Six Lakes Chain (Strong, Hoffman, Long, and Round Lakes)
Mecosta, Isabella counties, T15N, R06, 07W
Last Surveyed 2016

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Environment

Four lakes were surveyed as part of the Six Lakes Chain. These included Round, Long, Hoffman and Strong Lakes. The lakes are located 6 miles north and 15 miles west of Mt. Pleasant along the Isabella/Mecosta County lines (T15 N, R 06, 07W, Many). These lakes are connected by Bamber Creek and collecting a few unnamed inlets which eventually outlets to the Chippewa River (from Long Lake) and eventually empty to Saginaw Bay. The public can access these lakes from a county road ending off Rosebush Rd. and can navigate at least 4 of these small lakes by boat through shallow channels that connect these waters (Figure 1). There are another series of lakes to the southwest in Montcalm County also known as Six Lakes near the town of Six Lakes; these lakes are in the Lake Michigan drainage and are a completely different system. The Six Lakes surveyed and described in this report are fairly small and drop off quickly making deploying survey gear difficult.

Topography in the area varies from level to 35 percent slope. Soil maps indicate a predominance of muck type soils in the low lying areas, and sparse areas of intermixed sandy loams and sands. No formal bathymetry maps are on file for this chain of lakes. Past limnological surveys indicate a maximum depth of 10 feet for Strong Lake, but the other three are deeper. Hoffman, Long and Round Lakes were 20, 22, and 28 feet respectively. Bottom types in the lakes appear to be organic fibrous peat. Surrounding land in the area is wooded and land use nearby is mostly agricultural. Using an aerial map, approximate areas were calculated. Round lake was 20 acres, Long Lake was 21.4 acres, Hoffman Lake was 8.4, and Strong Lake was 11 acres. The channels that connect the lakes are navigable much of the time, but the one to Strong Lake was impassible in August 2016 due to lower water levels and beaver activity.

Surveys on these lakes have typically been combined for analysis with the exception of a set of limnological surveys conducted in 1991. The water color in all the lakes was brown. Round, Long and Hoffman Lakes are fairly deep with steep drop-offs going to depths of 20-26 feet. Strong Lake is shallow with depths to 10 feet.

Recent limnological surveys were conducted in each of the lake basins with the exception of Strong Lake. Individual descriptions are as follows:

Round Lake
A limnological survey conducted in August 2016 showed a secchi depth of 13.5 feet indicating excellent water clarity, a pH range of 7.5-8.5, and an alkalinity of 170 mg/l. The lake had a deep thermocline with gradual water temperature changes from 76-70° F through the upper water column and then a sharper temperature drop occurring at 14 feet to a low of 44 degrees at the bottom (28 feet). Oxygen declined in deeper areas and was limiting (below 3 ppm) below 15 feet. Limnological parameters measured in 2016 found characteristics of a mesotrophic lake. Measurements of secchi disk (13.5 ft.), total phosphorus (0.0163 mg/l), and total chlorophyll-a (5.07 ug/l) yielded a Carlson

Trophic Status Index of 43.49 (Carlson 1996). Mesotrophic lakes are typically those that have good water quality and medium biological productivity. Lakes in the mesotrophic range are moderately productive, with some chance of hypolimnetic anoxia in summer (as the index approaches 50), and are fully supportive of all water uses. The total distance around the lake was .78 miles. In this distance there were no residences, no docks, no armored shoreline, and five submerged trees. Fish habitat was drop-offs and aquatic vegetation.

Long Lake

A limnological survey conducted in August 2016 showed a secchi depth of 9.2 feet indicating good water clarity, a pH range of 7.3-8.4, and an alkalinity of 186 mg/l. The lake had a moderate thermocline with gradual water temperature changes from 76-71° F through the upper water column and then a temperature drop occurring at 14 feet to a low of 45 degrees at the bottom (24 feet). Oxygen declined in deeper areas and was limiting (below 3 ppm) below 13 feet. Limnological parameters measured in 2016 found characteristics of a mesotrophic lake. Measurements of secchi disk (9.2 ft.), total phosphorus (0.0206 mg/l), and total chlorophyll-a (8.24 ug/l) yielded a Carlson Trophic Status Index of 48.09 (Carlson 1996). The total distance around Long Lake was 1.13 miles. In this distance there were no residences, no docks, no armored shoreline, and one submerged trees. Fish habitat was drop-offs and aquatic vegetation.

