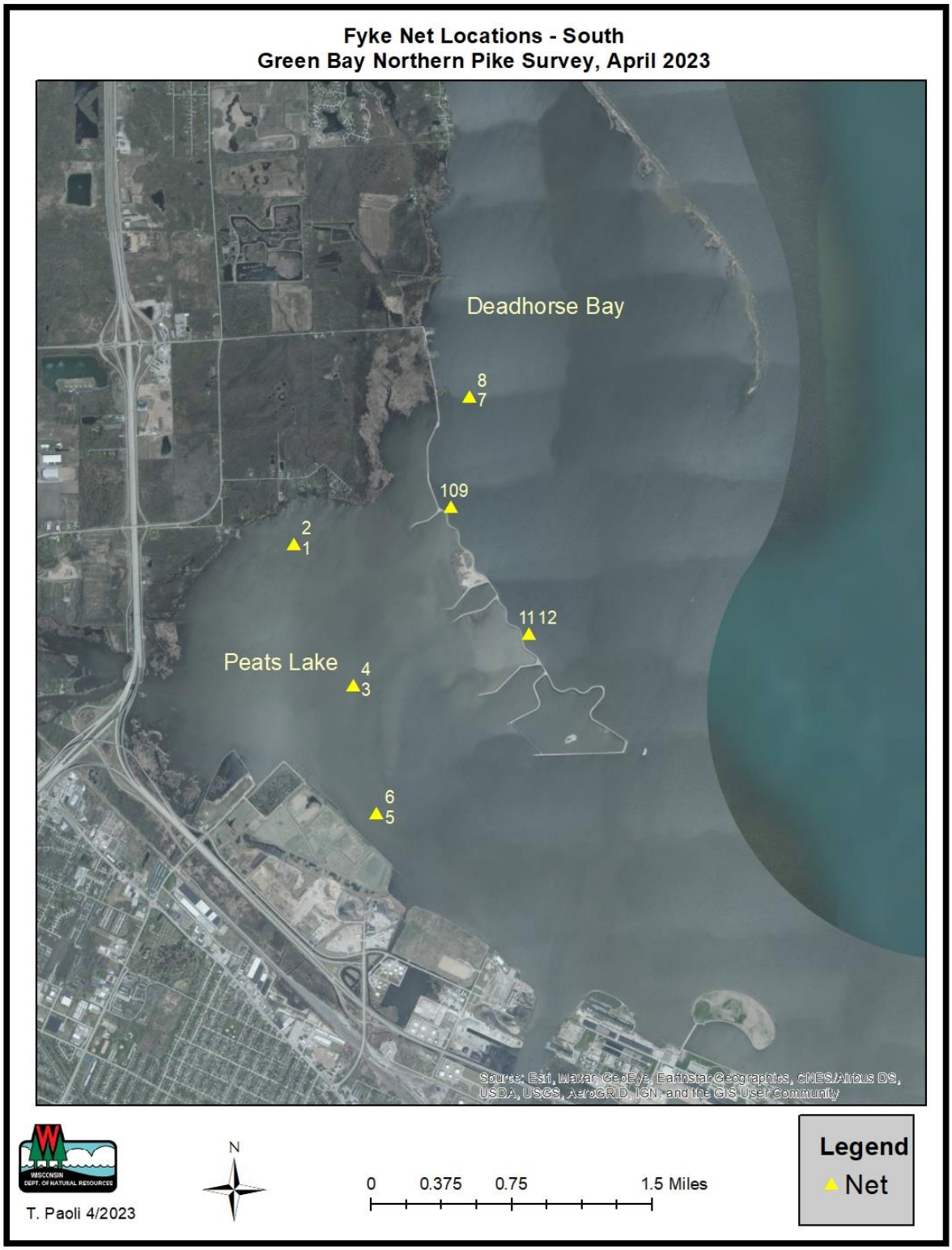

Figure 6. Map of fyke net locations in Deadhorse Bay and Peats Lake, southern Green Bay.

Results

A total of 787 northern pike were handled during the survey. This includes 388 (49%) females, 342 (44%) males, and 57 (7%) unknown sex (Table 1). Twenty-eight (3.6%) pike were recaptured fish having a top caudal clip. One recaptured 29.5 inch female from the Pensaukee River had a floy tag and was first tagged in April 2022 by Oconto County Land Conservation Department at nearby Pecor Point Lane ditch when it was 27.25 inches.

The catch per effort (CPE) of northern pike in the Marinette sites (Peshtigo River and Seagull Bar) was 9.8 and 11.2 fish per net night, respectively. For the Oconto county sites, Pensaukee River had the highest CPE at 12.3 per net night. The Oconto River CPE was 9.1 fish per net night, followed by the nets in Green Bay proper nets outside of Oconto Sportsman's Club property at 4.2 fish per net night (Table 1). CPEs greater than 3.7 fish per net night are above the 75th percentile compared to other complex-warm-dark Wisconsin lakes. The CPE of northern pike in the Brown county (Peats Lake and Deadhorse Bay) sites ranged from 0.2 to 1.0 fish per net night (Table 1) and was near the 25th percentile compared to other complex-warm-dark Wisconsin lakes. Catch per effort was measured as the number of net pots per night, so a double-ended fyke net was counted as two nets per night. Because some of the nets rolled or filled with debris but sometimes still caught fish that were included in the analysis, all nets were counted in the total effort regardless of condition.

Table 1. Number of northern pike captured by location and sex.

COUNTY	LOCATION	NET NIGHTS	NUMBER OF NORTHERN PIKE				#/NET NIGHT
			Males	Females	Unknown	Total	
Marinette	Seagull Bar	10	89	21	2	112	11.2
	Peshtigo River	29	128	133	24	285	9.8
Oconto	Oconto River	19	66	101	6	173	9.1
	Oconto, GB proper	10	24	18		42	4.2
	Pensaukee River	12	30	96	21	147	12.3
Brown	Deadhorse Bay	22	1	4		5	0.2
	Peats Lake	24	4	15	4	23	1.0
	Total		**342**	**388**	**57**	**787**	

Mean total length for all females was 28.1 inches (n=388, minimum=17.6 inches, maximum=42.5 inches). A total of 93 percent of females were at least 21 inches (PSD), 45% were at least 28 inches (RSD-preferred), and 16% were 34 inches or above (memorable) and 1.3% were 40 inches or greater (trophy) (Figure 7).

Mean total length for all males was 21.5 inches (n=342, minimum=10.5 inches, maximum=35 inches). A total of 67 percent of fish over 14 inches (stock size) were 21 inches or greater (PSD) and 6% of males were greater than 28 inches (RSD-preferred)

(Figure 8). Mean total length of unknown sex fish was 12.8 inches (n=57, minimum=8.8 inches, maximum=17.0 inches) (Figure 9).

Total instantaneous mortality rate of mature (age-3 to the age-10) fish was 40%. Each year approximately 40% of the total northern pike population is lost to some combination of natural mortality, angler harvest, hooking mortality, predation or other causes (Figure 10). This is between total instantaneous mortality rates for northern pike in Lake Mendota (32%)[8] and Lake Waubesa (48%)[9].

Mean length at age was calculated separately by sex because male and female pike grow at different rates and have different growth potential (Figure 11). Typically, females grow faster and larger than males. Female northern pike ages ranged from 2 to 10 years (Figure 7). Only one known female between 18-18.9 inches was sampled, so the sample size was too low to compare to growth rates of other female pike in that length bin using protocols in Dembkowski et al[7]. Instead, mean length at age of Green Bay pike was compared to statewide data from 2014 to 2022 (P. Frater, pers. comm.). In general, female pike from Green Bay grow up to 2 inches more per year compared to other lakes in Wisconsin (Figure 12). Male northern pike ages ranged from 1 to 10 years (Figure 8). Mean age of 18-18.9 inch male northern pike (n=7) was 2.57 years. This is between the 75-90th percentile and indicates fast growth rates compared to other populations of male pike in Wisconsin[7]. The predicted length infinity (L_{inf}) from the von Bertalanffy growth model was 39.5 inches for females and 28.6 inches for males (Figures 13 and 14).

There were not enough recaptured fish (3.6%) to reliably calculate a population estimate for Green Bay or for individual tributaries or areas.

Discussion

High flows in the rivers and wind, ice, and fog were encountered during the survey. Despite these environmental challenges during the week-long survey, a good sample of northern pike was obtained during the survey in order to evaluate length frequency, growth parameters and the population status.

Northern pike inhabiting the productive waters of Green Bay have a wide variety of forage to grow quickly. It is not uncommon for anglers to report catching fish in the upper 30 to low 40-inch size range, and this survey confirmed that size structure is very good on Green Bay. Growth rates were above average. Because the vast size of Green Bay reduces competition between top predators and because it hosts an

[8] Oele, D. 2019a. Comprehensive fishery survey of Lake Mendota, Dane County, Wisconsin 2019. Wisconsin DNR report, online.

[9] Oele, D. 2019b. Comprehensive fishery survey of Lake Waubesa, Dane County, Wisconsin, 2017-2018. Wisconsin DNR report, online.

abundance of prey fish, we do not see stunted populations of northerns as is sometimes seen in many inland lakes.

Northern pike catch and harvest on Green Bay is estimated through a creel survey from January 1 to mid-November. The recreational fishery is popular with anglers throughout the year, particularly in nearshore areas during winter and early spring months of ice cover. Over the last 5 years, catch of northern pike has ranged from 6,200 to 28,000 northern pike, while harvest has ranged from 1,900 to 5,300 northern pike (Figure 15). Despite liberal harvest regulations in Wisconsin waters of Green Bay, anglers release approximately three out of four pike caught.

The Future Of The Northern Pike Fishery

The northern pike population in Green Bay has good size structure accompanied by above average growth rates. Recruitment can be greatly influenced by environmental conditions such as water levels and spring precipitation. The presence of ten year classes of pike suggests good recruitment in recent years that is bolstering the population.

Management recommendations are:

1. Retain current fishing regulations on Green Bay and tributaries. These regulations allow for consumptive harvest as well as trophy opportunities for pike.
2. Explore ways to improve the creel survey to better estimate pike catch and harvest, both during the open water and ice creel seasons.
3. Continue to work with county, town, and other organizations such as The Nature Conservancy to identify opportunities for habitat improvements or culvert replacements on streams where pike are known to utilize for spawning and migration.
4. Continue to work with local county staff who are floy-tagging adult pike captured in fyke nets each spring. Use tagging data to monitor fish movement and exploitation based on tag returns.
5. Continue to support research on northern pike movements and use of wetlands. A ongoing study by UW-Green Bay M.S. candidate Sadie Swindall will aid in understanding habitat preferences and movements of adult pike in the main basin of Green Bay throughout the year and not just during spawning.
6. Continue to monitor the status of northern pike in Green Bay waters to track population trends such as recruitment, mortality, size structure, age structure and abundance.

Acknowledgements

Data collection for the 2023 DNR survey was completed by fisheries staff Ronald Rhode, Tammie Paoli, Brandon Rotolo, Chip Long, Cory Wienandt, Greg Matzke, Katie

Renschen, Joe Fashingbauer and David Boyarski. Fish aging and data entry into the DNR Fisheries Management Information System was done by Brandon Rotolo and Ronald Rhode.

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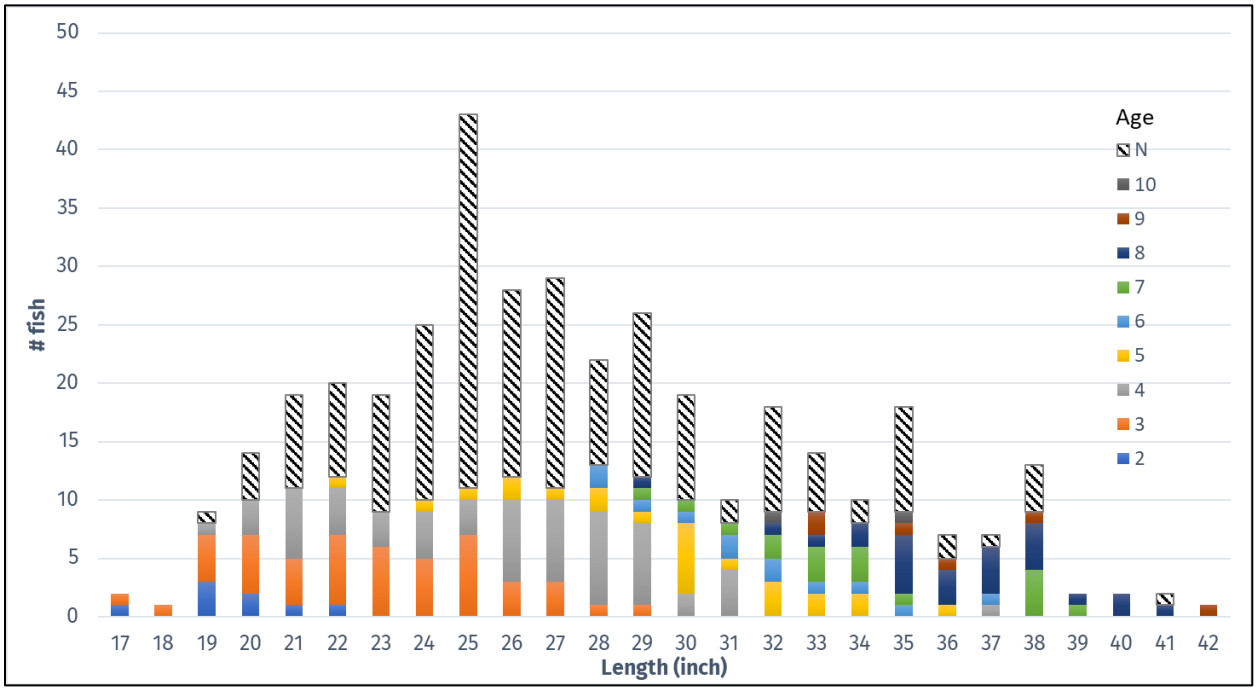


Figure 7. Length frequency by age of female northern pike sampled. Black and white bars indicate that no age data was collected.

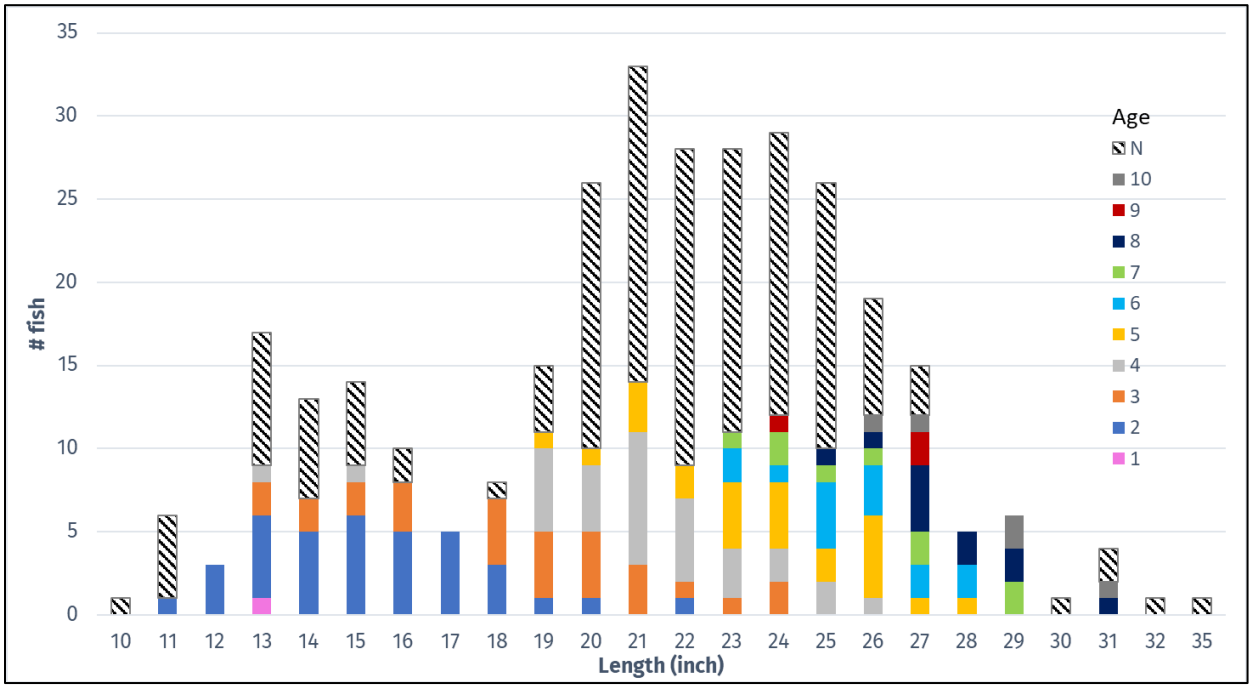


Figure 8. Length frequency by age of male northern pike sampled. Black and white bars indicate that no age data was collected.

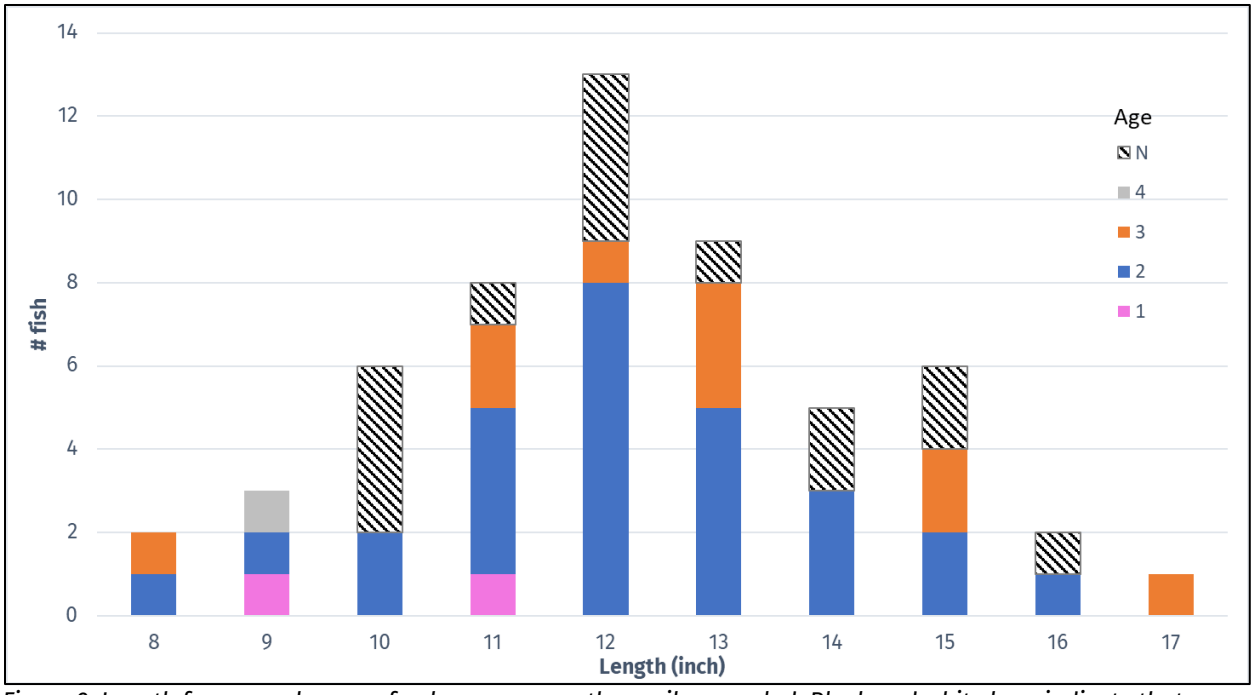


Figure 9. Length frequency by age of unknown sex northern pike sampled. Black and white bars indicate that no age data was collected.

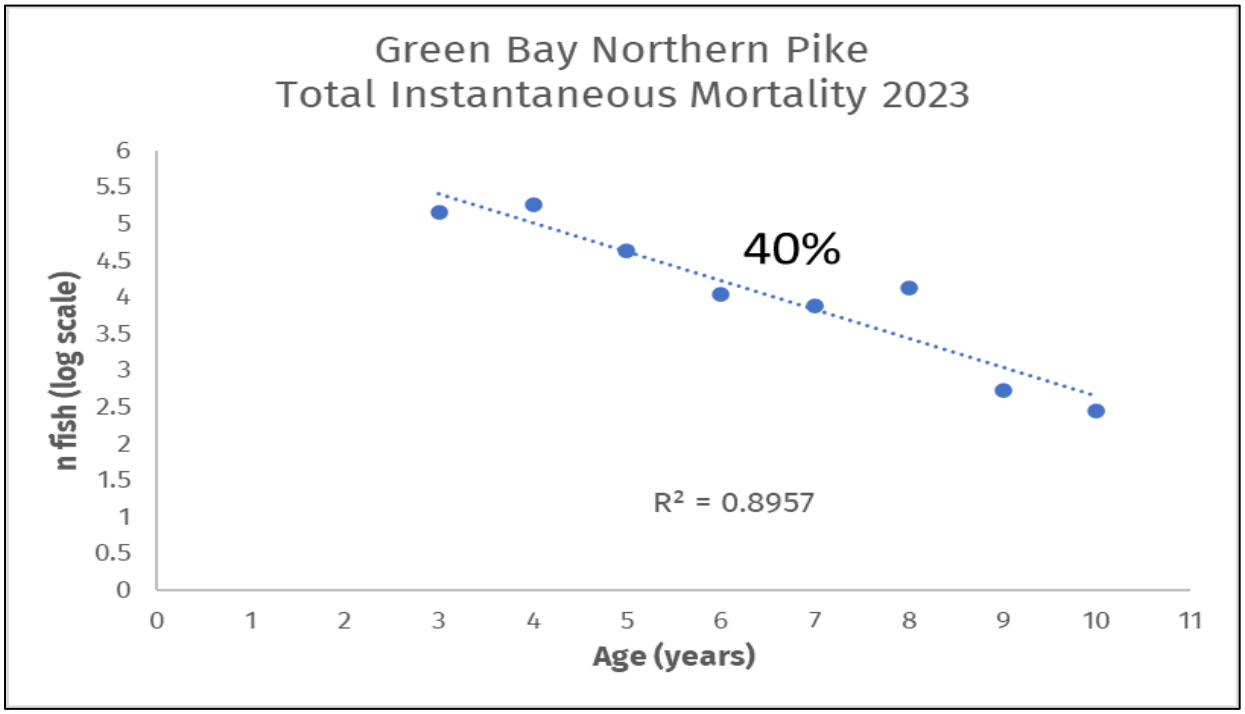


Figure 10 . Green Bay northern pike mortality estimate for 2023. The slope of the age-3 to the age-10 fish is the total instantaneous mortality rate (40%). Each year approximately 40% of the total northern pike population is lost to some combination of natural mortality, angler harvest, hooking mortality, predation or other causes.

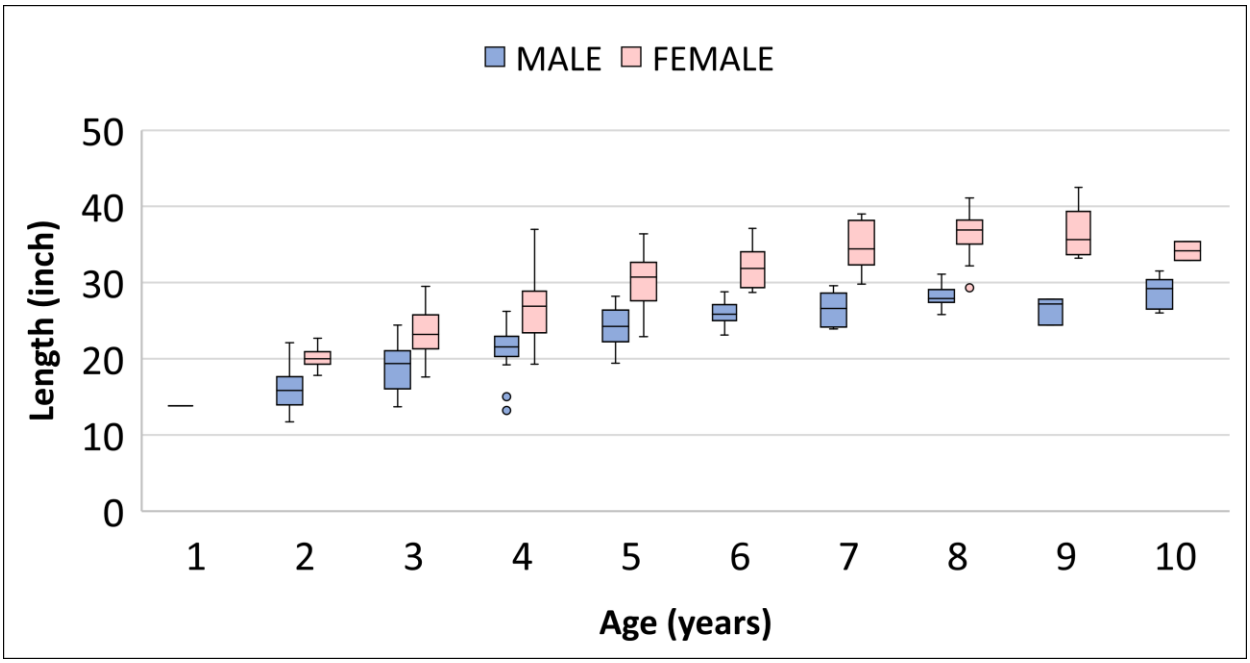


Figure 11. Box plot of TL at age (years; pelvic fin ray-based estimates) for male and female northern pike (n =363) sampled from Green Bay (Lake Michigan) in 2023. The lower and upper boundaries of the boxes indicate the 25th and 75th quantiles, respectively. Lines within the boxes indicate the medians. Whiskers indicate 1.5x the interquartile range, while dots represent outliers.

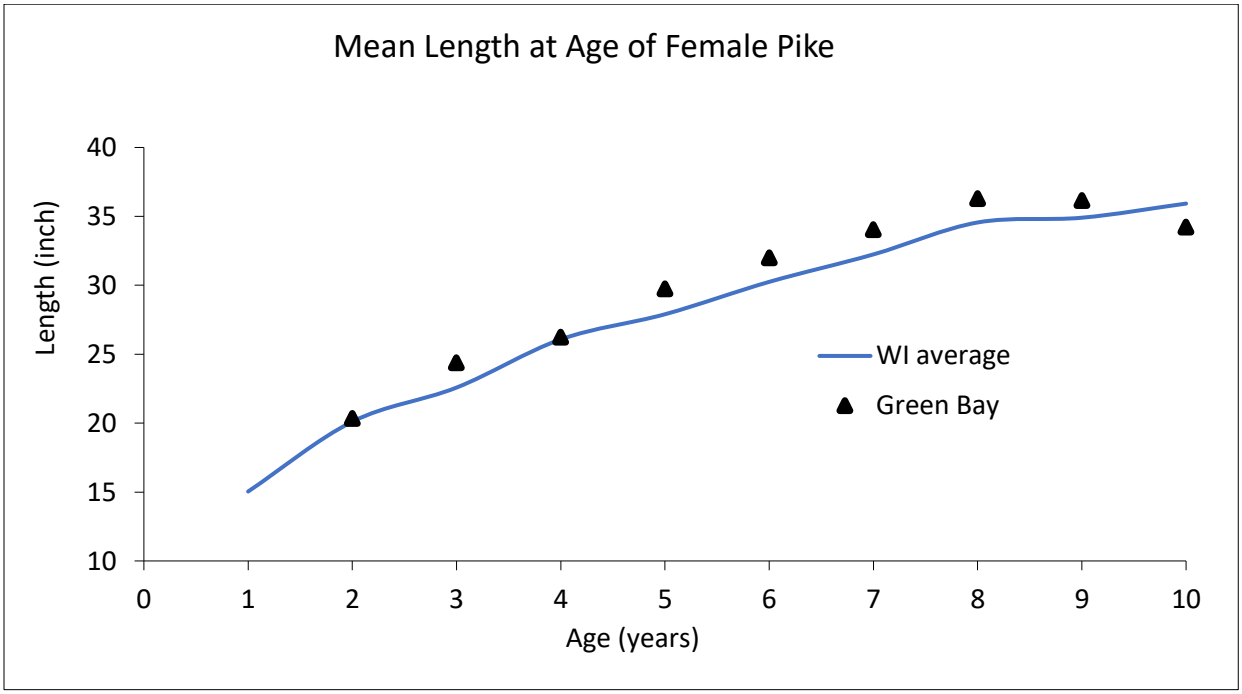


Figure 12. Mean length at age of female pike in Green Bay (2023), compared to Wisconsin average across all lake types from surveys conducted between 2014 and 2022 using ages derived from spines or fin rays and entered into the DNR Fisheries Management Information System database (P. Frater, pers. comm.).

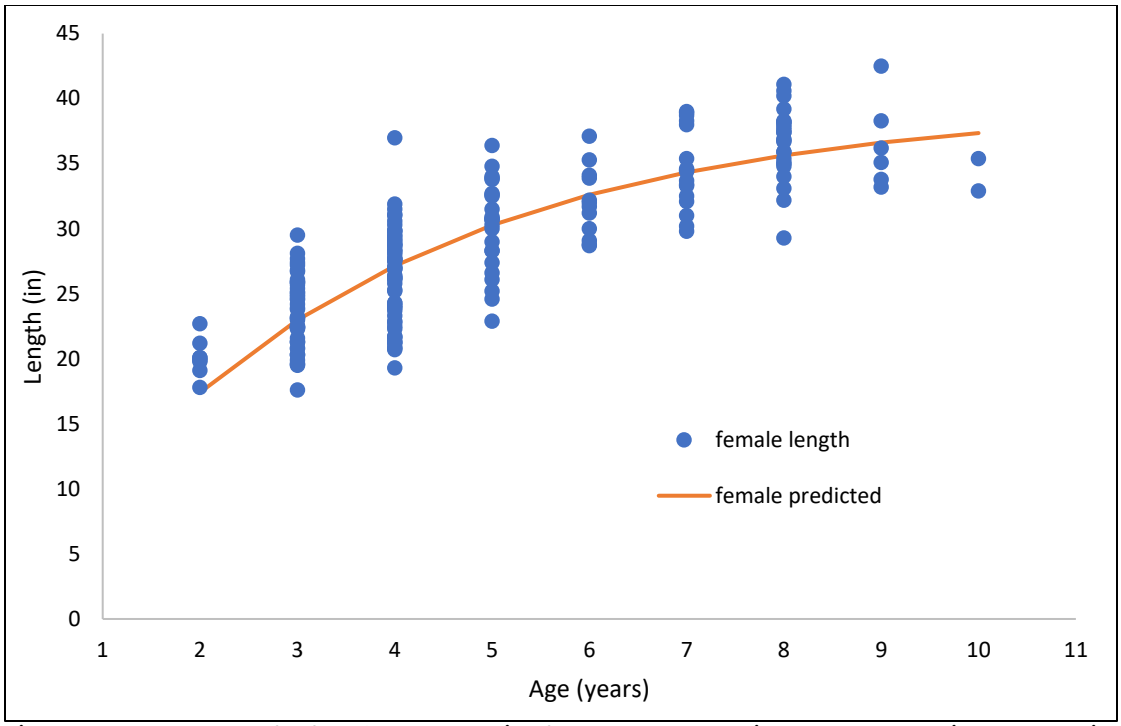


Figure 13. Length at age for female northern pike from Green Bay during 2023. The predicted theoretical maximum length from the von Bertlanaffy growth mode (orange line) was 39.5 inches with k (growth coefficient) and t_0 (time at which length equals zero) was estimated to be 0.3 and 0, respectively.

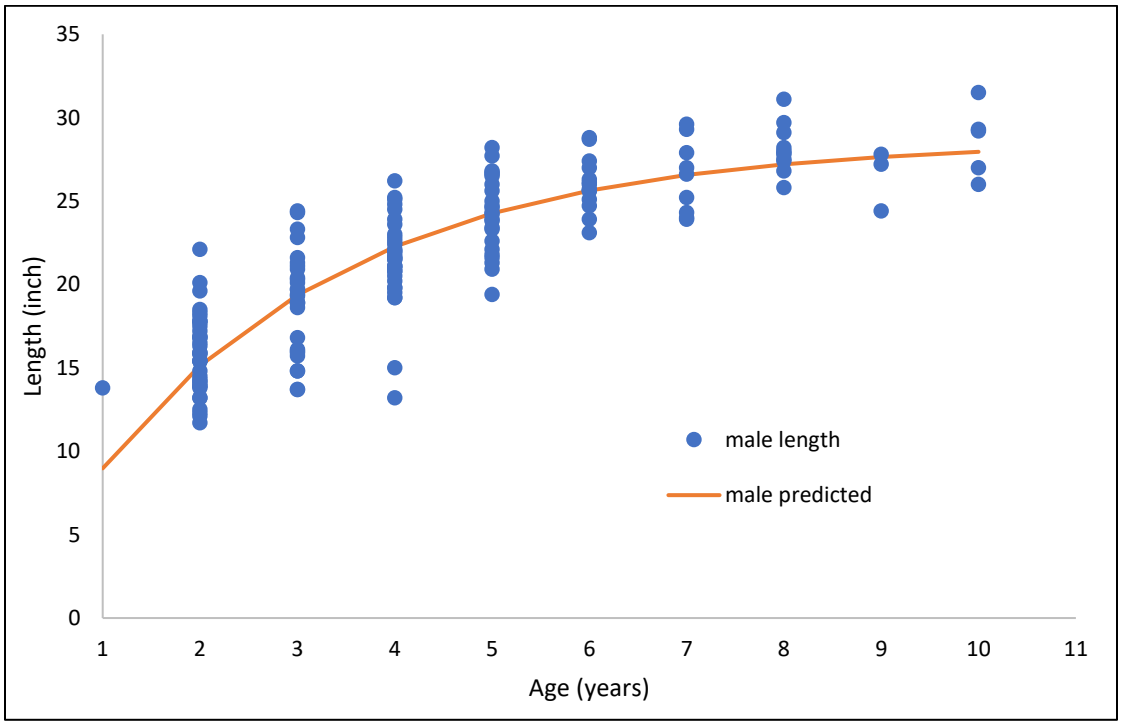


Figure 14. Length at age for male northern pike from Green Bay during 2023. The predicted theoretical maximum length from the von Bertlanaffy growth mode (orange line) was 28.6 inches with k (growth coefficient) and t_0 (time at which length equals zero) was estimated to be 0.4 and 0, respectively.

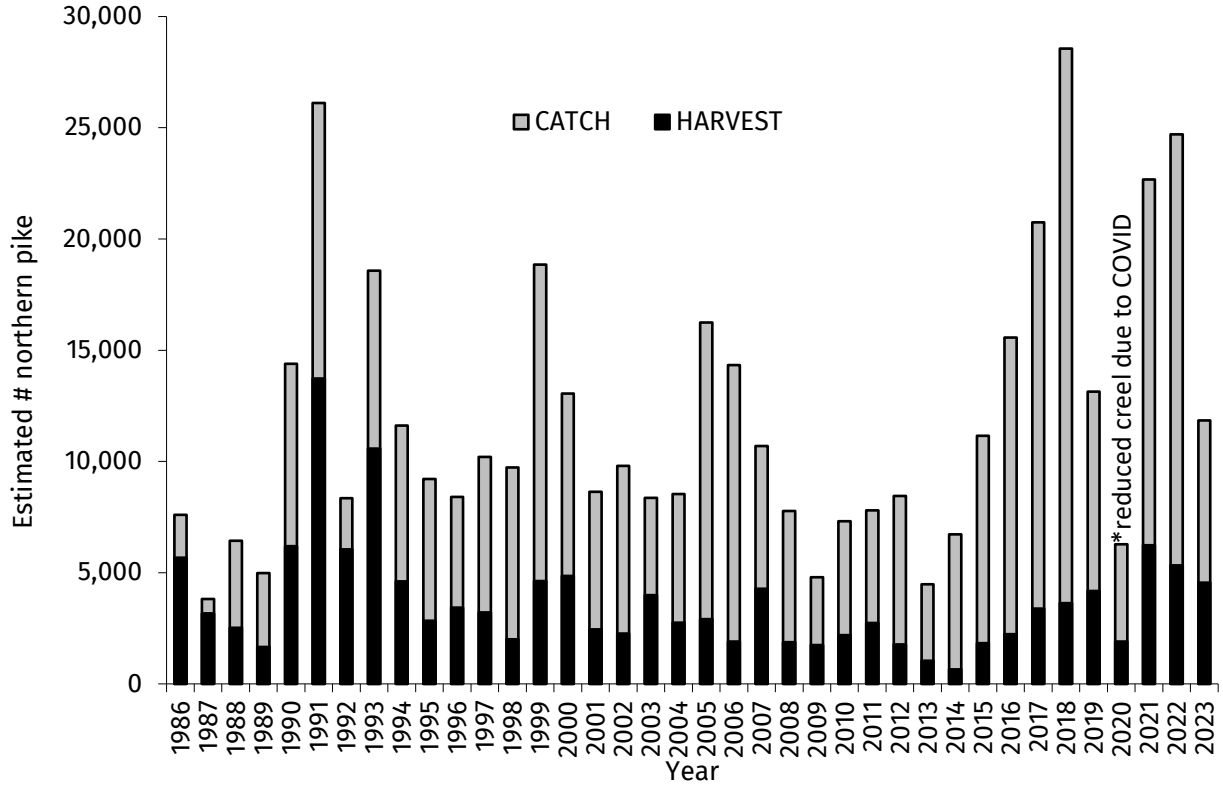


Figure 15. Estimated number of northern pike caught (gray) and harvested (black) each year as estimated from creel surveys in Wisconsin waters of Green Bay, 1986-2023.

Smallmouth Bass In Door County: 2017 And 2021 Sturgeon Bay/Little Sturgeon Bay Population Assessments And Sport Fishery

Executive Summary

Smallmouth bass populations in the Sturgeon Bay/Little Sturgeon Bay areas of Door County waters of Green Bay were evaluated during the pre-spawn period during the spring of 2017 and 2021. Overall, the size and numbers of fish were in good condition although some indices of abundance were lower than historical levels. Unlike in previous surveys, there appeared to be few strong year classes represented in the catch. Angling effort has declined somewhat in recent years, although smallmouth bass are still a primary target for many anglers in the nearshore waters of Door County. Recent angling catch rates are at modest levels relative to historical values but still near the long-term average. Another episode of smallmouth bass displaying a high prevalence of lesions was observed in 2021 and Largemouth Bass Virus was isolated in affected fish for the first time in this area. Several issues that are important considerations to manage Door County's smallmouth bass populations persist, including habitat alterations due to extensive shoreline development, increasing tournament activity (particularly during the spawning period), and the continued stressors from invasive species proliferation. Finally, two research studies commenced in 2022/2023 that will greatly help inform smallmouth bass management in this area.

Introduction

The waters surrounding Door County are well known for their flourishing smallmouth bass populations both in terms of fish size and abundance. Various discrete populations can be found in areas along the Green Bay side of Door County as well as northern areas of the county along Lake Michigan. Smallmouth bass populations have been assessed in selected areas of Door County periodically since 1995 to evaluate the population structure and dynamics of this very popular sport fish. The areas around Sturgeon Bay and Little Sturgeon Bay are assessed most consistently. Herein we report results from the 2017 and 2021 Sturgeon Bay area population assessments as well as the smallmouth bass sport creel surveys for the Door County waters of Green Bay/Lake Michigan through 2022. We also draw references to historical data to illustrate changes in the population over time and discuss additional population management concerns.

