Long Lake- 2007 Survey Report

Steve Hogler and Steve Surendonk,
WDNR Fisheries-Mishicot

ABSTRACT

Long Lake is a drainage lake located in western Manitowoc County. The lake has a surface area of 120 acres and a maximum depth of 38 feet. The lake is moderately developed with residences and has public access on the northeast corner of the lake.

Since the 1940's fish surveys have been conducted on Long Lake. Over time abundant, desirable species such as northern pike, largemouth bass, yellow perch and fast growing bluegill have been replaced by carp, bullhead and slow growing panfish. During this same period water quality in the lake has also declined. The fish population was further perturbed by a large fish kill in 1984, caused by a copper sulfate treatment for aquatic plants that killed a large percentage of the fish population of the lake. In 1999, a comprehensive fish survey along with a creel survey characterized the fish populations of the lake. A total of 7,474 fish were collected representing sixteen species during the fisheries survey. The most abundant fish were bluegill followed by black crappie and yellow bass. The most common gamefish were largemouth bass and northern pike.

A 2007 fish survey utilizing fyke nets in spring followed by early summer electrofishing was conducted on Long Lake. A total of 1,524 fish were collected representing thirteen species. Overall the most abundant fish were bluegill followed by black crappie and northern pike. Northern pike were the most common gamefish followed by largemouth bass and walleye. Carp and bullhead were also present. Survey results from this survey were consistent with the findings of previous surveys.

Gamefish populations in Long Lake were fair. Bass and pike have had variable recruitment (good and bad years) probably due to poor water quality, lack of feed for young fish, or high angler exploitation. To improve the bass population, more restrictive harvest limits may be needed to protect large fish. To improve northern pike numbers stocking may be required if water levels can not be manipulated to improve spawning success. Walleye numbers remain low and stocking will be needed to maintain the population.

Panfish numbers were down since the 1999 survey, but panfish are still abundant in the lake. Although growth has improved, they are generally small in size. Small size may be due to angler harvest of larger individuals or selective mortality caused by fish kills. To improve panfish size structure, harvest limits may be needed.

Conclusions from this fish survey can be the basis for a long range management

plan for Long Lake that should focus on three areas, water quality, habitat and fisheries. It is important that lake residents and other community members develop a vision of what they want Long Lake to be, within ecosystem system bounds. Any plan that is developed should outline a strategy to deal with each of the three focus areas in an organized fashion.

INTRODUCTION

Long Lake (WBIC-0077500) is a drainage lake located in western Manitowoc County (T19N, R21E, Sections 6 and 7) (Figure 1). The lake has a surface area of 120 acres, a maximum depth of 38 feet and a shoreline development factor of 2.18. The lake basin is divided into two lobes and the lake bottom is a mixture of muck and gravel. Long Lake has hard water and is surrounded by agricultural land. The lake is moderately developed with residences and has public access on the northeast corner of the lake.

Hogler (2001) summarized the past fifty years of surveys on Long Lake. He indicated that a survey in the 1940's found an abundance of bluegill, crappie, largemouth bass and northern pike that exhibited good growth. However, that survey also found numerous carp and indicated that water quality in the lake was poor. Furthermore, Hogler described surveys in the following decades that documented the state of the fishery. Surveys conducted in the 1950's through the 1980's found that panfish, bullhead and carp dominated the fishery, with largemouth bass the most common gamefish. Panfish were considered over-abundant and slow growing while gamefish were heavily exploited by anglers. Water quality was poor with low dissolved oxygen levels during winter and algae blooms during summer months. A fish kill in 1984, caused by a copper sulfate treatment for aquatic plants killed a large percentage of the fish population of the lake (Peeters 1984). Fish management suggested a rotenone treatment and restocking, but lake residents voted not to eradicate the remaining fish.

A 1999 comprehensive fish survey along with a creel survey on Long Lake characterized the fish populations of the lake (Hogler 2001). During this survey, a total of 7,474 fish were collected that represented sixteen species. The most abundant fish were bluegill followed by black crappie and yellow bass. The most common gamefish were largemouth bass and northern pike.

The creel survey estimated that anglers during the open water fishing season fished 16,046 hours on Long Lake and harvested 7,782 fish. Yellow bass, bluegill and black crappie were the most commonly harvested fish.

Conclusions based on survey results included that (1) gamefish populations in Long Lake were fair. Largemouth bass and northern pike have had variable recruitment (good and bad years) probably due to poor water quality, lack of feed for young fish, or high angler exploitation, and (2) panfish were numerous but small in size. The small size may be due to angler harvest of larger individuals or lack of forage because length at age analysis indicated growth to be near state averages.

In 2007, a fish survey was conducted following State protocols to assess the current status of the fish population of Long Lake.

