Hart's Lake
Calhoun County, T2S R8W S7
Surveyed June and August 2008

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Environment

Hart's Lake is located in Calhoun County near Battle Creek, a large metropolitan center with a population over 53,000 residents. Harts Lake is a 55 acre lake with a maximum depth of 47 feet. Harts Lake is surrounded by 326 acres of public land situated to the west of the I-94 business loop and bordered on all other sides by Fort Custer Training Center, with the Kalamazoo River to the North. The riparian land surrounding the lake is primarily emergent wetland with a mature mesic forest encroaching closer to the shore. During a survey in 1952 (Institute for Fisheries Research, University of Michigan, unpublished data), the lake was mapped as two basins with an island in the center. Current condition of the lake is one basin with submerged vegetation in the center of the lake. Public access to the lake allows visitors to enjoy non-motorized, passive recreational opportunities through a walk-in access site.

Important components of water quality include phosphorus, nitrogen (ammonia, nitrate, and nitrite), water temperature, oxygen, carbon dioxide, pH, and a number of metals and salts. Water temperature and dissolved oxygen are critical habitat components for aquatic organisms. Water temperature influences internal structure, chemistry, biological metabolism, and the types of aquatic organisms that live in lakes. Water temperatures in Michigan lakes vary from the southern portion of the state to the northern portion. Internal lake water temperatures also vary. The warmest water temperatures are found near the surface of the lake (epilimnion) during summer months and near the bottom of the lake (hypolimnion) during winter months. This condition is called stratification. Stratification is most pronounced during summer months when temperature changes are the greatest. A zone of rapid temperature change occurs in the metalimnion (also called thermocline), and this often forms a physical barrier that prevents interchange of water, gases, organic material, and nutrients between the epilimnion and the hypolimnion. A temperature profile was obtained from the deepest location in Hart's Lake during mid-August 2008. This temperature profile illustrates that summer stratification occurred in the lake, with the metalimnion beginning at approximately 11 feet (Figure 1).

Dissolved oxygen is important for sustaining aquatic life. The solubility of oxygen and other gases depend on water temperature. Colder water can contain more dissolved gases. Oxygen enters the water from the atmosphere, and it is produced by aquatic plants during photosynthesis. Oxygen is used by all animals and microorganisms in lakes, and it is removed by plants during respiration when sunlight is not available. Oxygen depletion can occur in lakes with high plant and animal oxygen demand, especially in areas of lakes where waters do not mix freely or come in contact with the atmosphere. Water quality standards (related to discharges) in Michigan require maintenance of 7 mg/l dissolved oxygen for all Great Lakes and connecting waters, designated trout streams, and coldwater inland lakes. The water quality standard for other water bodies is 5 mg/l. Minimum dissolved oxygen levels for suitable summer habitat are approximately 3.0 mg/l for coldwater and cool-water fish and 2.5 mg/l for warm-water fish. The influence of water temperature stratification, dissolved oxygen, and trophic status determine the types of aquatic organisms that live in a lake. Dissolved oxygen profiles in Harts

Lake showed a clinograde curve where the oxygen content of the hypolimnion was depleted (Figure 2). The hypolimnion remains anaerobic in Hart's Lake throughout the summer stratification period. Increases in dissolved oxygen were observed at depths of 10 and 22 feet followed by decreases in oxygen below each depth. This type of increase is nearly always the result of oxygen produced by algal populations in the lower metalimnion of eutrophic lakes where access to nutrient concentrations is higher. Dissolved oxygen concentrations were above the warm-water fish levels of 2.5 mg/l at a depth of 24 feet with anaerobic conditions in the hypolimnion. Critical depth is defined as the point at which dissolved oxygen concentrations are less than 0.5 mg/l and refers to depths below which microorganisms like zooplankton will not occur. The critical depth in Hart's Lake occurred around 25 feet.

Hart's Lake can be classified as a eutrophic lake characterized by high levels of chlorophyll a (11.6 ug/L Figure 3), moderate concentrations of phosphorus (13.6 ug/L Figure 4) and nitrogen (901ug/L), and moderate secchi depth (10 ft.). Total alkalinity (160 mg/L) of the lake suggests a hardwater lake with a good buffering capacity. This is corroborated by the slightly alkaline pH values (7.5-8.4) recorded for the lake since 1945 (MDNR Fisheries Division, unpublished data).

