Cary Lake 2012 Survey Report

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Introduction

Cary Lake is a 79-acre natural lake located immediately south of US-12 between the towns of Bronson and Coldwater. The lake consists of a single basin with a maximum depth of 38 ft (Figure 1). Drop-offs are steep, and approximately 60% of the lake is deeper than 20 ft. Marl and sand are the predominant substrates along the shoreline, whereas organic substrates are common offshore. A small unnamed stream flows into the north end of Cary Lake. Water exits the lake via the outlet at the southwest end, flows into Sprong Lake, and ultimately intersects with another stream to form the South Branch of Swan Creek.

The lake is surrounded by deposits of glacial outwash sand and gravel and postglacial alluvium covered with loamy sands of the Spinks-Houghton-Boyer series. These materials are relatively porous, and Michigan Department of Conservation maps indicate the presence of groundwater seeps along the shoreline of Cary Lake. Agriculture is the predominant land use within the watershed (Figure 2). Residential and vacation home development is limited to the northern two-thirds of the west shore. A variety of wetland types (e.g., emergent, shrub, and forested) surround the remainder of the shoreline. The 2012 habitat survey revealed a total dwelling density of 9.1 dwellings/mile, which is low relative to most other lakes in southwest Michigan. Only 10% of the shoreline is armored with seawalls or riprap. Large woody cover is scarce. The Michigan Department of Natural Resources (MDNR) boat launch on the west shore provides public access to Cary Lake.

Limnological sampling was conducted at the deepest point in Cary Lake on August 22, 2012. As expected, the lake was thermally stratified (Figure 3). The epilimnion extended from the surface to a depth of 16 ft. Water temperatures within the epilimnion were relatively uniform, ranging from 75.4 ^{o}F to 73.5 ^{o}F. The metalimnion (zone of thermal change) extended from 16 ft to the bottom of the lake. Water temperatures declined from 73.5 ^{o}F at the top of the metalimnion to 46.2 ^{o}F at 36 ft. The oxygen distribution within Cary Lake followed a clinograde cure, with the highest oxygen concentrations occurring near the surface (Figure 3).

The biological productivity of a lake is strongly dependent on its supply of two key nutrients: phosphorus and nitrogen. The most recent nutrient testing on Cary Lake was completed by Michigan Department of Environmental Quality (MDEQ) personnel in August 2005. The ratio of total nitrogen to total phosphorus was >20:1 in 2005, so it appears that phosphorus is the limiting nutrient in this system (Shaw et al. 2004). The total phosphorus concentration at mid-depth was 0.016 mg/L. The chlorophyll *a* concentration, which provides an index of algal biomass, was 2.3 µg/L. Another water quality indicator is the Secchi disk depth, which is a measure of water clarity. On August 22, 2012 the Secchi disk depth was 8.5 ft. Based on these water quality parameters, Cary Lake is considered a mesotrophic (moderately productive) lake (Carlson and Simpson 1996).

The first fisheries survey of Cary Lake was conducted in 1927. Bluegills, largemouth bass, yellow perch, and spotted gar were collected during this initial sampling effort. Fall fingerling bluegills and largemouth bass were stocked in Cary Lake during 1935-1945 (Table 1). Throughout the state, annual stocking programs for these species were discontinued after research indicated that spawning habitat (e.g., sand, gravel, or firm mud) for largemouth bass and bluegills was abundant in Michigan lakes and that supplemental stocking had minimal effects on the quality of the fishery (Cooper 1948).

Limnological sampling completed during 1947 and 1957 indicated that water temperatures and dissolved oxygen concentrations in the lake were suitable for trout survival, and a rainbow trout stocking program was initiated in 1958 (Table 1). Legal-sized rainbow trout were stocked again in 1961, 1964, and 1966. No rainbow trout were captured during surveys conducted in the 1960s, and anglers reported poor fishing for trout. Seventeen other fish species were collected during these sampling efforts. Bluegills, yellow perch, and largemouth bass were the most abundant species in the catch. Growth was average for bluegills and largemouth bass.

Since 1973, yearling rainbow trout have been stocked in Cary Lake nearly every spring. Rainbow trout spawn in flowing water over gravel substrate. As this type of habitat is not accessible to Cary Lake rainbow trout, annual stocking is necessary to maintain the fishery. During 1973-2000 summer gill net surveys, hook-and-line surveys, and angler reports generally indicated acceptable survival of rainbow trout through the first summer, with occasional carryover to age 2.

Redear sunfish were stocked in Cary Lake during 1991-1993. Spring netting surveys were completed in 1994 and 1998 to evaluate survival, growth, and reproduction of redear sunfish and to assess the species composition and size structure of the fish community in the lake. No redear sunfish were captured in 1994 and only 11 were collected in 1998. All of the redear sunfish captured in 1998 had total lengths of 9.0-10.9 inches, and growth was slightly above average. Bluegills composed the bulk of the catch during both surveys. Numerically, the most abundant predatory species was largemouth bass. However, bowfin composed a larger percent of the total biomass than largemouth bass. Growth was average for largemouth bass and average to slightly above average for bluegills.

Materials and Methods

A fisheries survey was conducted on Cary Lake during March 19-21, 2012. The primary objective of this survey was to assess the survival and growth of stocked rainbow trout. A secondary objective was to obtain information on the species composition and size structure of the rest of the fish community in the lake. Fish were captured using fyke nets and gill nets (Table 2). Total lengths were recorded for all fish. For game fish species, dorsal spine samples were collected from 10 fish per inch group for age determination.

A nighttime electrofishing survey also was completed on November 5, 2012. Only rainbow trout were targeted. The survey encompassed the entire shoreline, and the total electrofishing time was 58 minutes.

Results

No rainbow trout were captured or observed during the spring netting effort or the fall electrofishing survey. One angler reported catching 14 rainbow trout (average length around 11.5 inches) in 2012. Two other anglers reported poor fishing in 2010 and 2011, but they said that they had caught many rainbow trout in Cary Lake prior to 2010. One of these anglers indicated that he had caught rainbow trout as large as 23 inches in this system.

Fifteen fish species were collected during the spring 2012 netting survey (Table 3). Bluegill (n = 185) was the most abundant species in the catch. Ninety-four percent of the bluegills captured were 6 inches or larger (Figure 4). 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. In Cary Lake, 97% of the bluegills were captured in large-mesh fyke nets. The bluegill size score based on the fyke net catch was 5.6 (good-excellent). The mean growth index for bluegills was +0.4, which is indicative of average growth (Figure 5).

Black crappie (n = 65) was the second most abundant species in the catch. Eighty-six percent of the black crappies collected were 7 inches or larger (Figure 6). Mean lengths-at-age for crappies age 2-4 were similar to statewide averages, whereas mean lengths-at-age for older crappies were above average (Figure 7). Yellow perch (n = 45) composed 10% of the total catch by number and 12% by weight. Seventy-eight percent of the perch captured were 7 inches or larger (Figure 8). The mean growth index for yellow perch was -0.3, which indicates that growth of yellow perch is within the average range for Michigan populations (Figure 9).