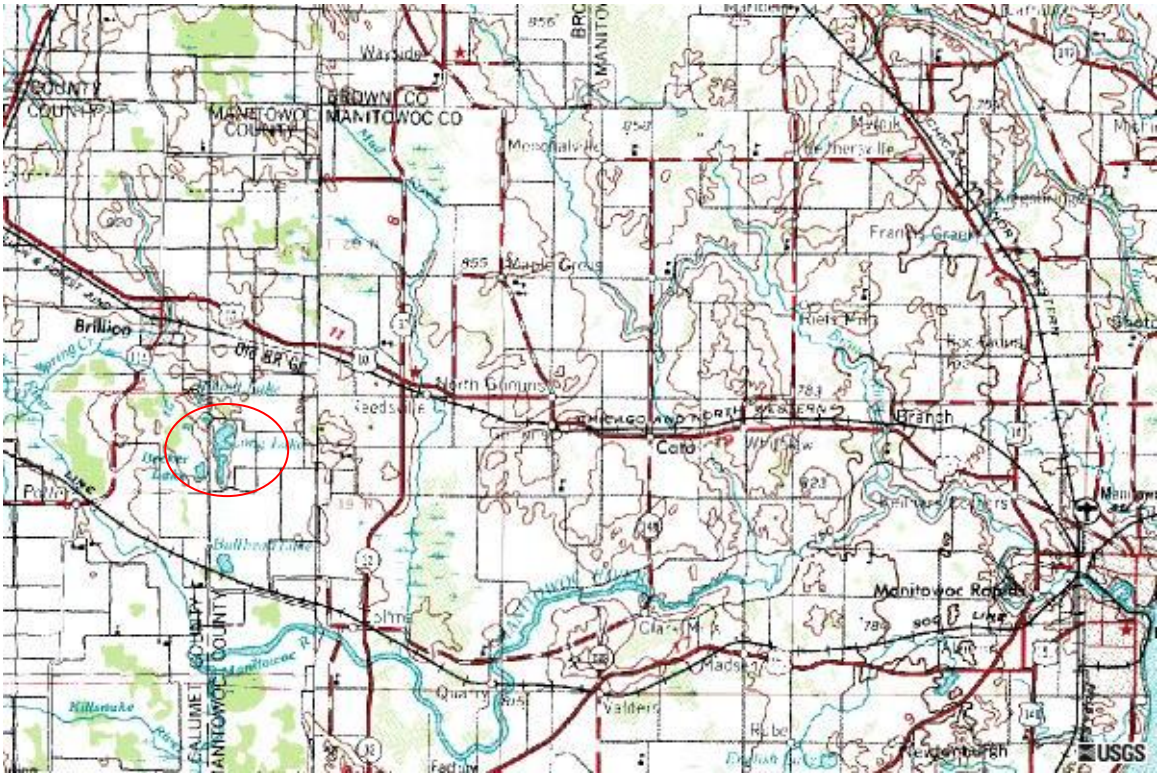

Figure 1. Long Lake is located on the western edge of Manitowoc County, west of the city of Manitowoc.

METHODS

Spring Fyke Netting

Seven fyke nets were set shortly after ice-out on March 27, fished until April 5 and were used to capture and mark adult spawning northern pike, walleye and yellow perch for the purpose of estimating adult population size (Figure 2). Other species captured in fyke nets were also marked for potential population size estimation, but nets were set in habitats to target early spring spawning fish. All fish were identified, measured, marked with a caudal fin clip and scales were removed from a sub-sample for age determination.