Methods

POPULATION ASSESSMENT

Fyke nets (width = 6 feet, height = 3 feet, mesh size = 1.5 inches stretch; leads = 75 feet) were set in Little Sturgeon Bay and Sawyer Harbor (part of Sturgeon Bay) (Figure 1) beginning April 25, 2017 and most were removed after May 18. Several nets were later fished in Little Sturgeon Bay and another area of Sturgeon Bay known as the "Flats" from May 31-June 2, 2017. Between three to five nets were fished on a given date, and effort was made to place them in locations similar to past surveys while also keeping them in areas with consistent smallmouth bass activity. (Nets were removed from the water most weekends and when conditions were not conducive to netting.) In 2021, nets were set in Little Sturgeon Bay and Sawyer Harbor beginning May 4 and were removed after May 27. Several nets were later fished in the "Flats" area of Sturgeon Bay, primarily between May 22-27, 2021. Smallmouth bass total length was measured to the nearest millimeter. In 2017, scales were used for aging and were sampled from the left side of the fish, near the tip of the relaxed pectoral fin just below the lateral line. In 2021, the second dorsal spine was sectioned and used for aging. Age structures were taken from 15 fish per 10 mm length increment, and an age-length key was developed to examine the overall population age composition. Fish health was evaluated by examining for any external lesions or other abnormalities. Specifically, any lesions were counted, and the level of severity was generally described. All other gamefish were identified, counted, measured and a fin was clipped to record fish that were captured multiple times. Non-gamefish were identified and counted, although not clipped, so recording non-game fish multiple times was possible. Estimates were sometimes made for non-gamefish on days the catch was extreme. Although the Sturgeon Bay Flats area was sampled during these surveys, the specific catch data are not described herein due to the restricted timing of the sampling (later in the spawning period) and the transition to more sub-adult fish as adult fish become more sedentary (males) and others leave the area after spawning (females). Data from Little Sturgeon and Sawyer Harbor from approximately the first three weeks in May are reported herein for key metrics such as catch-per-effort (CPE), size and age structure. Data from this period comprises the majority of the sampling effort and generally encompasses the pre-spawn period, a time when smallmouth bass are

Figure 1. Door County peninsula and surrounding areas of Green Bay and Lake Michigan. Red box indicates Sturgeon Bay/Little Sturgeon Bay area.

active and fish are generally mixed in terms of size and sex (Becker 1983). Restricting data to this time period also helps ensure some consistency when making interannual comparisons.

CREEL SURVEY

The sport fishery for smallmouth bass has been assessed annually in the outlying Door County waters since the 1970s using a randomized angler creel survey. The creel season begins with the May opener and typically runs through mid-October. Survey sites include most of the popular access points along the Door County shoreline. Standard creel survey interview data include information collected regarding effort, catch, harvest, biological data (length, weight, marks/tags) and angler demographics (Masterson and Eggold 2013).

Population Survey Results

CATCH

2017
Nets were fished for a total of 48 net nights (number of nets x number of nights fished) in Sawyer Harbor and 70 net nights in Little Sturgeon Bay. A total of 1,492 smallmouth bass were caught during this survey: 389 in Little Sturgeon Bay, 951 in Sawyer Harbor and 152 from the Sturgeon Bay Flats.

Approximately 937 fish of other species were captured in Little Sturgeon Bay, including white sucker (n=28), northern pike (n=16), bullhead spp. (n=268), rock bass (n=283), yellow perch (n=200), bowfin (n=29), common carp (n=5), alewife (n=3), pumpkinseed (n=41), gar spp. (n=5), muskellunge (n=2), common shiner (n=1), carpsucker spp. (n=19), redhorse spp. (n=2), bluegill (n=2), largemouth bass (n=2), black crappie (n=1), walleye (n=29) and freshwater drum (n=1). There were 3,561 fish of other species captured in Sawyer Harbor, including white sucker (n=8), rock bass (n=1,081), northern pike (n=57), bullhead spp. (n=1,764), common carp (n=1), bowfin (n=101), gar spp. (n=5), redhorse spp. (n=1), pumpkinseed (n=106), bluegill (n=16), largemouth bass (n=2), black crappie (n=1), yellow perch (n=340) and walleye (n=78).

2021
Nets were fished for a total of 35 net nights (number of nets x number of nights fished) in Sawyer Harbor and 49 net nights in Little Sturgeon Bay. A total of 1,210 smallmouth bass were caught during this survey: 545 in Little Sturgeon Bay, 340 in Sawyer Harbor and 325 from the Sturgeon Bay Flats.

Approximately 2,688 fish of other species were captured in Little Sturgeon Bay, including white sucker (n=10), northern pike (n=17), bullhead spp. (n=607), rock bass (n=1,746), yellow perch (n=103), bowfin (n=85), common carp (n=8), alewife (n=5), pumpkinseed (n=13), longnose gar (n=5), shortnose gar (n=2), common shiner (n=1), golden shiner (n=2), redhorse spp. (n=1), bluegill (n=1), walleye (n=23), white perch

(n=51) and round goby (n=8). There were 7,470 fish of other species captured in Sawyer Harbor, including white sucker (n=1), rock bass (n=1,811), northern pike (n=12), bullhead spp. (n=4,708), common carp (n=2), bowfin (n=191), pumpkinseed (n=572), bluegill (n=48), largemouth bass (n=2), white perch (n=2), yellow perch (n=120) and walleye (n=1).

CATCH PER UNIT OF EFFORT

The number of smallmouth bass caught per net per night of fishing (total nets/nights fished) can be used as a general index of relative abundance. To make reasonable comparisons of this catch per unit of effort (CPE) between years, it's important that the timing and locations of sampling are as consistent as possible. However, given changing water levels and large temperature swings, maintaining interannual consistency between net sites can be challenging, and fish may change the areas they inhabit based on conditions. Nets are occasionally moved (within an embayment) to stay in areas where fish are most active and susceptible to capture. Net locations in Little Sturgeon Bay and Sawyer Harbor have been placed in relatively consistent locations over time and are generally fished during the first three weeks in May during the pre-spawn period, allowing for reasonable comparisons of catches between survey periods.

In 2017, catch rates were 5.2 fish caught per net night in Little Sturgeon and 20.4 fish caught per net night in Sawyer Harbor (a mean of 11.5 smallmouth bass caught per net night between the two locations) (Figure 2a-b). In 2021, catch rates were 11.1 fish caught per net night in Little Sturgeon and 9.7 fish caught per net night in Sawyer Harbor (a mean of 10.5 smallmouth bass caught per net night between the two locations). Since 2009, the CPE for Little Sturgeon alone has decreased considerably, although there was a small increase in 2021. However, the CPE in Sawyer Harbor had shown an increasing trend until a substantial drop in 2021. Between the 2009 and 2015 surveys, the combined CPE for these locations decreased by about 50% and then remained relatively consistent (Figure 2b).

2a. **2b.**

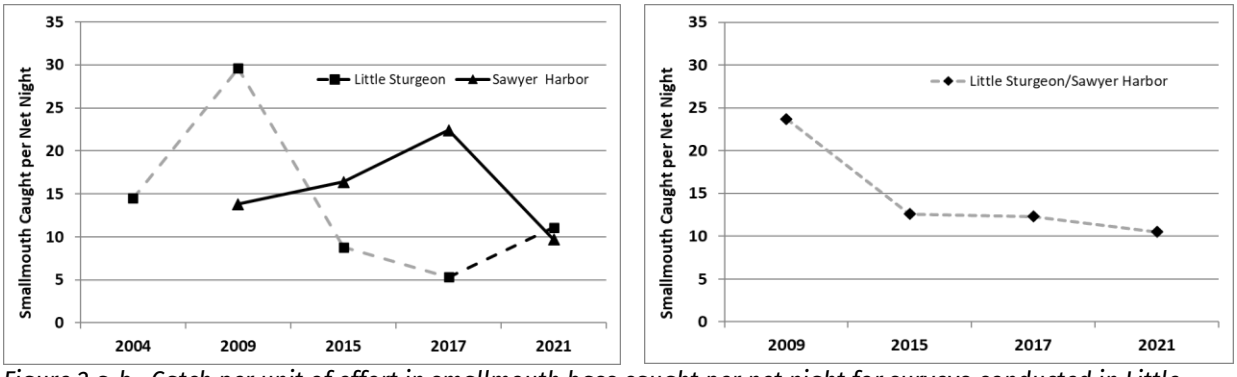


Figure 2 a-b. Catch per unit of effort in smallmouth bass caught per net night for surveys conducted in Little Sturgeon Bay and Sawyer Harbor independently (2a) and for the locations combined (2b). Although the surveys may have started earlier or run later, for consistency, only data from the first three weeks in May are presented here, except for 2004 and 2021 where nets were fished until May 27 (three additional days).

AGE COMPOSITION

The estimated ages of smallmouth bass sampled in Little Sturgeon and Sawyer Harbor were between three and 16 years in 2017 and between two and 17 years in 2021. Ages five and six made up the strongest year classes in 2017, suggesting stronger recruitment in 2011 and 2012 (Figure 3a). There were apparently no strong year classes (relative to 2017) represented in the 2021 survey (Figure 3b).

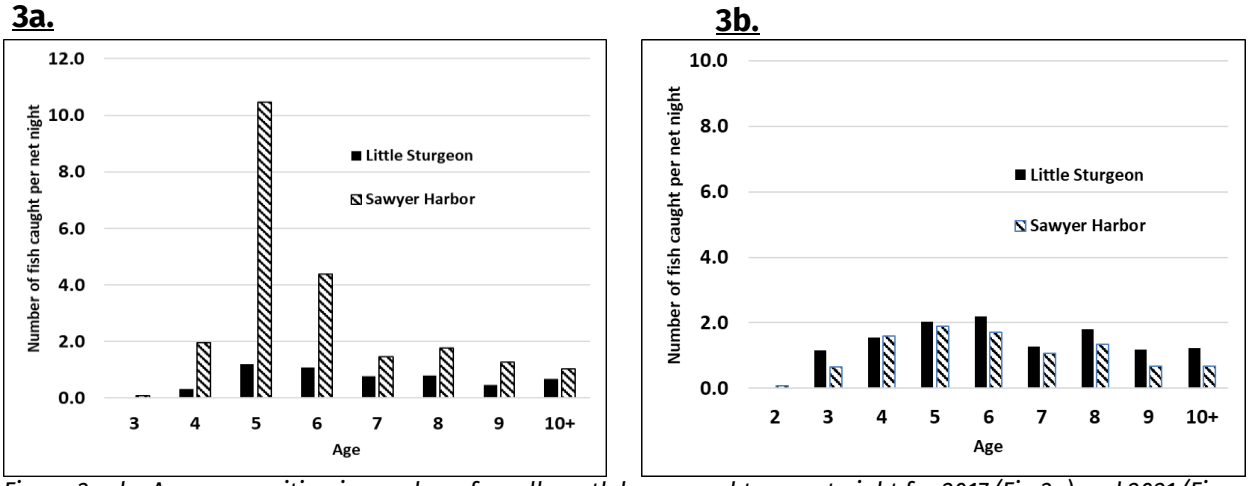


Figure 3 a-b. Age composition in number of smallmouth bass caught per net night for 2017 (Fig 3a) and 2021 (Fig 3b) spawning surveys in Little Sturgeon Bay and Sawyer Harbor. Age-10 and older fish are pooled due to smaller sample sizes and decreasing accuracy of age estimates for older fish. (Maceina and Sammons 2006).

SIZE STRUCTURE

The combined length compositions of smallmouth bass from the Little Sturgeon and Sturgeon Bay (Sawyer Harbor) areas during 2017 indicate the population size composition was generally skewed to smaller fish, while in 2021, there was a substantial shift to larger fish in the overall population (Figure 4). This is consistent with the higher catches of younger fish in Sawyer Harbor in 2017 (i.e., younger and smaller), while conversely, catch rates for younger fish in Little Sturgeon were quite low in 2017. This would indicate that the overall size composition of fish in the 2017 survey is driven by the larger recruitment events (large numbers of younger fish) recorded in the Sawyer Harbor catch data (Figure 3a-b). Meanwhile, the shift in 2021 to larger fish in the general population suggests there was not any substantial recruitment in either location in recent years, as indicated in lower catches of younger fish (e.g., ages 3-5) in either location. Fish length ranged from 9 to 22 inches for both years, and the largest fish measured 22.2 inches. The proportion of fish 18 inches or greater doubled between 2017 and 2021, increasing from 17% to 34%. The average length of smallmouth bass sampled in the spawning surveys has remained relatively similar across the last five survey years, although there was a relatively larger increase between the last two surveys (16.1 inches in 2004, 16.5 inches in 2009, 16.3 inches in 2015, 15.7 inches in 2017 and 16.9 inches in 2021).

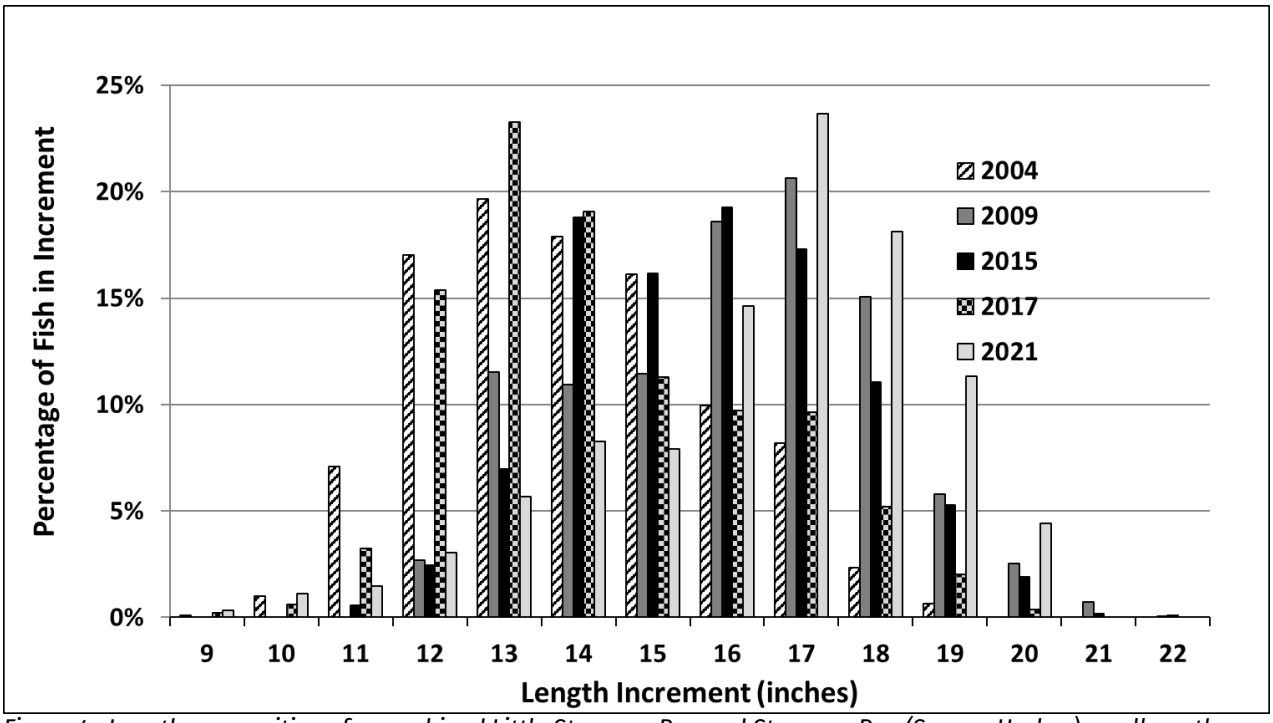


Figure 4. Length compositions for combined Little Sturgeon Bay and Sturgeon Bay (Sawyer Harbor) smallmouth bass surveys between 2004 and 2021. Length bins are delineated by any fish that fell within a particular inch group (e.g., a fish in the 16-inch bin could have been between 16 and 16.99 inches long).

Mean length at age has increased considerably since the mid-1990s (Figure 5). While the mean lengths at age for the 2009 and 2015 surveys were close, length data from the 2021 population surveys showed a considerable increase in sizes. This was especially true for the younger age classes where the mean size at age increased as much as one to two inches. During the 1990s and early 2000s, on average, a fish did not reach the 14-inch legal size limit until around six or seven years of age. However, on average, fish now reach the legal limit by at least four years of age, with some even reaching 14 inches by age-3 (data not shown).

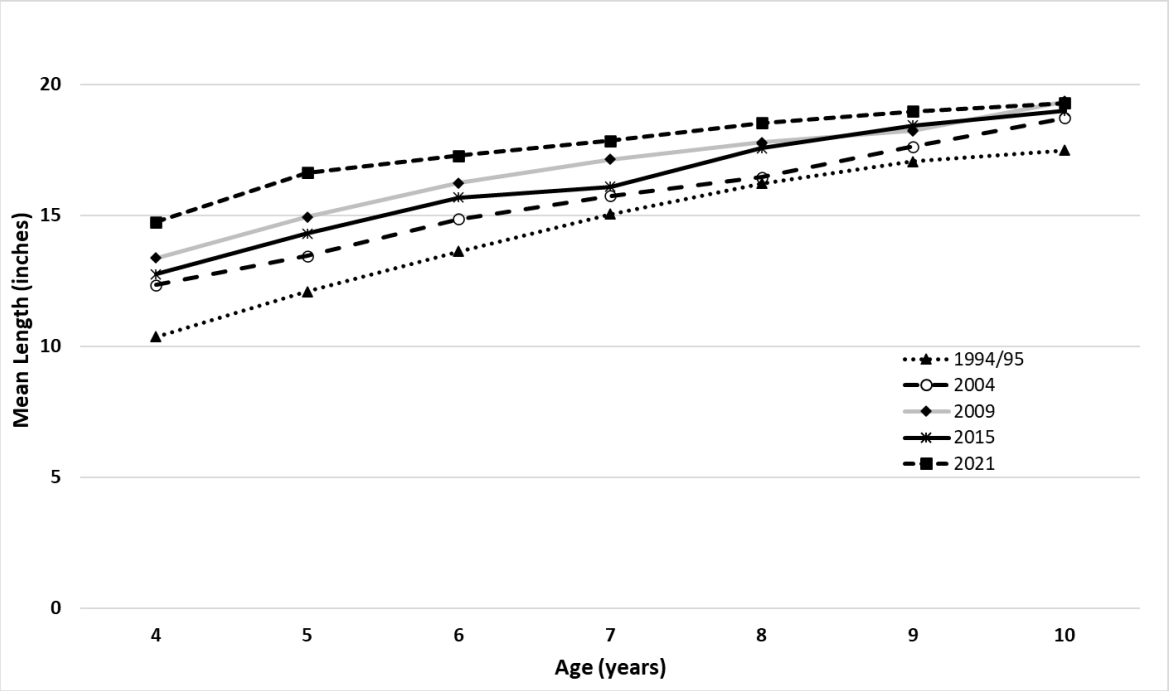


Figure 5. Mean length (inches) at age of smallmouth bass sampled during the 1994/1995, 2004, 2009, 2015 and 2021 spring spawning periods in Little Sturgeon Bay and Sturgeon Bay/Sawyer Harbor. Age-10 and older fish are pooled due to smaller sample sizes and decreasing accuracy of age estimates for older fish.

Fish Health

Smallmouth bass were examined for lesions and other external health issues. And while evidence of disease-related issues was noted in some fish during the 2017 and 2021 survey periods, the incidence was not considered particularly high. However, beginning in 2008, there have been three episodes of apparently high levels of external lesions affecting smallmouth bass based on reports both from anglers and in field survey observations. These specific lesions have typically been observed on the upper portion of the fish, are often circular in shape and can severely erode the skin and muscle tissue (Figure 6 a-b). Wounds often resemble scars left by lamprey attacks. Aside from 2008, additional episodes of a relatively higher prevalence of fish with lesions occurred in 2015 and 2021 (late summer), with fewer affected fish observed for years in between. While it is not possible to compare rates of affected fish between spring field surveys and angler catch reports, it does appear that the prevalence (and possibly severity) of affected fish increased later in the season as waters the warmed. While tests from the first two episodes (2008, 2015) had been inconclusive, in September 2021, 14 diseased fish tested positive for largemouth bass virus (LMBv) (Smallmouth Bass in Door County Waters Test Positive for Largemouth Bass Virus). Aside from the extreme severity of some of the lesions, the affected fish appeared to be in physically good condition. No large-scale fish kills involving smallmouth bass were reported during these outbreaks.

6a.

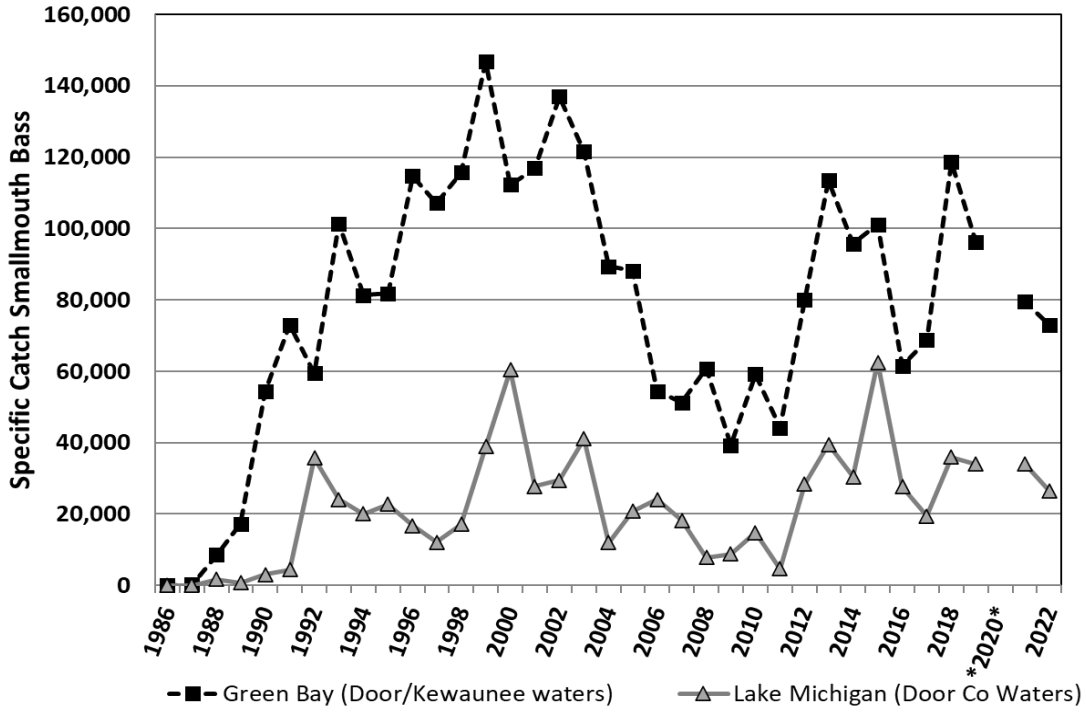
6b.

Figure 6 a-b. Lesions observed in smallmouth bass in 2009 (left image) and 2015 (right image).

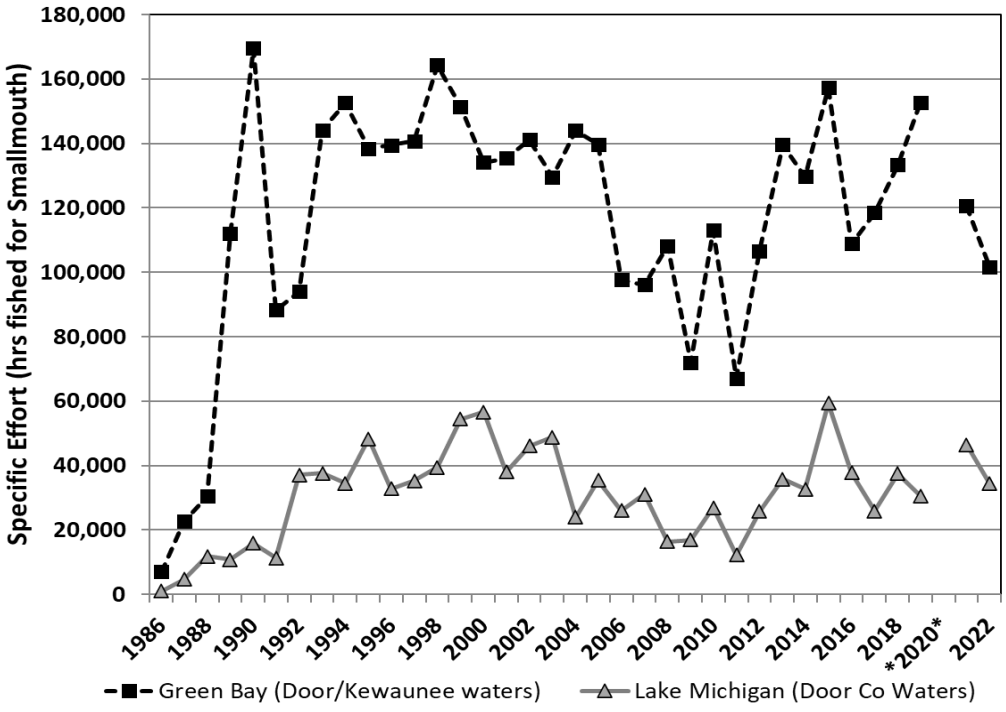
Creel Survey

Angler fishing effort and catch for smallmouth bass in Door County waters increased rapidly beginning the late 1980s and through the 1990s, dropped somewhat through the mid-2000s, and increased again around 2012, though the values have been highly variable since then (Figure 7 a-c). Targeted catch rates (the number of smallmouth bass caught by anglers specifically targeting them) were 0.8-1.0 fish per hour in the late 1990s-2003. Catch rates declined to 0.5-0.6 fish caught per hour of fishing from 2004-2010 but have since generally increased (with some variation), peaking at nearly 0.9 fish per hour in Green Bay in 2018 and at greater than one fish per hour for several years in Lake Michigan. Catch rates over the past two years have declined from recent peaks in Green Bay and Lake Michigan. However, Green Bay catch rates for the past two years are still greater than the previous 15-year (2005-2019) mean of 0.64 fish per hour. Since 2011, the hours of fishing effort for smallmouth bass have generally climbed back to the high levels experienced in the late 1990s (140,000-160,000 hours in Green Bay and 40,000-60,000 in Lake Michigan). The 2015 angler effort for smallmouth bass on Green Bay was the third-highest, on record while during that same year, the effort on Lake Michigan was the highest on record. Effort has generally declined each year since then.

7a.


Specific Catch Smallmouth Bass
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Green Bay (Door/Kewaunee waters)
Lake Michigan (Door Co Waters)

7b.


Specific Effort (hrs fished for Smallmouth)
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Green Bay (Door/Kewaunee waters)
Lake Michigan (Door Co Waters)

7c.

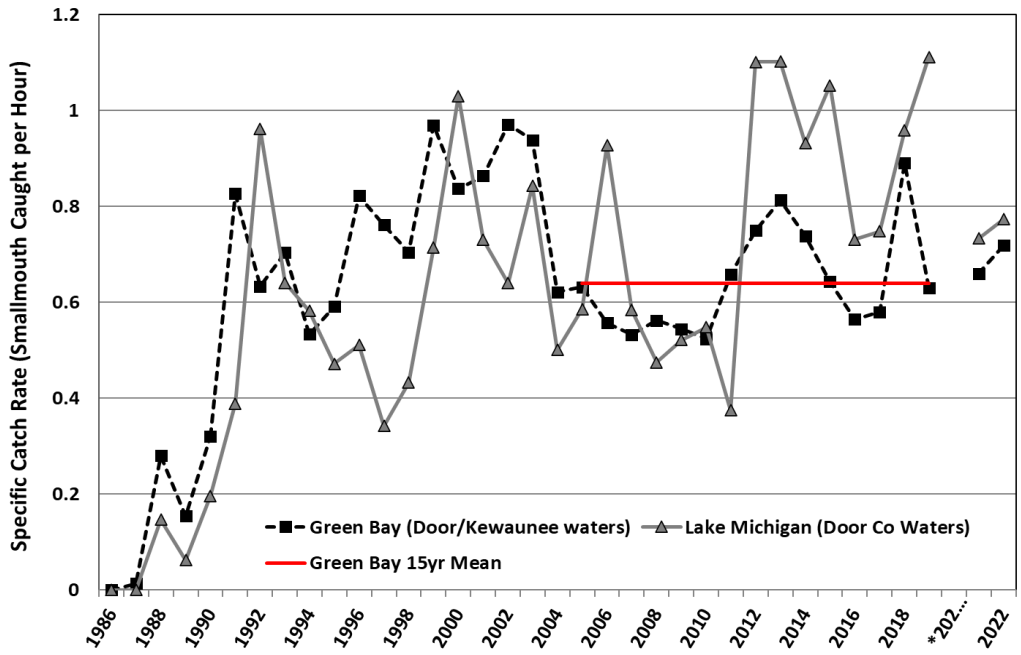


Figure 7 a-c. Creel survey results for Door County waters of Green Bay and Lake Michigan, 1986-2022. Catch, effort and catch rates are specific to anglers targeting smallmouth bass. 2020 data not shown due to incomplete creel survey year.

During the middle to late 1980s, harvest of smallmouth bass in Door County's outlying waters was relatively low, likely due to lower population abundance. However, smallmouth bass harvest increased dramatically in the early 1990s. This occurred despite the implementation of a 12-inch size limit in 1989 (there was no size limit prior), with harvest more than doubling between 1990 and 1991 in Green Bay waters of Door County (Figure 8). The mean annual harvest from 1991 to 1997 in Green Bay waters was 34,649 ±6,314 (1 standard deviation (SD)), more than five times the average annual harvest (5,793) between 1986 and 1990. Implementation of a 14-inch size limit in 1998 likely reduced harvest dramatically and from 1998-2004 averaged 14,566 ±3,690 (1 (SD) fish annually. By 2005, a trend of lower harvest began and has remained relatively low ever since, which is likely a reflection of the strong catch and release philosophy among bass anglers. Between 2005 and 2022, the harvest in Green Bay waters averaged 6,580 ±1,832 (1 SD) fish annually. The percentage of fish kept in Green Bay waters of Door County declined in the late 1990s and has remained relatively low ever since, with generally less than 10% of fish caught being harvested annually over the last 10 years. Harvest in Lake Michigan waters of Door County generally follows the same patterns as Green Bay although the large reduction in harvest after the 1998 size limit change has perpetuated through recent years. Harvest in Lake Michigan is generally substantially lower than that in Green Bay. Limited boat access and smaller, more concentrated smallmouth bass populations characterize the fishery on the Lake Michigan side of Door County.

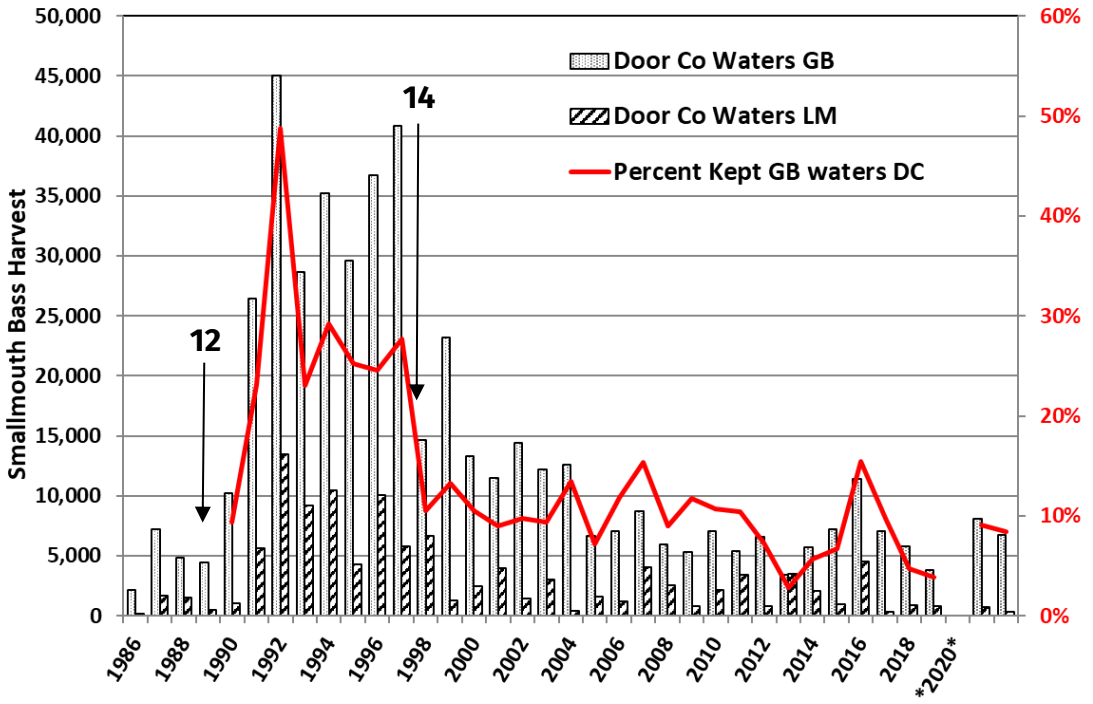


Figure 8. Smallmouth bass harvest history in the Door County waters of Green Bay and Lake Michigan, 1986-2022. Arrows indicate size limit changes in 1989 and 1998. 2020 data not shown due to incomplete creel survey year.

Summary

Abundance and size data suggest the smallmouth bass population in the Sturgeon Bay/Little Sturgeon Bay area was in good condition during the 2017 and 2021 survey years. While angler catch rates are somewhat variable in recent years, they remain at modest levels and are slightly above average for the time series. Although fishing effort for smallmouth bass has declined over the last two years, it still accounts for around 60% of the total fishing effort in Green Bay waters of Door County, with some years as high as 80% of the total effort.

Total catch per effort from fyke nets has varied at the Little Sturgeon Bay and Sturgeon Bay area locations over the last four surveys and the trends are surprisingly not consistent between the two despite their proximity. When compared to very strong smallmouth bass production in the 1990s and 2000s, there appeared to be few strong year classes measured in both locations in recent surveys. The most recent stronger year classes appear to have been produced in 2011 and 2012, as measured in the 2017 survey of age-5 and age-6 CPEs from Sawyer Harbor. Growth continues to be very good, and even improve, with more fish reaching the legal-size limit at an earlier age than ever before. Size composition varies with year class strength (large year classes can negatively affect growth). Consequently, with apparent poor recruitment in recent years, along with a potential density-dependent effect (i.e., fewer but bigger

fish due to reduced competition for resources), these factors may have contributed to a larger size structure in 2021.

Assessing Door County's smallmouth bass populations and sport fishery will continue to be an important and ongoing component of successful management of this resource. DNR annually conducts smallmouth bass netting surveys on a rotation around Door County and has focused mainly on Little Sturgeon Bay, Sawyer Harbor/Sturgeon Bay, Rowley Bay, and Washington Island (Kroeff 1995, 1996, 1997; Kroeff and Toneys 2004; Hansen and Kroeff 2014; Hansen and Kurszweski 2017). The continued monitoring of the numerous populations that make up the overall Door County smallmouth bass metapopulation will be very important in informing management decisions. However, gathering more specific population information requires targeted studies that are not possible without specifically funded projects. While the primary intent of this report is to summarize recently completed surveys, we conclude by addressing several locally important management considerations below including recruitment and movement studies, fishing tournaments, extreme water level fluctuations, shoreline development, and invasive species.

MANAGEMENT CONSIDERATIONS

Lower relative angling catch rates for smallmouth bass over the past 5-10 years have raised concerns among some anglers, and indeed, catch rates are down relative to historical highs but are still around the previous 15-year average. A clear explanation for this in a complex system such as Green Bay can be very challenging. Recruitment success, or failure, is impacted by numerous variables, including water temperatures, wind events, habitat quality, predation, invasive species, angling pressure, etc. The focus on adults during our spring surveys limits our ability to thoroughly evaluate the strength of young fish in the population before they become reproductively mature and enter the sport fishery. This limits our ability to forecast the future of the sport fishery and makes it difficult to ascertain where recruitment bottlenecks may lie. While we have conducted a limited number of recruitment and nest success assessments using different gear types (seining, mini-fyke nets, snorkeling), the extent of these surveys has been relatively limited given the scale of the smallmouth bass habitat and spawning areas in the waters surrounding Door County. Furthermore, these evaluations are often characterized by generally low catch rates, further adding to the uncertainty of the results. To address some of these concerns, beginning in 2022, research staff from UW-Stevens Point began a two-year study to measure young-of-year recruitment from various Door County smallmouth bass populations using different sampling approaches to determine the most effective and efficient method for evaluating early life stages of smallmouth bass. This study was also designed to measure smallmouth nesting success/failure in these same populations and determine the mechanisms that may contribute to nesting failures, including nest predation (e.g., round gobies), angler-targeted bed fishing and climatological impacts. Information collected from these studies will help inform

smallmouth bass management and target potential future regulatory changes to further protect and enhance the smallmouth bass populations around Door County.

Door County is a prominent destination for bass fishing, so much so that in 2014, Bassmaster ranked Door County waters of Green Bay as the top location in the entire United States to fish for smallmouth bass. Following 2014, the number of permitted bass fishing tournaments in Door County rose sharply. Between 2007 and 2014, there was an average of 5.75 permitted tournaments annually, while between 2015 and 2022, there was an average of 12.5 permitted tournaments annually, many of them focused on the pre-spawn and spawning periods. In 2022, there were 18 permitted bass tournaments in Green Bay waters of Door County, the highest number to date. Tournaments targeting smallmouth bass, particularly during the pre-spawn and spawning periods, continue to be a contentious issue in Door County, with mixed opinions among stakeholders.

The previously mentioned recruitment study by UW-Stevens Point should help to address some of the questions and concerns related to tournament angling. An additional study using acoustic telemetry and genetics is investigating smallmouth bass dispersal/site fidelity and implications of large-scale displacement during angling tournaments, as smallmouth bass in Door County waters typically have a relatively small home range (Wiegert 1966; Kroeff 1993, Hansen and Kroeff 2014). This project is in the early stages and is also being conducted by researchers at UW-Stevens Point. These studies will provide very important information to assist us in the management of smallmouth bass.

While it is suspected that LMBv was involved in the development of the skin lesions on the 14 smallmouth bass tested in 2021, little is definitively known about its ability to cause disease or death in the species. LMBv has been found throughout the Eastern United States and was previously identified in Wisconsin's Mississippi River Basin (Grizzle and Brunner 2011). The virus can cause weakness, skin lesions, abnormal swimming, swim bladder over-inflation and death in largemouth bass (Zilberg et al. 2000, Boonthai et al, 2018). While the appearance of LMBv in Door County smallmouth populations has been disconcerting, there is no evidence it has had any population-level effect. Affected fish seem to be in good condition, and healed lesions have been observed. DNR staff will continue to monitor smallmouth bass populations and collect additional samples to confirm LMBv in future outbreaks. To avoid spreading LMBv and other harmful pathogens, anglers should follow the DNR's aquatic invasive species guidance and actively practice the following:

- Drain all water from boats, motors and all equipment.
- Do not move live fish away from a waterbody.
- Handle bass as quickly and gently as possible if you intend to release them.
- Target smallmouth bass during cooler weather to reduce the stress on fish.
- Refrain from hauling fish in live wells unless fish are to be harvested.
- Report smallmouth bass with skin lesions and dead or dying fish to local biologists or fish health staff.

While LMBv is not known to infect humans, the DNR urges anglers harvesting any fish to thoroughly cook their catch, never consume dead or dying fish and follow the Center for Disease Control's food safety guidelines.

Great Lakes water levels have undergone extreme fluctuations over the last decade, approaching near-record lows and highs within an eight-year span from 2013 (low) to 2020 (high) (NOAA, The Great Lakes Dashboard). Smallmouth bass tend to occupy nearshore habitats for much of their life history, so fluctuating water levels have the potential to impact smallmouth bass recruitment success through loss or gain of spawning and nursery habitat. Changes to the nearshore habitat can be further exacerbated by shoreline development projects that impact the riparian zone and the aquatic life that inhabits this area. Much of the Door County shoreline is highly developed, particularly the embayments that are critical to bass spawning and rearing, and much of this development involved decades of dredging and shoreline hardening in response to fluctuating water levels resulting in the loss of natural shoreline. During the period of 2019 to 2020, 248 permits were issued through a self-certification process for the installation of rip rap along Door County waters in response to high water. Many additional projects were done without permits, and some projects went through the normal permitting process. Shoreline development projects like this have been implicated in the direct loss of habitat and impairment to the ecological functioning of the riparian zone and the lakebed (Engel and Pederson Jr. 1998; Wensink et al 2016). These shoreline modifications may also exacerbate the impact of storms that are known to negatively impact smallmouth bass nesting success and are increasing in frequency due to climate change (Steinhart et al. 2005).

