Crooked Lake
T17N, R6W, Sec 22, Clare County
North Branch Tobacco, 2008

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Environment

Crooked Lake is located in southwestern Clare County within the east central Lower Peninsula of Michigan. More specifically, it is in the village of Lake Station, just south of US 10 and approximately seven miles west of Clare (Fig.1). The lake is 264 acres in size with a maximum depth of 73 feet. There is a public access site operated by the Michigan Department of Natural Resources (MDNR) on the northeast shore. Parking is limited to about 15 vehicles and trailers. The boat ramp is concrete and the access site has a vault toilet. The access site is closed from 11:00 pm to 4:00 am, and the site is closed to swimming, wading, and bathing.

The topography of the watershed is flat-to-gently-rolling hills. Soils are classified as sandy and the predominant land use in the area is mixed farm and woodland. The immediate shoreline of the lake is characterized as high-banked with sandy soils. The littoral zone of Crooked Lake drops off steeply and the lake basin is angular like the name suggests. The bottom substrate in the deeper areas is pulpy peat and muck, and the shoals are a mixture of pulpy-peat, sand and marl. The water is brown-colored and generally clear. Crooked Lake outlets via a control structure (built in 1976) to stream that flows to Cranberry Lake at the headwaters of the North Branch of the Chippewa River. There is one small inlet stream at the southwest end of the lake.

Crooked Lake is eutrophic (rich in nutrients and having excessive productivity). Several limnological studies measuring a variety of parameters have been conducted in the past, most recently in 2008. The lake is very productive and has an alkalinity ranging from 115-150 ppm. Limited limnology and habitat surveys were conducted by the MDNR, Fisheries Division during the 2008 survey. Twenty-eight transects were made around the shoreline (a total of 5.25 miles), during which relevant habitat information was recorded. A total of 234 small docks, 55 large docks, and 59 submerged trees were noted. About 46% of the shoreline was armored with rock, steel or concrete. There are 295 residences currently on Crooked Lake. In 1941 there were approximately 95 cottages (MDNR files).

Secchi depth readings measure light penetration or water transparency and were recorded as 16 feet. The lake was stratified at 18 feet at the time of the survey. The temperature ranged from 73 degrees Fahrenheit (F) at the surface to 42 degrees F at the bottom (Table 1). The dissolved oxygen concentration also changed at the thermocline. Below the thermocline, the dissolved oxygen was near 5 ppm and then dropped off rapidly. Below 21 feet, there was inadequate oxygen to support fish. The pH ranged from 8.15 (surface) to 6.7 (near the bottom) and the specific conductivity was 299-318 uS/cm.

Crooked Lake is a very productive system. Previous surveys and file notes document a long history of abundant aquatic vegetation. As a result, lake riparians have applied extensive annual weed treatments since at least 1995 (MDEQ database), including a complete fluridone treatment in 2002. The last aquatic vegetation survey was conducted in 2004 when thirteen submergent plant species were

documented, but no Eurasian milfoil was noted. The most dominant were white-stem pondweed, wild celery, water stargrass, and chara. Diversity and densities of aquatic plants in 2004 "looked good" (Matt Preisser, MDEQ, personal communication).

The lake typically experiences a large amount of pleasure boating and personal watercraft traffic in addition to the boating pressure from anglers. Winter ice fishing is practiced at a fairly low level.

History

According to Fisheries Division files, Crooked Lake was used extensively for logging operations in the early 1900s. Fish were stocked as early as 1938. Bluegill were stocked from 1938 to 1941, smallmouth bass in 1939, and largemouth bass from 1940 to 1942. Fishery management records date back to 1941. Management records indicate that the lake was surveyed in 1941 and several species were present (Table 3). Apparently fish growth rates were perceived to be slow and pan fish overly abundant because the first management recommendation was to reduce the panfish population either biologically or artificially. In 1958 a chemical treatment was applied to reduce the fish population. The lake was subsequently re-stocked to bring the fish populations back into balance and hopefully achieve better growth. Rainbow trout were stocked for one year following the treatment to provide an interim fishery until other species could be re-stocked and provide additional fishing opportunities. Subsequent stockings were made with largemouth bass, northern pike, and bluegill in 1958 and 1959. Two pike marshes were constructed on Crooked Lake in 1959. All pike fingerling production went into the lake and these marshes were operated until 1962 when public interest for the program diminished.