Hoffman Lake

A limnological survey conducted in August 2016 showed a secchi depth of 6.7 feet indicating fair water clarity, a pH range of 7.0-8.2, and an alkalinity of 204 mg/l. The lake had a moderate thermocline with gradual water temperature changes from 74-68° F through the upper water column and then a temperature drop occurring at 11 feet to a low of 50 degrees at the bottom (19 feet). Oxygen declined in deeper areas and was limiting (below 3 ppm) below 7 feet. Limnological parameters measured in 2016 found characteristics of a beginning stage eutrophic lake. Measurements of secchi disk (6.7 ft.), total phosphorus (0.0426 mg/l), and total chlorophyll-a (6.46 ug/l) yielded a Carlson Trophic Status Index of 52.3 (Carlson 1996). Eutrophic lakes are typically those that are more enriched, have more nutrients available, and fairly high biological productivity. Lakes in the eutrophic range often have problems with increased hypolimnetic anoxia in summer and increased macorphyte growth especially if shallow. Early eutrophic lakes are usually fully supportive of all water uses. The total distance around the lake was .52 miles. In this distance there were no residences, no docks, no armored shoreline, and no submerged trees. Fish habitat was drop-offs and aquatic vegetation.

History

Surveys and historic records are sparse for this lake complex. Since there was only a road ending allowing for public access, survey efforts were concentrated elsewhere to accommodate waters with active management and higher public demand. Surveys here were limited to the limnologies conducted in 1991, and fish surveys with nets conducted in 1997 and a supplementary electrofishing survey in 1998. Netting was deployed in all 4 of these lakes but catches were sparse. The lakes drop off rapidly. Species captured in 1997 included black crappie, bluegill, bowfin, brown bullhead, common carp, white sucker, largemouth bass, northern pike, pumpkinseed sunfish and yellow bullhead. Electrofishing was conducted in 1998 to supplement the sparse data collected in 1997. Additional data for age growth was obtained particularly for bluegill and largemouth bass. New species recorded (1998) also included common shiner, golden shiner, grass pickerel, lake chubsucker, rock bass, warmouth, yellow perch, and brook silversides.

Current Status

This survey was in response to Fisheries Division's Status and Trends Monitoring Program. The Status and Trends Monitoring Program seeks to randomly sample various sized lakes, using similar protocol, to determine trends among lakes at the regional and statewide levels.

Status and Trends protocol incorporates a variety of gear to sample the fish community within a recommended temperature range (55º-80º F) (Figure 2). Standardized fyke nets are used to capture larger (>3 inches) species that inhabit the littoral zone or that move inshore at night. Gill nets are used to sample fish that occupy offshore waters and are particularly effective at capturing perch and northern pike. Smallmesh fyke nets are used to capture representative samples of small-bodied nongame species and smaller size classes (<3 inches) of sport fishes that inhabit the littoral zone. Collectively, the catch from these gears present a general picture of the overall fish community. No electrofishing was conducted with the 2016 survey.

The fish community of Six Lakes (Round, Long, Hoffman, and Strong) was sampled May 31- June 3, 2016 with largemesh fyke nets, smallmesh fyke nets, gill nets, and seining (Figure 2). Habitat sampling and the limnological survey occurred on August 29. Strong Lake was not sampled in August as a beaver dam blocked the passage. Each lake's data was collected separately. The chain can also be collectively examined to compare the individual lakes.

Strong Lake

Two hundred forty fish were captured in the survey (Tables 1-3). Species comprising the bulk of this catch included black crappie, bluegill, brown bullhead, white sucker, northern pike and pumpkinseed sunfish. All other species were represented by very low numbers of individuals. A total of thirteen species were observed. The other species collected were black bullhead, bowfin, Iowa darter, largemouth bass, tadpole madtom, rock bass, and yellow perch.

Bluegill were the most common species representing 39% of the survey catch by number. Bluegill averaged 5.5 inches and many were of desirable size (6 inches or above). There were six bluegill year-classes and they were growing somewhat slowly with a calculated mean growth index of -0.8.

The 49 black crappie in Strong Lake represented 20% of the catch by number. Sixty three percent of the black crappie were of desirable size to anglers (7 inches or above). The average length surveyed was 7.8 inches and they ranged from 2-11 inches. Many year-classes were present (ages 1-10). Black crappie are somewhat slow growing as the calculated mean growth index was -0.8, although many reach larger sizes.