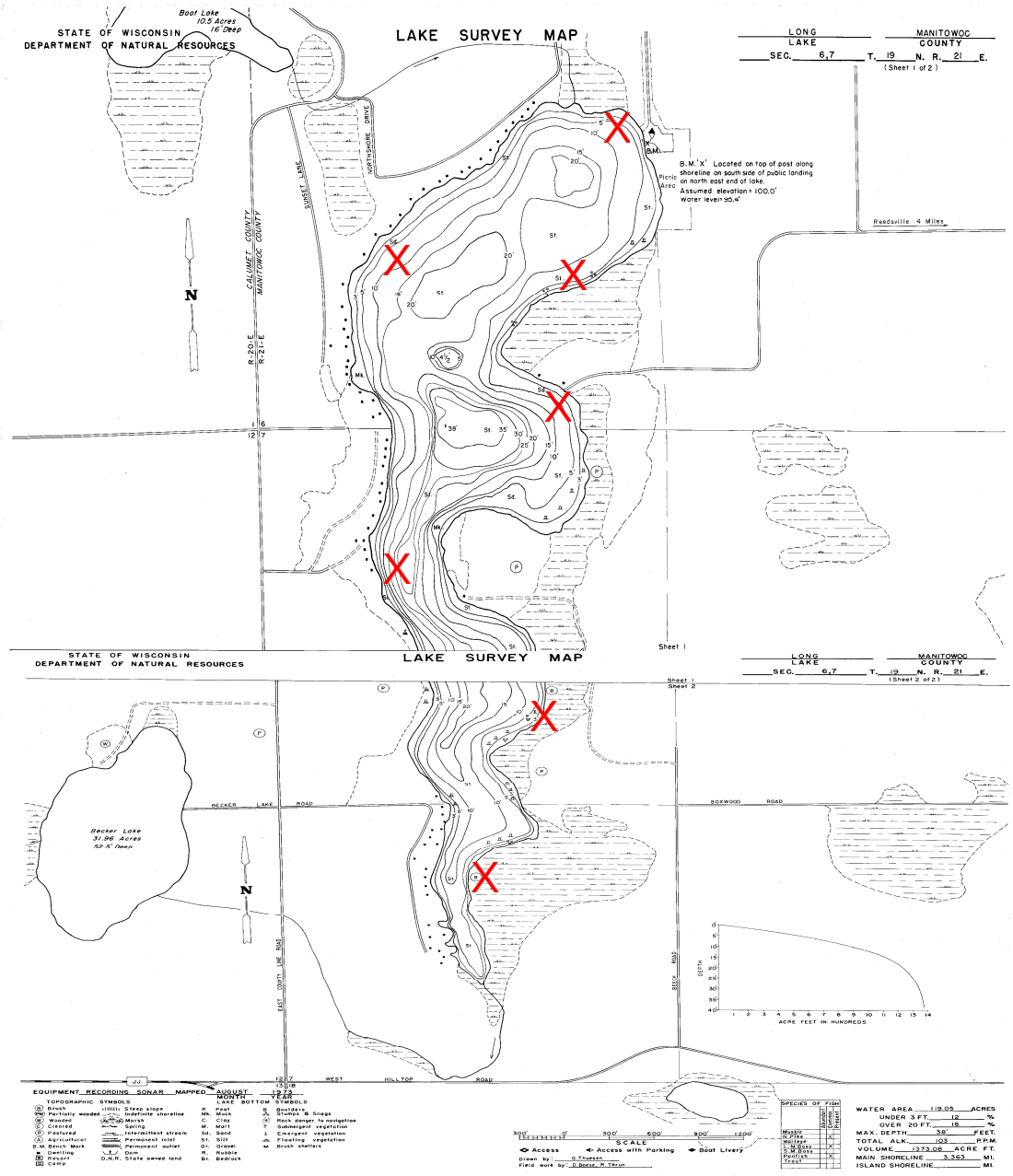

Figure 2. The locations of the seven fyke nets that were fished in Long Lake from March 27 through April 5, 2007 are marked by an X on the lake map.

Spring/Summer Surveys

Centrarchid Electrofishing

On the nights of May 31 and June 4, most of shoreline was electroshocked to estimate adult largemouth bass and panfish relative abundance (Figure 3). All fish were netted, identified, checked for marks and measured.

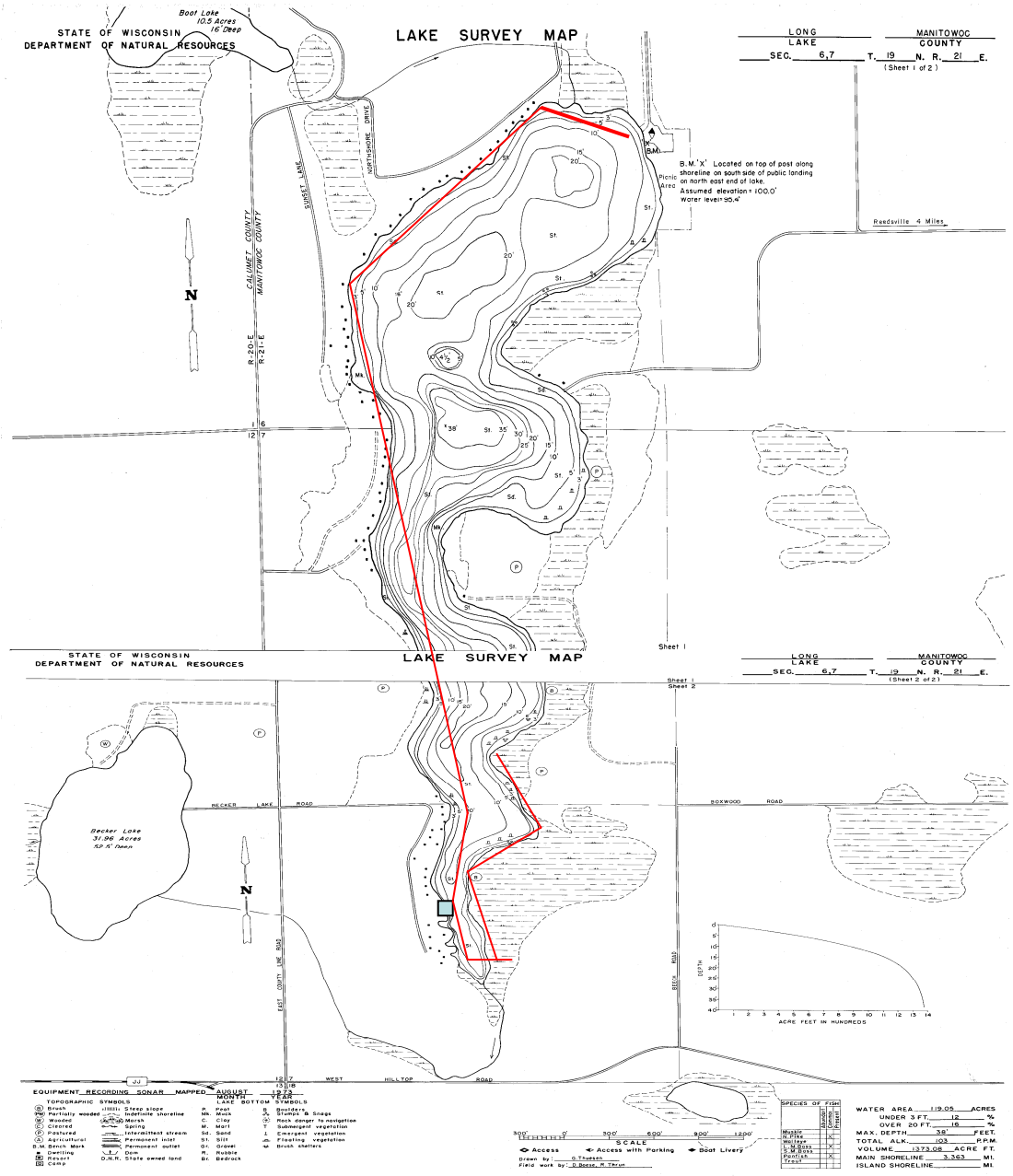

Figure 3. The red line denotes the shoreline that was electrofished on the nights of May 31 and June 4.

