Sand Lake 2012 Survey Report

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Introduction

Sand Lake is a 102-acre natural lake located on the south side of the community of Nottawa and approximately 4.5 miles east of the village of Centreville. The lake consists of a single basin with a maximum depth of 22 ft. Drop-offs are gradual and approximately two-thirds of the lake (by surface area) is less than 10 ft deep. Sand is the predominant substrate along the shoreline, whereas marl and peat are common in offshore areas.

Sand Lake has no natural inlets or outlets. In 1972, an underground pipe was installed to connect Sand Lake with Lake Templene (an impoundment on the Prairie River). A one-way valve in the pipe was designed to open when the water level in Sand Lake exceeds the water level in Lake Templene, thus allowing water to exit Sand Lake. This valve is in poor condition and currently is propped partially open so water is able to move into or out of Sand Lake. The St. Joseph County Drain Commissioner plans to replace the valve prior to spring 2014. Michigan Department of Natural Resources (MDNR) – Fisheries Division has requested installation of a screen at this valve to prevent movement of fish between Lake Templene and Sand Lake. The legal summer maximum lake level for Sand Lake is 828.5 ft above sea level.

Sand Lake lies within deposits of glacial outwash sand and gravel overlaid by loamy sands of the Coloma-Spinks-Oshtemo series. These materials are porous and allow rapid infiltration of precipitation. However, the flat terrain limits groundwater delivery to Sand Lake and Darcy maps indicate low-to-moderate groundwater inputs to this system.

Agriculture (54%) is the most common land use in the watershed (Figure 1). Urban areas (i.e., the community of Nottawa) cover 35% of the basin. Residential and seasonal homes surround most of the shoreline. Based on dwelling counts from aerial imagery (www.bing.com/maps) the estimated dwelling density for Sand Lake is 39.1 dwellings/mile, which is about average for lakes in southwest Michigan. A township park and boat launch on the eastern shore provides public access to Sand Lake.

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). The most recent water quality testing on Sand Lake was completed by the Michigan Department of Environmental Quality (MDEQ) in August 2005. At that time the ratio of total nitrogen to total phosphorus was 37:1, so phosphorus appears to be the limiting nutrient in this system. The total phosphorus concentration at mid-depth was 0.021 mg/L. The chlorophyll *a* concentration, which provides an index of algal biomass, was 7.4 µg/L. The Secchi disk depth (an indicator of water transparency) was 4 ft. Based on these water quality measurements, Sand Lake is considered a borderline mesotrophic-eutrophic lake (moderate to high productivity; Carlson and Simpson 1996).

The first fisheries survey on Sand Lake was conducted by the Michigan Fish Commission (predecessor to MDNR – Fisheries Division) in 1887. Largemouth bass, bluegills, gar, and bullheads were captured during this initial sampling effort. The survey notes indicate that largemouth bass were abundant but small, whereas bluegills were in good condition. Bluegills, largemouth bass, and yellow perch were stocked in Sand Lake during 1933-1945 (Table 1). These stocking programs were discontinued after research indicated that they had minimal effects on the quality of the fishery (Cooper 1948)

Large seines were used to sample the nearshore fish community in Sand Lake during April 1958 and September 1960. Bluegills composed 74% of the total catch by number. Other game fish species captured (in order of decreasing abundance) were largemouth bass, yellow perch, pumpkinseeds, and black crappies. Growth was average for bluegills, pumpkinseeds, and black crappies. Mean lengths-at-age for yellow perch were above average in 1958 and average in 1960. Anglers reported fair to good fishing for bluegills. Anglers also reported catching many small largemouth bass but few bass of legal size. Common carp were introduced into the lake sometime prior to 1953 and apparently were abundant by the late 1950s.