History

Land use around Hart's Lake has a military history that dates to 1917 when a General Order of the War Department established "Camp Custer". Following the Armistice of 1918, Camp Custer became a post-war demobilization center for upwards of 100,000 returning soldiers (Michigan Department of Military Affairs 1985). The post was officially renamed Fort Custer in 1940, when it was made into a permanent military property. Ultimately, Fort Custer was made an inactive base in 1953, as it no longer trained active Army troops (Michigan Department of Military Affairs 1985). Reallocation of Hart's Lake property to functions other than military training dates to the property's post-WWII de-activation. In 1947, 625 acres of land were transferred to the Veteran's Administration (VA) to develop the Fort Custer National Cemetery and the VA hospital. From 1971 to 1973, 3,033 acres were transferred to the State of Michigan to develop the Fort Custer Recreation Area. In the early 1970's, nearly 2,600 acres were acquired by the City of Battle Creek to develop the Fort Custer Industrial Park. Approximately 112 acres were relinquished to various municipalities and private interests between 1960 and 1985. Calhoun Conservation District purchased 326 acres around Hart's Lake from Battle Creek Unlimited in 2007.

The first survey conducted on Hart's Lake was completed in 1945 by the Institute for Fisheries Research at the University of Michigan. This survey noted the lake was open to Military Post personnel only with occasional use by anglers outside the Post. Gill nets were used for 3 net lifts during August to document the presence of yellow perch, bluegill, common white sucker, warmouth, and yellow bullheads. Anglers at the Post reported catches of these fish as well as a few northern pike, largemouth bass, and black crappie.

The only other survey conducted on Hart's Lake prior to 2008 was completed in 1952. This survey used gill nets for 14 net lifts of effort during July. This effort documented the presence of northern pike, yellow perch, largemouth bass, warmouth, bluegill, black crappie, common white sucker, and bowfin. A seine was also used during August to document the presence of grass pickerel,

pumpkinseed, blackchin shiner, banded killifish, Iowa darter, least darter, tadpole madtom, pugnose shiner, and creek chub. Pugnose shiner is currently listed as a state endangered species.

In September 1997, the Hart's Lake outlet stream was surveyed for possible trout management within the Fort Custer Area. A backpack electroshocker was used to survey this stream for the presence of trout. There were no trout captured, but the survey documented good numbers of creek chubs, white sucker, Johnny darter, and blacknose dace.

Current Status

The MDNR Fisheries Division conducted a fish community assessment of Hart's Lake during June, 2008. Hart's Lake was surveyed to provide information on the status of the resource because of impending opening of the lake to the public for fishing. Specific objectives were to describe the growth of fish commonly captured within our gear, quantify the relative abundance of largemouth bass and bluegill, and describe the fish community assemblage. Sampling effort included two experimental mesh gill nets set for six net nights, two large-mesh fyke nets set for six net nights, one trap net set for three net nights, a single small-mesh fyke net set for one net night, and three ten minute electro-shocking transects. Results from this survey will represent the baseline condition to which future surveys can be compared.

During this survey a total of 16 fish species and three turtle species were captured (Table 1). Fish species diversity was slightly lower than the regional average of 18 species commonly occurring in lakes in southwest Michigan. As one possible index of fish community composition, we calculated the percent by number of fish we collected in each of three feeding guilds; 1) species that are primarily piscivores (fish predators), 2) species that are primarily pelagic planktivores and/or insectivores, and 3) species that are primarily benthivores (bottom feeders). Of the species collected, we classified northern pike, grass pickerel, largemouth bass, and bowfin as piscivores. Bluegill, yellow perch, pumpkinseed, black crappie, blacknose shiner, golden shiner, and warmouth as pelagic planktivores-insectivores; and brown and yellow bullhead, common white sucker, lake chubsucker, and tadpole madtom as benthivores (Table 1). Fish from the pelagic feeding guild comprised 91.2% of the catch while fish from the piscivore guild comprised 7.5% of the catch. Fish from the benthic feeding guild comprised only 1.3% of the catch.

