Murray Lake

Kent County, T08N, R09W, S33
Grand River watershed, 2005

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Environment

Murray Lake is a 320-acre natural lake located approximately 15 miles northeast of the city of Grand Rapids. This horseshoe-shaped lake has a shoreline development index of 2.69 and a maximum depth of 72 feet (Figure 1; Orth 1983). Drop-offs generally are steep, and only about 30% of the lake is less than 15 ft deep. Sand and marl substrates predominate in the littoral zone. Peat and organic substrates are common in offshore areas. Two small streams enter along the west shore, but the main inlet flows out of the wetland complex at the north end of the lake. The outlet (Murray Lake Creek) leaves the southwest end of the lake and intersects with the Flat River 4.7 miles downstream.

Murray Lake is flanked by medium-textured till to the northwest and end moraines of medium-textured till to the southeast. Darcy maps indicate low groundwater recharge potential in this region. Agriculture is the predominant land use within the watershed, but there is considerable residential development along the shoreline of the lake. The 2005 habitat survey revealed a dwelling density of 30.0 dwellings/mile (18.6 dwellings/km). Approximately 18% of the shoreline is armored with seawalls or riprap, and large woody structure is scarce. Quantitative data regarding vegetative cover was not collected in 2005, but visual observations indicated that aquatic vegetation was moderately abundant in the littoral (nearshore) zone. The MDNR boat launch provides the only public access to this lake (Figure 1).

Limnological sampling was conducted at two basins within the lake on September 7, 2005 (Figure 1). The temperature and dissolved oxygen profiles for the two basins were similar (Figure 2). At both sites, the thermocline began at 17 ft. The hypolimnion was essentially anoxic, with dissolved oxygen concentrations < 1ppm at depths greater than 27 ft. Total alkalinities at the two basins were almost identical (166 mg/L and 167 mg/L) and were indicative of a hardwater lake with substantial buffering capacity. This conclusion is corroborated by the slightly alkaline pH values (7.35-8.95) recorded at these sites. Chorophyll a concentrations ranged from 1.8 ug/L to 1.9 ug/L. The ratio of total nitrogen to total phosphorus was >50:1 for both basins, so it appears that phosphorus is the limiting nutrient in this system. Total phosphorus concentrations were 10.0 ug/L for Basin 1 and 7.0 ug/L for Basin 2. The chlorophyll and phosphorus concentrations were within the "oligotrophic" category, but the Secchi disk depths (8-10 ft) were more typical of a mesotrophic lake (Carlson and Simpson 1996).

History

The first fisheries survey of Murray Lake was conducted in 1891. Largemouth bass, yellow perch, bluegill, sunfish (presumably pumpkinseeds), bullheads, and grass pickerel were collected during that effort. The fish were reported to be "in good condition and large." Whitefish (ciscoes?) apparently had been stocked a few years earlier, but no whitefish had been observed after stocking.

Murray Lake was not surveyed again until 1955. Bluegill, pumpkinseed, yellow perch, and black crappie were considered abundant. Northern pike, largemouth bass, and longear sunfish were considered common. (Note: The identification of longear sunfish is questionable, as this species was not captured during any other surveys on Murray Lake.) With the exception of black crappie, the panfish populations were dominated by small fish (< 6 inches). Mean growth indices for most game fish species generally were close to the state average, but growth of northern pike was well above the state average. Two state-listed fish species, cisco (threatened) and pugnose shiner (special concern), were captured during the 1955 survey.

Another fisheries survey conducted in 1970 indicated that yellow perch was the most abundant species in the littoral zone, but only a small percentage of the perch captured were larger than 7 inches. The pumpkinseed population also was composed primarily of small fish. Bluegill and black crappie were much less abundant than yellow perch; however, most of the bluegills and black crappies collected were of harvestable size. Largemouth bass were common and approximately 20% of these fish were larger than 14 inches. Few northern pike were encountered during this sampling effort.

To provide additional fishing opportunities in the greater Grand Rapids area, a tiger muskellunge stocking program was intiated in Murray Lake in 1970 and continued through 1991 (Table 1). Fisheries surveys (completed in 1978, 1980, 1982, and 1990) and angler reports generally indicated "fair" to "good" fishing for tiger muskellunge. The size structure of the pumpkinseed population remained poor throughout this period, but the size composition of the yellow perch and bluegill populations were more variable. Largemouth bass and northern pike consistently made up only a small percentage of the total catch. Although most sampling effort was directed toward nearshore species, several ciscoes were captured in gill nets during the 1990 survey.

The MDNR tiger muskellunge stocking program ended in 1991. During the mid 1990s, anglers expressed support for continued muskellunge management in this lake. Fall fingerling northern muskellunge were introduced into Murray Lake in 1998. Additional fall fingerlings were stocked in 2000, 2003, and 2005, and muskellunge fry were stocked in 2006 (Table 1).

Current Status

A variety of methods were used to evaluate the fish community and the fishery in Murray Lake during the 2005 open water season. Fish were captured with trap nets, gill nets, seines, and electrofishing gear in late May - early June as part of MDNR's Status and Trends Program. (This program involves standardized sampling in randomly selected lakes to provide information regarding spatial and temporal trends in Michigan's fish communities.) A creel survey also was conducted during April 4 through October 22 to collect additional information regarding fishing effort, harvest, and catch rates for various game fish species in Murray Lake.