During the late 1960s and early 1970s, fisheries surveys and angler reports indicated that the fish community in Sand Lake was dominated by small panfish. Only 5% of bluegills captured in 1972 and 1% of the bluegills collected in 1973 were 6.0 inches or larger. Mean lengths-at-age for bluegills also were below state averages. Quantitative data regarding the abundance, species composition, and distribution of aquatic plants in Sand Lake are not available for this period, but correspondence in MDNR – Plainwell Fisheries Office files suggests that the density of aquatic vegetation was increasing. The increase in aquatic vegetation growth probably was caused by the addition of nutrients from an adjacent cattle farm, septic systems for lakefront dwellings, and other anthropogenic sources (e.g., application of lawn fertilizers).

Sand Lake was treated with rotenone (a natural fish toxicant) at a concentration of 2 ppm in October 1974. The purpose of this treatment was to eliminate the common carp and stunted panfish populations. Once the lake had detoxified, it was restocked with hybrid sunfish and largemouth bass (Table 1). Yearling rainbow trout also were stocked in November 1974 to create a short-term fishery until the largemouth bass and sunfish reached harvestable size.

Fall electrofishing surveys were conducted in 1975, 1976, 1977, and 1979 to assess the recovery of the fish community in Sand Lake. Juvenile largemouth bass and hybrid sunfish composed the bulk of the catch in 1975. By 1977, bluegill abundance was rapidly returning to pre-treatment levels and bluegills composed 73% of the catch (by number). Mean growth indices for bluegills declined from +0.6 in 1976 to -0.6 in 1977 and -0.9 in 1979. Throughout this period, growth was average for largemouth bass and above average for yellow perch.

Fall fingerling tiger muskellunge were stocked in Sand Lake during 1977-1980. The objectives of this stocking program were to increase the predator-prey ratio in the lake and to create additional fishing opportunities. No tiger muskellunge were captured or observed during the fall electrofishing surveys in 1977 and 1979.

Trap nets, fyke nets, and gill nets were used to capture fish on Sand Lake in June 1990. Bluegills once again were the most common game fish, making up 63% of the catch by number and 26% of the catch by weight. Only 13% of the bluegills were 6 inches or larger. The mean growth index for bluegills was -0.8. Mean lengths-at-age were near state averages for young fish (ages 1-2) and substantially below average for adult bluegills. Growth was below average for yellow perch and black crappies. Few largemouth bass were collected, but the limited data available suggested that growth also was below average for this species. Fifteen common carp were captured, indicating that the carp population had rebounded from the

1974 rotenone treatment. Excessive weed growth continued to be a problem in this system and reduced sampling efficiency during the 1990 survey.

Trap nets were used to collect fish in Sand Lake in June 1997. Mean lengths-at-age for bluegills ages 3-4 were similar to state averages, whereas mean lengths-at-age for older fish were below average. Mean lengths-at-age for black crappies also were > 1 inch below average. Twenty adult flathead catfish were introduced into Sand Lake in June 1997, and harvest of flathead catfish was prohibited. The flathead catfish were expected to reduce abundance of bullheads and small bluegills in the lake. By decreasing competition for forage, fisheries managers hoped to improve the growth and size structure of the bluegill population in this system.

A follow-up survey was completed in May 2001 using the same sampling methods. Ten flathead catfish (total lengths = 32-40 inches) were recaptured. The introduction of flathead catfish had greatly affected bullhead abundance in Sand Lake. The bullhead catch declined from 119 fish in 1997 to zero in 2001. On the other hand, the introduction of flathead catfish had not produced the desired changes in the bluegill population. The bluegill catch-per-effort (CPE) was 2.5 times higher in 2001 than in 1997. Two year classes (ages 3-4) composed over 99% of the bluegill catch. No bluegills older than age 5 were collected in 2001. By contrast, fish older than age 5 had composed 57% of the catch in 1997. Mean lengths-at-age for bluegills ages 3 and 4 also had declined by 0.65 inches in 2001, and the percentage of bluegills of harvestable size (6 inches or larger) had decreased from 98% in 1997 to 20% in 2001.

Few black crappies were captured during the 2001 survey. The limited growth data available suggested a slight improvement from 1997. The CPE for pumpkinseeds was nearly identical in 1997 and 2001. However, the percentage of pumpkinseeds 6 inches or larger declined from 86% in 1997 to 35% in 2001. Seven redear sunfish were collected in 2001. This species is not native to Sand Lake. Local residents indicated that redear sunfish were stocked in the lake by a riparian landowner.