The fish community of Harts Lake is dominated by fish from the Centrarchid family (97% by number), commonly known as the sunfish family. Bluegills were the most abundant fish captured in the lake (80%). Relative abundance of bluegill (measured as the catch per unit of fyke net effort) was 70 fish per net night. The relative abundance of bluegills captured in Hart's Lake is above the median relative abundance for populations in the southwest region of Michigan (Figure 5). This indicates that the abundance of bluegill is higher than typical populations in the southwest region of Michigan. Pumpkinseed was the second most abundant fish captured in fyke net gear, with a relative abundance of 4 fish per net night. Largemouth bass relative abundance measured as the catch per unit of electroshocking effort was 2 fish per minute. Northern pike, yellow perch, and black crappie relative abundances are low. Lake chubsuckers and brown and yellow bullheads are the most common benthic fish species in the lake, although their abundances are also relatively low compared to the overall fish community.

The bluegill population was composed of fish from age 1 to 8, with the age frequency dominated by age 6 (27.5%) and age 5 (20.9%). Bluegill average length at age was below the state average from age 1 to 2, but higher than the state average from age 3 to 8 (Table 2). Mean length-at-age data for all bluegills captured (all gear types) were fitted to a von Bertalanffy equation. Maximum length of bluegill in Hart's Lake predicted from this equation was 9.9 inches, whereas the largest bluegill caught was measured at 9.4 inches. The length frequency distribution of bluegills captured in entrapment gear shows a steady increase in the numbers of fish with increasing length (Figure 6). Length frequency analysis indicates a high proportion of larger bluegills with eight inch fish comprising 35% of the catch and seven inch fish comprising 27% of the catch. Proportional stock density (the number of quality length fish greater than 6 in. relative to the number of stock length fish greather than 3 in.) for bluegill was calculated as 79, which is higher than the range of accepted stock density values from 20-60 for balanced fish populations (Anderson and Neumann 1996).

The Largemouth bass population was composed of fish from age 1 to 11, with the age distribution indicating similar frequencies from age one to seven. Age four was the dominant year class captured during the survey (17.7%). The average length of the largemouth bass population was 11.7 inches. Mean length-at-age data for all largemouth bass were fitted to a von Bertalanffy equation. Maximum length of largemouth bass predicted from this equation was 23.8 inches, whereas the largest bass caught was measured at 20 inches. The Length frequency distribution (calculated from all fish captured by electrofishing) indicates a high proportion of large bass, with 59% of the catch comprised of fish greater than the quality length of 12 inches. Proportional stock density of largemouth bass was calculated from stock length fish greater than 8 inches and quality length fish greater than 12 inches. Proportional stock density was 78, which is higher than the range of accepted stock density values from 40-70 for balanced fish populations (Anderson and Neumann 1996).

The pumpkinseed population was composed of fish from age 3 to 7, with only larger size groups (from five to eight inches) observed in the catch. These data indicate that Hart's Lake pumpkinseeds are older and larger (on average) than is typical for populations in southwest Michigan.

Analysis and Discussion

The fish species composition of the lake appears to be similar to early assessments of the lake conducted in 1945 and 1952. Fish from the benthic feeding guild represented a very low percentage of the overall fish community. Presumably this is a result of habitat limitation because of low dissolved oxygen concentrations in the hypolimnion during summer stratification. The pugnose shiner was documented to occur in the lake during 1952, however during the current survey we did not collect this species. Pugnose shiner are currently listed as a state endangered species and future efforts should be conducted to verify the status of this species in Hart's Lake, to determine the need for additional conservation and habitat protection measures.

Growth in length of fishes is typically fastest early in life, and then decreases over time as fish reach maximum size. Bluegill growth in Hart's Lake was slower than the state average during early age classes, but better than the state average at later ages (until they reached their maximum age). Age and length- frequency analysis indicate that there is a high proportion of older and larger bluegills in the population. These characteristics are typical for unexploited populations, which indicate that Hart's Lake supports a unique bluegill resource. Unexploited fish stocks are characterized by a high

proportion of old fish, slow individual growth rates, and low rates of total annual mortality (Clady et al. 1975). The presence of old fish and a skewed size structure towards larger sized panfish in Hart's Lake is reflective of low exploitation. When unexploited populations are opened to fishing, length and age frequency distributions typically shift toward smaller and younger fish, mean age declines, and total mortality increases as a result of increases in fishing mortality. Exploitation is not expected to affect the abundance or number of panfish harvested because the abundance of adult fish is not expected to be reduced in numbers to an extent that reproduction is affected. Exploitation may affect the number of quality fish available to anglers because harvest mortality on large sized panfish could result in smaller and younger panfish that grow slower and mature at an earlier age. The long-term effects of harvest on the current population structure are a function of new rates of mortality, growth, and reproduction. An excessive rate of harvest may change the balance and fishing may steadily reduce a population to a level at which angling for quality sized fish is no longer possible.