Other potential stressors to the smallmouth populations include invasive species, including the round goby (*Neogobius melanostomus*), whose impacts to native species such as smallmouth bass are still uncertain (e.g., negative impact as a nest predator vs positive impact as a major prey/food item). Round gobies well-documented to be aggressive nest predators, consuming eggs in a smallmouth bass nest in short order (Steinhart et al. 2004). Ohio closed smallmouth bass fishing in Lake Erie during May and June due to high predation rates by gobies on nests affecting recruitment. Other states maintain open seasons during this same period, including Wisconsin, who implemented a year-round catch-and-release season for smallmouth bass in 2020. Round gobies also compete with native fish to the detriment of certain species such as darters, sculpins, and other small fish (Janssen et al. 2001). However, gobies also make up a substantial part of fish diets in Green Bay (Koenig et al 2022), and their ubiquitous distribution and easy capture make them an important food source for many fish species and may be responsible for the increased growth rates of smallmouth bass in this area (Crane et al. 2016).

SUMMARY OF MANAGEMENT CONSIDERATIONS

The scale and complexities surrounding Great Lakes smallmouth bass populations create considerable challenges in applying direct management actions in areas such

as the waters surrounding Door County. Investigating highly specific issues at this scale is not possible with current funding and requires additionally funded projects. Fortunately, after considerable effort, we have been able to gather some internal and external funding to investigate issues such as those discussed in this report. We expect to use this information to make management and regulatory changes if needed. Furthermore, the dynamics of a changing climate and resulting changes to the aquatic ecology will require us to learn and adapt. Comprehensive stakeholder input and involvement will continue to be a factor in any future management decisions.

References

Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. Madison, Wisconsin.

Boonthai, T., Loch, T. P., Yamashita, C. J., Smith, G. D., Winters, A. D., Kiupel, M., Brenden, T. O., & Faisal. M. 2018. Laboratory investigation into the role of largemouth bass virus (*Ranavirus*, Iridoviridae) in smallmouth bass mortality events in Pennsylvania rivers. *BMC veterinary research*, 14(1), 62.

Crane, D. and D. Einhouse. 2016. Changes in growth and diet of smallmouth bass following invasion of Lake Erie by the round goby. Journal of Great Lakes Research. 42:405-412.

Engel, S. and J.L. Pederson Jr. 1998. The Construction, Aesthetics, and Effects of Lakeshore Development: A Literature Review. Wisconsin Department of Natural Resources Research Report 177. December 1998. 48 pp.

Grizzle, J.M. and Brunner, C.J. 2003. Review of Largemouth Bass Virus. *Fisheries*, 28: 10-14.

Hansen, S. and T. Kroeff. 2014. Smallmouth Bass in Door County: 2009/2012 Population Assessments and Sport Fishery. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 16 pp.

Hansen, S. and E. Kurszewski. 2017. Smallmouth Bass in Door County: 2015 Sturgeon Bay/Little Sturgeon Bay Population Assessment and Sport Fishery. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 14 pp.

Janssen, J., and D.J. Jude. 2001. Recruitment failure of mottled sculpin *Cottus bairdi* in the Calumet Harbor, southern Lake Michigan, induced by the newly introduced round goby *Neogobius melanostomus*. Journal of Great Lakes Research 27(2):319-328.

Koenig, L.D., D.J. Dembkowksi, S.P. Hansen, I. Tsehaye, T.J. Paoli, T.G. Zorn, and D.A. Isermann. 2022. Diet composition and overlap for adult walleye, lake whitefish, and yellow perch in Green Bay, Lake Michigan. Journal of Great Lakes Research. 48(2022):1681-1695.

Kroeff, T. 1993. A Summary of Recapture Data from Fish Tagged at the 1993 Sturgeon Bay Open Bass Tournament with Additional Age Information. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 8 pp.

Kroeff, T. 1995. Assessment of Spawning Populations and Early Life History of Smallmouth Bass as Several Locations Along the Door County Shoreline in 1995.

Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 16 pp.
Kroeff, T. 1996. Assessment of Spawning Populations of Smallmouth Bass at Little Sturgeon and the Mink River/Rowley Bay Area and Young-of-the-Year Surveys Along the Door County Shoreline in 1996. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 18 pp.
Kroeff, T. 1997. Assessment of Spawning Population of Smallmouth Bass in Detroit Harbor, Washington Island and Young-of-the-Year Surveys Along the Door County Shoreline in 1997. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 14 pp.
Kroeff, T. and M. Toneys. 2004. Summary of Smallmouth Bass Assessments in Selected Areas of Door County 2004. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 5 pp.
Maceina, M.J., Sammons, S.M., 2006. An evaluation of different structures to age freshwater fish from a northeastern US river. Fish. Manag. Ecol. 13, 237–242.
Masterson, C. and B. Eggold. 2013. Wisconsin's Open Water Sportfishing Harvest and Effort from Lake Michigan and Green Bay. Wisconsin Department of Natural Resources Fisheries Management Report. Milwaukee, Wisconsin. 12 pp. http://dnr.wi.gov/topic/fishing/Documents/LakeMichigan/LakeMichiganSportHarvestReport2012.pdf
NOAA. The Great Lakes Dashboard. Great Lakes Environmental Research Laboratory, https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html Accessed 07/13/2023.
Steinhart, G.B., E.A. Marschall, and R. Stein. 2004. Round goby predation on smallmouth bass offspring in nests during simulated catch-and-release angling. Trans. Am. Fish. Soc. 133(1): 121-131.
Steinhart, G. B., N. J. Leonard, R. A. Stein, and E. A. Marschall. 2005. Effects of storms, angling, and nest predation during angling on smallmouth bass (*Micropterus dolomieu*) nest success. Canadian Journal of Fisheries and Aquatic Sciences 62: 2649-2660.
Wensink, S. and S.D. Tiegs. 2016. Shoreline hardening alters freshwater shoreline ecosystems. Society for Freshwater Science. 35, 764-777.
Wiegert, L. 1966. A Four-year Study of the Smallmouth Bass in the Outlying Waters of Door County. Wisconsin Conservation Department Division of Fish Management Report No. 1, 11 pp.
Zilberg, D., Grizzle, J. M., & Plumb, J. A. 2000. Preliminary description of lesions in juvenile largemouth bass injected with largemouth bass virus. *Diseases of Aquatic Organisms*, 39(2), 143–146.

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Smallmouth Bass In Door County: 2014 And 2022 Washington Island - Detroit Harbor Population Assessments

Executive Summary

Smallmouth bass populations in Detroit Harbor of Washington Island, Door County waters of Green Bay were evaluated during the pre-spawn period during the spring of 2014 and 2022. Population abundance and size structure were in relatively good condition each survey year. However, the number of smallmouth bass caught per unit of effort and the size composition of the population had decreased between the survey periods. There appeared to be few strong year classes produced during the period of the early to mid-2010s. For most years beginning around the 1970s, angling for smallmouth bass has been closed during the pre-spawn/spawning periods, so annual angling effort is likely considerably lower in Detroit Harbor than in most of the other areas around Door County. A UW-Stevens Point graduate research study commenced in 2022 examining potential impacts on smallmouth bass nesting success and evaluating young-of-year recruitment.

Introduction

The waters surrounding Door County are well known for their flourishing smallmouth bass populations both in terms of fish size and abundance. Various discrete populations of smallmouth bass can be found in areas along the Green Bay side of Door County, beginning in Little Sturgeon Bay and north, as well as areas at the northern end of the Lake Michigan side of the county. The more isolated waters around Washington Island are known for their strong populations of smallmouth bass as well. The first documented assessments of smallmouth bass populations in Door County waters occurred between 1962 and 1965 (Wiegert 1966). Since then, smallmouth bass populations have been assessed in selected areas of Door County periodically beginning in 1995 (Kroeff 1995). However, before the surveys reported here, the population around Washington Island (Detroit Harbor) had only been assessed in 1997 (Kroeff 1997). While effort is made to rotate among the various sub-populations, the areas around Sturgeon Bay and Little Sturgeon Bay are assessed most often. Herein, we report results from the 2014 and 2022 Detroit Harbor (Washington Island) spring pre-spawn smallmouth bass population assessments.

Methods

POPULATION ASSESSMENT

Fyke nets (width = 6 feet, height = 3 feet, mesh size = 1.5 inches stretch; leads = 75 feet) were set in Detroit Harbor, Washington Island (Figure 1) in 2014, beginning May 13, and were fished intermittently through June 5. Between three and seven nets were fished on a given date, and effort was made to place them in locations similar to past surveys while also keeping them in areas with consistent smallmouth bass activity (nets were removed from the water or tied open during weekends and when weather conditions were not conducive to netting). In 2022, nets were set in Detroit Harbor beginning May 10 and were removed after May 27 (nets were removed from the water one weekend and when weather conditions were not conducive to netting). Four or five nets were fished on a given date, and effort was made to place them in locations similar to past surveys while also keeping them in areas with consistent smallmouth bass activity.

Figure 1. Door County peninsula and surrounding areas of Green Bay and Lake Michigan. Red box indicates the Detroit Harbor area of Washington Island.

Smallmouth bass total length was measured to the nearest millimeter. In 2014, scales were used for aging and sampled from the left side of the fish, near the tip of the relaxed pectoral fin just below the lateral line. In 2022, the second dorsal spine was removed and sectioned for aging. Age structures were taken from 15 fish per ten millimeter length increment, and an age-length key was developed to examine age composition. Fish health was evaluated by examining for any external lesions or other abnormalities (not reported here). All other game fish were identified, counted, measured and a fin was clipped to ensure fish were not being recorded multiple times. Non-game fish were identified and counted, although not clipped, so some non-game fish could have been recorded multiple times. Although the sampling effort extended into late May or early June for these surveys, only catch data from a relevant portion of the survey are reported herein for key metrics such as catch-per-unit-effort (CPE), size and age structure. Data from this period comprises the majority of the sampling effort and generally encompasses the pre-spawn period, when smallmouth bass are active and fish are generally mixed in terms of size and sex (Becker 1983). Restricting data to this time period also helps ensure some consistency when making interannual comparisons.

Due to its relative isolation, areas around Washington Island are not part of the annual Door County sport angler creel survey. However, the sport fishery for

smallmouth bass has been assessed annually in the outlying waters around mainland Door County since the 1970s using a randomized angler creel survey (Masterson and Eggold 2013). Recent creel survey summary results for the Door County mainland can be found in previous smallmouth bass reports (Hansen 2024).

Population Survey Results

CATCH

2014
Nets were fished for a total of 60 net nights (number of nets x number of nights fished) in 2014, including two days in early June. A total of 1,402 smallmouth bass were caught during the entire survey period. Approximately 165 fish of other species were captured including white sucker (n=32), northern pike (n=2), bullhead species (n=31), rock bass (n=43), yellow perch (n=5), bowfin (n=28), common carp (n=8), pumpkinseed (n=6), walleye (n=3), brown trout (n=3) and yellow bullhead (n=4).

2022
Nets were fished for a total of 56 net nights (number of nets x number of nights fished) in 2022. A total of 755 smallmouth bass were caught during the survey period. Approximately 982 fish of other species were captured, including white sucker (n=93), northern pike (n=1), bullhead spp. (n=405), rock bass (n=368), yellow perch (n=15), bowfin (n=59), alewife (n=6), pumpkinseed (n=11) and round goby (n=24).

CATCH PER UNIT OF EFFORT
The overall CPE for May was considerably higher in 2014, with an average catch of 19.9 ±9.4 ((1 standard deviation (SD)) smallmouth bass per net night versus 13.5 ±6.1 (1 SD) smallmouth bass per net night in 2022. Although netting in 2014 continued several days into June, for consistency between surveys, only CPE data through May 28 are shown, and it is likely spawning was in place by this time, if not earlier.

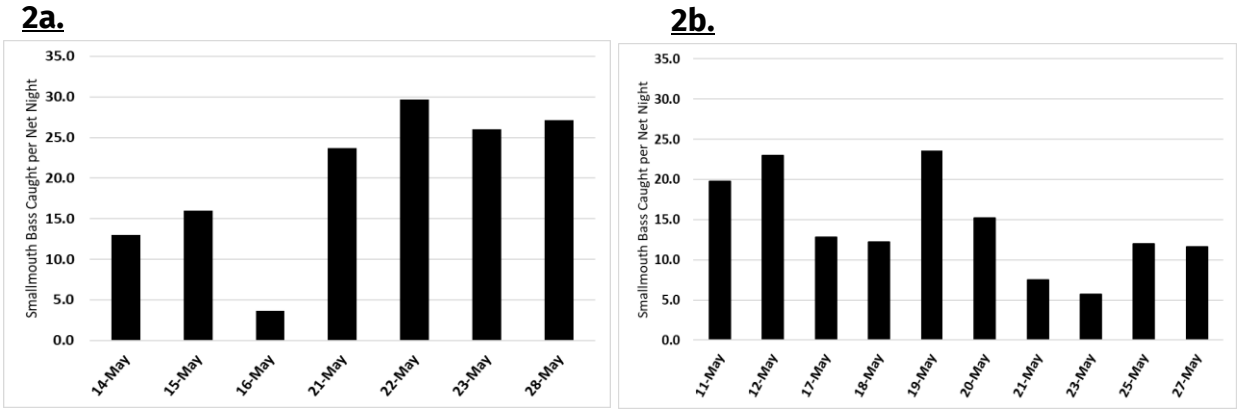
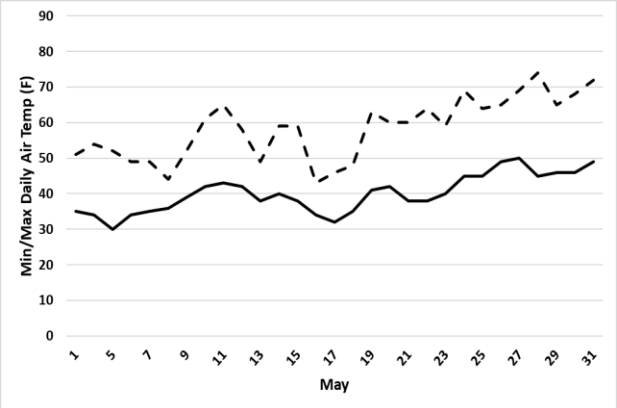


Figure 2a-b. Catch per effort of smallmouth bass caught per net night in 2014 (2a) and 2022 (2b) for surveys conducted in Detroit Harbor, Washington Island. Although the 2014 surveys ran several days later, for consistency and comparability, these days were not included here.

Smallmouth bass CPE generally followed water temperature trends, with catches building in 2014 and diminishing in 2022 during our sampling effort (Figures 2a-b and 3a-b). Distinct differences in spring air and water temperatures were noted between the survey years that may have affected smallmouth catch rates during certain periods. In 2022, there was a rapid warmup with air temperatures approaching 80° F by mid-May, while in 2014, air temperatures were lower and relatively consistent through mid-May, increasing by the end of the month. The progression of spring spawning activity is heavily dependent on water temperatures, and for smallmouth bass in Wisconsin, spawning generally occurs when water temperatures reach 60° F, although some spawning may occur in the mid-50° F range (Becker 1983). Patterns in water temperatures throughout May of each survey year were dramatically different (Figure 4). Water temperatures in 2014 were somewhat below preferred spawning temperatures until mid-May, while in 2022, temperatures at the start of the survey were already elevated to levels consistent with smallmouth spawning (Becker 1983). However, by the third week of May 2022, temperatures began to decline, while 2014 temperatures continued to warm, resulting in a period of overlap in temperatures between the surveys. As the water temperature in 2014 continued to increase through the end of the month, the 2022 temperatures likely moderated (data not shown).

3a.



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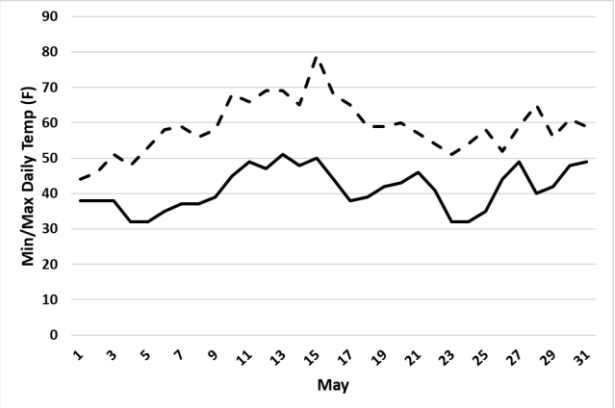

Figure 3a-b. Minimum and maximum daily air temperatures during May for Washington Island in 2014 (Fig 3a) and 2022 (Fig 3b) (NOAA 2023).

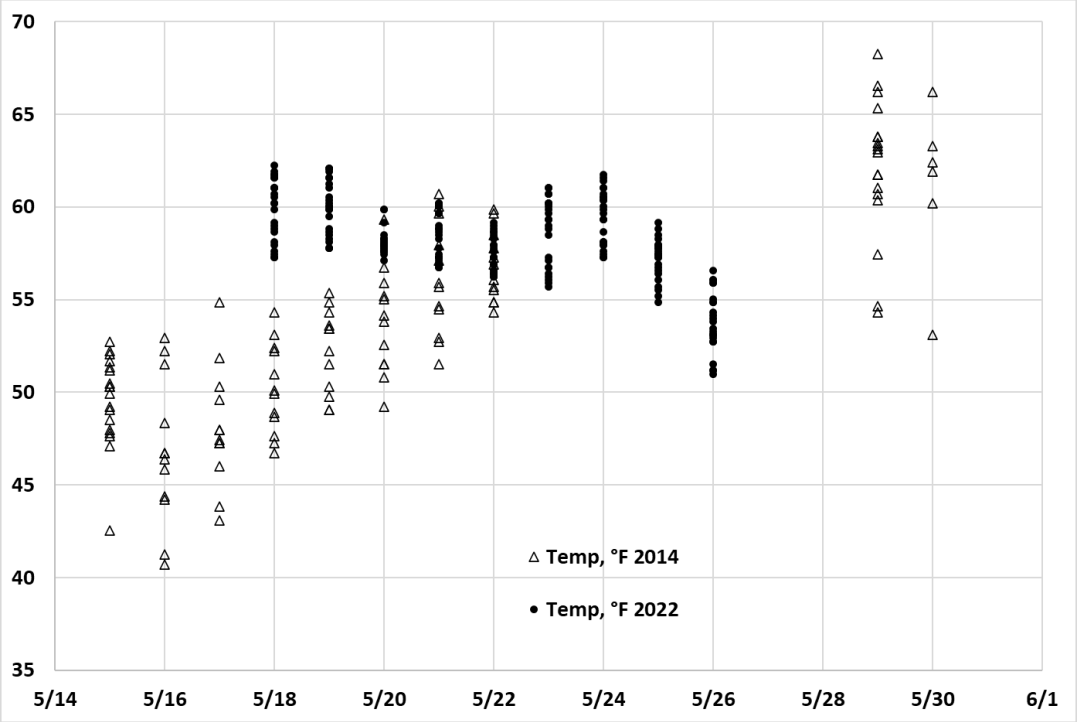

Figure 4. Daily water temperatures (°F) collected hourly for specific days in May in Detroit Harbor, Washington Island during 2014 and 2022.

AGE COMPOSITION

The ages for all smallmouth bass sampled in Detroit Harbor were between four and 19 years in 2014 and between two and 13 years in 2022. Fish were proportionally much older in 2014 than they were in 2022, demonstrating a considerable shift in the age structure of the population between these two survey years (Figure 5). Age data from the 2014 population sampling suggest that there were strong year classes generated from the early to mid-2000s as cohorts from those years are well represented in the catch (i.e., age-7 produced in 2007; age 10+ produced ≤2004). Meanwhile, the 2022 age data suggest there were strong year classes generated in 2017 (age-5) and 2018 (age-4), with relatively low recruitment during the early to mid-2010s (i.e., fewer fish ages ≥ age-6).

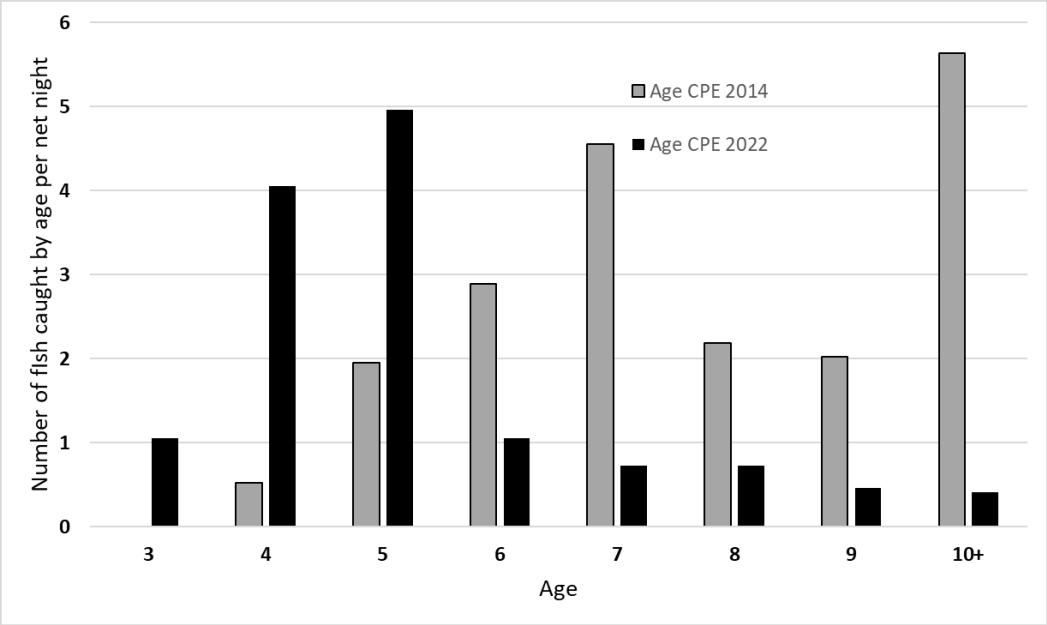

Figure 5. Age composition in number of smallmouth bass caught per net night by age for 2014 and 2022. Due to decreasing accuracy for older fish, age-10 and older fish are pooled. (Maceina and Sammons 2006)

SIZE STRUCTURE

The population length compositions generally follow the patterns of age composition between the two surveys, although the shift in length compositions was not as distinct as the shift in age compositions. In 2014, the population size composition was generally skewed to large fish, while in 2022, there was a shift toward relatively smaller fish in the overall sampled population (Figure 6). This is consistent with the relatively lower catches of younger fish in 2014 that are later reflected in the lack of older fish in the 2022 population assessment. Fish lengths ranged from 11 to 21 inches for both years and the largest fish measured 21.5 inches (2022). Over 65% of the 2014 population sampled was 16 inches or greater, while over 77% of the 2022 population sampled was 16 inches or less, again reflecting the different age compositions between survey years. However, the average length of smallmouth bass sampled between surveys was relatively similar (16.6 inches in 2014 and 15.8 inches in 2022).

It should be noted that because sampling started around mid-May for each of these surveys, it's possible the overall size structure of the sample could be skewed low (relative to the overall population). In general, our surveys have demonstrated that larger fish tend to make up a larger proportion of the catch early in the pre-spawn season. This could reflect older, more experienced males beginning to move into shallow waters in search of preferred spawning areas.

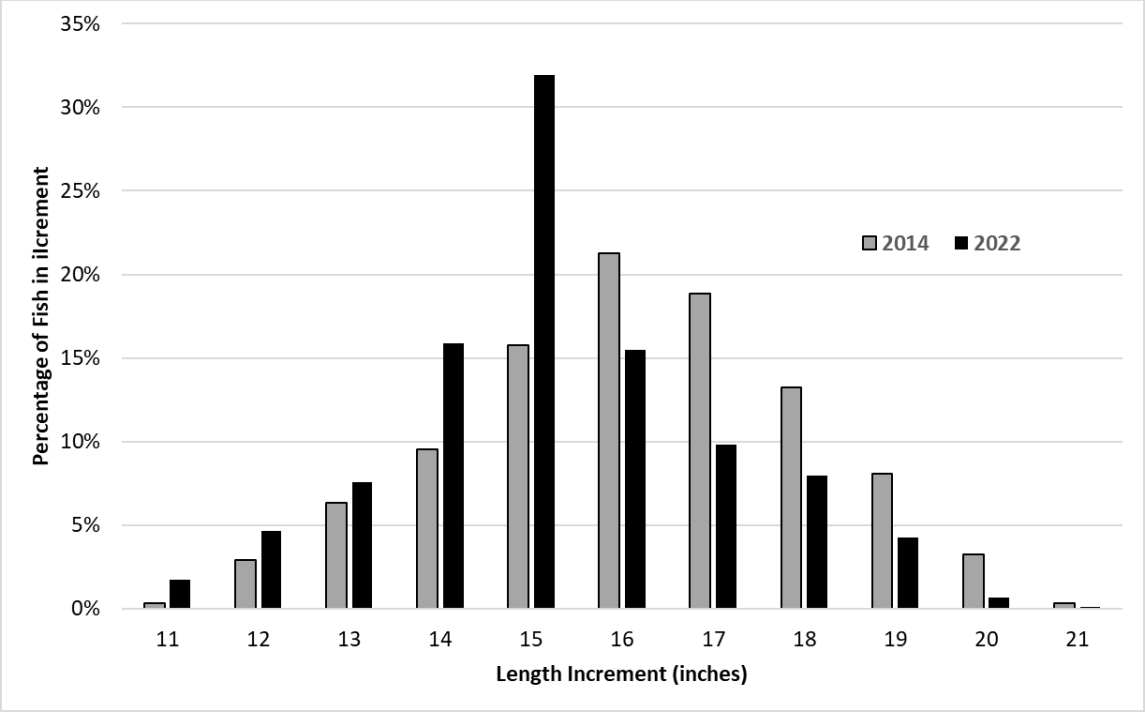

Figure 6. Length compositions for Detroit Harbor smallmouth bass surveys during 2014 and 2022. Length bins are delineated by any fish that fell within a particular inch group (e.g., a fish in the 16 inch bin could have been between 16 and 16.99 inches long).

The mean length at age increased between 2014 and 2022 (Figure 7). Mean length at age data from the 1997 survey (Kroeff 1997) indicate that, on average, a fish did not reach the 12-inch legal size limit for waters surrounding Washington Island until around five to six years of age. However, now fish, on average, reach the legal limit by three to four years of age.

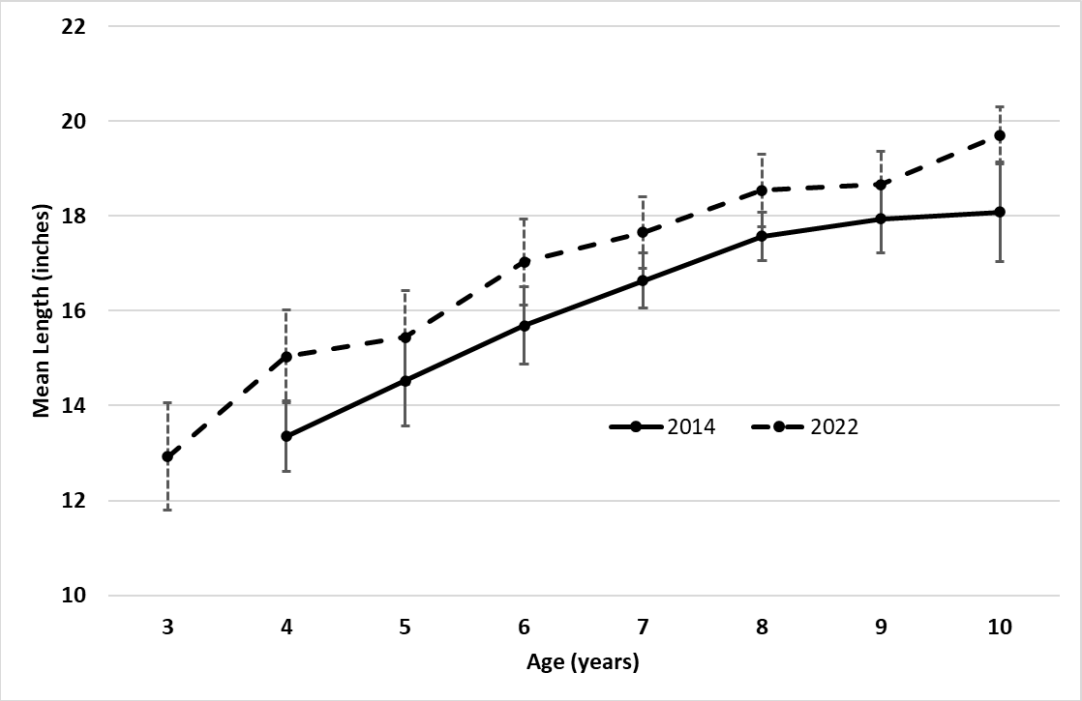

Figure 7. Mean length in inches (± 1 SD) at age of smallmouth bass sampled during the 2014 and 2022 spring spawning periods in Detroit Harbor, Washington Island. No age-3 fish were collected in 2014. (Due to decreasing ageing accuracy for older fish, data for fish older than age-10 are not shown.)

Summary

To compare population sizes, the number of smallmouth bass caught per net per night of fishing (total nets/nights fished) can be used as a general index of relative abundance. While mark-recapture population estimates are the preferred means of estimating abundance, the 'open system' characteristics of Great Lakes smallmouth bass populations and lower recapture rates confound making robust population estimates. To make reasonable comparisons of CPE for spawning populations between years, it's important that the timing, locations and water temperatures of the sampling are relatively consistent to ensure some level of reliable catchability. However, given changing Great Lakes water levels and variable temperatures, maintaining interannual consistency between net sites can be challenging, and fish may change areas they inhabit within the embayment based on environmental conditions. Nets are occasionally moved to areas where fish are active and susceptible to capture. Nets were placed in relatively consistent locations between the two survey years for Detroit Harbor although a dramatic change in the shoreline structure likely from the influence of storm and ice forces in an area known as the 'East Channel' precluded repeating a net site in this general area in 2022. An additional net was fished in Peterson Bay in 2022, whereas only one was fished there in 2014. While the temperature patterns differed considerably between the two survey years and could account for some of the CPE differences, by around the third

week in May, there were similar temperatures between years, and by the end of the month, most pre-spawn activity would have been expected to be completed. Therefore, we believe that the data suggest that there was a considerable decrease in population size of smallmouth bass in Detroit Harbor between 2014 and 2022, dropping by around 1/3 based on CPE during May. However, it is important to consider this CPE calculation was restricted to the approximate pre-spawn periods in these years. In 2014, the CPE would have likely increased if June catch data were included in the calculations because catches into June were very high. This likely reflects a high percentage of sub-adult and first-time spawners in the population at a time when larger males are sedentary while guarding nests and larger females may have left the area. This was also the case during the 1997 survey, where June catch rates were very high, reflecting very good periods of smallmouth bass recruitment during the 1990s (Kroeff 1997). Because we did not allow nets to fish into June in 2022, the information on the youngest age classes may be somewhat limited for this year.

The population age and size composition in 2014 indicated that recruitment was good for several years during the early to mid-2000s, as cohorts from that period are well represented in the survey catch data. However, the limited catch of three and four-year-old fish in the 2014 survey suggests that by the early 2010s, there were no strong year classes produced. This is further supported by comparatively few numbers of older fish (age-10+) in the 2022 survey (i.e., production from ≤2012). The ensuing years in the early to mid-2010s were relatively weak as well, as indicated by relatively low catch rates for ages six and older in the 2022 survey. However, good catch rates of age-4 and age-5 fish in 2022 suggest that 2017 and 2018 (and possibly 2019) were good years for smallmouth bass production. While the data from these two survey years describe different dynamics in the Detroit Harbor smallmouth bass fish population (i.e., different CPEs, ages, and size structure across years), the results are reflective of what can occur with normal population cycling in a fishery. Despite overall catch rates dropping by around one-third between 2014 and 2022, the population should still be considered relatively robust, and a considerable number of younger fish (ages three to five) sampled in the population should provide for a good future fishery. Smallmouth bass fishing regulations for this area have promoted considerable protection for the spawning population. Although the current size limit of 12 inches (within one-fourth mile of all islands in the Town of Washington Island) is for many smallmouth bass populations not protective enough to allow even one year of spawning effort, the areas around Washington Island have had a closed season until July 1 for most years since at least the 1970s. (During 2020-2021, the regulations around Washington Island followed those for the rest of Green Bay due to an inadvertent administrative change, but the rules reverted to the previous ones in 2022.) The smallmouth bass fishing closure until July 1 effectively protects smallmouth bass during the spawning period from harvest and stressors from removing nesting fish. Because of this protection, the strong catch and release mentality for smallmouth bass and the relative isolation of Detroit Harbor, it's reasonable to assume that the reduced relative abundance measured in 2022 is not due to angling pressure but is more likely a reflection of environmental influence.

Growth continues to improve for smallmouth bass around Washington Island (consistent with other Door County smallmouth bass populations), with fish reaching the legal-size limit (12 inches) at around three years, whereas historically, it took five to six years, on average (Kroeff 1997). The interpretation of trends in the composition of the youngest age class (ages three to four) in the population is confounded because the gear selectivity to younger age classes of fish may be increasing with increased growth rates. Between 2014 and 2022, the mean size at age had increased considerably (Figure 7) and has increased even more dramatically since the 1997 survey, where an age-4 fish from Detroit Harbor averaged just 9.3 inches (Kroeff 1997). While these fish may have been large enough to be selected by our fyke nets, particularly in 2014, the age at maturity may be decreasing (i.e., growth increases potentially resulting in increased energy to reproductive organs), meaning smallmouth maturing at an earlier age could result in younger fish becoming more susceptible to the nets, therefore increasing catch rates somewhat. It is important to recognize that different fish aging structures were used when aging bass for each survey year, scales in 2014 and fin spines in 2022. While we recognize that some under-aging may have occurred using scales (for older fish in particular), we are confident in the accuracy of fish in younger age classes. Other variables, such as staff with considerable experience aging bass with scales and robust growth rates, add further confidence to our age estimates. However, paired structure analysis (scales:spines) would be prudent to evaluate the level of precision between the structures. Such paired structures were collected in 2022, and ages from each will be compared as time and resources allow.

MANAGEMENT IMPLICATIONS

Lower relative sport fishing catch rates for smallmouth bass over the past five to ten years in the waters surrounding Door County have raised concerns among some anglers. Cohorts from the strong year classes in the 2000s survived well into the 2010s, resulting in a fishery made up of excellent catch rates for large fish among most populations in Door County waters, an often-infrequent occurrence in sport fisheries. There are many variables that can impact fish abundance, with angler exploitation one that is often in the spotlight. Considering the waters surrounding Washington Island have long had relatively conservative regulations during the spawning period when fish are susceptible to harvest and other stressors, the artifact of angler exploitation and pressure during the spawning period has mostly been removed. Fish populations often cycle naturally, and factors including climate change and invasive species can impact recruitment and exacerbate challenges with maintaining a strong fishery. However, it's important to consider the issues in a relative sense. Smallmouth bass populations around Door County are still considered healthy by most standards (i.e., good relative abundance, age and size structure). Therefore, we are not recommending any smallmouth bass management changes to the areas around Washington Island at this time.

The focus on adults during the pre-spawn surveys limits our ability to evaluate year class strength before the fish become reproductively mature and before they become susceptible to the sport fishery. While we have conducted periodic young-of-year recruitment and nest success surveys, given the inherent challenges with these types of surveys and the scale of the smallmouth bass fishery in Door County, it is challenging to incorporate these results into management applications. Consequently, a two-year UW-Stevens Point (UWSP) graduate study began in 2022 that was designed to measure Door County smallmouth bass nesting success/failure more intensively in these same populations and evaluate the mechanisms that may contribute to nesting failures including, nest predation (e.g., round gobies), angler-targeted bed fishing and changing climate patterns. This study will also measure young-of-year recruitment from various Door County smallmouth bass populations, experimenting with different sampling methods to determine the most effective and efficient method for evaluating this life stage. Detroit Harbor was selected as one of the sites to be included in these studies. The results of these UWSP studies, along with current survey data, should help provide insight into the mechanisms that affect smallmouth bass populations in Door County, as well as help inform DNR management approaches to best measure smallmouth bass recruitment in the future.

Various other factors may play a role in smallmouth bass life history and should be considered when trying to manage for healthy smallmouth bass populations in Door County waters of Green Bay and Lake Michigan. This may include possible impacts from tournaments (Maynard et al 2013), disease (DNR Press Release), invasive species (Steinhart et al 2004), frequent large-scale changes in Great Lakes water levels (NOAA, The Great Lakes Dashboard), shoreline development (Wensink and Tiegs 2016) and impacts from changing climate conditions (Steinhart et al 2005). See Hansen 2024 for further discussion of these topics as well as information regarding other current research studies concerning smallmouth bass in waters surrounding Door County.

References

Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. Madison, Wisconsin.

Kroeff, T. 1995. Assessment of Spawning Populations and Early Life History of Smallmouth Bass as Several Locations Along the Door County Shoreline in 1995. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 16 pp.

Kroeff, T. 1997. Assessment of the spawning population of smallmouth bass in Detroit Harbor, Washington Island and young-of-the-year surveys along the Door County shoreline in 1997. Wisconsin Department of Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 13pp.

Hansen, S. 2024. Smallmouth bass in Door County: 2017 and 2021 Sturgeon Bay/Little Sturgeon Bay population assessments and sport fishery. Wisconsin Department of

Natural Resources Fisheries Management Report. Sturgeon Bay, Wisconsin. 17pp.

Maceina, M.J., Sammons, S.M., 2006. An evaluation of different structures to age freshwater fish from a northeastern US river. Fish. Manag. Ecol. 13, 237–242.

Maynard, G. A., T. B. Mihuc, R. E. Schultz, V. A. Sotola, A. J. Reyes, M. H. Malchoff, and D. E. Garneau. 2013. Use of external indicators to evaluate stress of largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieu*) bass at Tournaments. Open Fish Science Journal 6:78-86.

Masterson, C. and B. Eggold. 2013. Wisconsin's open water sportfishing harvest and effort from Lake Michigan and Green Bay. Wisconsin Department of Natural Resources Fisheries Management Report. Milwaukee, Wisconsin. 12 pp. http://dnr.wi.gov/topic/fishing/Documents/LakeMichigan/LakeMichiganSportHarvestReport2012.pdf

NOAA 2023. Record of Climatological Observations, https://www.ncdc.noaa.gov/cdo-web/datasets, Accessed 07/25/2023.

NOAA. The Great Lakes Dashboard. Great Lakes Environmental Research Laboratory, https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html

Steinhart, G.B., E.A. Marschall, and R. Stein. 2004. Round goby predation on smallmouth bass offspring in nests during simulated catch-and-release angling. Trans. Am. Fish. Soc. 133(1): 121-131.

Steinhart, G. B., N. J. Leonard, R. A. Stein, and E. A. Marschall. 2005. Effects of storms, angling, and nest predation during angling on smallmouth bass (*Micropterus dolomieu*) nest success. Canadian Journal of Fisheries and Aquatic Sciences 62: 2649-2660.

Wensink, S. and S.D. Tiegs. 2016. Shoreline hardening alters freshwater shoreline ecosystems. Society for Freshwater Science. 35, 764-777.

Wiegert, L. 1966. A four-year study of the smallmouth bass in the outlying waters of Door County. Wisconsin Conservation Department Division of Fish Management Report No. 1, 11pp.

Wisconsin Department of Natural Resources. 2021. Smallmouth bass in Door County waters test positive for largemouth bass virus [Press release]. https://dnr.wisconsin.gov/newsroom/release/50921

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Status Of Walleye In Green Bay, The Fox River And Other Major Tributaries

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 Department of Natural Resources (DNR) began to stock fry and fingerling walleye to rehabilitate the population. This stocking program was so successful in re-establishing 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 major tributaries.