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 Schnabel and Petersen population estimation methods were used 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 (Ricker 1975). Using the Schnabel multi-census model, each fyke netting day and each electrofishing run were defined as a sampling time period, and running population estimates were calculated for each time period (Ricker 1975). In general, Schnabel population estimates tend to be more precise than Petersen estimates because the population is sampled repeatedly in time, and with each successive time period sampled, we know the true population size with more certainty.

RESULTS

Spring Fyke Netting

During the fyke net portion of the survey, a total of 1,248 fish were captured during the 42 net nights fished for a CPE of 29.7 fish per net per night. Of the thirteen species captured, bluegill dominated the catch with substantially fewer black crappie, northern pike, yellow bass, yellow perch and other species captured (Table 1).

Table 1. Abundance of fish captured with fyke nets on Long Lake during the 2007 survey. Peterson Population estimates were based on the last day of fyke net catch while the Schnabel Population estimates were based on daily fyke net catch.

Species	Number Caught	Number Marked	Number Recaptured	Peterson		Schnabel	
				PE	Range	PE	Range
Northern Pike	142	106	36	418	333-661	183	134-260
Walleye	8	8	0				
Largemouth Bass	30	30	0				
Bluegill	537	416	0				
Black Crappie	186	144	2	13,392	3,377-121,580	3,698	1,353-9,245
Pumpkinseed Sunfish	12	8	0				
Yellow Perch	103	72	2	3,708	1,009-36,330	1,364	499-3,410
Yellow Bass	138	81	0				
Brown Bullhead	27	17	3	142	43-632	56	23-140
Black Bullhead	9	7	0				
Yellow Bullhead	20	14	2	140	14-500	23	8-58
Golden Shiner	12	0	0				
Carp	24	0	0				
Total	**1248**	**903**	**45**				

Gamefish

Northern Pike

Northern pike were the most common gamefish that we captured during fyke netting (Table 1). The 106 northern pike ranged in size from 333 mm to 821 mm and had an average length of 589 mm (Table 2). Most of the captured northern pike were between 500 mm and 650 mm in length with very few small or large fish handled. Eighteen of the 106 captured northern pike that we handled were larger than the 26" minimum size limit regulation.

We used mark and recapture methodology during the fyke net survey and the Peterson and Schnabel techniques to estimate population size in Long Lake. The Peterson Method estimated that 416 northern pike population reside in Long Lake, while the more conservative Schnabel estimated that 183 pike are in the lake (Table 1). Since it is likely that the large number of recaptures of small males reduced the estimate, the true population number is likely closer to the Peterson estimate and that between 333 and 661 individual pike or 2.8 to 5.5 per surface acre reside in the lake (Table 1).

The captured northern pike ranged in age from age 2 through age 7 (Table 3). Age 3 northern pike were the most common age fish in the sample and they averaged 557 mm in length. Ages 4 and 6 were also well represented in the sample. Very few fish younger than age 3 or older than age 6 were captured.

We compared length at age for fish captured during this survey to state averages to determine how well northern pike are growing in Long Lake. Length at age for northern pike aged during this survey was above state averages for pike older than age 2 and was greater than those measured during the 1999 survey (Table 4). Since our sample size was low, we combined male and female pike that grow at differing rates, so these results should be viewed cautiously.

Largemouth Bass

Largemouth bass were the second most common gamefish that we captured during the fyke net survey (Table 1). The 30 bass ranged in length from 294 mm to 475 mm and they had an average length of 382 mm (Table 2). Most of the captured bass (80%) had lengths greater than the 14" minimum size limit. Additionally, 33% of the bass had lengths greater than 16" and 10% were longer than 18".

We were unable to make a population estimate because we did not recapture any bass that we had previously handled during this survey.

Captured largemouth bass ranged in age from age 3 to age 8 (Table 5). Age 5 and age 6 bass were the most commonly captured age classes with other age bass caught in lower numbers.

Length at age for bass from this survey was greater than state averages at all

captured ages and was also greater than those measured in the previous two surveys. But because of small sample size, these results should be viewed cautiously.

Table 2. Length frequency of gamefish captured during fyke netting on Long Lake 2007.

Length (mm)	Northern Pike	Largemouth Bass	Walleye
250			1
260			
270			
280			
290		1	
300			
310			
320		1	
330	1	4	
340			
350			
360		3	1
370	1	3	
380		5	1
390		3	1
400		3	
410		2	
420			1
430			
440		1	
450	1	1	
460		1	
470	2	2	
480	3		
490	2		1
500	2		
510	3		
520	7		
530	5		
540	3		1
550	4		1
560	5		
570	3		
580	5		
590	9		
600	8		
610	8		
620	8		
630	4		
640	1		
650	3		
650	3		
660	4		
670	2		
680			
690			
700	2		
710			
720			
730	1		
740	2		
750			
760	2		
770	1		
780	1		
790			
800	1		
810	1		
820	1		
Number	**106**	**30**	**8**
Ave. Length	**589**	**382**	**423**
S.D.	**82.3**	**43.9**	**100.8**

Table 3. Age distribution by length for northern pike captured during fyke netting on Long Lake in spring 2007.

