WISCONSIN DEPARTMENT OF NATURAL RESOURCES

2023 Thunder Lake Fisheries Survey Report

Waterbody Code 1618100

Photo Credit: Lakeland Aerial

Nathan Lederman
Fisheries
Biologist

Chad Leanna
Fisheries
Technician

Royce Zehr
Fisheries
Team Supervisor

February 2025

Table Of Contents

Introduction 1
Methods 5
  Survey Effort 5
  Data analysis 7
Results 8
  Black crappie 8
  Bluegill 9
  Largemouth bass 10
  Muskellunge 11
  Northern pike 11
  Pumpkinseed 14
  Walleye 14
  Yellow perch 17
Other species 19
Discussion 19
Recommendations 21
Acknowledgments 21
References 21

Introduction

Farmland was drained by ditches during the 1910s creating a deep marsh that laid the foundation for Thunder Lake. A log dam placed on one of the drainage ditches in 1917 artificially increased water level formally creating Thunder Lake. Dam enhancements in 1938 and 1948 added 2.8 feet to the water level ensuring Thunder Lake maintained an ability to function as a shallow lake. Water level in Thunder Lake has been variable as seepage into the surrounding wetlands lowers water levels. Berms and dikes were added by the Thunder Lake Protection and Rehabilitation District and the Town of Three Lakes in 1994 reducing water loss. This armoring stabilized water levels and much of the basin of Thunder Lake now remains around 6 feet in depth.

Thunder Lake has had periods in the turbid state and clear state of a shallow lake. During the 1980s, Thunder Lake was in a turbid state with limited amounts of aquatic vegetation and frequent winter kills. The turbid state and lack of vegetation favored a bullhead fishery undesired by users. The Thunder Lake Protection and Rehabilitation District installed an aerator during the winter of 1984 to prevent winter kill in hopes of ensuring the survival of more fish and shift the fish community to one more desirable to them. Bullhead removals also occurred in 1980s removing 56 tons of bullheads from Thunder Lake to aid in the fish community shift. The bullhead removal, prevention of winterkills and stocking (Table 1) aided in shifting the system to a clear water state. Thunder Lake has been in a clear water state since the 1990s with productive beds of aquatic vegetation and a fishery more desirable to users. Additional information on Thunder Lake can be found on the Wisconsin Department of Natural Resources' (DNR) Lake Page.

Three resorts, approximately 50 property owners and the public utilize Thunder Lake year-round (Andrews and Threinen 1966). A complex-cool-dark fish community provides a variety of fish species for anglers to target (Rypel et al. 2019). Angling effort was below the Oneida county 33.7 hours per acre average in 2015 with winter angling the preferred season to fish (Halverson and Blonski 2016). Northern pike were the most targeted species when angling with bluegills, black crappies and yellow perch commonly targeted as well (Halverson and Blonski 2016).

Fishery monitoring has focused on recreationally important species resulting in size and creel limit changes ensuring species are sustained (Table 1). Dissolved oxygen levels were routinely monitored by the DNR during the 1930s through 1980s until the citizen began monitoring that in 1986 through the Citizen Monitoring Program.

The objectives of the 2023 fishery survey on Thunder Lake survey were to

1. assess the status of the fish community
2. attain northern pike and walleye population estimates
3. update fisheries management recommendations

Table 1. Fish stockings from 1934-2023 on Thunder Lake, Oneida County, Wisconsin.

YEAR	SPECIES	AGE CLASS	NUMBER OF FISH STOCKED	SOURCE TYPE
1934	walleye	unknown	86,220	DNR
1937	yellow perch	fingerling	24,000	DNR
1937	largemouth bass	fingerling	5,000	DNR
1938	bluegill	adult	1,375	DNR
1938	muskellunge	fingerling	18	DNR
1938	muskellunge	fry	17,010	DNR
1938	northern pike	fry	750,000	DNR
1938	yellow perch	fingerling	50,000	DNR
1938	walleye	fry	633,070	DNR
1939	largemouth bass	yearling	45	DNR
1939	muskellunge	fry	10,000	DNR
1939	yellow perch	adult	150	DNR
1939	yellow perch	eggs	6,600	DNR
1939	rock bass	adult	195	DNR
1939	rock bass	yearling	78	DNR
1939	walleye	fry	540,000	DNR
1940	muskellunge	fry	10,000	DNR
1940	northern pike	fry	50,000	DNR
1940	walleye	fry	720,000	DNR
1941	muskellunge	fingerling	54	DNR
1941	muskellunge	fry	2,250	DNR
1941	white sucker	adult	950	DNR
1941	walleye	fry	540,000	DNR
1942	walleye	fry	960,000	DNR
1942	muskellunge	fry	80,000	DNR
1943	walleye	fry	562,500	DNR
1950	walleye	fingerling	9,550	DNR
1951	muskellunge	fingerling	7,300	DNR
1952	walleye	fingerling	9,100	DNR
1953	muskellunge	fingerling	3,635	DNR
1955	walleye	fingerling	1,910	DNR
1956	walleye	fingerling	4,500	DNR
1958	walleye	fingerling	15,350	DNR
1977	walleye	fry	2,000,000	DNR
1978	walleye	fingerling	90,000	DNR
1979	largemouth bass	fingerling	11,700	DNR
1980	walleye	fingerling	88,120	DNR
1981	largemouth bass	fingerling	50,000	DNR
1981	walleye	fingerling	79,360	DNR
1984	walleye	fingerling	74,385	DNR
1985	walleye	fingerling	91,000	DNR
1986	walleye	fingerling	90,000	DNR
1987	walleye	fingerling	261,900	DNR
1988	walleye	fingerling	90,000	DNR
1992	largemouth bass	fingerling	11,780	Federal

YEAR	SPECIES	AGE CLASS	NUMBER OF FISH STOCKED	SOURCE TYPE
1993	largemouth bass	fingerling	20,000	DNR
1994	walleye	fingerling	58,770	DNR
1995	bluegill	yearling	282	Field
1995	pumpkinseed	yearling	13	Field
1995	walleye	fingerling	46,004	DNR
1995	yellow perch	yearling	25	Field
1997	walleye	large fingerling	45,450	DNR
1999	walleye	small fingerling	107,702	DNR
1999	walleye	small fingerling	29,032	DNR
1999	walleye	small fingerling	36,000	DNR
2000	walleye	yearling	1,500	Private
2001	walleye	large fingerling	2,300	Private
2001	walleye	small fingerling	183,500	DNR
2003	yellow perch	yearling	4,100	Private
2003	walleye	small fingerling	183,500	DNR
2004	walleye	large fingerling	600	Private
2004	walleye	yearling	1,550	Private
2005	walleye	large fingerling	2,000	Private
2006	walleye	small fingerling	91,735	DNR
2006	walleye	large fingerling	2,000	Private
2009	walleye	small fingerling	62,766	DNR
2011	walleye	small fingerling	64,170	DNR
2013	walleye	small fingerling	48,916	DNR
2013	walleye	small fingerling	57,825	DNR
2014	walleye	small fingerling	68,085	DNR
2014	walleye	large fingerling	7,300	Private
2015	walleye	small fingerling	62,741	DNR
2015	walleye	large fingerling	4,246	Private
2016	largemouth bass	large fingerling	36,887	DNR
2016	walleye	small fingerling	62,791	DNR
2016	walleye	large fingerling	3,152	Private
2017	largemouth bass	large fingerling	17,918	DNR
2017	walleye	small fingerling	25,422	DNR
2017	walleye	small fingerling	37,372	DNR
2018	largemouth bass	large fingerling	17,943	DNR
2018	walleye	large fingerling	6,000	Private
2019	walleye	small fingerling	69,075	DNR
2019	walleye	large fingerling	2,999	Private
2020	walleye	yearling	3,150	Private
2021	walleye	small fingerling	62,779	DNR
2021	walleye	large fingerling	5,006	Private
2022	walleye	large fingerling	3,200	Private
2023	walleye	small fingerling	62,757	DNR
2023	walleye	large fingerling	4,000	Private

Table 2. Fish surveys from 1977-2023 on Thunder Lake Oneida County, Wisconsin.