Largemouth bass (n = 19) are the dominant fish predators in Cary Lake. Total lengths for most of the largemouth bass collected during the 2012 netting survey were between 10.0 inches and 13.9 inches, and two fish (total length = 21.1-21.7 inches) exceeded the legal minimum size limit of 14 inches (Figure 10). The sample size was limited, but the available length-at-age data suggest that growth is below average (Figure 11).

The 2012 survey provided the first documentation of gizzard shad (n = 5) and channel catfish (n = 3) in Cary Lake. Both of these species are present in Long Lake and could have moved upstream through Swan Creek into Cary Lake. Although such actions are illegal, it is possible that anglers released these species directly into Cary Lake.

Analysis and Discussion

Unusual weather conditions were at least partially responsible for the absence of rainbow trout in the 2012 catch. The period from March through May of 2012 was the warmest spring on record in southwest Michigan (Marino 2012a). The abnormally high water temperatures forced rainbow trout to move offshore earlier in the season, which made them less vulnerable to our sampling gear. Rainbow trout evaluations typically are conducted in late March-early April when surface water temperatures are in the upper 40s-lower 50s (Fahrenheit). During March 19-21, 2012, the surface water temperatures in Cary Lake varied from 62 ^{o}F to 64 ^{o}F.

The abnormally hot weather continued through the summer. Average air temperatures in southwest Michigan were 3 ^{o}F above normal during June-August (Marino 2012b). This weather pattern created stressful environmental conditions for trout and other coldwater fishes. The optimal temperature range for rainbow trout is 53.6-64.4 ^{o}F (Raleigh et al. 1984). Zero growth occurs at 73.4 ^{o}F (Hokanson et al. 1977), and the incipient lethal water temperature for rainbow trout is approximately 77 ^{o}F (Black 1953; Bidgood and Berst 1969; Hokanson et al. 1977).

Dissolved oxygen concentrations also can influence growth and survival of trout. Optimal oxygen concentrations for rainbow trout are $\geq$ 7 mg/L at temperatures $\leq$ 59 ^{o}F and $\geq$ 9 mg/L at temperatures > 59 ^{o}F (Raleigh et al. 1984).

> The incipient lethal level of dissolved oxygen for adult and juvenile rainbow trout is approximately 3 mg/L or less, depending on environmental conditions, especially

> temperature (Gutsell 1929; Burdick et al. 1954; Alabaster et al. 1957; Downing and Merken 1957; Duodoroff and Warren 1962). Although fish can survive at concentrations just above this level, they must make various physiological adaptations to low levels of dissolved oxygen that may jeopardize their health (Randall and Smith 1967; Kutty 1968; Hughes and Saunders 1970; Cameron 1971; Holeton 1971). For example, low levels of dissolved oxygen can result in reduced fecundity and even prevent spawning. Large fluctuations in dissolved oxygen may cause a reduction in food consumption and impaired growth (Duodoroff and Shumway 1970). [From Raleigh et al. 1984]

Thus, both water temperatures and dissolved oxygen concentrations influence the distribution of rainbow trout within a lake. May (1973) found that lake-dwelling rainbow trout typically occupied depths with water temperatures $\leq$ 70 ^{o}F and dissolved oxygen concentrations > 3 mg/L. Such conditions existed in a 2 ft deep band within the metalimnion in Cary Lake on August 22, 2012 (Figure 3). Overall, the temperature and dissolved oxygen profiles indicated that rainbow trout potentially were able to survive in Cary Lake through the summer of 2012, but the adverse environmental conditions probably had sub-lethal effects on the growth and health of rainbow trout in this system.

The 2012 limnological data represent a "worst case scenario" for Cary Lake. Data collected during previous years indicated that in late summer there typically is a wider band within the metalimnion with water temperatures $\leq$ 70 ^{o}F and dissolved oxygen concentrations > 3 mg/L. However, depth strata with optimal conditions (i.e., water temperatures $\leq$ 64.4 ^{o}F and dissolved oxygen concentrations $\geq$ 9 mg/L) have never been observed during late summer surveys. Thus, some level of physiological stress is expected during late summer in Cary Lake (and most other stocked trout lakes in southwest Michigan), but the magnitude of this stress was unusually great in 2012.

Trout fishing opportunities are limited in Branch County. Cary Lake has supported a trout fishery for many years, and fishing reports indicate that anglers continue to target rainbow trout in this system. Continued stocking is warranted, but another rainbow trout evaluation should be completed in 2017. Close monitoring of the fishery is especially important due to the recent discovery of gizzard shad in the lake. Gizzard shad are planktivores and thus are potential competitors of rainbow trout.

Because the 2012 survey was not conducted during the normal sampling period for warmwater fishes (i.e., May-early June), inferring relative abundance from catch-per-effort data is tenuous. The size structure and growth data suggest that Cary Lake is providing good fishing opportunities for bluegills, black crappies, and yellow perch. The sample size for largemouth bass was small, but the capture of two fish larger than 20 inches was encouraging. From 2008-2011, MDNR completed intensive largemouth bass population evaluations at five lakes in southwest Michigan. During those surveys largemouth bass $\geq$ 20 inches only made up about 1% of the total catch.

Management Recommendations

Three fisheries management goals have been developed for Cary Lake. Goal 1: Protect and rehabilitate habitat for fish and other aquatic organisms. Goal 2: Maintain or enhance the existing rainbow trout fishery. Goal 3: Collect additional information on growth and survival of rainbow trout. Goal 4: Collect additional information on water temperatures and dissolved oxygen concentrations in Cary Lake during summer stratification.

At least two different methods will be used to accomplish Goal 1. Fisheries Division personnel will continue to review MDEQ permit applications for potential effects on aquatic resources. If a proposed project is likely to degrade the aquatic habitat, Fisheries Division staff will object to the proposal and suggest feasible alternatives. Fisheries Division also will partner with other organizations to educate riparian landowners on the effects of various practices (e.g., chemical weed treatments, seawall construction, and removal of large woody cover) on aquatic ecosystems.

Annual stocking of 3,950 yearling rainbow trout (50/acre) will continue. For the near future, Eagle Lake strain fish will be stocked in Cary Lake. Recent studies in several inland lakes have indicated that Lake Michigan steelhead strain rainbow trout have higher survival and better return to the creel than Eagle Lake strain fish (Caroffino and Nuhfer In Press). At present, all steelhead are allocated for the Great Lakes, so no fish are available for inland stocking programs. If additional steelhead become available, these will be stocked in Cary Lake in place of Eagle Lake strain rainbow trout.

The unusual weather conditions in 2012 hampered assessment of the rainbow trout population in the lake. Another survey will be completed in 2017. This survey will include a netting effort in late March-early April and water temperature and dissolved oxygen monitoring in August.