Twenty-two fish species were collected during the Status and Trends (S&T) survey (Table 2). Numerically, bluegill (N = 840) was the most abundant species, making up 58% of the total catch. Thirty-one percent of the bluegills measured were of harvestable size. Size structures of bluegill populations can be challenging to interpret because each gear type exhibits some degree of size selectivity. In an effort to minimize the subjectivity associated with analyses of bluegill catch data, Schneider (1990) developed a standardized scoring system for interpreting length-frequency distributions of bluegills collected with various types of sampling gear. The size score for the Murray

Lake bluegill population was 4.25 (satisfactory) based on the trap net sample and 2.25 (poor) based on the electrofishing sample (Schneider 1990). The mean growth index for bluegills was -1.2, indicating that growth is slower than the state average. (Note: Schneider et al. [2000] calculated different state average lengths for January-May and June-July. During the 2005 S&T survey, scale samples were collected in May and June. The June-July average lengths from Schneider et al. [2000] were used to calculate the mean growth indices discussed in this paper.) Based on the length-at-age data, it appears that most bluegills reach harvestable size during their sixth summer (age 5). The age frequency distribution suggests adequate survival to age 6, but only a few fish older than 6 years were collected (Figure 3).

Bluegills composed approximately 82% of the total harvest during the 2005 creel survey (Table 3). For April through October, the bluegill harvest estimate was 11,436 fish. An additional 37,983 bluegills were caught and released, so it appears that anglers had to release about 3 undersized fish for every "keeper". The bluegill harvest per angler hour (CPH) for Murray Lake was 0.47. For comparison, the bluegill CPH values for Gull Lake (Allegan and Barry counties), Muskegon Lake (Muskegon County), and Campau Lake (Kent County) were 0.59, 0.36, and 0.05, respectively (Su et al. 2006).

Four other panfish species also were collected during the S&T survey: black crappie (N = 130), pumpkinseed (N = 54), yellow perch (N = 30), and green sunfish (N = 2). Ninety-eight percent of the black crappies captured were of harvestable size, compared to 52% for pumpkinseeds, and only 3% for yellow perch. The poor yellow perch catch during the S&T survey apparently was not representative of the Murray Lake perch population, as the yellow perch harvest estimate (N = 1,106) from the 2005 creel survey was higher than the estimates for black crappie and pumpkinseed. The observed size structures for the perch population also differed between the S&T and creel surveys. The harvest and release estimates for yellow perch indicate that only 2 perch were released for each fish harvested (i.e., about 33% harvestable). Length-at-age data revealed average growth for black crappie and pumpkinseed, and below average growth for yellow perch.

Largemouth bass (N = 113) made up 15% of the biomass during the S&T survey. Nineteen percent of the bass measured were of legal size (14 inches or larger). The creel results indicate that over 8,900 bass (CPH = 0.39) were caught during 2005 open water fishing season. The bass fishery in Murray Lake is almost entirely a catch-and-release fishery, and only 1% of these fish were harvested. The mean growth index for largemouth bass was -1.5, so it appears that growth is slower than the state average. Ten different year classes were represented in the S&T sample.

Nineteen muskellunge were captured during the S&T sampling. The length range for these fish was 19-41 inches, so no fish were legal under the current minimum size limit of 42 inches. Although not numerically abundant, muskellunge composed 23% of the biomass in the catch. No muskellunge were harvested during the creel survey, but the catch-and-release estimate was 584 fish. Fish from three different year classes were captured during the S&T survey: 2003, 2000, and 1998. Growth of young muskellunge was slightly better than the state average (Figure 4). Growth rate apparently declined for older muskellunge, as lengths of age 7 muskellunge were well below the state average.

Ciscoes (N = 101) made up the bulk of the gill net catch in Murray Lake. The length range for captured ciscoes was 8-11 inches, with most fish in the 9-10 inch size classes. Three year classes (ages 2-4) were represented in the catch. No ciscoes were observed during the creel survey.

Northern pike (N = 8) are rare in Murray Lake. Only 90 pike were recorded during the creel survey, and 78 of these fish were released.

Analysis and Discussion

The creel survey results indicate that Murray Lake receives heavy fishing pressure. The number of angler hours per acre was 71.7 for Murray Lake, compared to 58.5 for Campau Lake (Kent County) and 18.7 for Paw Paw Lake (Van Buren County; Su et al. 2006).

This intensive fishing pressure influences the size and age composition of the Murray Lake bluegill population. Most bluegills in Murray Lake reach harvestable size at age 6, and the age-frequency distribution suggests that most fish are harvested before reaching age 7 (Figure 3). Below average growth further reduces the odds of catching a "trophy" bluegill in this system.

