Palmer Lake

St. Joseph County, T6S, R9W, S13-14 & 23-24
St. Joseph River watershed, 2011

Brian Gunderman, Fisheries Biologist, Plainwell

Environment

Palmer Lake is a 448-acre lake located on the south side of the village of Colon. Palmer Lake is connected to Long Lake via a channel that is 1.2 miles in length, typically more than 300 ft in width, and less than 5 ft deep (Figure 1). Water flows northward from Long Lake to Palmer Lake. Little Swan Creek flows into the channel between the lakes. Two smaller tributaries empty into Palmer Lake from the east. Swan Creek flows out of the northwest end of Palmer Lake and intersects with the St. Joseph River 1.3 miles downstream. The water levels in Long and Palmer lakes are controlled by the Lamberson Dam. The legal lake levels are 850.7 ft in summer and 850.3 ft in winter. Drop-offs generally are gradual and 63% of the lake (by surface area) is less than 10 ft deep (Figure 2). Organic substrates predominate near the channel and at the southeastern end of the lake. Sand and marl substrates are common along the remainder of the shoreline.

Palmer Lake is surrounded by deposits of glacial outwash sand and gravel and postglacial alluvium. Well-drained soils of the Coloma-Spinks-Oshtemo series are common around the lake, whereas a variety of loams and sandy loams occur upstream of Palmer Lake. Agriculture is the predominant land use in the watershed. Many wetlands within the watershed have been drained, but some wetland complexes remain along the channel between Palmer and Long lakes. Residential and vacation homes surround nearly the entire shoreline of Palmer Lake. The 2011 habitat survey revealed a total dwelling density of 53.6 dwellings/mile (33.3 dwellings/km). Approximately 81% of the shoreline is armored with seawalls or riprap, which is one of the highest percentages recorded for lakes in southwest Michigan. Large woody structure is scarce. Since the fall of 2002, persistent algal blooms (primarily of the genera Fragilaria and Euglena) have reduced water clarity in Palmer and Long lakes (Weed Patrol, Inc. 2008). The reduced water clarity has been accompanied by a decrease in the abundance of rooted aquatic plants.

The biological productivity of a lake is strongly dependent on its supply of two key nutrients: phosphorus and nitrogen. Nitrogen is the limiting nutrient when the ratio of total nitrogen to total phosphorus is <10:1, and phosphorus is the limiting nutrient when this ratio is >15:1 (Shaw et al. 2004). Water samples collected in Palmer Lake on August 23, 2011 indicated that the ratio of total nitrogen to total phosphorus was 26:1. Thus, phosphorus is the limiting nutrient in this system. The total phosphorus concentration was 0.0213 mg/L. The chlorophyll a concentration, which provides an index of algal biomass, was 0.0074 mg/L. The Secchi disk depth (an index of water clarity) was 4.0 ft. These water quality parameters indicate that Palmer Lake is a eutrophic or highly productive system (Carlson and Simpson 1996).

History

The first fisheries survey of Palmer Lake was completed in 1887 by the Michigan Fish Commission. Bluegills, black crappies, yellow perch, northern pike, and "sunfish" (presumably pumpkinseeds) were collected during this initial assessment, along with bullheads, gar, and bowfin. During 1933 through 1945, bluegills, largemouth and smallmouth bass, and yellow perch were stocked in Palmer Lake (Table 1). Throughout the state, annual stocking programs for these species were discontinued after fisheries managers determined that such programs were unnecessary and could have undesirable effects on the receiving populations (e.g., reduced growth due to increased competition for forage).

Conservation officers recorded catch and effort data for anglers encountered on Palmer Lake during 1953-1964. These qualitative creel reports indicated that bluegill was the primary game species, followed by yellow perch, pumpkinseed, largemouth bass, black crappie, and northern pike. The first electrofishing survey on the lake was completed in October 1981. Bluegills were abundant, but the population was dominated by small fish. Largemouth bass were common and growth rates for bass were acceptable. Pumpkinseeds, yellow perch, black crappies, and northern pike composed a small percentage of the total electrofishing catch.

A variety of gear types were used to collect fish in Palmer Lake during September-October 1992. As noted during the previous survey, bluegills were abundant but small. Anglers reported that the average size of bluegills had decreased during the last 15 years. The black crappie, yellow perch, pumpkinseed, and largemouth bass populations also exhibited poor size structures. Growth was about average for bluegills, slightly below average for crappies and bass, and substantially below average for yellow perch. Though not particularly abundant, most northern pike were larger than 24 inches and were growing rapidly. Some private stocking of walleyes occurred during the late 1980s-early 1990s, and anglers reported catching a few walleyes in Palmer Lake.

Local anglers expressed strong interest in enhancing the walleye fishery in Palmer Lake. Beginning in 1993, the Michigan Department of Natural Resources (MDNR) stocked walleye fry into local rearing ponds. The Colon Area Anglers Association (CAAA) managed these ponds and harvested spring fingerling walleyes for stocking in Palmer Lake and various other water bodies. Spring fingerling walleyes were stocked in Palmer Lake several times during 1993-2006 (Table 1). In 2007, MDNR's statewide walleye stocking program was interrupted due to the discovery of viral hemorrhagic septicemia virus in the Great Lakes. Full production of spring fingerling walleyes did not resume until 2011.

Two other fish species have been stocked in this system to provide diverse fishing opportunities. Two-year old channel catfish were stocked in Palmer Lake in 1992. During 1999-2002, the CAAA stocked redear sunfish in Long Lake. Some of these fish moved downstream through the channel into Palmer Lake.

Largemouth bass virus was detected in Long Lake in 2001. This virus has caused die-offs of largemouth bass in other systems, with most fish kills occurring during mid-July through mid-August. Large adult fish appear to be especially vulnerable to this pathogen. No major die-offs of largemouth bass have been reported on Long and Palmer lakes.

Current Status

A variety of methods were used to evaluate the fish community in Palmer Lake during May 2011. Fish were captured with trap nets, fyke nets, gill nets, seines, and nighttime electrofishing gear (Table 2) 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. Total lengths were recorded for all fish. For game fish species, spine or scale samples were collected from 10 fish per inch group for age determination.

Twenty-seven fish species were collected during the 2011 survey (Table 3). Bluegill (n = 3,824) was the most abundant species, composing 71% of the catch by number and 39% of the catch by weight. Seventy-nine percent of the bluegills were 6 inches or larger. Size structures of bluegill populations can be challenging to interpret because each gear type exhibits some degree of size selectivity (Figure 3). 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 scores for the Palmer Lake bluegill population were 4.8 (satisfactory-good) based on the trap net and large-mesh fyke net samples and 3.4 (acceptable-satisfactory) based on the electrofishing sample (Schneider 1990).

The mean growth index for bluegills was +0.3, which is indicative of average growth (Figure 4). Eight year classes of bluegills were collected (Figure 5). Age 4-6 bluegills made up the 80% of the catch. Annual total mortality was estimated to be 87% (Figure 6) for adult bluegills (ages 4-8), which is one of the highest mortality estimates recorded for Michigan bluegill populations.

Redear sunfish (n = 154) and pumpkinseeds (n = 128) composed approximately 6% of the total fish biomass in the catch. More than 90% of these fish were larger than 6 inches, and mean lengths-at-age were above statewide averages (Figures 7-9). Multiple year classes of both species were represented in the catch (Figure 10). Redear sunfish and pumpkinseeds often hybridize with bluegills and with each other. Hybrid sunfish (n = 232) made up 4% of the total fish biomass during the 2011 survey.

Black crappies (n = 60) and yellow perch (n = 44) were minor components of the fish community. These two species together made up less than 2% of the total fish biomass in the catch. Length-at-age data indicated average growth for both species.

Numerically, largemouth bass (n = 161) were the most abundant predators in the catch. Legal-sized fish (14 inches and larger) composed 13% of the sample (Figure 11). Mean lengths-at-age for largemouth bass were below state averages (Figure 12). Eleven year classes were represented in the catch (Figure 13), and total annual mortality for largemouth bass ages 4-10 was estimated to be 40% (Figure 14).

Twelve channel catfish were captured during the 2011 survey. The total length range for these fish was 19-28 inches. The limited data available suggest above average growth of channel catfish in Palmer Lake. Only three northern pike were collected. Two of these fish were 30 inches or larger. No walleyes and no smallmouth bass were captured during the survey.

Analysis and Discussion

Predators (largemouth bass, spotted gar, channel catfish, northern pike, and bowfin) composed 19% of the fish biomass during the 2011 survey. Schneider (2000) observed that predators typically make up 20-50% of the biomass in lakes with desirable fish communities. Thus, it appears that predators are rare in Palmer Lake.

As with most other lakes in southern Michigan, bluegill is the primary game species in Palmer Lake. Catch-per-effort (CPE) with specific gear types provides an index of relative abundance of bluegills. During the 2011 survey, the bluegill CPE in large-mesh fyke nets was 181.3 fish/net night in Palmer Lake, compared to 146.8 fish/net night in Sturgeon Lake and 81.0 fish/net night in Long Lake. Out of 140 lakes sampled as part of the Status and Trends Program during 2002-2007, only two lakes had bluegill CPEs for fyke nets that were higher than observed in Palmer Lake (K. Wehrly, MDNR - Fisheries Division, unpublished). Furthermore, the bluegill CPE for trap nets in Palmer Lake (552.0 fish/net night) was substantially higher than the CPEs for Long and Sturgeon lakes and was higher than all of the trap net CPEs for Status and Trends lakes surveyed during 2002-2007 (K. Wehrly, MDNR - Fisheries Division, unpublished). Obviously, bluegills are very abundant in Palmer Lake.

