Kangaroo Lake Comprehensive Fisheries Survey Report

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ABSTRACT

Kangaroo Lake has a surface area of 1,123 acres and is the largest lake in Door County. The lake has a maximum depth of 12 feet and an average depth of 6 feet. Kangaroo Lake has a Trophic State Index (TSI) rating of eutrophic indicating nutrient rich, productive lake water. At times, because the lake is shallow, lake water can be very turbid due to wind action or from heavy boating use.

Since the 1940's, surveys approximately every ten years have tracked the fish populations in the lake. Surveys in the 1940's and 1950's indicated that smallmouth bass, northern pike and bluegill dominated the fish community, but by the 1970's, walleye, yellow perch and rock bass were the dominant fish in the lake. Because of concerns about the perceived decline in the fishery of Kangaroo Lake, a comprehensive fish survey was conducted in 2004 to evaluate the fish community of the lake. A total of 10,120 fish were collected during the survey with yellow perch the most abundant fish captured during the survey. The most common gamefish were walleye, followed by smallmouth and largemouth bass.

A comprehensive fish survey was conducted in 2008 on Kangaroo Lake to evaluate the fishery of the lake as part of baseline lake monitoring. A total of 5,315 fish were collected during the fish surveys. The most abundant fish were yellow perch and bluegill. The most common gamefish were walleye, followed by smallmouth bass and northern pike.

Fish populations in Kangaroo Lake appear to be in a state of change. Bass and panfish populations are up while the walleye population is stable although lower in abundance than historic highs. Likely the changes are due to a combination of changing lake conditions that favor panfish and bass and angler harvest of desirable species. In general the fish population of the lake appears to be in good condition.

It is recommended that (1) Fish Management continue to monitor the fish population of Kangaroo Lake and determine if the newly established walleye regulations have been effective in increasing walleye abundance and improving the size structure, (2) encourage recolonization of native aquatic plants and restoration of natural shorelines for the benefit of fish communities and the ecology of the lake and (3) monitor the movement and abundance of exotics such Eurasian water milfoil, zebra mussels, rusty crayfish and VHS into Kangaroo Lake. If these species get firmly established in the lake, more changes in the fish community are likely.

INTRODUCTION

Kangaroo Lake (WBIC 98600) has a surface area of 1,123 acres and is the largest lake in Door County. It is a shallow lake with a maximum and average depth of 12 feet and 6 feet respectively (Figure 1). Because the lake is shallow lake water can be very turbid at times due to wind action or from heavy boating use. Water quality in Kangaroo Lake is good although the lake has a Trophic State Index (TSI) rating of eutrophic indicating that the lake has seen some nutrient enrichment from its watershed (WDNR 2001).

In the late 1800's a causeway was constructed across the northern third of the lake creating a two basin lake (Door County SWCD 2000). The north basin is shallow, clear, and contains a variety of open water and wetland plants. The shoreline of this basin is lightly developed. Much of the shoreline and the surrounding land in this basin are part of the Kangaroo Lake Preserve Natural Area.

The south basin is highly developed and experiences heavy boating use during summer months. Once abundant aquatic vegetation has been reduced to small patches of native plants and stands of non-native Eurasian water milfoil.

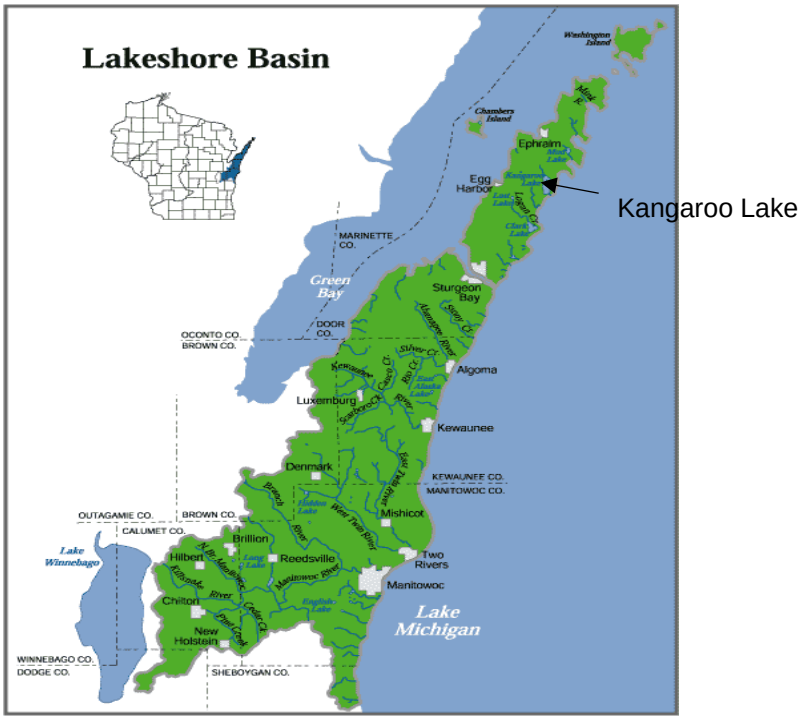

Figure 1. Location of Kangaroo Lake in northern Door County.

Hogler (2005) detailed the past 70 years of stocking and the results from past fish surveys on Kangaroo Lake. Here I will only summarize those reports. Most of the past efforts to manage the fishery of Kangaroo Lake have focused on fish

stocking. Records indicate that a variety of species have been stocked in the lake since 1935, but the most common stockings were large and smallmouth bass, yellow perch, walleye and in the 1970's northern pike. Despite the numerous stocking events, fish surveys to evaluate these stockings have been limited.

Since the 1940's, surveys approximately every ten years have tracked fish populations in the lake (Hogler 2005). Surveys in the 1940's and 1950's indicated that smallmouth bass, northern pike and bluegill dominated the fish community, but by the 1970's, walleye, yellow perch and rock bass were the dominant fish in the lake. Although documenting changes in the fish population, these surveys have likely also noted concurrent changes in the lake environment as abundant plant beds and natural shorelines were lost due to shoreline alterations, fast boating and increasing nutrient loading to the southern basin of the lake. As the habitat shifted from a natural shoreline with abundant plant beds to disturbed shoreline with more open water, the fish population also changed. Those fish species favoring open water or increased turbidity such as walleye or yellow perch increased in abundance while those preferring natural shoreline, clear water and abundant plants such as bass, bluegill and pike decreased in number.

Because of concerns about the perceived decline in the fishery of Kangaroo Lake since the 1995 survey, a comprehensive fish survey was conducted in 2004 to evaluate the fishery of the lake (Hogler 2005). A total of 10,120 fish were collected during the survey with yellow perch the most abundant fish captured during the survey. The most common gamefish were walleye, followed by smallmouth and largemouth bass.

