2015 Silver Lake Survey

Conducted By
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Abstract

Silver Lake is located in east-central Wisconsin, near the City of Manitowoc. It is a 69-acre drainage lake that has a maximum depth of forty-three feet. Silver Creek is the major inlet and outflow of the lake. Less than half of the shoreline is developed with most of the residential development along the eastern shore of the northern basin. Public access is off of Highway 151 and the lake has an electric motor only ordinance. Fishing activity on the lake can be heavy in spring and during the ice fishing season.

Historically, poor water quality has led to numerous fish kills in Silver Lake. Major fish kills have occurred during the winters of 1956, 1963, 1964, 1965, 1969, 1976 and 1996. Partial winter and summer kills have occurred on a more frequent and regular basis during this period as well. In the early 2000's a full lake restoration consisting of isolation of Silver Creek from Silver Lake, the use of rotenone to remove the fish population of the lake and an alum treatment to reduce in-lake phosphorus levels was completed. Subsequently the lake was restocked with a desirable mix of fish species to establish a quality fishing opportunity for Manitowoc County anglers. During the winter of 2014-15 a severe fish kill occurred in Silver Lake that impacted the fish community.

A comprehensive fish survey was conducted in 2015 to evaluate the status of the fish populations of Silver Lake as part baseline lake monitoring that followed DNR Lake monitoring protocols for bass/panfish lakes.

The 2015 fisheries survey on Silver Lake characterized the fish populations of the lake using various fisheries assessment gear during multiple seasons. Each gear type was efficient in capturing certain fish species and fish sizes. The use of multiple gears during different sampling seasons provided a clearer picture of the entire fish community and fish population characteristics of individual species within the lake. However, in 2015 the survey followed a severe winterkill event that likely reduced the species and number captured during the survey.

It is recommended to maintain the current suite of fishing regulations for Silver Lake and to judiciously restock fish species that were lost because of the recent winter kill.

INTRODUCTION

Silver Lake (WBIC 67400) is located in east-central Wisconsin, near the City of Manitowoc (Figure 1). It is a bi-lobed 69-acre drainage lake that has a maximum depth of forty-three feet and a mean depth of sixteen feet (Figure 2). Silver Creek is the major inlet and outflow of the lake. Less than half of the shoreline is developed with most of the residential development along the eastern shore of the northern basin. Holy Family Convent and Silver Lake College are located along the shores of the southern basin. Public access is off of Highway 151 and the lake has an electric motor only ordinance. Fishing activity on the lake can be heavy in spring and during the ice fishing season.

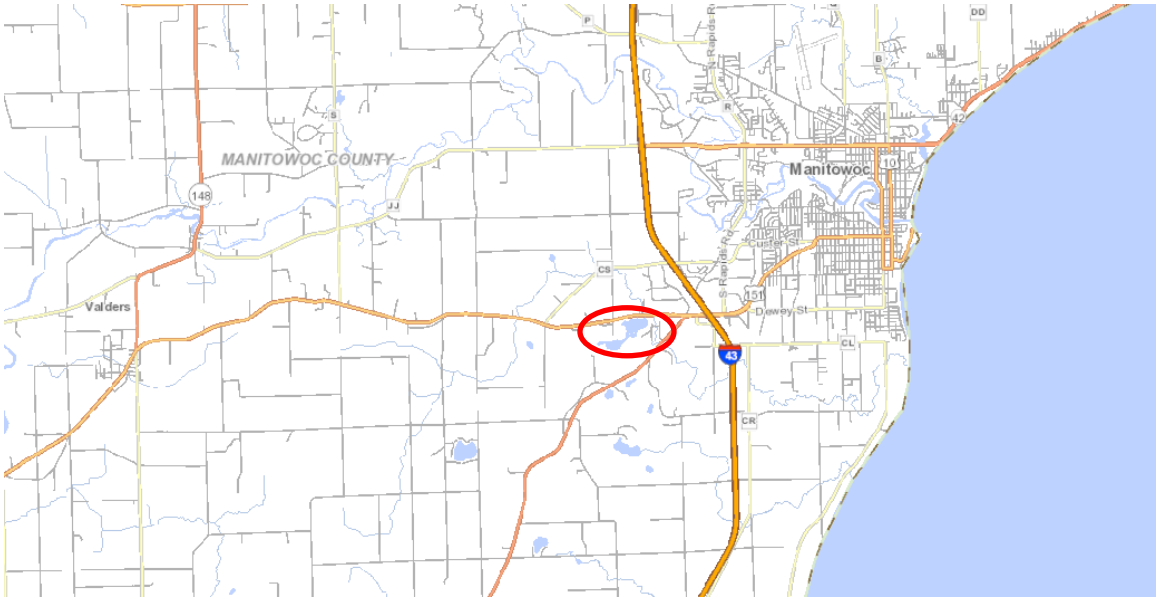

Figure 1. Silver Lake is located southeast of Manitowoc on Highway 151.

Historically, poor water quality has led to numerous fish kills in Silver Lake. Major fish kills occurred during the winters of 1956, 1963, 1964, 1965, 1969, 1976 and 1996. Partial winter and summer kills occurred on a more frequent and regular basis. During the fall of 1965, Silver Lake was treated with toxaphene to control the rough fish population found in the lake. A total of 10,000 pounds of rough fish were removed from the lake with Carp, making up 40% of the harvest and Bullheads the remaining 60%. Minor components of the catch were Largemouth Bass and Northern Pike. At that time, very few panfish were observed (Schultz, 1965). After treatment, the lake was restocked with 4000 legal sized Brook Trout to provide immediate fishing, Northern Pike fry, fingerlings and adults, Walleye fry and fingerlings, Yellow Perch adults, and Largemouth Bass fingerlings and adults were also stocked. Concurrently, a fish weir was proposed to block the upstream migration of Carp from Lake Michigan into Silver Lake. Plans were dropped when revisions that allowed the structure to withstand a twenty year flood, made the cost to high for the lake association.