YEAR	TYPE	GEAR	TARGET SPECIES	SURVEY PURPOSE
1947	FN	netting	all species	relative abundance
1977	FE	boom	walleye	recruitment
1979	FE	boom	walleye	recruitment
1986	FE	boom	walleye	recruitment
1989	SN 1	fyke net	walleye	relative abundance
1994	FE	boom	walleye	recruitment
1995	FE	boom	walleye	recruitment
1997	FE	boom	walleye	recruitment
2001	FE	boom	Walleye	recruitment
2002	SE 1	boom	walleye	relative abundance
	FE	boom	walleye	recruitment
2003	FE	boom	walleye	recruitment
2005	FE	boom	all species	relative abundance
	FN	mini fyke	all species	relative abundance
2006	SN 1	fyke net	walleye	mark-recapture
	SE 1	boom	walleye	population estimate
	SE 2	boom	all species	mark-recapture
	SE 2	boom	Basses	population estimate
	SN 3	fyke net	panfish	relative abundance
	FE	boom	walleye	recruitment
2009	FE	boom	walleye	recruitment
2011	FE	boom	walleye	recruitment
2014	SE 2	boom	all species	relative abundance
2015	SN 1	fyke net	walleye and northern pike	mark-recapture
	SE 1	boom	walleye	population estimate
	FE	boom	walleye	recruitment
	Creel	survey	all species	effort and harvest
2023	SN 1	fyke net	walleye and northern pike	mark-recapture
	SE 1	boom	walleye	population estimate
	SE 2	boom	all species	relative abundance
	FE	boom	gamefish	recruitment

Methods

A comprehensive fishery survey was conducted on Thunder Lake following the treaty assessment protocol (Cichosz 2021) during the spring and fall of 2023. Spring fyke netting for walleye and northern pike (SN 1), early spring electrofishing for walleye (SE 1), late spring electrofishing for bass and panfish (SE 2) and fall electrofishing for juvenile gamefish (FE) occurred (Figure 1). Effort provides a description of the overall status of the fishery, size structure of select fish species and population size estimates of important gamefish.

SURVEY EFFORT

Ten standard 4-foot frame fyke nets were set on April 23 and fished until April 28, 2023. Nets were checked once every 24 hours totaling 47 net night. Nets were set in varying habitats (i.e., substrate and vegetation) and water depths targeting spawning adult gamefish. Nets that showed decreases in catch rates or did not fish well (e.g., nets rolled, water level changed or flows increased) were periodically moved.

Early spring electrofishing (SE 1) targeting walleye was conducted around the entire shoreline on the of night April 28, 2023. Late spring (SE 2) electrofishing targeting bass and panfish was completed on May 24, 2023. When conducting the SE 2, eight sites were randomly selected, four 0.5-mile stations where all fish species were targeted and four, 1.5-mile stations where all gamefish were targeted.

Fall electrofishing targeting juvenile gamefish around the entire shoreline was conducted on the night of October 5, 2023. During all electrofishing effort, each boat used two dippers, two probes with a total of 6 droppers, and a dip net bar mesh of 0.375 inches.

Captured gamefish were measured to the nearest 0.1 inch, and sex noted when evident based on expression of eggs or milt. Individuals were checked for lesions, tumors or malformities and noted when found. Largemouth bass, northern pike and walleye were marked with a left ventral fin clip. Marking allowed a mark-recapture population estimate to be calculated. Dorsal fin rays from five walleye within every half-inch increment of each sex were collected allowing age and growth estimation. Pelvic fin rays from five northern pike within every half-inch of each sex were collected for age and growth estimation. Counts were recorded for all other species collected.

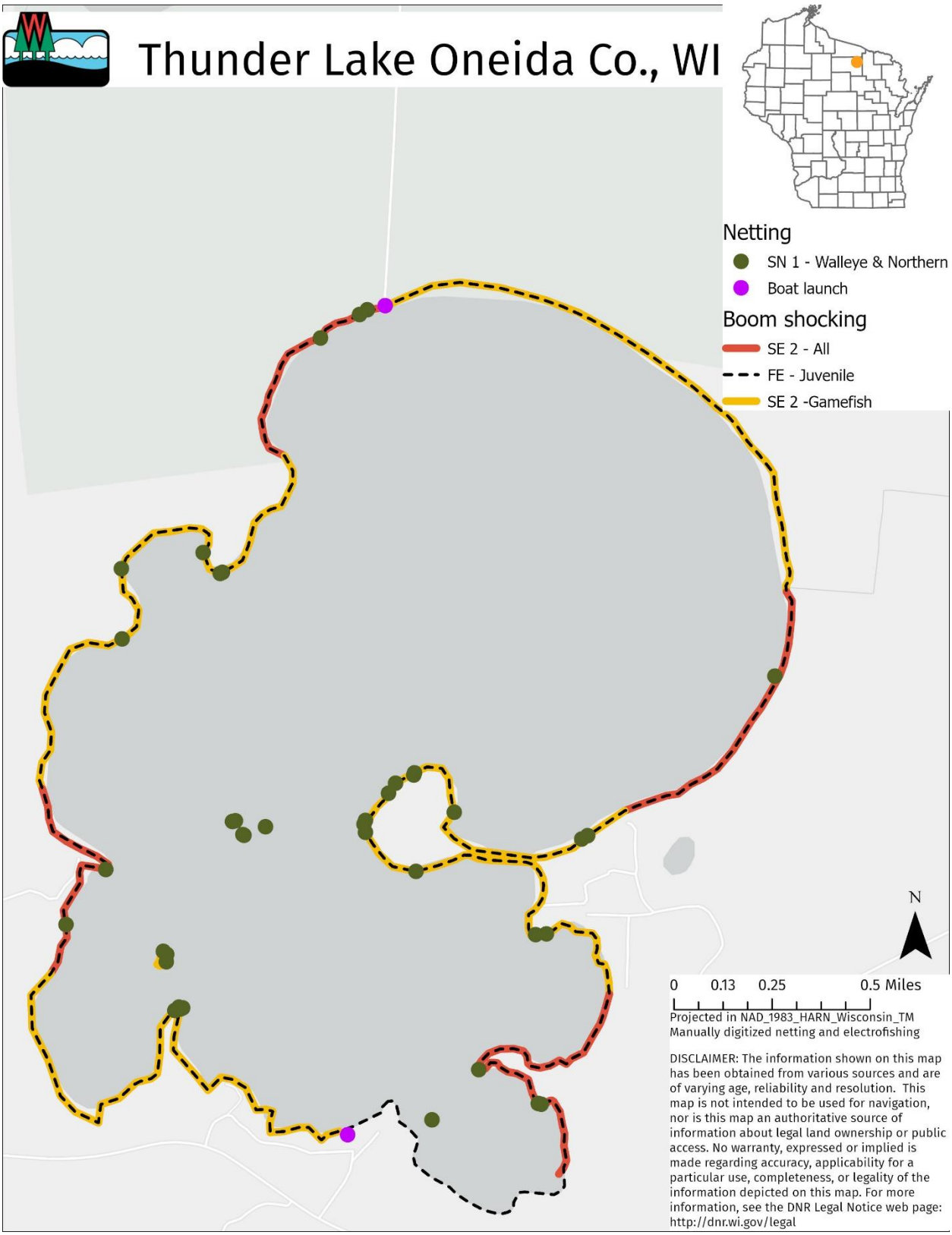

Figure 1. Sampling locations in Thunder Lake Oneida County, WI with the capture gears during the comprehensive survey in 2023.

DATA ANALYSIS

Abundance was indexed with a population estimate and quantified to a density estimate (number acre) by dividing the population estimate number by how acres Thunder Lake is. The walleye population was estimated using the Chapman's version of the Petersen method (Chapman 1951) as follows

$$N = \frac{(M+1) * (C+1)}{(R+1)}$$

The northern pike population was estimated using the Schnabel method (1938) as computed from Ricker (1975) as follows

$$\widehat{N} = \frac{\sum_{i=1}^{k} n_i M_i}{(\sum_{i=1}^{k} m_i) + 1}$$

Species in which a population estimate was not created used relative abundance as the index of density. Bluegill, largemouth bass and pumpkinseed relative abundance was indexed as number of individuals per shoreline mile during SE 2 runs collecting all fish. Black crappie, muskellunge and yellow perch relative abundance were index as number of individuals per net night during SN 1.

Size structure of fish were described using length frequencies, descriptive statistics and proportional size distribution (PSD; Gabelhouse 1984). Length frequencies were created for each species from all individuals measured within that species among all capture gears. The mean, minimum and maximum length of each fish species was calculated. The PSD value for a species was calculated as the number of fish of a quality size and longer divided by the number of stock length fish or longer and multiplied by 100. Quality-sized fish are 36% of the world-record length and preferred-sized fish are 45% of the world record length representing fish lengths anglers likely enjoy catching (Table 3).

Table 3. Proportional size distribution values for select fish species in Thunder Lake, Oneida County, WI.

SPECIES	STOCK SIZE	QUALITY SIZE	PREFERRED SIZE
black crappie	5	8	10
bluegill	3	6	8
largemouth bass	8	12	15
northern pike	14	21	28
muskellunge	20	30	38
pumpkinseed	3	6	8
walleye	10	15	20
yellow perch	5	8	10

Population estimates, relative abundance indices, mean length and growth of each fish species were compared to other complex-cool-dark lakes within the Wisconsin lake systems (Rypel et al. 2019) and other Oneida county lakes when appropriate.