This report aims to summarize data collected on the walleye stocks in Green Bay including the Fox River and other major tributaries during the 2023 field season. The report will describe long-term trends in YOY production and angler catch and harvest.

Spring Electrofishing Surveys

In 2023, electrofishing surveys were conducted on each of the four major tributaries that support walleye spawning runs (i.e., the Fox River, Oconto River, Peshtigo River, and Menominee River). The goal of these surveys was to collect biological data on the adult spawning population in each river. Data collected includes total length, sex and a fin spine to estimate the age composition of the adult spawning population. A dorsal fin spine was collected from up to 10 walleye per ½ inch length bin for each sex from each river. A river specific age-length key was used to assign ages to all walleye from a given river that did not have a fin spine collected based on an individual walleye's length and the age composition of fish of a similar length and sex. The percentage of male and female walleye of each age (i.e., an age class) was calculated for each river to evaluate the age structure of the spawning population in a given river. Mean lengths at age were calculated for male and female walleye in the spawning population across all rivers to get average growth rates for the adult population of male and female walleye across Green Bay. A von Bertlalanffy growth curve was fit to mean lengths at age for each sex to get a predicted mean length at

age for each sex that accounts for variability in growth rates of different ages in the population. Results from spring surveys on each of the major tributaries are presented below.

FOX RIVER

Spring 2023 electrofishing surveys of the Fox River were conducted on March 23, March 28 and April 4. Water temperatures ranged from 39-44° F depending on location and date. A total of 4.22 hours of electrofishing effort over 5.72 miles of river was expended to capture 509 walleye for a catch rate of 120.6 walleye per hour of electrofishing or 89.0 walleye per mile of electrofishing. Captured walleye ranged in size from 15.2 to 28.7 inches (385 to 728 mm) and had an average length of 20.6 inches (523 mm).

Over the three days of electrofishing, 336 female walleye were captured, ranging in size from 15.2 to 28.7 inches (385 to 728 mm) with an average length of 21.9 inches (557 mm; Figure 1). Just under 2/3 of the female walleye that were captured were <22.0 inches (559 mm), whereas just over 13% were ≥26.0 inches (660 mm; Figure 1). A total of 166 male walleye were also captured, ranging in size from 15.4 to 22.9 inches (391 to 584 mm) with an average length of 17.9 inches (455 mm; Figure 1). Less than 10% of the males that were captured were >20 inches or 508 mm (Figure 1). Only seven walleye of unknown sex were captured over a range of sizes from 16.4 to 26.6 inches (416 to 675 mm; Figure 1).

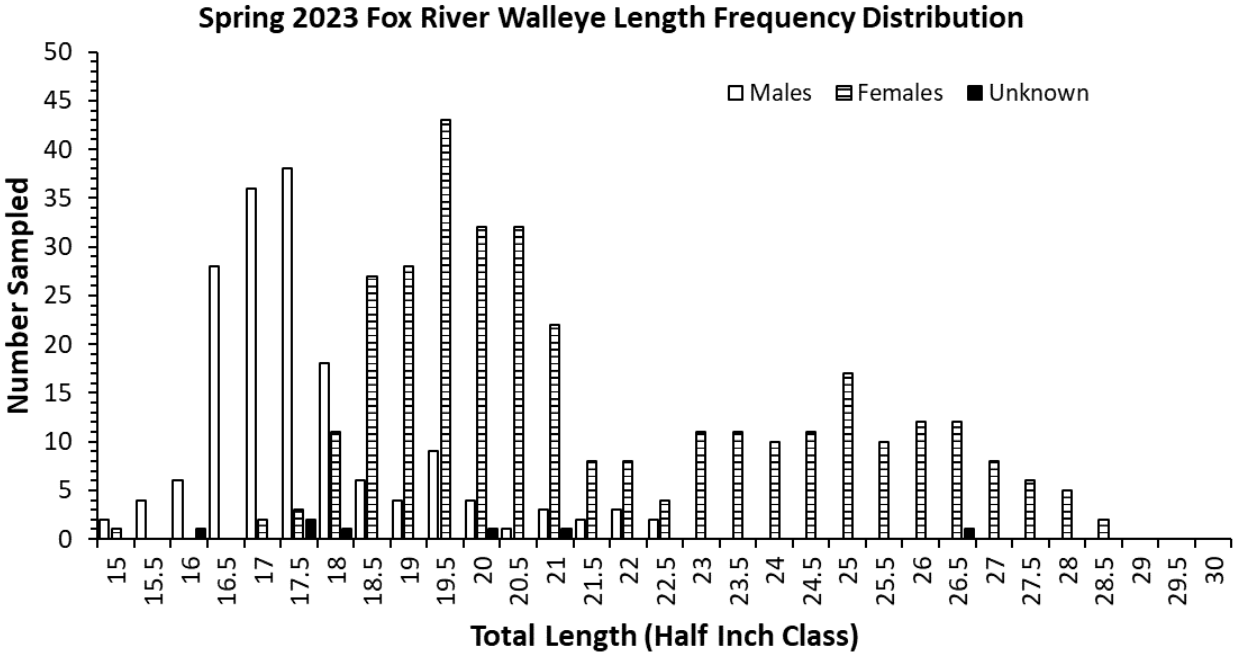

Figure 1. The length distribution of walleye captured during the 2023 spring electrofishing survey on the Fox River.

During the 2023 spring Fox River survey, dorsal fin spines were collected from 319 walleye while an age length key was used to assign ages to 183 walleye. The percentage of male and female walleye in each age class in the Fox River adult spawning population is shown in Figure 2. Age-5 walleye were the largest age class in the spring adult spawning population, making up approximately 81% of the male walleye and 62% of the female walleye that were captured (Figure 2). It is not surprising that age-5 walleyes were the largest age class in the adult spawning population since all male and female walleye should be maturing by this age and the 2018 year class (i.e., the age-5 adults) was the largest year class recorded in fall young of year (YOY) electrofishing surveys.

Ages 4, 6, 8 and 9 were the next largest age classes for male walleye, with each of these age classes making up 2-5% of the male spawning walleye population (Figure 2). Ages 8, 9, 10, 12 and 13 were the next largest age classes for female walleye, with each of these age classes making up 4-9% of the female spawning walleye population (Figure 2). All age classes from 2 – 12 were present in the male walleye spawning population while all age classes from 4 – 17 were present in the female walleye spawning population, meaning at least 16 age classes were contributing to the adult spawning population of walleye in the Fox River in 2023 (Figure 2).

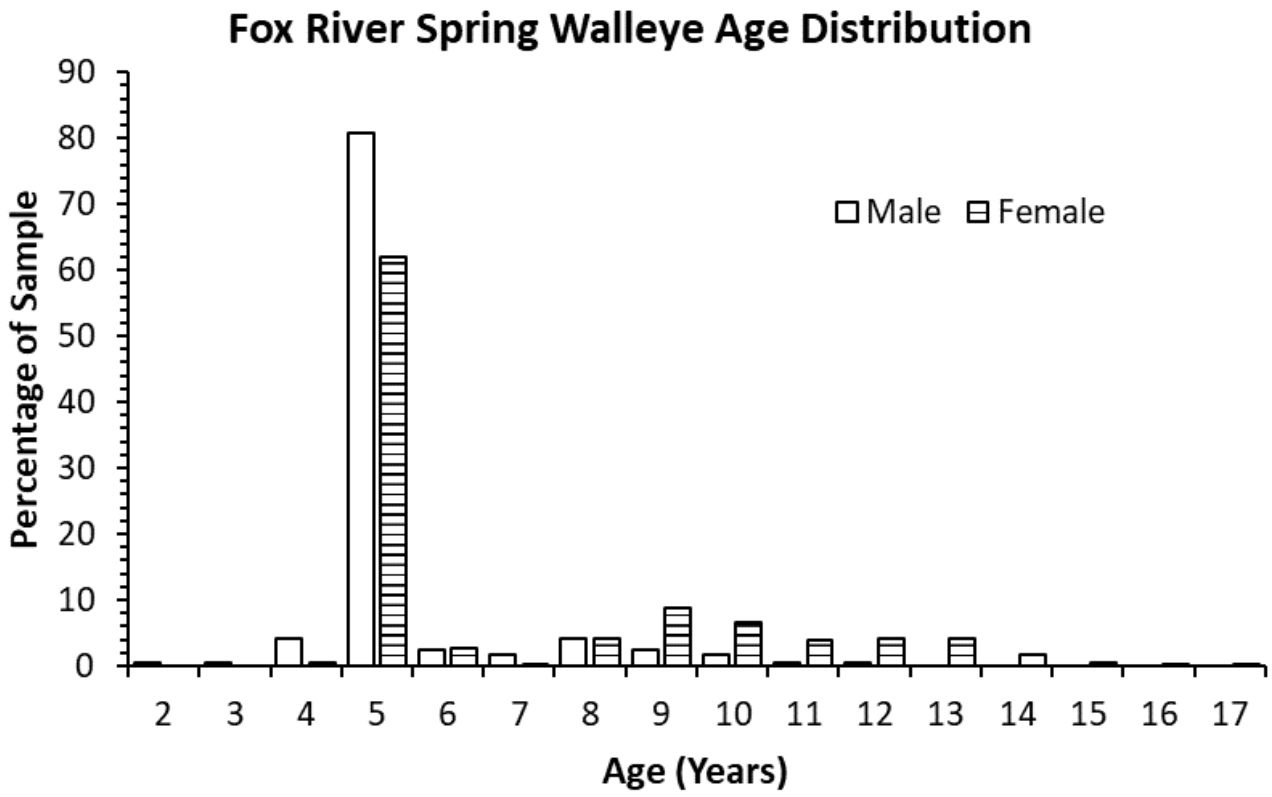

Figure 2. Age-frequency distribution of male and female walleye captured during the spring spawning run from the Fox River in 2023. The data are presented as the percentage that each age class contributes to the total sample.

OCONTO RIVER

Spring 2023 electrofishing surveys of the Oconto River were conducted on April 11 and April 12. Water temperatures ranged from 46-55°F depending on location and date. A total of 2.17 hours of electrofishing effort over 6.33 miles of river was expended to capture 245 walleye for a catch rate of 112.9 walleye per hour of electrofishing or 38.7 walleye per mile of electrofishing. Captured walleye ranged in size from 15.5 to 28.8 inches (394 to 732 mm) and had an average length of 20.1 inches (511 mm).

Over the two days of electrofishing, 97 female walleye were captured, ranging in size from 18.5 to 28.8 inches (469 to 732 mm) with an average length of 22.5 inches (573 mm; Figure 3). Just over half of the female walleye that were captured were <22.0 inches (559 mm), whereas just over 11% were ≥26.0 inches (660 mm; Figure 3). A total of 147 male walleye were also captured, ranging in size from 15.5 to 23.1 inches (394 to 586 mm) with an average length of 18.5 inches (470 mm; Figure 3). Just under 20% of the males that were captured were >20 inches or 508 mm (Figure 3). Only one walleye of unknown sex was captured and that fish was 17.9 inches long (456 mm; Figure 3).

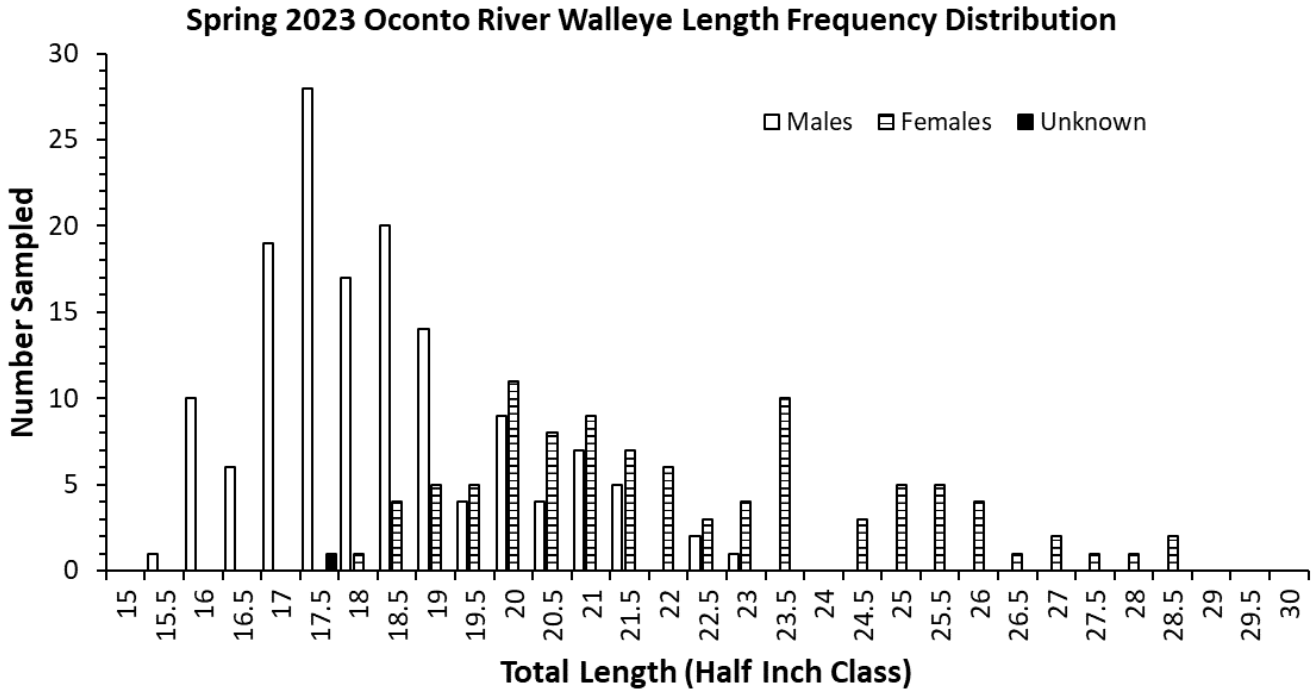

Figure 3. The length distribution of walleye captured during the 2023 spring electrofishing survey on the Oconto River.

During the 2023 spring Oconto River survey, dorsal fin spines were collected from 207 walleye while an age length key was used to assign ages to 37 walleye. The percentage of male and female walleye in each age class in the Oconto River adult spawning population is shown in Figure 4. Age-5 walleye were again the largest age class in the Oconto River spring adult spawning population, making up approximately 66% of the male walleye and 47% of the female walleye that were captured (Figure 4). It is not surprising that age-5 walleyes were the largest age class in the adult spawning population since all male and female walleye should be maturing by this age and the 2018 year class (i.e., the age-5 adults) was the largest year class recorded in fall young of year (YOY) electrofishing surveys.

Ages 7, 8 and 10 were the next largest age classes for male walleye, with each of these age classes making up 3-12% of the male spawning walleye population (Figure 4). Ages 6, 7, and 8 were the next largest age classes for female walleye, with each of these age classes making up 5-17% of the female spawning walleye population (Figure 4). All but one age class from 4-13 were present in the male walleye spawning population while all but three age classes from 4-19 were present in the female walleye spawning population, meaning at least 14 age classes were contributing to the adult spawning population of walleye in the Oconto River in 2023 (Figure 4).

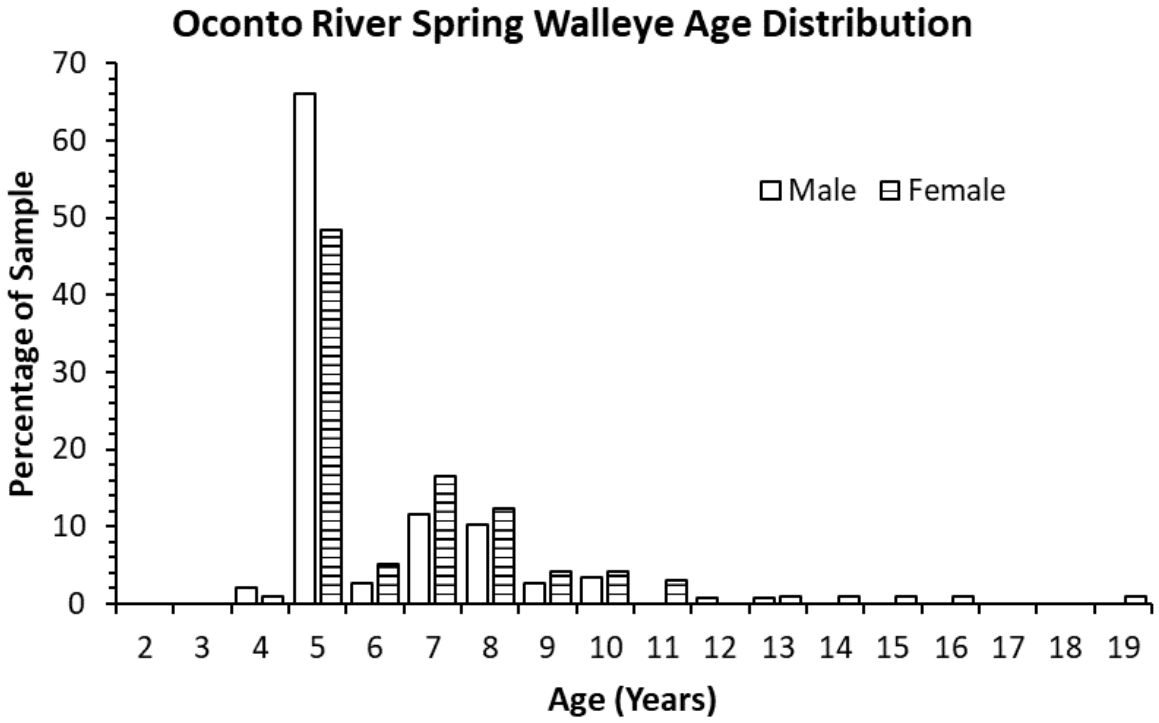

Figure 4. Age-frequency distribution of male and female walleye captured during the spring spawning run from the Oconto River in 2023. The data are presented as the percentage that each age class contributes to the total sample.

PESHTIGO RIVER

Spring 2023 electrofishing surveys of the Peshtigo River were conducted on April 12. The water temperature was 57° F throughout the area surveyed. A total of 37 minutes (0.52 hours) of electrofishing effort over 1.04 miles of river was expended to capture 184 walleye for a catch rate of 353.8 walleye per hour of electrofishing or 176.9 walleye per mile of electrofishing. Captured walleye ranged in size from 15.9 to 30.4 inches (406 to 772 mm) and had an average length of 20.3 inches (516 mm).

Throughout the night of electrofishing, 24 female walleye were captured, ranging in size from 19.9 to 30.4 inches (506 to 772 mm) with an average length of 23.7 inches (603 mm; Figure 5). Just 25% of the female walleye that were captured were <22.0 inches (559 mm), whereas just under 17% were ≥26.0 inches (660 mm; Figure 5). A total of 160 male walleye were also captured, ranging in size from 15.9 to 25.6 inches (406 to 649 mm) with an average length of 19.8 inches (503 mm; Figure 5). Nearly 44% of the males that were captured were >20 inches or 508 mm (Figure 5). No walleyes of unknown sex were captured in the Peshtigo River.

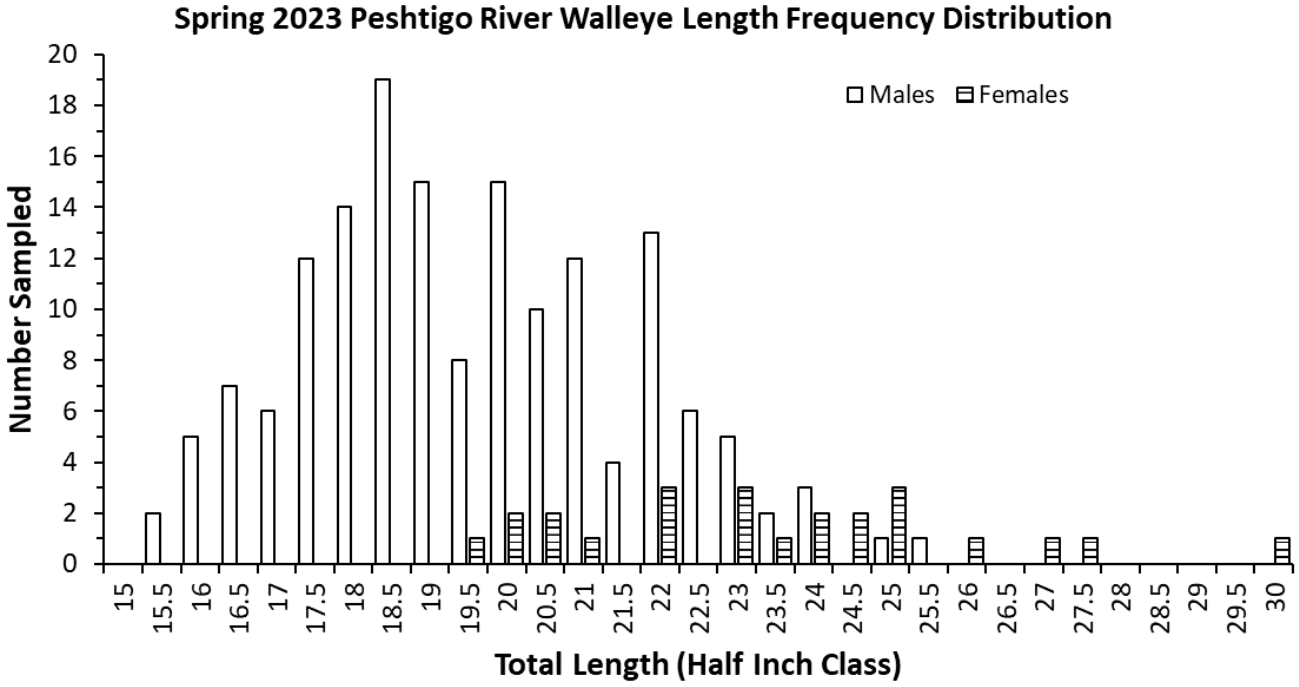

Figure 5. The length distribution of walleye captured during the 2023 spring electrofishing survey on the Peshtigo River.

During the 2023 spring Peshtigo River survey, dorsal fin spines were collected from 171 walleye while an age length key was used to assign ages to 13 walleye. The percentage of male and female walleye in each age class in the Peshtigo River adult spawning population is shown in Figure 6. Age-5 walleye were again the largest age class in the spring adult spawning population, making up approximately 44% of the male walleye and 29% of the female walleye that were captured (Figure 6). It is not surprising that age-5 walleyes were the largest age class in the adult spawning population since all male and female walleye should be maturing by this age and the 2018 year class (i.e., the age-5 adults) was the largest year class recorded in fall young of year (YOY) electrofishing surveys.

Ages 6, 7 and 8 were the next largest age classes for male walleye, with each of these age classes making up 9-14% of the male spawning walleye population (Figure 6). Ages 9 and 10 also made up just over 5% of the male spawning population (Figure 6). Ages 7, 8 and 10 were the next largest age classes of female walleyes, with each of these age classes making up 17-21% of the female spawning walleye population (Figure 6). All but one age class from ages 3-16 were present in the male walleye spawning population while all but two age classes from ages 5-14 were present in the female walleye spawning population, meaning at least 13 age classes were

contributing to the adult spawning population of walleye in the Peshtigo River in 2023 (Figure 6).

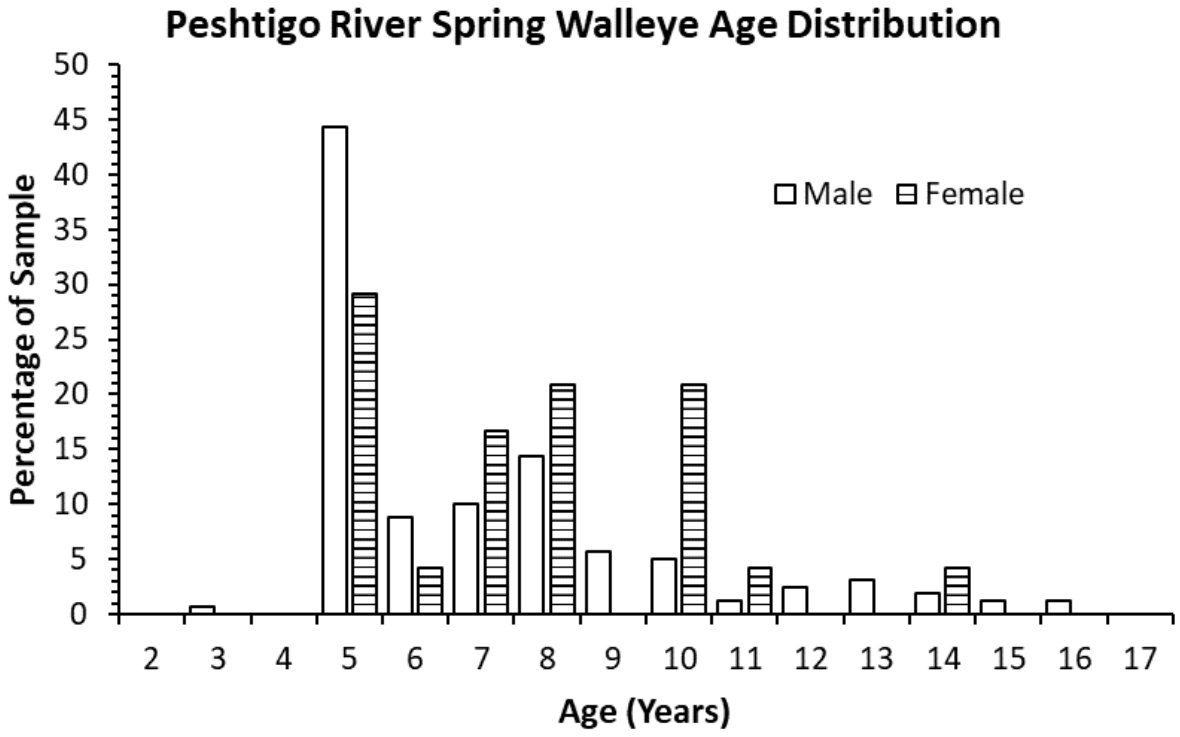

Figure 6. Age-frequency distribution of male and female walleye captured during the spring spawning run from Peshtigo River in 2023. The data are presented as the percentage that each age class contributes to the total sample.

MENOMINEE RIVER

Spring 2023 electrofishing surveys of the Menominee River were conducted on April 10, April 11 and April 12. Water temperatures ranged from 44-47° F depending on location and date. A total of 2.1 hours of electrofishing effort was expended to capture 248 walleye for a catch rate of 118.1 walleye per hour of electrofishing. Distance electrofished was not recorded for all stations; therefore, walleye catch per mile of electrofishing cannot be calculated. Captured walleye ranged in size from 15.4 to 28.7 inches (392 to 728 mm) and had an average length of 20.7 inches (526 mm).

Over the three days of electrofishing, 107 female walleye were captured, ranging in size from 17.8 to 28.7 inches (454 to 728 mm) with an average length of 22.1 inches (561 mm; Figure 7). Just over half of the female walleye that were captured were <22.0 inches (559 mm), whereas just over 6% were ≥26.0 inches (660 mm; Figure 7). A total of

141 male walleye were also captured, ranging in size from 15.4 to 25.2 inches (392 to 639 mm) with an average length of 19.7 inches (501 mm; Figure 7). Just over 40% of the males that were captured were >20 inches or 508 mm (Figure 7). No walleyes of unknown sex were captured in the Menominee River.

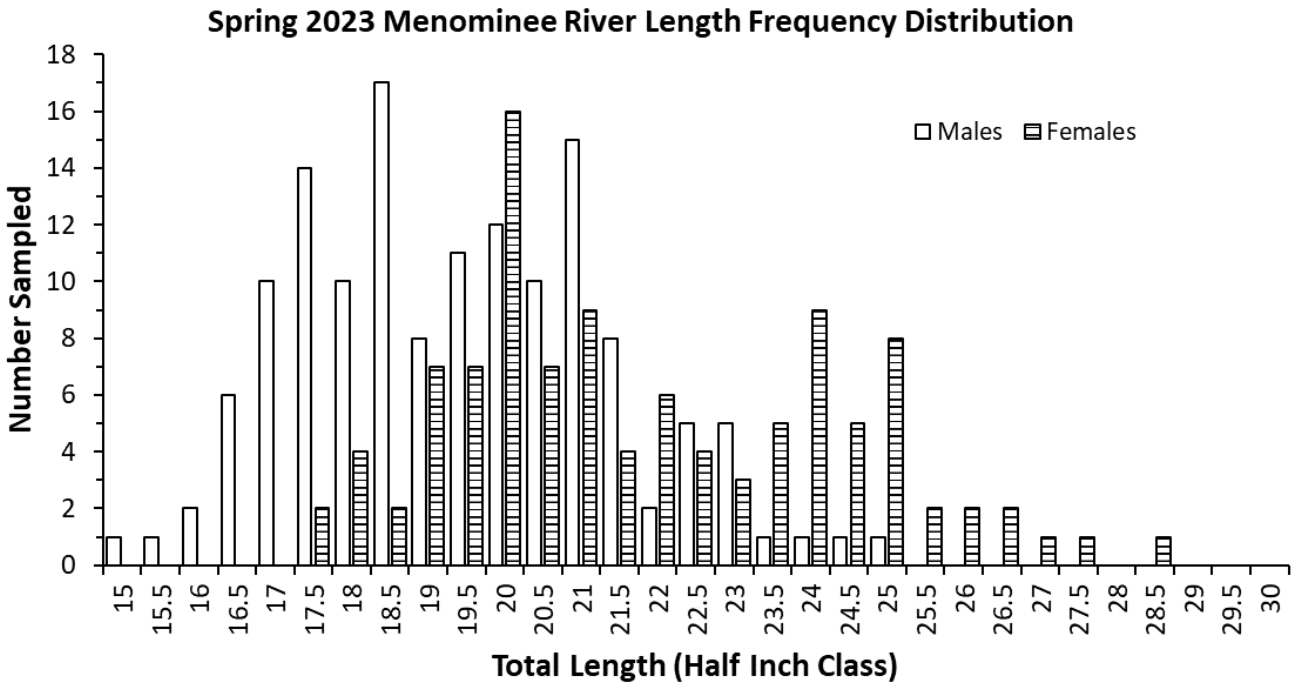

Figure 7. The length distribution of walleye captured during the 2023 spring electrofishing survey on the Menominee River.

During the 2023 spring Menominee River survey, dorsal fin spines were collected from 133 walleye while an age length key was used to assign ages to 115 walleye. The percentage of male and female walleye in each age class in the Menominee River adult spawning population is shown in Figure 8. Age-5 walleye were again the largest age class in the spring adult spawning population, making up approximately 47% of the male walleye and 50% of the female walleye that were captured (Figure 8). It is not surprising that age-5 walleyes were the largest age class in the adult spawning population since all male and female walleye should be maturing by this age and the 2018 year class (i.e., the age-5 adults) was the largest year class recorded in fall young of year (YOY) electrofishing surveys.

Ages 7, 9 and 10 were the next largest age classes for male walleye, with each of these age classes making up 8-13% of the male spawning walleye population (Figure 8). Ages 7, 8 and 10 were the next largest age classes of female walleyes, with each of these age classes making up 8-9% of the female spawning walleye population (Figure

8). All but two age classes from ages 3-15 were present in the male walleye spawning population while all age classes from ages 5-14 were present in the female walleye spawning population, meaning at least 12 age classes were contributing to the adult spawning population of walleye in the Menominee River in 2023 (Figure 8).

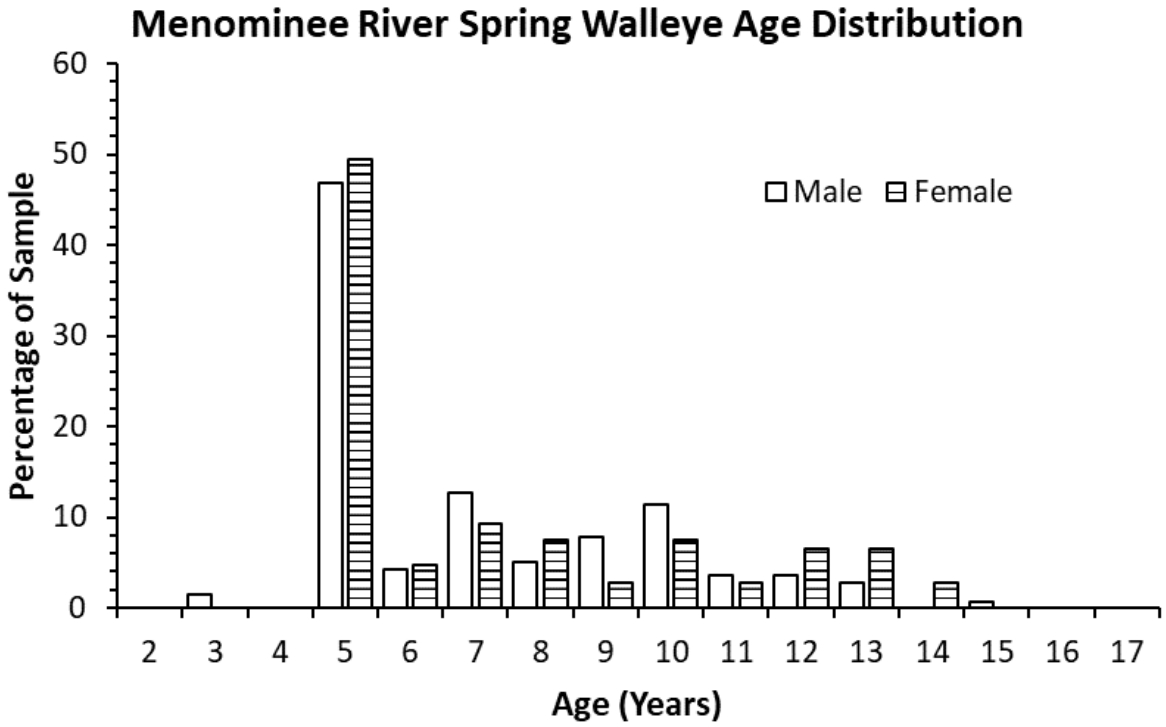

Figure 8. Age-frequency distribution of walleye captured during the spring spawning run from the Menominee River in 2023. Male and female ages are pooled to determine the percentage of the run represented by each year class. The data are presented as the percentage each age class contributes to the total sample.

WALLEYE GROWTH RATES

Both male and female walleye from the Green Bay system are growing fast. By age-5, male walleye average just over 18 inches long and female walleye average about 20.5 inches long (Figure 9). Both male and female walleye from the Green Bay system are growing faster than the statewide average with both sexes tending to be 1.5-2 inches longer than an average walleye of the same age captured throughout the state of Wisconsin (Figure 9).

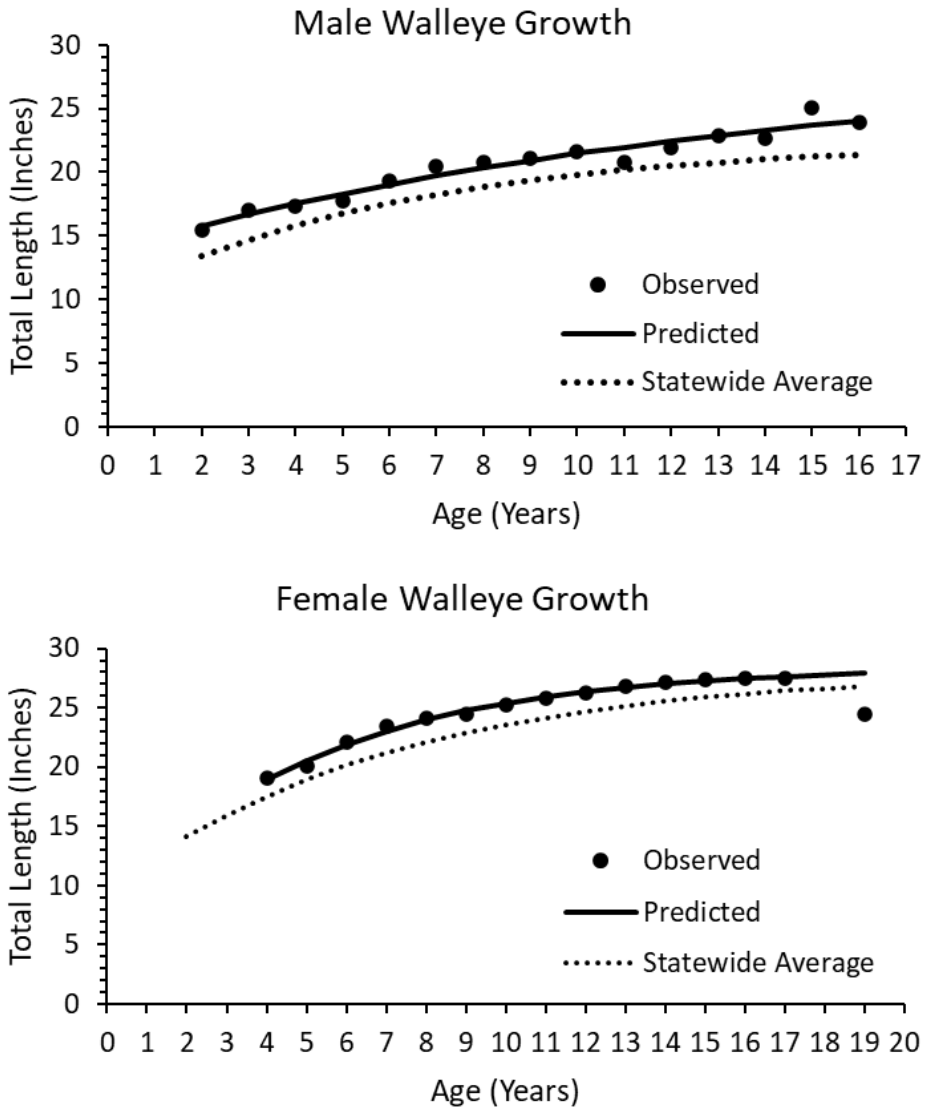

Figure 9. Observed (solid black dots) and predicted (solid black line) mean lengths at age for male (top) and female (bottom) walleye captured in 2023 spring electrofishing surveys of the Fox River, Oconto River, Peshtigo River and Menominee River. The dotted black line represents the statewide average growth for male and female walleyes.

SYNOPSIS OF ADULT SPAWNING POPULATIONS

All four of the major tributaries continue to support healthy walleye spawning populations. Age-5 walleye were the dominant age class in all four tributaries, with this age class making up 25 percent or more of the adult spawning population for each sex in each river. Age-5 walleye made up the largest percent of the adult population in the Fox River, making up 81% of the male walleye and 62% of the female walleye that were captured. Despite the dominance of age-5 walleye in the

spawning populations, walleye that were age-15 or older were captured in all four tributaries with most age classes up to 15 years old being present in all four rivers. Many large walleye were captured in each river with the average length of a female walleye being 21.9 inches or larger across the four rivers and walleyes >28.0 inches being captured in each of the four rivers.

Fall Electrofishing Index Surveys

During the fall of 2023, a total of 10.03 hours was spent electrofishing 20.56 miles of shoreline between lower Green Bay (9.38 miles and 4.58 hours) and the Fox River (11.18 miles and 5.45 hours) as part of the annual fall YOY walleye index electrofishing survey. A total of 509 walleye ranging in size from 7.1 to 27.3 inches (181 to 693 mm) were captured, with an average length of 13.9 inches (354 mm; Figure 10). Of the 509 walleyes that were captured, 178 were YOY walleye and 331 were age-1 and older. The majority (i.e., 168 or 94%) of the YOY walleye were captured in the Fox River with only 10 (i.e., 6%) being captured in lower Green Bay. About half of the age-1 and older walleye were age-1 (i.e., 12 -15 inches long) from the large 2022 year class.