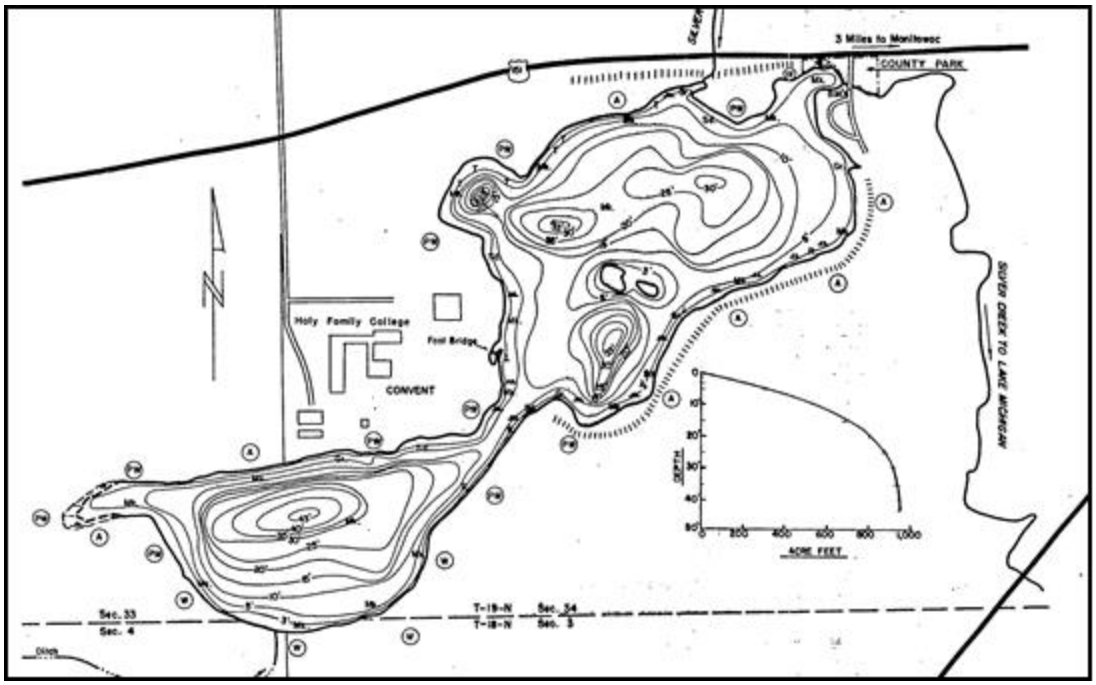

Figure 2. A morphometric map of Silver Lake that shows where Silver Creek entered the lake prior to construction of the berm in 2003 and the bi-lobed basin structure of the lake.

Fish surveys following the chemical treatment indicated that the fishery was dominated by Carp, panfish and Lake Michigan run White Sucker. An electroshocking survey in August 1967, indicated Carp and Bluegill were the dominant species with Northern Pike, Walleye, and Largemouth Bass present. Alewife was also captured (Schultz, 1967). A May 1974 electroshocking survey provided similar results with numerous Carp and White Sucker seen. Sixteen Yellow Perch and one Northern Pike were also caught. Other fish observed were Black Bullhead, Bluegill and Pumpkinseed (Belonger, 1974). The lake was electroshocked again in September 1978. Carp was the dominant species, with approximately 500 seen. The next most abundant species was Black Crappie with 53 caught. Yellow Perch, Bluegill and White Suckers were also present (Belonger, 1978). A spring 1979 fyke net survey indicated Carp, Black Crappie, Yellow Perch and White Sucker, in decreasing order of abundance, the dominant species. Also noted were the poor condition of Crappie and Perch and the extreme turbidity of the water (Hanson, 1979). A fall 1980 electroshocking survey found the most common species were Yellow Perch, Black Crappie and Black Bullhead. Carp, White Sucker, Northern Pike and other species of panfish were also observed (Peeters, 1980).

A 1985 feasibility study by the Wisconsin Department of Natural Resources (WDNR, 1985), indicated that the total phosphorus loading to Silver Lake was 10,015 pounds per year. This total was further divided by location and the type of source, with 97% (9700 lbs/yr) of the nonpoint sources of phosphorus occurring upstream of the lake. All other sources including the sewage treatment plant on the lake, residential-both septic and yard runoff and adjacent wetlands accounted for only 3% of the phosphorus load. Because of the high phosphorus loading, the trophic status of the lake was eutrophic. Plans were developed to improve water quality and the fishery of Silver Lake in succeeding years. This action plan

was based on extensive watershed research included: a partial diversion that moved the inlet to directly point at the outlet to reduce water residence time, a temporary fish weir below the lake to reduce rough fish migrations into the lake, construction of watershed practices such as wetlands, stormwater ponds and barnyard and manure storage to reduce the amount of phosphorus and sediment reaching the lake, removal of outlet stream obstructions to improve water flow and predator stocking to balance the fishery. These practices were implemented during the 1990's. By 2000, it was clear that these practices did little to improve the water quality or the fishery of Silver Lake. Following additional public input and planning meetings, a four phase plan was developed to: a) reduce external phosphorus loading by constructing a berm across the lake to isolate the lake from Silver Creek, b) removal of the resident fish community of Silver Lake with rotenone, c) treatment of the lake with alum (aluminum sulfate) to reduce in-lake phosphorus levels and d) restocking the lake with a desirable mix of fish species that would be predator heavy to reduce the ability of undesirable fish species to reinvade the lake.