Length	Northern	Age							
(mm)	Pike	1	2	3	4	5	6	7	8
330	1		1						
340									
350									
360									
370	1		1						
380									
390									
400									
410									
420									
430									
440									
450	1			1					
460									
470	2			2					
480	3			3					
490	2			2					
500	2			2					
510	3			2	1				
520	7			3	4				
530	5			2	2	1			
540	3			2	1				
550	4				4				
560	5				5				
570	3			3					
580	5				3		2		
590	9			5	2		2		
600	8			6	2				
610	8			5	1	1	1		
620	8			5		1	1	1	
630	4						4		
640	1						1		
650	3				3				
660	4				4				
670	2					2			
680									
690									
700	2					2			
710									
720									
730	1					1			
740	2						2		
750									
760	2						2		
770	1						1		
780	1						1		
790									
800	1						1		
810	1						1		
820	1						1		
Number	**106**		**2**	**43**	**32**	**8**	**20**	**1**	
Ave. Length	**589**		**350**	**557**	**578**	**654**	**686**	**620**	
S.D.	**82.3**		**28.3**	**53.8**	**48.7**	**64.4**	**87.3**	**--**	

Table 4. Average length at age for selected species captured during fyke net surveys on Long Lake in 2007 compared to previous Long Lake surveys, 1983 (Hogler 1999), and 1999 (Hogler 2001) and statewide average length at ages (WDNR 1990).

Species	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10	AGE 11
Northern pike											
2007 survey	--	350	557	578	654	686	--	--	--		
1999 survey	143	311	455	547	617	664	716	787	910		
1983 survey	291	454	554	639	702	736	804	829			
(State Average)	(356)	(406)	(470)	(546)	(610)	(650)	(706)	(762)	(787)		
Yellow bass											
2007 survey	--	--	--	--	--						
1999 survey	83	135	174	196	204						
1983 survey	90	149	191	212	216						
(State Average)	(76)	(162)	(234)	(253)	(274)						
Green sunfish											
2007 survey	--	--	--	--	--						
1999 survey	52	108	110	127	149						
1983 survey	--	--	--	--	--						
(State Average)	(24)	(54)	(91)	(117)							
Pumpkinseed											
2007 survey	--	--	--	--							
1999 survey	36	85	111	125							
1983 survey	--	--	--	--							
(State Average)	(53)	(89)	(117)	(140)							
Bluegill											
2007 survey	99	113	169	187	--	--	--				
1999 survey	46	84	124	155	175	191	209				
1983 survey	43	90	143	169	188	--	--				
(State Average)	(64)	(97)	(122)	(147)	(167)	(183)	(196)				
Largemouth Bass											
2007 survey	--	--	317	327	376	388	446	460	--	--	--
1999 survey	68	138	216	279	330	369	406	437	460	481	492
1983 survey	66	141	213	271	326	372	409	435	454	474	488
(State Average)	(97)	(165)	(229)	(290)	(338)	(384)	(414)	(447)	(454)	(485)	
Black crappie											
2007 survey	--	137	207	224	244	253					
1999 survey	53	107	146	173	197	201					
1983 survey	56	113	153	182	205	228					
(State Average)	(79)	(137)	(183)	(218)	(241)	(267)					
Yellow perch											
2007 survey	--	--	--	--	--						
1999 survey	83	129	164	190	205						
1983 survey	71	135	173	--	--						
(State Average)	(74)	(119)	(152)	(180)	(206)						
Walleye											
2007 survey	--	--	--	--	--	--					
1999 survey	151	341	446	503	531	555					
1983 survey	209	345	444	514	567	643					
(State Average)	(152)	(254)	(324)	(381)	(432)	(457)					

Table 5. Age distribution by length for largemouth bass captured during fyke netting on Long Lake in spring 2007.

Length	Total	Age							
(mm)	Number	1	2	3	4	5	6	7	8
250									
260									
270									
280									
290	1			1					
300									
310									
320	1				1				
330	4			2	2				
340									
350									
360	3					3			
370	3					2	1		
380	5					2	3		
390	3						3		
400	3					2	1		
410	2						1	1	
420									
430									
440	1							1	
450	1							1	
460	1							1	
470	2							1	1
480									
490									
500									
Number	**30**			**3**	**3**	**9**	**9**	**5**	**1**
Ave. Length	**382**			**317**	**327**	**376**	**388**	**446**	**460**
S.D.	**43.9**			**23.1**	**5.8**	**15.9**	**12.1**	**23.1**	**--**

Walleye

The eight walleye that were captured during this survey ranged in length from 251 mm to 555 mm and had an average length of 423 mm (Table 2). It is likely the captured walleye were fish that have been stocked on an alternative year basis since the last survey, although the smallest fish may have been a natural recruit.

Panfish

Bluegill

Bluegill dominated the panfish catch with fewer black crappie, pumpkinseed sunfish, yellow perch and yellow bass captured (Table 1). The 415 measured bluegill that were captured in fyke nets ranged in length from 95 mm to 200 mm and had an average length of 115 mm (Table 6). Most of the measured bluegill had lengths tightly clustered around 115 mm with only 6.5% of the captured bluegill having a length greater than 150 mm.

Table 6. Length frequency of panfish and other species of fish captured during the fyke net survey on Long Lake, 2007.