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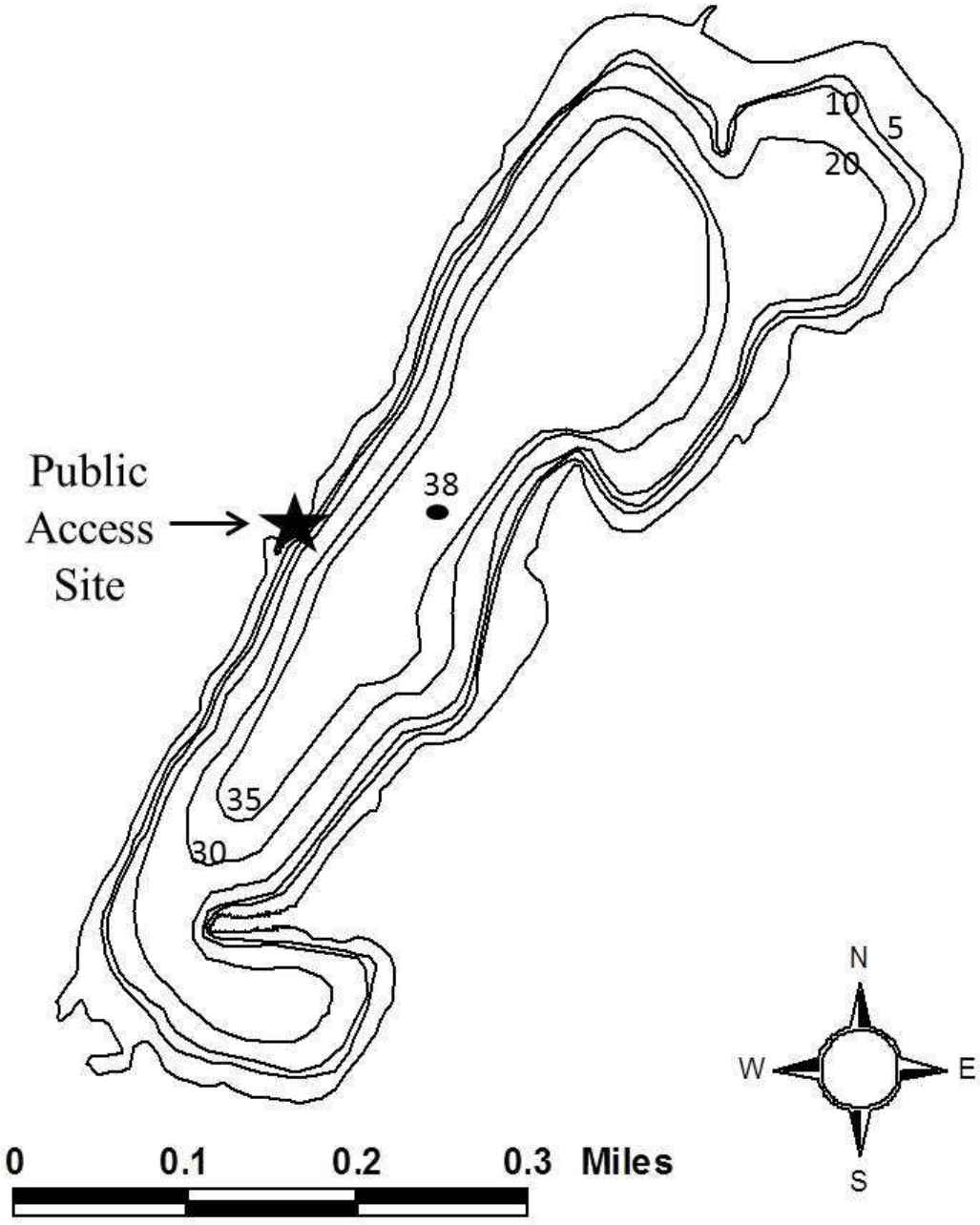


Figure 1.–Bathymetry of Cary Lake, Branch County. Depths are in feet.

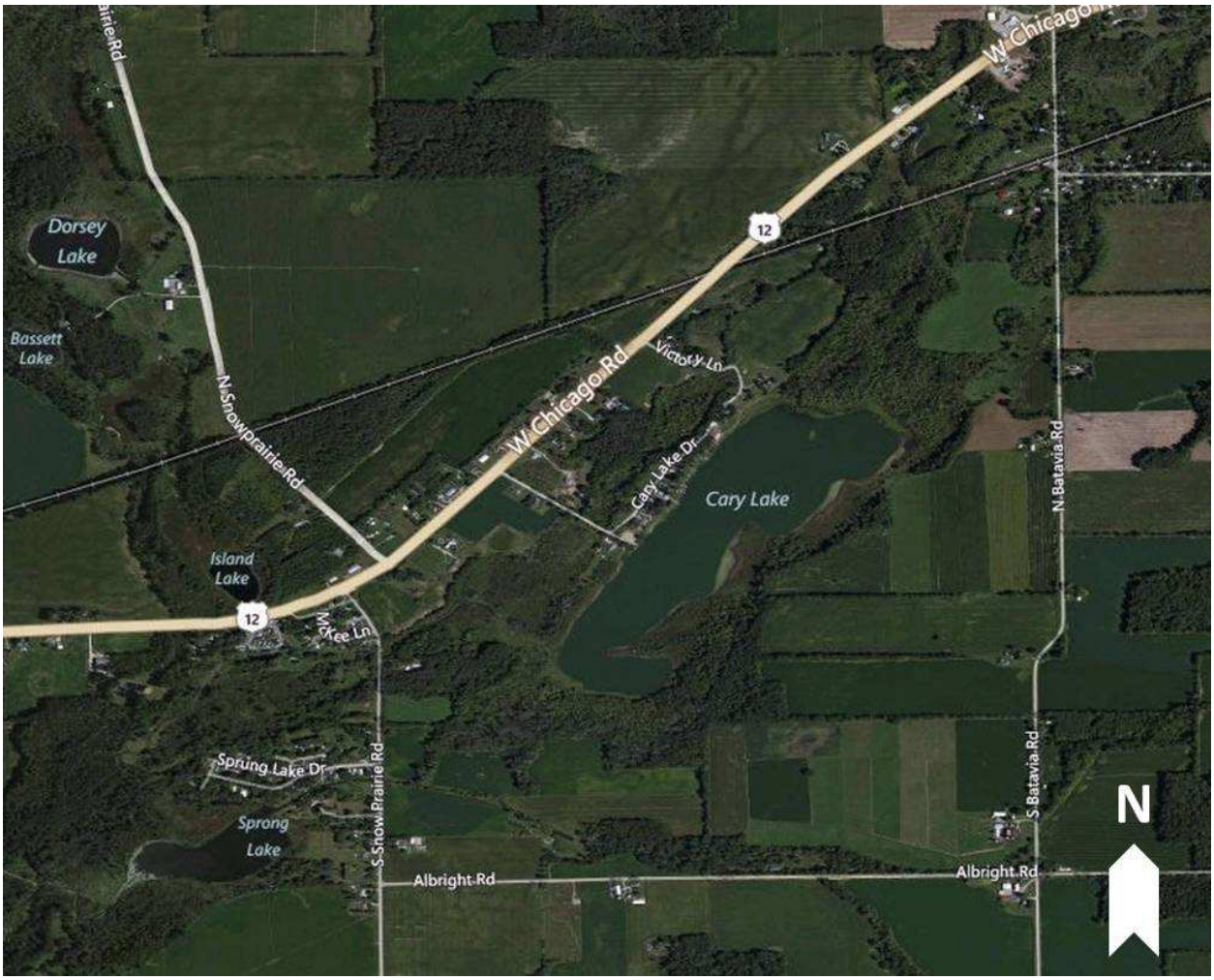
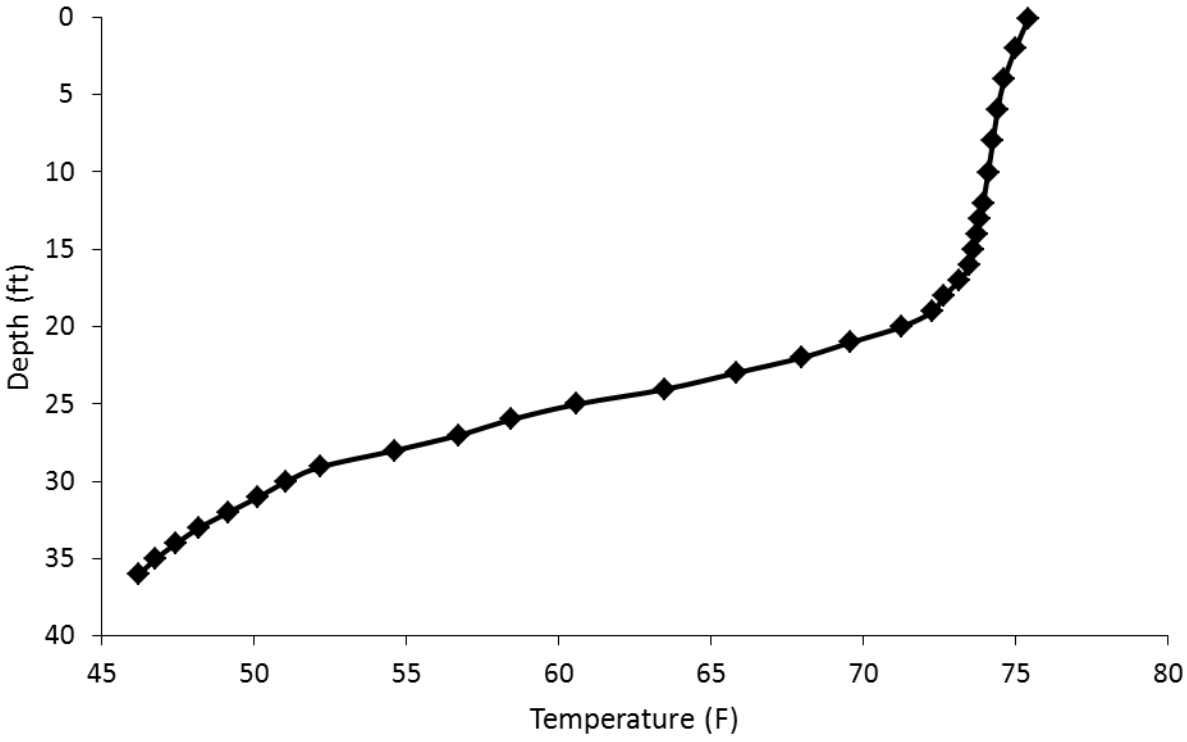