The total annual mortality estimate for adult bluegills was one of the highest estimates recorded for Michigan bluegill populations (Schneider 2000). High fishing mortality could have produced the observed population age structure; however, no creel data are available to test this hypothesis. Another possible explanation is that bluegill reproductive success was low in 2003 and 2004 compared to successive years. Such recruitment variability would lead to overestimation of total annual mortality.

Palmer Lake supports strong populations of redear sunfish and pumpkinseeds. The size structures of these populations were impressive, and growth was above average. The pumpkinseed CPEs for trap nets and large-mesh fyke nets were in the top 20% of the range reported for lakes sampled as part of the Status and Trends Program (K. Wehrly, MDNR - Fisheries Division, unpublished), so it appears that pumpkinseeds are relatively abundant in this system.

The black crappie catch was much lower in Palmer Lake than in Long Lake. This difference in catch rates was at least partially due to survey timing. On Long Lake, netting was conducted during the pre-spawning period when black crappies were moving into shallow water and were highly vulnerable to entrapment gear. On Palmer Lake, netting was conducted during the latter portion of the spawning period. At that time, spawning fish were less mobile and fish that had finished spawning had moved offshore.

Nighttime electrofishing typically is the most effective method for capturing largemouth bass. The largemouth bass CPE for Palmer Lake was 4.3 fish/minute, which is near the top of the range recorded for Michigan populations (K. Wehrly, MDNR - Fisheries Division, unpublished). Because sampling only was conducted during a single year, data on year-to-year variation in recruitment of largemouth bass in Palmer Lake are not available. Based on the catch curve analysis (which assumes consistent recruitment from year-to-year), total annual mortality of bass appears to be similar in Palmer and Long lakes and is low relative to most other largemouth bass populations in North America (Allen et al. 2008).

Mean lengths-at-age for largemouth bass in Palmer Lake were below the statewide averages (Schneider et al. 2000). This is not uncommon for lakes in southwest Michigan, where mean growth indices for largemouth bass typically range from -0.5 to -1.5. There does not appear to be a shortage of suitable prey for largemouth bass in this system. As noted previously, predators only composed 19% of the biomass in the catch.

The age structure of the channel catfish population in Palmer Lake is skewed toward older fish. Only one of the catfish collected was younger than age 7. Channel catfish were stocked in Long and Palmer lakes in 1992. Channel catfish also were stocked in Matteson lake (located upstream on Little Swan Creek) annually from 1995 through 2005. The older catfish collected during the 2011 survey could have been survivors from the Matteson Lake stocking events. The presence of one age 4 fish in Palmer Lake and several smaller fish in Long Lake suggests that a limited amount of channel catfish natural reproduction is occurring in this system.

Northern pike abundance appears to be low in Palmer Lake. The gill net CPE for northern pike was 0.5 fish/net night in Palmer Lake, compared to the statewide average of 2.6 fish/net night (K. Wehrly, MDNR - Fisheries Division, unpublished). The wetlands adjacent to the channel between Long and Palmer lakes provide spawning habitat for northern pike and yellow perch. These wetlands also serve as nursery areas for juvenile fish of many different species. Because these wetlands are so important to the continued health of the fish, reptile, and amphibian communities, they should be protected from future draining, filling, or development.

The results of the 2011 survey and anecdotal reports from anglers indicate poor survival of stocked walleyes in Palmer Lake. Spring fingerling and fry stocking programs have created popular fisheries in the St. Joseph and Grand rivers, but these stocking programs have been less effective in inland lakes across southwest Michigan. The abundance of panfish (especially bluegills, crappies, and yellow perch) appears to have a strong negative effect on walleye survival. These species are prey for adult walleyes, but they can consume spring fingerling walleyes. Stocking in rivers likely has been more effective because panfish are less common and more of the fish community biomass is composed of minnows and suckers.

The recent decline in water clarity in Long and Palmer lakes is perplexing. One possible theory is that the algal blooms are the result of colonization of Long and Palmer lakes by gizzard shad (G. Pullman, Aquest Corporation, personal communication). These fish may have been accidentally introduced during channel catfish stocking in Long, Palmer, or Matteson lakes. The channel catfish were purchased from a hatchery in Ohio where gizzard shad were used as forage for catfish. Another possible explanation is that gizzard shad were introduced via anglers releasing unused baitfish into the lake. Gizzard shad feed on zooplankton and decaying organic matter (Yako et al. 1996). Samples collected during August-September 2011 indicated that total zooplankton abundance was about average in Palmer Lake and low in Long Lake. Daphnia density was low in both lakes. As zooplankton consume algae, reducing zooplankton abundance theoretically would result in increased algal abundance.

There are caveats to this analysis of the role of gizzard shad in promoting algae growth. On each lake, zooplankton were collected at a few locations during a single day. Thus, the reported densities may not accurately represent zooplankton densities in the lakes throughout the year. Second, gizzard shad only made up 5-7% of the fish biomass during the 2011 surveys on Long and Palmer lakes. In other systems where the ecological effects of gizzard shad have been studied, gizzard shad composed much greater percentages of the total biomass (e.g., Kirk et al. 1986; Dettmers and Stein 1996). Third, the interactions between planktivorous fish, zooplankton, and algae are complex (DeMelo et al. 1992). For example, Dettmers and Stein (1996) found that increasing gizzard shad abundance only affected algal production if Daphnia densities initially were high. Finally, if gizzard shad were severely depressing zooplankton abundance in Long and Palmer lakes, we would expect reductions in the abundance and growth of other planktivorous fishes (e.g., bluegill; Dettmers and Stein 1992). As noted previously, bluegill CPE was above average in Long Lake and substantially above average in Palmer Lake. In both lakes, bluegill growth was average.

A wide variety of factors likely have contributed to the recent decline in water clarity in Long and Palmer lakes. Big Swan Creek and Little Swan Creek flow through a landscape that has been heavily modified for row crop agriculture. Thus, these streams probably deliver large quantities of sediment and nutrients to Long and Palmer lakes. During the 1990s, this eutrophication was manifested in dense growth of aquatic plants. When herbicides were used in the lake to reduce the abundance of rooted vegetation, more nutrients became available for growth of algae. High-speed boating activity also reduces water clarity by stirring up sediment from the lake bottom. Seawalls exacerbate this problem. Natural shorelines absorb wave energy (e.g., from passing boats), but seawalls reflect this energy back into the lake.

Management Direction

Five fisheries management goals have been developed for Palmer Lake. Goal 1: Protect and rehabilitate habitat for fish and other aquatic organisms. Goal 2: Enhance the walleye fishery in Palmer Lake. Goal 3: Enhance the channel catfish fishery in the lake. Goal 4: Reduce the abundance of gizzard shad. Goal 5: Maintain a healthy predator-prey ratio within the fish community.

Goal 1: Several different methods will be used to accomplish this goal. Fisheries Division personnel will continue to review Michigan Department of Environmental Quality (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 will work with the lake association and other organizations to educate riparian landowners on the effects of various practices (e.g., chemical weed treatments, seawall construction, and removal of large woody structure) on aquatic ecosystems. The water quality in Palmer Lake is strongly influenced by land use practices on tributary streams. Fisheries Division will collaborate with MDEQ, Michigan Department of Agriculture and Rural Development, United States Fish and Wildlife Service, and other partners to help riparian landowners restore wetlands and utilize best management practices to reduce inputs of sediment, nutrients, and additional pollutants to Palmer Lake tributaries. As opportunities arise, Fisheries Division also will provide technical assistance to local units of government interested in establishing ordinances that protect aquatic habitats from pollution or unwise development.

Goal 2: Stocking spring fingerling walleyes in Palmer Lake has yielded poor returns. In southwest Michigan lakes, survival typically has been much greater for walleyes stocked as fall fingerlings as opposed to spring fingerlings, and even low density stockings have created popular fisheries in some systems. A fish stocking request will be submitted to stock 4,480 fall fingerling walleyes (10/acre) in Palmer Lake on a biennial schedule. Only a small percentage of Fisheries Division's walleye ponds are suitable for producing fall fingerlings. Fisheries Division is exploring options for producing more fall fingerling walleyes; however, the supply of fall fingerlings is likely to remain sporadic for the next several years. Private fish stocking (with an approved fish stocking permit) could be used to augment the walleye population until the Division consistently can fill the stocking request for Palmer Lake.

Goals 3 and 4: The channel catfish is a popular game fish species in southern Michigan. Channel catfish also are known to consume gizzard shad. Thus, stocking channel catfish would facilitate attainment of goals 3 and 4. Biennial stocking of 4,480 yearling channel catfish (10 fish/acre) is recommended. The preferred size at stocking is 8 inches or larger. New protocols have reduced the likelihood of gizzard shad being transported with channel catfish. Given that gizzard shad already are established in this system, the benefit of increased predation pressure from stocked catfish greatly outweighs any risks of inadvertently stocking a few additional gizzard shad in the lake.

Goal 5: The relative abundance of predators in Palmer Lake currently is slightly below the acceptable range. Thus, the walleye and channel catfish stocking programs are not expected to overtax the forage base. In addition, channel catfish are opportunistic feeders and can consume aquatic insects and mollusks if abundance of prey fish decreases.

References

Allen, M. S., C. J. Walters, and R. Myers. 2008. Temporal trends in largemouth bass mortality, with fishery implications. North American Journal of Fisheries Management 28:418-427.

Carlson, R. E., and J. Simpson. 1996. A coordinator's guide to volunteer lake monitoring methods. North American Lake Management Society, Madison, Wisconsin.

DeMelo, R., R. France, and D. J. McQueen. 1992. Biomanipulation: hit or myth? Limnology and Oceanography 37:192-207.