Length (mm)	Bluegill	Black Crappie	Pumpkinseed Sunfish	Yellow Perch	Yellow Bass	Yellow Bullhead	Brown Bullhead	Black Bullhead	Golden Shiner
90	5								
100	76								
110	204	1	8	1					
120	82	5							
130	17	17		8	1				
140	4	19		17					1
150	3	9		11					1
160	11	3		7					1
170	3	1		9		2			1
180	6	2		10					
190	3	6		2					2
200	1	7		3	2				
210		11		1	6	1			
220		24			23		1	1	1
230		16		1	39	2		1	1
240		17		1	9		2	1	
250		2			2	3	1	1	
260						2			
270		1				1	1	2	
280		2				2	2		
290						1	2		
300							2	1	
310							3		
320							2		
330						1			
340							2		
350									
Number	415	143	8	71	82	15	18	7	8
Ave. Length	115	190	110	159	225	221	289	254	181
S.D.	18.9	44.6	--	24.7	14.2	91.7	34.6	27.6	32.3

We were unable to make a population estimate for bluegill because we did not recapture any bluegill that we had previously handled during this survey.

Age classes 1 through 4 were present in the scale samples that were analyzed (Table 7). Age 2 bluegill were the most abundant cohort captured with the frequency of the other age cohorts substantially lower in number. Age 2 bluegill averaged 113 mm in length.

Length at age for bluegill in 2007 was greater than the previous two surveys and state averages for all captured ages (Table 4). However, the average length at age may be inflated due to the low numbers of fish sampled in some age classes.

Table 7. Age distribution by length for bluegill measured during fyke netting on Long Lake in spring 2007.

Length (mm)	Bluegill	Age			
		1	2	3	4
90	5	1	4		
100	76	8	68		
110	204		204		
120	82		82		
130	17		17		
140	4		4		
150	3		1	2	
160	11		9	2	
170	3			2	1
180	6			5	1
190	3				3
200	1				1
Number	415	9	389	11	6
Ave. Length	115	99	113	169	187
S.D.	18.9	3.3	11.2	12.2	10.3

Black Crappie

Black crappie were the second most common panfish that we captured using fyke nets (Table 1). The 143 measured crappie ranged in length from 115 mm to 286 mm and had an average length of 190 mm (Table 6). Eighty of the 143 measured crappie (55.9%) had a length greater than 8", but only 3.5% of the fish were greater in length than 10".

We recaptured two crappie during fyke netting which allowed us to calculate population estimates using both the Peterson and Schnabel method, although because of low recapture number, these estimates should be viewed cautiously (Table 1). The Peterson method estimated there were 13,393 (range 3,377-121,580) crappie in the lake while the Schnabel estimate was 3,698 (range 1,353-9,245). Both methods most likely underestimate the number of crappie in the lake.

Ages 2 through 6 were present in the scale samples that were analyzed (Table 8). Age 2 crappie were the most abundant, although age 3 and age 4 fish were also commonly captured. Age 2 black crappie averaged 137 mm in length.

When 2007 black crappie length at age is compared to state averages, fish captured during this survey grew at state average rates (Table 4). Length at age in 2007 was much greater than averages from the previous two surveys indicating improved crappie growth in Long Lake.

Table 8. Age distribution by length for black crappie measured during fyke netting on Long Lake in spring 2007.

Length (mm)	Total Number	Age					
		1	2	3	4	5	6
90							
100							
110	1		1				
120	5		5				
130	17		17				
140	19		18	1			
150	9		9				
160	3		2	1			
170	1			1			
180	2			2			
190	6			5	1		
200	7			4	3		
210	11			9	2		
220	24			16	8		
230	16			3	10	3	
240	17				7	8	2
250	2					2	
260							
270	1					1	
280	2					1	1
290							
Number	143		52	42	31	15	3
Ave. Length	190		137	207	224	244	253
S.D.	44.6		10.6	19.5	13.6	14	23.1

Other Panfish

Other panfish captured during fyke netting included yellow perch, yellow bass and pumpkinseed sunfish (Table 1). The average length of the yellow perch, yellow bass and pumpkinseed were 159 mm, 226 mm and 110 mm respectively (Table 6).

Other Species

During fyke netting we captured a number of other species which included black, brown and yellow bullheads, golden shiner and common carp (Table 1). Average lengths were 221 mm, 289 mm, 254 mm and 181 mm for yellow bullhead, brown bullhead, black bullhead and golden shiner respectively (Table 6).

Summer Surveys

Centrarchid Electroshocking

On the nights of May 31 and June 4, Long Lake was electroshocked to assess centrarchid populations. The same shoreline segment was shocked each night (Figure 3). Although we planned to shock the entire shoreline, dense aquatic plant growth prevented us from doing so. Effort on May 31 was 50 minutes and on June 4 we shocked for 50 minutes for a total effort of 100 minutes.

Total catch was low each night of shocking, with 168 fish caught on May 31 and 108 fish captured on June 4 (Table 9). Bluegill dominated the catch each night and was the most common fish captured during this survey. Largemouth bass and walleye were the most common gamefish captured during electrofishing. Carp were also commonly caught and were the third most abundant fish captured during electroshocking.

The average length of fish that were captured during electroshocking included 296 mm for largemouth bass, 127 mm for bluegill and 148 mm for black crappie (Table 10).

We were unable able to make any population estimates for any species because we did not recapture any fish that we had previously handled during this survey.