Figure 2.–Aerial view of Cary Lake and the surrounding area. Image from www.bing.com/maps.



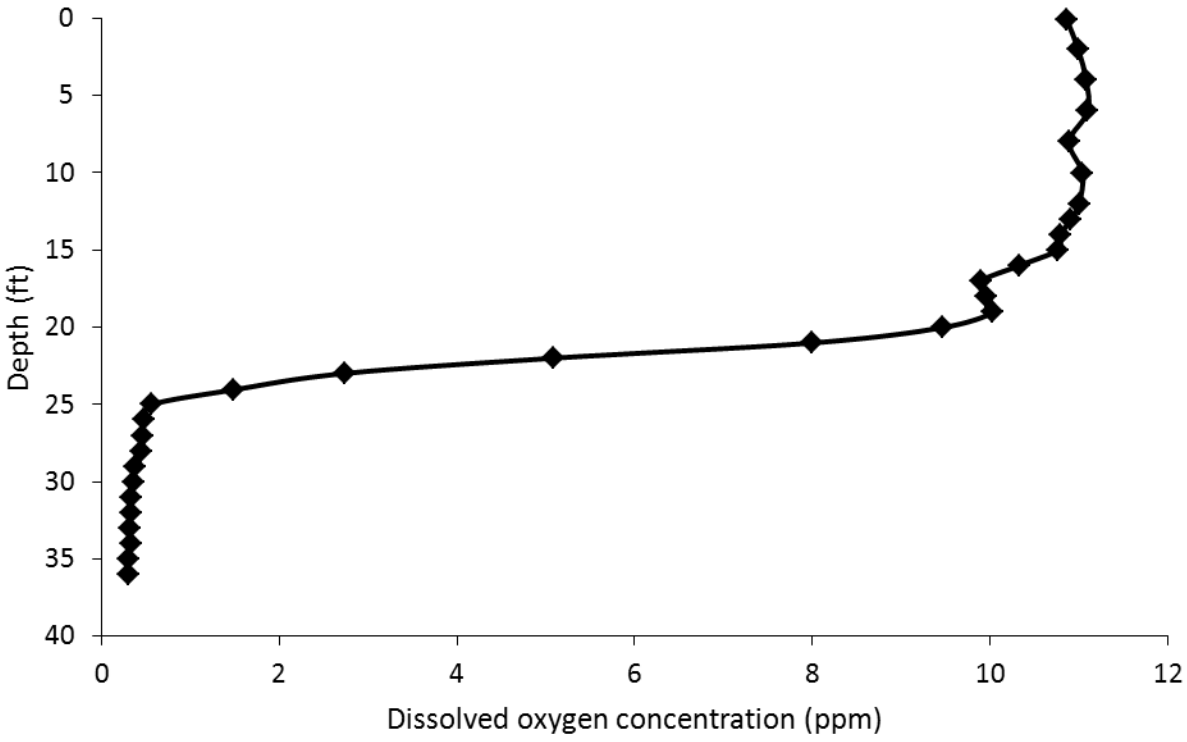


Figure 3.–Temperature and dissolved oxygen profiles for Cary Lake on August 22, 2012.