Plans were developed to construct a berm that would not overtop until a 20 year event occurred (Figure 3). Construction of the berm was completed late in 2002 with the rotenone treatment in late 2003. The alum treatment was conducted in April 2004 and stocking began immediately after and continued through 2015.

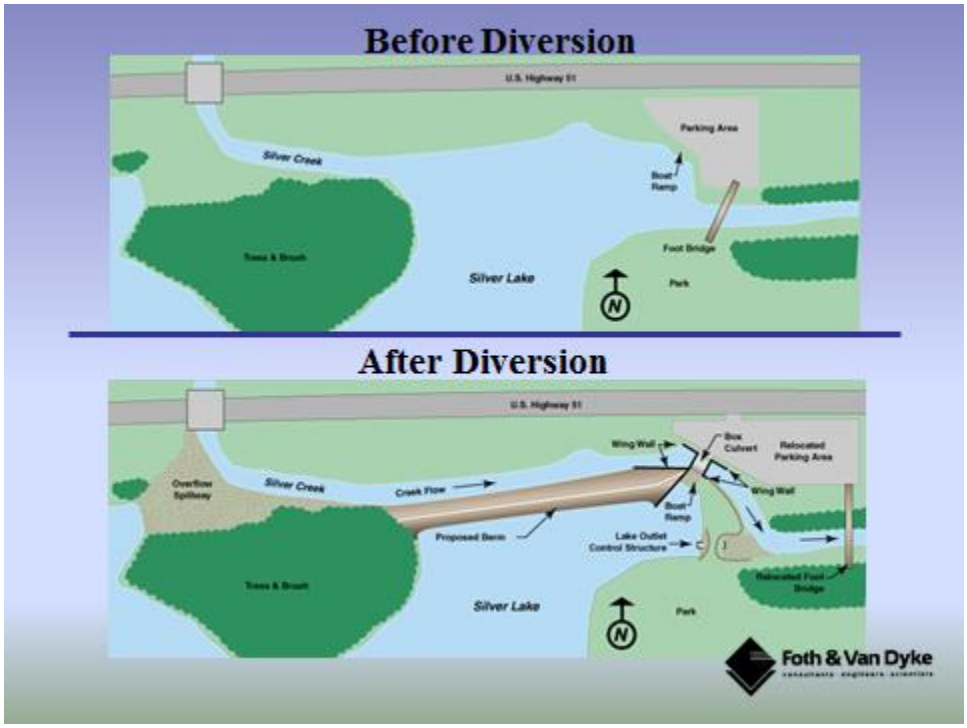

Figure 3. The conceptual plan for the diversion of Silver Creek out of Silver Lake by constructing a berm across the north corner of Silver Lake. The Plan was developed by Foth and Van Dyke (now Foth) Engineering, Green Bay, Wisconsin.

From 2004-15, more than 252,000 fish have been restocked into Silver Lake (Table 1). Most of the fish were Fathead Minnow stocked during the initial restocking year, otherwise Northern Pike have dominated the stocking events.

Table 1. Fish stocked into Silver Lake by WDNR since the 2003 rotenone treatment.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	Total
Largemouth Bass (Small Fing.)	10,000	1,000						2,997	3,400			**17,397**
Walleye (Small Fing.)	1,000	1,400	1,360	1,358	1,358	1,360	2,395	1,494	1,045	1,344	3,073	**17,187**
Northern Pike (Small Fing.)	2,000	6,800			6,800	6,790	8,482	7,995	6,790	6,780	6,798	**59,235**
Northern Pike (Large Fing.)	100		3,000									**3,100**
Yellow Perch (Small Fing.)	4,000	1,000										**5,000**
Fathead Minnow (Adult)	150,000											**150,000**
White Sucker (Adult)	250	250	322									**822**
Total	**167,350**	**10,450**	**4,682**	**1,358**	**8,158**	**8,150**	**10,877**	**12,486**	**11,195**	**8,124**	**9,871**	**252,692**

Fish surveys since the recent, onset of restocking have shown that some of the fish populations most notably Yellow Perch, Northern Pike and Walleye have done well in the lake (Hogler 2004, 2005, 2006, 2007, 2008, 2009, 2010 and 2012). These species appeared to demonstrate good survival, above average growth and some level natural reproduction. After initial surveys showed good survival and growth of Largemouth Bass, more recent surveys have indicated that survival had declined and that natural reproduction was extremely limited. Surveys also indicated that probable, illegal stocking of Bluegill, Pumpkinseed and Green Sunfish had occurred. We also captured Black Bullhead which likely survived the rotenone treatment and several Carp that entered the lake during rainfall or spring runoff events that caused Silver Creek to overtop the berm and enter the lake. The most notable impact of the multiple berm overtopping events was the decline in water clarity and quality that was observed. During the winter of 2014-2015, the decline in in water quality (high levels of phosphorus and low levels of dissolved oxygen (DO)) caused a large fish kill. It appeared that low DO severely impacted the Largemouth Bass, Bluegill and Walleye populations based on the observation of dead fish on the lake bottom.

A comprehensive fish survey was conducted in 2015 to evaluate the status of the fishery populations of Silver Lake as part baseline lake monitoring and followed DNR lake monitoring protocols for bass/panfish lakes.