Table 10. Abundance of fish captured during electrofishing on Long Lake during the 2007 survey.

Species	31-May Total	04-Jun Total	Total
Largemouth Bass	20	15	35
Walleye	1	0	1
Bluegill	69	26	95
Black Crappie	26	14	40
Yellow Perch	2	0	2
Golden Shiner	28	24	52
Carp	22	29	51
Total	**168**	**108**	**276**

Table 11. Length frequency of fish captured during nighttime May/June electroshocking on Long Lake, 2007.

Length (mm)	Largemouth Bass	Walleye	Bluegill	Black Crappie	Yellow Perch	Golden Shiner
90			1			
100			4	1		
110			16			2
120	4		35	4		8
130	5		31	3	1	11
140	2		4	14		12
150			3	13	1	7
160				3		6
170	1					2
180			1			1
190				1		1
200						1
210						
220				1		1
230						
240						
250						
260						
270						
280	1					
290						
300						
310						
320	1					
330	2	1				
340	1					
350	1					
360	2					
370	3					
380	3					
390	2					
400	5					
410						
420						
430						
440						
450	1					
460						
470						
480	1					
Number	35	1	95	40	2	52
Ave. Length	296	330	127	148	146	148
S.D.	122.2	--	12.1	19.6	17	21.3

DISCUSSION

The 2007 fishery survey on Long Lake characterized the fish populations of the lake. Each gear type was more efficient in capturing certain species of fish than other gear. The use of multiple gears gave a much clearer picture of the fish population of the lake.

During the 2007 survey, a total of 1,524 fish were collected representing thirteen species (Table 1). Overall the most abundant fish were bluegill followed by black crappie and northern pike. Northern pike were the most common gamefish followed by largemouth bass and walleye. Carp and bullhead were also present. Survey results from this survey were consistent with the findings of most previous surveys.

Gamefish

Northern pike number in 2007 improved over what was captured during the previous two surveys although they are much lower than other historic surveys (Hogler 2001). Improvement in the number of pike in the lake since 1999 is likely due to ongoing stocking while the overall decline in pike numbers since the 1970's is most likely due to the lack of spawning success caused by constant water levels maintained by the outlet dam. Restoration of fluctuating water levels and suitable spawning sites may positively affect pike numbers in the lake. Growth, as measured by length at age was above state averages for most ages in 2007 and was substantially better those measured in 1999 (Table 4). Most northern pike were between 500 mm and 650 mm in length, with few less than 400 mm or greater than 700 mm (Table 2). Since it appears that recruitment is low, the continuance of stocking is recommended

The number of largemouth bass captured during fyke netting and summer electrofishing in 2007 declined from what was captured during the 1999 survey. In addition, average length also decreased in 2007. The decline in overall number was likely due to fewer small bass (less than 300 mm) being captured, while the decline in average length is likely due to fewer larger bass (greater than 450 mm) being captured in 2007 (Table 2). Length frequencies for each gear type and scale age analysis indicate a good number of younger, smaller fish in the population, but a rapid decline in the number of larger, older fish. Growth rates were near state averages at all ages (Table 4). More conservative size and bag limits may be needed to maintain production of young fish because of habitat loss and continued poor water quality and to increase the number of larger fish in the fishery because of the past history of high angler harvest (Hogler 2001). Protection of spawning areas is also critical for a healthy population of bass.

Walleye were captured in low number during surveys. Stocked fish appear to be growing well, although survival appears low. Reproduction if present is extremely limited and maintenance stocking will be required if walleye are to continue as

part of the fishery of the lake.

Panfish

Bluegill, black crappie and yellow bass dominated the panfish community of Long Lake, although yellow perch were also commonly captured. Most of the panfish were small and young in age with average lengths less than 200 mm and ages less than 5. Very few larger panfish were observed in any 2007 survey on Long Lake. Growth appears to be good. Improvements in growth observed in 2007 compared to earlier surveys are likely due to reduced competition for food because of reduced panfish numbers caused by several fish kills since 1999 survey. Fish may also be small (young) because anglers are removing larger individuals and leaving small fish in the lake as was observed in the creel survey associated with the 1999 survey (Hogler 2001) or because larger fish were selectively killed by disease during recent fish kills. Bluegill appears to be an example of this with rapidly declining numbers after age 2. Additionally, following the completion of fyke netting, a large, severe fish kill caused by a virus (not VHSv) substantially reduced yellow bass abundance in the lake. No yellow bass were captured in electroshocking surveys which followed the kill. Past history indicates that the yellow bass population although nearly eliminated from Long Lake following the 1984 fish kill rebounded to its previous level by the time of 1999 survey. Time will tell if the yellow bass population will recover following their latest decline.

Past angling history has shown that anglers have been generally dissatisfied with the bluegill size structure on Long Lake (Hogler 2001). Comparison of catch and harvest rates on Long Lake to other lakes indicate much poorer catch and harvest rates for bluegill because bluegill are perceived as being stunted. Improved growth rates may change this perception. Increasing angler harvest, however, may once again remove larger fish leaving only small bluegill in the lake. High harvest rates for black crappie and yellow perch noted in 1999 may have continued since the past survey and may be responsible for our reduced catch in 2007 of these species. Long term impacts of alternating cycles of high harvest of abundant fish followed by low harvest of recovering populations are not well understood and may impact the future populations of each species in the lake.