Dettmers, J. M., and R. A. Stein. 1992. Food consumption by larval gizzard shad: zooplankton effects and implications for reservoir communities. Transactions of the American Fisheries Society 121:494-507.

Dettmers, J. M., and R. A. Stein. 1996. Quantifying linkages among gizzard shad, zooplankton, and phytoplankton in reservoirs. Transactions of the American Fisheries Society 125:27-41.

Kirk, J. P., W. D. Davies, and K. Park. 1986. Response of some members of the fish community to gizzard shad removal from Chambers County Public Fishing Lake, Alabama. North American Journal of Fisheries Management 6:252-255.

Schneider, J. C. 1990. Classifying bluegill populations from lake survey data. Michigan Department of Natural Resources, Fisheries Technical Report 90-10, Ann Arbor.

Schneider, J. C. 2000. Interpreting fish population and community indices. Chapter 21 in Schneider, J. C. (editor). 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Schneider, J. C., P. W. Laarman, and H. Gowing. 2000. Age and growth methods and state averages. Chapter 9 in Schneider, J. C. (editor). 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Shaw, B., C. Mechenich, and L. Klessig. 2004. Understanding lake data. University of Wisconsin - Extension, Publication G3582, Madison.

Weed Patrol, Inc. 2008. Long Lake: three-year vegetation management plan. Prepared for Michigan Department of Environmental Quality and the Colon Township Lake Board by Weed Patrol, Inc., Elkhart, Indiana.

Yako, L. A., J. M. Dettmers, and R. A. Stein. 1996. Feeding preferences of omnivorous gizzard shad as influenced by fish size and zooplankton density. Transactions of the American Fisheries Society 125:753-759.

Table 1.–Fish stocking in Palmer Lake, 1933-2011.

Year	Species	Life stage	Number	Number/acre	Average length (inches)
1933	Bluegill	Fall fingerling	10,000	22	---
	Largemouth bass	Fall fingerling	1,500	3	---
1934	Bluegill	Fall fingerling	15,000	33	---
	Largemouth bass	Fall fingerling	1,000	2	---
1935	Bluegill	Fall fingerling	20,000	45	---
	Largemouth bass	Fall fingerling	1,000	2	---
	Yellow perch	Fall fingerling	10,000	22	---
1936	Bluegill	Fall fingerling	23,000	51	---
	Largemouth bass	Fall fingerling	500	1	---
1937	Bluegill	Fall fingerling	50,000	112	---
	Largemouth bass	Fall fingerling	1,000	2	---
1938	Bluegill	Fall fingerling	80,000	179	---
	Largemouth bass	Fall fingerling	1,500	3	---
	Yellow perch	Fall fingerling	15,000	33	---
1939	Bluegill	Fall fingerling	80,000	179	---
	Largemouth bass	Fall fingerling	2,500	6	---
	Smallmouth bass	Fall fingerling	2,000	4	---
	Yellow perch	Fall fingerling	10,000	22	---
1940	Bluegill	Fall fingerling	60,000	134	---
		Yearling	1,000	2	---
	Largemouth bass	Fall fingerling	2,000	4	---
		Yearling	1,000	2	---
	Smallmouth bass	Fall fingerling	2,000	4	---
1941	Bluegill	Fall fingerling	120,000	268	---
	Largemouth bass	Fall fingerling	500	1	---
1942	Bluegill	Fall fingerling	20,000	45	---
	Largemouth bass	Fall fingerling	500	1	---
1943	Bluegill	Yearling	4,000	9	---
	Largemouth bass	Fall fingerling	1,000	2	---
1944	Bluegill	Fall fingerling	20,000	45	1.50
	Largemouth bass	Fall fingerling	3,000	7	3.00
1945	Bluegill	Fall fingerling	15,000	33	2.00
	Largemouth bass	Fall fingerling	2,000	4	3.00
1992	Channel catfish	Adult	2,000	4	9.64
1993	Walleye	Spring fingerling	22,401	50	2.20
1994	Walleye	Spring fingerling	7,500	17	2.45
1996	Walleye	Spring fingerling	20,934	47	2.30
1998	Walleye	Spring fingerling	27,728	62	0.48
1999	Walleye	Spring fingerling	22,378	50	1.56
2003	Walleye	Spring fingerling	44,807	100	1.22
2006	Walleye	Spring fingerling	22,523	50	1.19

Table 2.–Sampling effort during the fish community survey on Palmer Lake, May 2011. Each net night equals one overnight set of one net.

Sampling period	Gear	Effort
May 16	Electrofishing	30 minutes
May 16	Seine	4 hauls (25 ft each)
May 23-26	Trap net	4 net nights
May 23-26	Large-mesh fyke net	6 net nights
May 23-25	Small-mesh fyke net	4 net nights
May 23-25	Graded-mesh gill net	4 net nights

Table 3.–Numbers, weights, lengths, and growth indices for fish species collected during the fish community survey on Palmer Lake, May 2011. Fish were captured using trap nets, fyke nets, gill nets, seines, and nighttime electrofishing gear.

Species	Number	Percent by number	Weight (lbs)	Percent by weight	Length range (inches)	Percent legal or harvestable[1]	Growth index[2]
Bluegill	3,824	71.1	742.2	38.5	1-8	79	+0.3
Hybrid sunfish	232	4.3	80.6	4.2	2-10	90	---
Largemouth bass	161	3.0	102.3	5.3	3-19	13	-1.2
Redear sunfish	154	2.9	79.7	4.1	5-11	98	+1.2
Pumpkinseed	128	2.4	41.7	2.2	1-8	94	+1.1
Gizzard shad	120	2.2	129.5	6.7	3-19	---	---
Spotted gar	114	2.1	172.6	9.0	14-31	---	---
Warmouth	106	2.0	31.5	1.6	3-8	77	---
Yellow bullhead	97	1.8	60.7	3.2	7-13	---	---
Blackchin shiner	79	1.5	0.2	0.0	1-2	---	---
Black crappie	60	1.1	24.4	1.3	4-12	68	+0.7
Brown bullhead	47	0.9	36.8	1.9	7-13	---	---
Yellow perch	44	0.8	5.6	0.3	2-10	25	-0.3
Common carp	26	0.5	245.0	12.7	16-33	---	---
White sucker	21	0.4	51.0	2.6	13-20	---	---
Brook silverside	19	0.4	0.0	0.0	3-3	---	---
Channel catfish	12	0.2	67.0	3.5	19-28	100	---
Golden redhorse	12	0.2	24.8	1.3	12-19	---	---
Golden shiner	8	0.1	0.5	0.0	2-7	---	---
Northern pike	3	0.1	18.0	0.9	23-33	67	---
Bluntnose minnow	3	0.1	0.0	0.0	2-3	---	---
Banded killifish	3	0.1	0.0	0.0	1-1	---	---
Bowfin	2	0.0	9.2	0.5	19-26	---	---
Blacknose shiner	2	0.0	0.0	0.0	2-2	---	---
Pugnose shiner	2	0.0	0.0	0.0	1-1	---	---
Spotted sucker	1	0.0	3.4	0.2	20	---	---
Johnny darter	1	0.0	0.0	0.0	2	---	---
Rainbow darter	1	0.0	0.0	0.0	1	---	---
Total	5,282		1,926.7				

[1] Harvestable size is 6 inches for bluegill, pumpkinseed, rock bass, hybrid sunfish, redear sunfish, and warmouth, 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.