METHODS

Spring Fyke Netting

A standard comprehensive fisheries survey on Silver Lake began in April 2015 and continued through May. Eight fyke nets were set following ice-out on April 6, fished until April 15 and were used to capture and mark spawning Walleye and Northern Pike for the purpose of estimating adult population size (Figure 4). Other species captured in fyke nets were also marked for potential population size estimation, but nets were set in habitats to target adult spawning Walleye and Northern Pike. All fish were identified, measured, marked with a caudal fin clip and scales, anal rays or spines were removed from a sub-sample of fish for age determination.

Figure 4. The locations of the eight fyke nets that were fished in Silver Lake from April 6 through April 15, 2015 are marked on the lake map.

Spring Electrofishing

The entire shoreline was electroshocked on the night of May 13 to assess Largemouth Bass and panfish populations as well as to look for fish marked during fyke netting to allow a population estimate to be made. All fish were netted, identified, examined for marks, and measured. A spring recapture run immediately following fyke netting was not run because of the low number of walleye marked.

Statistical Analyses

Basic fisheries statistics, such as average length, length frequencies by survey type, age distributions, and population estimates were calculated. Mean length at age was determined first by using an age length key to extrapolate length age distributions from the sub-sample of fish that were aged to the full sample length frequency, then second calculating the arithmetic mean of the length for a given age from the estimated full sample age distribution.

The Petersen population estimation method was used when possible to estimate community population size when the recapture numbers were large enough to provide an unbiased estimate of population size. For the Petersen method, population size was estimated as the ratio between the number of fish initially marked and released during the marking period (M), times the number of fish captured and examined for marks (C) during the recapture period, divided by the number of fish that were found to have marks during the recapture period (R) using the Petersen estimator.

RESULTS

Spring Netting

Shortly after ice out, eight fyke nets were set in Silver Lake to capture spring spawning fish. The eight nets were lifted eight times for a total effort of 72 net-nights. During the fyke net portion of the survey, 1088 fish were captured for a total catch per effort (CPE) of 15.1 fish per net per night (Table 2). Of the twelve species captured, Northern Pike and Yellow Perch dominated the catch, with substantially fewer Largemouth Bass, Walleye and Bluegill captured.

Table 2. Fish captured by species from Silver Lake with fyke nets from April 6-115, 2015. Catch per effort (CPE) is the number of each species captured divided by the total effort of 72 net nights.

	Number	Size Range (mm)	Average Length (mm)	CPE (#/ net-night)
Largemouth Bass	1	442 mm	442 mm	0.0
Walleye	18	352 mm-635 mm	487 mm	0.3
Northern Pike	526	205 mm-781 mm	559 mm	7.3
Yellow Perch	279	112 mm-203 mm	151 mm	3.9
Bluegill	42	110 mm- 195 mm	143 mm	0.6
Black Crappie	15	152 mm- 255 mm	173 mm	0.2
Pumpkinseed Sunfish	5	95 mm- 112 mm	104 mm	0.1
Hybrid Sunfish	1	--	--	0.0
Black Bullhead	101	146 mm- 368 mm	323 mm	1.4
Brown Bullhead	17	316 mm- 362 mm	334 mm	0.2
White Sucker	77	--	--	1.1
Golden Shiner	6	--	--	0.1
Total	1088			15.1

Gamefish

Northern Pike

Northern Pike were the most common gamefish that we captured during fyke netting (Table 2). Overall, 526 Northern Pike were captured ranging in length from 205 mm to 781 mm with an average length of 559 mm (Table 2). Of this total, 259 were male, 156 were female and 111 were sex unknown.

The 259 male Northern Pike ranged in length from 252 mm to 720 mm and had an average length of 526 mm (Table 3). Although none of the male Northern Pike were greater than 812 mm (32”) which is the minimum size for harvest on Silver Lake, 62 (23.9%) were greater than 660 mm (26”) which is the minimum size for Pike on other Manitowoc County Lakes.

Age was determined for Northern Pike using an anal fin ray that was cross sectioned. Male Pike ranged from age 1 through age 9 with ages 3 and 4 the most common (Table 4). Other age classes were also well represented in the sample.

Female Northern Pike ranged in length from 290 mm to 781 mm and had an average length of 629 mm (Table 3). Like male Northern Pike, no female Pike were greater in length than 812 mm but 3.8% (6/156) were greater than 660 mm in length.

The age of captured female Northern Pike ranged from age 2 through age 9. Age 4 female Pike were the most common and they averaged 639 mm in length (Table 5). Other younger age classes were also well represented in our sample.

During the fyke net survey, 111 Northern Pike were captured of which sex could not be determined. Most pike were immature fish but others were adult fish that had likely completed spawning before being captured. These unknown fish ranged in length from 298 mm to 753 mm and had an average length of 538 mm (Table 3). One fish was sexed but not measured. No unknown sex fish was greater than 812 mm in length but 17.2% (19/110) were longer than 660 mm in length.

Unknown sex Pike ranged in age from age 1 through age 6 and age 8 (Table 6). Age 2 unknown sex Pike were the most common with other ages captured in lower numbers.

After pooling all the age data, it appears that in Silver Lake, Northern Pike grow based on average length at each age, at a rate greater than seen in other state lakes (Table 7). The best growth is seen in younger fish with older fish still growing at state averages. Based on current growth rates in Silver Lake, it is likely that pike will need to be 10 to 12 years of age before reaching the legal minimum size limit.

Table 3. The distribution of length of gamefish captured during the fyke net survey of Silver Lake.