Although few pumpkinseed sunfish were captured, these were enough for a growth index to be calculated. Pumpkinseed sunfish are growing above state average with a mean growth index of +0.2. Five year-classes were present. The average length in the catch was 5.9 inches. Fifty-six percent were of desirable size for anglers (6 inches or above).

Thirteen northern pike were caught. Northern pike ranged from 17-27 inches and averaged 23 inches. Thirty-eight percent of the northern pike were legal size (24 inches or larger). Northern pike growth is

less than state average with a calculated mean growth index of -3.7. There were 6 year-classes of northern pike (ages 2-7).

Hoffman Lake

Four hundred thirty two fish were captured in the survey (Tables 1-3). A large portion of the fish collected were bluegills. Eighty-one percent of the catch were bluegills. All other species were represented by very low numbers of individuals. Fifteen species were collected. The other species captured were: black crappie, bluntnose minnow, bowfin, brown bullhead, brook silverside, common carp, white sucker, golden shiner, greenside darter, horneyhead chub, largemouth bass, northern pike, pumpkinseed sunfish, and yellow perch.

The only species captured in appreciable numbers was bluegill. Bluegill ranged from 1-8 inches. Bluegill average length in Hoffman Lake was 2.3 inches. Only 3 percent of the bluegill captured were of acceptable size to anglers (6 inches or above). The size range of bluegills was skewed toward smaller fish. Only 4 year-classes were present. Bluegills were growing somewhat below state average with a calculated mean growth index of -0.8.

Despite low individual representation, enough black crappie and largemouth bass were collected in Hoffman Lake to examine growth. Like bluegill, black crappie are growing below state average with a calculated mean growth index of -1.2. Largemouth bass are growing below state average as well with a calculated mean growth index of -2.6. None of the largemouth bass were legal (14 inches or larger) and they were mostly represented by a school of age 1 fish. Three age-classes of pumpkinseeds were captured in Hoffman Lake (ages 1-3). Pumpkinseed sunfish are growing near state average and reaching acceptable sizes.

Four year-classes of yellow perch were present in the survey catch. Only age one fish had enough representation for age and growth calculations. These had a calculated mean growth index of -0.9.

Northern pike were not captured in sufficient numbers to calculate a mean growth index. Only one of the six northern pike was legal (24 inches or larger). Pike averaged 19.5 inches in length.

Long Lake

Long Lake had the fewest fish of the four lakes surveyed in the chain of lakes (Tables 1-3). Only 77 total fish were caught. Sixteen species were captured including black crappie, black bullhead, bluegill, bowfin, brown bullhead, white sucker, green sunfish, Iowa darter, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, tadpole madtom, warmouth, yellow perch, and yellow bullhead.

There were very few numbers of fish within any species captured in Long Lake. Bluegills (33) were the most numerous. Bluegill averaged 3.9 inches in length and ranged from 1-9 inches. Bluegill were the only species where growth could be calculated. Bluegill were represented by 5 year-classes (ages 1-5). Bluegill are growing below state average with a calculated mean growth index of -0.6. No other inferences can be made as numbers captured were insufficient.

Round Lake

Four hundred seventy-nine fish were captured in the survey (Tables 1-3). This is the most of the four lakes surveyed. A large portion of the fish captured were bluegills. Eighty-one percent of the catch

were bluegill. All other species were represented by very low numbers of individuals. Fifteen species and one hybrid were caught. The other species captured were black crappie, bluntnose minnow, bowfin, brown bullhead, white sucker, Iowa darter, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, tadpole madtom, warmouth, yellow perch, and yellow bullhead.

The only species captured in appreciable numbers was bluegill. Bluegill ranged from 1-9 inches. Bluegill average length in Round Lake was 3.1 inches. Twenty-one percent of the bluegill captured were of acceptable size to anglers (6 inches or above). The size range of bluegills was skewed toward small fish despite the presence of seven year-classes. Bluegill were growing above state average with a calculated mean growth index of +0.5.

Despite only having a few individuals of the other gamefish species, enough black crappie and largemouth bass were collected in Round Lake to examine growth. Like bluegill, black crappie are growing above state average with a calculated mean growth index of +0.1. Largemouth bass are growing slightly below state average with a calculated mean growth index of -1.2. None of the largemouth bass was legal (14 inches or larger).

Rock bass were the only other species captured in any numbers. Rock bass were not aged for growth analysis, although they averaged 6.5 inches. Fifty-four percent of the rock bass caught were of desirable size (6 inches or larger).