Fish surveys were conducted from 1958-1960 to assess the post treatment fish population. These indicated that the treatment was a success, that the rainbow trout were providing good fishing opportunities, that northern pike were surviving in good numbers, and that the remaining warmwater species were coming back but still present in low numbers. Crooked Lake was seined in 1962 and it was noted that panfish reproduction was heavy and that there was a shortage of larger panfish. Fish growth was close to the state averages. Another follow-up survey was conducted in 1969 with gill nets. This survey indicated the fish species community to be similar to before the thinning treatment, and age-growth data documented slow growth of bluegill, crappie, perch and pike. Age and growth data was also collected in the 1983 fisheries survey, and most fish species once again were found to be slow growing when compared to state averages: bluegill (-1.0 inches); black crappie (- 2.8 inches); yellow perch (-0.9 inches); largemouth bass (- 0.2 inches); and northern pike (-0.9 inches). Additional sample collection via electrofishing indicated that largemouth bass may have been actually growing 1.0 inches above the state average as many additional large fish were collected to increase the sample size to give a clearer picture of the bass growth. The Crooked Lake fish population appeared to have reverted back to similar conditions as pre-treatment. The analysis indicated problems with excessive vegetation, poor panfish fishing, and fair to good bass and pike fishing. Efforts to change the fish population appear to be limited because of the excessive weed growth. Because of this survey, in an effort to control panfish and to provide anglers with opportunities for catching large fish, stocking of northern pike was initiated. Fingerling pike were stocked from 1985 - 1991 (Table 2). A survey was conducted in 1991 to determine the success of the stocking and the effects on the rest of the fish species. This survey found fair to good bass populations and fair populations of larger panfish.

All panfish were still growing below state average. Again the main problem was believed to be excessive aquatic vegetation growth. Past research studies have indicated that northern pike are not good predators of panfish, but rather prefer tubular-shaped soft-rayed forage. This seemed to be verified in Crooked Lake as northern pike growth was also well below state averages even though panfish were abundant and slow-growing therefore, pike stocking was discontinued. Schneider (1981) found that in general, better sport fishing was experienced in deeper clearer, moderately vegetated lakes which had a layer of cool, oxygenated water in the summer. Fishing was also better in lakes with high proportions of largemouth bass and relatively low proportions of bluegill , carp and white sucker. Heavy weed growth inhibits predation and causes over-population of bluegill and other panfish and slower growth.

As previously stated, excessive weed growth has been an issue in Crooked Lake for many years. The Lake Association has been conducting regular weed treatments and an extensive complete weed treatment was conducted using fluridone (Sonar) in 2002.

A pre-treatment survey was conducted in 1995 in advance of the fluridone herbicide treatment. The treatment was not conducted until 2002.. Species composition and age-growth was similar to 1991. The pike were all skinny - like "hammer handles". Rough fish comprised 39% of the survey catch.

Current Status

The most recent survey was conducted in May, 2008 using standard trap nets, standard large mesh fyke nets, experimental gill nets, night-time DC boomshocking, and seining as recommended by the MDNR Fisheries Division's Status and Trends Protocol. Survey locations are identified in Figure 1.

The fish community found in 2008 did not differ significantly from most previous surveys. For a brief period after the chemical treatment, growth of panfish improved and rainbow trout provided an interim fishery. But this soon reverted back to a similar community as before the treatment. In 2008 a total of 1,509 fish weighing 729.3 lbs and representing 15 species were captured (Tables 3 and 4).