Length (mm)	Largemouth Bass	Walleye	N.Pike Female	N. Pike Male	N.Pike Unknown
200					1
210					
220					1
230					
240					
250				3	
260				1	
270				1	2
280				2	2
290			1	1	1
300				1	4
310				6	1
320				3	1
330				2	
340				1	2
350		1		2	
360				1	1
370					
380		1		1	1
390		1		2	1
400				1	1
410					
420				4	2
430				6	
440	1			8	2
450		3		2	2
460		2		10	2
470		2	1	8	
480		2	2	9	
490			1	9	3
500		2	2	10	7
510			4	9	2
520			3	11	4
530			3	6	3
540			6	13	1
550		1	4	11	6
560			4	15	5
570			2	14	4
580		1	7	13	3
590			7	16	3
600			3	14	5
610			11	9	2
620		1	11	12	2
630		1	6	7	4
640			8	8	4
650			7	1	6
660			18	2	3
670			11		3
680			13	2	3
690			2		7
700			5	1	1
710			2		
720			2	1	1
730			3		
740			4		
750			2		1
760					
770					
780			1		
Total	1	18	156	259	110
Ave. Length	442	487	629	526	538
S.D.	--	975.7	94.2	69.4	129.6

Table 4. The age distribution of male Northern Pike captured during fyke netting on Silver Lake.

Length (mm)	N. Pike Male	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
250	3	3								
260	1	1								
270	1	1								
280	2	2								
290	1	1								
300	1	1								
310	6	6								
320	3	3								
330	2	2								
340	1	1								
350	2		2							
360	1	1								
370										
380	1	1								
390	2	1	1							
400	1		1							
410										
420	4		4							
430	6		2	4						
440	8		4	4						
450	2		1	1						
460	10		3	7						
470	8		5	3						
480	9		4	2	2	1				
490	9		5	4						
500	10		3	4	2	1				
510	9			6	1	1		1		
520	11		1	7	3					
530	6			2	4					
540	13			4	6	1	1		1	
550	11			2	6	2	1			
560	15			4	6	4			1	
570	14			1	6	3	3	1		
580	13			1	7	1	1	2	1	
590	16			1	1	7	7			
600	14			1	4	4	4			1
610	9				2	5	1	1		
620	12				2	2	5	1	1	1
630	7				1	6				
640	8				2	1	2	2	1	
650	1							1		
660	2					1			1	
670										
680	2					1			1	
690										
700	1						1			
710										
720	1					1				
Total	259	24	36	58	55	42	26	9	7	2
Ave. Length	526	312	458	506	564	599	605	604	617	614
S.D.	95.2	36.6	40.9	43.6	37.9	45.3	32.5	43.6	53.5	17.0

Table 5. The age distribution of female Northern Pike captured during fyke netting on Silver Lake.

Length (mm)	N. Pike Female	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
290	1	1							
300									
310									
320									
330									
340									
350									
360									
370									
380									
390									
400									
410									
420									
430									
440									
450									
460									
470	1	1							
480	2	2							
490	1	1							
500	2	2							
510	4	2	1	1					
520	3	3							
530	3	2	1						
540	6	3	1	2					
550	4	2	1		1				
560	4	3	1						
570	2		1	1					
580	7	1	2	2	1	1			
590	7		3	1	1	1	1		
600	3		1	1		1			
610	11		3	8					
620	11		3	8					
630	6		1	5					
640	8		4	2	1	1			
650	7		2	4	1				
660	18		4	9	2	2	1		
670	11		5	2	2	2			
680	13			9	2				2
690	2			2					
700	5			1	1	3			
710	2				1	1			
720	2					2			
730	3					2		1	
740	4				1	2	1		
750	2					1	1		
760									
770									
780	1					1			
790									
800									
Total	156	23	34	58	14	20	4	1	2
Ave. Length	629	517	621	639	658	693	689	731	684
S.D.	69.1	59.2	45.1	39.1	53.5	54.7	71.2	--	2.1

Table 6. The age distribution of unknown Northern Pike captured on Silver Lake.

(mm)	Length Unknown	N. Pike Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
200	1	1								
210										
220	1	1								
230										
240										
250										
260										
270	2	2								
280	2	2								
290	1	2								
300	4	3	1							
310	1	1								
320	1	1								
330										
340	2	2								
350										
360	1	1								
370										
380	1			1						
390	1		1							
400	1		1							
410										
420	2		2							
430										
440	2		2							
450	2		2							
460	2		2							
470										
480										
490	3		3							
500	7		6	1						
510	2		2							
520	4		2	1		1				
530	3		3							
540	1		1							
550	6		4	1	1					
560	5			4	1					
570	4		3				1			
580	3				3					
590	3			3						
600	5			3	2					
610	2				1	1				
620	2			2						
630	4				4					
640	4				3		1			
650	6			1	2	2	1			
660	3					1	1		1	
670	3				3					
680	3				2	1				
690	7				2	3			1	
700	1				1					
710										
720	1						1			
730										
740										
750	1					1				
Total	110	16	35	17	25	10	5	0	2	0
Ave. Length	538	296	495	573	638	665	653	--	678	--
S.D.	129.9	40.8	60.5	59.9	42.0	60.0	54.0	--	21.9	--

Table. 7. The length at age of fish from Silver Lake compared to Statewide averages.

Species	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9
Northern Pike									
2015	305	486	553	610	622	645	630	641	649
(State Average)	356	406	470	546	610	650	706	762	787
Bluegill									
2015	73	119	143	169					
(State Average)	64	97	122	147	167	183	196	--	--
Yellow Perch									
2015		141	163	181					
(State Average)	74	119	152	180	208	226	241	--	--
Walleye									
2015			373	458	497	551	543	508	
(State Average)	152	254	324	381	432	457	497	526	551

Walleye

A total of 18 Walleye were captured during the fyke net survey (Table 2). The Walleye ranged in length from 352 mm to 635 mm and had an average length of 487 mm. Most (12 of 18) of the captured Walleye were greater than the 457 mm (18”) size minimum for Walleye on Silver Lake (Table 3). Few Walleye were less than 400 mm in length.