The reasons for the poor growth of bluegills in Murray Lake are not completely understood, but a variety of potential limiting factors have been identified. The phosphorus and chlorophyll a concentrations from the 2005 survey indicate that Murray Lake is an oligotrophic system with a scant supply of nutrients. Nutrients ultimately determine the production of the zooplankton and aquatic macroinvertebrates that are the main food sources for bluegills. Thus, Murray Lake is only capable of supporting a low density bluegill population. Bluegill growth also can be influenced by the presence of predators. During the S&T survey, piscivores (largemouth bass, muskellunge, northern pike, longnose gar, and bowfin) made up over 60% of the biomass in the catch. It typically is undesirable for piscivores to make up >50% of biomass in a fish community, as these conditions can lead to depletion of the forage base and reduced growth rates for predators (Schneider 2000). An overabundance of predators also can retard growth of prey species. When piscivores are abundant, prey species can be forced to remain in sub-optimal foraging habitats to find protection from predators (Matthews 1998).

The yellow perch, black crappie, and pumpkinseed populations provide additional fishing opportunities in Murray Lake. The black crappie fishery is seasonal, with the vast majority of the harvest occurring during the spring spawning season (Table 3).

In terms of numbers, Murray Lake supports a high quality largemouth bass fishery. Legal-sized fish made up about 20% of the S&T survey catch, which is about average for lakes in this area. The age-frequency distribution and the creel data do not indicate that overharvest is a problem. The primary reason for the lack of large bass in this system is poor growth (growth index = -1.5).

Murray Lake is providing an excellent catch-and-release fishery for northern muskellunge. The CPH during the 2005 creel survey was higher than any of the CPH values reported by Su et al. (2006) for other inland muskellunge fisheries. No legal-sized muskellunge were observed during the 2005 survey efforts. With average growth, muskellunge reach the minimum size limit of 42 inches at age 8. Because the northern muskellunge stocking program in Murray Lake did not begin until 1998, the oldest fish in the population were age 7. At this time, there is no evidence of natural reproduction of muskellunge in Murray Lake. All captured muskellunge were traced back to years in which stocking occurred.

The observed growth pattern for muskellunge probably can be explained by forage availability. Small prey fish (e.g., bluegills) are relatively common in Murray Lake. These fish are suitable forage for young muskellunge. Growth of older muskellunge is tied to the availability of large, soft-rayed forage fishes, such as white suckers. White suckers composed only 0.7% of the biomass during the S&T survey. In addition to negatively affecting growth of adult muskellunge, the scarcity of this nearshore prey species probably has shifted muskellunge predation pressure toward the pelagic cisco population.

The gill net catch indicates that Murray Lake supports a moderately strong cisco population. Ciscoes require cool, well-oxygenated water. During the summer, ciscoes are restricted to the water layer where the temperature is 68 degrees (Fahrenheit) or less and the dissolved oxygen concentration is at least 3.0 ppm (Latta 1995). In Basin 1, this layer extended from 18 ft to 26 ft (Figure 2). The "cisco layer" was slightly narrower in Basin 2, extending from 18 ft to 24ft.

Although ciscoes are common in Murray Lake, no ciscoes were harvested during the creel survey. Ciscoes typically inhabit the deep, offshore regions of lakes and feed primarily on zooplankton and aquatic insects. Thus, incidental catches of ciscoes are uncommon, and it is likely that most anglers are not even aware that the species resides in Murray Lake.

Northern pike make up a small percentage of the fish community in Murray Lake. All of the pike collected during the S&T survey were of legal size, and the limited growth data available suggest that growth is above average.

Because sampling gear and the timing of survey efforts have varied widely over the years, it is difficult to directly compare the 2005 catch rates for each species with historical data. Although the species composition of the catch has fluctuated during the last 50 years, no major changes in the fish community structure have been evident (except the recent replacement of tiger muskellunge with northern muskellunge).

Management Direction

Three primary fisheries management goals have been developed for Murray Lake. Goal 1: Maintain the highly popular muskellunge fishery in this water body. Goal 2: Protect the Murray Lake cisco population. Goal 3: Reduce the predator-prey ratio for this fish community.

The management goals for Murray Lake are interrelated. Muskellunge were the most abundant piscivores (by weight) during the S&T survey and probably are the main predators of adult ciscoes in this system. Thus, a slight reduction in muskellunge abundance would help accomplish goals 2 and 3.

The biennial muskellunge stocking program should continue, but the stocking density should be reduced from 3-5 fall fingerlings/acre to 2 fall fingerlings/acre. The current stocking rate is at the high end of the range recommended by Dexter and O'Neal (2004). The poor growth observed for older muskellunge in Murray Lake, coupled with the high predator-prey ratio during the S&T survey, suggests that the current stocking program is overtaxing the forage base. The muskellunge CPH probably will decrease if the stocking rate is reduced, but the size structure of the population should improve as prey fish populations recover. Thus, reducing the stocking density actually may increase the number of legal-sized muskellunge in the lake.

The revised muskellunge stocking program will begin in 2009. Due to the longevity of muskellunge and the unusually high stocking density in 2006, it will take several years for the effects of this management change to be fully realized. (Muskellunge stocked in 2009 would not be expected to attain legal size until at least 2017). A fisheries survey should be conducted during 2017 to assess the status of the muskellunge fishery and the Murray Lake fish community. To facilitate temporal comparisons, the timing and gear used during the 2017 survey should match those of the 2005 S&T survey. A creel survey also could be completed to obtain additional information regarding the muskellunge fishery. In the interim, Fisheries Division will rely on local contacts to provide qualitative information on muskellunge fishing opportunities in Murray Lake.

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Table 1.–Fish stocking in Murray Lake, 1970-2006.