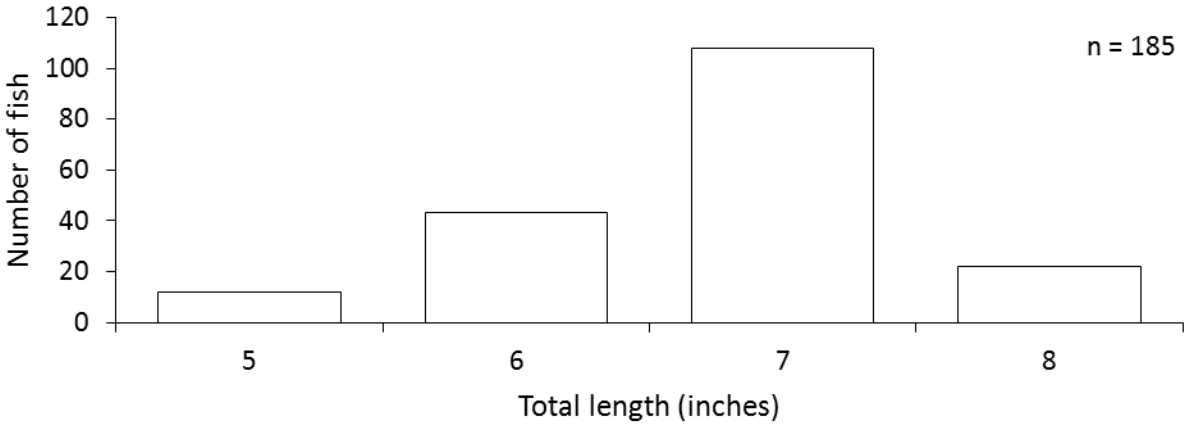


Figure 4.–Length frequency distribution for bluegills captured in Cary Lake during March 19-21, 2012.

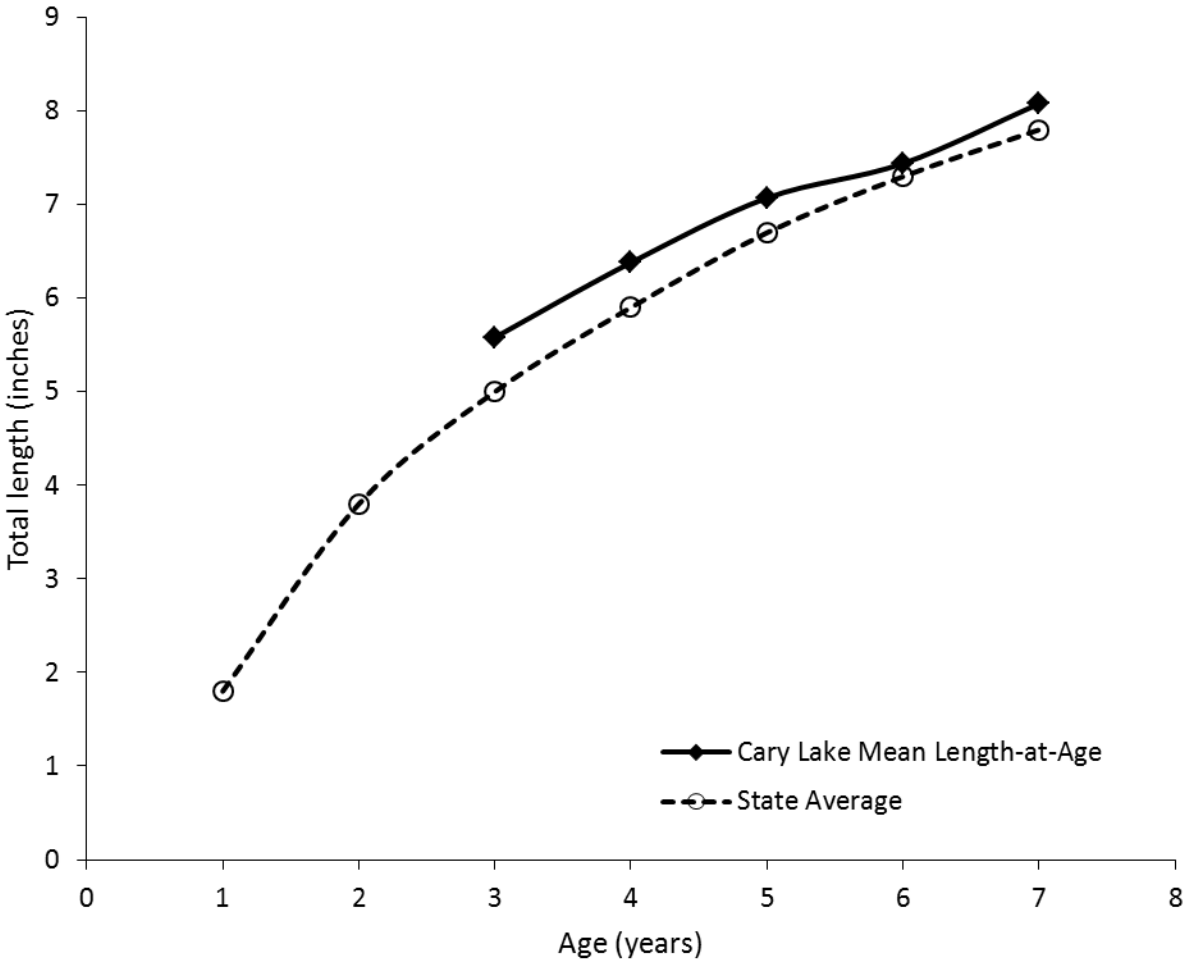


Figure 5.–Growth of bluegills in Cary Lake, as determined from dorsal spine samples collected during March 19-21, 2012. State average lengths from Schneider et al. (2000).

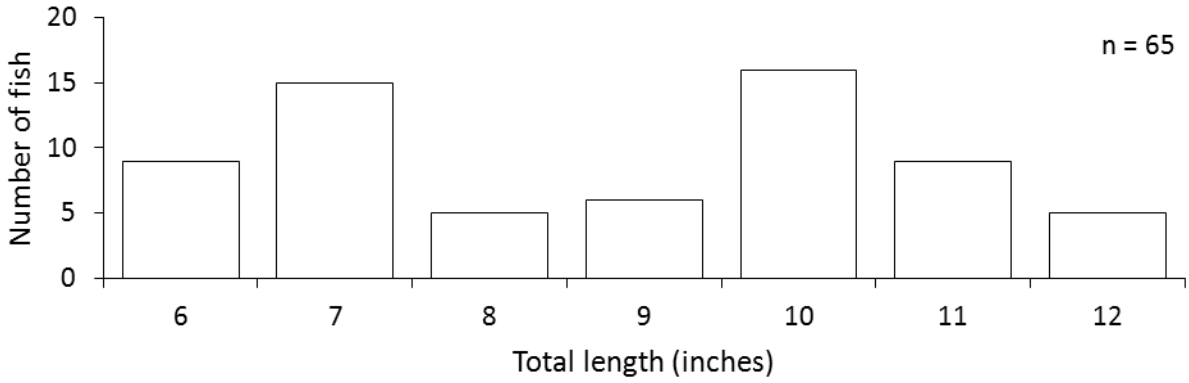


Figure 6.–Length frequency distribution for black crappies captured in Cary Lake during March 19-21, 2012.