Management Direction

Hart's Lake should be included in the Quality Non-trout Fishing Lakes designation to provide a unique fishery opportunity. Hart's Lake contains a unique panfish community that exhibits characteristics (assemblage, growth, and size structure) of an unexploited population. Catch-and-release fishing is recommended to maintain higher quality angling opportunities at Hart's Lake. The mandatory release of important game species is encouraged, to provide stronger, more balanced fish stocks and higher quality sized fish in an area of the State of Michigan close to human population centers.

Catch-and-release fishing achieves the overall ecosystem management goal by providing a sustainable and biologically diverse fish community while providing for some human uses. Although alternative harvest restrictions could be implemented, monitoring and assessment of the fisheries resource supports the catch-and-release management of this fishery. While catch-and-release regulations usually protect exceptional populations and fisheries, restoring those characteristics to lakes that already have been depleted by exploitation may be a slow process requiring anglers to curtail fishing activity as well as stop harvesting.

To prevent the collapse of panfish population size structure, it is recommended to start with a catch-and-release fishery, then adjust harvest regulations that are supported with survey data that follows trends in species adjustments to fishing pressure. At Mill Lake, closure to all angling for 5 years, combined with chance occurrence of strong year classes, improved both panfish and game fish populations and created exceptional angling when the fishery was reopened after collapse (Schneider 1971, 1973). Special regulations that allow even a slight amount of harvest seem to be considerably less successful at protecting largemouth bass populations and fisheries than complete no-kill (Schneider, 2001).

The success of special regulations at Hart's Lake may be achieved if these factors occur. Implementation while the fish populations are still in excellent shape and before public anglers have become accustomed to harvesting fish there. Since fish are more abundant, larger, and easier to catch than in average lakes, anglers are more likely to be supportive of efforts to maintain a high quality fishery. Since no public anglers have enjoyed harvest privileges during private ownership, none can claim that catch-and release rules would be a personal hardship. Catch-and-release provides anglers the opportunity for multiple recaptures of fish, with subsequent high catch rates. The fish that are the most easily caught are the most important portion of the population to protect because they contribute most to fishing success. And finally, low fishing pressure, so that fish would remain relatively easy to catch and the remote atmosphere would be retained. Experiences from Wakeley Lake and lakes in the Sylvania Tract suggest that good fishing can be maintained by catch-and-release regulations if daily average pressures do not exceed approximately 0.3 angler hours per acre (Schneider 2001, Schneider and Juetten, 1989).

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Table 1. Fish and turtles captured by all gear types in Harts Lake, Calhoun County

Species name	Scientific name	# caught	Guild type
Black crappie	Pomoxis nigromaculatus	9	Pelagic
Blacknose shiner	Notropis heterolepis	3	Pelagic
Bluegill	Lepomis macrochirus	940	Pelagic
Bowfin	Amia calva	5	Piscivore
Brown bullhead	Ameiurus nebulosus	3	Benthic
Common white sucker	Catastomus commersoni	1	Benthic
Golden shiner	Notemigonus crysoleucas	4	Pelagic
Grass pickerel	Esox americanus	2	Piscivore
Hybrid sunfish		31	Pelagic
Lake chubsucker	Erimyzon sucetta	6	Benthic
Largemouth bass	Micropterus salmoides	79	Piscivore
Northern pike	Esox lucius	2	Piscivore
Pumpkinseed	Lepomis gibbosus	70	Pelagic
Tadpole madtom	Noturus gyrinus	1	Benthic
Warmouth	Lepomis gulosus	5	Pelagic
Yellow Perch	Perca flavescens	6	Pelagic
Yellow bullhead	Ameiurus natalis	3	Benthic
Turtles			
Snapping Turtle	Chelydra serpentina	9	
Common musk	Sternotherus odoratus	7	
Painted Turtle	Chrysemys picta	2	