Pumpkinseed sunfish and northern pike were not captured in sufficient numbers to calculate a mean growth index. It should be noted that all the pumpkinseeds observed were of desirable size and averaged 6.5 inches. None of the five northern pike were legal (24 inches or larger).

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, the individual four lakes were scored and a combined score was also calculated as the sample sizes were somewhat low in the individual lakes. The combined index score for a sample size of 220 was 4.75 which put the combined lakes in the "good" rank (Table 4). Individual lake scores are also noted in table 7. Round Lake had the best Schneider score and the highest sample size as well. Growth for bluegill also is better in Round Lake. This lake offers the best access and excellent fishing opportunity for bluegill.

Fish are able to move from lake to lake most of the season. On occasion there may be blockages resulting from low water or beaver activity (dams). Evaluating individual lakes is difficult as there may be a certain amount of mixing that occurs. Table 2 shows the species distribution by lake.

Growth in the individual lakes also varies slightly (Table 3). Individual sample sizes are somewhat low making a good comparison difficult. Growth of the major species examined if fairly similar between lakes. Round Lake appears to have slightly better growth and productivity than the other 3 lakes. Round Lake is the deepest of the 4 lakes. Black crappie, pumpkinseed sunfish, and rock bass

also thrive in Six Lakes despite lesser numbers captured in the survey. These species add to the diversity of desirable species for anglers to catch.

Predators in the Six Lakes Chain are difficult to gauge. Largemouth bass numbers were skewed toward smaller, younger fish and few larger individuals were captured. Largemouth bass are notoriously "net shy". During the survey, several anglers were observed targeting bass. Largemouth bass were found in all four lakes. Growth could only be examined in two of the lakes (Table 3) and like the bluegill, Round Lake had better growing conditions for largemouth bass. A night of electrofishing would provide a better picture of largemouth bass abundance.

Northern Pike were also captured in all four lakes. Insufficient individuals were captured in most lakes to properly access the population or growth except for in Strong Lake. Pike were slow growing but the sizes captured showed a good portion of legal size fish (24 inches or larger).

Currently, a good fishery exists for most game species. This lake complex is popular for bluegill and bass fishermen in particular but anglers can also capitalize on the variety of other nice sized fish described earlier.

Management Direction

Presently, Six Lakes (Strong, Hoffman, Long, and Round) are in good condition in terms of its overall fishery. The lake offers very good angling opportunities for several species including bluegill, black crappie, rock bass, sunfish, largemouth bass, and northern pike. Additional opportunities are available for non-game species. This complex of lakes is ideal for small boats, canoes, or kayaks.

Fisheries management of the Six Lakes Chain should continue to focus on warmwater species. Sustainable populations of largemouth bass and northern pike as top predators will help maintain an improved bluegill size structure. Presently, these species occur in sufficient numbers and appear healthy and no management actions need to be directed toward them at the present time. Efforts should continue to protect the habitat and riparian area and ensuring continued public access.

References

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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. Location map of Six Lakes (Strong, Hoffman, Long, and Round).