Walleye were the most abundant gamefish captured during the 2004 survey (Hogler 2005). Although walleye have been the most abundant gamefish captured in surveys since 1980, their abundance has been declining since 1983. As was the case in 1995, a large percentage of captured walleye were juvenile fish. It appears that reproduction is good, indicating recruitment into the population. The presence of very old walleye (greater than 20 years of age) shows that walleye are able to survive in the lake although low adult abundance suggests that total annual mortality (natural and angler) is probably high.

The trend in the smallmouth bass population was not as clear. Fyke net and electrofishing data suggest that the smallmouth bass population is increasing in number, but the results were not consistent across all surveys. Panfish populations continue to grow in Kangaroo Lake, with yellow perch dominating the panfish community. Bluegill increased in abundance in the time between the last two surveys, while rock bass numbers declined.

Fish populations in Kangaroo Lake appear to be in a state of change after more than 20 years of stability. Walleye abundance was down, while bass and panfish abundances were increasing. It is not clear if the increasing number of smallmouth bass and panfish were linked to the decline in walleye abundance or

to environmental conditions in the lake that have begun to shift toward a condition that again will favor a bass-bluegill fish community in Kangaroo Lake.

A comprehensive fish survey was conducted in 2008 on Kangaroo Lake to evaluate the fishery of the lake as part of baseline lake monitoring.

METHODS

Spring Fyke Netting

A standard comprehensive fisheries survey on Kangaroo Lake began in April 2008 and continued through October. Eight fyke nets were set shortly after ice-out on April 14, fished until April 22 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 or a dorsal spine removed from a sub-sample for age determination.

Spring Electrofishing I

Shortly after the completion of fyke netting, on the night of April 30, three 2 mile shoreline segments of Kangaroo Lake were electroshocked to look for marked fish (Figure 3). All gamefish and panfish fish were netted, identified, examined for marks, and measured. Other species were identified and counted.

Spring Electrofishing II

On the nights of May 7 and June 3 the same three 2 mile shoreline segments were electroshocked to estimate adult bass and panfish relative abundance (Figure 3). All gamefish and panfish were netted, identified, checked for marks and measured. Other species were identified and counted.

Fall Electroshocking

On the night of October 16, the three shoreline sections were electroshocked to determine the abundance young-of-year (yoy) fish and to assess the general population of fish (Figure 3). All fish were netted, identified, and counted. Gamefish and panfish were also measured.

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.

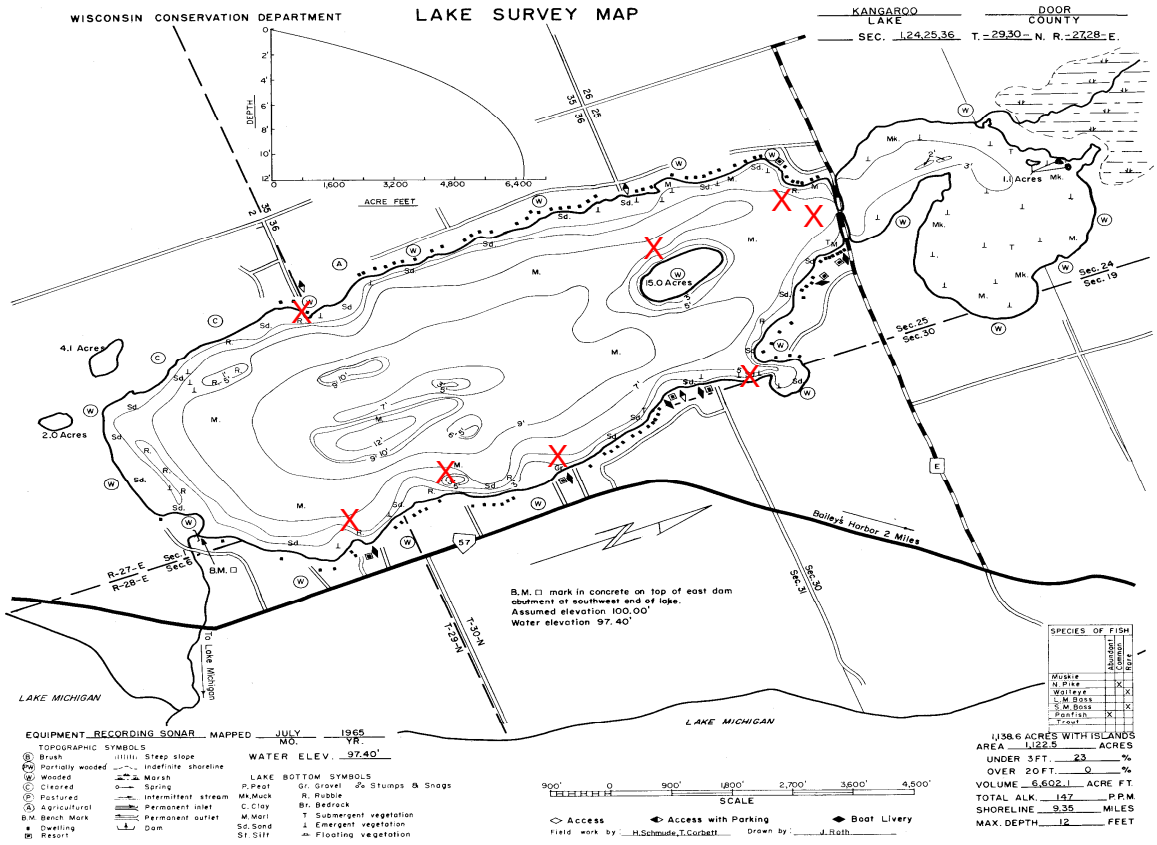

Figure 2. The locations of the eight fyke nets that were fished in Kangaroo Lake from April 14 through April 22, 2008 are marked by an X on the lake map.