Results

BLACK CRAPPIE

A total of 2,723 black crappie were captured while surveying Thunder Lake in 2023. Catch rate for black crappie was 57.7 per net night during netting and 4.5 per mile during electrofishing. Catch per net night of black crappie was greater than the 100th percentile (42.2 per net night) for complex-cool-dark lakes.

Lengths of measured black crappies ranged from 4.0 inches to 12.4 inches with a mean length of 7.0 inches (Figure 2). Mean length of black crappie was around the 75th percentile (6.8 inches) for complex-cool-dark lakes. Six percent of measured black crappie were 10 inches or greater (Figure 2). Black crappie size structure increased with a greater proportion of 8 inch and 12 inch or larger individuals in 2023 compared to 2006 (Figure 3).

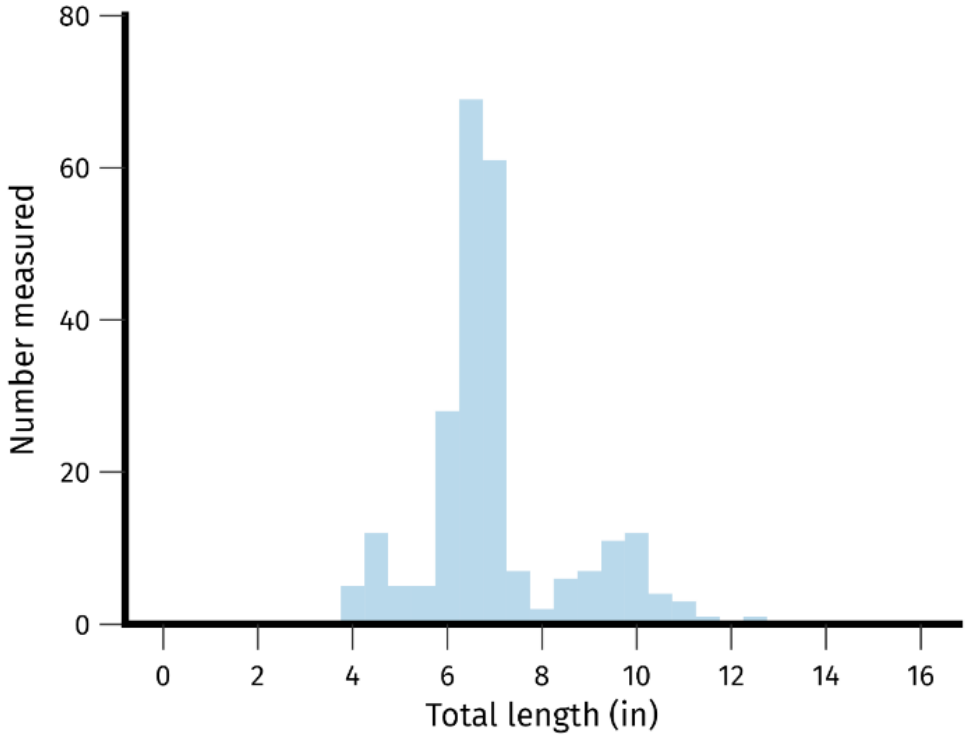

Figure 2. Length frequency of black crappie captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 0.5 inches.

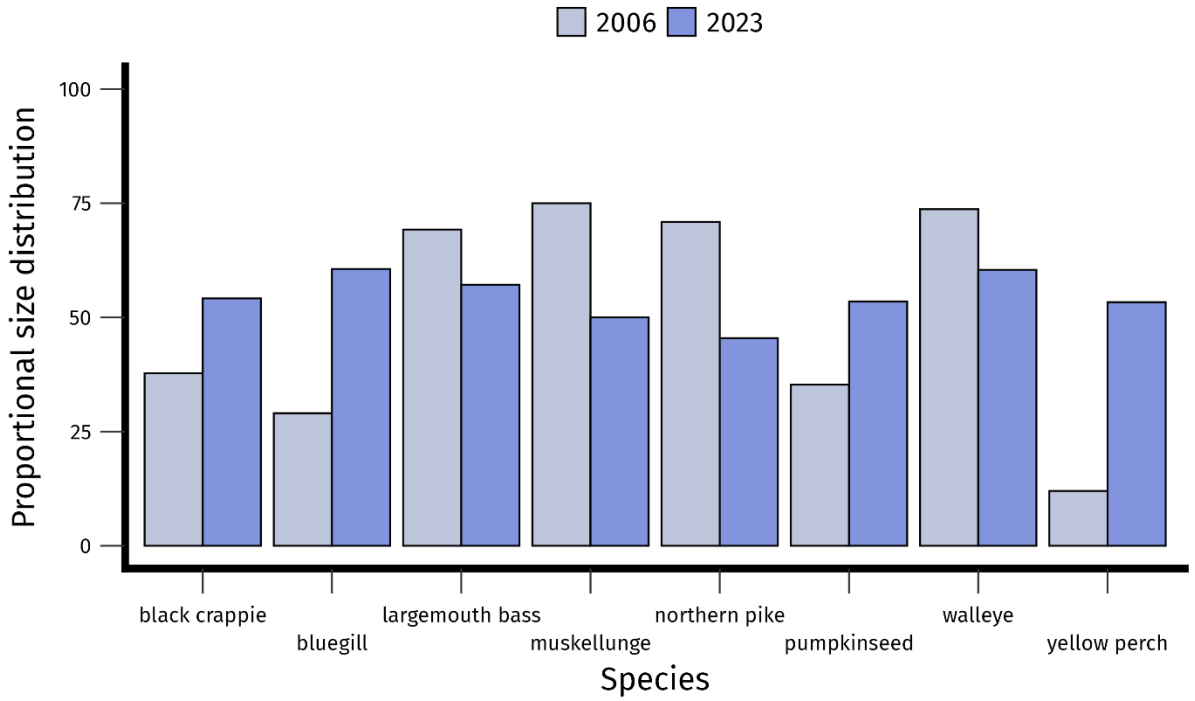

Figure 3. Proportional size distributions of species captured in Thunder Lake, Oneida County, WI during the 2023 and 2006 comprehensive surveys.

BLUEGILL

A total of 1,668 bluegills were captured while surveying Thunder Lake in 2023. Catch rate for bluegill was 33.3 per net night during netting and 52.5 per mile during electrofishing. Catch per mile of bluegill was slightly above the 25th percentile (42.1 per mile) for complex-cool-dark lakes and other lakes across Oneida County (20.8 per mile).

Lengths of measured bluegills varied between 2.6 inches to 10.5 inches with a mean length of 6.7 inches (Figure 4). Mean length of bluegill was in the 100th percentile (6.7 inches) for complex-cool-dark lakes. The majority (57%) of measured bluegill were 6 inches or greater (Figure 4). Bluegill size structure has increased with a greater proportion of 6 inch and 8 inch or larger individuals in 2023 compared to 2006 (Figure 3).

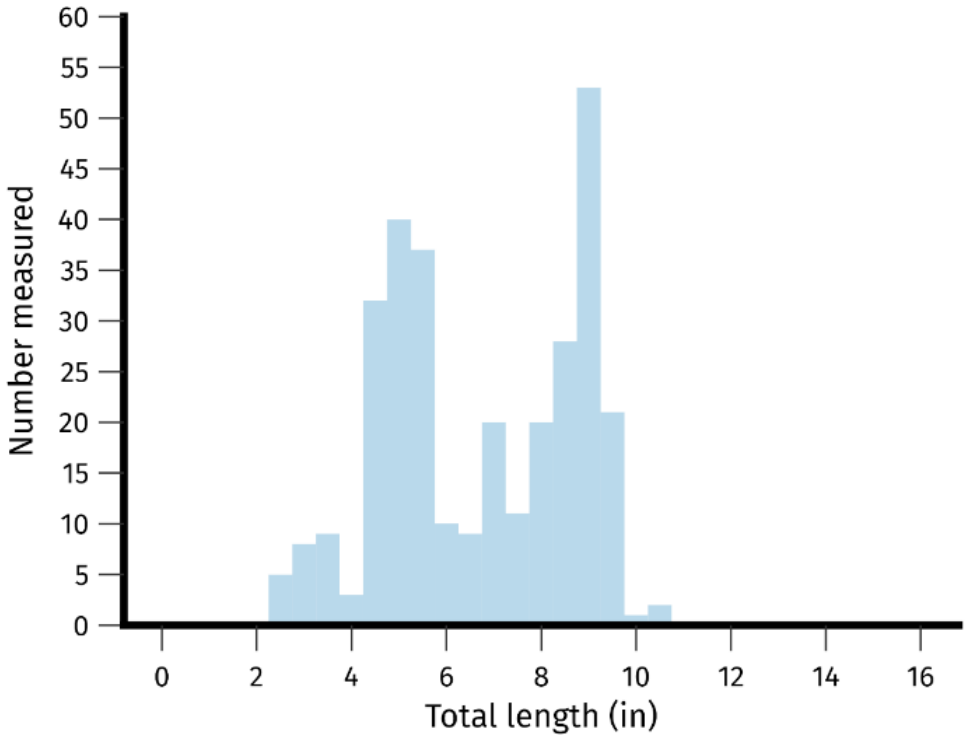

Figure 4. Length frequency of bluegills captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 0.5 inches.