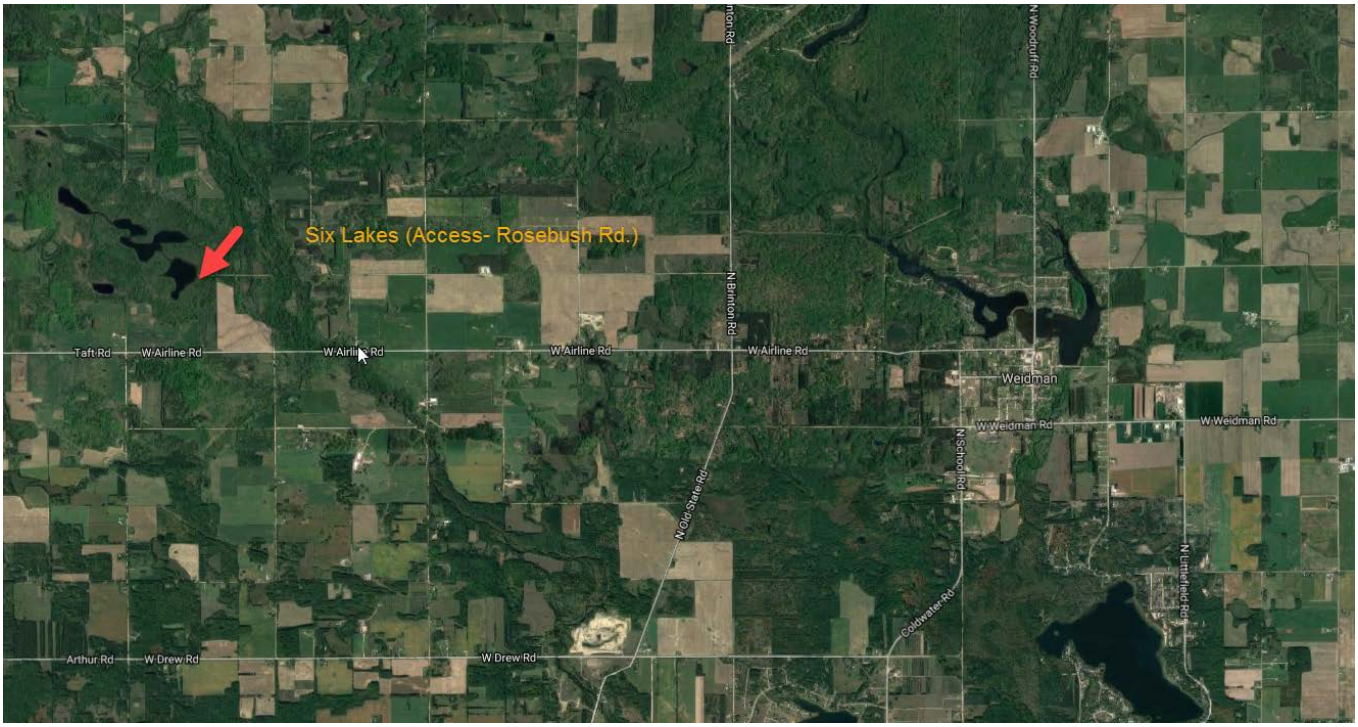

Figure 2. Map of Six Lakes (Strong, Hoffman, Long, and Round) showing survey gear deployment locations.