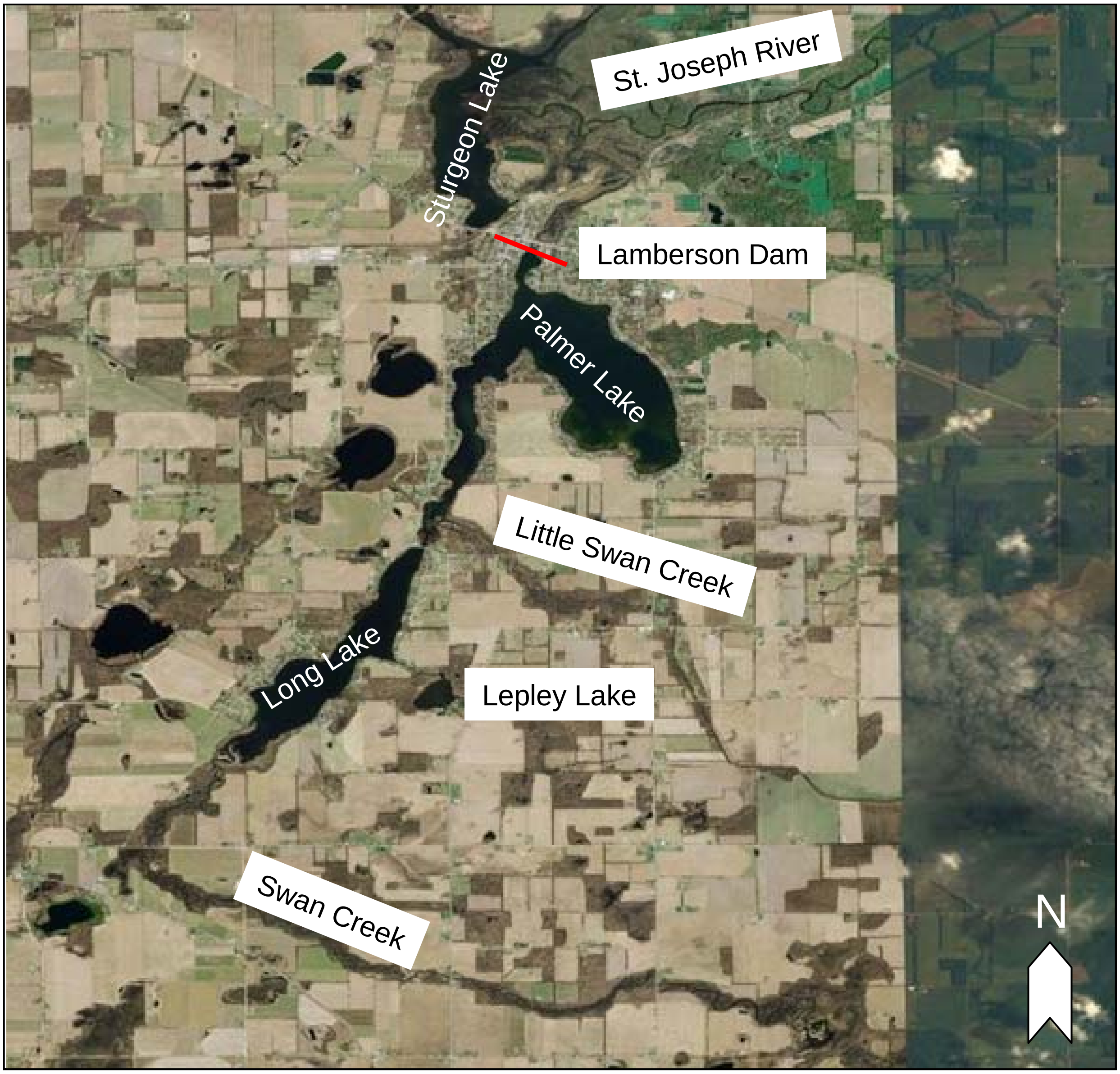


Figure 1.–Aerial view of Palmer Lake and the surrounding area. Image from www.bing.com/maps.

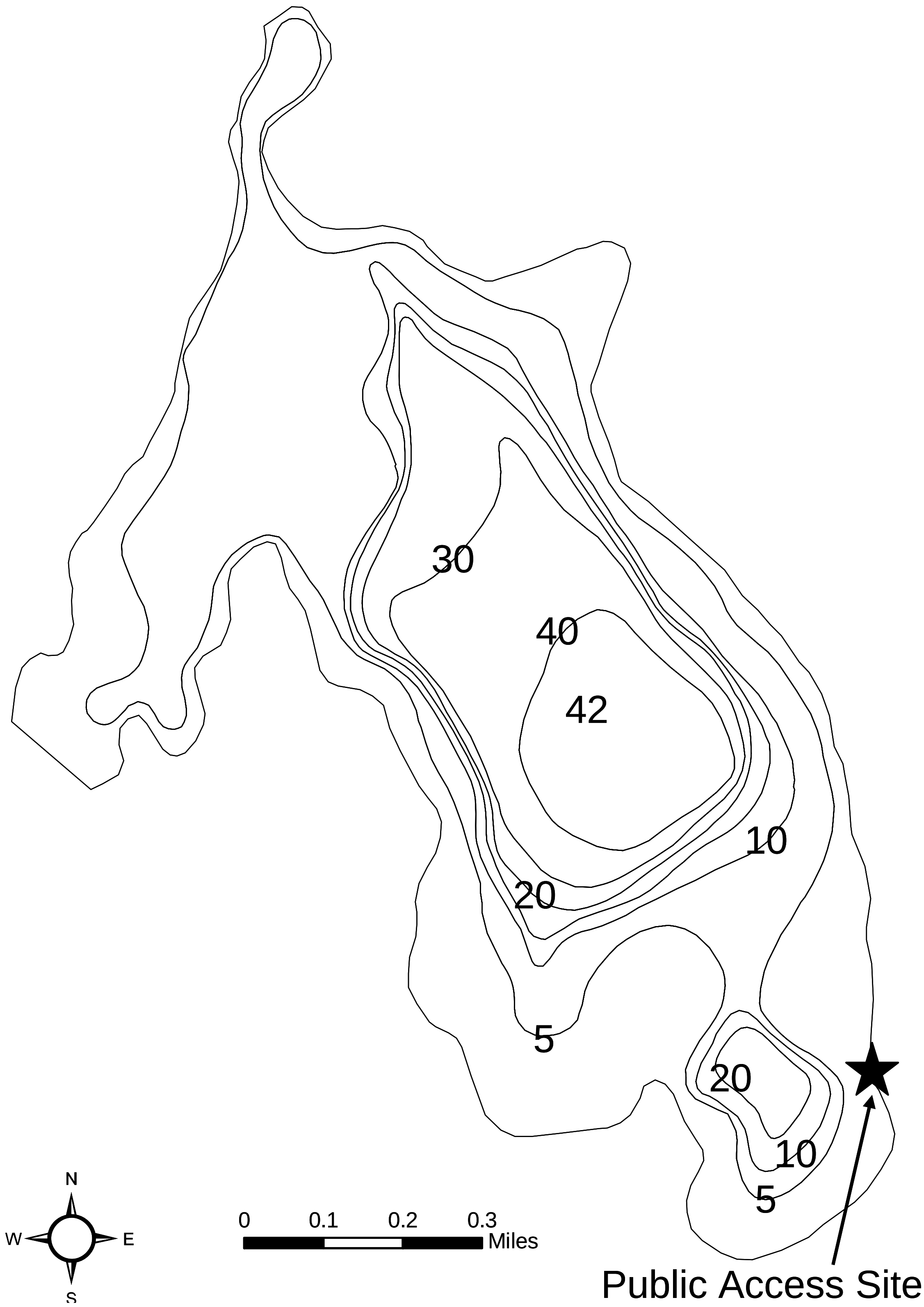


Figure 2.–Bathymetry of Palmer Lake. Depths are in feet.

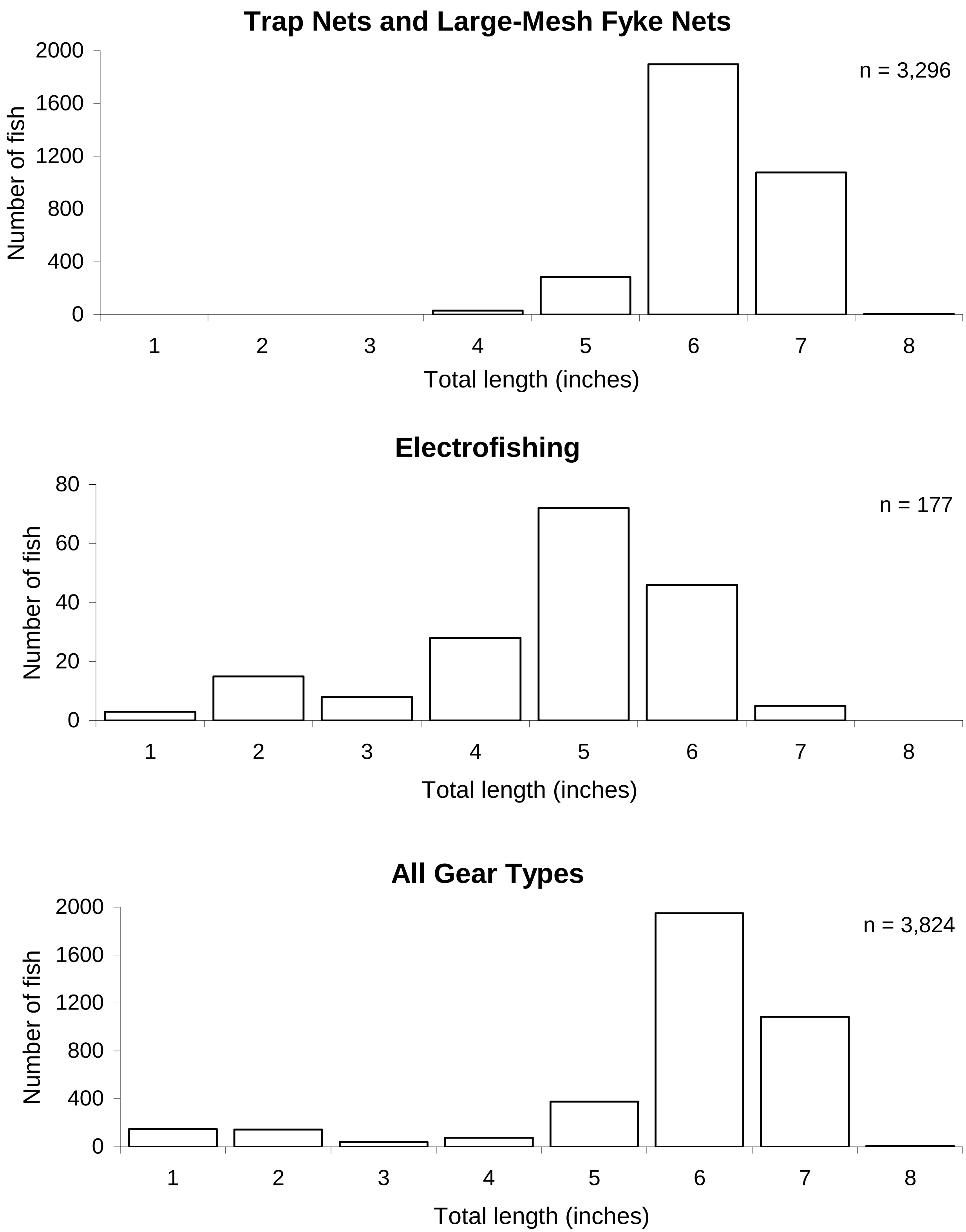


Figure 3.–Length-frequency distributions for bluegills captured in Palmer Lake using trap nets and large-mesh fyke nets, nighttime electrofishing gear, and all gear types, May 2011.