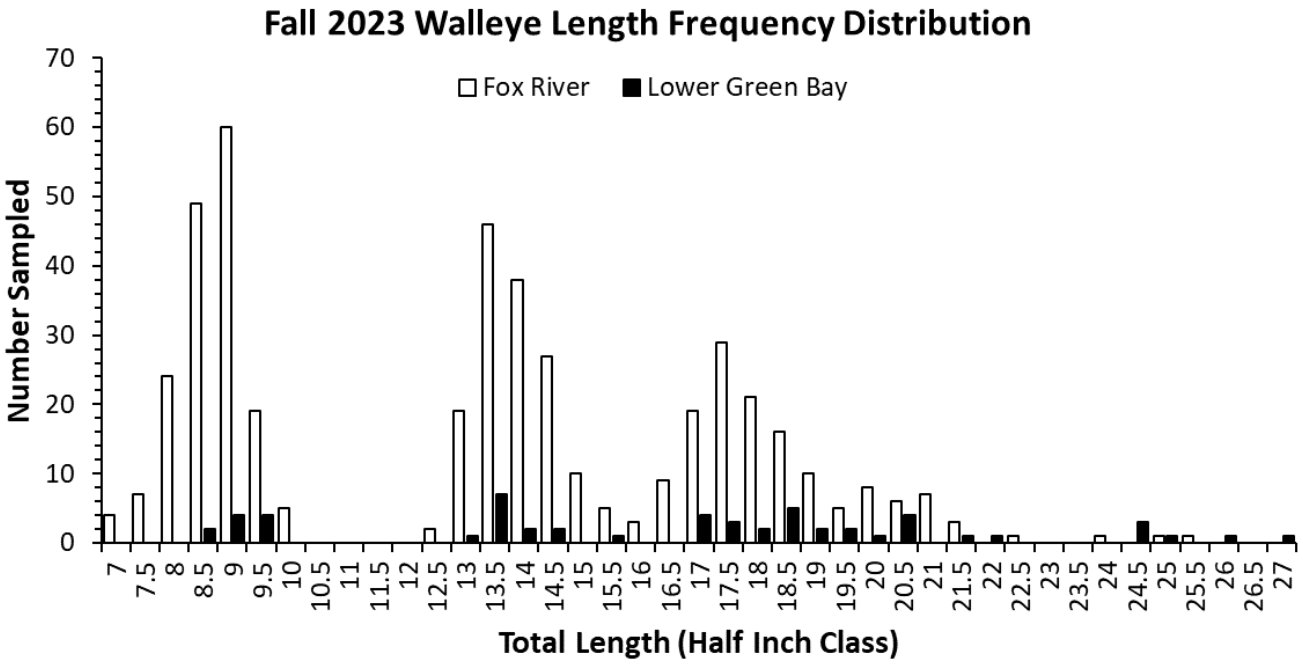

Figure 10. Length frequency distribution of walleye captured in the fall 2022 electrofishing surveys of Lower Green Bay and the Fox River.

RECRUITMENT OF YOY WALLEYE

Results from our 2023 fall YOY electrofishing index surveys were mixed between the Fox River and Green Bay. Catch per unit effort of YOY walleye captured on the Fox River was 30.8 per hour of electrofishing, which was one of the highest CPUEs observed in the Fox River going back to 1993 when the survey started (Figure 11). Furthermore, this catch rate is nearly double the average CPUE of 17.6 YOY walleye per hour of electrofishing between 1993-2022 (Figure 11). The catch rate of YOY walleye in lower Green Bay in 2023 was quite a bit lower at just 2.2 YOY walleye per hour of electrofishing (Figure 11). A catch rate of 2.2 YOY walleye per hour of electrofishing is about 20% of the long-term average catch rate for lower Green Bay between 1993-2022, which is 10.5 walleye per hour of electrofishing (Figure 11). It is unknown why there was such a large difference in catch rates of YOY walleye between the Fox River and lower Green Bay over the last two years. Historically, strong year classes have resulted in high catch rates of YOY walleye in both the Fox River and lower Green Bay. Given the high catch rate of YOY walleye observed in the Fox River over the last two years, the future of the walleye fishery in Green Bay looks bright.

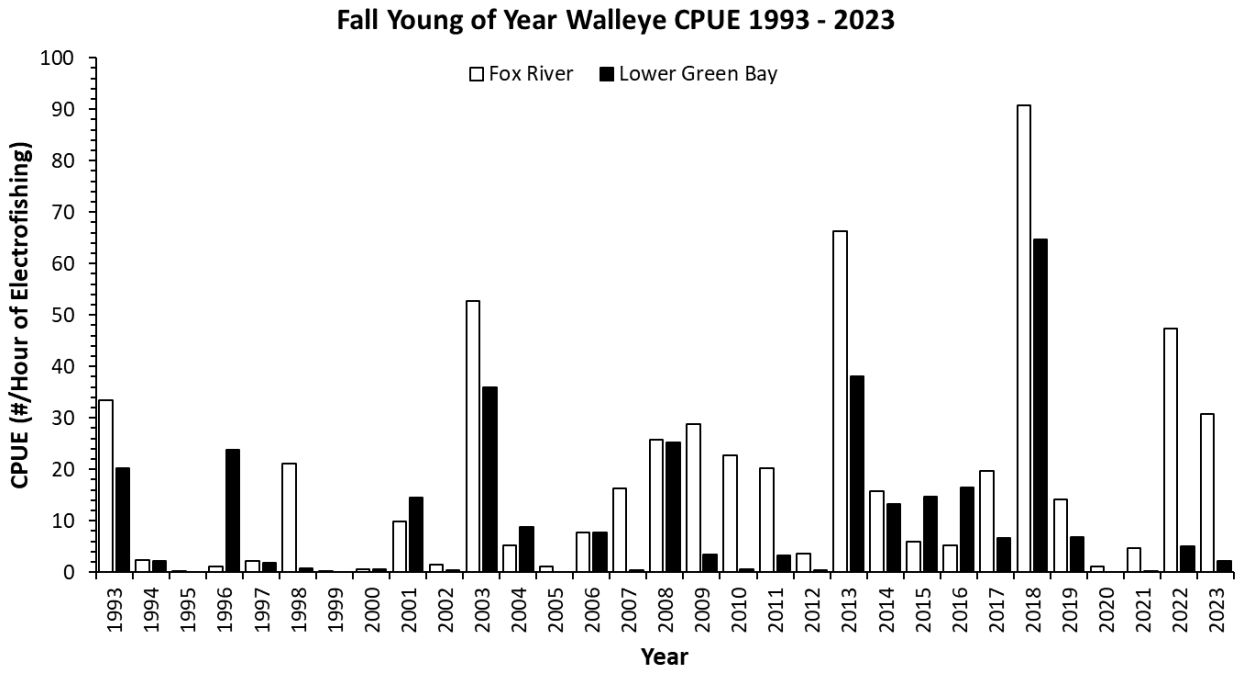

Figure 11. Catch per unit effort (CPUE) of young of year (YOY) walleye in the lower Fox River and lower Green Bay (south of a line drawn from Longtail Point to Point Sable), as measured by CPUE (number per hour) from data collected in electrofishing index surveys during 1993-2023.

Open Water Catch And Harvest Trends

Estimates of catch and harvest of walleye from Wisconsin waters of Green Bay and its tributaries have been generated from creel survey data collected during the open water fishing 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 and the Fox River.

The total catch of walleye during the 2023 open water season was estimated at 328,366 fish (Figure 12). This was highest estimated catch of walleye in any open water season going back to 1986, was about 25,000 walleyes more than what was estimated to be caught in 2022 and is about 35.4% higher than the estimated average annual total catch of 242,498 walleye from 2013-2022. The years 2013-2022 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 walleye in 2023 was estimated to be 131,612 fish, which is nearly identical to the estimate number of walleye that were harvested during the 2022 open water season (Figure 12). Harvest of walleye during the 2023 open water season was about 25.0% higher than the average annual total harvest estimate of 105,306 walleye from 2013-2022 (excluding 2020 because of COIVD and reduced creel effort).

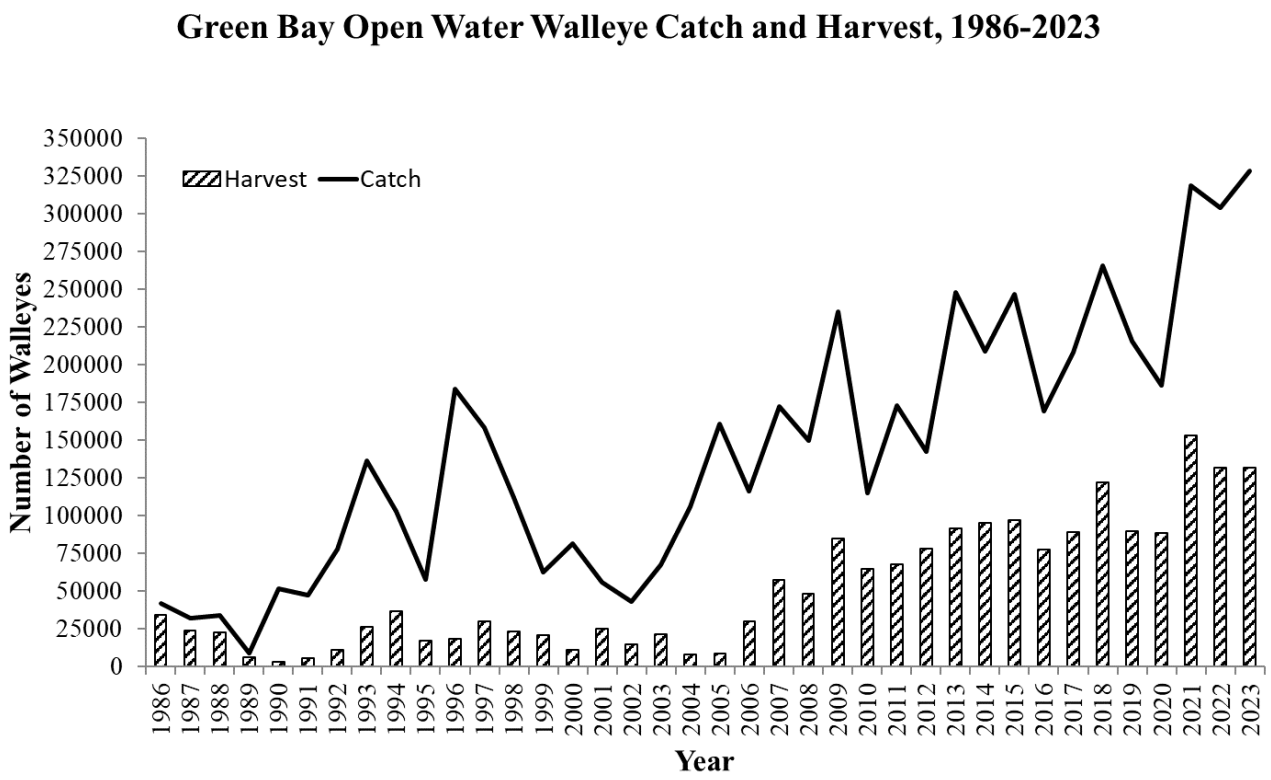

Figure 12. Estimated total open water season catch and harvest of walleye from Wisconsin waters of Green Bay and the lower Fox River from 1986 through 2022. 2020 data reflects only July-November data because of reduced creel effort due to the COVID-19 pandemic. Starting in 2013, the end date for open water creel was extended from Oct. 31 to Nov. 15.

Trends In Angler Effort, Catch Rates And Harvest Rates

Over the last 10-15 years, the number of hours that anglers have spent specifically targeting walleye has steadily increased (Figure 13). For example, in 2011 and 2012, anglers were spending about 400,000–500,000 hours targeting walleye across Green Bay during the open water fishing season (Figure 13). Over the last three years, the number of hours spent targeting walleyes has increased to over 700,000 hours per year (Figure 13). It should be noted that the significant decline in effort observed in 2020 was the result of reduced creel survey effort due to the COVID-19 pandemic.

Despite significant increases in the amount of angling effort targeting walleye over the last 10-15 years, walleye catch rates and harvest rates have remained stable through time (Figure 14). Walleye catch rates show some year-to-year variability but have remained relatively stable with anglers catching between 0.30-0.45 walleye per hour of fishing effort (Figure 14). Walleye harvest rates have also shown some year-to-year variability but have remained relatively steady with anglers harvesting 0.10-

0.20 walleye per hour of fishing effort (Figure 14). Steady angler catch and harvest rates show that the walleye fishery remains strong in Green Bay and is not showing any signs of significant declines.

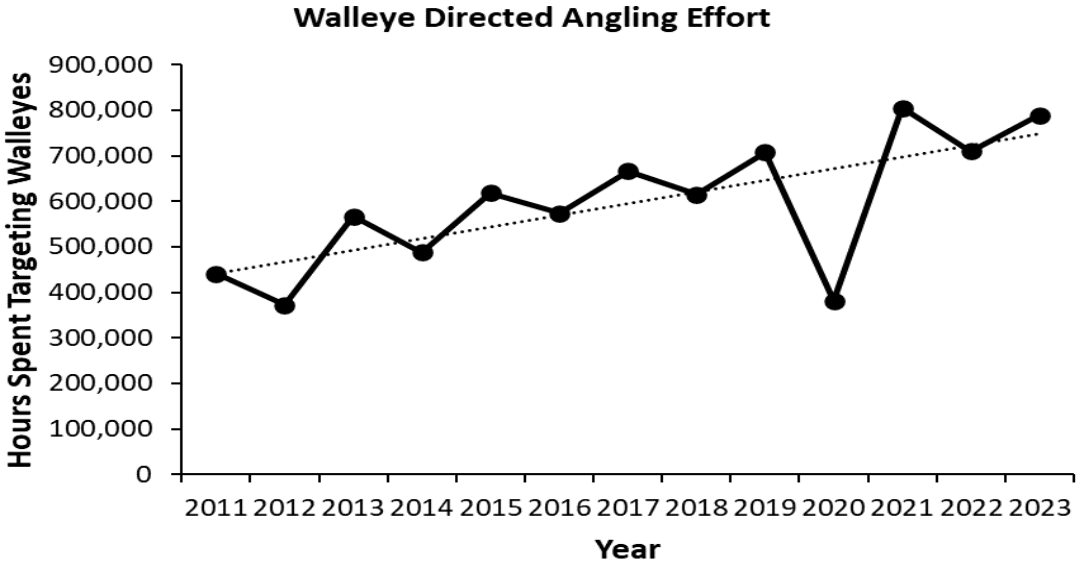

Figure 13. Estimated number of angling hours spent specifically targeting walleye in Wisconsin waters of Green Bay from 2011 through 2023. The light dotted line represents a linear trend line to show the general trend in directed angling effort through time. 2020 data reflects only July-November data 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.

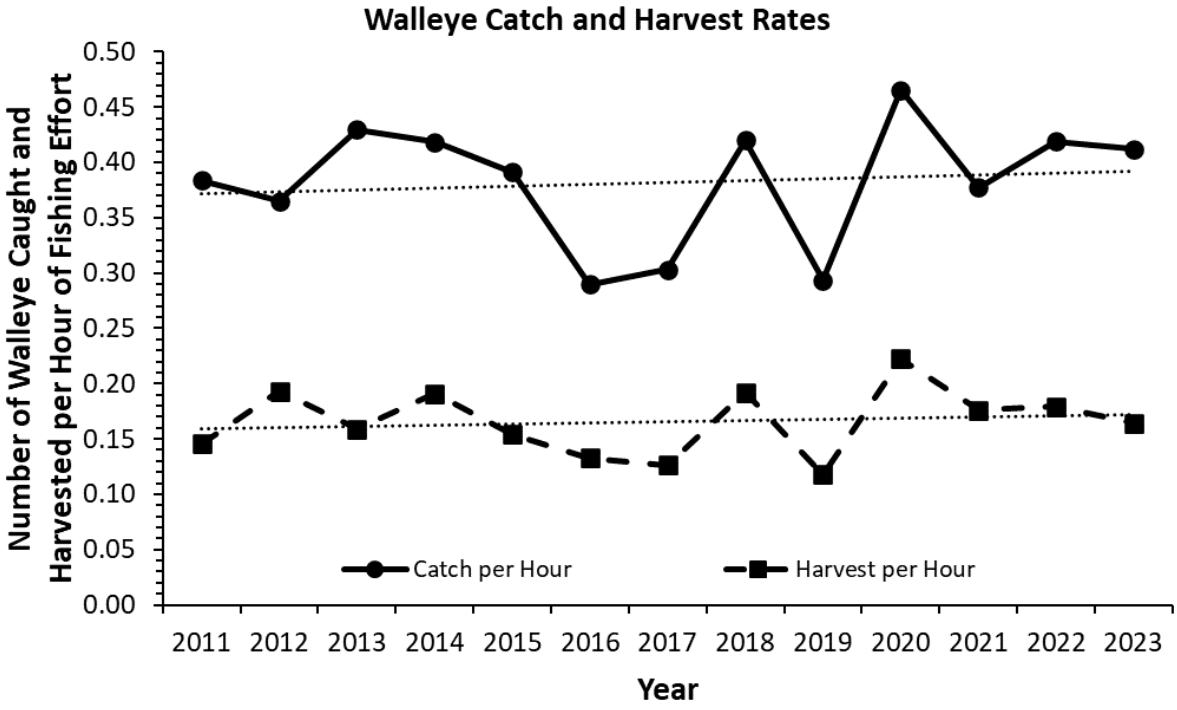

Figure 14. Estimated catch rates (solid black circles and solid line) and harvest rates (sloid black squares and dashed line) from anglers specifically targeting walleye in Wisconsin waters of Green Bay from 2011 through 2023. The light dotted lines represent a linear trend line to show the general trend in angler catch rates and harvest rates through time. 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 Green Bay walleye fishery appears to be very promising. Substantial walleye year classes have been measured in 13 of the past 16 years during fall electrofishing surveys, with the 2018 cohort being the strongest year class measured since the DNR began monitoring walleye recruitment in 1993. As walleye from the 2018 year class continue to grow, the size of walleye caught by anglers will likely increase for the next year or two. With the large 2022 and 2023 year classes, recruiting to the fishery in a couple of years, the walleye population should remain strong for the foreseeable future.

As the popularity of the fishery continues to grow and as contaminant levels continue to decrease from the Fox River polychlorinated biphenyls (PCB) clean-up, walleye harvest will likely continue to remain high. Despite increases in the number of walleye caught and harvested by anglers, results from surveys show the Green Bay system continues to provide a high-quality walleye fishery that's showing no indications of significant declines that could jeopardize the long-term sustainability

of the fishery. For example, between 6.5-16.6% of the female walleye captured in spring electrofishing surveys across all four rivers were ≥26.0 inches with walleye >28.0 inches also being captured in all four rivers. Furthermore, walleyes age-15 or older were captured in all four of the rivers that support spring spawning runs. Walleye do not often live to be 15+ years old with ≥26.0 inches making up as much as 16% of the female walleye in spring spawning runs in waters that have excessively high amounts of harvest and are experiencing significant quality overfishing. Despite steady increases in the amount of effort targeting walleyes over the last decade, angler catch rates (i.e., the number of walleye caught per hour of fishing) have remained constant and have not shown any signs of declining like would also be expected if the number of walleye in the Green Bay system were declining significantly.

Even though the walleye fishery in Green Bay continues to produce large numbers of walleye as well as trophy walleye, increasing trends in angler effort and harvest have resulted in some anglers sharing their concerns about declines in the quality of the fishery along with the long-term sustainability of the fishery. Many of these anglers have also been asking if more restrictive walleye regulations are necessary. In order to determine if angler harvest is too high and more restrictive regulations are necessary, DNR fisheries staff partnered with Walleyes for Tomorrow to implement a large reward tag study to get annual estimates of angler exploitation (i.e., the percentage of the walleye population that is harvested each year).

This reward tag study started in the spring of 2024 and will continue for the next several years. As part of the reward tag study, fisheries staff will aim to tag up to 5,000 walleyes with floy tags each spring across the five major walleye spawning locations. Two hundred of these tagged walleye will receive a red reward tag that will say “REWARD $100” and will have a “valid until” date printed on the tag.

Anglers who report catching a walleye with a red reward tag that is still valid and have proper verification will receive a $100.00 reward from Walleyes for Tomorrow for reporting this tagged fish. Anglers must have proper verification that they caught a reward tagged walleye with a tag that is still valid to receive the $100 reward. Proper verification could include mailing the physical tag if the fish was harvested or emailing a picture of the tag that includes the three-digit tag number. The walleye does not need to be harvested to receive the $100 reward. Proper verification for a fish that is released includes a close-up picture of the tag in the fish including the three-digit tag number and a picture of the angler holding the fish showing the tag next to the dorsal fin. Anglers should then release the fish with the tag in-tact. The rest of the walleyes will be tagged with a yellow or green floy tag.

Anglers who catch any tagged walleye are encouraged to report their tags to DNRFHGBFISH@WI.GOV, 920-662-5411 or the following address: Attn Fish Biologist, 2984 Shawano Ave, Green Bay, WI 54313. Results from the reward tag study should provide accurate estimates of exploitation in each of the years walleye are tagged. These estimates of annual walleye exploitation rates will give managers a much better understanding of the sustainability of current harvest trends and guide the future management of this fishery. Tools such as a tagging study and the Green Bay creel survey will continue to play a vital role in managing the walleye fishery in the future.

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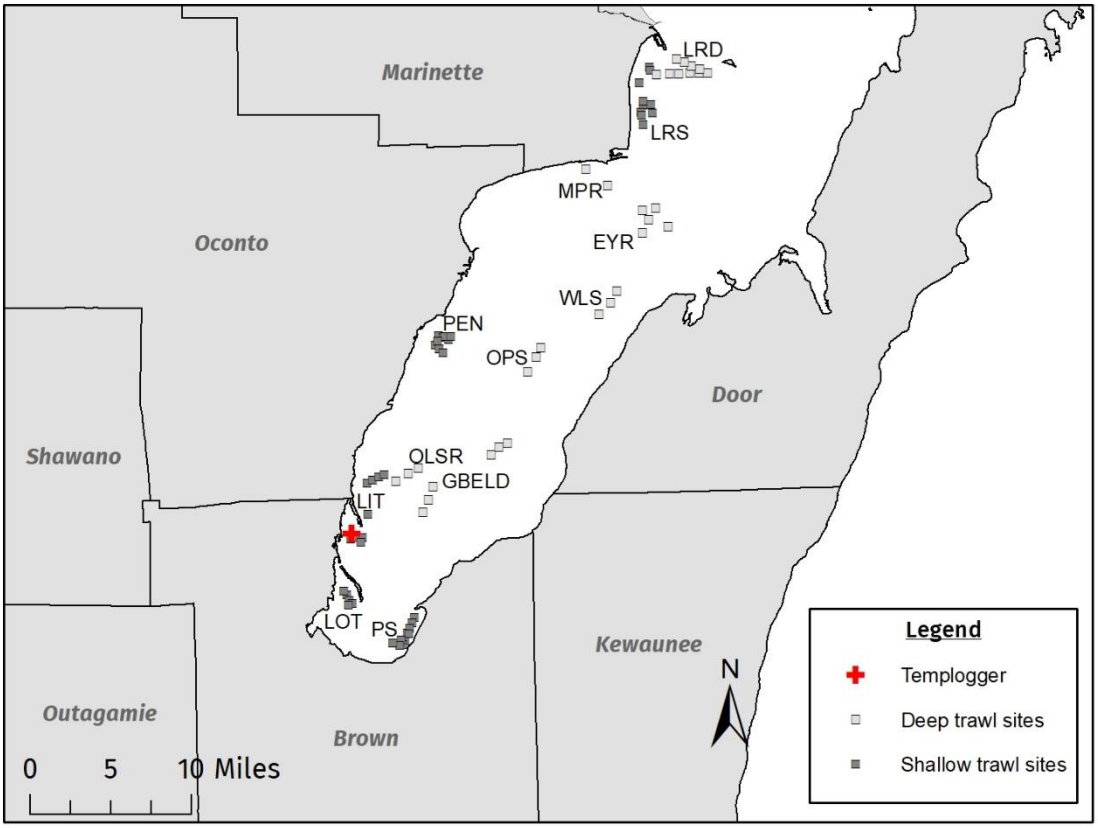
Green Bay Yellow Perch

This report summarizes assessments and monitoring of yellow perch in southern Green Bay completed in 2023 by the Wisconsin Department of Natural Resources (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. Methods are described within each survey section.

Yellow perch abundance in Green Bay was at high levels through the 1980s and early 1990s. During this time, the population ranged from 14 to over 35 million adult yellow perch. The population growth was fueled by strong year classes in 1982 (2,314/trawl hour), 1985 (1,790/hour), 1986 (4,480/hour) and 1988 (1,500/hour). Yellow perch abundance began to decline in the mid-1990s, primarily due to poor recruitment. From 1988 to 2002, only two reasonably strong year classes appeared during summer trawling surveys: 1991 (1,908/hour) and 1998 (849/hour). Since 2002, moderately strong year classes were measured in many but not all years (Figure 2). Since the peak of the perch population in the 1980s, the Green Bay ecosystem has undergone significant changes, most notably the introduction of many invasive species.

Map Of 2023 Sampling Locations



Spawning Assessment

The spring spawning assessment inside of Little Tail Point is currently completed every 3 to 5 years. The last survey was in 2019. The primary objective of that survey is to collect age at maturity data on spawning yellow perch, which is used in the population model. In 2023, double-ended fyke nets were set at three locations offshore in 5 to 8 feet of water as soon as forecasted winds allowed (April 13, 2023). Nearshore surface water temperatures were 52° F when nets were set and reached 57° F when nets were tied open, and this coincided with several days of air temperatures over 80 degrees. Nets were lifted daily until the majority of mature females sampled were ripe or spent on April 15 for a total effort of 12 net nights. April 15 (2023) was the earliest date that 75% of mature female perch were ripe or spent since 1988. Previously, this date has ranged from as early as April 19 (2012) to as late as May 8 (2014), with a mean date of April 25.

Aging structures from immature females, mature females and males were collected from five fish per 10 mm group when possible. Lengths were taken from up to 500 yellow perch per sex and maturity category and incorporated into the age expansion. Due to the large number of yearling yellow perch (<100 mm; n=3976) captured as the survey progressed, only yellow perch >130 mm and gamefish were processed in five of the 12 pots lifted. Age-2 (2021 year class) males comprised 83% of the total males over 100 mm that were measured (n=514) with a mean length of 154 mm, or 6.0 inches. Of the mature females sampled (n=188), 47% were age-2 with a mean length of 174 mm (6.9 inches), while 23% of mature females were age-3 with a mean length of 215 mm (8.5 inches). Age-2 and age-3 females continue to contribute significantly to the spawning population in southern Green Bay (Table 1). As a result of the survey, maturity schedules for age-3 fish were adjusted in the population model, from 100% to 85% of age-3 fish considered mature. Maturity schedules for other ages of yellow perch remained the same.

For other species, brown bullhead (n=45) dominated the catch followed by spottail shiners (n=38) and emerald shiners (n=31). For gamefish, seven adult walleye and two northern pike were captured during the two-night survey.

Table 1. Age composition of total mature females sampled during spring spawning surveys, 2007-2023.

YEAR	AGE-2	AGE-3	AGE-4	AGE-5	AGE-6+	TOTAL (N)
2023	47%	23%	15%	12%	3%	188
2019	48%	46%	5%	1%	1%	164
2016	62%	29%	8%	0%	1%	107
2014	41%	29%	22%	6%	2%	49
2012	37%	49%	12%	2%	0%	181
2011	43%	41%	9%	3%	3%	679
2010	91%	7%	1%	1%	0%	605
2009	75%	11%	11%	1%	2%	350
2008	56%	35%	2%	5%	2%	271
2007	72%	6%	16%	3%	3%	511

Water Temperature

Annual spring and summer temperature monitoring has been ongoing since 2003, with the exception of 2020. A HOBO Water Temp Pro v2® templogger U22 (Onset Computer Corporation) was deployed as soon as ice, weather and staffing conditions allowed (April 13, 2023) near Little Tail Point to record water temperature every 60 minutes until Sept. 20, 2023. Surface water temperature was 52° F and water

temperature at the templogger depth of 8 feet was 46° F at the time of deployment. The templogger was attached to a DNR buoy in approximately 12 feet of water. The May 2023 water temperatures averaged 54.8° F (Table 2). Yellow perch begin to spawn when water temperatures reach 50° F. In general, a later spawning date and warmer May average water temperatures favor yellow perch recruitment in Green Bay.

In 2023, water temperature rose in mid-April, coinciding with an unusual warm period when yellow perch spawning occurred, but then remained below 50° F for the next four weeks. By early June, water temperatures were over 70° F. With the exception of a nine-day period in mid-June, water temperatures were between 70-77° F throughout the summer until early September (Figure 1). Occasional extreme fluctuations of 15-20° F have been recorded in previous summers on the Little Tail templogger, most often during warm weather with strong west or southwest winds that bring in cooler water. However, no cold water upwellings were documented in 2023.

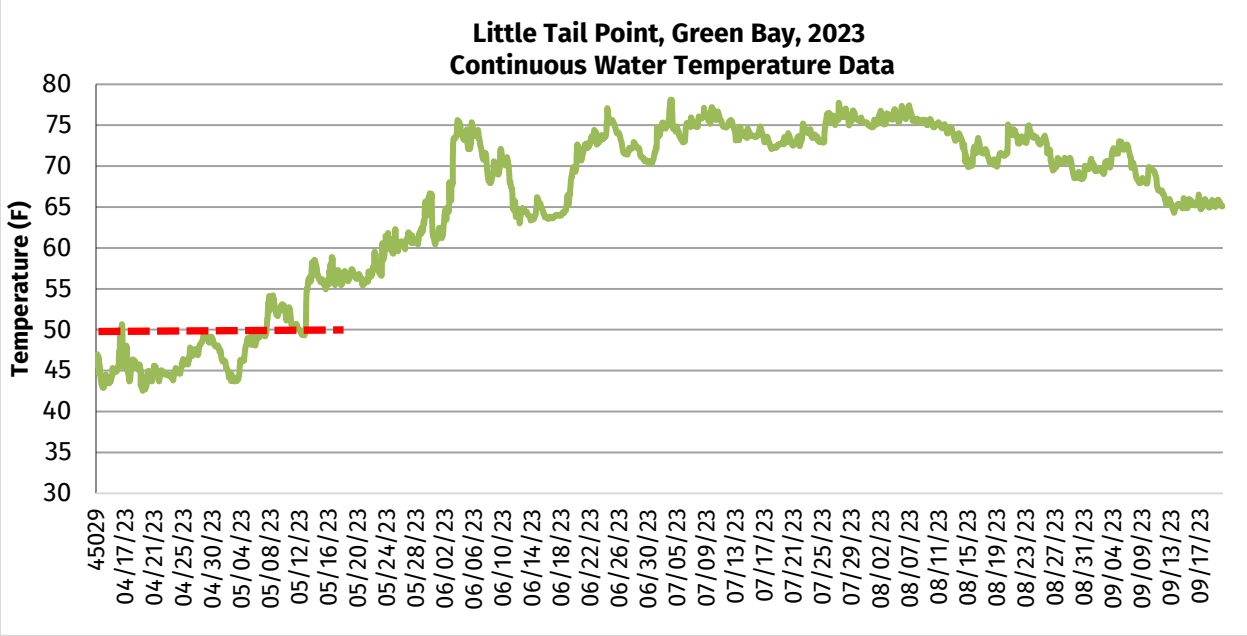


Figure 1. Continuous water temperature recorded at Little Tail Point from April 13 to Sept. 17, 2023. The red dashed line is the 50° F mark. Yellow perch spawning commenced in nearshore shallow areas on April 15.

Table 2. Little Tail Point May water temperature average by year and date when 50°F was reached at the templogger depth of 8 feet below the surface. 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
2023	54.8	16-Apr	2012	62.5	4-Apr
2022	57.3	6-May	2011	55.5	26-Apr
2021	55.4	12-Apr	2010	59.4	12-Apr
2019	52.8	24-Apr	2009	56.8	18-Apr
2018	59.3	Prior to deployment	2008	56.7	22-Apr
2017	55.4	17-Apr	2007	61.1	20-Apr
2016	56.4	17-Apr	2006	56.9	12-Apr
2015	58.8	16-Apr	2005	54.2	19-Apr
2014	55.2	6-May	2004	55.7	16-Apr
2013	56.7	30-Apr	2003	56.7	25-Apr

Beach Seining

In previous years, up to fifteen index sites along the west and east shores of Green Bay were sampled using a beach seine (25 ft wide x 6 ft high, ¼-inch delta mesh with 6 x 6 x 6 feet bag) once in late June and again in July. While this data was not incorporated into the statistical catch-at-age model for yellow perch, it was used as an early indicator of year class strength for yellow perch, walleye and other species prior to trawling surveys.

Due to budget constraints, beach seining surveys were not conducted in 2023 and are not planned for 2024.

Trawling Survey

Annual late summer trawl surveys continued for the 46th 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-foot 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 and an area of 1 acre. 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 collected for gamefish and lake whitefish.

For all locations, the mean length of YOY yellow perch was 74 mm (range: 63-88 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 2023 produced a weak year class, with the relative abundance of YOY yellow perch (2/hour), ranking as the lowest since the deep-water sites were added in 1988 (Figure 2).

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-1 and older fish was 1.3/hour in 2023 compared to the 36-year average of 380/hour. All eight of the age-1 and older fish captured were yearlings (2022 year class) with a mean length of 147 mm (range: 117-162 mm). Gizzard shad were the dominant species captured at shallow sites, followed by YOY alewife, YOY white perch and adult white perch. At deep sites, alewife adults were the most abundant species sampled. Other species in decreasing order of abundance captured at deep sites were rainbow smelt adults, YOY alewife, lake whitefish juveniles and round gobies.

At each of the 12 locations, a temperature and dissolved oxygen profile was taken along with a secchi disk reading. Water clarity was highest at the northernmost locations and decreased farther to the south, ranging from 5.2 m at Little River Deep (LRD) off Marinette to 0.4 m at Point Sable (PS) in the southern bay.

In 2023, dissolved oxygen levels were near or below 3 mg/L in the bottom 20 feet of water at sites 60 feet deep at the West of Little Sturgeon (WLS) site and in the bottom 10 feet of water at sites 33 feet deep at the Green Bay Entrance Light (GBELD). Warm water temperatures during the summer of 2023 likely contributed to the “Dead Zone,” a layer of cold water on the bottom that has low oxygen. Since 2018, the “Dead Zone” has been prevalent in four of the last six years of trawling surveys.

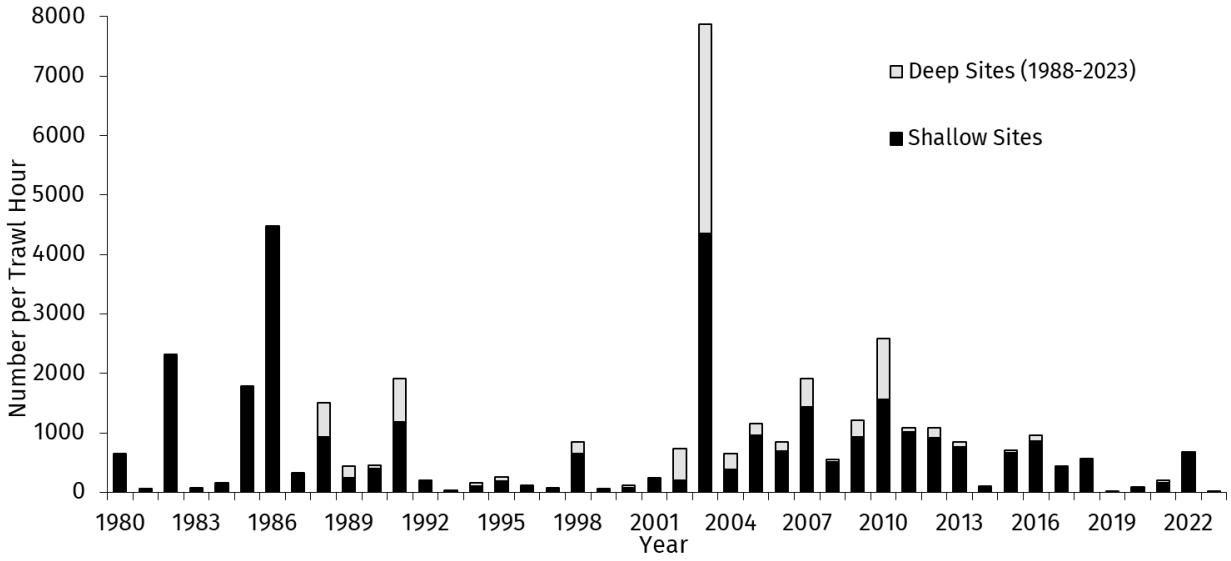


Figure 2. Relative abundance (weighted area average) of young of year yellow perch collected during late summer index trawling surveys in Green Bay from 1980 to 2023.

Recreational Harvest

Since 2006, recreational fishing regulations for yellow perch in Wisconsin waters of Green Bay consists of 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. Biological data from yellow perch collected through the creel survey were used to describe the age and size composition of the harvest.

Winter harvest is influenced largely by ice conditions, which can limit effort. This was certainly the case in the winter of 2023, when poor ice conditions prevailed in some areas of Green Bay. Overall angler effort (122,418 hours) for all species was the lowest recorded since 2006 and half of the previous 20-year (2003-2022) average of 224,639 hours. An estimated 26,136 yellow perch were harvested between January and March 15, 2023, which is well below the previous 20-year (2003-2022) average of 43,565 yellow perch harvested in the winter (Figure 3).

Open water harvest of yellow perch as estimated through creel surveys (May 20 to Nov. 16) in 2023 was 98,867 fish, down from 151,037 fish in 2022 (Figure 3). The majority of the open water harvest was by boat anglers launching at ramps in Brown County (37%), Door and Kewaunee counties (31%), and Oconto County (13%). A majority of the open water harvested fish were age-2 (2021 year class; 52%), age-3 (2020 year class; 21%) or age-4 (2019 year class; 14%), but ages from 1-6 were present. The mean length of open water harvested yellow perch was 8.9 inches (n=322).

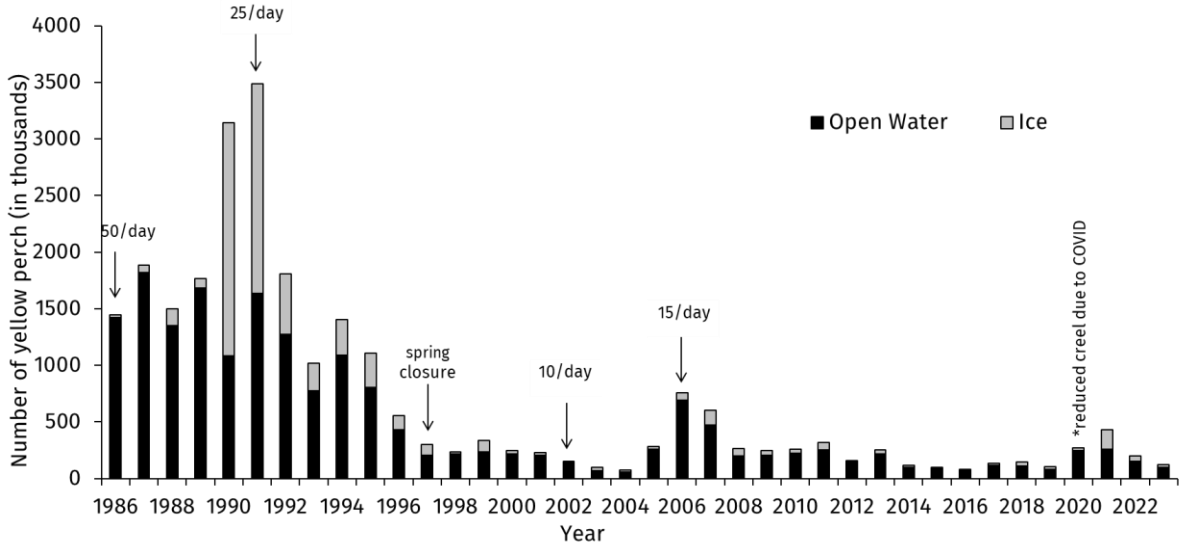


Figure 3. Estimated recreational harvest of yellow perch in Green Bay from 1986 to 2023. Regulation changes are indicated by arrows. Open water creel estimates for 2020 are from July-November only.