Year	Species	Strain	Number	Number/acre	Average length (inches)
1970	Tiger muskellunge		3,200	10	---
1971	Tiger muskellunge		1,631	5	---
1972	Tiger muskellunge		1,324	4	---
1973	Tiger muskellunge		913	3	---
1974	Tiger muskellunge		1,000	3	---
1975	Largemouth bass		430	1	---
1976	Tiger muskellunge		1,300	4	---
1977	Tiger muskellunge		1,300	4	---
1978	Tiger muskellunge		1,300	4	---
1979	Tiger muskellunge		1,300	4	5.36
1980	Tiger muskellunge		1,300	4	6.72
1981	Tiger muskellunge		700	2	6.20
1982	Tiger muskellunge		1,200	4	5.36
1984	Tiger muskellunge		1,120	4	6.96
1985	Tiger muskellunge		700	2	11.00
1986	Tiger muskellunge		1,000	3	8.00
1987	Tiger muskellunge		1,050	3	11.24
1988	Tiger muskellunge		1,000	3	10.44
1989	Tiger muskellunge		1,300	4	9.64
1990	Tiger muskellunge		1,300	4	10.32
1991	Tiger muskellunge		1,300	4	9.48
1998	Muskellunge	Northern	1,000	3	12.08
2000	Muskellunge	Northern	750	2	11.60
2003	Muskellunge	Northern	1,017	3	11.67
2005	Muskellunge	Iowa	1,600	5	11.80
2006	Muskellunge	Northern	100,000	313	0.32

Table 2.–Numbers, weights, lengths, and growth indices for fish species collected during the Status and Trends survey on Murray Lake, May-June, 2005. Fish were captured using trap nets, gill nets, and electrofishing gear. (Note: Lengths and weights were not recorded for fish captured with seines, so these fish are not included in the table. The total catch for 3 seine hauls was 125 spottail shiners, 9 brook silversides, 3 banded killifish, 2 bluntnose minnows, and 1 johnny darter.)

Species	Number	Percent by number	Weight (lbs)	Percent by weight	Length range (inches)	Percent legal or harvestable[1]	Growth index[2]
Bluegill[3]	840	58.0	108.4	15.4	1-9	31	-1.2
Black crappie	130	9.0	61.1	8.7	6-12	98	+0.4
Largemouth bass[3]	113	7.8	107.9	15.3	2-19	19	-1.5
Cisco	101	7.0	24.6	3.5	8-11	---	-0.1
Brown bullhead	57	3.9	43.2	6.1	8-15	---	---
Pumpkinseed	54	3.7	9.6	1.4	3-7	52	-0.5
Rock bass	34	2.3	11.9	1.7	4-10	82	-0.6
Yellow perch	30	2.1	1.4	0.2	3-8	3	-1.2
Warmouth	24	1.7	6.1	0.9	3-8	88	---
Muskellunge	19	1.3	159.7	22.7	19-41	0	-1.1
Longnose gar	15	1.0	54.8	7.8	30-39	---	---
Bowfin	9	0.6	52.2	7.4	22-27	---	---
Northern pike	8	0.6	53.1	7.5	25-37	100	---
Black bullhead	7	0.5	5.6	0.8	9-13	---	---
White sucker	3	0.2	4.9	0.7	12-19	---	---
Golden shiner	2	0.1	0.1	0.0	3-7	---	---
Green sunfish	2	0.1	0.2	0.0	3-5	0	---
Spottail shiner	1	0.1	0.0	0.0	2	---	---
Total	1,449		704.8				

[1] Harvestable size is 6 inches for bluegill, pumpkinseed, rock bass, warmouth, and green sunfish, and 7 inches for black crappie and yellow perch.

[2] Average deviation from the state average length at age.

[3] Some of the bluegills and largemouth bass were not measured. For each gear type, the total weight (of bluegills or largemouth bass) was calculated using the following formula: $W_t = W_m + W_m(N/N_m)$ where W_t = total weight, W_m = weight of measured fish, N = number of fish not measured, and N = number of measured fish.

Table 3.–Angler survey estimates for Murray Lake (Z. Su, MDNR Fisheries Division, unpublished). Survey period was April 4 through October 22, 2005. Two standard errors are given in parentheses. NA = estimates not available.