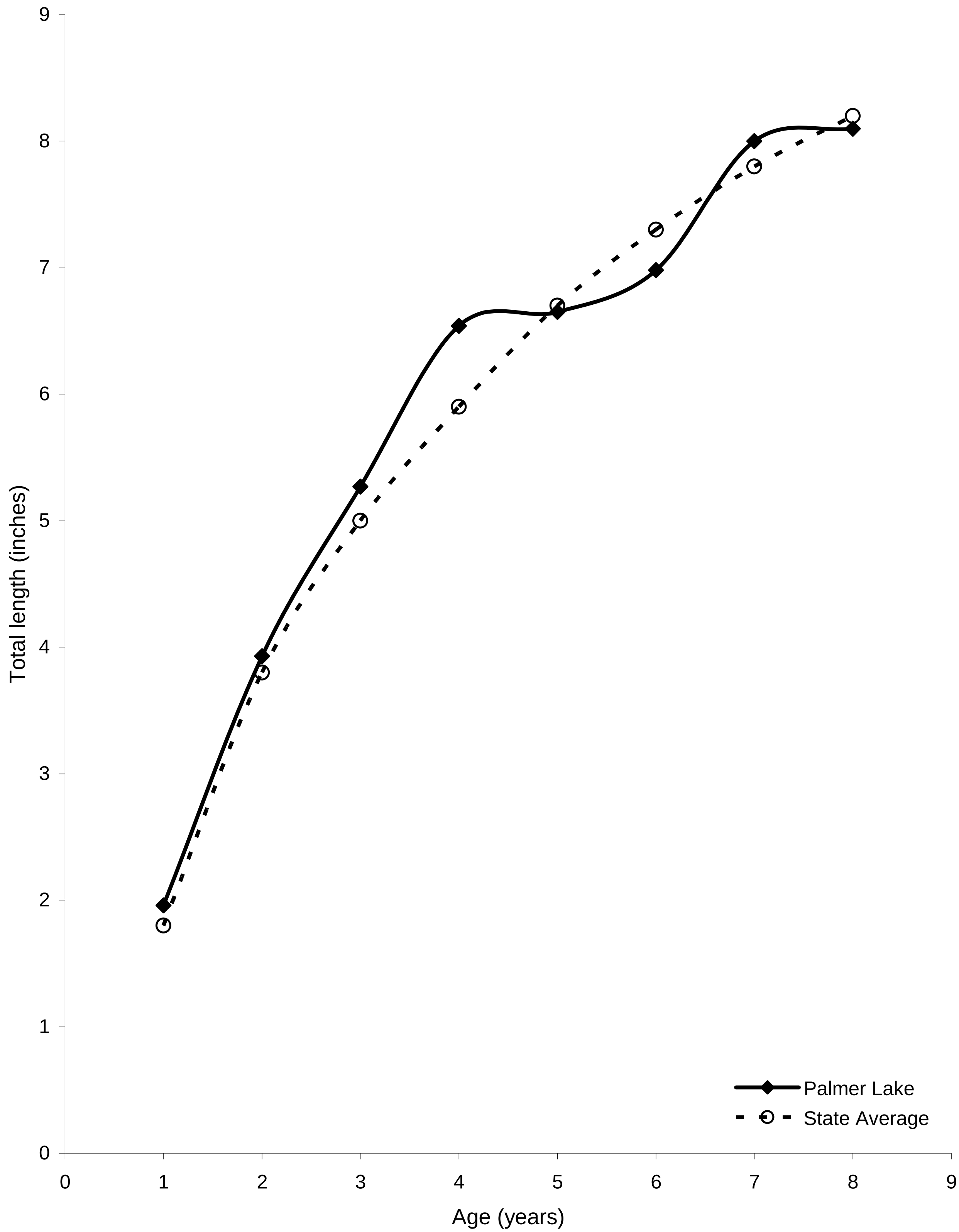


Figure 4.–Growth of bluegills in Palmer Lake, as determined from scale and dorsal spine samples collected during May 2011. State average lengths from Schneider et al. (2000).

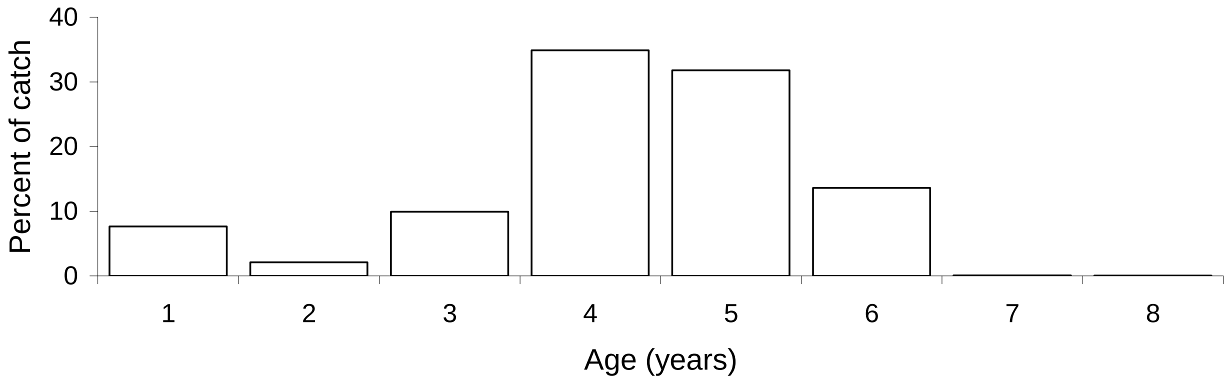


Figure 5.–Age frequency distribution for bluegills captured in Palmer Lake during May 2011.

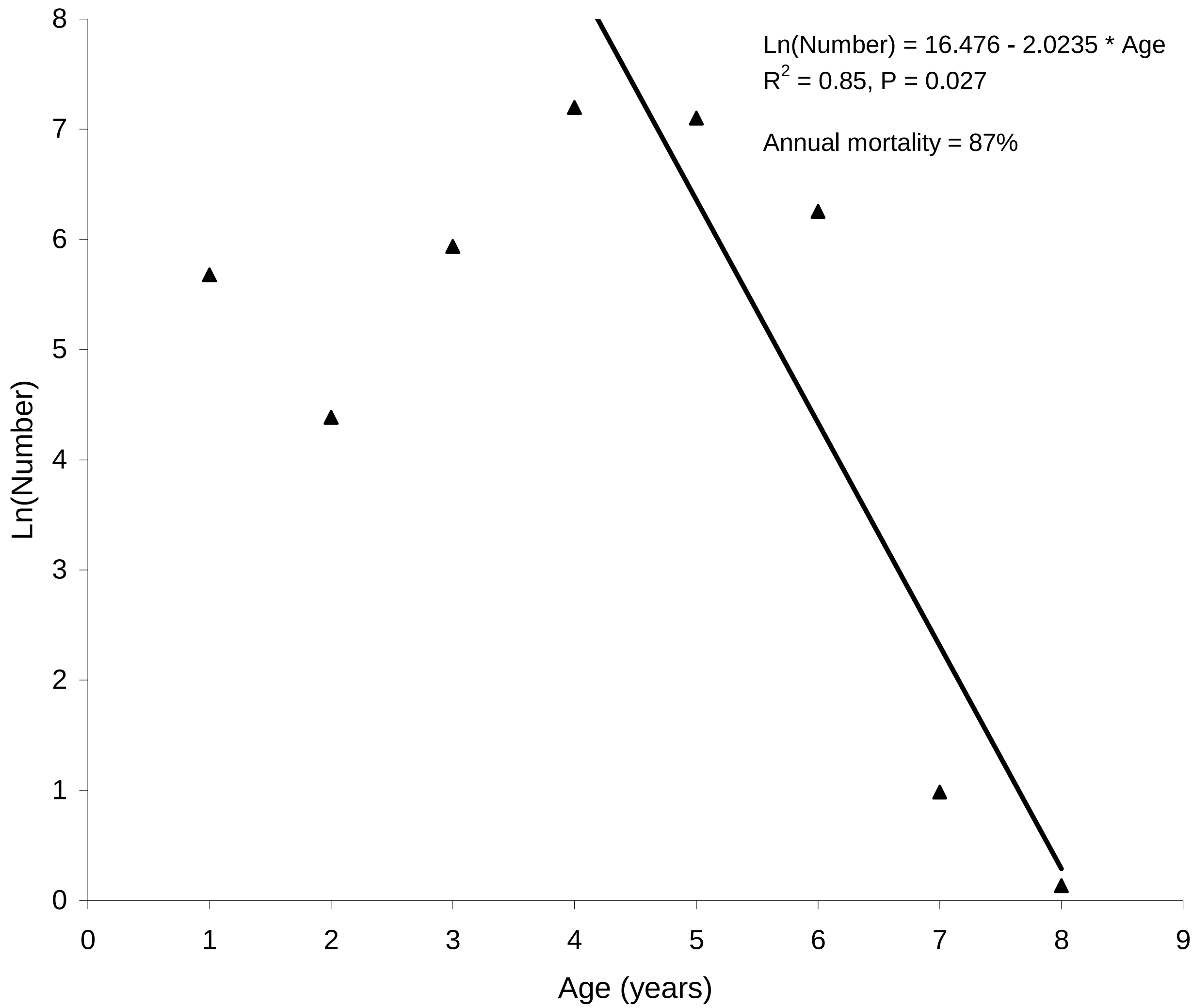
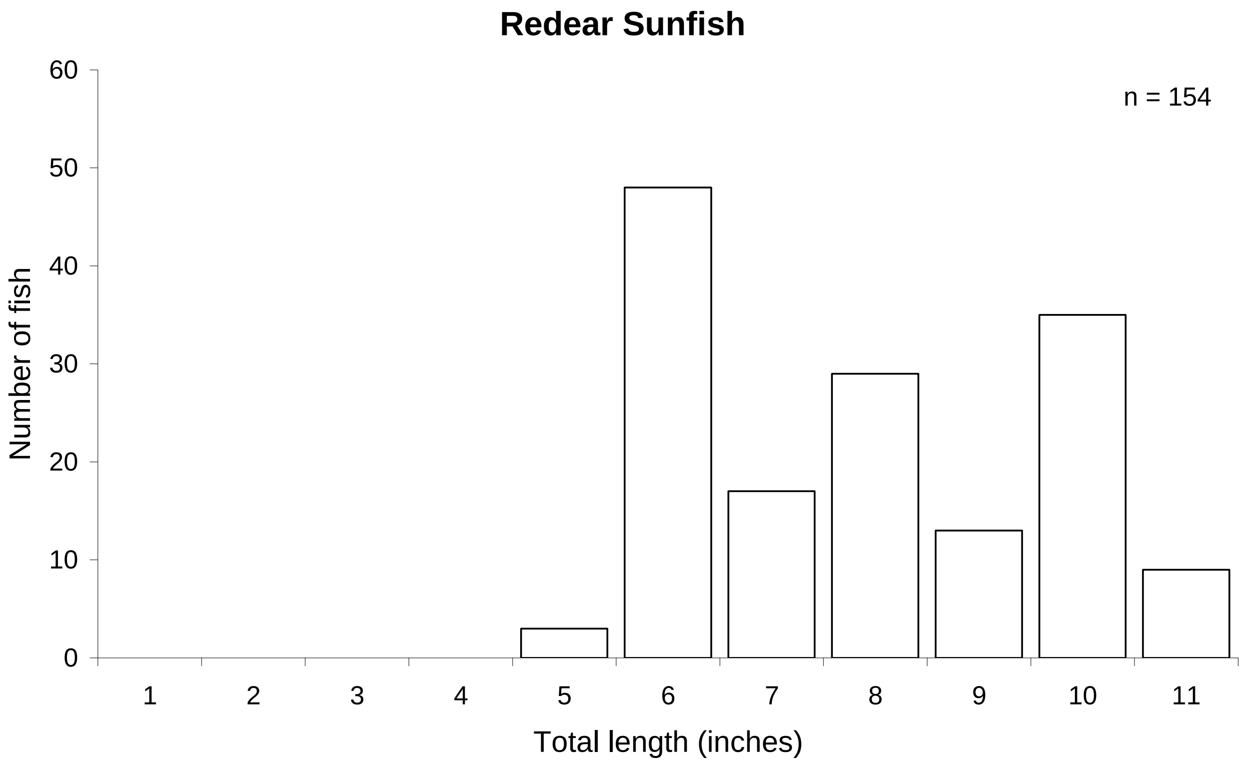