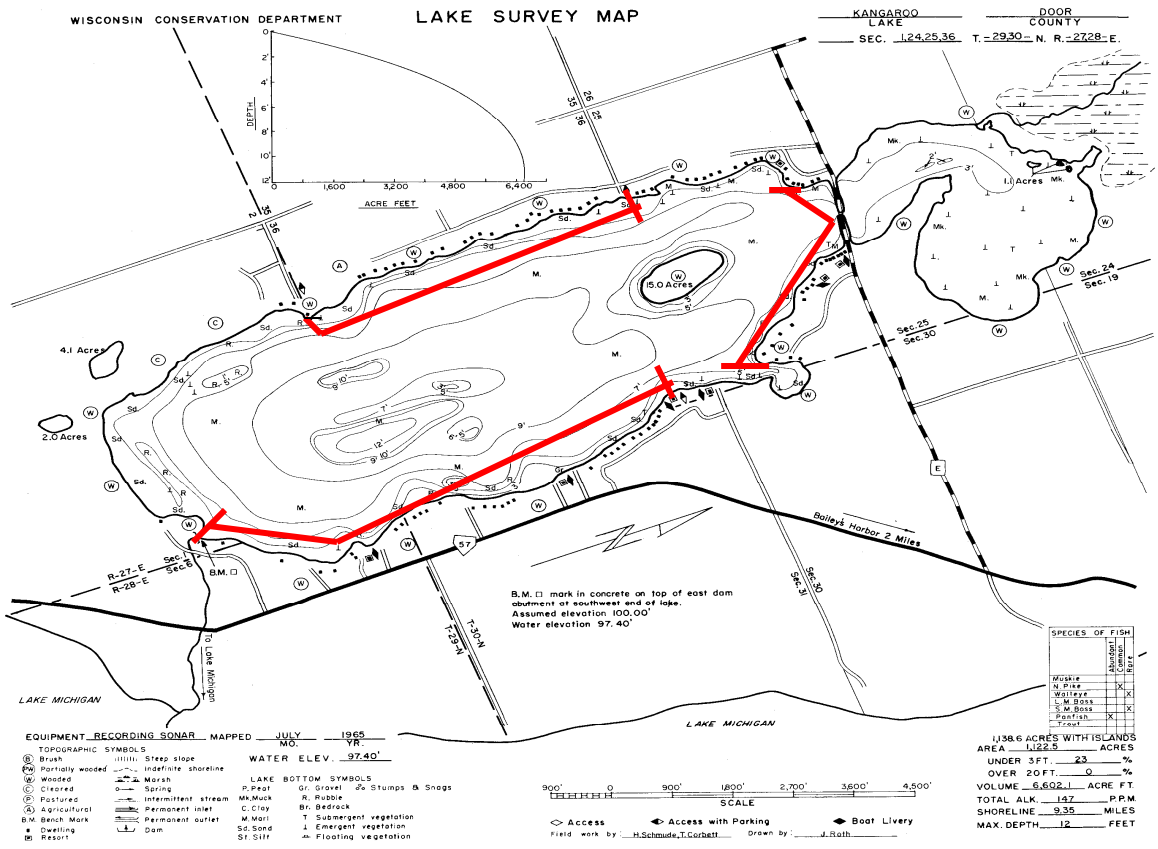

Figure 3. Location of the three electrofishing transects that were shocked on Kangaroo Lake during all electrofishing surveys during 2008.

RESULTS

Spring Fyke Netting

Eight fyke nets were set on April 14 and fished until April 22 with a total effort of 64 net-nights. During this period we captured 4,676 individual fish that represented fifteen species with a total catch per effort (CPE) of 73.06 fish per net per night (Table 1). Yellow perch, bluegill and longnose sucker dominated the catch with fewer individuals of other species captured. The most commonly captured gamefish were walleye, northern pike and smallmouth bass.

Table 1. Species captured from Kangaroo Lake with fyke nets during spring 2008. The Schnabel Estimates are based on recaptures during fyke netting and the Peterson Estimates are based on recaptures caught during electrofishing on April 30.

Species	Number Captured	Number Recaptured	CPE (#/ net-night)	Population Estimate Range (Schnabel)	Population Estimate Range (Peterson)
Gar sp.	7		0.11		
Bowfin	110		1.72		
Rainbow Trout	4	2	0.06		
Northern Pike	55	4	0.86	111-192	27-1,530
Carp	1		0.02		
Longnose Sucker	858		13.41		
White Sucker	286		4.45		
Bullhead sp.	63		0.98		
Rock Bass	392	51	6.13	876-1,560	453-3,313
Pumpkinseed	65	6	1.02	150-893	
Bluegill	1,196	51	18.69	8,716-15,525	4,554-66,792
Smallmouth Bass	36		0.56		
Largemouth Bass	28		0.59		
Yellow Perch	1,297	4	20.27	36,400-364,005	
Walleye	278	56	4.34	377-640	261-604
Total	**4,676**	**174**	**73.06**		

Gamefish

Walleye

Walleye were the most commonly captured gamefish during fyke netting (Table 1). The 278 walleye ranged in length from 222 mm to 670 mm and had an average length of 447 mm (Table 2).

Using mark and recapture during spring surveys and the Schnabel technique to estimate population size, the walleye population in Kangaroo Lake is likely between 377 and 640 individual walleye or 0.34 to 0.57 walleye per surface acre (Table 2). However, because we recaptured a large number of males during the survey and few female walleye, it is likely we missed peak spawning resulting in a population estimate that underestimates the true population size of walleye in the lake.

Table 2. Combined length frequency and age distribution for all sexes of walleye captured and aged on Kangaroo Lake with fyke nets, April 2008.

Walleye	Age										
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10+
200											
210											
220	3	3									
230	3	3									
240	7	7									
250	4	4									
260											
270											
280											
290											
300											
310											
320											
330											
340	2		2								
350											
360	13		13								
370	27		27								
380	34		34								
390	6		6								
400	1		1								
410											
420	1		1								
430	1			1							
440											
450	6			6							
460	3			2	1						
470	4			3	1						
480	6			4	2						
490	7			4	3						
500	19			15	4						
510	18				3	9	4	2			
520	11					2	5	4			
530	12				1	2	4	5			
540	5					2		2	1		
550	11					8	1		2		
560	5					3	2				
570	3						3				
580	1									1	
590	1								1		
600	1										1
610											
620	3									2	1
630											
640	1										1
650											
660	1										1
670	1										1
Total	221	17	84	35	15	26	19	13	4	3	5
Ave. Length	447	237	374	481	495	533	533	525	558	607	638
S.D.	96.24	10.5	11.5	21.3	17.7	19.7	22.2	4.7	22.2	25.1	28.6

Age was determined for walleye using either a scale for fish less than 275 mm in length or a dorsal spine for walleye greater than 275 mm in length. With the entire age sample combined (all sexes), captured walleye from this survey ranged from age 1 through age 11 (Table 2). Age 2 walleye were the most

common age in our sample followed by age 3. Age 2 walleye averaged 374 mm in length.

Captured male and unknown sex walleye from this survey ranged in age from age 1 through age 10 (Table 3). All walleye less than 350 mm (age 1) were of unknown sex.

Age 1, unknown sex walleye averaged 237 mm in length (Table 3). Age 2 was the dominant male walleye age class. Other male age classes were substantially less abundant (Table 3). Age 2 male walleye averaged 474 mm in length.

Female walleye ranged in age from age 2 through age 10+ (Table 4). Age 5 was the most common female age in the sample followed by age 6 walleye. Females of other year classes were much less abundant. Age 5 female walleye averaged 544 mm in length.

Growth of walleye in Kangaroo Lake when compared to statewide age at length tables, appears to be above state rates at all ages (Table 5). Transition from using scales to age walleye to spines may account for large differences in growth observed between the 2004 and 2008 surveys.

Northern Pike

The 55 northern pike that were captured during fyke netting ranged in length from 302 mm to 858 mm and had an average length of 560 mm (Table 6). Using the Schnabel method to estimate population number, it was estimated that between 111 and 192 northern pike were in the lake at the time of the survey (Table 1). This estimate should be viewed with caution because a substantial portion of the northern pike population may have been in the north basin and not vulnerable to our sampling gear.