Table 2. Weighted mean length-at-age and age frequency of bluegills, largemouth bass, and pumpkinseeds for Hart's Lake, June 2008

	Bluegill				Largemouth bass				Pumpkinseed			
Age	# aged	mean length	State avg.	Age Freq.	# aged	mean length	State avg.	Age Freq.	# aged	mean length	State avg.	Age freq.
1	13	1.7	2.4	2.3%	8	4.9	5.4	10.1%	0			
2	22	3.8	4.2	9.7%	8	6.4	8.7	10.1%	0			
3	17	5.6	5.3	15.5%	7	8.4	10.6	8.9%	7	6.6	5.2	21.6%
4	7	6.9	6.2	10.1%	11	11.2	12.0	17.7%	11	7.5	5.8	41.9%
5	8	7.5	6.9	20.9%	8	13.2	13.7	13.9%	6	7.7	6.3	25.7%
6	9	8.1	7.4	27.5%	11	14.2	15.0	13.9%	4	8.4	6.8	7.2%
7	4	8.6	8.0	12.9%	7	15.2	16.7	8.9%	2	8.5	7.2	3.6%
8	6	9.2	8.4	0.7%	5	17.2	17.6	6.3%				
9					3	18.7	18.6	3.8%				
10					1	17.8	19.3	1.3%				
11					3	18.87		3.8%				

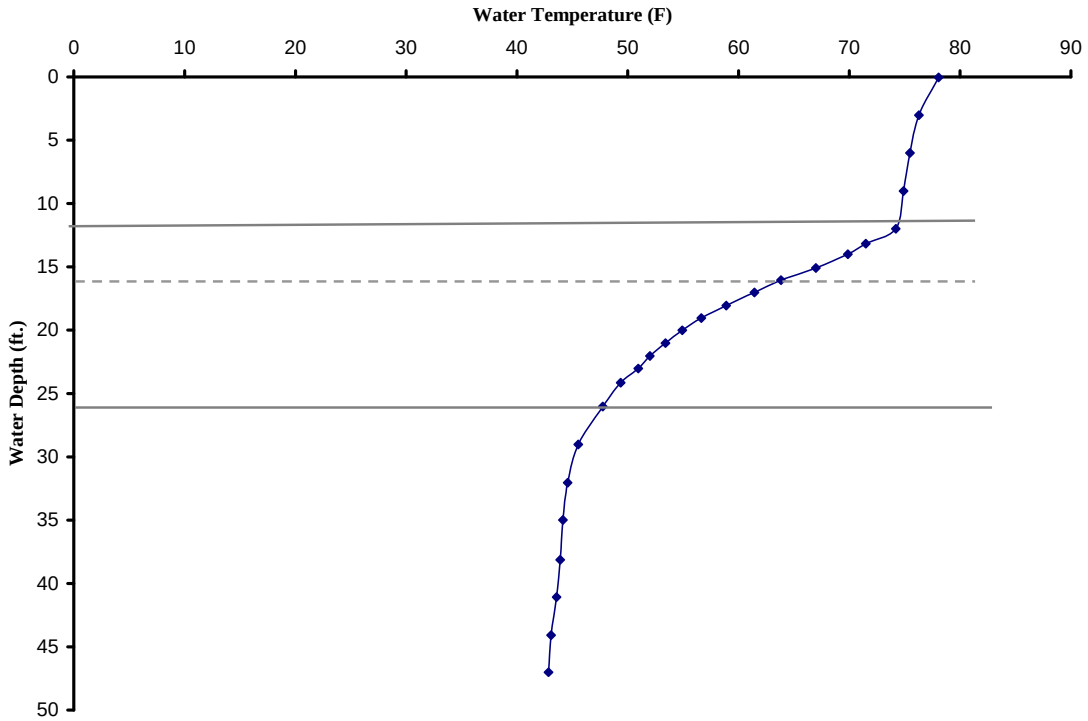

Figure 1. Water temperature profile in Harts Lake during summer stratification (August 2008). Solid grey lines demarcate the boundary of the metalimnion. Dashed grey line is the thermocline.