LARGEMOUTH BASS

A total of 89 largemouth bass were captured while surveying Thunder Lake in 2023. Catch rate of largemouth bass was 0.5 per net night during netting and 3.7 per mile during electrofishing. Catch per mile of largemouth bass was slightly above the 50th percentile (3.3 per mile) of complex-cool-dark lakes and the 25th percentile (2.1 per mile) relative to the other Oneida County lakes. A largemouth bass population estimate was unable to be generated in 2023 because of lack of sufficient recaptured individuals.

Lengths of largemouth bass varied between 8.2 inches to 18.4 inches with a mean length of 12.4 inches (Figure 5). Mean length of largemouth bass was around the 90th percentile (12.2 inches) for complex-cool-dark lakes. A majority (52.8%) of measured largemouth bass were 12 inches or greater (Figure 5). Largemouth bass size structure has decreased with a lower proportion of 12 inch and 15 inch or larger individuals in 2023 compared to 2006 (Figure 3).

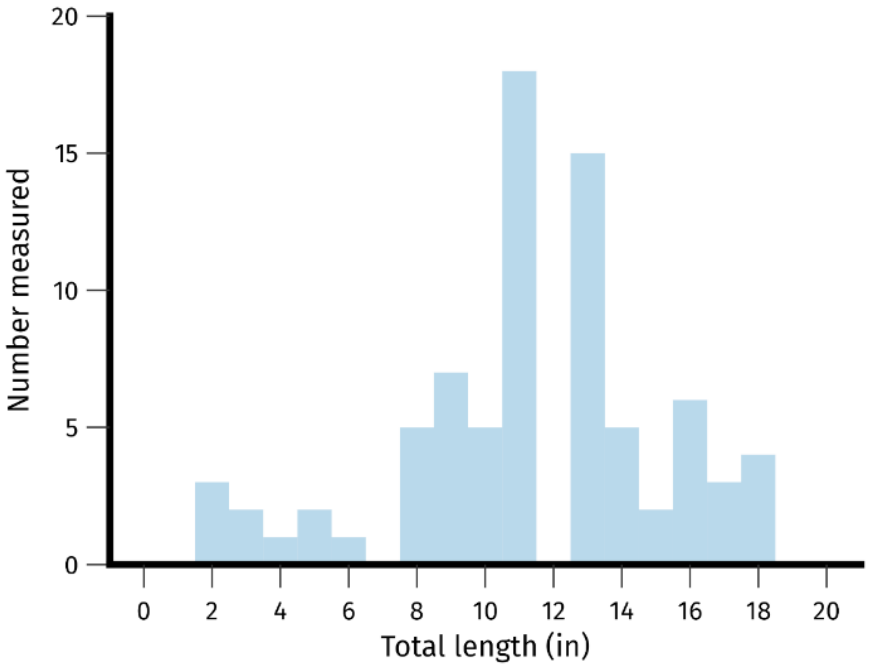

Figure 5. Length frequency of largemouth bass captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 1.0 inch.

.

MUSKELLUNGE

Two muskellunge were captured while surveying Thunder Lake in 2023. Muskellunge catch rate was 0.0 per net night during netting and 0.1 per mile during electrofishing. Muskellunge catch per net night was in the lowest percentile for complex-cool-dark lakes (0.01 per net night) and Oneida County lakes (0.08 per net night). Lengths of muskellunge varied between 25.5 inches to 42.5 inches with a mean length of 34.0 inches. Size structure comparisons should be avoided due to limited sample size (< 75 individuals; Miranda 2007).

NORTHERN PIKE

A total of 2,211 northern pike were captured while surveying Thunder Lake in 2023. Northern pike catch rate was 45.0 per net night during netting and 4.7 per mile during electrofishing. Catch per net night of northern pike was above the 100th percentile (24.2 per net night) for complex-cool-dark lakes and other Oneida County lakes (10.7 per net night). The northern pike population was estimated to be 10,020 ± 732 fish (5.7/acre) in Thunder Lake which is an increase from the 2006 estimate of 7,910 ± 2,042 (4.5/acre) (Kubisiak 2007).

Lengths of northern pike varied between 7.5 inches to 36.0 inches with a mean length of 18.4 inches (Figure 6). Mean length of northern pike was below the 75th percentile (19.5 inches) for complex-cool-dark lakes. Twenty percent of measured northern pike were 21 inches or greater (Figure 6). Northern pike size structure has decreased with a lower proportion of 21 inch and 28 inch or larger individuals in 2023 compared to 2006 (Figure 3).

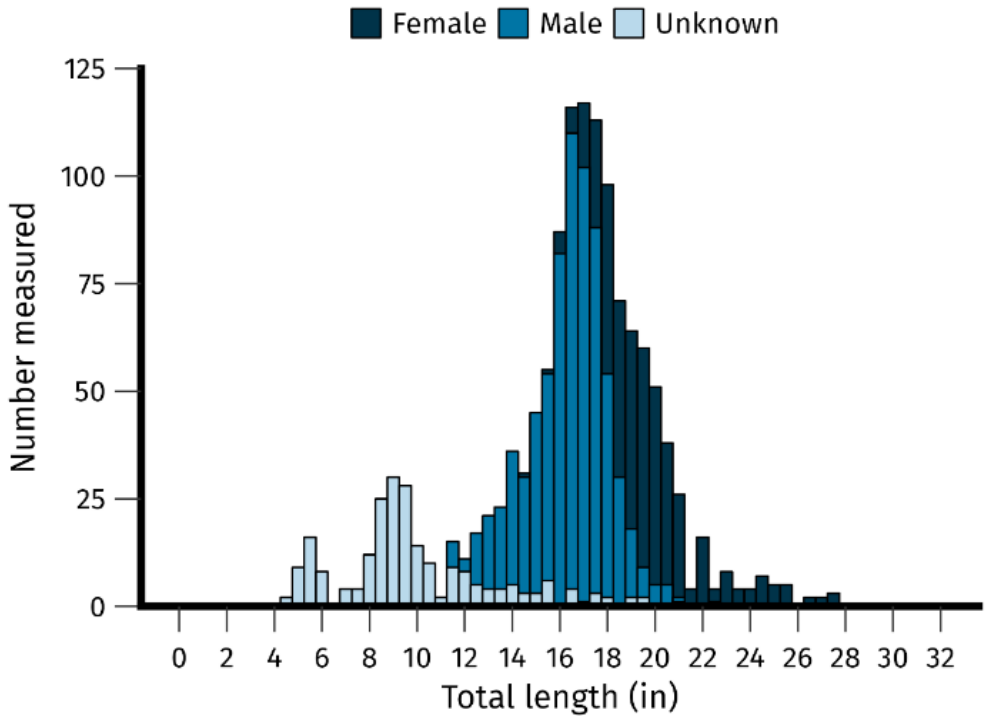

Figure 6. Length frequency of northern pike captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 0.5 inches.

Northern pike were represented by eight year classes varying from an estimate of 2 years old to an estimate of 9 years old. The number of year classes found in 2023 increased from that found in 2015 (ages 1-6) and decreased from the number observed in 2006 (ages 1-11). Female northern pike grew faster than males in Thunder Lake (Figure 7). Northern pike growth was quicker relative to other complex-cool-dark lakes up to age-4 after which growth reduced below the median length at that age (Figure 7). For example, male northern pike at age-3 were 1.5 inches larger than the median for complex-cool-dark lakes but were 2.8 inches smaller at age-6 (Figure 7). The predicated theoretical mean maximum length from the von Bertalanffy growth model for males was 21.5 (95% confidence interval; 20.3 – 23.4 inches) and 40.4 (95% confidence interval; 31.5- 46.1) inches for females. Total annual mortality of female northern pike was 36.4% (95% confidence interval; 16.5 – 51.5) in 2023 compared to 52.0% (95% confidence interval; 35.4% – 82.9%) in 2015 and 22.7% (95% confidence interval; 1.2% – 39.6%) in 2006 (Figure 8). Total annual mortality of males was 50.5% (95% confidence interval; 37.9% – 60.6%) in 2023 compared to 68.3% (95% confidence interval; 19.8% – 87.4.%) in 2015 and 44.6% (95% confidence interval; 4.3% – 67.9%) in 2006 (Figure 8). The observed northern pike mortality rate falls within the range of what has been previously observed within Wisconsin lakes (35-79%; Margenau et al. 1998).