Ages were obtained from scales. Ages 2 through 9 were identified in the collected sample (Table 6). Age 4 northern pike were the most abundant followed by age 3 pike. Age 4 northern pike had an average length of 564 mm. Very few northern pike older than age 6 were captured.

Growth of northern pike in Kangaroo Lake when compared to statewide age at length tables, appears to be normal or just slightly greater than state rates (Table 5).

Table 3. Combined length frequency and age distribution for male and unknown sex walleye captured on Kangaroo Lake with fyke nets, April 2008.

Walleye	Age										
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
200											
210											
220	3	3									
230	3	3									
240	7	7									
250	4	4									
260											
270											
280											
290											
300											
310											
320											
330											
340	2		2								
350											
360	13		13								
370	27		27								
380	33		33								
390	6		6								
400	1		1								
410											
420	1		1								
430	1			1							
440											
450	4			4							
460	3			2	1						
470	4			3	1						
480	6			4	2						
490	4			4							
500	16				12	4					
510	13					7	4	2			
520	11					2	5	4			
530	8						3	5			
540	3							2	1		
550	2								2		
560											
570											
580	1									1	
590											
600	1										1
Total	177	17	83	18	16	13	12	13	3	1	1
Ave. Length	418	237	374	469	493	509	519	525	547	580	600
S.D.	88.1	10.5	11.5	17.8	13.1	6.9	7.9	9.7	5.8	--	--

Table 4. Combined length frequency and age distribution for female walleye captured on Kangaroo Lake with fyke nets, April 2008.

Walleye	Age										
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10+
350											
360											
370											
380	1		1								
390											
400											
410											
420											
430											
440											
450	2			2							
460											
470											
480											
490	3				3						
500	3				3						
510	5				3	2					
520											
530	4				1	2	1				
540	2					2					
550	9					8	1				
560	5					3	2				
570	3						3				
580											
590	1								1		
600											
610											
620	3									2	1
630											
640	1										1
650											
660	1										1
670	1										1
Total	44	0	1	2	10	17	7	0	1	2	4
Ave. Length	543		380	450	503	544	559		590	620	648
S.D.	54.4		--	--	12.5	15.4	14.6		--	--	22.2

Table 5. Average length at age as determined by spines or scales for fish captured on Kangaroo Lake in 2004 and 2008 compared to statewide averages.

Species	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10+
Northern pike										
2008	--	347	496	564	630	692	776	845	825	--
2004	--	330	370	483	675	770	--	--	910	1007
(State Average)	(356)	(406)	(470)	(546)	(610)	(650)	(706)	(762)	(787)	--
Rock Bass										
2008	--	--	134	175	224	230	246	254	260	275
2004	--	--	--	--	--	--	--	--	--	--
(State Average)	(53)	(91)	(127)	(155)	(178)	(196)	(211)	(226)	(239)	(249)
Bluegill										
2008	--	115	144	185	200	218	229	232	256	270
2004	--	105	130	179	184	--	--	--	--	--
(State Average)	(64)	(97)	(122)	(147)	(167)	(183)	(196)	--	--	--
Smallmouth Bass										
2008	--	205	321	370	396	419	432	475	--	--
2004	--	178	235	373	418	423	480	450	--	--
(State Average)	(97)	(168)	(236)	(292)	(343)	(381)	(432)	(457)	(472)	--
Largemouth Bass										
2008	--	216	320	361	--	482	472	--	--	--
2004	--	--	--	--	--	--	--	--	--	--
(State Average)	(97)	(165)	(229)	(290)	(338)	(384)	(414)	(447)	(470)	(485)
Yellow Perch										
2008	110	143	171	192	224	225	270	--	--	--
2004	--	--	--	--	--	--	--	--	--	--
(State Average)	(74)	(119)	(152)	(180)	(208)	(226)	(241)	--	--	--
Walleye										
2008	237	374	481	495	533	533	525	558	607	638
2004	210	233	373	411	477	499	525	533	555	562
(State Average)	(152)	(254)	(324)	(381)	(432)	(457)	(497)	(526)	(551)	--

Table 6. Northern pike length frequency and age distribution of fish captured with fyke nets and aged during spring 2008 netting on Kangaroo Lake.

NP		Age									
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
300	1		1								
310											
320	1		1								
330	1		1								
340	3		3								
350											
360											
370	2		2								
380	1		1								
390											
400											
410											
420											
430											
440											
450	1			1							
460	1			1							
470											
480	2			2							
490	1			1							
500	1			1							
510	4			3	1						
520											
530	4			1	3						
540											
550											
560	5				4	1					
570	2				2						
580	3				3						
590	2				1						
600											
610											
620											
630	3					3					
640	1					1					
650											
660											
670	3					1	2				
680	1						1				
690	1						1				
700	1						1				
710	1						1				
720											
730											
740	1							1			
750											
760											
770											
780											
790											
800	1							1			
810											
820	1									1	
830	1								1		
840											
850	1								1		
Total	51		9	10	14	6	6	2	2	1	
Ave. Length	560		347	496	564	630	692	776	845	825	
S.D.	137.1		26.21	25.78	25.62	37.19	15.3	47.38	19.09	--	

Smallmouth and Largemouth Bass

A total of 36 smallmouth bass were captured by fyke net during this survey (Table 1). These bass ranged in length from 175 mm to 473 mm and had an average length of 359 mm (Table 7). Because we did not recapture any smallmouth bass, a Schnabel Population Estimate could not be made.

Age estimates were made with the use of scales. Ages 2 through 8 were present in the aged sample. Age 7 and age 2 fish were the most common although other ages were also commonly represented in the sample (Table 7). Age 7 smallmouth bass averaged 432 mm in length.

When age at length data from this survey was compared to statewide average age at length data, it appears that smallmouth bass in Kangaroo Lake are growing better (longer at age) than smallmouth bass from other populations across Wisconsin (Table 5).

Table 7. Smallmouth bass length frequency and age distribution of fish captured with fyke nets during spring 2008 netting on Kangaroo Lake.

SMB		Age									
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
150											
160											
170	2		2								
180											
190	1		1								
200	1		1								
210	2		2								
220	1		1								
230	1		1								
240											
250											
260											
270											
280											
290	1			1							
300											
310											
320											
330	2			2							
340	1				1						
350											
360	1				1						
370	1				1						
380	1					1					
390	3				1	2					
400	3					1	2				
410	3					1	1	1			
420	5						2	3			
430	4						1	3			
440	1							1			
450											
460	1							1			
470	1								1		
Total	36		8	3	4	5	6	9	1		
Ave. Length	359		205	321	370	396	419	432	475		
S.D.	91.55		23	21.94	20.63	11.23	10.88	15.08	--		

The 28 largemouth bass captured during fyke netting ranged in length from 204 mm to 482 mm and had an average length of 325 mm (Tables 1 and 8). Similar to smallmouth bass we could not calculate a Schnabel Population Estimate for largemouth bass because of a lack of recaptured fish.