Commercial Harvest

Beginning in 1983, the yellow perch commercial harvest in Green Bay (Zone 1) was regulated on a "quota year" basis beginning in July and running through June of the following year, with a closed period from March 16 to May 19. In 2012, the quota season began operating on a "calendar year" basis, from Jan. 1 to Dec. 31, with the same closed period in spring. The initial quota established in 1983 was set at 200,000 pounds. Since then, it increased several times up to 475,000 pounds during the 1989-90 quota year. The quota was adjusted to as low as 20,000 pounds in 2001-02. Following the strong 2003 year class, the quota was increased to 60,000 pounds in 2005-06 and again to 100,000 pounds in 2008-09. The total allowable commercial harvest has remained at 100,000 pounds since. The minimum size limit for yellow perch commercial harvest in Zone 1 is 7½ inches. Commercial fishing rules are further detailed in Wisconsin Administrative Code Chapter NR 25[10].

The 2023 commercial harvest was reported by commercial fishers, who are required to weigh and report their harvest daily into an online database. Fish sampled by the DNR at commercial landings were used to describe the age and size composition of the catch.

[10] https://docs.legis.wisconsin.gov/code/admin_code/nr/001/25

In 2023, commercial fishers harvested 58,202 pounds of yellow perch (an estimated 184,976 fish), compared to 68,515 pounds in 2022. Most commercial harvest was with gill nets (98.6%), while drop nets comprised only 1.4% of the total harvest in 2023. The average harvest rate (CPUE) for gill nets in 2023 was 41 pounds per 1,000 feet fished, up from 36 pounds per 1,000 feet fished in 2022. Drop net CPUE was 6 pounds per lift in 2023, down from 43 pounds per lift in 2022. Age-2 perch (2021 year class) comprised 74% of the total commercial harvest in 2023, while age-3 (2020 year class) comprised 11%.

Population Modeling

Data collected in 2023 was incorporated into the statistical catch-at-age model for yellow perch in the Wisconsin waters of Green Bay. The model was updated and re-run during the spring of 2024. Inputs included harvest, effort and age composition from commercial and sport fisheries and YOY data from trawling surveys. Outputs of the model estimate that the adult (age-1 and older) yellow perch population in 2023 was 1.2 million fish (Figure 4). This is a decrease from the previous 10-year average of 1.75 million yellow perch.

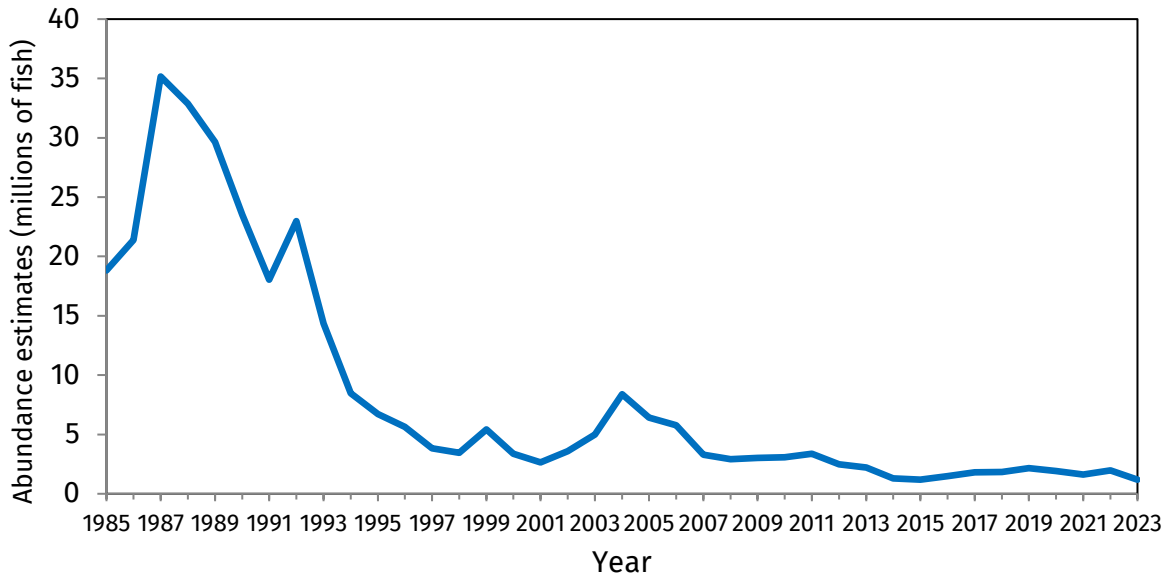


Figure 4. Estimated yellow perch abundance from 1985 to 2023, Wisconsin waters of Green Bay.

The Future Of The Yellow Perch Fishery

The yellow perch population in Green Bay has remained relatively stable for the last decade, with measurable year classes (500/hour or greater) produced in 2015, 2016, 2017, 2018 and most recently in 2022. Although very low numbers of YOY yellow perch were captured in the 2023 trawling survey, environmental factors during the survey (warm water temperatures and low oxygen) at many sites likely affected catches during the two-week trawling survey. Catches of several other species commonly encountered such as round goby, trout-perch, and common carp were also much lower than previous surveys. Anecdotal observations of YOY yellow perch during fall (Sept/Oct) walleye electrofishing surveys in southern Green Bay suggest that the 2023 year class of yellow perch may be more abundant than August trawling surveys indicated. In the spring of 2024, county Land and Water Conservation Department staff noted high numbers of yearling (3-4 inch) yellow perch in some of their fyke nets set in small tributaries near the Bay while targeting northern pike. Yellow perch aging data collected in 2024 and 2025 (creel, trawl surveys, commercial monitoring) will retrospectively show if the 2023 trawling survey was indeed an underestimate.

For example, the 2021 year class was fairly low (203/hour) based on trawling surveys that year. However, the “Dead Zone” effect in 2021 may have led to an underestimation of that year class. The 2021 year class made a strong showing in the fishery, comprising 74% of the commercial harvest and 52% of the sport harvest in 2023. In addition, the moderately strong 2022 year class of yellow perch (660/hour) should be available for harvest by the summer of 2024. The DNR will continue monitoring the yellow perch fishery, provide status updates to the public 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 2,485,275 hours during 2023, which was approximately 3% above the five-year average of 2,407,018 hours (Table 1). The most notable changes in the effort were in the moored boat fishery, which was down almost 25% from the five-year average, and in the shore fishery, which was down 35% from the five-year average. Effort in the ramp fishery increased from 2022 (1,521,125 hours in 2022 and 1,644,268 hours in 2023) and was approximately 11% above the five-year average. Effort in the charter fishery decreased from 2022 (314,892 hours in 2022 and 279,220 in 2023) and was approximately 7% below the five-year average. Effort in both the pier and stream fisheries increased since 2022. Effort in the pier fishery was almost 7% above the five-year average and effort in the stream fishery was 5% above the five-year average.

Overall, the 2023 season was successful for Wisconsin's Lake Michigan trout and salmon anglers. Overall harvest was higher, with 298,528 salmonids harvested (Table 4). The harvest rate increased from 2022 to 0.1201 fish per hour, which was higher than the five-year average harvest rate. Harvest for both Chinook salmon and coho salmon were above the five-year average harvest. The 2023 Chinook harvest of 130,811 fish was the highest Chinook harvest on record since 2016 and approximately 32% above the five-year average. Although the 2022 coho harvest of 87,792 fish was a decrease from 2022, it was the second-highest harvest on record since 2018 and 27% above the five-year average. Harvest for rainbow trout and brown trout were both below the five-year average, but the rainbow trout harvest of 47,322 was an increase from 2022. The brown trout harvest of 6,963 fish was the second-lowest on record since 1986. The 2023 lake trout harvest of 25,580 was a slight increase from 2022, but remained 20% the five-year average. The decrease in lake trout harvest can most likely be attributed to increased salmon harvest. In 2023, 60 brook trout were harvested in the stream fishery. Brook trout were stocked in two Lake Michigan tributaries from 2020-2023.

The standard weights for all five major salmonid species (rainbow trout, lake trout, coho salmon, Chinook salmon, and brown trout) were below the five-year average (Table 5).

The open-water yellow perch harvest in 2023 was 99,994 fish (Table 2). This was a decrease in harvest from 2022. Lake Michigan yellow perch harvest was 2,353 fish and the Green Bay harvest was 97,641 fish.

Table 1. Fishing effort (angler hours) by various angler groups in Wisconsin waters of Lake Michigan and Green Bay during 2023 and percent change from the 5-year average (2019-23).

YEAR	RAMP	MOORED	CHARTER	PIER	SHORE	STREAM	TOTAL
2023	1,644,286	171,115	279,220	95,521	54,689	240,444	2,485,275
% change	11.55%	-24.97%	-7.71%	6.74%	-35.27%	5.29%	3.25%

Table 2. Sport harvest by fishery type and species for Wisconsin waters of Lake Michigan and Green Bay during 2023.

SPECIES	RAMP	MOORED	CHARTER	PIER	SHORE	STREAM	TOTAL
Coho salmon	39,119	13,258	31,294	2,085	1,037	999	**87,792**
Chinook salmon	55,351	21,751	39,009	1,285	320	13,095	**130,811**
Rainbow trout	18,522	10,689	15,115	41	65	2,890	**47,322**
Brown trout	5,073	609	755	90	215	221	**6,963**
Brook trout	0	0	0	0	0	60	**60**
Lake trout	8,233	2,853	14,486	8	0	0	**25,580**
Northern pike	3,543	0	0	35	411	97	**4,086**
Smallmouth bass	1,803	1,839	0	107	278	45	**4,072**
Yellow perch	85,340	8,916	0	2,327	1,735	1,676	**99,994**
Walleye	109,089	2,286	0	254	0	20,764	**132,393**
TOTAL	**326,073**	**62,201**	**100,659**	**6,232**	**4,061**	**39,847**	**539,073**

Table 3. Total number of fish harvested by species across all angler groups in Wisconsin waters of Lake Michigan, 2014-2023.

SPECIES	2014	2015	2016	2017	2018	2019	2020*	2021	2022	2023	TOTAL (SINCE 1986)
Brook trout	0	0	0	0	0	0	0	0	8	60	39,108
Brown trout	23,511	20,335	23,885	20,404	12,625	8,013	3,317	9,178	9,013	6,963	1,202,455
Rainbow trout	72,724	59,127	77,004	66,599	57,141	50,258	54,430	58,597	35,304	47,322	2,511,766
Chinook salmon	130,231	114,528	138,110	84,163	84,228	63,043	80,890	100,323	120,148	130,811	7,499,830
Coho salmon	52,297	41,067	125,748	119,788	85,459	32,197	40,349	80,009	104,692	87,792	3,044,489
Lake trout	25,424	35,778	19,046	20,345	26,747	34,197	38,271	40,145	23,067	25,580	1,611,305
TOTAL	304,187	270,835	383,793	311,299	266,200	187,708	217,257	288,252	292,232	298,528	15,908,953
Harvest Per Hour	0.1164	0.0989	0.1464	0.1222	0.1086	0.0795	0.1111	0.1054	0.1174	0.1201	0.1402

Table 4. Total number of salmonids harvested by year by angler group in Wisconsin waters of Lake Michigan, 2014-2023.

FISHERIES TYPE	2014	2015	2016	2017	2018	2019	2020*	2021	2022	2023	TOTAL (SINCE 1986)
Ramp	114,649	103,602	163,103	135,785	103,356	59,786	51,777	95,194	109,698	126,298	6,118,894
Moored	57,004	53,182	74,000	46,638	50,785	43,816	47,463	67,073	52,521	49,160	3,982,793
Charter	97,186	91,255	112,150	100,333	89,446	73,521	92,845	106,351	98,387	100,659	4,012,739
Pier	7,898	8,197	10,153	4,963	2,493	695	1,066	2,396	2,419	3,509	373,038
Shore	10,001	4,935	9,446	7,119	4,242	2,946	4,460	2,643	4,647	1,637	467,705
Stream	17,449	9,664	14,941	16,461	15,878	6,944	19,646	14,595	24,560	17,265	953,784
TOTAL	**304,187**	**270,835**	**383,793**	**311,299**	**266,200**	**187,708**	**217,257**	**288,252**	**292,232**	**298,528**	**15,908,953**

**Note: Creel estimates for 2020 are from May-November only. Final column in Tables 3 and 4 represents total number of salmonids harvested from 1986-2023.*

Table 5. Standard weight (lbs) for salmonids from Wisconsin waters of Lake Michigan and Green Bay from 2018-2023 and percent change from the 5-year average.

SPECIES	2018	2019	2021	2022	2023	% CHANGE
Brown trout	3.45	5.48	3.93	3.22	3.26	-15.76%
Rainbow trout	3.74	4.35	4.41	4.57	3.59	-13.05%
Chinook salmon	10.01	10.94	10.63	9.58	9.91	-3.01%
Coho salmon	4.29	4.45	4.26	4.44	3.37	-19.03%
Lake trout	6.08	6.35	5.89	6.28	5.80	-4.60%

*** Note – No biological data was collected from sport-caught fish in 2020.*

Harvest of northern Pike, smallmouth bass and walleye decreased from 2022. However, walleye harvest only slightly decreased (133,239 were harvested in 2022, and 132,393 were harvested in 2023). The 2023 northern pike harvest was estimated at 4,086 fish and smallmouth bass harvest was estimated at 4,072 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, 2023

The total bloater chub harvest from commercial gill nets was 4,879 pounds for the calendar year 2023. This was a minimal increase from last year in the southern zone. Although there were 13 permits in the northern zone and 24 in the southern zone, no fishers 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, 1986-2023.

YEAR	HARVEST	QUOTA	FISHERS	EFFORT (X 1,000 ft)	CPE
1986	1,610,834	2,700,000		34,606.1	46.5 [b]
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 [a]
1991	1,946,793	3,000,000	58	45,288.3	43.0
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	0.0	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
2022	4,866	2,645,625	26	304.7	15.9
2023	4,879	2,645,625	24	409.0	12.1 [c]

[a] for the years 1990, 1991, & 1998-2023 totals were by calendar year.
[b] for the years 1986-89 & 1992-97 the totals were through Jan. 15 of the following year.
[c] for the year 2023, the harvested weight of chubs was reported in both round and dressed weight. All weights were converted to dressed and reported combined in the table above.

Table 2. Harvest, quota, number of fishers and effort (feet) for the Wisconsin Northern Zone gill net chub fishery, 1986-2023.

YEAR	HARVEST	QUOTA	FISHERS	EFFORT (x 1,000 ft)	CPE
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[a]
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
2022	0	600,000	16	0	0
2023	0	600,000	13	0	0[c]

[a] *for the years 1990, 1991, & 1998-2023 totals were by calendar year.*
[b] *for the years 1986-89 & 1992-97 the totals were through Jan. 15 of the following year.*
[c] *for the year 2023, the harvested weight of chubs was reported in both round and dressed weight. All weights were converted to dressed and reported combined in the table above.*

Harvest in the southern zone, including waters from Algoma south to Illinois, was 4,879 pounds in 2023. The total catch in the southern zone remained about the same as 2022 and remains at less than 1% of the allowed quota of approximately 2.6 million pounds for the southern zone. In the northern zone, essentially waters from Baileys Harbor to Michigan, zero pounds were reported. The southern zone CPUE was slightly down compared to 2022. Total gill net effort was up slightly in the southern zone compared to 2022. In the south, 24 permits were issued, with 2 reporting harvesting chubs in 2023, while 0 of 13 permit holders reported harvesting chubs in the north.

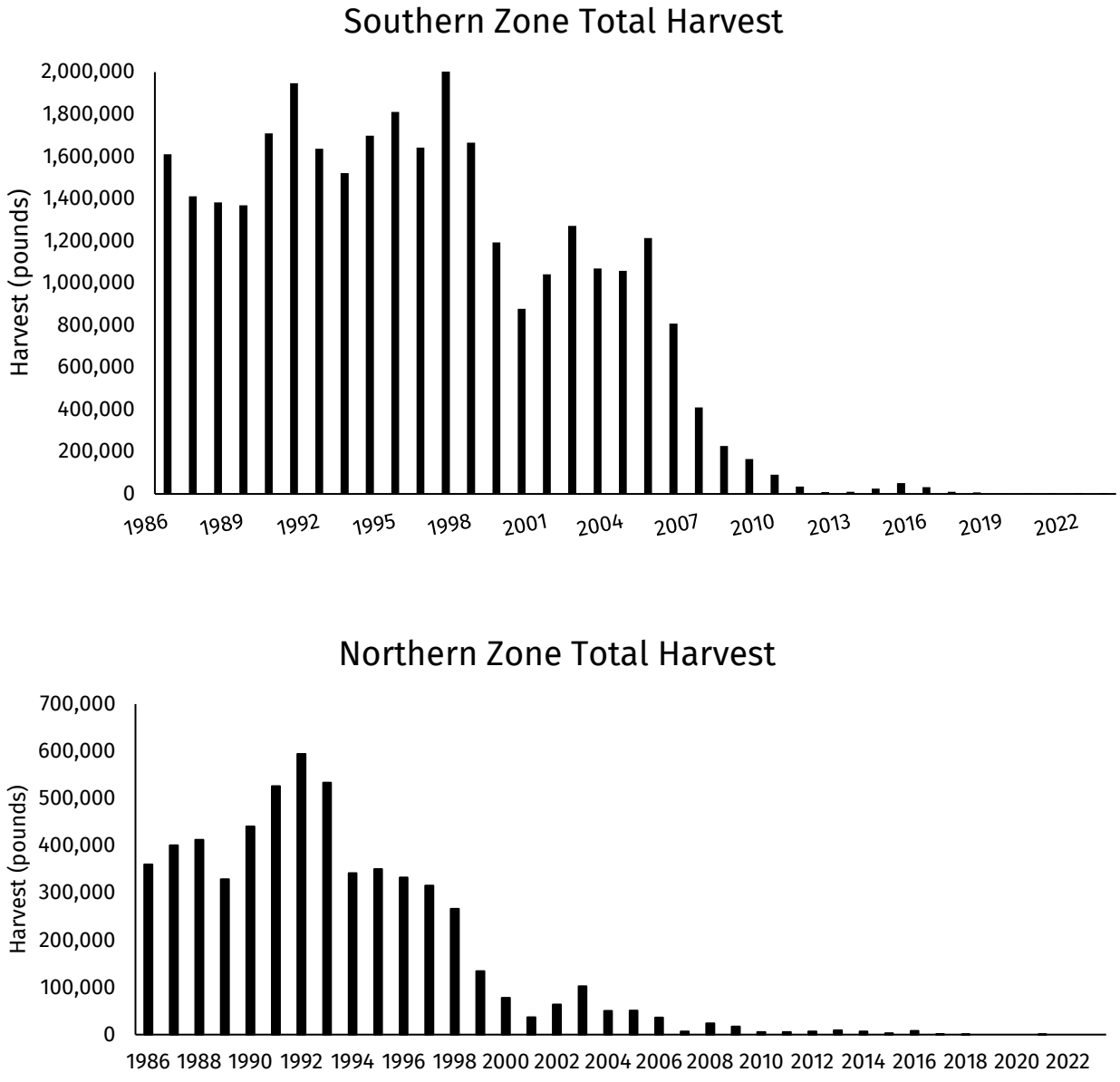

Figure 1. Total harvest (pounds) by year and zone for the Wisconsin gill net chub fishery, 1986-2023.

Population assessments off Baileys Harbor and Sheboygan were not conducted in 2023 due to budget constraints.

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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

Lake sturgeon populations in Green Bay are being monitored with PIT tag arrays in multiple rivers and many are being monitored with acoustic tags as well. Due to current vacancies, the data for 2023 has not been analyzed but data is still being recorded. The fish elevator continues to operate to pass adult lake sturgeon at the Menominee and Park Mill dams on the Menominee River. 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. The movements will be documented in Green Bay until 2024 and between the four major Green Bay rivers through 2025.

Milwaukee Update

MILWAUKEE RIVER STREAMSIDE REARING FACILITY

The Milwaukee River streamside rearing facility (SRF) was put into service mid-April of 2023. Wisconsin DNR personnel artificially spawned eight females and 40 males from the Wolf River and transferred those fertilized eggs to the SRF trailer on May 6, 2023. Eggs from each female were placed into separate hatching jars.

Lake sturgeon larvae began to hatch on May 14 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 and chopped krill. 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 on June 12, 2023. We began seeing above normal mortalities shortly after. Dissolved oxygen was high, but temperature was above normal for that time of year. We alternated treatments between salt and Halamid beginning on June 22. Mortalities continued at varying rates. By July 1, we were down to approximately 1,500 lake sturgeon in the trailer. The Fish Health Team visited the trailer many times and sampled the sturgeon searching for what was causing mortalities. We began once a week peroxide treatments July 30 continuing through the rest of the rearing season.

On Sept. 24, 2023, 583 large fingerlings and 12 yearlings (age-1) were stocked at the School of Freshwater Sciences Building. All fish released in September received a right ventral fin clip and 442 of the fingerlings were large enough to receive a PIT tag. The large fingerlings averaged 5.35 inches in total length and weighed an average of 10.8 g, both well below recent averages.

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 4.5-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, 145 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. In 2023, only five sets were made, and 11 lake sturgeon were captured. Of the sturgeon captured, all but one had RV fin clips, eight had PIT tags and three did not. There was a single fish captured that did not have any fin clips or PIT tag. The age of the recaptured lake sturgeon ranged from 1-6 years old, and the size ranged from 14-34 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

In spring of 2023, a handful of lake sturgeon sightings were reported, and fisheries staff were able to net four adult lake sturgeon. All four lake sturgeon had right ventral clips indicating they originated from the Milwaukee River SRF but were missing PIT tags. The fish ranged from 49 to 53 inches. Without PIT tags, the age of these fish is unknown. All fish were implanted with new PIT tags in case they are encountered again.

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. In 2023, twenty-two PIT tagged lake sturgeon

were detected. Detections began April 10 and peaked early May. Fish remained in the river until the end of May. Ages of the fish detected in the spring run ranged from 11 to 17. There was a single lake sturgeon detected June 24 that was stocked in 2019 and is only the second juvenile to be detected on the array. There were no lake sturgeon detections in July through September, but two lake sturgeon were detected in October and another in November.

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. For the 2023 season, approximately 60,000 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 11.1° C (52° F). Unfortunately, there was a significant mortality event that occurred in June following a large rain event and very few sturgeon made it through. There were not enough sturgeon remaining in the facility after the fish health examination to continue raising the sturgeon for the season, therefore, no sturgeon were stocked out of the Kewaunee SRF in 2023.

Table 1 shows the fish clipped, PIT-tagged, and then stocked into the river below the BAFF dam from 2009 to 2023.

Table 1. Spawning date, number stocked, average length and weight of lake sturgeon produced from the Kewaunee SRF 2009-2023.

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
2022	4/29	1,500	2,000	16.3	152
2023	5/6	0			

Number stocked only reflects fish released in October, and not early release fish

New Projects

HABITAT MAPPING

Through Focus Area 4 grants, the EPA has funded a lake sturgeon habitat mapping project that includes the Milwaukee and Kewaunee Rivers. The main objective of this effort is to highlight potential spawning locations in each river. These locations can be improved or protected if lake sturgeon are vulnerable in that location. Likely spawning locations will also be closely monitored when spawning may be occurring. This work began in 2022 and will conclude in late 2024.

KLETZSCH PARK FISH PASSAGE – MILWAUKEE RIVER

A fish passage has been constructed around the Kletzsch Park Dam on the Milwaukee River at river mile 10. The construction of the fish passage was made possible by the collaboration of MMSD, Milwaukee County, and WDNR. The nature-like fishway was designed to improve passage of native lake sturgeon and northern pike. The Fund for Lake Michigan provided funds for the installation of two PIT antennas in the fishway to evaluate its effectiveness and monitor the movement of native species upstream. The installation of this array is the third on the Milwaukee River and will allow WDNR to monitor the lake sturgeon migration more closely. Data collected on fish passage in the fishway will also inform the design of future fishways looking to improve passage for native species.

MILWAUKEE ESTUARY JUVENILE LAKE STURGEON HABITAT USE

In 2023, an array of 30 acoustic receivers were deployed in strategic locations within the Milwaukee Estuary. Twelve yearling lake sturgeon were implanted with acoustic transmitters before release into the harbor. The receivers will record the location of the tagged lake sturgeon to identify seasonal use of the outer harbor, inner harbor, and rivers by juveniles. This information will also be used to highlight habitats frequently utilized by juvenile lake sturgeon considering the upcoming work in the Milwaukee Estuary.

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2023 Status Of Lake Trout In Southern Lake Michigan

Background

The purpose of this report is to summarize data collected during the 2023 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 2023, the Wisconsin DNR surveyed two reefs within the Southern Refuge (the Northeast and East Reefs) between May 31 and June 6. Ten nets were set on the East Reef and eight were set on the Northeast Reef. Protocols established by the Lake Trout Working Group specify twelve nets per location. Effort was reduced on both Refuge reefs due to high catches in 2022. Each set consists of two 800-foot gangs of graded-mesh multifilament net, with 100 ft panels each of 2.5 inch, 3.0 inch, 3.5 inch, 4.0 inch, 4.5 inch, 5.0 inch, 5.5 inch, and 6.0 inch mesh. Gillnets are set for 24 hours at multiple depth strata. In 2023, nets were set from 184 feet to 238 feet of water. Bycatch is typically minimal; in 2023, lake trout were the only fish caught during the entire survey.

Catch-per-unit-effort (CPUE) on the two reefs sampled increased annually from 2014-2022, but decreased slightly in 2023 (Figure 1). In 2023, spring CPUE was 66.7 fish/1,000 feet of net on the Northeast Reef and 67.4 fish/1,000 feet of net on the East Reef.

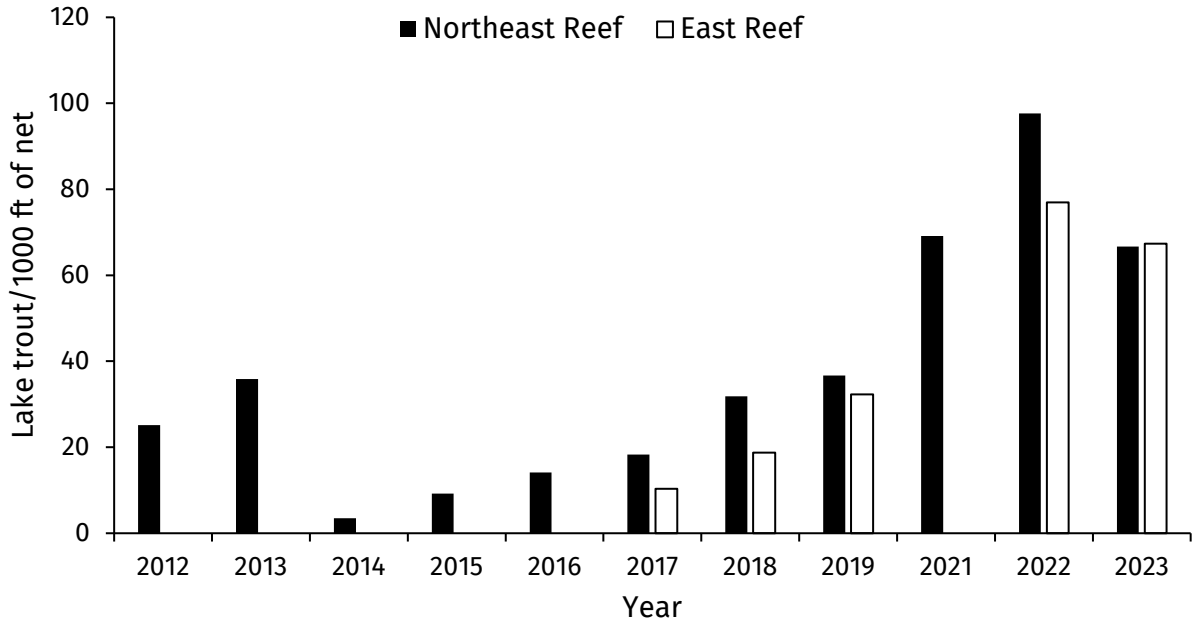

Figure 1. Spring catch-per-unit effort of lake trout by year for offshore reefs.

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 2018 and on the East Reef since 2019 (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 9.3 years in 2023 (Figure 2). Although the ages shown in Figure 2 are only from CWT lake trout, it is worth noting that 98% of lake trout caught during spring assessments in 2023 were adipose-clipped. Of the 659 lake trout collected for CWT, 648 (98%) were Klondike Reef strain (Figure 3). The remaining lake trout were either Seneca Lake (8 fish), Lewis Lake (2 fish) or Lake Ontario (1 fish) strains. 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 were stocked on the Southern Refuge from 2012-2020. The majority of the catch on offshore reefs in spring 2023 consisted of Klondike Reef strain lake trout from three year-classes (2013-2015 year-classes).

Every lake trout caught was examined for the presence of fin clips. Unclipped lake trout were presumed to be wild fish. In 2023, only 5 lake trout caught on the Northeast Reef and 15 caught on the East Reef were unclipped. The low number of wild lake trout encountered on both reefs is likely influenced by the high number of Klondike Reef fish encountered in 2023.

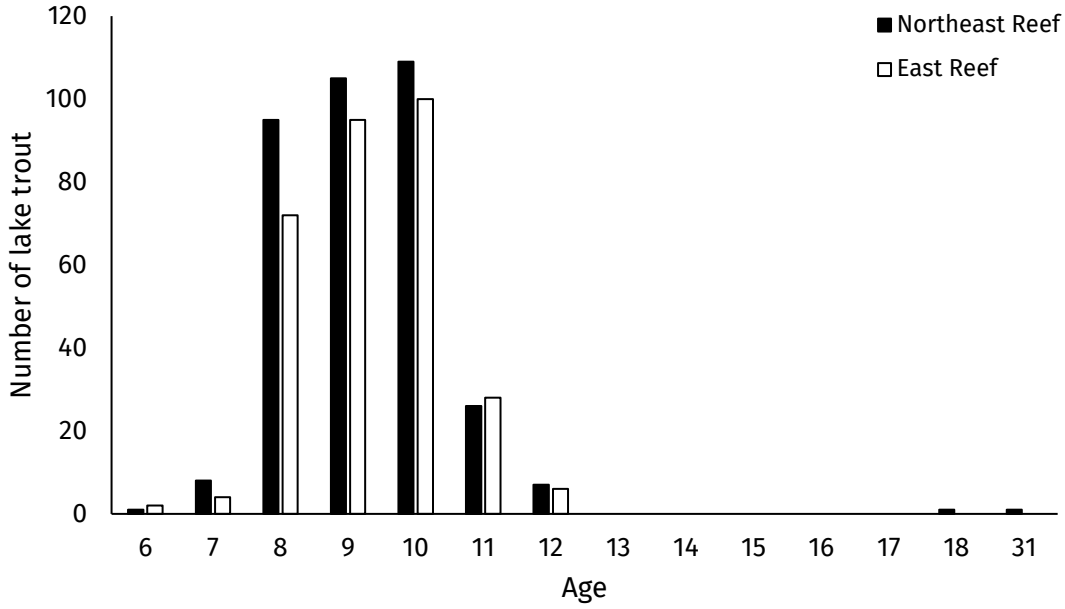

Figure 2. Age distribution of stocked lake trout caught on offshore reefs in spring 2023.

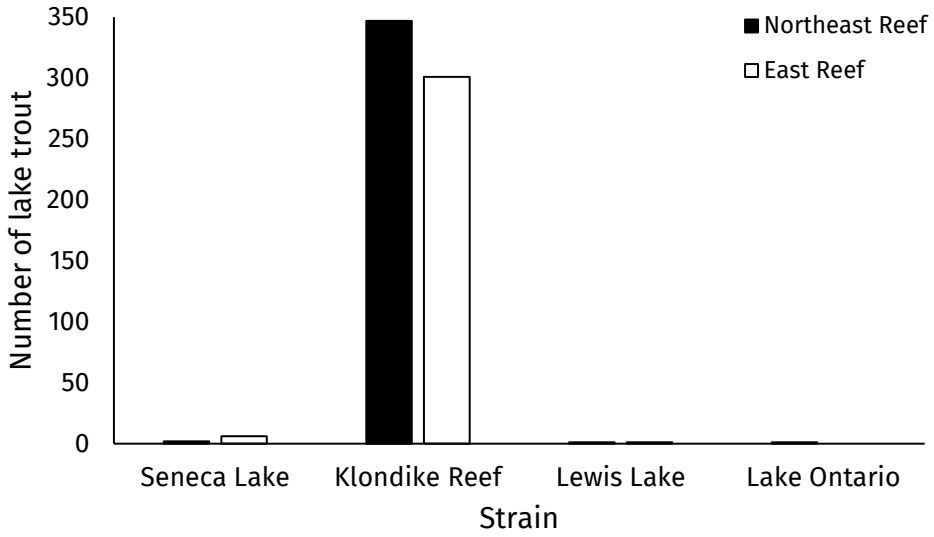

Figure 3. Strain composition of coded-wire tagged lake trout caught on offshore reefs in spring 2023.

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 and the East Reef has been sampled occasionally since 2009. The Southern Refuge was not sampled in fall 2023 due to poor weather conditions. The DNR will sample the Southern Refuge in fall 2024.

Both nearshore reefs were sampled on Oct. 31, 2023. 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. In 2023, nets were set from 32 to 50 feet of water. Of the 159 fish caught on the nearshore reefs, 16 were species other than lake trout (8 longnose sucker, 3 white sucker, 1 burbot, 2 brown trout, 1 round whitefish, and 1 channel catfish).

Overall catch-per-unit effort (CPUE) on the nearshore reefs has remained relatively consistent since 2013 (Figure 4). In 2023, the CPUE of lake trout on the South Milwaukee Reef was 41.9 lake trout/1,000 feet of net, while CPUE on the Green Can Reef was 47.5 lake trout/1,000 feet of net.

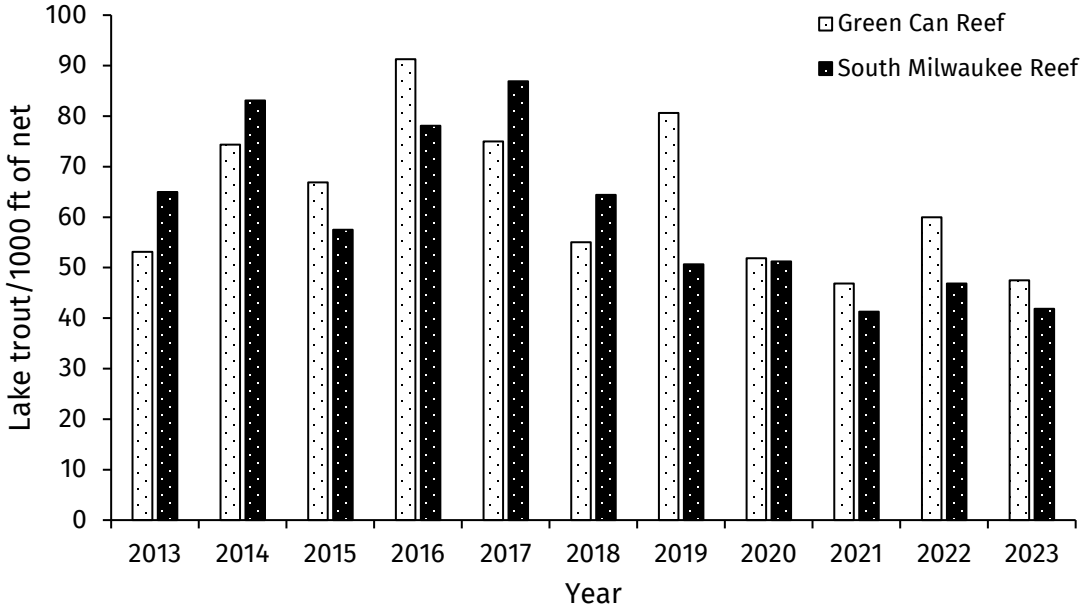

Figure 4. Fall catch-per-unit effort of lake trout by year for nearshore reefs.

Overall CPUE on the Northeast Reef has remained relatively consistent since 2013 (Figure 5), though CPUE increased in both 2021 and 2022. In addition, the catch has consistently been higher than on the nearshore reefs. In 2022, CPUE on the Northeast Reef was 137 lake trout/1,000 feet of net, and CPUE on the East Reef was 89 lake trout/1,000 feet of net.

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 and East Reefs. This objective has been met consistently since 2013 (Figure 5).

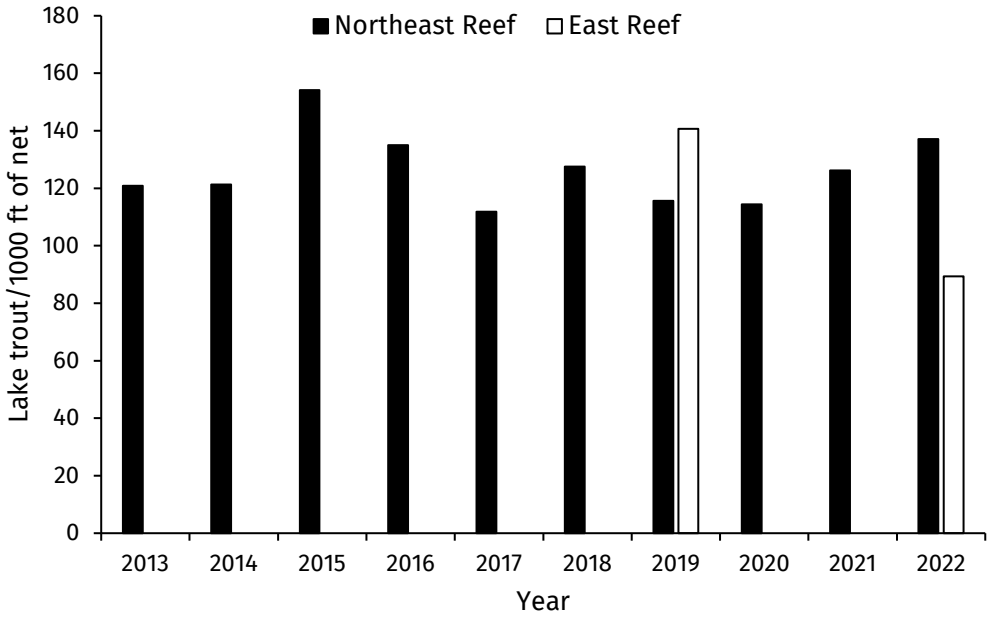

Figure 5. Fall catch-per-unit effort of lake trout by year for the Northeast Reef.

The age structure of lake trout captured during fall assessments is shown in Figures 6 and 7. The mean age of lake trout captured on the nearshore reefs for 2023 was approximately 13 years (Figure 6). This is older than the mean age of lake trout captured on the nearshore reefs in 2022 (mean age of 8 years). However, it is important to note that the reefs are only sampled on one day each fall, and the fish captured are a snapshot of lake trout currently utilizing the reefs.

Ages shown in Figures 6 are from stocked and wild lake trout combined. Wild lake trout and stocked lake trout that were not coded-wire tagged were aged using

otoliths. On the nearshore reefs, a total of 95 lake trout were aged, with 25 aged using CWTs and 70 using otoliths.