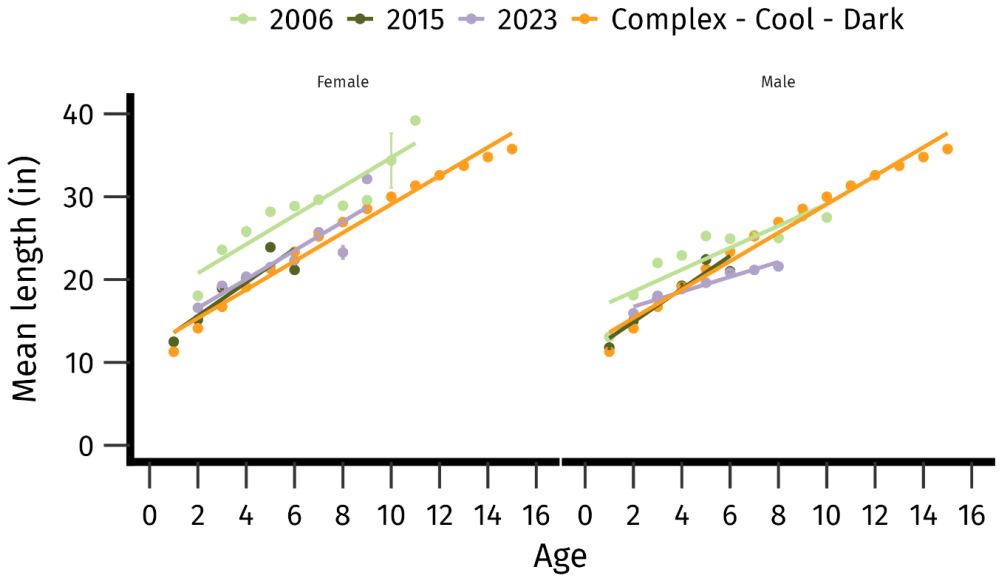

Figure 7. Mean total length at estimated age of northern pike within Thunder Lake, Oneida County, WI for each sex. Length of individuals with an unknown age were assigned an age with a year and sex specific age-length key. Fish ages were assigned using scales in 2006 and ventral fin rays in 2015 and 2023. Mean length at age for each year and the median length at age for complex-cool-dark lake class are represented by unique colors.

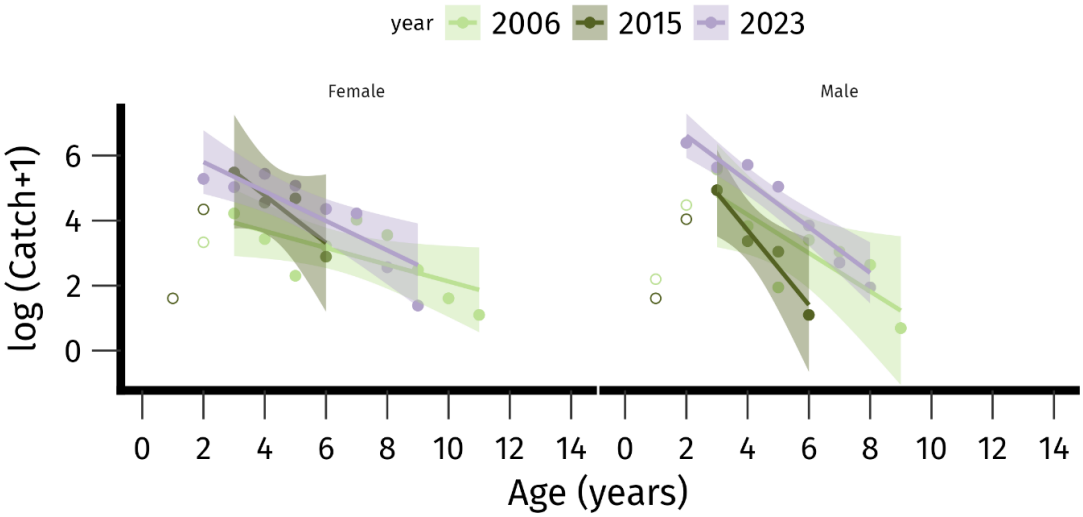

Figure 8. Catch curve of northern pike within Thunder Lake, Oneida County, WI. Ages were assigned from ventral rays in 2023 and 2015 and scales in 2006. Each year is represented by a unique color. Best fit line fit assigned based of linear model to fully vulnerable ages for each year and sex combination where the catch curve started descending with the associated 95% confidence interval of the estimate.

Bluespot virus (*esocid herpesvirus-1*) was visually detected on 7% of captured northern pike. Prevalence of bluespot detection decreased through the sampling starting at 12% of individuals having external symptoms on the first day of sampling ending at 0% having external symptoms on the final day of sampling.

PUMPKINSEED

A total of 1,535 pumpkinseed were captured while surveying Thunder Lake in 2023. Pumpkinseed catch rate was 31.6 per net night during netting and 25.0 per mile during electrofishing. Catch per mile of pumpkinseed was slightly below the 90th percentile for complex-cool-dark lakes (29.9 per mile) and for the other lakes across Oneida County (38.1 per mile). Catch per net night of pumpkinseed was below the 90th percentile for Oneida County Lakes (49.2 per net night).

Lengths of pumpkinseeds varied between 2.8 inches to 8.8 inches with a mean length of 6.3 inches (Figure 9). A majority (65%) of pumpkinseeds were 6 inches or greater. Pumpkinseed size structure has increased with a greater proportion of 6 inch and 8 inch or larger individuals in 2023 compared to 2006 (Figure 3).

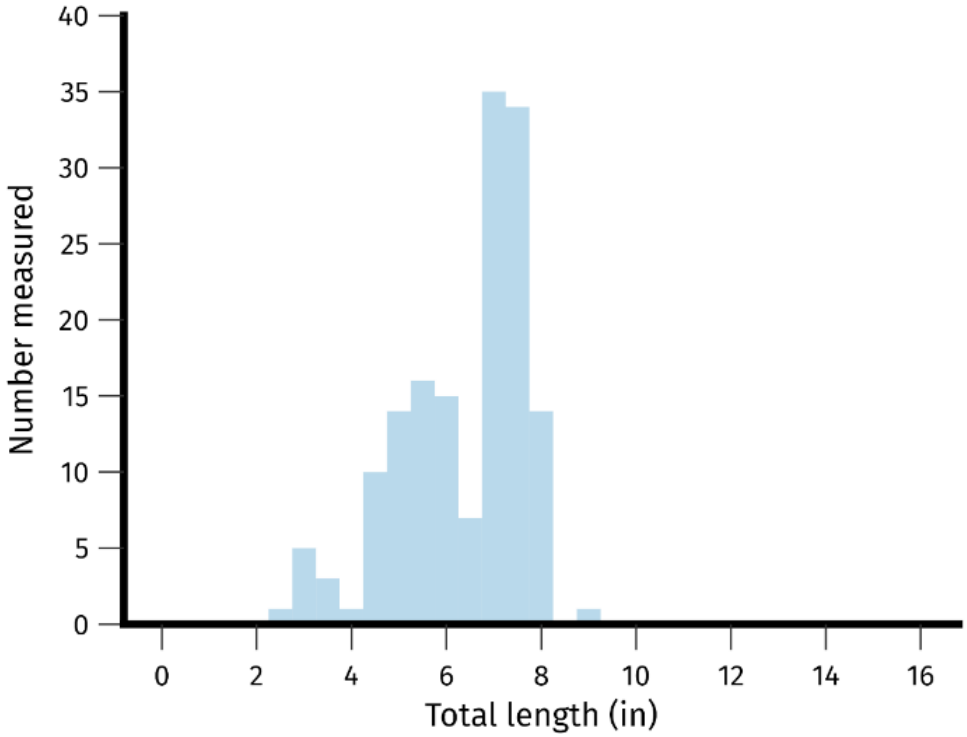

Figure 9. Length frequency of pumpkinseed captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 0.5 inches.

WALLEYE

A total of 1,323 walleye were captured with a male to female ratio of 1.24 while surveying Thunder Lake in 2023. Walleye catch rate was 5.6 per net night during netting and 12.7 per mile during electrofishing. Walleye catch per net night was below the 90th percentile for complex-cool-dark lakes (18.5 per net night) and below the 75th percentile for lakes in Oneida County (17.8 per net night). The walleye population was estimated to be 2,433 fish (1.4/acre), a slight increase from the 0.7 per acre in 2015 (Figure 10).