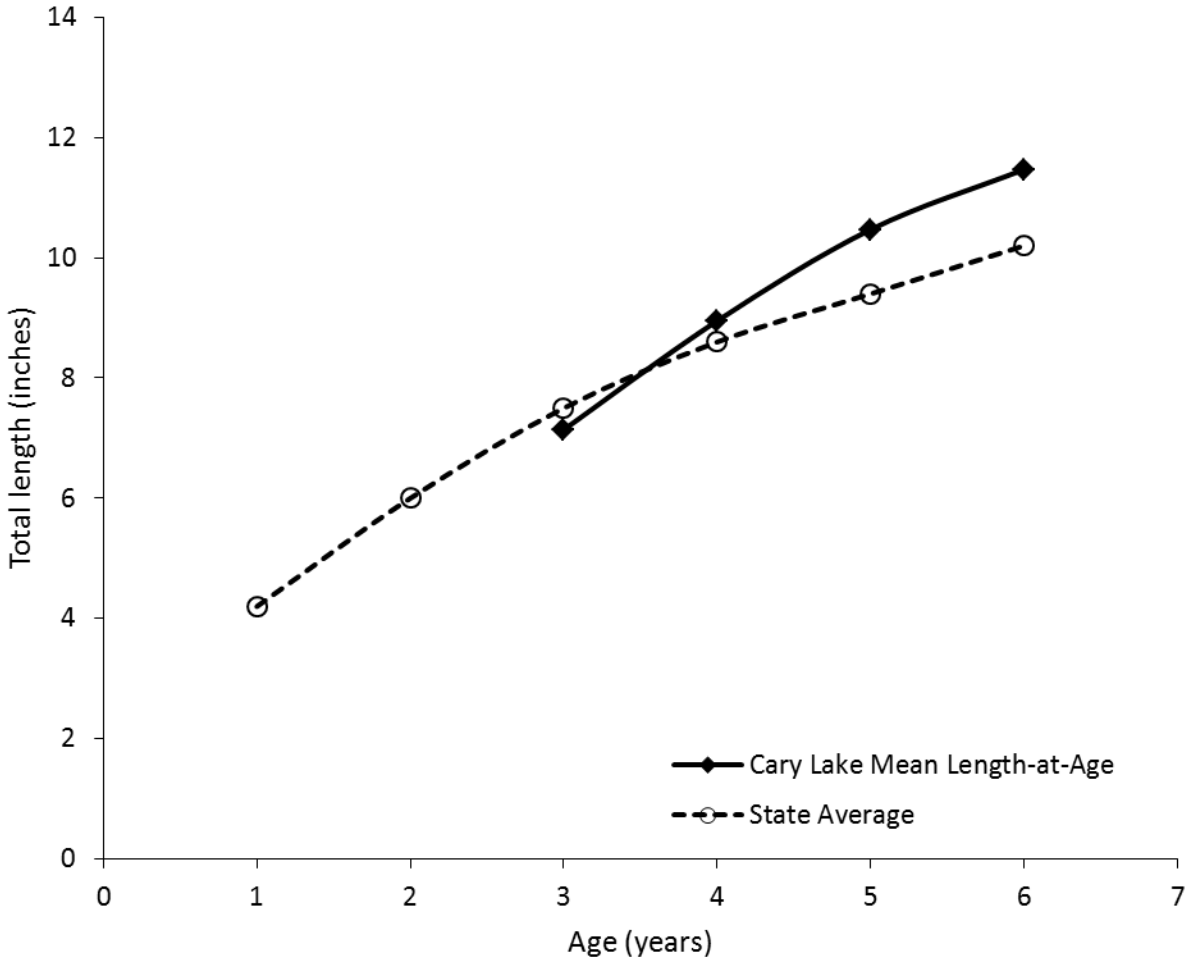


Figure 7.–Growth of black crappies in Cary Lake, as determined from dorsal spine samples collected during March 19-21, 2012. State average lengths from Schneider et al. (2000).

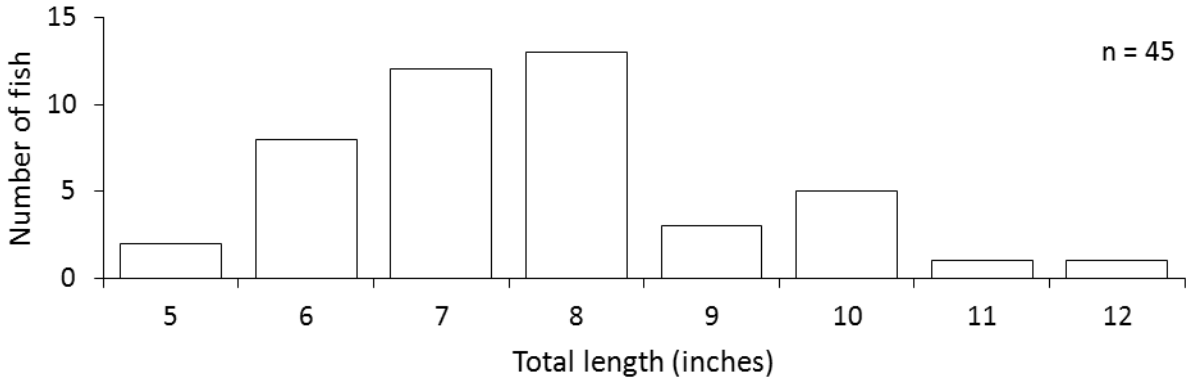


Figure 8.–Length frequency distribution for yellow perch captured in Cary Lake during March 19-21, 2012.