Figure 6.–Observed ln(number) versus age for bluegills captured in Palmer Lake during May 2011.



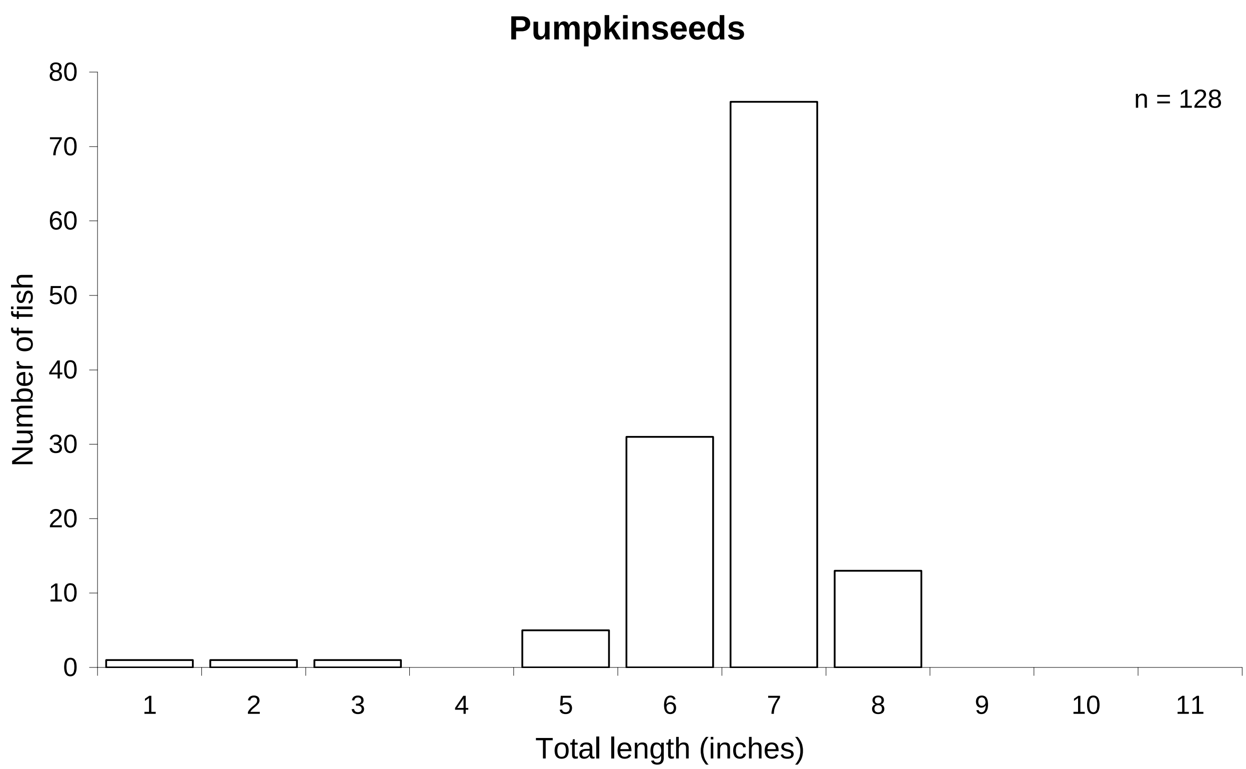


Figure 7.–Length-frequency distributions for redear sunfish and pumpkinseeds captured in Palmer Lake during May 2011.

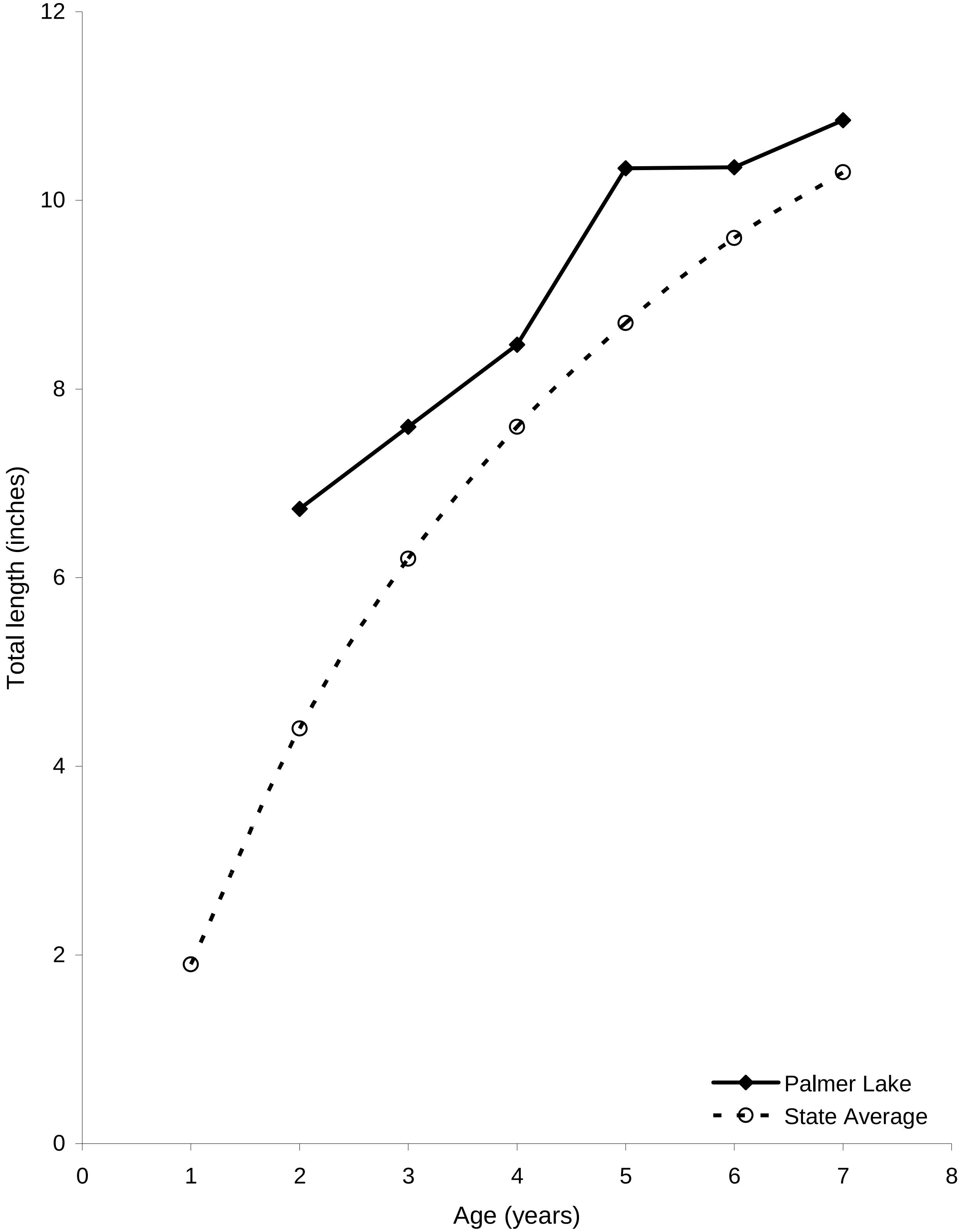


Figure 8.–Growth of redear sunfish in Palmer Lake, as determined from dorsal spine samples collected during May 2011. State average lengths from Schneider et al. (2000).