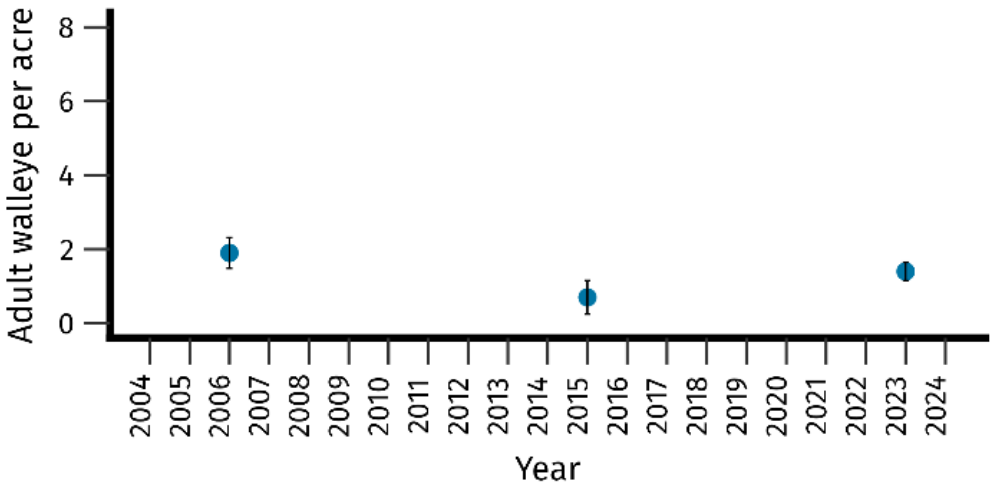

Figure 10. Population estimates for adult walleye (with 95% confidence intervals) in Thunder Lake, Oneida County, WI through time.

Lengths of walleye captured in Thunder Lake varied between 4.5 inches to 27.5 inches with a mean length of 16.4 inches (Figure 11). Eighty five percent of measured walleye were 15 inches or greater (Figure 11). Female walleye tended to be larger than male walleye (Figure 11). Walleye size structure has decreased with a lower proportion of 15 inch and 20 inch or larger individuals in 2023 compared to 2006 (Figure 3).

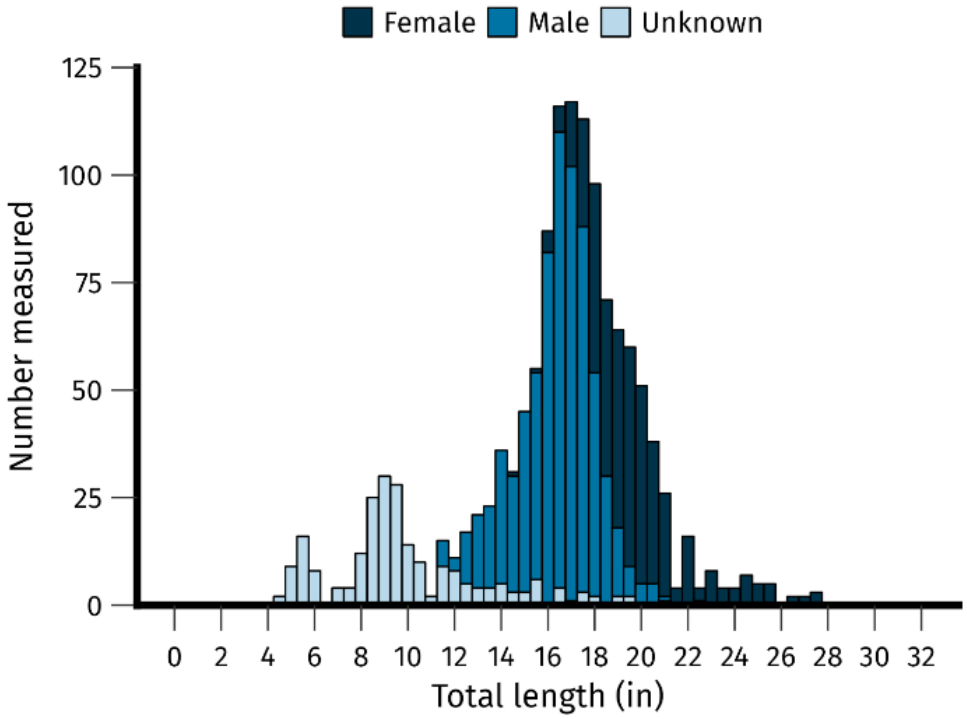

Figure 11. Length frequency of walleye captured in Thunder Lake, Oneida County, WI during the 2023 comprehensive survey. Length bins are every 1.0 inch.

Walleye were represented by 14 year classes from age-0 to age-14. This is an increase in the number of age classes from 2015 (ages 1-12) and from 2006 (ages 2-11). Female walleye grew faster than males in Thunder Lake. Female walleye growth was similar to the median for complex-cool-dark lakes while male growth was slower after age-5 (Figure 12). For example, female walleye at age-6 were 0.2 inches larger than the median length of other complex-cool-dark lakes while males were 1.0 inches smaller. The predicated theoretical mean maximum length from the Von Bertalanffy growth model for males was 21.5 inches (95% confidence interval; 20.3– 23.4) inches and an unrealistic value of 45.4 inches was produced for females indicating poor fit model for female data. Total annual mortality of female walleye was lowest in 2023 at 36.5% (95% confidence interval; 15.2 – 52.4) compared to 55.8% (95% confidence interval; -1315% – 98.6%) in 2015 and 45.2% (95% confidence interval; -32.4% – 55.7%) in 2006 (Figure 13). Total annual mortality of males was the highest in 2023 at 73.4% (95% confidence interval; -56.3% – 83.8%) compared to 15.6% (95% confidence interval; -33.0% – 46.5%) in 2015 and 42.6% (95% confidence interval; -21.9% – 57.8%) in 2006 (Figure 13).

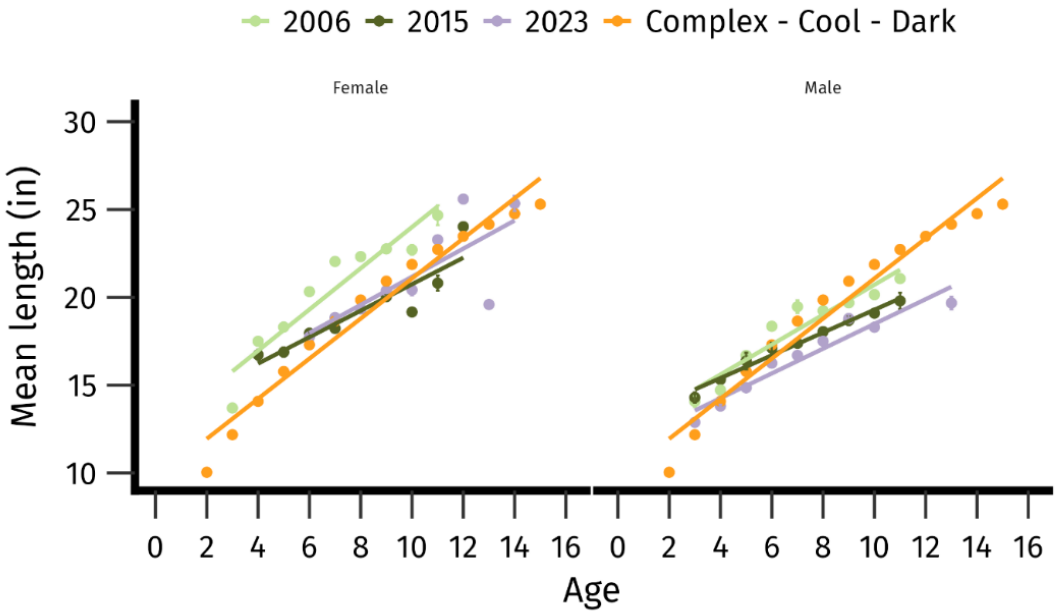

Figure 12. Mean total length at estimated age of walleye within Thunder Lake, Oneida County, WI for each sex. Fish ≤ 12 inches were assigned aged by scales and fish > 12 inches were assigned ages using dorsal spines. Length of individuals with an unknown age were assigned an age with a sex specific age-length key. Mean length at age for each year data were collected and for the median length at age for complex-cool-dark lake class are represented by unique colors.