Ages 2 through 4, 6 and 7 were represented in the scale samples that were collected from largemouth bass during spring fyke netting in Kangaroo Lake (Table 8). Age 3 largemouth bass were the most common age class in the sample and few bass greater than age 4 were encountered.

When largemouth bass growth is compared to statewide growth tables it appears that bass in Kangaroo Lake are growing faster than bass in other Wisconsin lakes (Table 5).

Table 8. Largemouth bass length frequency and age distribution of fish captured with fyke nets during spring 2008 netting on Kangaroo Lake.

LMB	Age										
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
200	1		1								
210	2		2								
220	1		1								
230											
240											
250											
260											
270											
280	1			1							
290	2			2							
300	2			2							
310	2			2							
320	6			5	1						
330	1			1							
340	3			2	1						
350	1			1							
360	2				2						
370											
380	2				2						
390											
400											
410											
420											
430											
440											
450											
460											
470	1							1			
480	1						1				
490											
500											
Total	28		4	16	6		1	1			
Ave. Length	325		216	320	361		482	472			
S.D.	64.09		10.11	19.49	22.68		--	--			

Panfish

Yellow Perch

With 1,297 handled, yellow perch were the most abundant fish captured during fyke netting (Table 1). The 667 perch that we measured ranged in length from 140 mm to 252 mm and had an average length of 185 mm (Table 9). The yellow perch population using the Schnabel Method was estimated to range from 36,400 to 364,005 individuals, but should be viewed cautiously because it is likely that we did not mark enough perch or recapture enough to make an accurate estimate (Table 1).

Age estimates were made with the use of scales. Ages 1 through 7 were present in the aged sample with age 3, followed by age 4 the most common age perch (Table 9). Age 3 yellow perch averaged 171 mm in length.

When age at length data from this survey was compared to statewide average age at length data, it appears that yellow perch in Kangaroo Lake are growing better (longer at age) than yellow perch from other populations across Wisconsin (Table 5).

Table 9. Yellow perch length frequency and age distribution of fish captured with fyke nets and measured during spring 2008 netting on Kangaroo Lake.

Yellow Perch Length (mm)	Number	Age									
		1	2	3	4	5	6	7	8	9	10
50											
60											
70											
80											
90											
100											
110	3	3									
120											
130											
140	14		11	3							
150	42		4	38							
160	78			78							
170	103			72	31						
180	160			135	25						
190	123			37	86						
200	84				84						
210	31				27	4					
220	16					11	5				
230	8					8					
240	3					3					
250	1						1				
260											
270	1							1			
280											
290											
300											
Total	667	3	15	363	253	26	6	1			
Ave. Length	185	110	143	171	192	224	225	270			
S.D.	19.46	--	4.58	12.15	11.46	8.98	12.25	--			

Bluegill

During fyke netting we captured 1,196 bluegill (Table 1). The 800 measured bluegill ranged in length from 99 mm to 270 mm and had an average length of 164 mm (Table 10). Based on fyke net data, it was estimated that the population of bluegill in Kangaroo Lake ranged between 8,716 and 15,526 individuals (Table 1).

Age for bluegill was estimated using scales from a portion of the bluegill measured during netting. Ages 2 through 10 were found in our sample, with age 3 bluegill the most common age class (Table 10). Following age 6, bluegill age class abundance dropped rapidly.

When bluegill length at age for Kangaroo Lake were compared to state averages, bluegill in Kangaroo Lake were consistently larger than an average bluegill across the state at all ages (Table 5).

Table 10. Bluegill length frequency and age distribution of fish captured with fyke nets and measured during spring 2008 netting on Kangaroo Lake.

Bluegill		Age									
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
50											
60											
70											
80											
90	2		2								
100	18		18								
110	72		72								
120	84		25	59							
130	69		35	34							
140	76			76							
150	67			67							
160	73			58	15						
170	52			31	21						
180	73				66	7					
190	53				42	11					
200	56				34	17	5				
210	41				15	5	21				
220	27					9	12	6			
230	25						14	7	4		
240	8						4	3	1		
250	3							1		2	
260											
270	1										1
280											
290											
300											
Total	800		152	325	195	49	56	17	5	2	1
Ave. Length	164		115	144	185	200	218	229	232	350	270
S.D.	36.57		10.16	15.72	13.27	12.9	11.25	8.99	4.47	--	--

Rock Bass

The 392 (279 measured) rock bass captured during fyke netting ranged in length from 96 mm to 285 mm and had an average length of 205 mm (Tables 1 and 11). The Schnabel Population Estimate ranged from 876-1,560, but should be viewed cautiously. The large number of multiple recaptures we saw around some nets likely caused us to underestimate the total number of rock bass in the lake.

Rock bass were aged using scales collected from a representative sub-sample of our fyke net catch. Within the aged sub-sample, ages 3 through 10 were noted with ages 3 and 5 the most common although ages 4 and 6 were also well represented (Table 11). After Age 7, the frequency of older year classes dropped rapidly.

Similar to yellow perch and bluegill, length at all ages for rock bass in Kangaroo Lake were longer than an average rock bass from across the state (Table 5).

Table 11. Rock bass length frequency and age distribution of fish captured with fyke nets and measured during spring 2008 netting on Kangaroo Lake.

Rock Bass		Age									
Length (mm)	Number	1	2	3	4	5	6	7	8	9	10
50											
60											
70											
80											
90	3			3							
100	1			1							
110	3			3							
120	7			7							
130	15			15							
140	23			21	2						
150	20			18	2						
160	10				10						
170	5				5						
180	11				11						
190	7				7						
200	7				5	2					
210	16					16					
220	33					17	16				
230	40					22	18				
240	36					12	12	12			
250	31						3	5	3		
260	7							4	2	1	
270	2										2
280	2										2
290											
300											
Total	279			68	42	69	49	21	5	1	4
Ave. Length	205			134	175	224	230	246	254	260	275
S.D.	45.51			15.29	16.42	11.13	9.12	8.05	5.48	--	5.77

During fyke netting we also captured 65 pumpkinseed sunfish (Table 1). These sunfish ranged in length from 103 mm to 238 mm and had an average length of

158 mm. Their population was estimated to range between 150 to 893 individuals.

Other Species

In addition to the species already discussed, we captured a number of other species during fyke netting (Table 1). These species included in decreasing abundance, longnose sucker, white sucker, bowfin, bullhead, gar, rainbow trout and carp. It is likely that some of these species, chiefly the suckers and the rainbow trout migrated up Heins Creek from Lake Michigan.

Spring Electrofishing I

On the night of April 30 we shocked the 3 designated shoreline segments (Figure 3) over the course of 98 minutes to look for fish marked during fyke netting. During shocking we captured 179 fish of thirteen species with a CPE of 29.83 fish per mile (Table 12). Bluegill, white sucker and smallmouth bass were the most abundant species captured with lower numbers of other species collected (Table 13).