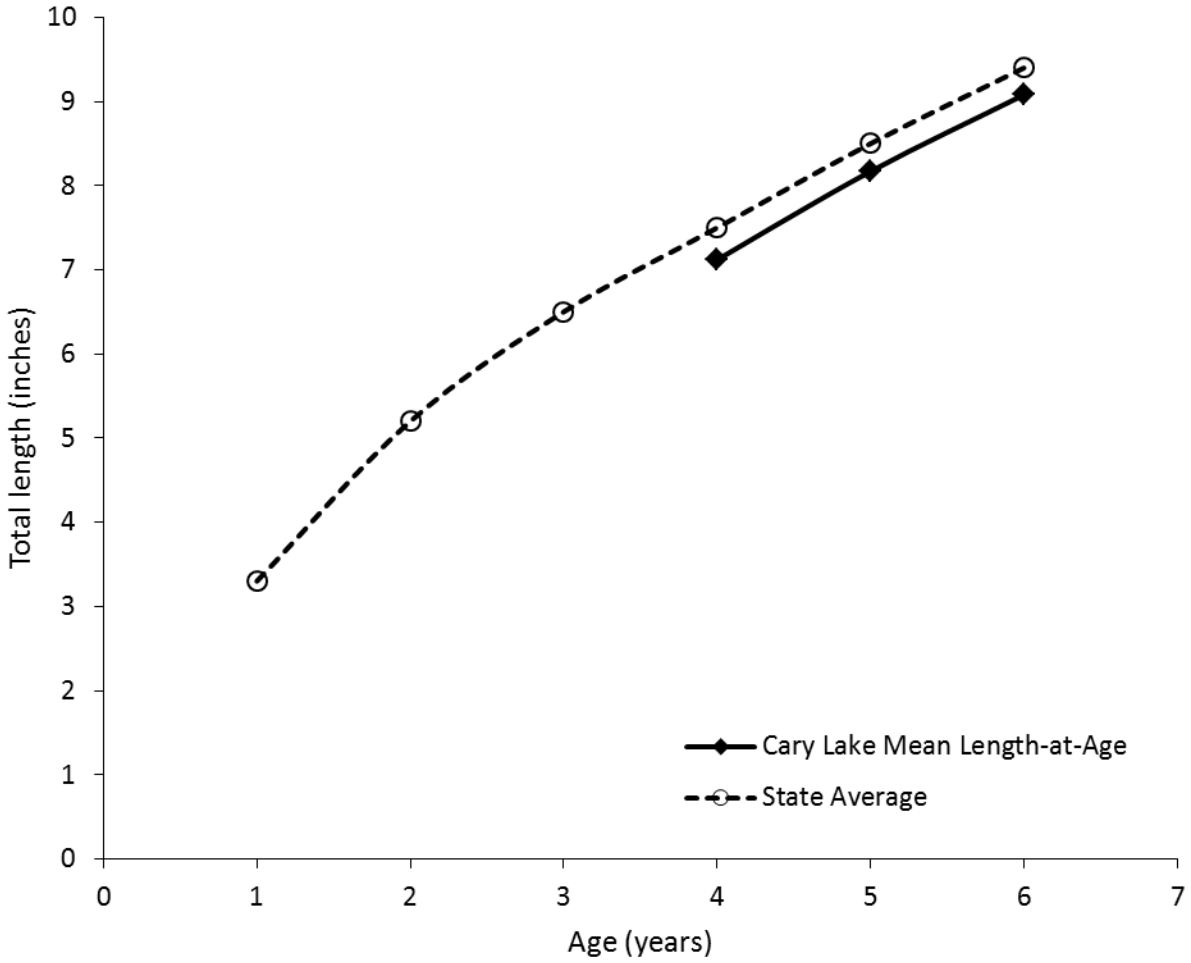


Figure 9.–Growth of yellow perch in Cary Lake, as determined from dorsal spine samples collected during March 19-21, 2012. State average lengths from Schneider et al. (2000).

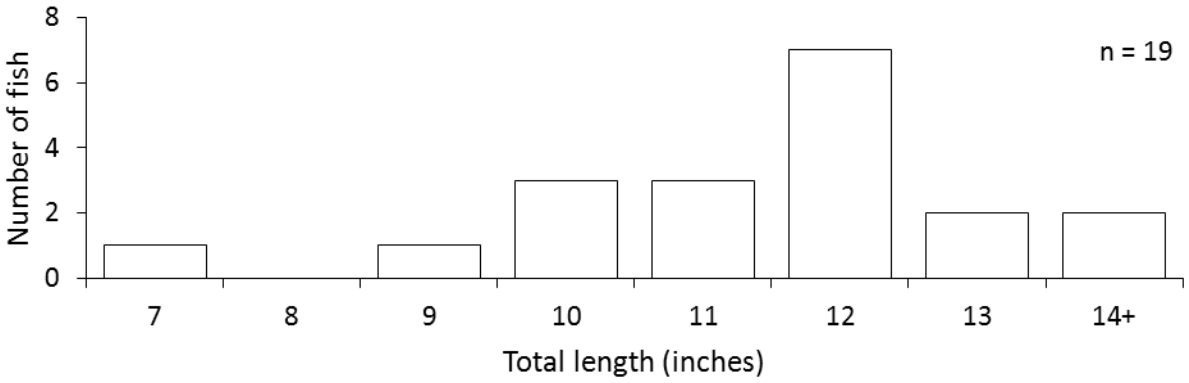


Figure 10.–Length frequency distribution for largemouth bass captured in Cary Lake during March 19-21, 2012.

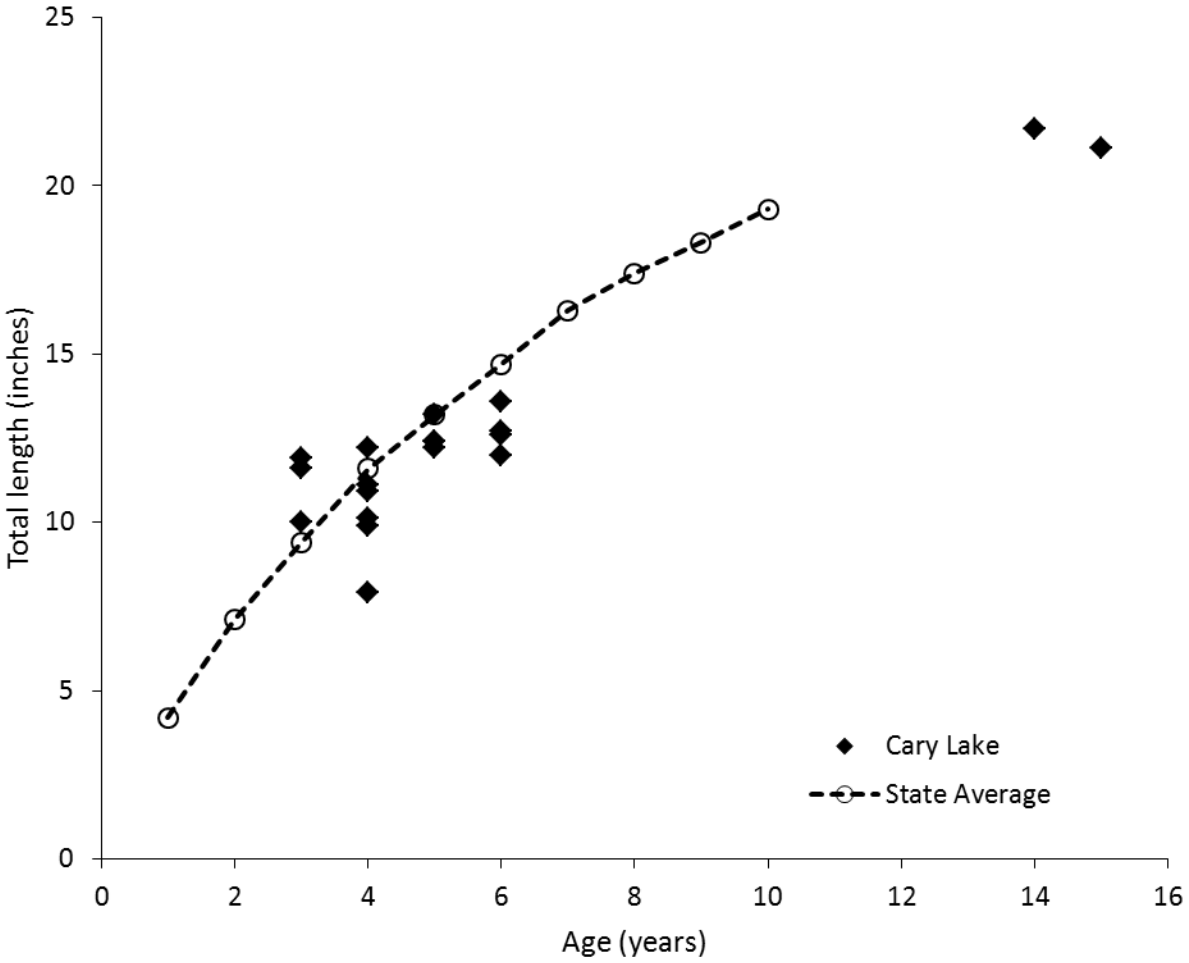


Figure 11.–Growth of largemouth bass in Cary Lake, as determined from dorsal spine samples collected during March 19-21, 2012. State average lengths from Schneider et al. (2000).