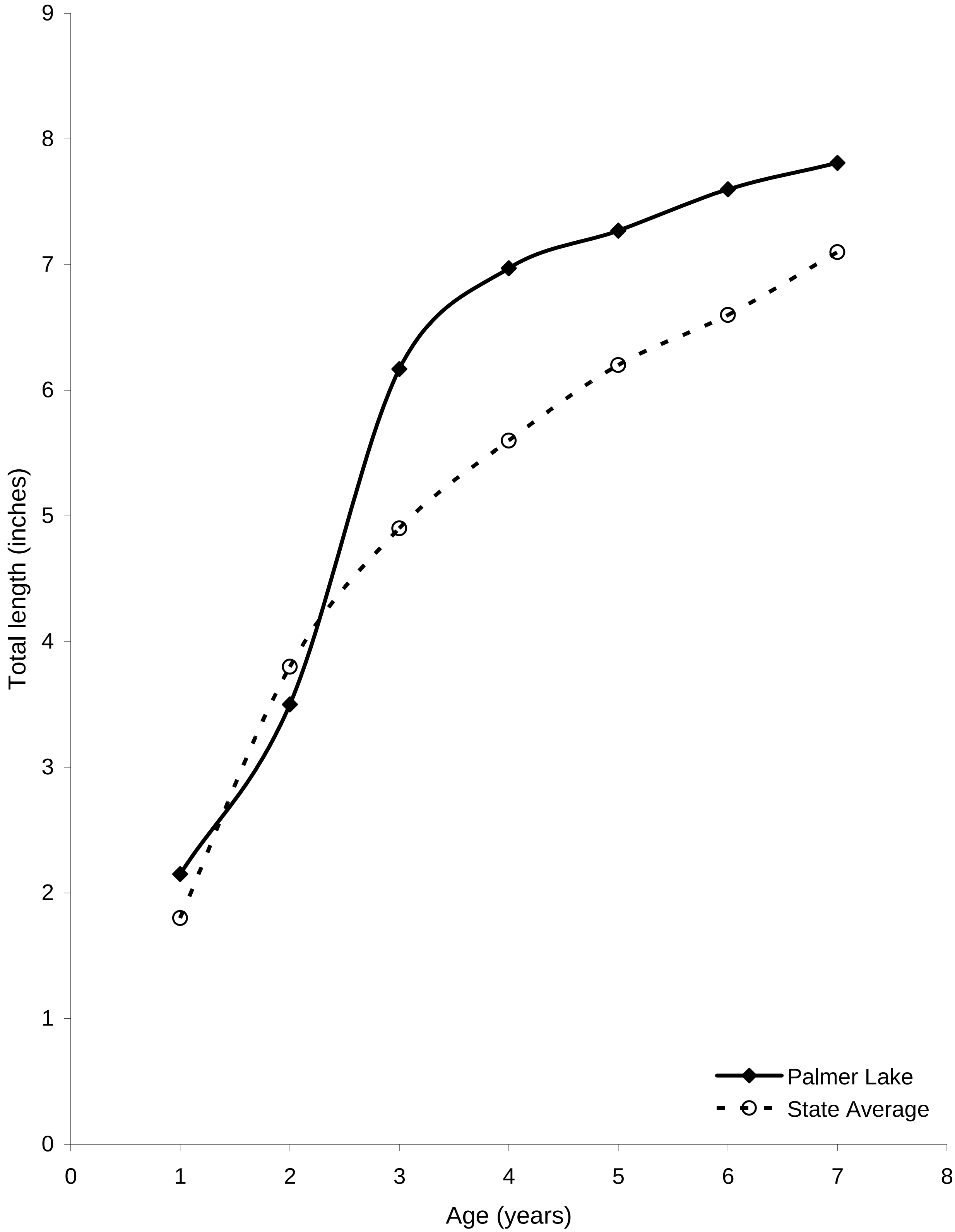


Figure 9.–Growth of pumpkinseeds in Palmer Lake, as determined from scale and dorsal spine samples collected during May 2011. State average lengths from Schneider et al. (2000).

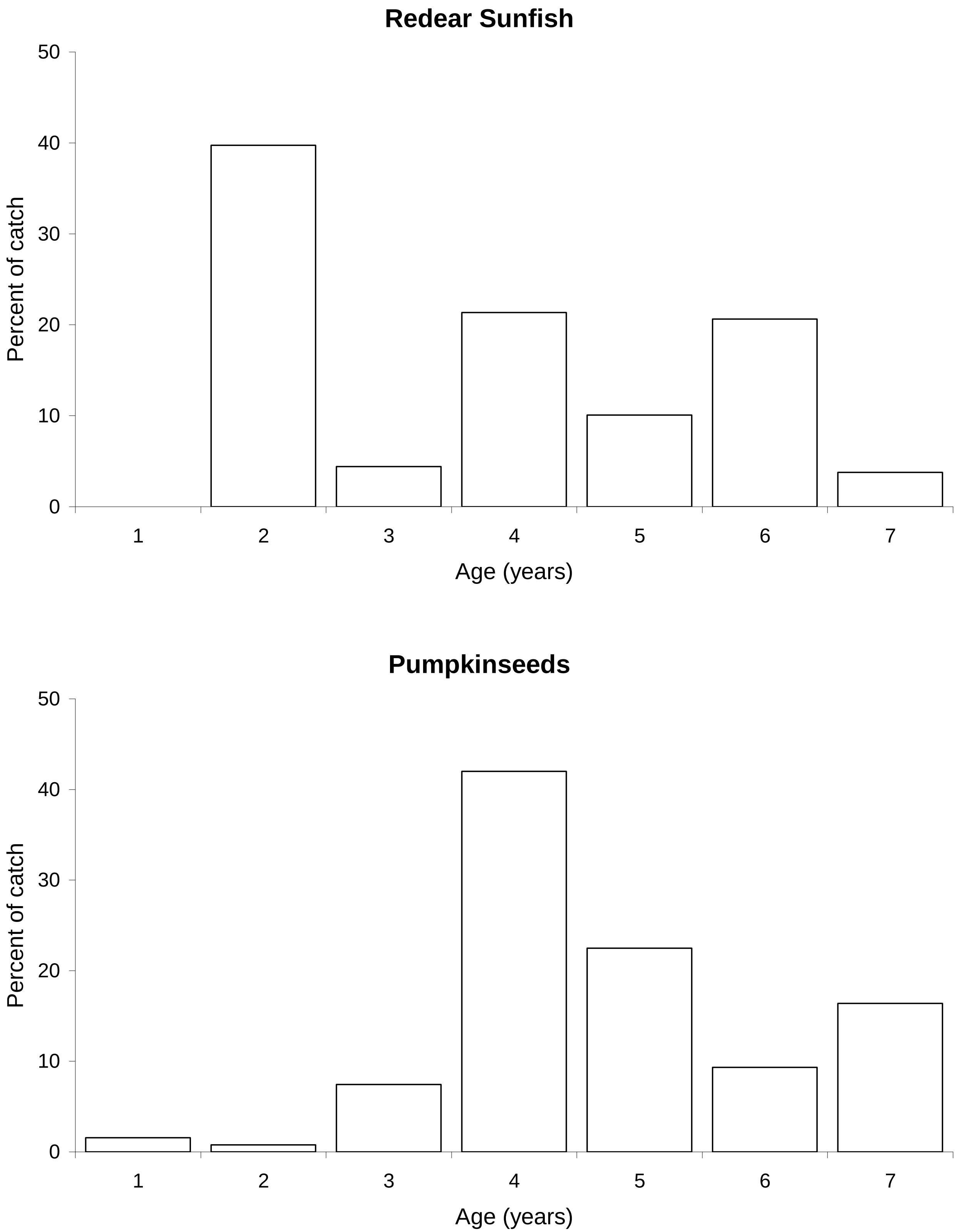


Figure 10.–Age frequency distributions for redear sunfish and pumpkinseeds captured in Palmer Lake during May 2011.

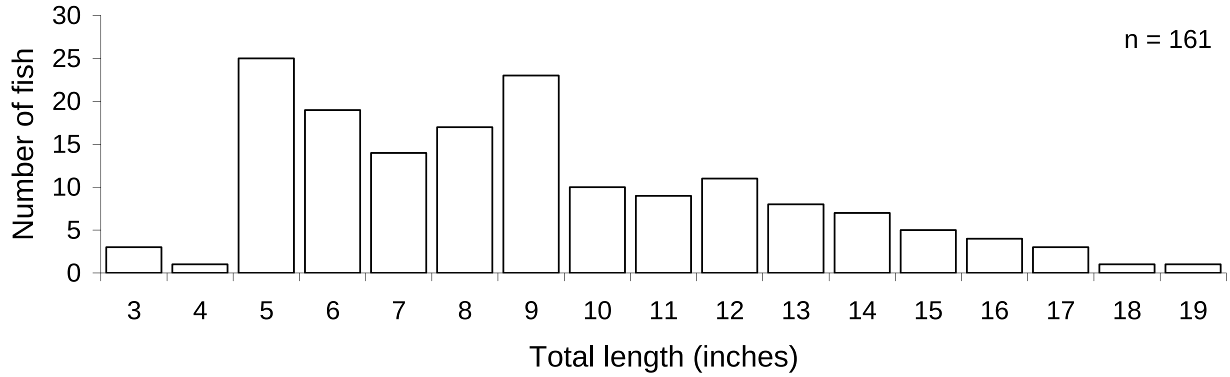


Figure 11.–Length frequency distribution for largemouth bass captured in Palmer Lake during May 2011.