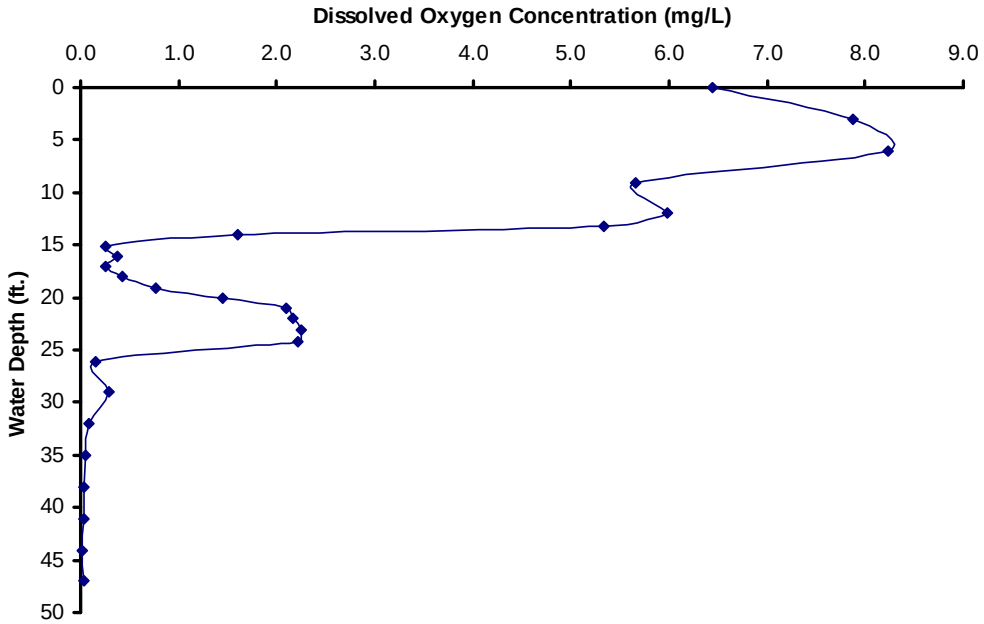

Figure 2. Dissolved oxygen concentrations in Harts Lake during summer stratification 2008.

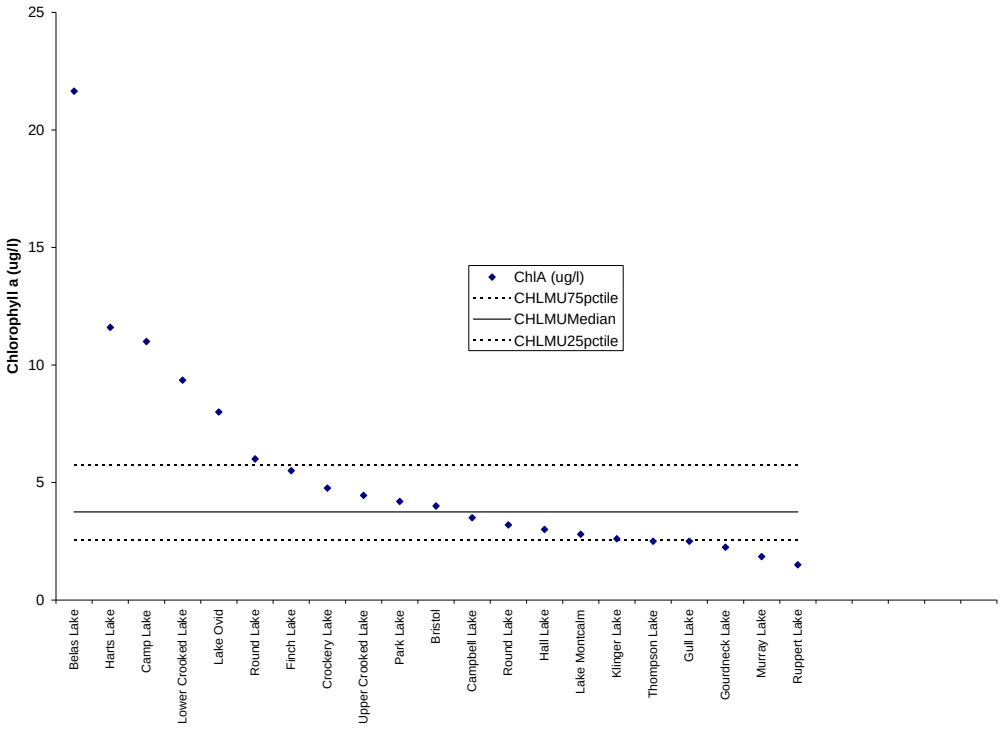

Figure 3. Chlorophyll a concentrations in Harts Lake and compared to status and trends lakes in the region (2002-2007).