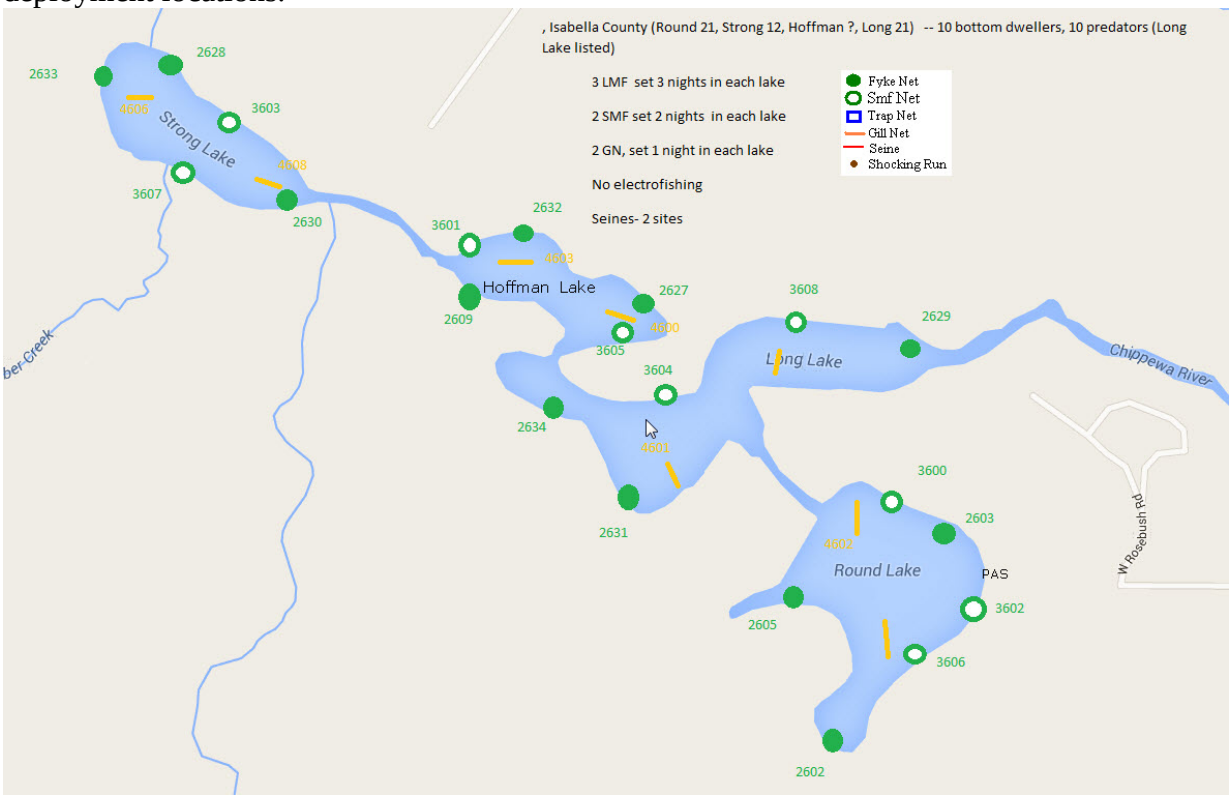

Table 1. Fish species captured during the 2016 survey of lakes in the Six Lakes Chain.

Strong Lake, Mecosta County

Species	Number	Percent by number	Weight (lb.)	Percent by weight	Length range (in.)*	Average length (in.)	Percent legal size**
Black crappie	49	20.4	15.5	9.6	2-11	7.8	63
Black bullhead	2	0.8	0.4	0.3	7-7	7.5	100
Bluegill	93	38.8	12.5	7.8	1-8	5.5	34
Bowfin	7	2.9	28.9	18.0	17-27	22.4	100
Brown bullhead	19	7.9	10.6	6.6	7-12	10.4	100
White sucker	25	10.4	51.3	31.9	7-20	17.1	100
Iowa darter	3	1.3	0.0	0.0	2-2	2.5	100
Largemouth bass	7	2.9	1.6	1.0	2-13	5.6	0
Northern pike	13	5.4	36.1	22.4	17-27	23.0	38
Pumpkinseed	16	6.7	3.0	1.9	3-7	5.9	56
Rock bass	1	0.4	0.2	0.1	6-6	6.5	100
Tadpole madtom	1	0.4	0.0	0.0	3-3	3.5	100
Yellow Perch	4	1.7	0.7	0.4	6-8	7.5	75
All species totals:	240	100	160.9	100			

Hoffman Lake, Mecosta County

Species	Number	Percent by number	Weight (lb.)	Percent by weight	Length range (in.)*	Average length (in.)	Percent legal size**
Black crappie	15	3.5	1.5	3.6	2-10	4.8	13
Bluegill	350	81.0	7.4	17.9	1-8	2.3	3
Bluntnose minnow	1	0.2	0.0	0.0	2-2	2.5	100
Bowfin	2	0.5	7.0	17.1	21-21	21.3	100
Brown bullhead	4	0.9	2.7	6.6	10-12	11.3	100
Brook silverside	1	0.2	0.0	0.0	3-3	3.5	100
Common carp	1	0.2	9.4	22.9	27-27	27.5	100
White sucker	1	0.2	0.1	0.3	6-6	6.5	100
Golden shiner	2	0.5	0.0	0.0	2-3	3.0	100
Greenside darter	1	0.2	0.0	0.0	1-1	1.5	100
Horneyhead chub	3	0.7	0.0	0.1	1-3	2.5	100
Largemouth bass	11	2.5	0.1	0.3	2-3	2.9	0
Northern pike	6	1.4	10.7	26.0	13-24	19.5	17
Pumpkinseed	14	3.2	1.5	3.7	2-7	4.7	29
Yellow Perch	20	4.6	0.6	1.6	2-8	3.8	5
All species totals:	432	100	41.1	100			

Long Lake, Isabella County

Species	Number	Percent by number	Weight (lb.)	Percent by weight	Length range (in.)*	Average length (in.)	Percent legal size**
Black crappie	4	5.2	1.2	1.9	5-9	8.0	75
Black bullhead	1	1.3	0.7	1.1	11-11	11.5	100
Bluegill	33	42.9	2.1	3.3	1-9	3.9	6
Bowfin	5	6.5	14.1	22.3	8-23	18.7	100
Brown bullhead	1	1.3	0.9	1.4	12-12	12.5	100
White sucker	10	13.0	23.0	36.2	16-19	18.0	100
Green sunfish	1	1.3	0.2	0.3	6-6	6.5	100
Iowa darter	1	1.3	0.0	0.0	1-1	1.5	100
Largemouth bass	3	3.9	0.2	0.3	3-6	4.5	0
Northern pike	5	6.5	17.9	28.2	17-29	24.5	60
Pumpkinseed	5	6.5	1.3	2.0	6-7	6.7	100
Rock bass	2	2.6	0.3	0.5	5-6	6.0	50
Tadpole madtom	1	1.3	0.0	0.0	1-1	1.5	100
Warmouth	1	1.3	0.1	0.2	5-5	5.5	0
Yellow Perch	2	2.6	0.1	0.2	4-6	6.5	0
Yellow bullhead	2	2.6	1.3	2.1	9-12	11.0	100
All species totals:	77	100	63.5	100			