Species	CPH	April	May	June	July	August	September	October	Season
HARVEST									
Yellow Perch	0.0455	32	96	541	237	201	0	0	1,106
	(0.0396)	(63)	(119)	(838)	(351)	(221)	(0)	(0)	(945)
Northern pike	0.0005	0	12	0	0	0	0	0	12
	(0.0010)	(0)	(25)	(0)	(0)	(0)	(0)	(0)	(25)
Black crappie	0.0143	0	314	17	0	19	0	0	349
	(0.0166)	(0)	(398)	(33)	(0)	(37)	(0)	(0)	(401)
Bluegill	0.4699	788	832	4,042	2,934	1,763	700	379	11,436
	(NA)	(758)	(NA)	(1,969)	(1,895)	(1,211)	(682)	(NA)	(NA)
Largemouth bass	0.0040	0	0	28	56	0	13	0	97
	(0.0036)	(0)	(0)	(40)	(71)	(0)	(26)	(0)	(85)
Pumpkinseed	0.0289	47	178	416	0	48	0	14	703
	(NA)	(68)	(192)	(309)	(0)	(96)	(0)	(NA)	(NA)
Rock bass	0.0077	19	69	22	0	67	11	0	188
	(0.0064)	(26)	(96)	(44)	(0)	(103)	(23)	(0)	(152)
Green Sunfish	0.0005	0	0	0	0	0	13	0	13
	(0.0011)	(0)	(0)	(0)	(0)	(0)	(26)	(0)	(26)
Other	0.0027	0	67	0	0	0	0	0	67
	(0.0055)	(0)	(133)	(0)	(0)	(0)	(0)	(0)	(133)
TOTAL HARVEST	0.5741	885	1,567	5,065	3,227	2,098	737	393	13,972
	(NA)	(764)	(NA)	(2,164)	(1,928)	(1,239)	(683)	(NA)	(NA)
RELEASED									
Smallmouth bass	0.0010	0	0	25	0	0	0	0	25
	(0.0023)	(0)	(0)	(56)	(0)	(0)	(0)	(0)	(56)
Largemouth bass	0.3676	34	356	2,675	2,758	2,561	423	139	8,947
	(0.1305)	(50)	(253)	(1,764)	(1,568)	(1,465)	(266)	(127)	(2,805)
Northern pike	0.0032	0	44	12	0	0	9	12	78
	(0.0026)	(0)	(52)	(24)	(0)	(0)	(19)	(17)	(62)
Muskellunge	0.0240	49	57	147	0	140	107	83	584
	(0.0098)	(62)	(60)	(118)	(0)	(114)	(92)	(63)	(217)
Rock bass	0.0446	26	66	611	224	39	119	0	1,085
	(NA)	(40)	(79)	(595)	(251)	(47)	(NA)	(0)	(NA)
Bluegill	1.5608	571	1,412	6,609	11,512	10,283	4,037	3,559	37,983
	(NA)	(524)	(NA)	(2,997)	(5,823)	(5,024)	(2,334)	(NA)	(NA)
Pumpkinseed	0.0256	0	0	33	233	286	72	0	624
	(0.0177)	(0)	(0)	(67)	(288)	(257)	(145)	(0)	(418)
Green Sunfish	0.0005	0	0	0	0	12	0	0	12
	(0.0010)	(0)	(0)	(0)	(0)	(24)	(0)	(0)	(24)
Yellow Perch	0.0842	0	179	309	480	767	178	137	2,050
	(NA)	(0)	(211)	(312)	(419)	(615)	(NA)	(NA)	(NA)
TOTAL RELEASED	2.1116	680	2,114	10,422	15,207	14,088	4,945	3,930	51,387
	(NA)	(531)	(NA)	(3,545)	(6,057)	(5,276)	(NA)	(NA)	(NA)
TOTAL CATCH	2.6857	1,565	3,681	15,487	18,434	16,186	5,682	4,323	65,359
	(NA)	(930)	(NA)	(4,153)	(6,357)	(5,420)	(NA)	(NA)	(NA)
ANGLER HOURS		1,235	3,386	5,621	4,836	5,312	2,515	1,432	24,336
		(863)	(1,291)	(2,335)	(1,586)	(2,226)	(894)	(540)	(4,053)
ANGLER TRIPS		384	1,073	1,658	1,184	1,390	822	346	6,857
		(235)	(453)	(827)	(479)	(582)	(359)	(138)	(1,288)