Table 12. Species captured from Kangaroo Lake by electroshocking during the spring and early summer of 2008.

Species	30-Apr	07-May	03-Jun	**Total Number**	**Total CPE (#/mile)**
Longnose Gar		4		**4**	**0.22**
Bowfin	1	1	3	**5**	**0.28**
Steelhead	2			**2**	**0.11**
Northern Pike	3	1	1	**5**	**0.28**
Carp	5	1		**6**	**0.33**
Longnose Sucker	4			**4**	**0.22**
White Sucker	31	49	11	**91**	**5.06**
Brown Bullhead		2		**2**	**0.11**
Rock Bass	19	34	41	**94**	**5.22**
Pumpkinseed	3			**3**	**0.17**
Bluegill	35	12	17	**64**	**3.56**
Smallmouth Bass	23	63	17	**103**	**5.72**
Largemouth Bass	2	5	2	**9**	**0.50**
Yellow Perch	4		2	**6**	**0.33**
Walleye	47	18	2	**67**	**3.72**
Total	**179**	**190**	**96**	**465**	**25.83**
CPE (#/mile)	**29.83**	**31.67**	**16.00**		

We captured marked walleye, rock bass, northern pike and bluegill enabling us to calculate Peterson Population Estimates and ranges for these species (Table 1). For walleye, the Schnabel and Peterson methodologies produced similar ranges, however for the other species the Peterson PE range was larger than the Schnabel range. The differences in the estimated ranges are most likely due to the lower number of recaptures used to calculate the Peterson Estimate and range.

Table 13. The length frequency of fish captured during electrofishing on April 30, 2008 on Kangaroo Lake.

Length (mm)	Rock Bass	Pumpkin-seed	Bluegill	Smallmouth Bass	Largemouth Bass	Yellow Perch	Walleye
100			2				
110			2				
120	1		7	1			
130	1		6			1	
140	1	2	5	1			
150	1		4	4			
160	1	1	5	3			
170	2			3		1	
180			1	2			
190	1		2	2		2	
200	1			4			
210	1				1		
220	1						
230	3		1				1
240	4						3
250	1						1
260							
270							
280							
290							
300							
310							
320							
330				1	1		
340							
350							
360							
370				1			1
380				1			1
390							
400							1
410							
420							
430							
440							
450							
460							1
470							3
480							1
490							2
500							5
510							4
520							6
530							8
540							1
550							2
560							1
570							1
580							1
590							1
600							2
Total	19	3	35	23	2	4	47
Ave. Length	202	150	145	199	275	173	488
S.D.	42.68	10.02	27.96	69.79	86.97	30.24	96.55

Spring Electrofishing II

On the nights of May 7 and June 3 we electroshocked the 3 designated shoreline segments to characterize bass and panfish populations of Kangaroo Lake (Figure 3). On May 7 we shocked 97 minutes targeting bass, although we did net all fish encountered. During shocking we captured 190 fish for a CPE of 31.67 fish per mile (Table 12). Smallmouth bass were the most abundant fish captured followed by white sucker and rock bass (Table 12).

Gamefish

Smallmouth and Largemouth Bass

The 63 smallmouth bass captured during shocking ranged in length from 114 mm to 433 mm and averaged 240 mm in length (Table 14). Scales were collected from each captured bass for age determination. Scale analysis indicated that age 1+ through age 7+ were in the collected scale samples (Table 15). Age 2+ was the dominant year class for captured smallmouth bass. Other year classes were substantially lower in abundance.

We captured 5 largemouth bass during shocking (Table 14). They ranged in length from 313 mm to 433 mm and had an average length of 359. Age classes 3+, 4+ and 5+ were present based on ages determined by scales (Table 16). Most largemouth bass were age 3+ and these bass had an average length of 320 mm.

Walleye and Northern Pike

Although targeting bass, we captured 18 walleye during shocking on May 7 (Table 14). They ranged in length from 245 mm to 553 mm and had an average length of 471 mm. The single northern pike captured was 596 mm in length.

Panfish

During shocking we captured 34 rock bass that ranged in length from 138 mm to 235 mm with an average length of 206 mm (Table 14). Rock bass CPE was 5.67 fish per mile. The 12 bluegill captured had an average length of 153 mm.

Table 14. The length frequency of fish captured during electrofishing on May 7, 2008 on Kangaroo Lake.

Length (mm)	Rock Bass	Bluegill	Smallmouth Bass	Largemouth Bass	Walleye
100		1			
110		3	1		
120		3			
130	2		1		
140	3				
150	6		5		
160		1	11		
170			8		
180	1		6		
190	2		6		
200	1	2	4		
210	1		3		
220	1	2			
230	7		1		
240	8		1		2
250					
260	1				
270					
280	1				
290					
300					
310				1	
320				1	
330				1	
340			1		
350					
360			3		1
370					
380					1
390			1	1	
400			1		
410			2		
420			2		
430			1	1	
440			2		
450			1		
460			1		1
470					
480					
490					2
500					1
510			1		2
520					3
530					3
540					1
550					1
Total	34	12	63	5	18
Ave. Length	206	153	240	359	471
S.D.	44.50	47.07	108.01	51.58	96.25

Table 15. Smallmouth bass length frequency and age distribution of fish captured during electrofishing on Kangaroo Lake during the May 7, 2008 survey.

Length	Smallmouth	Age								
(mm)	Bass	1+	2+	3+	4+	5+	6+	7+	8+	9+
100										
110	1	1								
120										
130	1	1								
140										
150	5		5							
160	11		11							
170	8		8							
180	6		6							
190	6		6							
200	4		4							
210	3		3							
220										
230	1		1							
240	1		1							
250										
260										
270										
280										
290										
300										
310										
320										
330										
340	1				1					
350										
360	3				2	1				
370										
380										
390	1				1					
400	1					1				
410	2						2			
420	2						2			
430	1							1		
440	2						2			
450	1						1			
460	1						1			
470										
480										
490										
500										
510	1									
520										
Total	63	2	45	0	4	2	8	1	0	0
Ave. Length	240	120	178		363	380	431	430		
S.D.	108.0	14.1	21.5		20.6	28.3	18.9	--		

Table 16. Largemouth bass length frequency and age distribution of fish captured during electrofishing on Kangaroo Lake during the May 7, 2008 survey.

Length (mm)	Largemouth Bass	Age			
		2+	3+	4+	5+
300					
310	1		1		
320	1		1		
330	1		1		
340					
350					
360					
370					
380					
390	1			1	
400					
410					
420					
430	1				1
440					
450					
Total	5	0	3	1	1
Ave. Length	359		320	390	430
S.D.	51.6		70.0	--	--

On June 3 we shocked 85 minutes and captured 96 fish for a CPE of 16.0 fish per mile (Table 12). Rock bass dominated the catch with fewer bluegill, smallmouth bass and other species captured.