Table 1.–Fish stocking in Cary Lake, 1935-2012.

Year	Species	Strain	Life stage	Number	Number/acre	Average length (inches)
1935	Bluegill		Fall fingerling	10,000	127	---
1937	Bluegill		Fall fingerling	10,000	127	---
1938	Bluegill		Fall fingerling	10,000	127	---
1939	Bluegill		Fall fingerling	20,000	253	---
1940	Bluegill		Fall fingerling	10,000	127	---
1941	Bluegill		Fall fingerling	15,000	190	---
1942	Bluegill		Fall fingerling	3,750	47	---
1944	Bluegill		Fall fingerling	10,000	127	2.00
	Largemouth bass		Fall fingerling	1,500	19	3.00
1945	Bluegill		Fall fingerling	7,000	89	1.50
	Largemouth bass		Fall fingerling	1,000	13	3.50
1958	Rainbow trout		Legal	2,500	32	---
1961	Rainbow trout		Legal	3,500	44	---
1964	Rainbow trout		Legal	2,000	25	---
1966	Rainbow trout		Fall fingerling	3,200	41	---
1967	Rainbow trout		Yearling	2,000	25	---
1968	Rainbow trout		Yearling	3,160	40	---
1969	Rainbow trout		Yearling	3,160	40	---
1973	Rainbow trout		Yearling	2,000	25	---
1974	Rainbow trout		Yearling	2,000	25	---
1975	Rainbow trout		Yearling	2,000	25	---
1976	Rainbow trout		Yearling	2,000	25	---
1977	Rainbow trout		Yearling	2,000	25	---
1978	Rainbow trout		Yearling	2,000	25	---
1979	Rainbow trout		Yearling	2,000	25	6.20
1980	Rainbow trout		Yearling	2,000	25	7.20
1981	Rainbow trout	*Harrietta*	Yearling	2,000	25	6.12
1982	Rainbow trout	*Harrietta*	Yearling	3,000	38	5.60
1983	Rainbow trout	*Harrietta*	Yearling	4,000	51	6.92
1984	Rainbow trout	*Harrietta*	Yearling	3,900	49	6.36
1985	Rainbow trout		Yearling	4,000	51	5.44
1986	Rainbow trout	*Shasta*	Yearling	4,000	51	6.52
	Rainbow trout	*Michigan*	Adult	517	7	11.44
1987	Rainbow trout	*Shasta*	Yearling	4,000	51	6.64
1988	Rainbow trout	*Shasta*	Yearling	4,000	51	6.16
1989	Rainbow trout	*Shasta*	Yearling	4,000	51	6.40
1990	Rainbow trout	*Arlee*	Yearling	3,995	51	6.88

Table 1.–Continued.

Year	Species	Strain	Life stage	Number	Number/acre	Average length (inches)
1991	Rainbow trout	*Arlee*	Yearling	4,000	51	7.12
	Redear sunfish		Fall fingerling	23,300	295	1.12
1992	Rainbow trout	*Shasta*	Yearling	3,998	51	6.84
	Redear sunfish		Fall fingerling	7,900	100	1.32
1993	Redear sunfish		Fall fingerling	8,000	101	1.44
1994	Rainbow trout	*Shasta*	Yearling	4,494	57	6.92
1995	Rainbow trout	*Arlee*	Yearling	4,500	57	7.12
1996	Rainbow trout	*Shasta*	Yearling	4,500	57	6.44
1997	Rainbow trout	*Eagle Lake*	Yearling	4,498	57	6.00
1998	Rainbow trout	*Shasta*	Yearling	4,450	56	5.96
1999	Rainbow trout	*Shasta*	Yearling	4,430	56	6.88
2000	Rainbow trout	*Shasta*	Yearling	4,500	57	5.60
2003	Rainbow trout	*Eagle Lake*	Yearling	4,501	57	5.90
2004	Rainbow trout	*Eagle Lake*	Yearling	4,500	57	7.26
2005	Rainbow trout	*Eagle Lake*	Yearling	4,345	55	6.98
2006	Rainbow trout	*Eagle Lake*	Yearling	3,950	50	6.50
2007	Rainbow trout	*Eagle Lake*	Yearling	4,200	53	6.23
2008	Rainbow trout	*Eagle Lake*	Yearling	3,950	50	6.56
2009	Rainbow trout	*Eagle Lake*	Yearling	4,300	54	6.55
2010	Rainbow trout	*Eagle Lake*	Yearling	4,100	52	6.93
2011	Rainbow trout	*Eagle Lake*	Yearling	4,100	52	6.16
2012	Rainbow trout	*Eagle Lake*	Yearling	3,950	50	6.82

Table 2.–Sampling effort during the rainbow trout stocking evaluation on Cary Lake, March-November 2012. Each net night equals one overnight set of one net.

Sampling period	Gear	Effort
March 19-21	Large-mesh fyke net	6 net nights
March 19-21	Graded-mesh gill net	6 net nights
March 20-21	Floating gill net	1 net night
November 5	Nighttime electrofishing	58 minutes

Table 3.–Numbers, weights, lengths, and growth indices for fish species collected during the fisheries survey on Cary Lake, March 19-21, 2012. Fish were captured using gill nets and large-mesh fyke nets.

Species	Number	Percent by number	Weight (lbs)	Percent by weight	Length range (inches)	Percent legal or harvestable[1]	Growth index[2]
Bluegill	185	41.0	51.3	19.7	5-8	94	+0.4
Black crappie	65	14.4	33.1	12.7	6-12	86	+0.6
White sucker	56	12.4	73.0	28.0	6-18	---	---
Yellow perch	45	10.0	11.7	4.5	5-12	78	-0.3
Yellow bullhead	38	8.4	22.5	8.6	7-13	---	---
Rock bass	20	4.4	7.3	2.8	5-9	90	---
Largemouth bass	19	4.2	25.1	9.6	7-21	6	-1.3
Spotted sucker	6	1.3	10.1	3.9	15-18	---	---
Gizzard shad	5	1.1	8.5	3.3	15-17	---	---
Channel catfish	3	0.7	9.2	3.5	19-23	---	---
Spotted gar	3	0.7	2.6	1.0	10-24	---	---
Hybrid sunfish	2	0.4	0.6	0.2	7-7	100	---
Bowfin	1	0.2	2.3	0.9	18	---	---
Golden redhorse	1	0.2	1.9	0.7	17	---	---
Brown bullhead	1	0.2	1.1	0.4	13	---	---
Pumpkinseed	1	0.2	0.2	0.1	6	100	---
Total	451		254.0				

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

[2] Average deviation from the state average length at age. Mean growth indices <-1 indicate below average growth, indices between -1 and +1 indicate average growth, and indices >+1 indicate growth is faster than the state average.