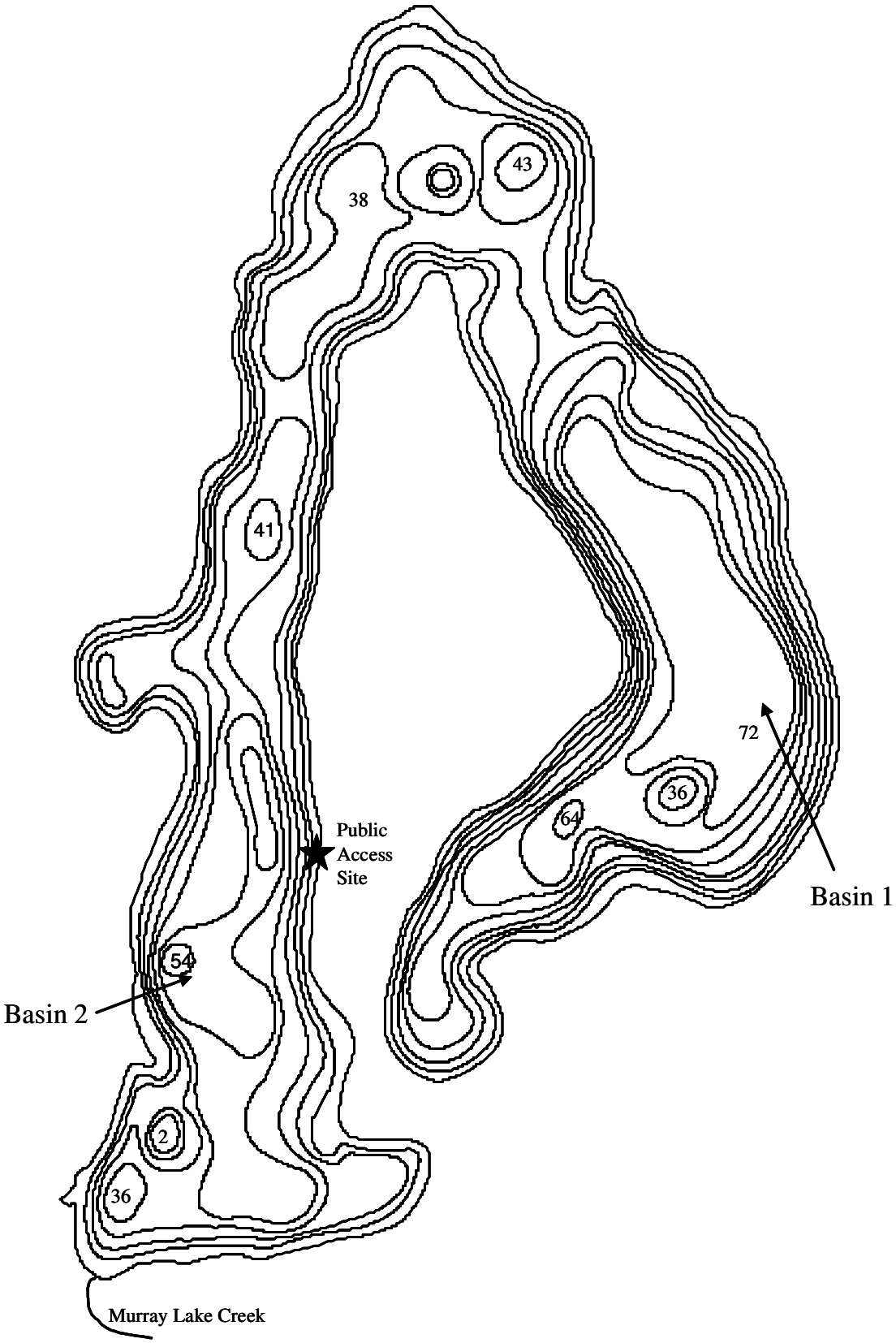
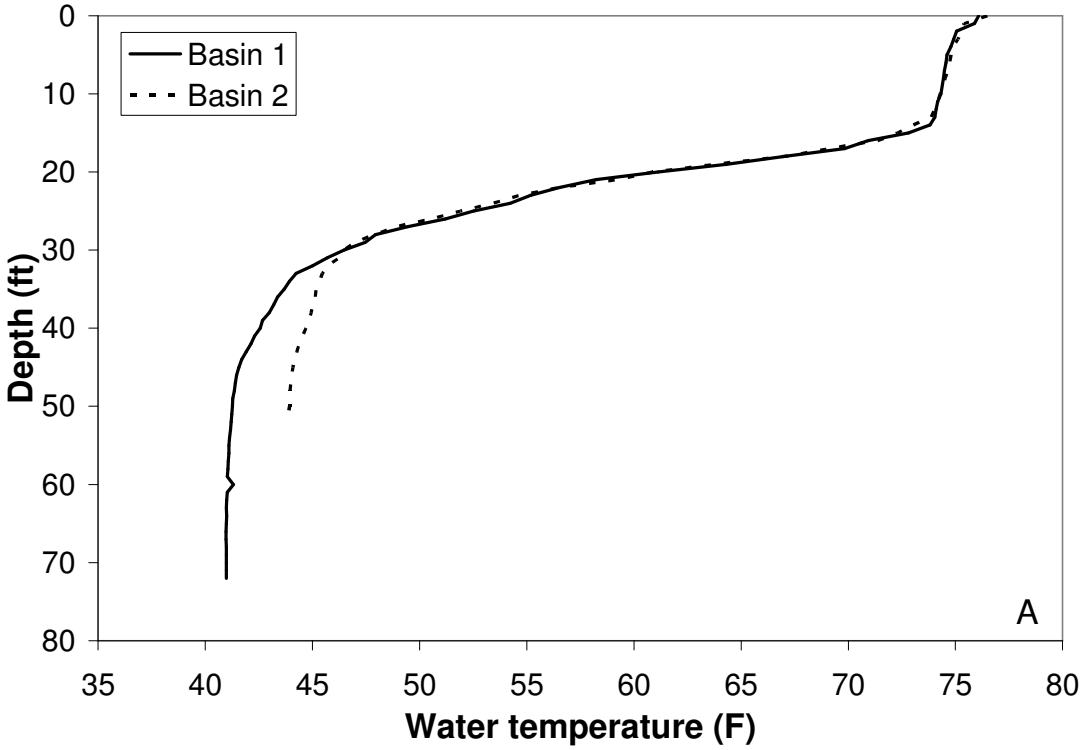


Figure 1.–Bathymetry of Murray Lake, Kent County.