The 41 rock bass averaged 168 mm in length and the bluegill averaged 153 mm in length (Table 17). The average lengths of smallmouth bass, largemouth bass, yellow perch and walleye were 222 mm, 348 mm, 193 mm and 380 mm respectively.

Table 17. The length frequency of fish captured during electrofishing on June 3, 2008 on Kangaroo Lake.

Length (mm)	Rock Bass	Bluegill	Smallmouth Bass	Largemouth Bass	Yellow Perch	Walleye
90	2					
100						
110	1					
120	1	7				
130	7	4				
140	11					
150	2					
160	2	2	2			
170	3		1			
180	2	1	5		1	
190			1		1	
200		1	2			
210			1			
220	2		2			
230	2	1				
240	5	1	1			
250	1					
260						
270						
280						
290						
300						
310				1		
320						
330						
340						
350						
360						
370						1
380				1		1
390			1			
400						
410						
420			1			
430						
440						
450						
Total	41	17	17	2	2	2
Ave. Length	168	153	222	348	193	380
S.D.	45.68	39.97	76.06	53.74	4.95	12.02

Fall Electroshocking

On the night of October 16 we shocked the 3 shoreline segments (Figure 3) to assess the abundance of yoy walleye and to characterize the fish population of the lake. During the 122 minutes of shocking we captured 174 fish of 10 species (Table 18). Total CPE was 29.0 fish per mile or 85.7 fish per hour. Walleye and smallmouth bass dominated the catch with fewer fish of other species captured.

Table 18. Species captured from Kangaroo Lake by electroshocking on the night of October 16, 2008.

Species	Number	CPE (#/mile)
Bowfin	2	0.33
Northern Pike	3	0.50
White Sucker	7	1.17
Rock Bass	20	3.33
Green Sunfish	2	0.33
Bluegill	5	0.83
Smallmouth Bass	63	10.50
Largemouth Bass	3	0.50
Yellow Perch	14	2.33
Walleye	55	9.17
Total	**174**	
CPE (#/mile)	**29.00**	

Gamefish

Smallmouth and Largemouth Bass

The 63 smallmouth bass captured during electrofishing ranged in length from 78 mm to 472 mm and had an average length of 196 mm (Table 19). Based on the length frequency it is likely that bass less than 120 mm in length were yoy smallmouth bass indicating successful reproduction in 2008.

Three largemouth bass were handled and they had an average length of 291 mm (Table 19).

Walleye

During electroshocking we captured 55 walleye (Table 18). The captured walleye ranged in length from 154 mm to 547 mm and had an average length of 214 mm (Table 19). Walleye less than 230 mm in length were likely yoy walleye indicating successful reproduction in 2008. Most of the walleye captured, 94.5% (52 of 55) were yoy fish.

Panfish

Rock bass were the most common panfish captured during electrofishing (Table 18). The 20 rock bass ranged in length from 100 mm to 195 mm and had an average length of 167 mm (Table 19). The other panfish captured included yellow perch, bluegill and green sunfish in decreasing abundance. Their average lengths were 162 mm, 184 mm and 144 mm respectively (Table 19).

Table 19. The length frequency of fish captured during electrofishing on October 16, 2008 on Kangaroo Lake.

Length (mm)	Rock Bass	Green Sunfish	Bluegill	Smallmouth Bass	Largemouth Bass	Yellow Perch	Walleye
70				1			
80							
90				3			
100	1			2			
110			1	1		1	
120							
130	3					2	
140	3	2				2	
150	2			3		4	1
160	1			9			
170	1		1	11		1	
180	3			3	1	1	2
190	4			5		2	19
200	1		1	4			23
210			1	1			5
220			1	2			2
230	1			4			
240				3		1	
250				4			
260				2			
270				1			
280				1			1
290							
300							
310				1			
320							
330							
340					2		
350							
360							
370							
380							
390							
400							
410							
420							
430							
440							
450				1			
460							
470				1			
480							
490							
500							
510							
520							
530							
540							2
Total	20	2	5	63	3	14	55
Ave. Length	167	144	184	198	291	162	214
S.D.	31.78	--	43.79	69.33	91.52	33.84	66.40

DISCUSSION

The 2008 comprehensive fisheries survey on Kangaroo Lake characterized the fish populations of the lake with the use of multiple gear types. The use of multiple gears gave a much clearer picture of the status of the fish population of Kangaroo Lake.

A total of 5,315 fish were collected during the surveys. The most abundant fish were yellow perch and bluegill. The most common gamefish were walleye, followed by smallmouth and northern pike.

Gamefish

Walleye were the most abundant gamefish captured during surveys in 2008. Although walleye have been the most abundant gamefish captured in surveys since 1980, their abundance has been declining since 1983 although the decline has stabilized during the past two surveys (Table 20).

The fall survey captured a large number of young of year walleye which were distributed throughout the survey segments (Table 18). It appears that walleye reproduction is good. If lake conditions remain stable, good recruitment and conservative regulations may lead to improved walleye numbers in the future.

Estimated growth (length at age) is above statewide averages but since it is likely there are some discrepancies in age determination when the current survey is compared to past surveys and statewide averages due to changes in ageing structure, growth (length at age) should be viewed cautiously. Since walleye growth in Kangaroo Lake has been at or above statewide averages in recent surveys, it is likely that trend has continued through this survey (Hogler 2005). Additionally, it appears that although walleye have the ability to grow to old age in the lake, low adult abundance suggests that total annual mortality (natural and angler) is probably high. The restrictive bag and size limit now in place should increase the number of large walleye in the lake over time.

Table 20. Summary of fyke net surveys, numbers of fish and fish per net-night (CPE) from Kangaroo Lake 1973-2008. The 1973-2004 data is after Hogler (2005).

Species	1973	1980	1983	1995	2004	2008
Walleye	193 (2.5)	234 (8.7)	1,498 (11.7)	1,297 (8.5)	242 (4..7)	278 (4.3)
Northern Pike	223 (2.9)	14 (0.5)	112 (0.9)	151 (1.0)	38 (0.7)	55 (0.9)
Smallmouth Bass	2 (0.1)	11 (0.4)	7 (0.1)	25 (0.2)	21 (0.4)	36 (0.6)
Largemouth Bass	13 (0.2)		1 (0.0)	9 (0.1)	1 (0.0)	28 (0.6)
Bowfin	10 (0.1)		13 (0.1)	30 (0.2)	37 (0.7)	110 (1.7)
Rock Bass	220 (2.9)	139 (5.2)	112 (0.9)	1,112 (7.3)	33 (0.6)	392 (6.1)
Bluegill	132 (1.7)	4 (0.2)	10 (0.1)	437 (2.9)	377 (7.3)	1,196 (18.7)
Pumpkinseed	8 (0.1)			21 (0.1)	8 (0.2)	65 (1.0)
Yellow Perch	424 (5.6)		2,559 (20.0)	9,619 (62.9)	8,270 (159.0)	1,297 (20.3)
Bullhead sp.			2 (0.0)		24 (0.5)	63 (1.0)
Gar sp.		2 (0.1)		1 (0.0)	1 (0.0)	7 (0.1)
White Sucker	172 (2.3)	145 (5. 4)	501 (3.9)	1,118 (7.3)	213 (4.1)	286 (4.5)
Longnose Sucker		101 (1.5)	1 (0.0)		1 (0.0)	858 (13.4)
Trout	3 (0.0)	4 (0.2)	3 (0.0)	8 (0.1)	3 (0.1)	4 (0.9)
Carp			1 (0.0)			1 (0.0)