The 77 bluegill captured made them one of the most abundant gamefish species collected, representing 5.1% by number in the survey. Only 18% of the bluegill collected were considered to be of acceptable size to anglers (6 inches or above). Bluegill ranged in length from 1 to 7 inches, and averaged 5.0 inches. Growth rates were 0.5 inches below the state average (Table 5). Seven year classes of bluegills were represented in the survey catch.

Black crappie were rather abundant in the survey catch with 48 captured representing 3.2 % of the catch by number. These fish ranged from 6 to 11 inches and averaged 8.3 inches. Over 58% of those collected were considered as acceptable size for anglers (7 inches or larger). Five year classes were present (Table 5). No smaller black crappies were captured in the survey. Growth rates averaged 0.5 inches above state average, a dramatic improvement from the past surveys.

Seventy-six pumpkinseed sunfish were also collected representing 5% of the total catch by number (Table 4). They ranged from 2 to 8 inches and averaged 5.8 inches. Fifty-three percent of the sunfish collected were of acceptable size for anglers (6 inches or larger). Surprisingly, pumpkinseed sunfish are now growing 0.3 inches above state average.

Fifty-five rock bass were captured, accounting for 3.6% of the total catch by number (Table 4). They averaged 7.5 inches in length and ranged from 2 to 10 inches. Eighty percent were of acceptable size to anglers (6 inches or larger). As in the past, rock bass are growing 1.2 inches above state average. Rock bass were represented by 7 year classes.

Yellow perch were the most abundant gamefish species and most were collected using electrofishing. Yellow perch represented 52.6% of the total catch by number with 793 collected (Table 4). They ranged from 2 to 8 inches in length and averaged 3.1 inches. Most of these were ages I through III (Table 5). Four age groups were present in the survey catch. Yellow perch were growing 1.1 inches below state average.

A total of 91 largemouth bass ranging from 5 to 18 inches and averaging 14.0 inches were collected (Table 4). Fifty-two percent were of legal size (14 inches) or larger. There were ten year classes collected, and growth rates were 0.4 inches below state average (Table 5).

Thirty-nine northern pike were captured. Only 8 percent of the pike were over the legal size limit (24 inches), and growth rates were 2.9 inches below the state average (Table 5). Six year classes were present. Past surveys have continuously documented slow growth of pike in Crooked Lake.

Rough fish did not make up as high a percentage of the total catch as in the past. Brown bullhead (233) still represented 15.4% of the total survey catch by number. Forty-one bowfin were captured. Eight common carp and 32 yellow bullhead were also captured. All bullhead were of catchable size. Collectively, the bullheads and bowfin provide excellent predatory control and may be fun for anglers to catch. Bullheads are also excellent table fare. Collectively, bowfin and carp made up 3.2% of the catch by number and 29.3% of the catch by weight.

Analysis and Discussion

In mid- Michigan warmwater lakes, bluegill are typically one of the most abundant fish species present and play a key role in community structure and overall sportfishing quality (Schneider 1981). Schneider (1990) suggests indices of bluegill characteristics can be used to classify populations. The "Schneider Index" uses size scores of length frequency and growth data and relates them to an objective ranking system ranging from "very poor" to "superior". Using this index, Crooked Lake scored 4.25 for a "Satisfactory" rank (Table 6). Bluegill size structure was considered poor in 1995, and satisfactory in 1998. Sample sizes were very low in 1998, and fyke net data was used in 1995. Fyke nets (small mesh) tend to catch more small fish, so the 1995 index is biased toward small fish. Sample sizes in the 2008 Crooked Lake fish survey are somewhat small when compared with the large numbers of bluegill caught in typical southern Michigan lake surveys.

Typically, bluegill populations with poor size structure are the result of an over-abundance of young fish which exhibit poor growth due to competition, an absence of adult fish due to high mortality, and an imbalanced predator-prey ratio. Crooked Lake's bluegill population and size structure remains in the middle of the rankings and really has been remarkably unchanged over the years. Growth has been consistently slow. Most of this is probably due to the excessive macrophyte growth and the ineffectiveness of predators in controlling prey populations in such habitats. This causes over population and poor growth can result.