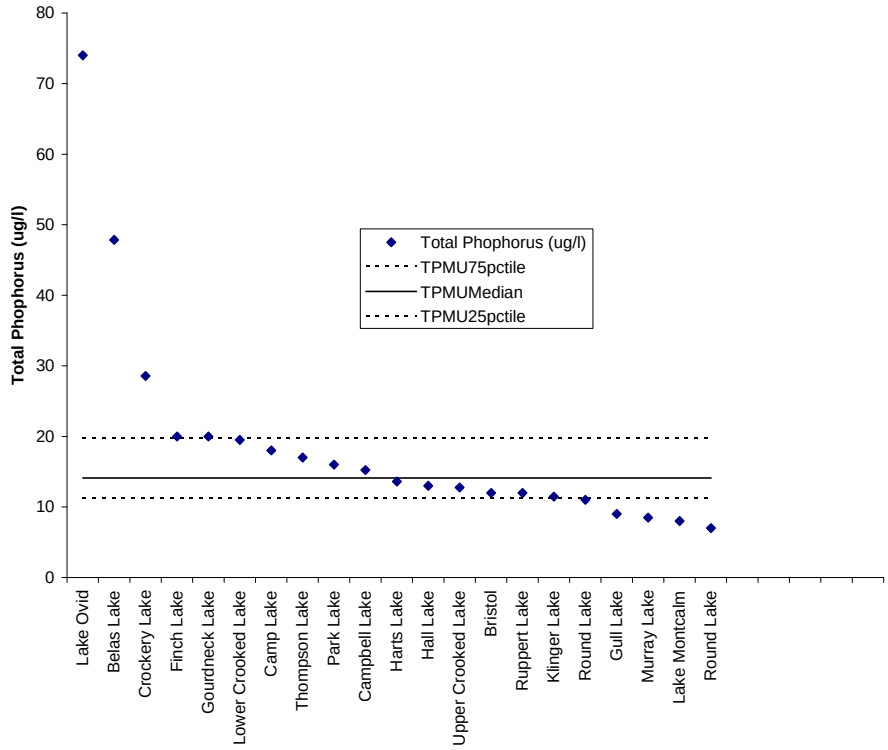

Figure 4. Total Phosphorus concentration in Harts Lake and compared to status and trends lakes in the region (2002-2007).

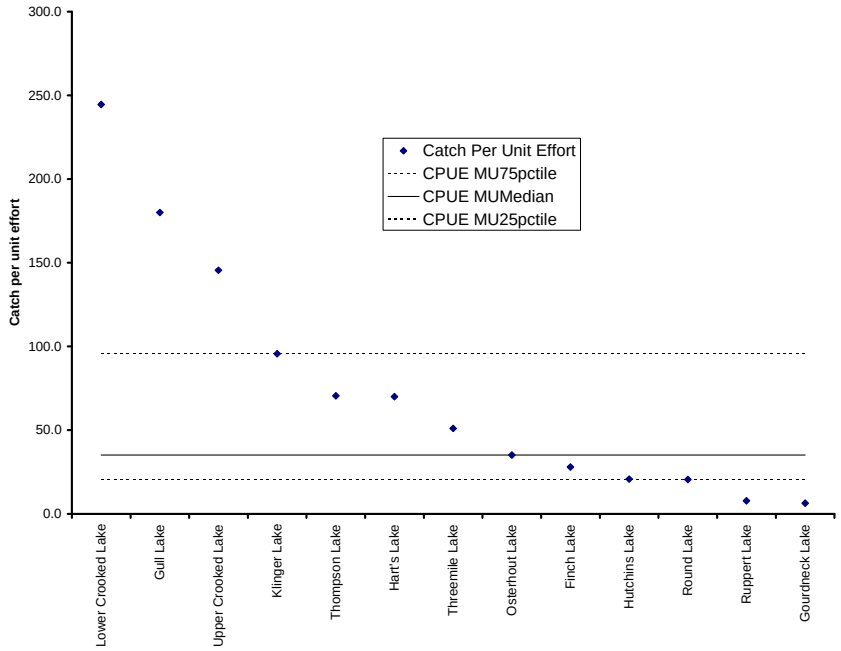

Figure 5. Relative abundance of bluegills in Hart's Lake compared to other lakes in the southwest Michigan region. CPUE data is the number of bluegills captured per fyke net night.