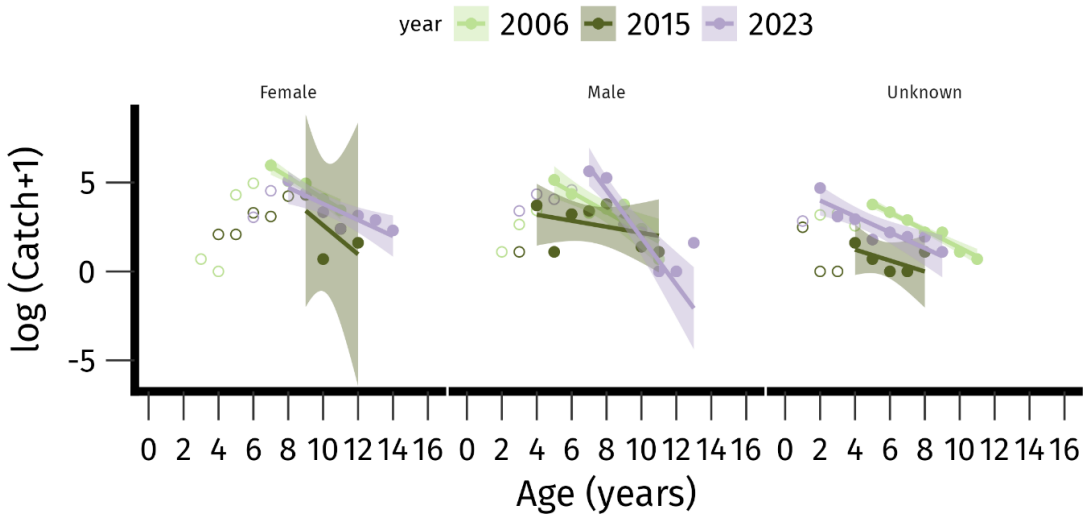

Figure 13. Catch curve of walleye within Thunder Lake, Oneida county, WI. Ages were assigned from dorsal spines in 2023 and 2015 and scales in 2006. Each year is represented by a unique color. Best fit line fit assigned based off linear model to fully vulnerable ages for each year and sex combination where the catch curve started descending with the associated 95% confidence interval of the estimate.

Thirty-four age-0 walleye and three age-1 walleye were captured during the fall electrofishing in Thunder lake in 2023. Catch rate of age-0 and age-1 walleye was like those historically found in Thunder Lake and below average compared to other stocked lake (Figure 14). Stocking of small fingerling walleye occurred prior to the fall electrofishing (June 23) survey while large fingerlings were stocked after (October 24) in Thunder Lake in 2023.

YELLOW PERCH

A total of 1,847 yellow perch were captured while surveying Thunder Lake. Catch rate of yellow perch was 37.2 per net night during netting and 50.0 per mile during electrofishing. Catch per mile of yellow perch was in the 90th percentile statewide and above the 75th percentile for Oneida County lakes (41.2 per mile). Catch per net night of yellow perch was slightly above the 75th percentile of complex-cool-dark lake class (31.3 per net night) and above the 90th percentile for Oneida County lakes (27.2 per net night).

Yellow perch lengths varied between 2.2 inches to 13.6 inches with a mean length of 6.4 inches. Thirty one percent of measured yellow perch were 8 inches or greater in Thunder Lake (Figure 15). Size structure of yellow perch has increased with a greater proportion of 8 inch and 10 inch or larger individuals in 2023 compared to 2006 (Figure 3).

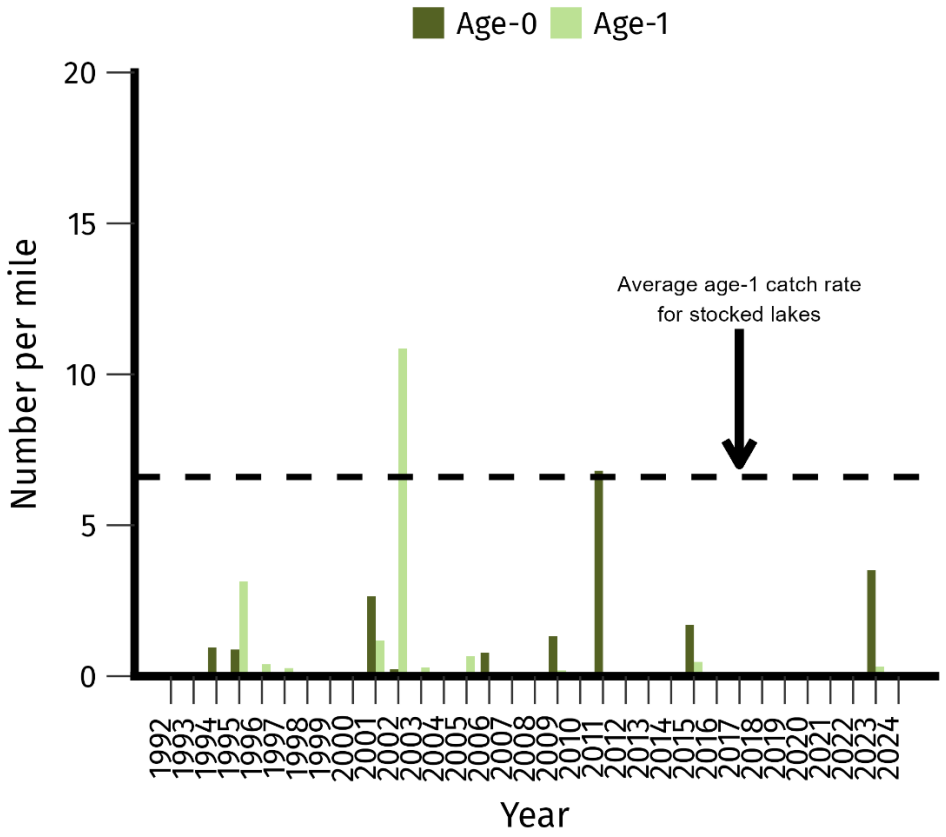

Figure 14. Number of age-0 and age-1 walleye per mile captured during fall boom shocking within Thunder Lake Oneida County, WI throughout time. Fish ages were assigned by scales.

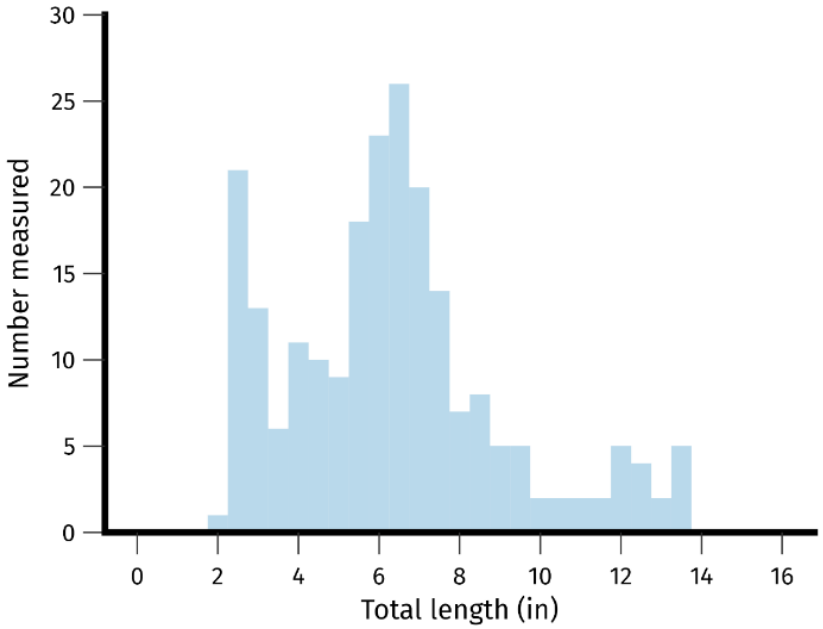

Figure 15. Length frequency of yellow perch captured in Thunder Lake Oneida County, WI during the 2023 comprehensive survey. Length bins are every 0.5 inches.

OTHER SPECIES

Other species encountered during the 2023 comprehensive survey of Thunder Lake included black bullhead (4), golden shiner (151), white sucker (30) and yellow bullhead (206).

Discussion

Thunder Lake functions as a shallow lake with moderate fertility supporting a mixed fishery. Northern pike dominate the fishery with smaller sized individuals abundant. Panfish were found in good numbers and of desirable sizes. Stocking maintains a low abundance walleye fishery near the 1.5 per acre benchmark used as a fishable population by the state (WWMT 2022). Many abiotic and biotic factors are likely influencing the fishery within Thunder Lake.

The history and prevalence of winterkills in Thunder Lake shaped the initial fish community and continues to influence it. One of the common fish assemblages found in winterkill prone systems consists of pumpkinseed, bullhead, and northern pike (Tonn and Magnuson 1982) matching what was found in Thunder Lake during the 2023 sampling. The lake association has operated an aerator since 1984 to prevent the regularity of winterkills. This oxygenated refuge has likely aided in restructuring the fish community some by allowing less tolerant species such as largemouth bass and walleye to become better established within the lake. However, aerators cannot prevent all winterkills as evidenced by winterkill that occurred 2014 despite aerator operation. Thus, the fish community within Thunder Lake will continue to be shaped by winterkills and tolerant species adapted to survive through times of low dissolved oxygen levels such as northern pike and pumpkinseed should continue to be supported.