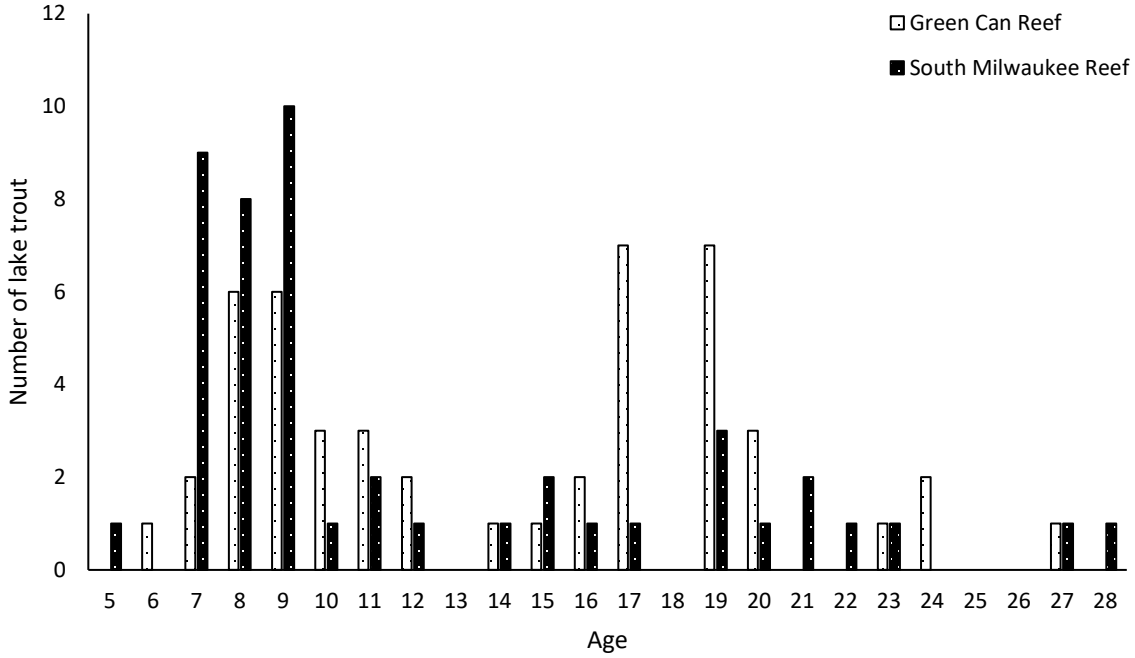

Figure 6. Age distribution of lake trout caught in the 2023 fall assessment survey on nearshore reefs.

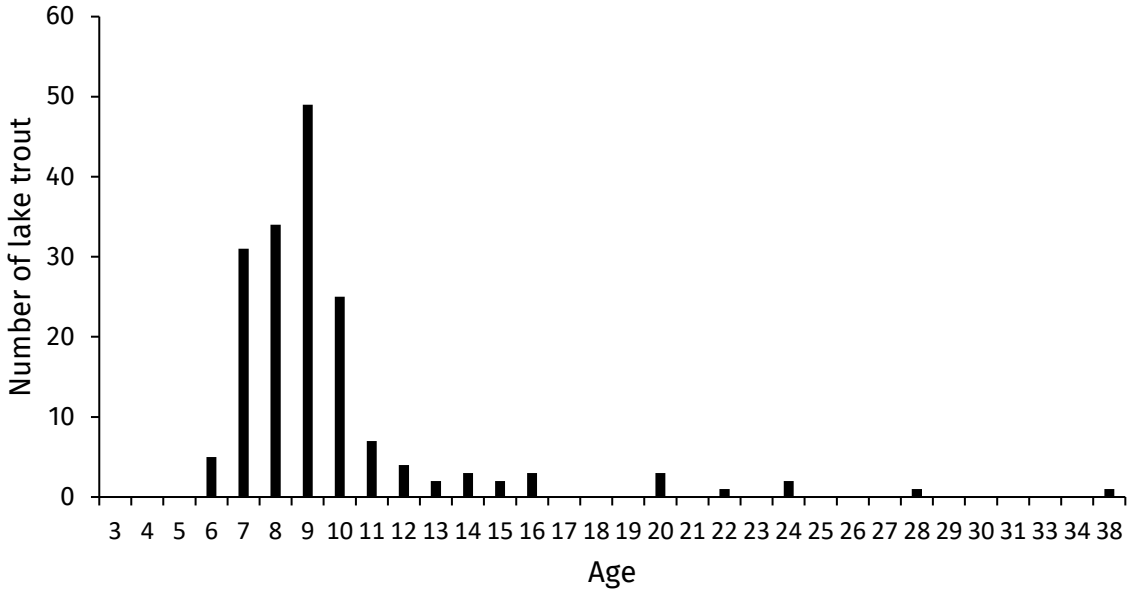

Figure 7. Age distribution of lake trout caught in the fall assessment survey on offshore reefs from 2013-2022.

The mean age of lake trout captured on the offshore reefs in 2022, for comparison, was 9 years (Figure 7). This was a younger mean age than what was seen on offshore reefs in previous years as well as the nearshore reefs and could be a result of the Klondike Reef strain fish maturing and showing up on spawning reefs.

The strain composition of CWT fish caught in the 2023 nearshore fall assessment is shown in Figure 8. The Seneca Lake and Lewis Lake strains made up the majority of the returns nearshore, while in recent years, the Klondike Reef strain has made up the majority of offshore returns (Figure 9).

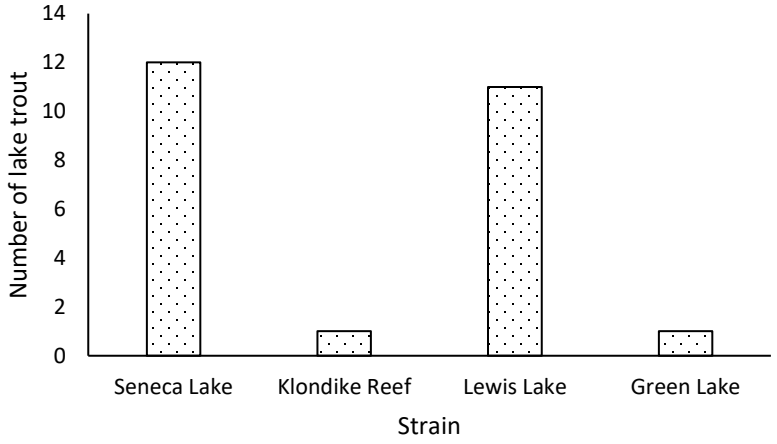

Figure 8. Strain composition of coded-wire tagged lake trout caught in fall assessment surveys on nearshore reefs in 2023.

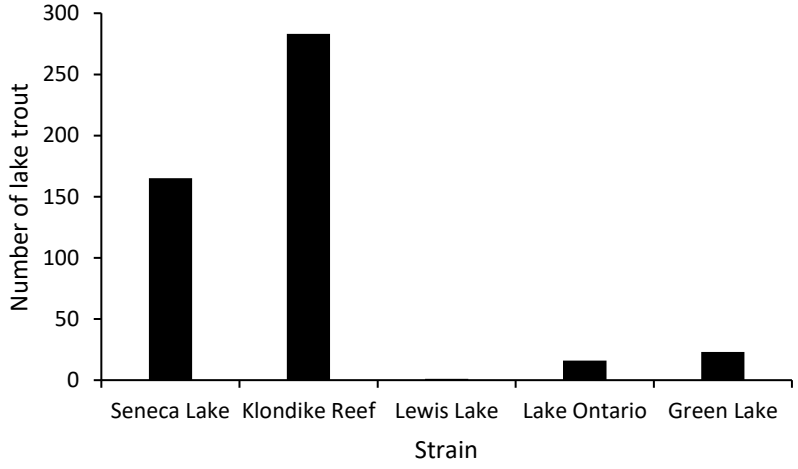

Figure 9. Strain composition of coded-wire tagged lake trout caught in fall assessment surveys on offshore reefs from 2018-2022.

In 2023, 29 lake trout caught on the Green Can Reef and 24 lake trout caught on the South Milwaukee Reef were wild (Figure 10). Wild catches in the fall have increased overall in the past few years nearshore. Wild catch-per-effort is shown in Figure 10 compared to the overall catch-per-effort to reflect increasing wild catches as naturally reproduced fish mature with simultaneous declines in catches of stocked lake trout nearshore as a result of reduced stocking numbers. This trend has also been seen in recent years on offshore reefs in the fall (Figure 11). This is a different trend than what has been seen on these same reefs in the spring, although mesh sizes are larger in the fall, possibly selecting against the Klondike Reef strain which are still maturing and do not grow as large as other strains.

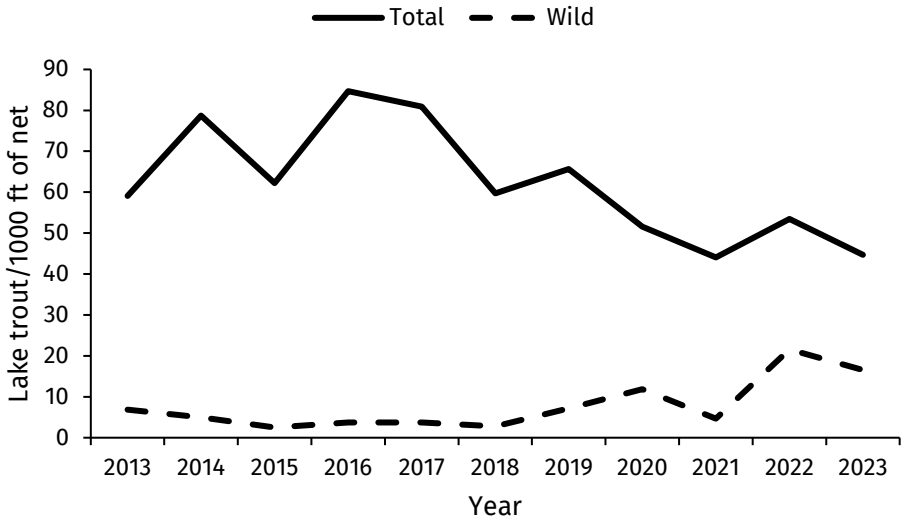

Figure 10. Catch-per-unit effort (CPUE) of lake trout captured in fall assessment surveys on nearshore reefs from 2013-2023. The solid black line shows total CPUE, while the dashed line shows the CPUE of wild lake trout only.

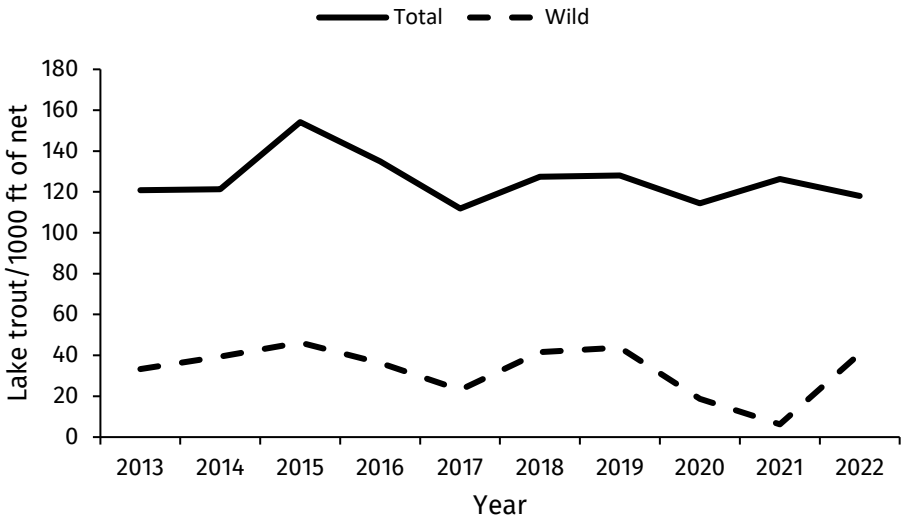

Figure 11. Catch-per-unit effort (CPUE) of lake trout captured in fall assessment surveys on offshore reefs from 2013-2022. The solid black line shows total CPUE, while the dashed line shows the CPUE of wild lake trout only.

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. We observed 10 or more age groups older than age-7 on the offshore reefs in multiple years (Figure 7). Although we are not consistently observing spawning populations that are at least 25% female, in 2023, this metric was met on the Green Can Reef (26% of lake trout caught were female). This metric was met at all surveyed locations in 2022.

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

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Lake Whitefish

Stock Management

Lake whitefish *Coregonus clupeaformis* commercial harvest in Wisconsin waters of Lake Michigan and Green Bay was historically managed as originating from one stock spawning in the areas around North and Moonlight bays in Lake Michigan. The commercial quota was allocated to three zones in Green Bay and Lake Michigan[11]. The entire commercial quota had not been caught in decades, which was largely reflective of whitefish recruitment failures in Lake Michigan proper and an artifact of the management zones established by the Individually Transferrable Quota system established in 1989-90. Meanwhile, lake whitefish production in Green Bay has been very strong in recent decades. Commercial lake whitefish harvest and effort have reflected these ecological changes and prompted the need to develop two population models, one for Wisconsin waters of Green Bay and one for Lake Michigan. Tagging studies of whitefish populations in Green Bay and northwest Lake Michigan indicate that fish originating from these respective areas maintain a relatively discrete distribution, generally remaining in their natal waters. This mark-recapture information provided confidence that lake whitefish from Lake Michigan and Green Bay could be managed independently and that individual population models could be developed.

During August of 2022, Wisconsin officially implemented one harvest quota each for Green Bay and Lake Michigan waters as a reflection of the waterbody-specific population changes described above. Statistical-catch-at-age (SCAA) models were developed for each waterbody to best describe lake whitefish population dynamics in these waters. Due to the relatively short history of the contemporary Green Bay lake whitefish commercial fishery, this population model is considerably more limited in scope compared to the Lake Michigan SCAA model. Furthermore, the advent of the large winter lake whitefish sport ice fishery in 2007 required incorporating sport fishing data into a model that was historically based mainly on input data from commercial fishing. The differing population dynamics are reflected in estimates of spawning stock size with biomass declining precipitously in Lake Michigan due to recruitment failures (Figure 1) while strong recruitment events in Green Bay have resulted in an increase in stock size in those waters (Figure 2). The

[11] WDNR. 2022. Lake Michigan Management Reports (pp. 76-85). Wisconsin Department of Natural Resources.

last quota for the entire Lake Michigan commercial fishery (through 2021) under the single stock management model, including Green Bay, was approximately 3.18 million pounds. Under the current two-stock management, the quota for Green Bay waters is approximately 2.28 million pounds, evenly split between the commercial and sport fisheries. The quota for Lake Michigan proper is set at approximately 874,000 pounds. These total allowable catch recommendations were implemented in 2024 and were made using data through 2021. Quota recommendations will be made every three years.

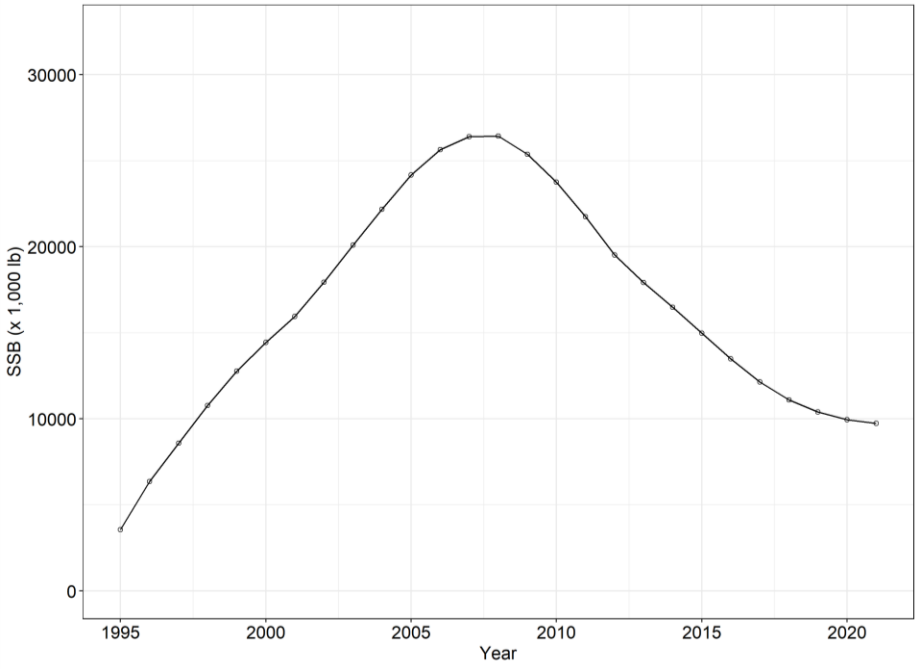

Figure 1. Estimated spawning stock biomass (SSB) for lake whitefish, at time of spawning, in Wisconsin waters of Lake Michigan, 1995-2021.

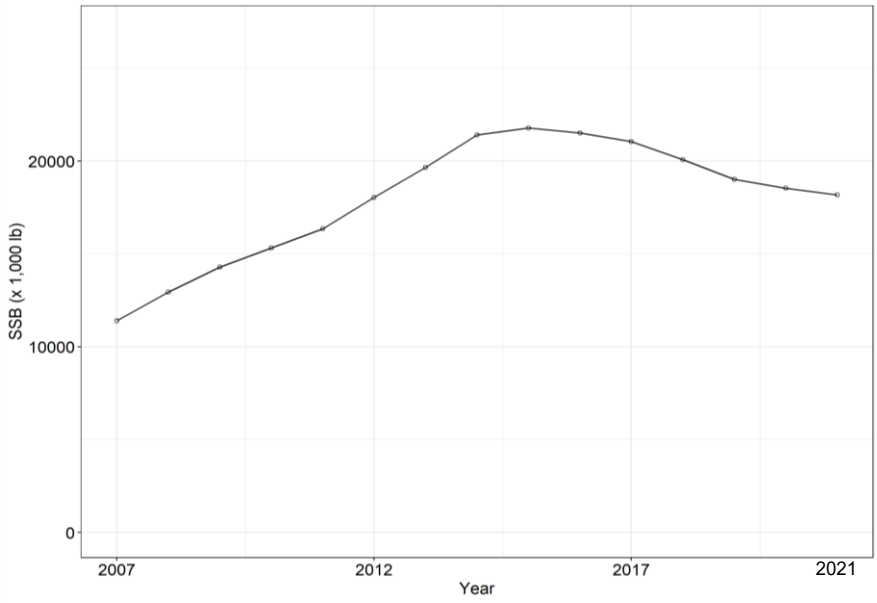

Figure 2. Estimated spawning stock biomass (SSB) for lake whitefish, at time of spawning, in Wisconsin waters of Green Bay, 2007-2021.

Commercial Effort And Harvest

Trap and gill nets have been the primary gear used to harvest lake whitefish in Wisconsin waters of Lake Michigan. Pound nets were used historically but have not been employed since 2009. In 2020, a bottom trawl fishery for lake whitefish was implemented; but it is restricted to only the Manitowoc/Two Rivers area of Lake Michigan.

Changes in whitefish population dynamics and gear functionality/catchability have resulted in dramatic shifts in the amount and type of commercial effort between these two waterbodies and these changes have generally favored the use of trap nets. Commercial fishers have used trap nets as legal gear to harvest lake whitefish from Lake Michigan since 1976, and trap nets have long been the primary gear for lake whitefish. The use of trap nets was strongly encouraged by the Wisconsin Department of Natural Resources (DNR) to help reduce bycatch mortality.

The amount of overall trap net effort was historically skewed toward Lake Michigan waters through the early 2000s (Figure 3). The following 10 years effort was roughly divided evenly between Green Bay and Lake Michigan as commercial fishing in Green Bay improved. Effort in Lake Michigan began to decline in 2016, primarily as a function of fishers in the Two Rivers area switching from trap nets to trawl gear.

However, considerable reductions in trap net effort in historically heavily fished areas in recent years has exacerbated the overall decline in Lake Michigan. Gill net effort has followed a long-term decline in both waterbodies, although it has stabilized somewhat in recent years (Figure 4). Preference for trap net-caught fish is largely responsible for the overall decline in gill net use. Although, the decline in gill net catchability brought on by ecological perturbations from invasive species is also a major contributor (increased water clarity and algal fouling). The practice of "day sets" (i.e., allowing nets to fish for only a few hours before lifting) has increased considerably in Green Bay in recent years because of the high concentration of lake whitefish in southern Green Bay and has been remarkably successful. Commercial trawl effort increased from 392 hours of trawling in 2021 to 483 hours in 2022. However, because the trawl fishery is still relatively new, it's difficult to interpret any effort trend data at this time.

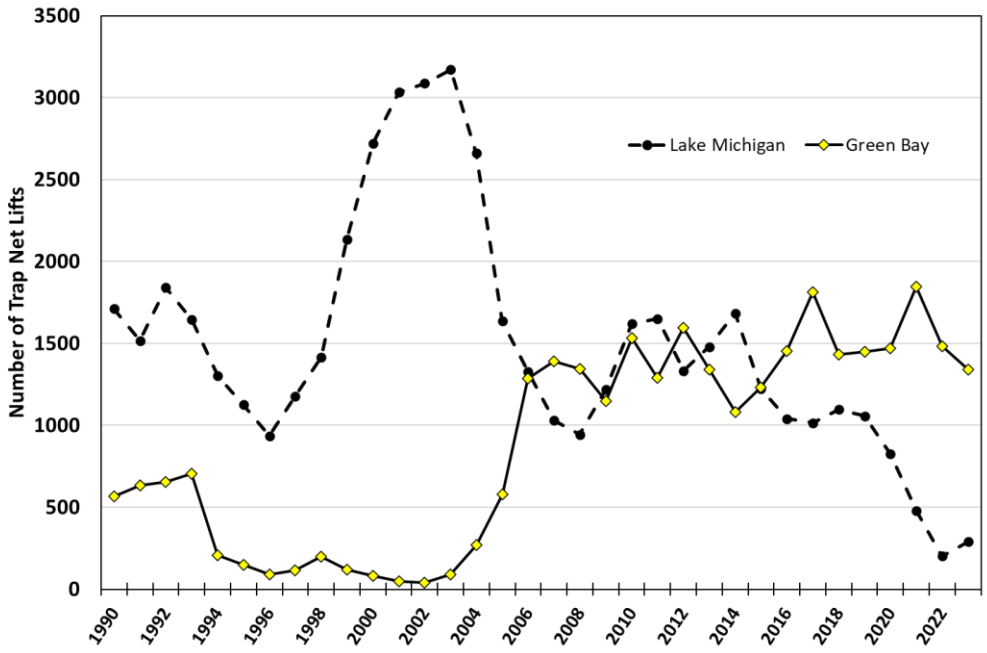

Figure 3. Trends in trap net commercial fishing effort for lake whitefish in Wisconsin waters of Lake Michigan and Green Bay, 1990-2023.

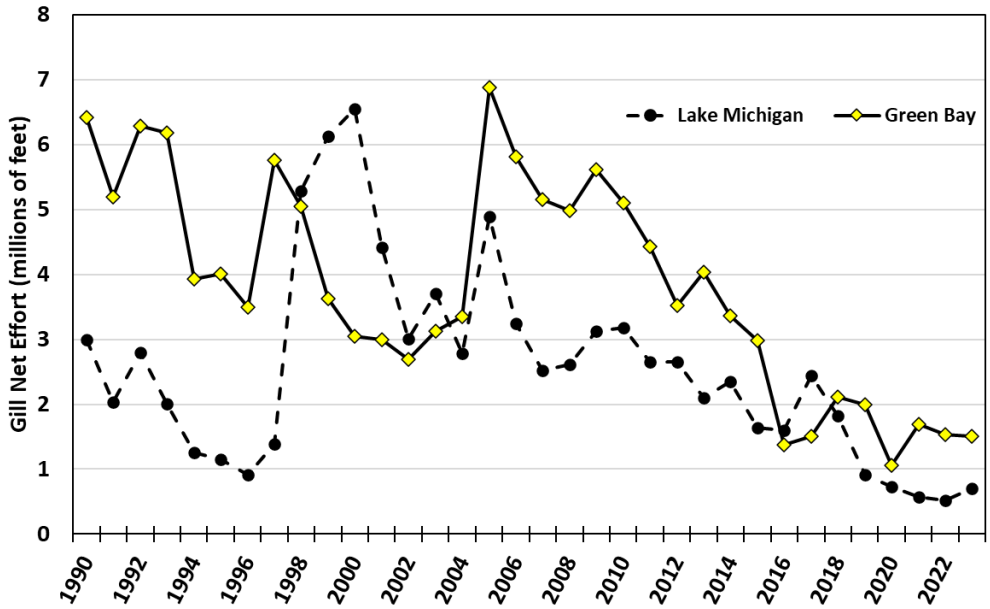

Figure 4. Trends in gill net commercial fishing effort for lake whitefish in Wisconsin waters of Lake Michigan and Green Bay, 1990-2023.

Harvest levels and type of gear used follow very different trends between the waters of Green Bay and Lake Michigan (Figures 5 and 7). Lake whitefish harvest patterns in Lake Michigan followed the high productivity of the lake in the 1990s, with increasing harvest levels into the early 2000s. However, recruitment failures beginning in the early 2000s have resulted in a continually decreasing harvest trend and lower fishing mortality rates (Figure 6). Trawling has the exceedingly highest proportion of harvest in Lake Michigan, likely due to its characteristic as an active versus passive fishing gear. Harvest in Green Bay has shown a very different pattern with contemporary levels that reflect the high whitefish production in the bay. And while fishing mortality is somewhat higher than in Lake Michigan, it is still below the targeted rate (Figure 8). Relatively high gill net catches during the 1990s generally originated from northern Green Bay waters and were associated with the large populations of lake whitefish in Lake Michigan waters. Meanwhile, southern Green Bay waters (focused on areas offshore of Sturgeon Bay) are largely responsible for increased harvest beginning around 2006, albeit using trap nets. The relatively steady harvest levels since then are somewhat reflective of southern Green Bay being in a commercial zone historically having a low allocation (~9%) of the total quota.

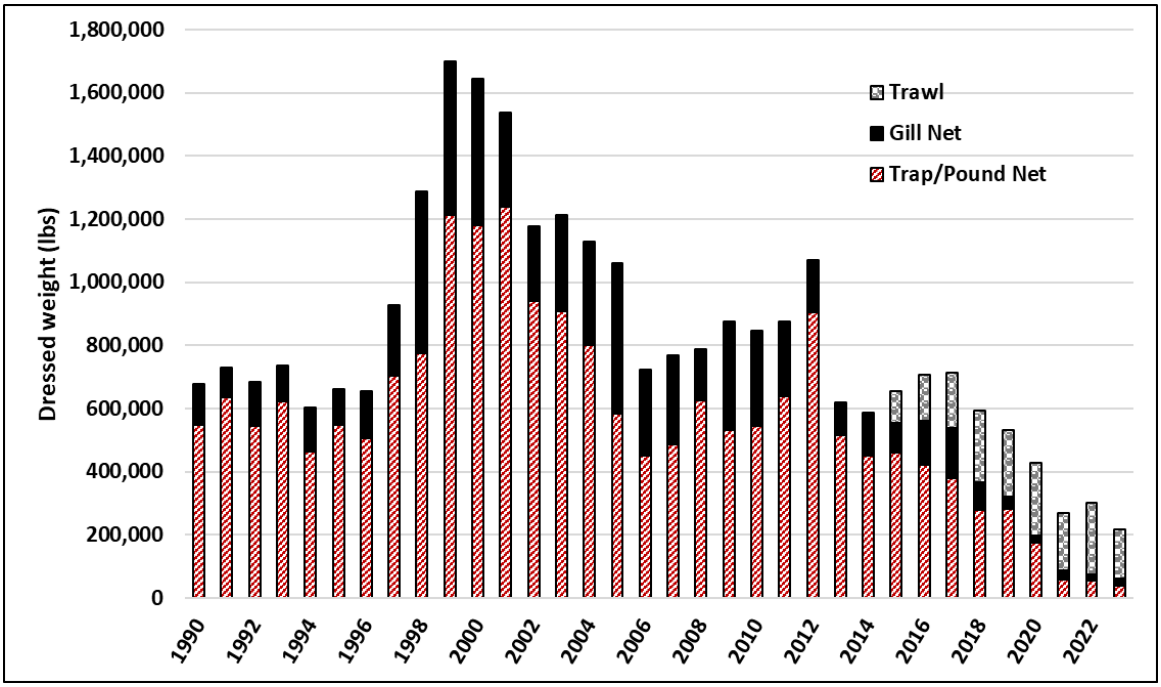

Figure 5. Trends in commercial fishing harvest for lake whitefish in Wisconsin waters of Lake Michigan, 1990–2023.

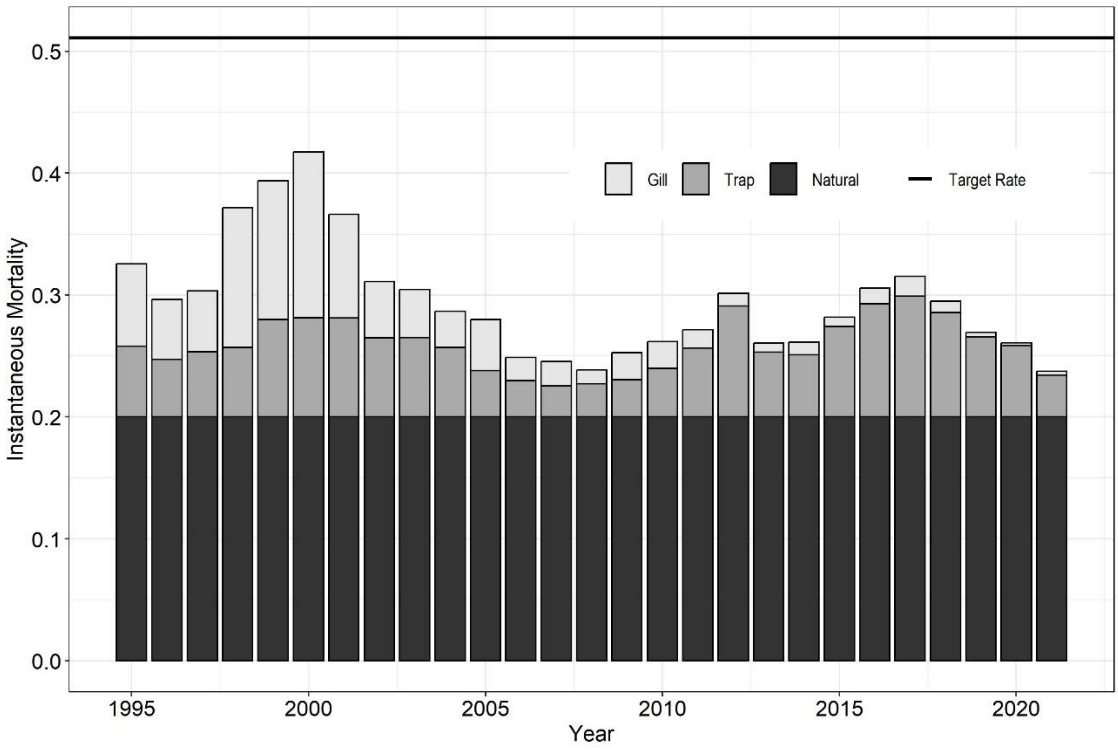

Figure 6. Trends in natural and commercial fishing maximum instantaneous mortality rates for ages 4-12 and the current targeted maximum mortality rate for lake whitefish in Wisconsin waters of Lake Michigan, 1995–2021.

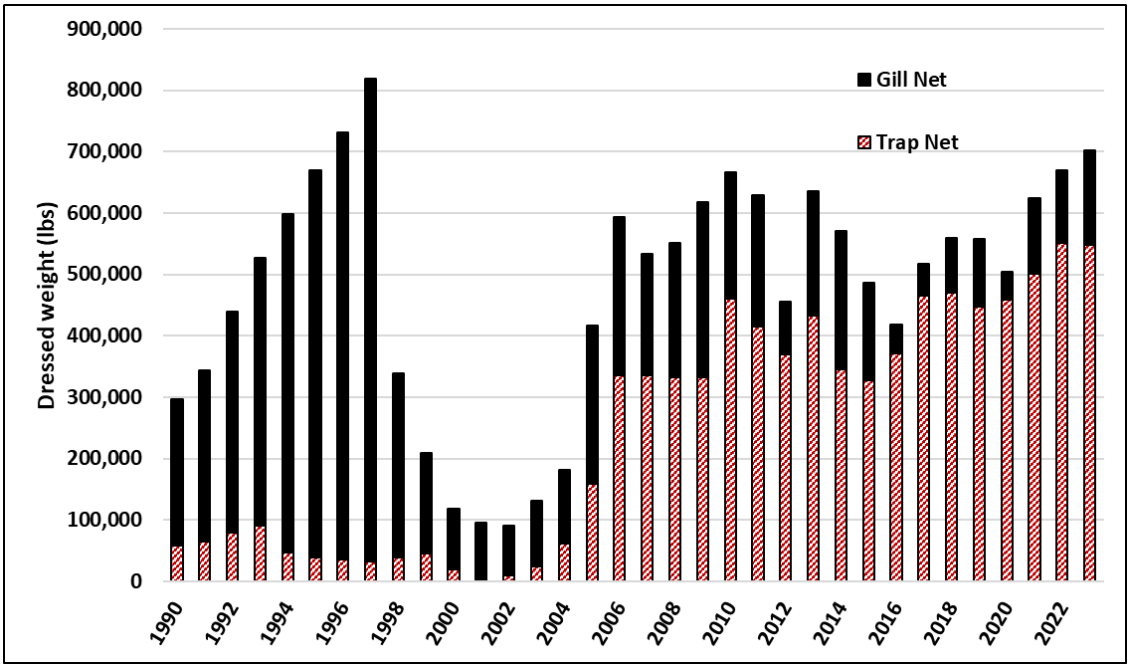

Figure 7. Trends in commercial fishing harvest for lake whitefish in Wisconsin waters of Green Bay, 1990–2023.

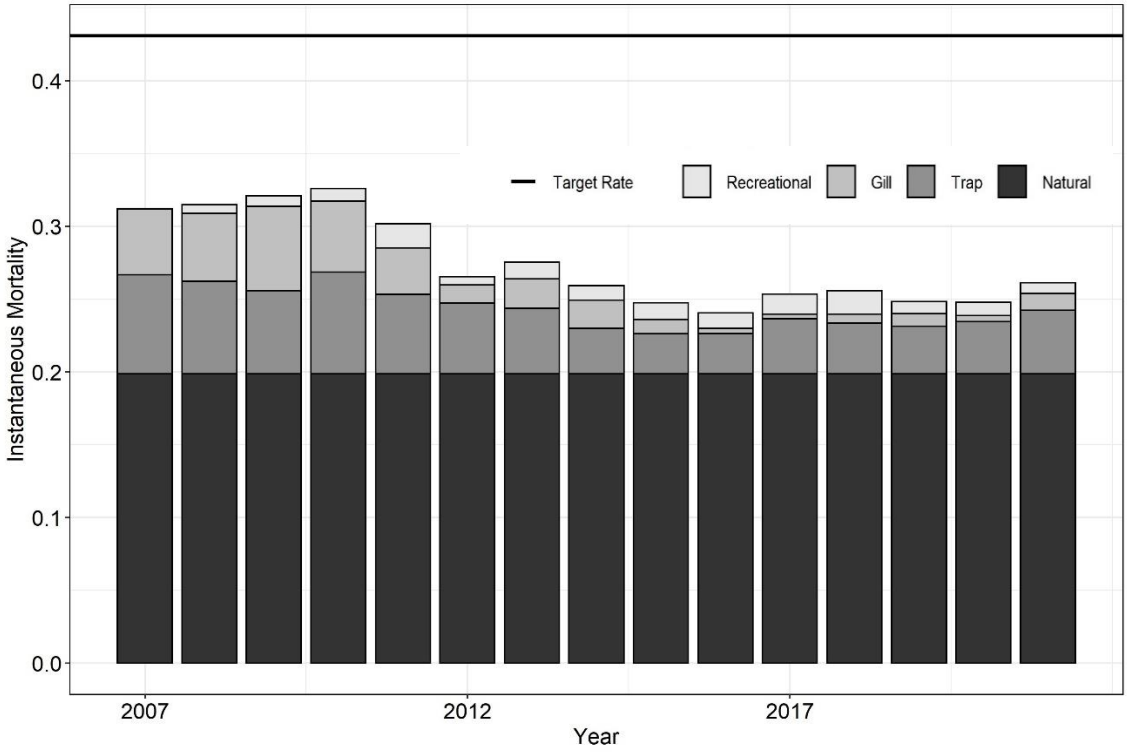

Figure 8. Trends in natural and commercial fishing maximum instantaneous mortality rates for ages 4-12 and current targeted maximum mortality rate for lake whitefish in Wisconsin waters of Green Bay, 2007–2021.

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 until recently. The advent of lake whitefish fishing is largely responsible for the resurgence of the overall ice fishing effort on the Wisconsin waters of Green Bay (Figure 9). A formal Guide Reporting Program for ice fishing on Green Bay was implemented in 2017. Before 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 2023, the estimated whitefish harvest was 10,465 fish, a decrease of 79,000 from the previous year (Figure 9). This large decrease was primarily due to poor ice conditions in 2023 as overall effort was less than half of that in 2022. Whitefish catch per unit of effort (CPUE), measured in lake whitefish caught per hour of fishing specifically for that species, decreased dramatically as well between 2022 and 2023, again likely due to poor ice conditions (Figure 10). These CPUE values are calculated from the sport angler creel survey and do not include catch data from guided trips.

Picture: Juvenile lake whitefish caught in trawl survey. Photo credit: Tammie Paoli.

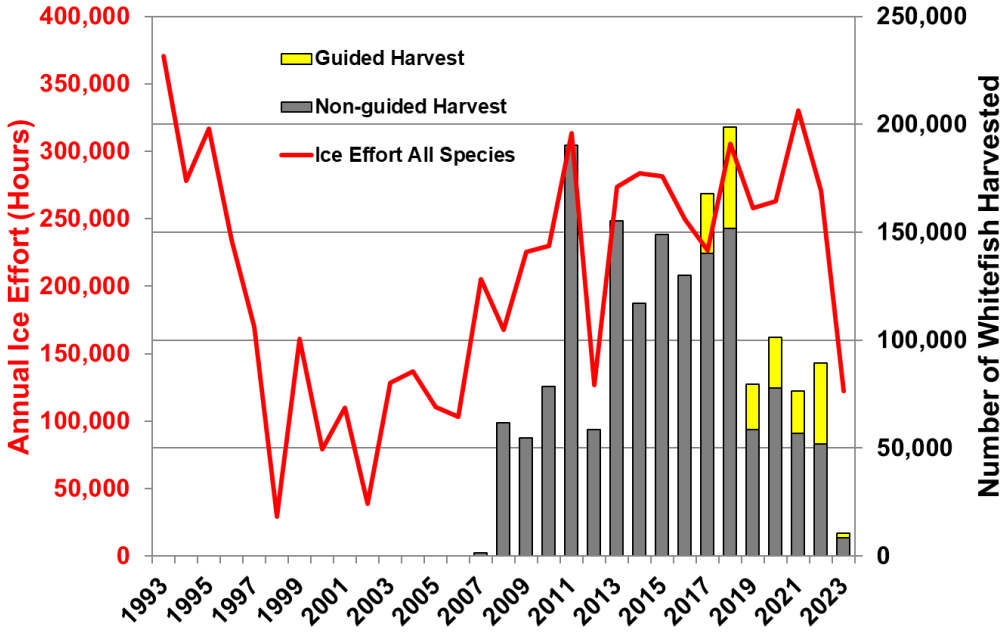

Figure 9. Estimated number of lake whitefish harvested and total effort for all species in Wisconsin waters of Green Bay during the winter creel season (January-March) for 2007-2023.