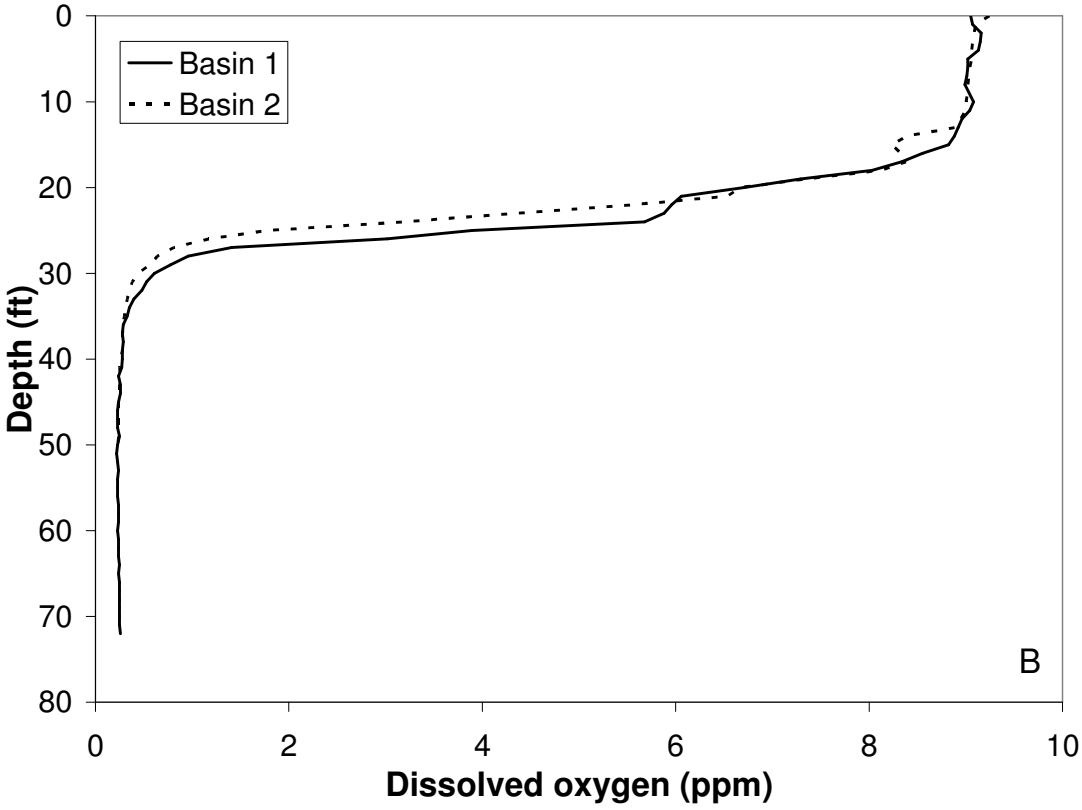


Figure 2.–Temperature (A) and dissolved oxygen profiles (B) for Murray Lake on September 7, 2005.