Other Fish

Carp and bullhead are present in Long Lake although the numbers caught in 2007 were substantially less than those captured in 1999 (Hogler 2001). Earlier surveys indicated that their high abundance could negatively impact water quality and ultimately the fish community of the lake. Perhaps the slightly improved water quality of the lake and abundant Eurasian water milfoil has shifted the fish community of the lake away from carp and toward panfish. To establish better populations of more desirable species, greater improvements in water quality and

establishment of a more desirable plant community must be made.

Forage species are lacking in this lake. Golden shiners were the only minnow species collected during surveys. The lack of forage may be the cause for slow growth in some of the fish species.

CONCLUSIONS

Conclusions from this fish survey can be the basis for a long range management plan for Long Lake that should focus on three areas, water quality, habitat and fisheries. It is important that lake residents and other community members develop a vision of what they want Long Lake to be, within ecosystem system bounds. Any plan that is developed should outline a strategy to deal with each of the three focus areas in an organized fashion.

First and foremost is to continue to strive towards a goal of improved water quality. Past water quality issues have lead to low dissolved oxygen levels in the lake which have resulted in fish kills. These frequent low DO events lead the Lake Association to install and use an in-lake aerator to maintain DO during winter months. Over the past decade however, the use of the aerator has been much more infrequent perhaps indicating some improvement in water quality.

Although water quality has continued to improve during the past several years because of reduced levels of phosphorus entering the lake, lake water quality must continue to improve to promote a healthy lake and a healthy fish population. Efforts to restore natural shoreline vegetation and nearby wetlands, which act as a buffer to incoming nutrients, must be encouraged to help improve water quality.

The trend toward the loss of shoreline and nearshore shallow water habitat needed by fish for spawning, feeding and refuges must stop. Protection and re-establishment of natural shorelines and littoral areas must be encouraged. Far too much habitat is being lost through rip-rapping of shorelines, removal of downed vegetation and the removal of aquatic and semi-aquatic plants. Restoration of nearshore plants would also stabilize shorelines and reduce the need for rip-rap.

Gamefish populations in Long Lake are fair. Bass and pike have had variable recruitment (good and bad years) probably due to poor water quality, lack of feed for young fish, or high angler exploitation. Growth is good once fish are large enough to eat an average size bluegill.

To improve the bass population, more restrictive harvest limits may be needed. It appears that anglers harvest bass soon after they reach 356 mm (14”) size limit. Reduced harvest should improve the size structure and increase the number of small bass in the lake. I would recommend an 18” minimum size with a 1 daily bag limit for bass in Long Lake.

Northern pike numbers are lower than they should be. It is likely that construction of a low head dam with a fixed head in 1977 to minimize spring flooding has hurt the northern pike population of the lake. The loss of seasonal (spring) high water has limited the access of pike to their historic spawning areas. In 1993, the Long Lake Association attempted to construct a pike spawning area by dredging a wetland in the northeast corner of the lake to remediate for the loss of spawning habitat caused by the dam stabilizing water levels. Underlying peat deposits rose to the surface making dredging ineffective and causing this attempt to compensate for the dam a failure. In the years following 1993, the Lake Association has continued to try to improve the northern pike population by stocking large yearling fish. Since the late 1990's WDNR has also stocked fingerling northern pike on alterative year basis to improve the population. Since water levels at this time can not be manipulated to improve spawning success, continued stocking or enhancement of adjacent wetlands may be required to improve pike numbers. Additionally, to protect stocked northern pike from overharvest and allow additional years to spawn, it may be necessary to reduce angler harvest by setting a 32" minimum size and a 1 bag for pike in Long Lake.

Although the goal for walleye stocking was to add additional predation pressure on small panfish, anglers have harvested some large walleye. Since successful walleye spawning is unlikely because of limited spawning habitat, even to maintain a low abundance walleye population alternative year stocking will be needed.

Panfish numbers are down since 1999, but they are still abundant in the lake. Although growth has improved, they are generally small in size. Small size may be due to angler harvest of larger individuals or selective mortality caused by fish kills. If angler harvest is selectively removing the largest fish, Beard and Essington (2000) indicate that in bluegill, shifts in life strategies can occur when larger (older) individuals are removed from the population and cause fish to spawn at a younger age. Younger age at maturity also leads to smaller fish because of reduced growth rates that occur once maturity is reached. Over time this leads to significant decreases in average length for the entire population. They suggest a reduction in harvest may cause bluegill to delay spawning until they are older in age. This shift in spawning strategy may offer some improvement in average size, although the recovery can be slow.

Lack of forage fish in the lake may slow growth in species that feed on these fish. Improvement in water quality and restoration of in-lake habitat should improve the long-term abundance of forage and help improve growth rates.

REFERENCES

Beard Jr., T.D. and T.E. Essington, 2000. Effects of angling and life history processes on bluegill size structure: Insights from an individual-based model. Trans. American Fisheries Soc. 129:561-568.

Hogler, S. 1999. 1983 Comprehensive Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural 22 pages.

Hogler, S. 2001. 1999 Comprehensive Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural 28 pages.

Peeters, P.1984. Fish Kill on Long Lake Report. Unpublished. Wisconsin Department of Natural Resources. 4 pages.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada. Bulletin 191. Ottawa, Ontario, Canada.

WDNR. 1990. Fish Management Reference Book. Wisconsin Department of Natural Resources. Madison, Wisconsin. May 3, 1990.