Black crappie have historically been an important component of the sport fishery in Crooked Lake. They have typically been more abundant than what was recorded in the 2008 assessment. This may perhaps be due to timing or water temperatures during the survey. Size structure and average length have remained fairly consistent over the years. Black crappie growth has improved to above state average for the first time. Perhaps fish are responding to recent weed treatments.

As in the past, northern pike are small and slow growing. Very few reach sufficient size to be interesting to anglers. A better predator may be the largemouth bass which is somewhat slow growing, but is reaching sizes that anglers would enjoy. These larger bass can also exert predatory control on panfish if macrophyte density is not excessive. Bass exhibit good recruitment and have multiple year classes represented in the survey catch.

Management Direction

Presently, Crooked Lake offers opportunity for anglers to catch acceptable sized crappie, fair sized bluegill, large rock bass and large pumpkinseed sunfish. Anglers can also catch a variety of larger predators including largemouth bass, bowfin, and bullheads. Northern pike are available but tend to be skinny and slow growing. Crooked Lake will always have issues with stunted panfish and pike - most likely due to the excessive macrophyte growth. In this case the only management to help the fish may be for weed control.

Management should continue for species present. There are no recommendations for stocking additional fish species at this time.

References

Schneider, J.C. 1981. Fish communities in warmwater lakes. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1890, Ann Arbor, Michigan.

Schneider, J.C. 1990. Classifying bluegill populations from lake survey data. Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report No. 90-10, Ann Arbor, Michigan.

Figure 1. Map of Crooked Lake Clare County with survey locations (2008) marked.