To determine the age distribution of Walleye in Silver Lake, we collected a dorsal spine from each of the Walleye handled during fyke netting. The ages of Walleye captured in these surveys ranged from age 3 to age 8 (Table 8). All age groups were captured in similar number.

The growth of captured Walleye in Silver Lake was greater than Statewide averages from age 3 through age 7 but less than state averages at age 8 (Table 7). This was likely due to the low number of older fish that were sampled (Table 3). Based on the 2015 age sample, it takes a Walleye in Silver Lake four years to reach the minimum harvest length.

Largemouth Bass

Only one Largemouth Bass was captured during fyke netting (Table 2). The Bass was 442 mm in length (Table 3).

Table 8. The age distribution of Walleye captured during fyke netting on Silver Lake.

Length (mm)	Number	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
350	2	2					
360							
370							
380	1	1					
390	1	1					
400							
410							
420							
430							
440							
450	3		2			1	
460	1		1				
470	2			2			
480	2			1	1		
490							
500	2				1		1
510							
520							
530							
540							
550	1			1			
560							
570							
580	1				1		
590							
600							
610							
620	1				1		
630	1					1	
640							
650							
Total	18	4	3	4	4	2	1
Ave. Length	487	373	458	497	551	543	508
S.D.	81.1	23.1	6.6	39.2	66.2	130.8	--

Panfish

Yellow Perch

Yellow Perch were the most common panfish captured during fyke netting (Table 2). The 279 Yellow Perch captured ranged in length from 112 mm to 203 mm and had an average length of 151 mm. Most of the captured Yellow Perch ranged between 130 mm and 160 mm in length, with few greater than 200 mm in length (Table 9).

Table 9. The length distribution of panfish and bullhead species captured during April fyke netting in Silver Lake.

Length (mm)	Y. Perch Female	Y. Perch Male	Y. Perch Unknown	Bluegill	Black Crappie	P. seed Sunfish	Black Bullhead	Brown Bullhead
90						2		
100						1		
110		1		4		2		
120		14		10				
130	2	67	2	9				
140	23	37	4	5			1	
150	13	23	3	3	1			
160	6	40	3	2	7			
170	4	27		5	5			
180	1	4		1				
190	1	3		3				
200		1						
210								
220								
230								
240								
250					1			
260								
270								
280								
290								
300								
310							3	1
320							3	1
330							6	
340							4	
350								
360							1	1
Total	50	217	12	42	14	5	18	3
Ave. Length	153	150	150	142	173	104	323	334
S.D.	17.3	12.3	11.6	22.9	23.4	7.8	46.4	24.6

The average length of captured male, female and unknown sex Yellow Perch were very similar in Silver Lake. The 217 male Yellow Perch handled ranged in length from 112 mm to 203 mm and had an average length of 150 mm (Table 9). Female Yellow Perch ranged in length from 135 mm to 192 mm and had an average length of 153 mm and unknown sex Perch ranged in length from 130 mm to 165 mm and had an average length of 150 mm.

When Yellow Perch spines were analyzed, age classes 2 through 4 were identified in our sample (Table 10). Age 2 were the most common followed by age 3 Yellow Perch. Based

on the age samples, it appears that Yellow Perch take nearly three years to become 150 mm in length.

The 2015 age samples indicate that Yellow Perch in Silver Lake were longer at each age than in other lakes across the state (Table 7).

Table 10. The age distribution of Yellow Perch captured in fyke nets in Silver Lake.

Length (mm)	Number	Age 2	Age 3	Age 4
100	0			
110	1	1		
120	14	14		
130	71	71		
140	64	56	8	
150	39	16	23	
160	49	9	31	9
170	31		24	7
180	5		1	4
190	4			4
200	1			1
Total	279	167	87	25
Ave. Length	151	141	163	181
S.D.	18	10.6	9.7	12.9

Bluegill

A total of 42 Bluegill were captured during fyke netting on Silver Lake. These fish ranged in length from 110 mm to 195 mm and had an average length of 143 mm (Table 2). Most of the fish (28 of 42) were less than 150 mm in length and none were greater than 200 mm in length (Table 9).

Bluegill age was determined by the use of scales that were collected during the fyke net and spring electroshocking survey to increase the sample size. The 55 aged Bluegill ranged in age from age 1 through age 4, with age 3 the most common (Table 11).

Based on the average length at age determined from age samples collected in 2015, Bluegill in Silver Lake grow at or above State average rates at all ages. On average in Silver Lake, it takes Bluegill three years to reach 150 mm in length (Table 11).

Table 11. The age distribution of Bluegill captured by fyke net and electroshocking during spring surveys on Silver Lake.

Length (mm)	Number	Age 1	Age 2	Age 3	Age 4
50	1	1			
60	0				
70	0				
80	0				
90	1	1			
100	0				
110	4		3	1	
120	14		7	7	
130	13			10	3
140	5			5	
150	4			3	1
160	2			2	
170	6			4	2
180	2				2
190	3				3
Total	55	2	10	32	11
Ave. Length	140	73	119	143	169
S.D.	26.9	31.8	3.5	7.1	1.4

Other Panfish

During the fyke net survey, we captured additional panfish species including: Black Crappie, Pumpkinseed Sunfish and Hybrid Sunfish (Table 2). These fish were captured in low numbers and the Black Crappie and Pumpkinseed Sunfish averaged 173 mm, and 104 mm in length respectively (Table 9). The single Hybrid Sunfish was not measured.