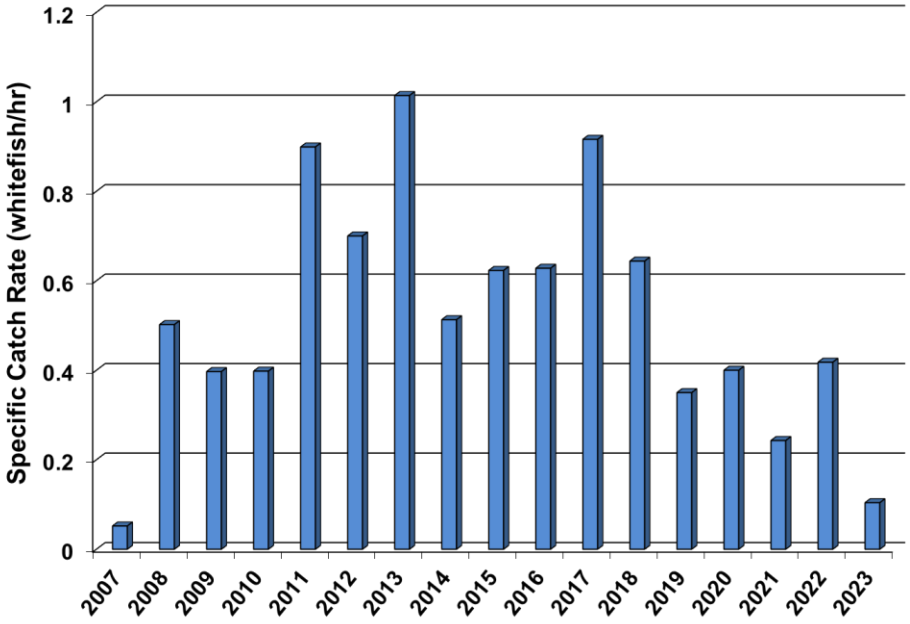

Figure 10. Specific catch rate estimates of lake whitefish caught per hour for anglers targeting lake whitefish in Wisconsin waters of Green Bay during the winter creel season (January-March) for 2007-2023.

Tributary Populations And Recruitment

During the mid-1990s, lake whitefish began a recolonization of the Menominee River where spawning populations had not been observed since the late 1800s[12]. 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, 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 likely constrains accurate population estimates as well.

Strong young-of-year recruitment events have been measured intermittently within the last couple decades in the waters of southern Green Bay. Bottom trawling assessments, conducted annually during August targeting juvenile yellow perch, has captured this trend of increasing numbers since the mid-1990s (Figure 11). 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. The initial occurrence of large year classes of young-of-year lake whitefish generally follows trends of adults colonizing the tributaries suggesting these river populations are important sources for lake whitefish recruitment into the Green Bay fishery. However, emerging evidence suggests that some lake whitefish recruitment is also 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 several years with very low catches in 2023.

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

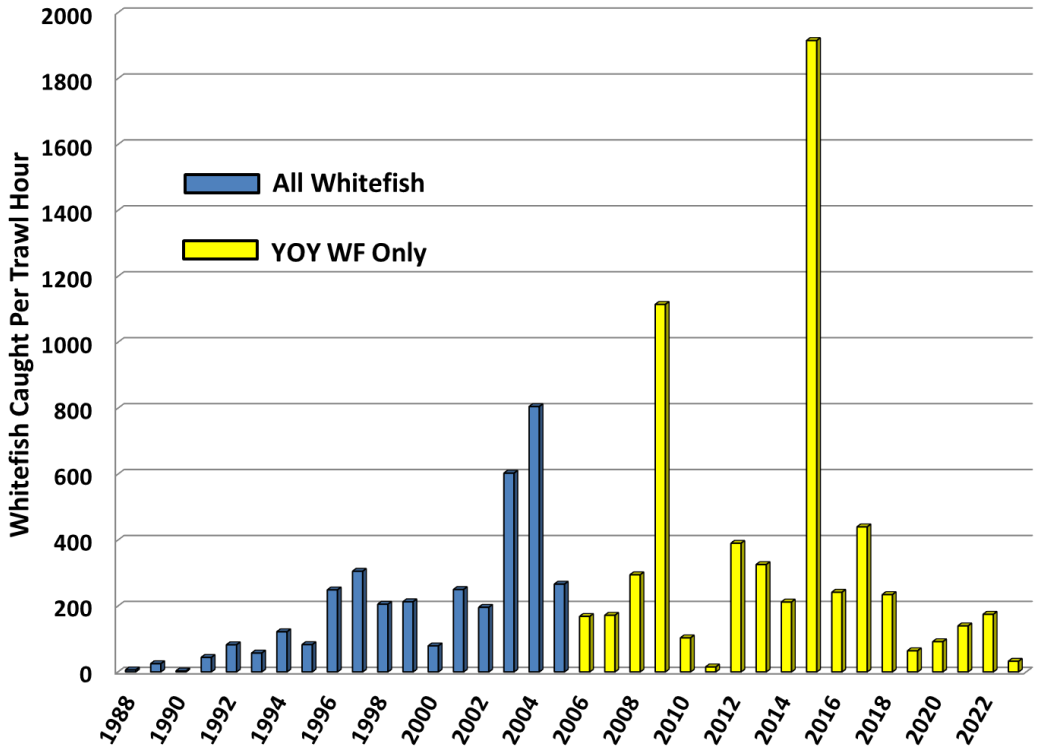

Figure 11. Lake whitefish captured during August bottom trawling assessments in Green Bay between 1988 and 2023. Young-of-year (YOY) whitefish were not separated in counts until 2006; therefore, blue bars represent all whitefish combined in the catch while yellow bars represent only YOY whitefish.

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2023 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 on Strawberry Creek in Door County and has operated since the early 1970s. SCW is the DNR's primary egg collection facility for chinook salmon (*Oncorhynchus tshawytscha*) and typically provides the entire egg supply needed 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 2023. Please note that reported values are not absolute numbers of fish returned to each river and many factors influence spawning runs, including stream flow, lake level, water temperature, stocking numbers, survival, harvest, dates of operation for each weir, etc. These factors vary annually and impact the numbers of fish available and processed at each egg collection facility. Egg collection goals also vary annually, depending on projected stocking quotas, DNR production needs and egg requests from other states or agencies. 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 coded-wire tags before release, and tags were sampled for tags from BAFF and RRSF. Analysis of the tags will provide fish managers with more information on the movement patterns of steelhead, growth rates and the occurrence of straying.

Overall, 2023 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

FALL 2023 STRAWBERRY CREEK SUMMARY

SCW was operated for Chinook salmon spawning from Sept. 29 to Oct. 18, 2023. The weir was open and fishing for 19 nights. Specific processing dates for egg and data collections were Oct. 2, 5, 9, 12, 16 and 19. The number of Chinook salmon processed for data each day were 654, 574, 924, 581, 495 and 236, respectively (a total of 3,464). In addition to the 3,464 spawning Chinook salmon processed for data, another 493 mortalities were removed from the pond and tallied at SCW during 2023 (a total of 3,957). This number of Chinook (3,957) is below the long-term average of 4,609 (Figure 1). Overall, 650 female Chinooks were spawned, and nearly 3.5 million eggs were collected (Table 1). The Chinook eggs were transferred to Wild Rose State Fish Hatchery, where they were incubated, hatched, and raised until the following spring for stocking into several Lake Michigan tributaries.

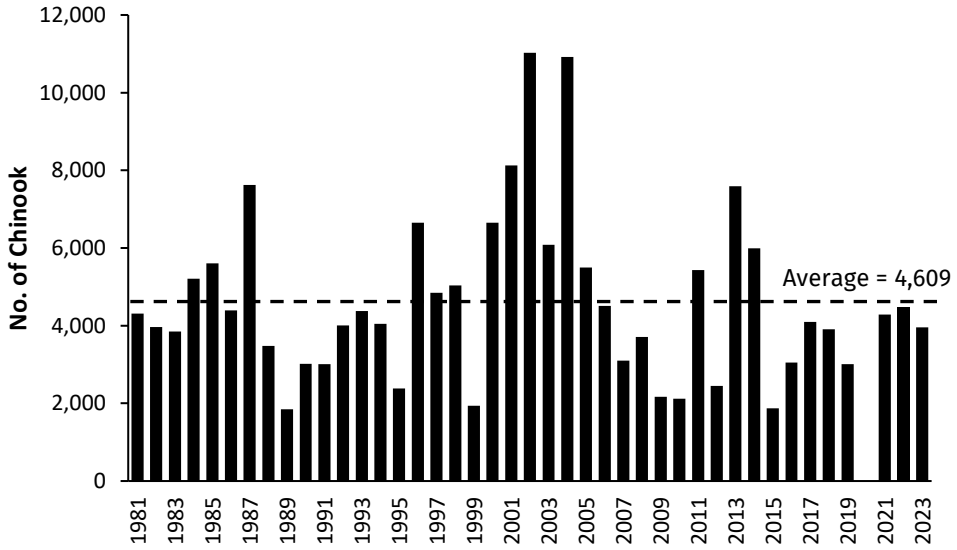

Figure 1. Numbers of Chinook salmon handled during autumn spawning operations at the Strawberry Creek Weir per year from 1981-2023 (2020 data not available). The long-term average is 4,609 (dashed line). Several factors impact these numbers including stream flow from rainfall and supplemental water pumping, lake level, water temperature, stocking numbers, survival rates, dates of operation for the weir, etc.

Table 1. Numbers of Chinook salmon processed for data, females spawned, eggs collected and average number of eggs per female at Strawberry Creek Weir during autumn 2023. (Note: All fish were not always removed from the pond each day, and instead fish were sometimes processed at a later date).

DATE	CHINOOK PROCESSED	FEMALES SPAWNED	EGGS COLLECTED	AVG. EGGS PER FEMALE
Oct. 2, 2023	654	0	0	--
Oct. 5, 2023	574	79	375,254	4,750
Oct. 9, 2023	924	114	561,314	4,924
Oct. 12, 2023	581	180	991,082	5,506
Oct. 16, 2023	495	179	1,032,969	5,771
Oct. 19, 2023	236	95	538,332	5,493
Total	**3,464***	**650**	**3,498,951**	**5,289**

**An additional 493 Chinooks were removed from the pond and stream and were just tallied from Sept. 29 to Oct. 21 (3,464 processed + 493 tallied = 3,957 total).*

Almost all Chinook salmon at SCW were processed for data, including total length (mm), weight (kg), sex, lamprey scars and fin clips. Fish health veterinarians also collected samples from a subsample of fish. The total length for all Chinooks ranged from 11.1 to 42.8 inches (average = 32.8 inches) and ranged in weight from 0.6 to 29.5 pounds (average = 12.8 pounds). A total of 2,013 males were sampled and ranged in total length from 11.1 to 42.8 inches (average = 32.2 inches) and in weight from 0.6 to 26.5 pounds (average = 11.6 pounds). A total of 1,451 females were sampled and ranged in total length from 18.7 to 41.9 inches (average = 33.5 inches) and in weight from 6.5 to 29.5 pounds (average = 13.9 pounds). The average weight of age-3 female Chinooks in 2023 was 18.0 pounds (N=346) based on known age-3 fish from fin clips at Strawberry Creek (Figure 2).

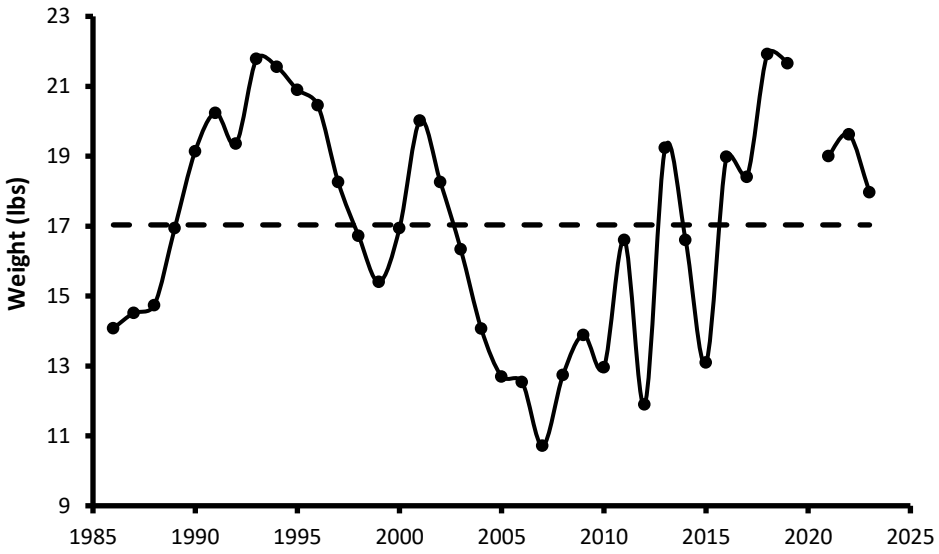

Figure 2. The average weight of age-3 female Chinook salmon processed at the Strawberry Creek Weir per year from 1986-2023 (2020 data not available). The long-term average is 17.0 pounds (dotted line). Many factors impact Chinook size including alewife biomass, Chinook abundance and the ratio of predator/prey (etc.).

A water pump powered by a diesel engine was operated continuously to supplement stream flow at SCW from Sept. 29 to Oct. 18, 2023. The water level in Strawberry Creek was relatively low prior to pump operation. The pump increased flow and ensured that Chinook Salmon could easily swim upstream and seemed to trigger the annual Chinook spawning run by increasing stream flows. The water pump went down due to mechanical issues sometime between the evening of Oct. 1 and the morning of Oct. 2. The mechanical issues caused the pump to stop supplying SCW with fresh cool oxygenated water, which led to increased stress and mortality of the fish that were being held at that time. All the fish in the pond were removed on Oct. 2, and the pump was repaired and running that evening.

Besadny Anadromous Fisheries Facility (BAFF)

SPRING 2023 BAFF SUMMARY

Four steelhead processing days occurred at the BAFF on the Kewaunee River during 2023 on April 12, 13, 19 and 26. A total of 797 steelhead were processed. 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. A total of 842,036 eggs were collected from 242 female steelhead. Numbers of steelhead processed annually at BAFF during

recent years include 989 (2022), 408 (2021), 677 (2019), 710 (2018), 708 (2017), 535 (2016) and 429 (2015).

FALL 2023 BAFF SUMMARY

A total of 713 Chinook and 444 coho salmon were processed for data at BAFF during fall 2022 from Oct. 1 to Nov. 9 (Table 2). These salmon were sacrificed and processed for data including length (mm), weight (kg), sex, lamprey wounds and fin clips. Processed Chinook salmon averaged 33.3 inches and 12.4 pounds and coho salmon averaged 20.4 inches and 3.4 pounds. Eggs and fish health samples were collected from both Chinook and coho. A total of 375,144 eggs were collected from 198 female coho salmon (Table 2). A summary of Chinooks processed at BAFF by year from 1990-2023 can be seen in Figure 3. Numbers of coho processed annually at BAFF during recent years include 1,522 (2022), 701 (2021), 1,857 (2020), 602 (2019), 1,480 (2018), 1,044 (2017), 861 (2016), 689 (2015), 786 (2014), 2,286 (2013) and 1,298 (2012).

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 fall 2023. Tallies of dead fish routinely removed from holding ponds are not included in this table.

DATE	CHINOOK PROCESSED	COHO PROCESSED	FEMALE COHO SPAWNED	COHO EGGS COLLECTED
Oct. 7, 2023	59	5		
Oct. 18, 2023	355	13		
Oct. 25, 2023	182	69	34	71,513
Oct. 30, 2023	101			
Nov. 1, 2023	16	213	93	172,350
Nov. 8, 2023		44	21	42,762
Nov. 21, 2023		100	50	88,519
Total	**713**	**444**	**198**	**375,144**

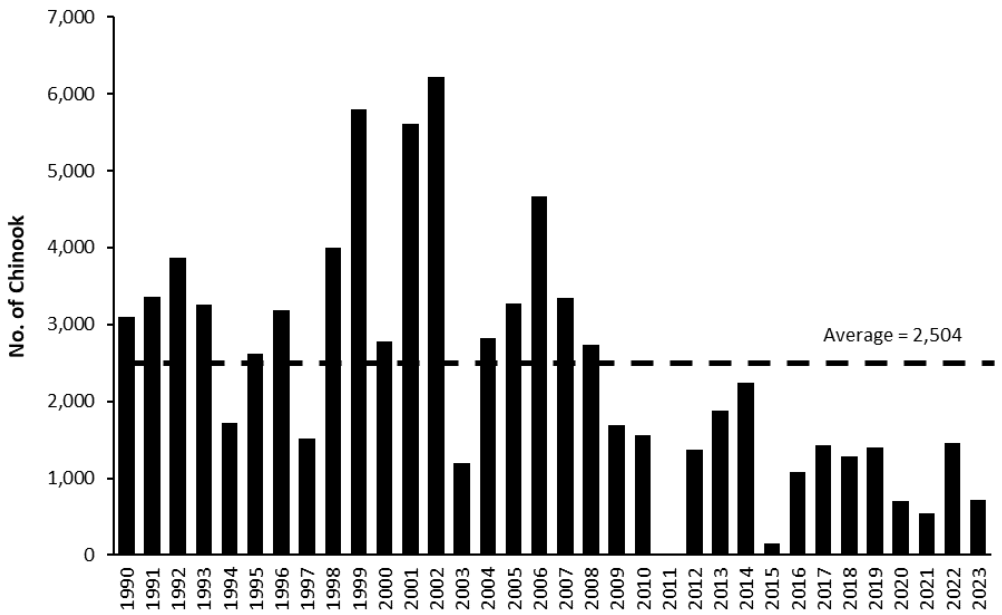

Figure 3. Number of Chinook salmon handled during fall spawning operations at the Besadny Anadromous Fisheries Facility (BAFF) per year from 1990-2023. The average since 1990 is 2,504 (dotted line). Several factors impact these numbers including stream flow, water temperature, stocking numbers, survival rates, dates of operation for the weir, etc.

Root River Steelhead Facility (RRSF)

SPRING 2023 RRSF SUMMARY

The RRSF was in operation for five processing dates during the spring 2023 spawning migration, and we captured 450 steelhead between March 22 and April 17. Our biological sampling goals were met, and fish health inspections were conducted.

The number of fish captured at RRSF is a sample of the 2023 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 can 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. The spring 2023 RRSF steelhead effort is summarized below (Table 3).

Table 3. Numbers of steelhead by strain processed for data, spawned and eggs collected during 5 processing dates during the spring 2023 at the RRSF.

STRAIN	FEMALES SPAWNED	EGGS COLLECTED
Chambers Creek	67	318,532
Ganaraska	45	214,156
Unspecified		
Total	**112**	**532,688**

Any unspecified strain steelhead reared will be stocked into non-brood rivers.

FALL 2023 ROOT RIVER SUMMARY

The Root River Steelhead Facility in Racine County was in operation for 13 processing days during the fall 2023 spawning migration. Between Sept. 25 and Nov. 13, a total of 4,450 fish were captured and processed. Biological sampling goals were met, and fish health inspections were conducted on coho salmon. The Wisconsin Department of Natural Resources (DNR)'s fall 2023 Root River effort is summarized below (Table 4).

Table 4. Numbers of Chinook salmon, coho salmon, rainbow trout, and brown trout processed for data, spawned, and passed upstream during fall 2023 operation of the RRSF.

	TOTAL CAPTURED	FEMALES SPAWNED	EGGS COLLECTED	PASSED UPSTREAM
Chinook salmon	2,409			2,342
Coho salmon	2,010	142	492,542	1,939
Rainbow trout	17			9
Brown trout	13			13
Pink salmon	1			1
Total	**4,450**	**142**	**492,542**	**4,304**

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

The Root River Open House was held on Saturday, Oct. 14. DNR Fisheries staff gave tours of the facility and conducted fish processing and spawning demonstrations. DNR Law Enforcement staff displayed their Lake Michigan vessel, and US Coast Guard

staff answered questions regarding safety and regulations. Volunteers from Salmon Unlimited of Wisconsin welcomed visitors, provided food samples, displayed a Lake Michigan fishing boat, and instructed kids on how to cast a fishing rod and tie fishing knots. Trout Unlimited and the Kenosha Sport Fishing and Conservation Association also provided volunteers to teach fly casting and fly tying. Attendees were able to tour the Touch of the Wild trailer sponsored by the Wisconsin Conservation Congress and the Outdoor Heritage Education Center. Thank you to all who participated and helped make the day a success!

The DNR would like to acknowledge the support of Salmon Unlimited in keeping the Root River Steelhead Facility operational. In addition, a special thank you to the volunteers for the daily opening and closing of the viewing window at the facility.

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 2023

2023 Spawning Survey

SPRING GILL NET SURVEY DATES (MAY 15 – MAY 30, 2023)

The Wisconsin Department of Natural Resources (DNR)'s 2023 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, 2.25-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). A single gill net is 600 feet long and two gillnets tied together create one 1,200-foot-long gang. When setting nets off of the RV Sturgeon, individual gill nets were used. When setting nets off of the RV Coregonus, gangs of gillnets were set. For 2023, only the RV Sturgeon was used. The survey began May 15, 2023 and continued through May 30, 2023. Depths from 17 to 50 feet of water were sampled. Water temperature on the bottom of the lake ranged from 46°F to 50.4°F during the survey. The total effort for the 2023 survey was 5,500 feet of gillnet set for one night.

The first nets were set on May 15 from the RV Sturgeon, capturing 82 perch. This set consisted of 1,800 feet of gill net set from 17 to 40 feet of water. The bottom temperature was 46°F.

The second nets were set on May 22, capturing 109 perch. This set consisted of 2,400 feet of gill net set from 17 to 50 feet of water. The bottom temperature was 46°F at the time nets were set.

The third and final nets were set on May 29 from the RV Sturgeon, capturing 23 perch. This set consisted of 1,800 feet of gill net set from 17 to 40 feet of water. The bottom temperature was 50.4°F at the time nets were set.

In total, 217 yellow perch were captured, 175 of which were ripe males, one fish of unknown sex and the remaining 41 were females (Figure 1). Aging structures were collected from all individuals. Most of the perch (55) were from the 2016 cohort (7 years old), 38 fish were from the 2017 cohort (6 years old) and 33 fish were from the 2018 cohort (5 years old). The age composition of perch captured in the 2023 survey closely reflected that of the 2022 survey with one exception (Figure 2). The 2020

cohort emerged in the recent survey and appears to be relatively strong as we captured 49 perch that were 3 years old. The number of yellow perch in the 2023 spawning survey increased from prior years. The 2016 year-class continues to show up and is producing some large fish, while the 2020 year-class may provide a new cohort of fish recruiting to the recreational fishery. It has been many years since over 200 perch were encountered in a spawning survey. The last time that occurred was in 2011 (Figure 1).

In addition to yellow perch, round whitefish, alewife, burbot, lake trout, longnose sucker, white sucker, rock bass and round goby were also captured. Typically, the spawning survey is concluded with a dive survey searching for perch skeins. Unfortunately, no diving survey was conducted in 2023.

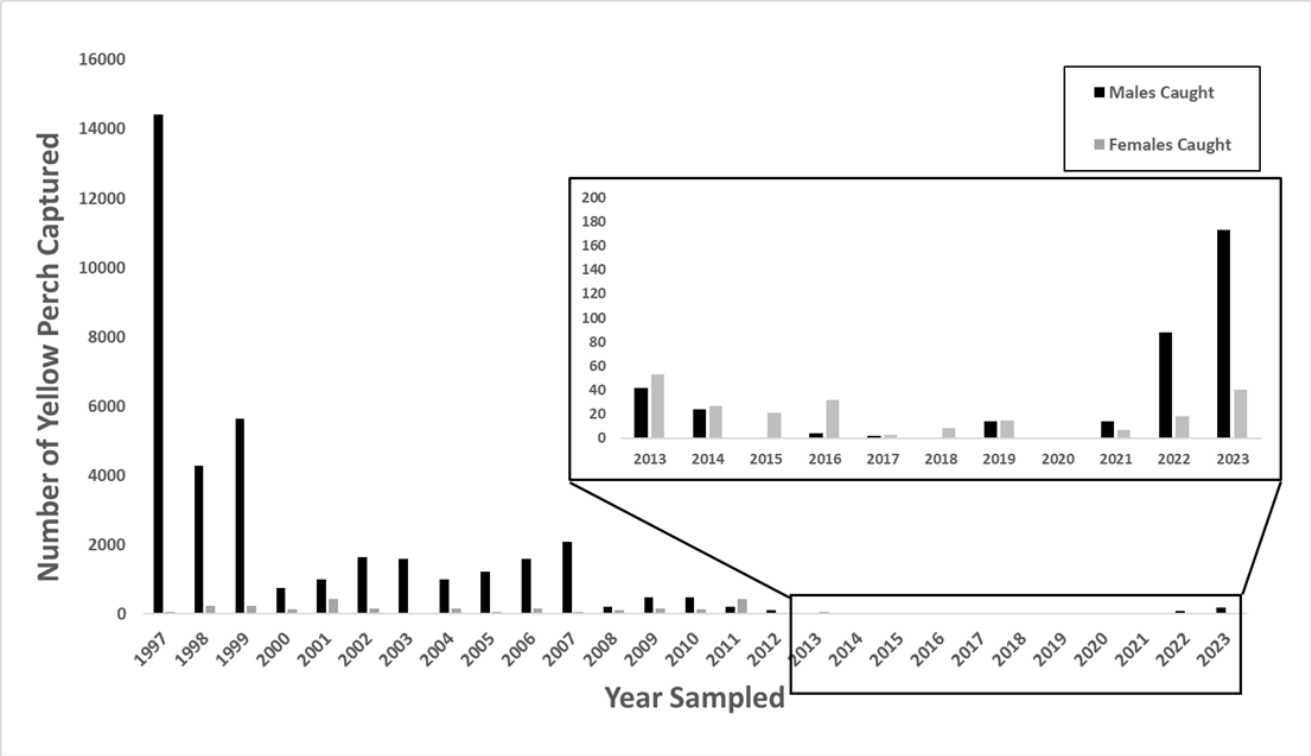

*Figure 1. Yellow perch spawning assessment at the Green Can Reef, Lake Michigan, Milwaukee, DNR 1997-2023. *No spawning survey was conducted in 2020.**

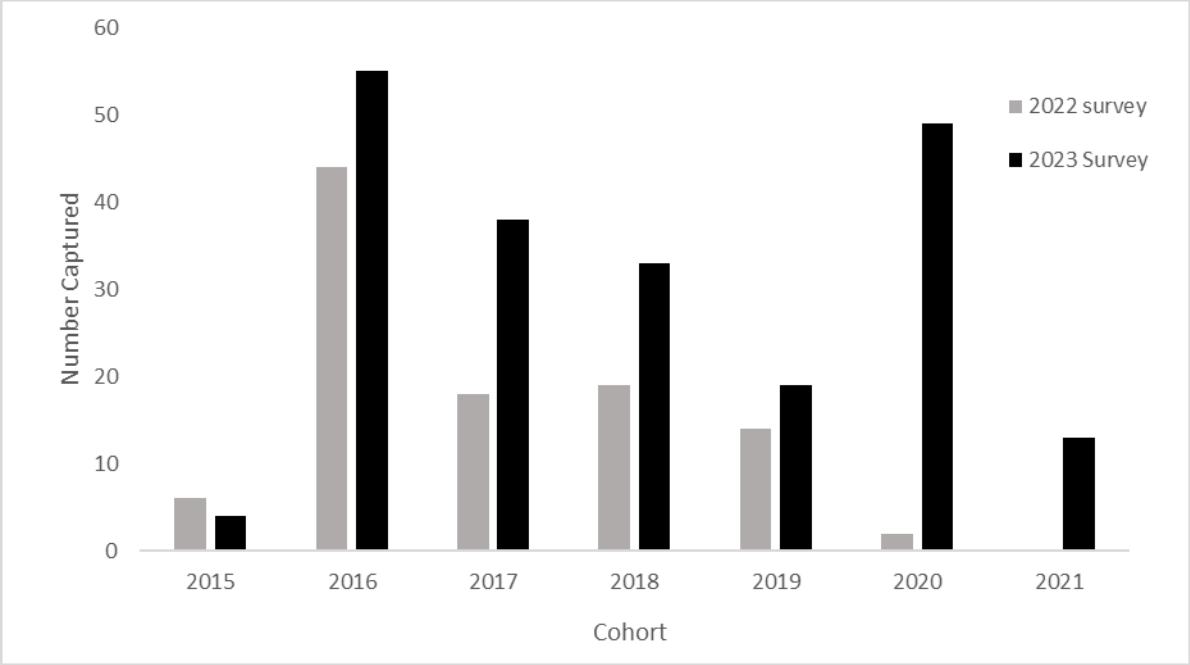

Figure 2. Cohorts of yellow perch captured during annual spawning assessments on Green Can Reef, Lake Michigan, Milwaukee, DNR 2023.

Young Of Year Survey

SURVEY DATES (AUG. 16 AND 29, 2023)

An annual survey of young-of-the-year (YOY) yellow perch along the Lake Michigan shoreline typically consists of both seining and micromesh gill netting efforts encompassing sampling sites from Sheboygan to Kenosha. In 2023, no micromesh survey was conducted due to weather and staff constraints, but a seining survey was completed.

The seining survey was carried out on Aug. 16 and then again on Aug. 29, 2023. A standard 25-foot beach seine was pulled by two persons in shallow nearshore waters of Lake Michigan. Each pull consisted of a 100-foot sweep either parallel to the beach or perpendicular to the beach or along piers and jetties depending on the depth and feasibility of seining. At each station, depending on conditions, two 100-foot pulls were attempted unless algae bloom limited our ability to effectively pull the net, especially when sampling around jetties and windward shores.

A total of fifteen stations were sampled from Sheboygan to Kenosha (Sheboygan – 3. Ozaukee – 3, Milwaukee – 5, Racine – 2 and Kenosha – 2). Most sites were sampled twice, once during the first portion of the survey in mid-August and then again at the end of August. Seining conditions during the sampling period varied among different

sites on different days depending on wind direction. Some sites were difficult or impossible to seine due to abundant cladophora, while others were clear and easy to sample. In general, seining conditions this year were favorable for this assessment. A total of 42 seine hauls were usable from the 15 sites for a total of 4,200 feet of seine haul. The water temperature during the survey ranged from 67-77°F during the August sampling.

Three perch were captured during the entirety of this survey. In other terms, it took an average of 14 seine hauls to capture one YOY yellow perch in our 2023 seining survey (Figure 3). Researchers in the UW-Milwaukee School of Freshwater Sciences predicted a quality yellow perch recruitment for 2023 based on the timing and abundance of diatoms in the nearshore area throughout the summer. It has been theorized that food availability is a bottleneck for young yellow perch since the water has cleared up due to invasive mussels. Unfortunately, we did not detect a significant year class with the seining survey in 2023. It is always possible that the perch recruited but did not utilize nearshore habitat at the time of the survey due to weather or water conditions. If that is the case, we should see the 2023 cohort show up in the winter graded mesh surveys or the spawning surveys of 2026 and beyond.

Other species captured included alewife, spottail shiner, round goby, Johnny darter, longnose dace and bloater chub. YOY alewife dominated the catch, which is encouraging after a lack of recruitment in 2022. Young alewife are a preferred prey species for yellow perch large enough to catch and consume them. The presence of YOY alewife often results in faster growth rates in yellow perch.

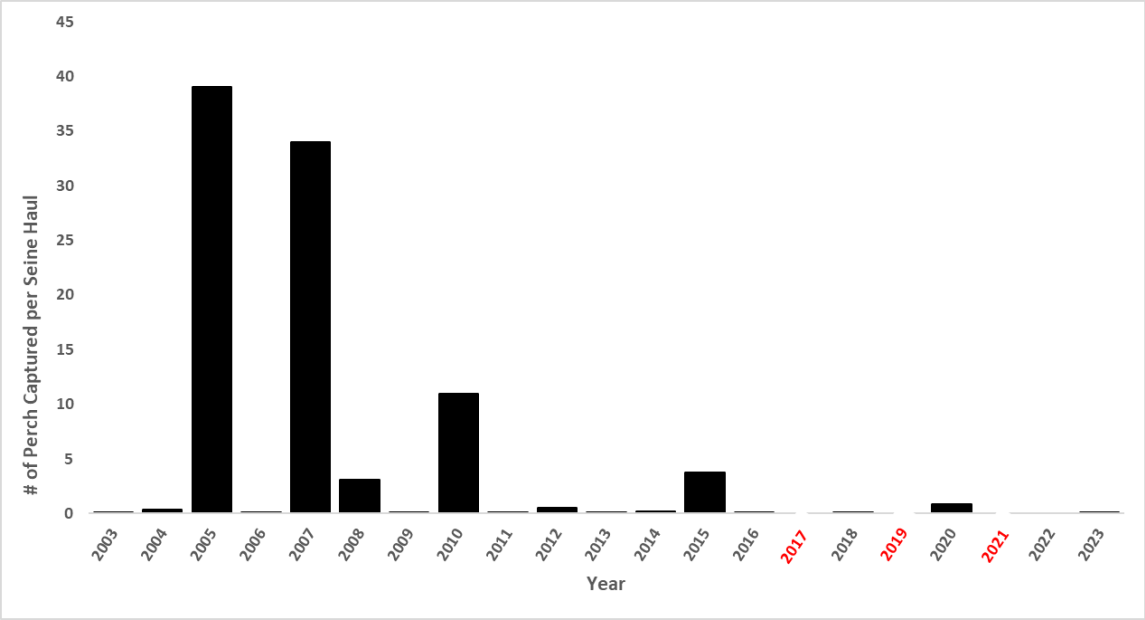

Figure 3. *Number of yellow perch captured per seine haul in annual beach seining surveys at index sites from Kenosha to Sheboygan on Lake Michigan from 2003-2023. *Surveys were not conducted in 2017, 2019 or 2021.*

Winter Graded Mesh Assessment

NOT CONDUCTED FOR 2024

Our annual winter graded mesh assessment of the yellow perch population in Lake Michigan is typically conducted in early December and is an index of the age structure of the yellow perch population. The survey was not conducted in December 2023. This survey will resume in the future and will continue to monitor for significant cohorts recruiting to the fishery. The figures below are results from the 2023 survey, conducted in December 2022, indicating low catch rates and only a few cohorts represented in the population. With the recent increased catch rate in the spawning survey, the age structure of the perch population may be better informed by those estimates. Sampling locations and effort have been manipulated in recent years to increase catch in the winter graded mesh survey with minimal results. It is possible that the perch are no longer using historical wintering grounds. Alterations to this survey are being considered to better sample yellow perch in winter months.

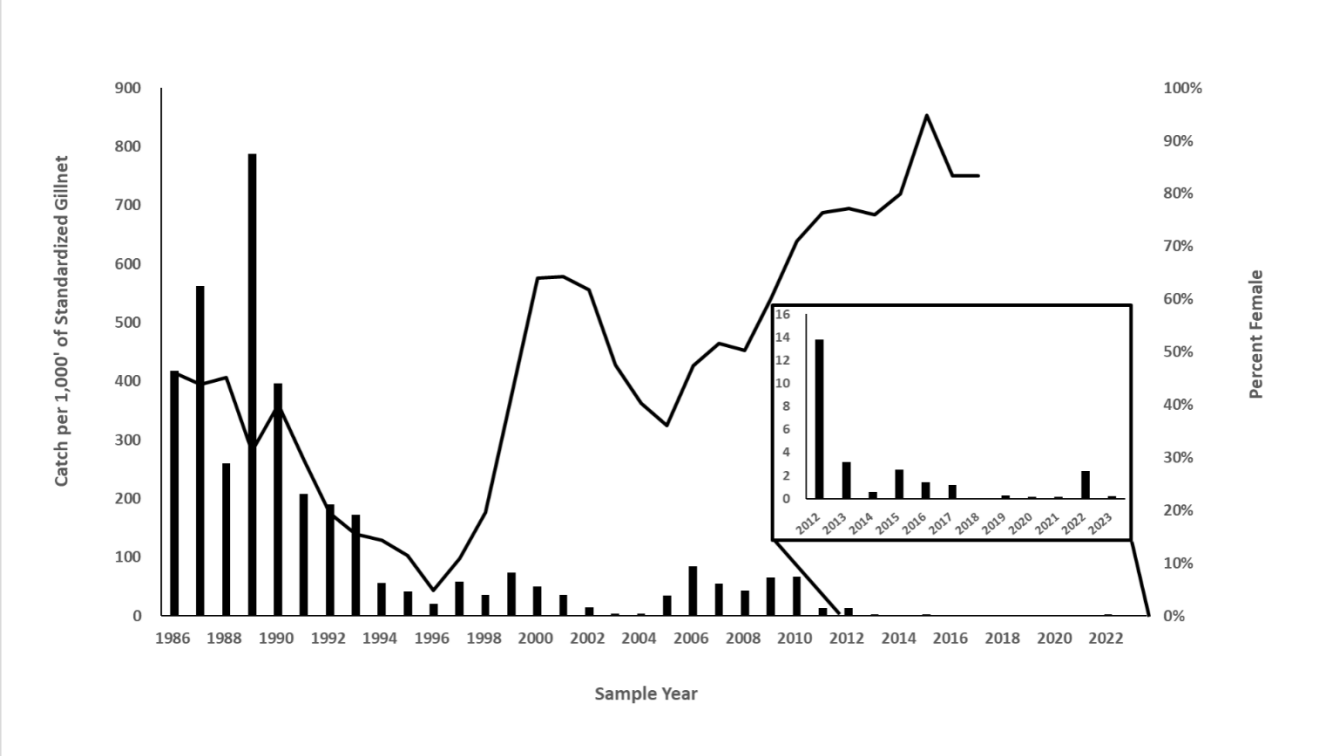

*Figure 4. Adult yellow perch standardized CPUE (bars) and percent female (line) in the Wisconsin waters of Lake Michigan winter gill net assessment, Milwaukee, WI, 1986-2023. Percent female calculation ends in 2018 due to insufficient sample size. *Mesh size and effort has changed over time. This figure standardizes both effort and mesh size to compare recent catches with historical catches using similar gear.*

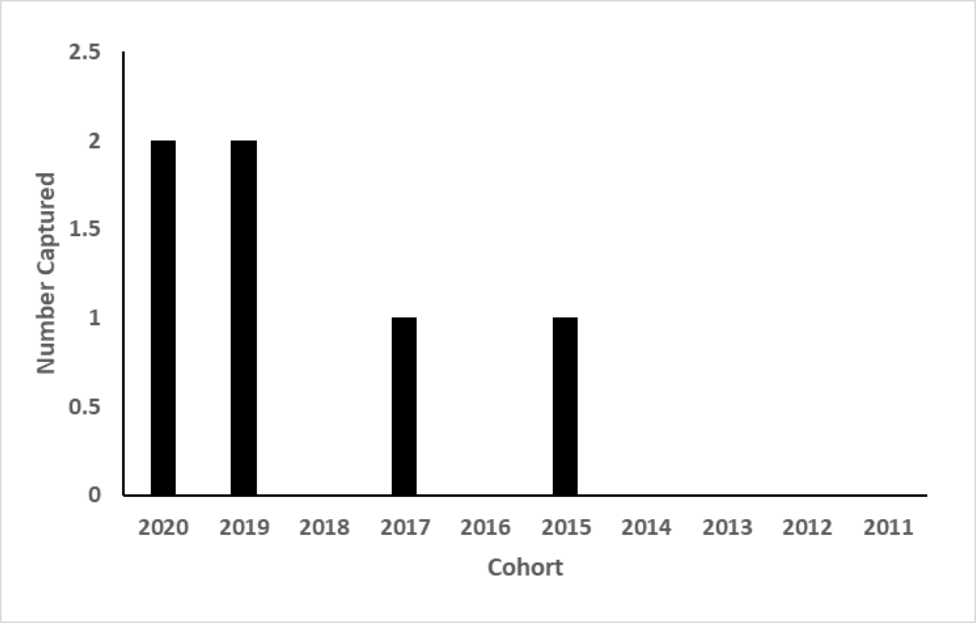

Figure 5. Cohorts of yellow perch captured during annual graded mesh assessment in Milwaukee, WI, 2023.

2023 Survey Year Summary

Yellow perch populations remain historically low and struggle to consistently produce significant year classes. Yellow perch from the 2016 cohort continue to produce the majority of the large fish. There is an up-and-coming class of fish from the 2020 cohort that should start to show up in the fishery in 2024 if they haven't been encountered already. The spawning stock biomass is increasing with the addition of the 2020 year class. Our YOY surveys in recent years have been limited but the data from the other surveys can help fill in data gaps. Overall, the catch of yellow perch is increasing and the population is relying heavily on one or two years of successful recruitment. Hopefully, an increase in spawner biomass and some favorable weather trends will result in an increase of yellow perch in the Milwaukee area.

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