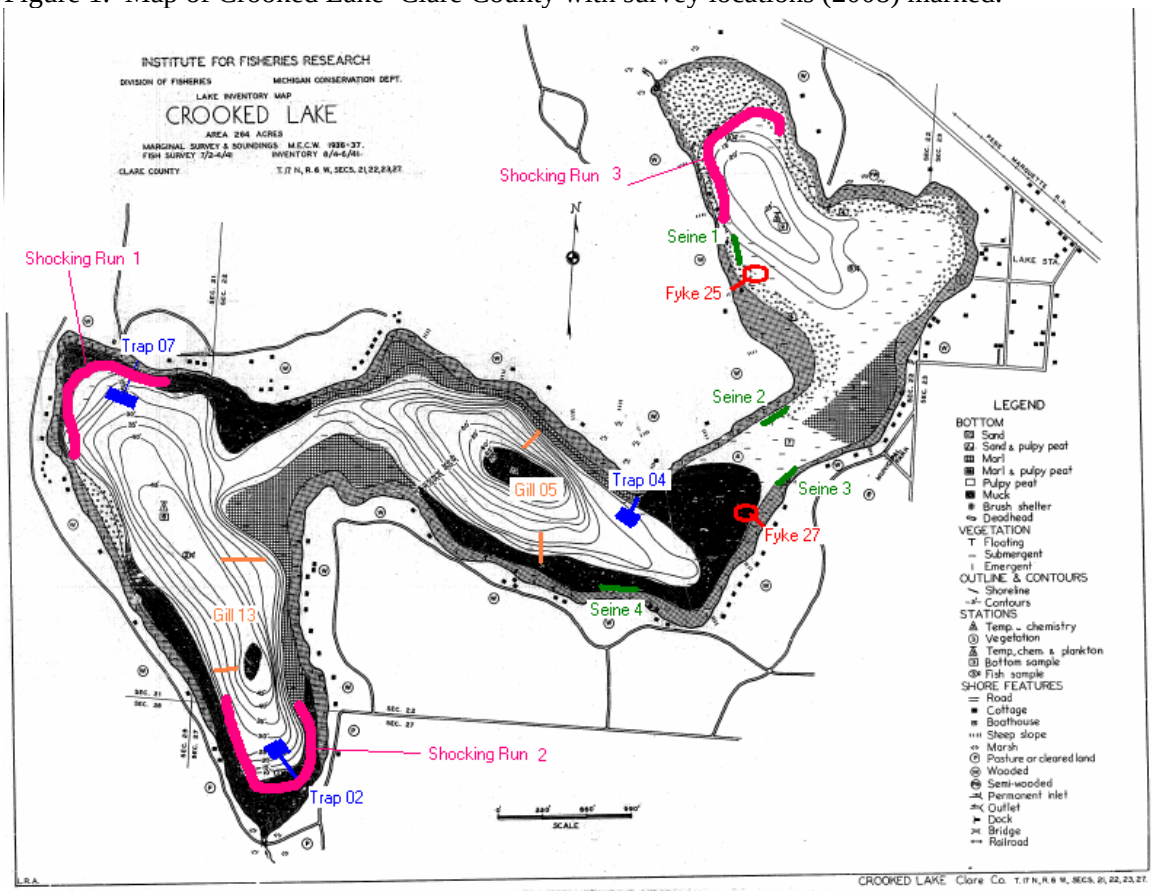

Table 1.-Temperature, oxygen, and pH profile from deep basin of Crooked Lake, Clare County. Data collected August, 2008 by MDNR, Fisheries Division.

Depth (ft.)	Temperature (ºF)	Oxygen (ppm)	pH
Surface	73.34	11.25	8.15
3	73.34	11.24	8.01
6	73.33	11.26	7.97
9	73.26	11.33	7.97
12	72.75	11.51	8.00
15	71.88	10.12	7.66
18	65.77	5.51	7.32
21	57.57	2.55	7.10
24	51.45	2.26	7.00
27	48.24	2.23	6.94
30	46.18	2.02	6.89
33	44.6	1.62	6.80
36	43.46	1.62	6.78
39	42.9	1.61	6.74
42	42.71	1.6	6.73
45	42.49	1.6	6.72
48	42.35	1.59	6.71
51	42.23	1.56	6.70
54	42.09	1.53	6.70
57	42.01	1.46	6.69
60	41.95	1.41	6.68
63	41.89	1.39	6.68
66	41.83	4.87	7.07
69	41.79	3.11	7.05
Bottom (70.5)	41.88	2.3	7.01

Table 2. Fish stocked into Crooked Lake, Clare County (1985 to present).

Year	Species	Number	Rate (#/acre)	Size (in)
1985	Northern pike	5,280	20	3.56
1986	Northern pike	10,560	40	4.24
1987	Northern pike	5,280	20	4.20
1988	Northern pike	10,560	40	3.36
1990	Northern pike	5,280	20	3.56
1991	Northern pike	11,000	42	2.36

Table 3.–List of fishes in Crooked Lake, Clare County. Origin: N= native, I= introduced, C= colonized. Status: P= recent observations. U= Not found in 2008. Data from: Michigan Department of Natural Resources, Fisheries Division records.

Common name	Scientific name	Origin	Status
Blackchin shiner	*Notropis heterodon*	N	U
Black crappie	*Pomoxis nigromaculatus*	N	P
Bluegill	*Lepomis macrochirus*	N	P
Bluntnose minnow	*Pimephales notatus*	N	P
Bowfin	*Amia calva*	N	P
Brown bullhead	*Ameiurus nebulosus*	N	P
Central mudminnow	*Umbra lima*	N	P
Common carp	*Cyprinus carpio*	C	P
Common shiner	*Luxilus cornutus*	N	P
Golden shiner	*Notemigonus crysoleucas*	N	P
Grass pickerel	*Esox americanus*	N	U
Green sunfish	*Lepomis cyanellus*	N	U
Lake chubsucker	*Erimyzone sucetta*	N	U
Northern pike	*Esox lucius*	N	P
Pumpkinseed	*Lepomis gibbosus*	N	P
Rainbow trout	*Oncorhynchus mykiss*	I	U
Rock bass	*Ambloplites rupestris*	N	P
Yellow bullhead	*Ameiurus natalis*	N	P
Yellow perch	*Perca flavescens*	N	P

Table 4.-Number, weight, and length range of fishes collected with trap net, gill net, seine, and electro-fishing gear from Crooked Lake, Clare County in 2008. Data from Michigan Department of Natural Resources, Fisheries Division records.