The smallmouth population has increased in abundance since 1995 based on fyke net data (CPE) (Table 20). The increasing number of smallmouth bass may be linked to either the decline in walleye abundance since both complete for food resources and adult fish of one species may prey on the young of the other species or to changing lake conditions that favor bass. Young of year bass were captured during fall electrofishing indicating successful reproduction (Table 19). Nearly all the yoy bass were captured when structure such as rocky points were encountered. Growth appears to be good for smallmouth bass (Table 5).

No clear trend is apparent for largemouth bass from fyke net data (Table 20). However, results from other survey gears indicate that largemouth bass are present and producing year classes that maintain their population in Kangaroo Lake (Tables 12 and 18).

Northern pike CPE's have remained steady since 1980 although much lower than seen in 1973 (Table 20). The high pike CPE in 1973 is likely a sampling artifact since nets were set north of the causeway during that survey likely capturing northern pike that were moving towards spawning areas, while since 1980 fyke nets have only been set south of the causeway. Natural reproduction is occurring in Piel Creek as documented by a joint effort of the Lake Association and the Nature Conservancy (Paul Maulberg, personal communication).

Panfish

Panfish populations continue to grow in Kangaroo Lake. Yellow perch continue to dominate the panfish community in the lake. Reduced catch number and declines in CPE noted in this survey from those seen in 2004 are likely due to fyke net placement away from yellow perch spawning sites to reduce net mortality (Table 20).

Bluegill are increasing in abundance and in 2008 had their highest ever measured CPE (Table 20). The increase in abundance (CPE) noted in 2008 was a twofold increase over the 2004 level and continued the trend of increasing abundance noted in surveys since 1983. Growth (length at age) is above statewide averages (Table 5).

Rock bass number increased in 2008 after a decline noted in the 2004 survey (Table 20). CPE in 2008 was similar to results from 1995 survey and was near the historic average CPE.

Other Species

Several other species were captured that are worth noting. White sucker and longnose sucker CPE's increased from 2004 levels and are similar in CPE to those measured in surveys before 1995 (Table 20). The high number of longnose sucker captured during this survey is of concern because it indicates that Lake Michigan fish are easily able to transit the dam on Heins Creek exposing the Kangaroo Lake fish population to the viral hemorrhagic septicemia (VHS) virus. Because we captured longnose sucker and steelhead during our survey, the lake is now on the list of waters considered to be VHS positive.

Bullhead sp. appears to be increasing in number, but limited data make this trend shaky (Table 20). Bowfin have also increased in number since 1973, but likely are not a problem in the lake. The gar sp. population has remained steady since 1973 (Table 20). Carp were captured during most surveys, but in low numbers Tables (1 and 12). It is not known if carp number is high enough to cause damage to existing bulrush stands or to stands that are being rehabilitated.

CONCLUSIONS

Fish populations in Kangaroo Lake appear to be in a state of change. Bass and panfish populations are up while the walleye population is stable although lower than historic highs. Likely the changes are due to a combination of changing lake conditions that favor panfish and bass and angler harvest of walleye. In general, the fish population of Kangaroo Lake appears to be in good condition. However it should be noted that:

- Changes in the diatom community found in the paleolimnetic record of the lake suggest that Kangaroo Lake may be becoming more productive (Garrison 2008). It is not known if the increased productivity will lead to an increase in abundance of the rooted plant or algal communities of the lake in the long term. Increasing productivity may also lead to increased abundances in some fish populations. At this time, when coupled with angler harvest of gamefish, chiefly walleye, it appears that panfish and bass will dominate the fish community of the lake in the short term.

- Garrison's study (2008) also indicated that Kangaroo Lake may be losing its historic rooted plant population. It is clear that since surveys conducted in the 1940's, physical and biological characteristics of the lake have changed. Most of these changes have occurred because the lake (southern basin) has become more developed and has experienced heavier boating use over the past 60 years. Extensive beds of bulrush, pond weed and other plant species are now only present in limited areas south of the causeway. The shoreline in the southern basin has been altered by placement of rock, concrete and sheet piling. It also appears that boating activity (and speed of the boats) has increased since the 1940's. These changes in the southern basin have likely affected fish populations in the lake. Fish species that need vegetation for spawning or spawn near vegetation such as northern pike or black crappie have declined in number as plant communities have declined. Forage minnow abundance, survival of young fish or growth of adult fish could also have been negatively influenced by the lack of vegetation. Finally, because plants provide structure for fish, reduced plant abundance has made it more difficult for anglers to find and catch fish.

- Walleye in Kangaroo Lake continue to be highly desired by anglers. Survey results indicate that walleye numbers in 2008 are similar to those in 2005 although walleye abundance is still less than what it was in the 1980's. Lychwick (1996) suggested that low adult numbers could be attributed to poor spawning years or high angler harvest. He also suggested that as walleye number decreased, panfish numbers have increased. The survey in 2004 (Hogler 2005) found good numbers of juvenile walleye, low adult numbers and increasing panfish populations which was similar to results from the previous survey by Lychwick (1996) . Based on these survey results we suggested a change to the walleye regulation for Kangaroo Lake from 15" minimum size and a daily bag limit of 5 to 18" minimum size and a daily bag of 3. This rule took effect in May 2007 and has not been in place long enough to determine its effectiveness. In 2008 we found good evidence of successful walleye reproduction during fall electrofishing. We also noted good numbers of juvenile walleye during fyke netting. For these reasons stocking walleye at this time is not recommended.

RECOMMENDATIONS

- Continue to monitor the fish population of Kangaroo Lake. During the next several surveys determine if the current walleye regulations have been effective in improving the abundance and size structure of walleye in the lake.

- Encourage the recolonization of aquatic plants by establishing no wake areas or by temporary placement of wave and turbidity barriers to get plants started. Reestablishment of aquatic plants is necessary to have a healthy stable fish community in the lake.

- Encourage shoreline residents to reestablish natural shorelines by removing hard structures that have been placed on the shoreline. This will also help plant communities as well as many other animal populations.

- Monitor the movement and abundance of exotics such eurasian water milfoil, zebra mussels, rusty crayfish and VHS into Kangaroo Lake. If these species get firmly established in the lake, more changes in the fish community are likely.

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