Round Lake, Isabella County

Species	Number	Percent by number	Weight (lb.)	Percent by weight	Length range (in.)*	Average length (in.)	Percent legal size**
Black crappie	12	2.5	6.0	8.1	8-11	9.6	100
Bluegill	386	80.6	28.8	38.8	1-9	3.1	21
Bluntnose minnow	7	1.5	0.0	0.0	1-2	2.4	100
Bowfin	1	0.2	4.6	6.2	23-23	23.5	100
Brown bullhead	2	0.4	1.8	2.5	11-13	12.5	100
White sucker	5	1.0	11.3	15.2	17-19	17.9	100
Hybrid Sunfish	1	0.2	0.0	0.0	3-3	3.5	0
Iowa darter	14	2.9	0.0	0.0	1-2	1.6	100
Largemouth bass	16	3.3	6.0	8.1	2-12	7.8	0
Northern pike	5	1.0	7.9	10.7	18-20	19.5	0
Pumpkinseed	4	0.8	1.0	1.3	5-7	6.5	75
Rock bass	13	2.7	3.1	4.1	4-8	6.5	54
Tadpole madtom	1	0.2	0.0	0.0	3-3	3.5	100
Warmouth	1	0.2	0.2	0.3	6-6	6.5	100
Yellow Perch	3	0.6	0.1	0.1	3-3	3.5	0
Yellow bullhead	8	1.7	3.3	4.4	7-11	9.3	100
All species totals:	479	100	74.2	100			

Table 2. Species distribution in four of the lakes in the Six Lakes Chain

	Strong	Hoffman	Long	Round
Species				
Black crappie	x	x	x	x
Black bullhead	x		x	
Bluegill	x	x	x	x
Bluntnose minnow		x		x
Bowfin	x	x	x	x
Brook silverside		x		
Brown bullhead	x	x	x	x
Common carp		x		
Golden shiner		x		
Horneyhead chub		x		
Green sunfish			x	
Greenside darter		x		
White sucker	x	x	x	x
Hybrid Sunfish Hybrid				x
Iowa darter	x		x	x
Largemouth bass	x	x	x	x
Northern pike	x	x	x	x
Pumpkinseed	x	x	x	x
Rock bass	x		x	x
Tadpole madtom	x		x	x
Warmouth			x	x
Yellow Perch	x	x	x	x
Yellow bullhead			x	x

Table 3. Mean growth indices of the 4 lakes for the major sportfish species

	Strong	Hoffman	Long	Round
Species				
Black crappie	-0.8	-1.2	--	+0.1
Bluegill	-0.8	-0.8	-0.6	+0.5
Largemouth bass	--	-2.6	--	-1.2
Northern pike	-3.7	--	--	--
Pumpkinseed	+0.3	-0.1	--	--
Rock bass	--	--	--	--
Yellow Perch	--	-0.9	--	--

Table 4. Bluegill Schneider Indices of individual lakes of Six Lakes chain and all lakes combined. Index scores for parameters are given in parenthesis.

	Strong	Hoffman	Long	Round	Combined
Date	June 16				
Sample size	81	32	18	86	220
Average length	5.8 (3)	5.5 (3)	4.8 (1)	7.5 (6)	6.2 (4)
% over 6	39% (3)	28% (3)	11% (2)	94% (6)	56% (4)
% over 7	16% (4)	12.5% (4)	5.5% (3)	76.7% (6)	38% (5)
% over 8	2.45% (5)	3.1% (5)	5.5% (5)	33% (6)	14.5% (6)
Schneider index*	3.75	3.75	2.75	6.0	**4.75**

4.75 overall (weighted for sample size). This is between satisfactory and good (toward good) on the scale of 1 (very poor) to 7 (superior).

* Schneider scale scoring index:

1- Very poor
2- Poor
3- Acceptable
4- Satisfactory
5- Good
6- Excellent
7- Superior