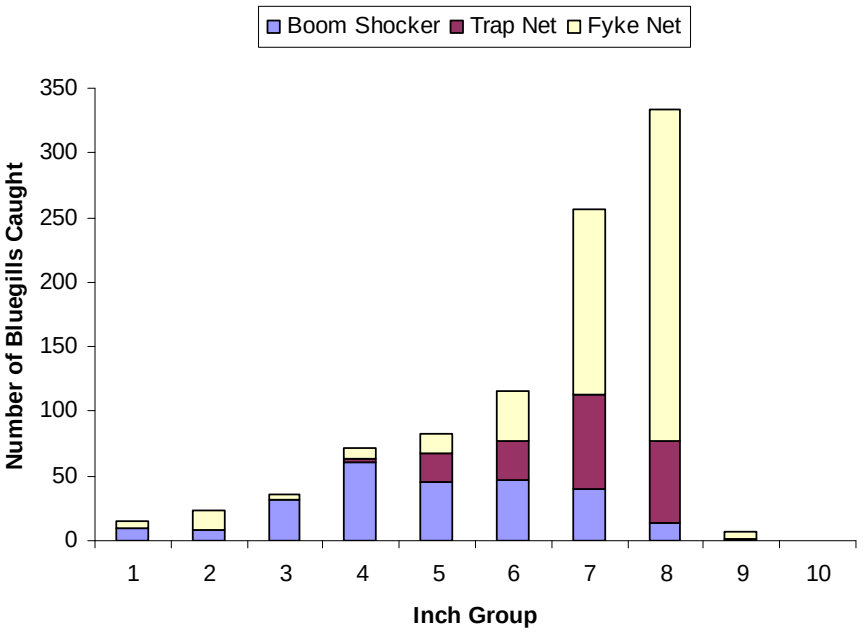

Figure 6. Length frequency distribution of bluegills captured by gear type in Hart's Lake.

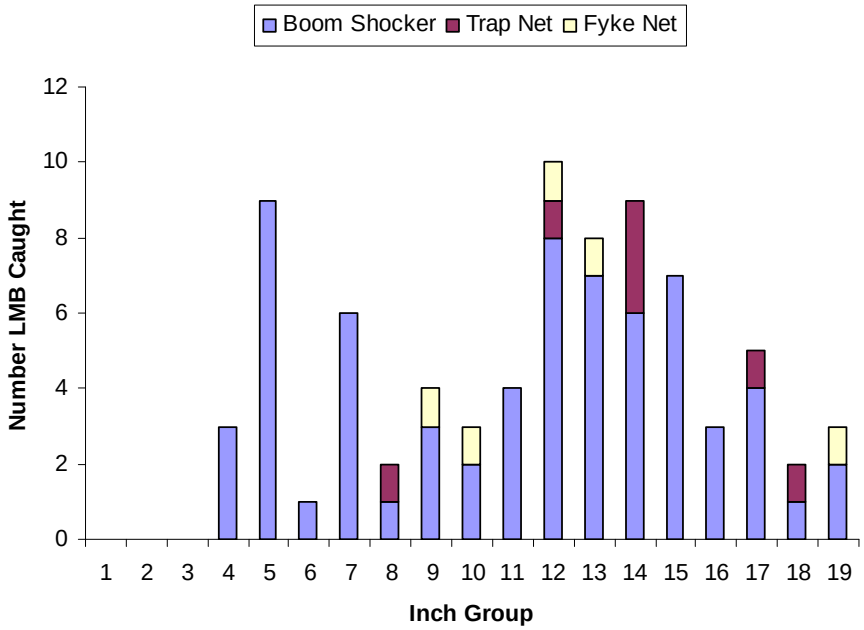

Figure 7. Length frequency distribution of largemouth bass captured by gear type in Hart's Lake.