Common name	Number	Percent by number	Length range (inches)	Weight (lbs.)	Percent by weight	Percent legal size	Average size (inches)
Black crappie	48	3	6-11	17.8	2.4	68	8.3
Bluegill	77	5	1-7	7.8	1.1	18	5.0
Bluntnose minnow	6	< 1	2	0.0	< 1	--	2.5
Bowfin	41	3	16-27	173.9	24	100	22.4
Brown bullhead	233	15	7-15	200.1	27	100	12.1
Central mudminnow	3	< 1	2	0.0	< 1	--	2.5
Common carp	8	< 1	18-29	47.6	7	100	22.9
Common shiner	3	< 1	3-5	0.1	< 1	--	4.2
Golden shiner	4	< 1	3-6	0.3	< 1	--	5.7
Largemouth bass	91	6	5-18	140.3	19	52	14.0
Northern pike	39	3	11-25	72.7	10	8	20.1
Pumpkinseed	78	5	2-8	16.0	2	53	5.8
Rock bass	55	4	2-10	20.5	3	80	7.5
Yellow bullhead	32	2	9-13	22.7	3	100	11.4
Yellow perch	793	53	2-7	9.8	1	0	3.1

Table 5.-Weighted mean length (inches) at age, and growth relative to the State average for fish sampled from Crooked Lake with trap nets, gill nets, and electro-fishing gear, May, 2008. Number of fish aged is in parentheses. Data from Michigan Department of Natural Resources, Fisheries Division records.

	Age/Length															
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean growth index[1]
Black crappie		6.7 (17)		9.2 (2)	9.8 (6)	10.6 (11)	11.1 (2)									+0.5
Bluegill	1.8 (2)	3.4 (15)	4.7 (11)	5.3 (2)	5.6 (13)	6.6 (3)	7.6 (5)									-0.5
Largemouth bass	4.2 (1)		10.0 (7)	13.0 (9)	13.5 (20)	13.9 (9)	15.0 (7)	16.0 (7)	17.1 (5)		18.4 (2)	18.0 (1)				-0.4
Northern pike	12.2 (1)	15.9 (4)	18.8 (8)	20.6 (13)	21.7 (9)	22.9 (3)										-2.9
Pumpkinseed sunfish		3.32 (19)	5.0 (12)	5.9 (5)	6.7 (10)	7.4 14)	7.1 (4)									+0.3
Rock bass	2.0 (1)	2.9 (2)	5.8 (14)	7.4 (7)	8.3 (14)	9.3 (8)	9.6 (4)									+1.2
Yellow perch	3.0 (19)	3.9 (6)	4.8 (13)	6.7 (3)												-1.1

[1] Mean growth index is the average deviation from the state average length at age.

Table 6.-Sanford Lake bluegill classification using trap net data and the Schneider Index (Schneider 1990). Size score is given in parentheses. Data from Michigan Department of Natural Resources, Fisheries Division records. 1995 data from fyke nets.

Sample date	5/18/95	5/18/98	5/12/08
Sample size	180	7	49
Average length (inches)	3.7 (1)	6.5 (5)	6.4 (4)
% ≥ 6 inches	3.9 (1)	43 (3)	67 (4)
% ≥ 7 inches	3.3 (2)	29 (4)	27 (4)
% ≥ 8 inches	1.1 (5)	29 (6)	2 (5)
Schneider Index	2.25	4.5	4.25
Rank[1]	Poor	Satisfactory	Satisfactory

[1]Rank: 1 = Very poor, 2 = Poor, 3 = Acceptable, 4 = Satisfactory, 5= good, 6 = Excellent, 7 = Superior