Lake morphology is also likely contributing to the fish community structure and size structure within Thunder Lake. Margenau et al. (1998) found that northern pike size structure and growth was negatively related to the amount of littoral area present within a system. The littoral area (areas 0-15 feet in depth) makes up 100% of Thunder Lake. Meaning the offshore open water areas required of larger northern pike (Jacobson 1992) is absent from Thunder Lake. Additionally, northern pike size structure has been found to be negatively related to their abundance (Margenau et al. 1998). The high abundance of northern pike is likely further limiting the growth potential of northern pike within Thunder Lake. Thus, lake morphology in addition to winterkills influence the fishery and size structure of those species present within Thunder Lake.

Blue spot is a herpesvirus of northern pike first described in 1983 (Yamamoto et al. 1983). Prevalence of blue spot is typically only visible for a short time during spawning. In Thunder Lake, the 7% prevalence falls within the typical range of affected populations (<1%- 34%; Yamamoto et al. 1983; Margenau et al. 1995) and was only present for a short period. Little is known about the impact of blue spot on

northern pike but it is believed to be of little threat to infected populations. Infected individuals are still able to be consumed as it is has not been found to infect humans. The number of individuals with external systems of blue spot was not recorded and no mention of detection was made in the 2006 survey (Kubisiak 2007). However, the virus is suspected to be widespread in water throughout most of the northern Midwest (Margenau et al. 1995) and merely may not have been recorded despite being present. Recording detections of northern pike with blue spot symptoms during future monitoring would allow for assessments if the virus is becoming more or less prevalent.

Northern pike have been found to compete and predate on walleye (Craig 2000). The high abundance of northern pike might be limiting stocking success and spawning potential of walleye within Thunder Lake. Combine the high presence of competitors with the lack of deep, darker water and a clean hard bottom with abundant boulders trees and logs (Bozek et al. 2011), stocking walleye is likely the only way to maintain that fishery. Stocking larger individuals may avoid the predation window (Claessen et al. 2002) at a higher dollar cost in raising those stocked individuals. Looking into the source of contributions between small fingerlings, large fingerlings, and naturally reproduced could inform future stocking approach. Genetic parentage analysis should be considered for adult walleye captured in the future.

Walleye growth was slow and the theorical mean maximum length was low in Thunder Lake. Slow growth may be a result of density dependance as there are a high number of predators competing within Thunder Lake. High abundances of predators has been found to reduce walleye growth rates in other Wisconsin lakes (Sass et al. 2004). Slow growth and low growth potential supports the idea of managing the stocked walleye fishery as a consumptive opportunity. Growth potential may increase if stocking rates are reduced at the expensive of a likely lower adult abundance or abundance of other predators could be reduced.

The quality of a panfish fishery is likely the result of the high abundance of predators within Thunder Lake. Having a narrow size range of predators, but ample numbers within that range allows those individuals to consume enough prey facilitating growth to those larger sizes (Spotte 2007). Thus, the high density of predators, like the smaller northern pike within Thunder Lake is likely facilitating the large size structure of panfish (mean of <6 inches) present. The habitat present is also likely aiding in the size structure of panfish providing ample amount of littoral habitat and aquatic vegetation which is desirable to panfish (Spotte 2007). However, a high rate of predation or high natural mortality is required to prevent panfish stunting. Reduction in this rate of natural mortality through reduction in predator abundance would impact the quality of the panfish fishery present in Thunder Lake.

Thunder Lake maintains a diverse fishery. Winterkills influenced the initial community structure and will likely continue to impact the fishery. Northern pike remain the dominant gamefish species as they have been in the past. The walleye

fishery is maintained by stocking with little to no successful reproduction being documented within Thunder Lake. Panfish were found to have a large size structure likely an artifact of the high number of predators present and the habitat within Thunder Lake. Thunder Lake is best managed for a quality panfish fishery and consumptive northern pike fishery with a bonus walleye fishery that could provide additional harvest opportunities.

Recommendations

1. Continued stocking walleye to maintain the heavily used fishery by anglers.
2. Evaluate walleye source contribution and cost per recruit to the adult population to inform size class of walleye to be stocked in the future through parentage analysis of adult walleye collected in 2023.
3. Monitor the size structure and abundance of the panfish populations to assess impacts of predator population changes as any changes in regulations and stocking approach could impact this fishery.

Acknowledgments

This report would not have been possible without effort from the many former DNR staff that collected information on Thunder Lake. Abbigail Ewert, Catherine Moeller, Eric Wegleitner, Jason Halverson, Joel Mommaerts, John Kubisiak, Royce Zehr and Tim Tobias assisted with field collection. Lawrence Eslinger calculated species-specific population estimates. Claire Gaber and Scott Toshner provided critical reviews of this report that improved readability and ensured it complied with DNR communication standards.

References

Andrews, L. M. and C. W. Threinen. 1966. Surface water resources of Oneida County. Wisconsin Conseration Department, Madison, Wisconsin. 287 pages.
Bailey, N. T. J. 1951. On estimating the size of mobile population from capture-recapture data. Biometrika 38:293-306.

Bozek, M. A, Haxton T.J., and Raabe J. K. 2011. Walleye and sauger habitat. Pages 133–197 *in* B. A. Barton editor. Biology, Management, and culture of Walleye and sauger in American Fisheries Society: Bethesda Maryland.

Claessen, D., C. Van Oss, A. M. De Roos and L. Persson. 2002. The impact of size-dependent predation on population dynamics and individual life history. Ecology 83: 1660– 1675.

Craig, J. F., 2000. Percid Fishes- Systematics, Ecology and Exploitation. Blackwell Science, Oxford

Chapman, D. G. 1951. Some properties of the hypergeometric distribution with applications to zoological censuses. University of Californica Press 1:131-60.

Cichosz, T.A. 2021. Wisconsin Department of Natural Resources 2019-2020 Ceded Territory Fishery Assessment Report. Wisconsin Department of Natural Resources. Administrative Report #95.

Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Halverson J. and J. Blonski. 2016. Wisconsin Department of Natural Resources creel survey report Thunder Lake, Oneida County 2015-16.

Jacobson, P. C. 1992. Analysis of factors affecting growth of northern pike in Minnesota. Minnesota Department of Natural Resources Section of Fisheries Investigational Report 424.

Kubisiak, J. 2007. Comprehensive Fisheries Survey of Thunder Lake, Oneida County Wisconsin during 2006.

Margenau, T. L., S. V. Marcquenski, P. W. Rasmussen, and E. MacConnell. 1995. Prevalence of Blue Spot Disease (Esocid Herpesvirus-1) on Northern Pike and Muskellunge in Wisconsin. Journal of Aquatic Health 7:29-33.

Margenau, T. L., P. W. Rasmussen, J. M. Kampa. 1998. Factors affecting growth of northern pike in small northern Wisconsin lakes. North American Journal of Fisheries Management 18:625-639.

Miranda, L. E. 2007. Approximate sample sizes required to estimate length distributions. Transactions of the American Fisheries Society 136:509-415.
Neumann, R.M., C.S. Guy, and D.W. Willis. 2013. Length, weight, and associated indices. Pages 637-676 in A.V. Zale, D.L. Parrish, and T.M. Sutton, editors. Fisheries techniques, 3rd edition. American Fisheries Society, Bethesda, Maryland.

Tonn, W. M. and J. J. Magnuson. 1982. Patterns in the species compositions and richness of fish assemblages in Northern Wisconsin Lakes. Ecology 63:1149-1166.
Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Technical Report Bulletin 191, Bulletin of Fisheries Research Board of Canada.

Rypel, A. L., T. D. Simonson, D. L. Oele, J. D. T. Griffin, T. P. Parks., D. Seibel, C. M. Roberts, S. Toshner, L. S. Tate., J. Lyons. 2019. Flexible Classification of Wisconsin Lakes for Improved Fisheries Conservation and Management. Fisheries 44:225-238.

Sass, G. G., S. W. Hewett, D. Beard, A. H. Fayram, J. F. Kitchell. 2004. The role density dependence in growth patterns of ceded territory walleye populations of northern Wisconsin: effects of changing management regimes. North American Journal of Fisheries Management 24:1626-1278.

Schnabel, Z. E. 1938. The estimation of the total fish population of a lake. American Mathematician Monthly 45:348-352.

Spotte, S. 2007. Bluegills: biology and behavior. American Fisheries Society, Bethesda, Maryland.

Wisconsin Walleye Management Team (WWMT). 2022. M. Donofrio, L. Eslinger, P. Frater, J. Gerbyshak, D. Heath, J. Hennessy, B. Heussner, K. Justice, M. Luehring, G. Muench, A. Nickel, J. Dan Rose, G. Sass, L. Tate, M. Vogelsang, E. Wegleitner, M. Wolter. Walleye 2022 – An updated 10-year walleye management plan of Wisconsin.

Yamamoto, T. R. K. Kelly, and O. Nielsen. 1983. Epidermal hyperplasias of northern pike (*Esox lucius*) associated with herpcsvirus and C-type particles. Archives of Virology 79:255-272.