Other Fish Species

In addition to the gamefish and panfish, we captured other species of fish during fyke netting. In declining order of abundance, fyke nets captured Black Bullhead, White Sucker, Brown Bullhead and Golden Shiner. Although all Bullhead were not measured, a representative sample was measured yielding an average length for Black Bullhead of 323 mm and 334 mm for Brown Bullhead.

Spring Electroshocking

The normal spring recapture run following fyke netting was not conducted this year because of the low number of fish marked during spring netting with the exception of Northern Pike, which typically do not electroshock well.

Once water temperatures stabilized above 60°F, spring electroshocking to assess bass and panfish populations was conducted.

On the night of May 13, the entire shoreline of Silver Lake was boomshocked following standard protocols for the number of dippers and with electroshocking settings at 190 volts, 19 amps, 25% duty cycle and a 65 pulse rate. All fish were identified, counted and most were measured. Scales were collected from Bluegill to increase the spring aging sample size.

A total of 188 fish representing twelve species were captured during the 70 minutes of electroshocking (Table 12). Total CPE was 85.5 fish per mile shocked or 156.7 fish per hour shocked. Yellow Perch dominated our catch with substantially fewer fish of other species captured. Northern Pike was the most common gamefish captured during shocking.

Gamefish

Northern Pike were the most common gamefish that we captured during electroshocking (Table 12). The 19 Pike ranged in length from 280 mm to 733 mm and had an average length of 526 mm. None of the captured Pike were greater in length than the 812 mm minimum size limit for Northern Pike on Silver Lake (Table 13).

Ten of captured Northern Pike were recaptured fish with a mark obtained during fyke netting. This allowed us to calculate a Peterson Population Estimate (PE) using fyke nets as the marking method and electroshocking as the recapture method. Based on the number of Northern Pike marked and recaptured, the Peterson PE for Pike was 909 with a 95% confidence range interval of 515 to 1753 (Table 12). This translates to 13.2 Pike per surface acre in Silver Lake.

The catch of other gamefish was low during electroshocking. Three walleye averaging 439 mm in length and one Bass, 389 mm in length were captured (Table 12).

One of the captured Walleye was recaptured with a mark from fyke netting. The Peterson PE for Walleye was 27 ranging from 8-49 (Table 12). This estimate should be viewed cautiously because of the low number of walleye caught and recaptured.

Panfish

Yellow Perch was the most common panfish that was captured during electroshocking (Table 12). 102 of the 141 captured Yellow Perch were measured. The measured Perch

ranged in length 120 mm to 200 mm and had an average length of 138 mm. Most Yellow Perch were less than 150 mm in length with few larger Perch captured (Table 14).

Other panfish captured during electroshocking included: Bluegill, Black Crappie, Pumpkinseed Sunfish and Green Sunfish (Table 12). The had average lengths of 130 mm, 80 mm, 105 mm and 83 mm respectively. Few of these fish were greater than 150 mm in length (Table 14).

Other Species

Other fish species captured during electroshocking included: Black Bullhead, Brown Bullhead, White Sucker and Golden Shiner (Table 12).

Table 12. Fish captured by species from Silver Lake by electroshocking on the night of May 13, 2015. Catch per Effort (CPE) is recorded as either fish per hour shocked or fish per mile shocked.

Species	Number	Size Range	Average Length	CPE (#/mile shocked)	CPE (#/ Hour Shocked)	Peterson Pop. Est.	Range at 95% Confidence
Largemouth Bass	1	389 mm	389 mm	0.5	0.8		
Walleye	3	354 mm- 508 mm	439 mm	1.4	2.5	27	8- 49
Northern Pike	19	280 mm- 733 mm	526 mm	8.6	15.8	909	515-1753
Yellow Perch	141	120 mm- 200 mm	138 mm	64.1	117.5		
Bluegill	13	50 mm- 181 mm	130 mm	5.9	10.8		
Black Crappie	2	77 mm- 82 mm	80 mm	0.9	1.7		
Pumpkinseed Sunfish	2	99 mm- 111 mm	105 mm	0.9	1.7		
Green Sunfish	1	83 mm	83 mm	0.5	0.8		
Black Bullhead	3	92 mm- 350 mm	254 mm	1.4	2.5		
Brown Bullhead	1	187 mm	187 mm	0.5	0.8		
White Sucker	1	--		0.5	0.8		
Golden Shiner	1	--		0.5	0.8		
Total	188			85.5	156.7		

Table 13. The length distribution of gamefish captured during spring electroshocking on Silver Lake during the night of May 13, 2015.

Length (mm)	Largemouth Bass	Walleye	Northern Pike
280			2
290			
300			1
310			1
320			
330			
340			
350		1	
360			
370			
380	1		
390			
400			
410			
420			
430			
440			
450		1	1
460			1
470			
480			
490			
500		1	
510			2
520			
530			1
540			
550			1
560			1
570			
580			
590			1
600			
610			
620			1
630			
640			2
650			
660			1
670			2
680			
690			
700			
710			
720			
730			1
Total	1	3	19
Ave. Length	389	439	526
S.D.	--	78.2	143.7

Table 14. The length distribution of panfish and bullhead species captured during spring electroshocking on Silver Lake during the night of May 13, 2015.