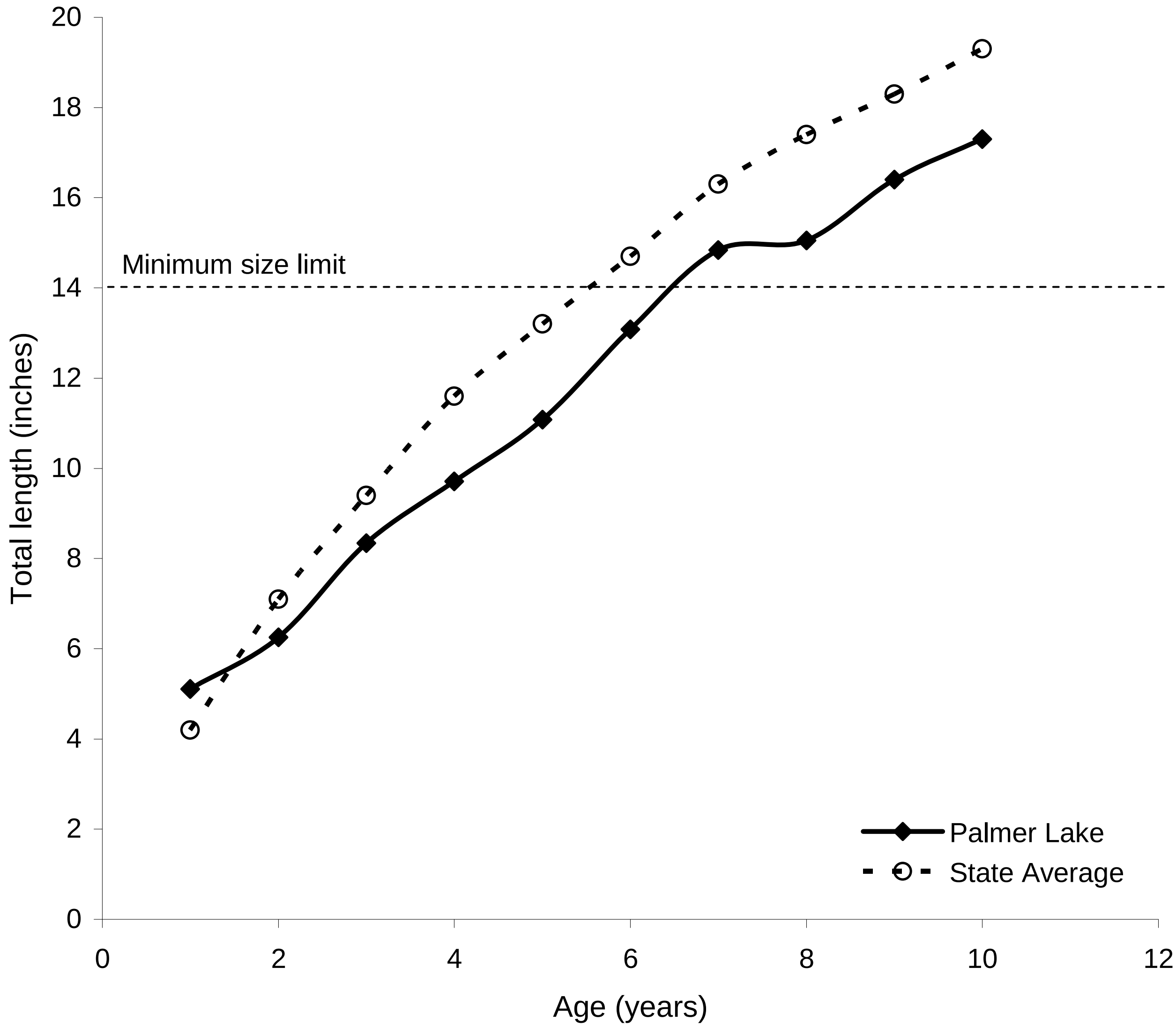


Figure 12.–Growth of largemouth bass in Palmer Lake, as determined from scale and dorsal spine samples collected during May 2011. State average lengths from Schneider et al. (2000).

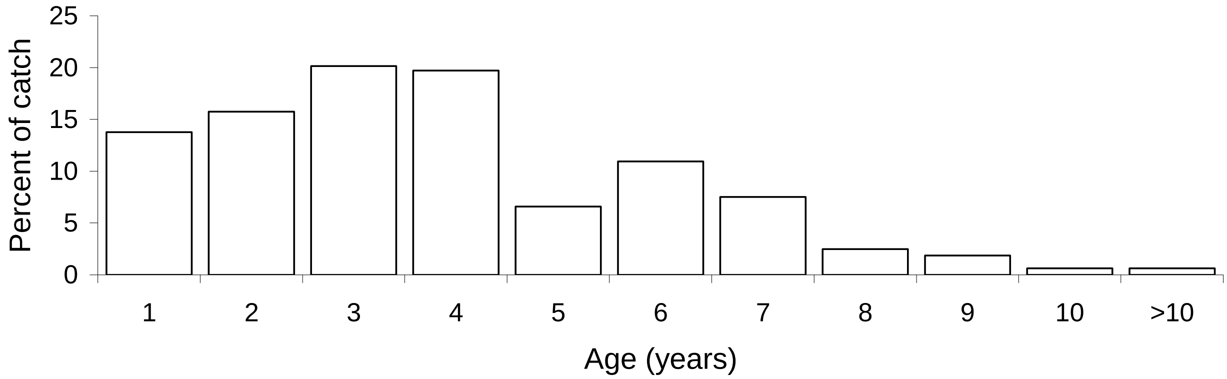


Figure 13.–Age frequency distribution for largemouth bass captured in Palmer Lake during May 2011.

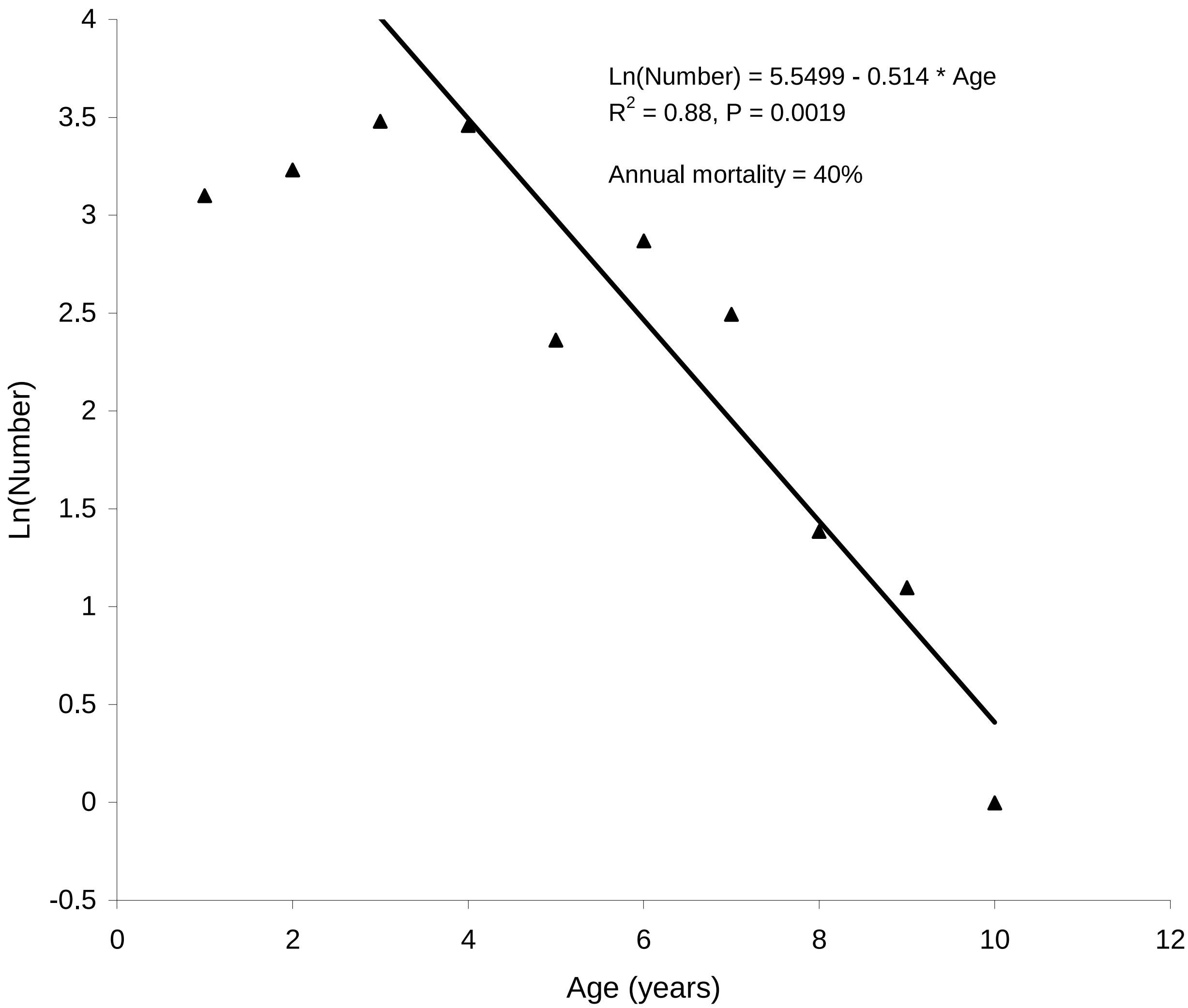


Figure 14.–Observed ln(number) versus age for largemouth bass captured in Palmer Lake during May 2011.