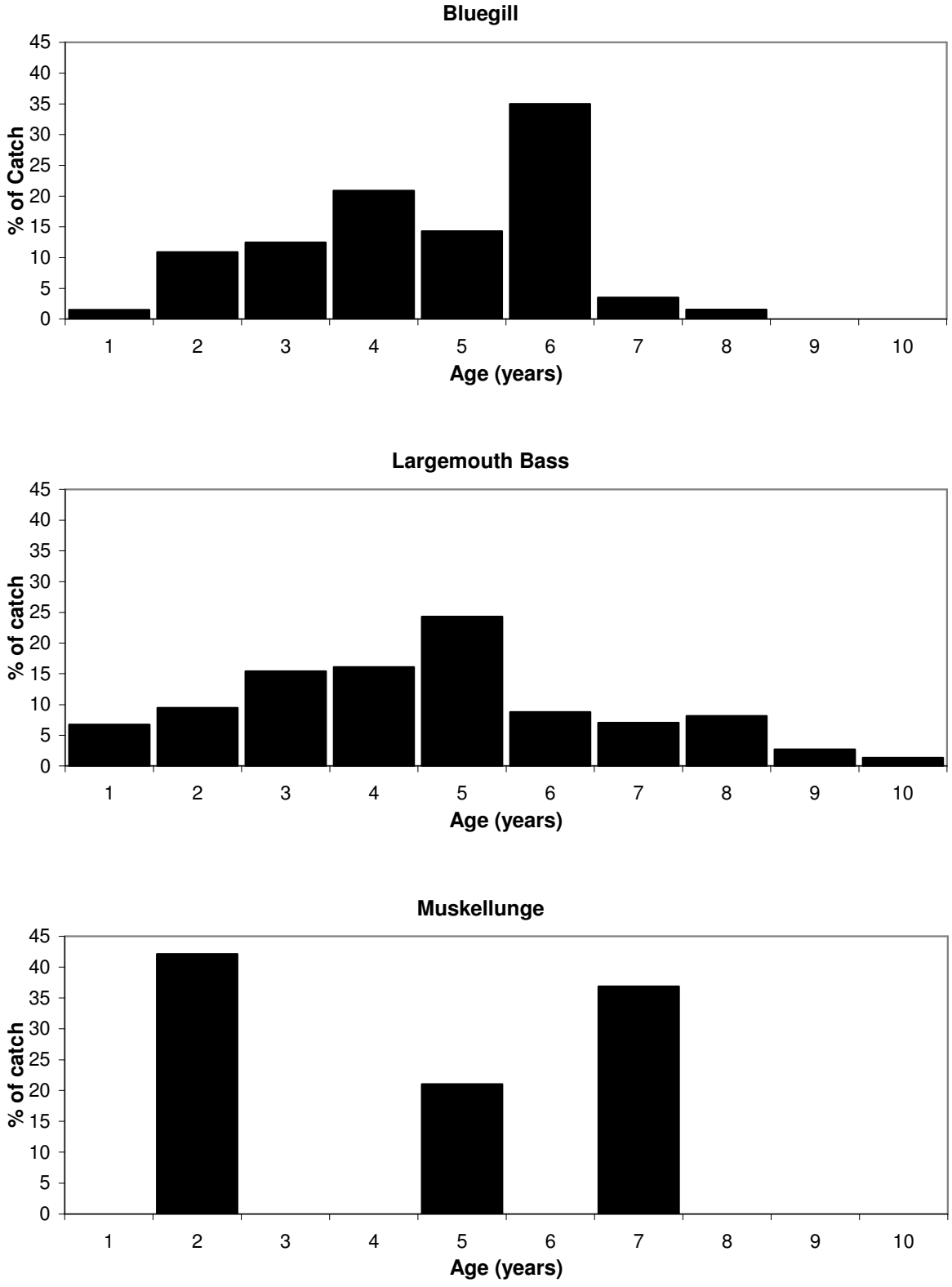


Figure 3.–Age-frequency distributions for bluegill, largemouth bass, and muskellunge captured in Murray Lake during May-June, 2005.

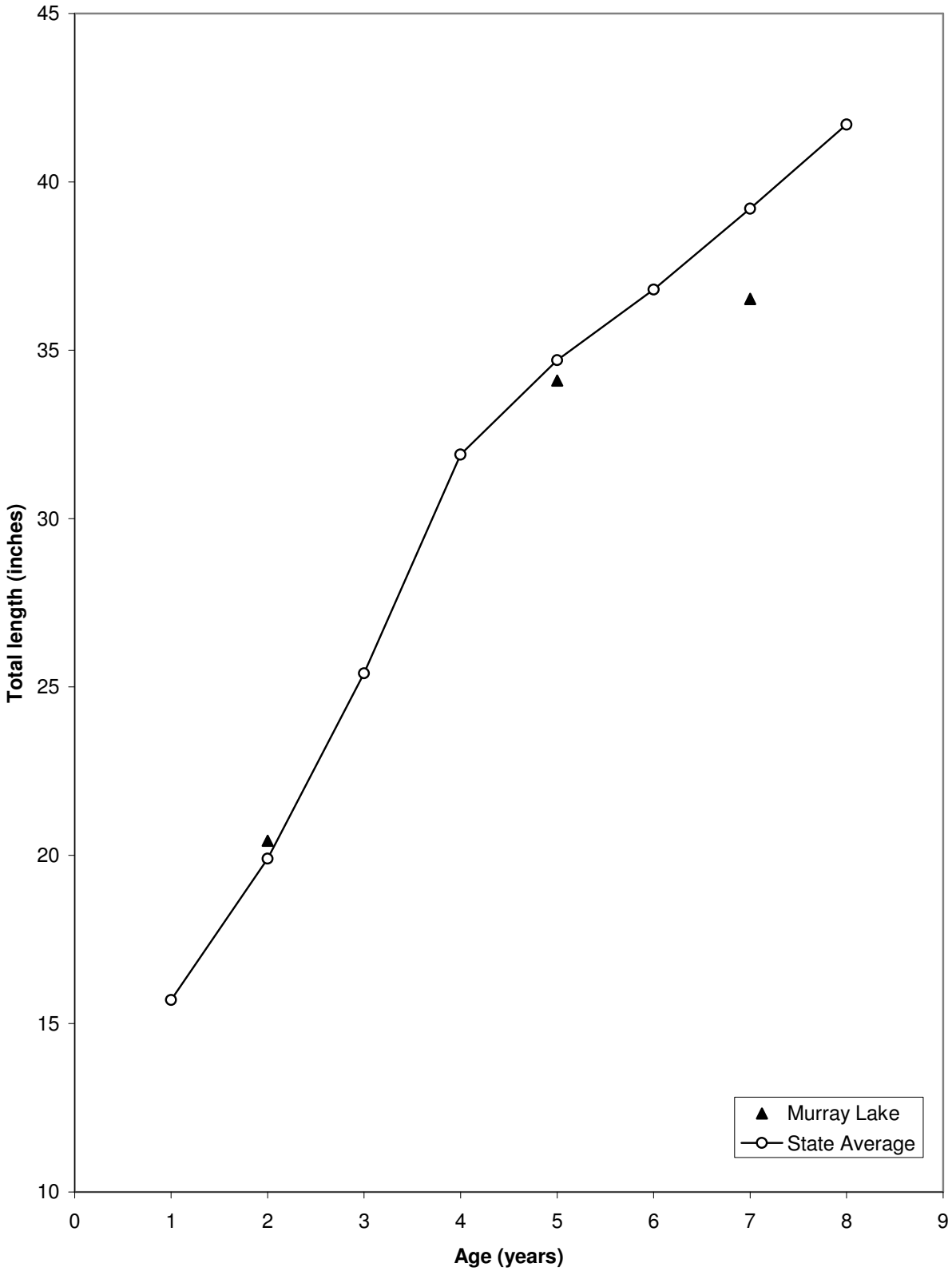


Figure 4.–Growth of muskellunge in Murray Lake. State average lengths from Schneider et al. (2000).