Length (mm)	Yellow Perch	Bluegill	Black Crappie	P. seed Sunfish	Green Sunfish	Black Bullhead	Brown Bullhead
50		1					
60							
70			1				
80			1		1		
90		1		1		1	
100	1						
110				1			
120	18	4					
130	43	4					
140	29						
150	6	1					
160	4						
170		1					
180		1					1
190							
200	1						
210							
220							
230							
240							
250							
260							
270							
280							
290							
300							
310							
320						1	
330							
340							
350						1	
Total	102	13	2	2	1	3	1
Ave. Length	138	130	80	105	83	254	187
S.D.	11.3	32.7	3.5	8.5	--	141.1	--

Discussion and Conclusions

The 2015 fisheries survey on Silver Lake characterized the fish populations of the lake using various fisheries assessment gear during multiple seasons. Each gear type was efficient in capturing certain fish species and fish sizes. The use of multiple gears during different sampling seasons provided a clearer picture of the entire fish community and fish population characteristics of individual species within the lake. However, in 2015 the survey followed a severe winterkill event that likely reduced the species and number captured during this survey.

A total of 1276 fish were collected during the fisheries surveys of Silver Lake with Yellow Perch and Northern Pike the most common species (Tables 2, and 12). Other species were captured in lower numbers.

Gamefish

Northern Pike were captured in high number in 2015 despite the winter kill. Pike CPE was excellent and we captured 526 Pike in fyke nets and 19 by electroshocking. The Peterson PE estimated that we had 13.2 Northern Pike per lake surface acre which is very good compared to other lakes in Manitowoc County. Growth was above State averages at each age sampled. Although we could not definitely determine if natural reproduction was occurring in lake, comparison to stocking records indicate that it is likely that some is occurring. Based on the number, growth and density of Northern Pike in Silver Lake the 812 mm (32") size minimum is working to produce an excellent Northern Pike fishery. No change in regulation is recommended. Further, it is recommended to stock Northern Pike for two more years since the level of natural reproduction is not known at this time and to replace the loss of small Pike caused by the winter kill.

Walleye were the second most commonly captured gamefish during the survey (Tables 2 and 12). It is likely the winter kill severely reduced their number in the lake since only 20 were captured throughout the survey and the Peterson PE was low at 27. The growth potential of Walleye is good in Silver Lake based on previous surveys (Hogler 2004, 2005, 2006, 2007, 2008, 2009, 2010 and 2012). No change in regulation is recommended. Since natural reproduction has not been noted in Silver Lake during previous surveys and since the impact of the winter kill on Walleye was severe, it is recommended to continue stocking Walleye on an alternate year basis although extended growth fingerlings may now be needed since the Northern Pike population dominates the predator population in the lake.

Largemouth Bass were rarely captured during the survey. It appears that the 2014-15 winter kill nearly eliminated all the Bass from the lake. The growth of bass was good based on previous surveys with some natural reproduction noted (Hogler 2004, 2005, 2006, 2007, 2008, 2009, 2010 and 2012). No change in regulation is recommended at this time. Stocking Largemouth Bass for three consecutive years is recommended to rebuild the population.

Panfish

Yellow Perch were the most common species captured across all surveys in 2015 (Table 2 and Table 12). Most Yellow Perch, however, were under 150 mm length (Table 9 and Table 14). Based on the aging data it appears that growth is above state averages but age is less than 5 years indicating harvest by anglers likely accounts for the small size of Yellow Perch in Silver Lake despite a 10 panfish bag limit. It should also be noted that Perch likely is one of the major prey items of predator fish in the lake. If larger Perch are desired by anglers, then it may be necessary to further reduce the daily bag limit or to impose a minimum size limit. No changes are recommended at this time.

Other panfish species were captured in Silver Lake including Bluegill, Black Crappie. Pumpkinseed Sunfish and Green Sunfish (Table 2 and Table 12). These fish were not stocked by DNR following a 2003 rotenone treatment that removed most of the fish population of the lake. Either these fish survived the rotenone treatment or were illegally stocked by anglers. Since they were stocked, it appears that these species have established reproducing populations in the lake. The average size of these fish are better than in other Manitowoc County lakes likely due to the reduced daily panfish bag limits on lake. No change in regulation is recommended. If adult Bluegill are available for field transfer, it would be recommended to stock these larger Bluegill into Silver Lake if the population has not rebounded from its current level.

Other Species

Other species including Bullhead, White Sucker and Golden Shiner were captured during this survey. None of these species appear to be causing any issues in the lake. No Carp were captured during this survey although several large carcasses were noted during the period when fyke nets were deployed.

During electroshocking on the night of May 13, we noted well over 1000 Double Crested Cormorants roosting on trees that surrounded the lake. Although it is likely that these birds spend only a day or two on the lake, the impact to the fishery could be substantial. If needed, nuisance control could be used reduce the number of Cormorants roosting around the lake.

Recommendations

- Continue the current restrictive suite of fishing regulations on Silver Lake. If anglers desire larger Yellow Perch, work with local sportsmen to either reduce the daily bag limit or impose an acceptable minimum size limit to achieve the goal of larger Perch.

- Continue alternate year, extended growth fingerling Walleye stocking to maintain a fishable population in Silver Lake since natural reproduction with current lake conditions is unlikely.

- Stock large fingerling Largemouth Bass for three years to replace the fish lost during the 2014-15 winter kill event. Stock Northern Pike for two years to replace the small Pike that were likely lost during the winter kill.

- Work with lake and county residents to explore management options to reduce the number and severity of overtopping events that have plagued the lake since 2004 and to address the recent low dissolved oxygen levels measured during winter months. Currently the County Lakes Association is developing a project to address these issues. DNR staff should work with the lake group to develop a successful plan.

- Monitor the movement and abundance of invasive species in Silver Lake. If new species get firmly established in the lake, changes in the fish community are likely. Continue to monitor the status of Eurasian Water Milfoil in Silver Lake and continue spot treatments at the boat launch and around the fishing pier to maintain public access and use. Recommend larger treatments if densities and coverage of Eurasian Water milfoils threatens to impact the fish population.

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