Materials and Methods

A fisheries survey was conducted on Sand Lake in 2012 to assess changes in the fish community since the 2001 sampling effort. Four trap nets were deployed on May 29th and lifted on May 30th. Total lengths were recorded for all fish captured. For game fish species, dorsal spine samples were collected from 10 fish per inch group for age determination. Weights were calculated for each species using the methods outlined by Schneider et al. (2000b).

Results

Fourteen fish species were collected during the 2012 survey (Table 2). Bluegill (n = 1,711) was the most abundant species, composing 47% of the catch by number and 23% of the catch by weight. Only seven bluegills (0.4%) were 6 inches or larger (Figure 2). 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 Sand Lake bluegill population was 1.2 (very poor).

The mean growth index for bluegills was -1.5, which is indicative of below average growth (Figure 3). Six year classes of bluegills were collected (Figure 4). Age 6 and older bluegills made up 5% of the catch. Annual total mortality was estimated to be 83% for adult bluegills (ages 4-8; Figure 5), which is one of the highest mortality estimates recorded for Michigan bluegill populations.

Redear sunfish (n = 874) made up 33% of the total fish biomass in the catch. Eighty-nine percent of the redear sunfish were in the 6.0-6.9 inch size class, and no fish larger than 7.9 inches were collected (Figure 6). Mean lengths-at-age were more than 2 inches below average (Figure 7). Two year classes (ages 5 and 6) composed 99% of the redear sunfish catch (Figure 8). Redear sunfish often hybridize with bluegills or pumpkinseeds. Hybrid sunfish (n = 1,011) made up 27% of the total fish biomass during the 2012 survey. Thirty-four percent of the hybrid sunfish were of harvestable size (i.e., 6 inches or larger), and only one hybrid sunfish larger than 7.9 inches was captured (Figure 9).

Pumpkinseeds (n = 29), black crappies (n = 15), and yellow perch (n = 1) were minor components of the catch. These species only composed 2% of the total fish biomass during the survey. Lengths-at-age for black crappies generally were below average (Figure 10).

One flathead catfish was captured during the survey. The total length of this fish was 41 inches. The other piscivores (fish-eaters) in the catch were spotted gar (n = 6), largemouth bass (n = 1), and channel catfish (n = 1). No bullheads were collected during the 2012 sampling effort.

Analysis and Discussion

The introduction of flathead catfish did not produce the desired changes in the growth and size structure of the bluegill population. Mean growth indices declined from 1997 through 2012 (Table 3). Conversely, bluegill CPE increased from 93 fish/net night in 1997 to 229 fish/net night in 2001 and 428 fish/net night in 2012. Overcrowding and stunting continue to hinder the development of a strong bluegill fishery in Sand Lake.

Flathead catfish also have been stocked in multiple lakes within the Muskegon River watershed. The effects of flathead catfish stocking on bluegill populations have been variable. A technical report that includes a detailed analysis of these introductions (plus the Sand Lake introduction) and the resulting changes in bullhead and panfish populations is being prepared by Rich O'Neal from the Central Lake Michigan Management Unit. One factor that may influence the effects of flathead catfish on bluegill populations is size at stocking. The mean total length for flathead catfish stocked in Sand Lake was 34 inches. At that size, these predators would be able to consume bluegills of all sizes, whereas smaller catfish would selectively prey on juvenile bluegills.

Largemouth bass and other predatory game fish currently are rare in Sand Lake. Schneider (2000) observed that predators typically make up 20-50% of the biomass in lakes with desirable fish communities. During the 2012 Sand Lake survey, predators only composed 11% of the total fish biomass. Guy and Willis (1990) found that the proportion of the bluegill population larger than 6 inches was positively correlated to the population density of largemouth bass smaller than 12 inches. Largemouth bass in this size range are important predators of juvenile bluegills, and predation by bass apparently reduced intraspecific competition for resources.

A variety of other biotic and abiotic factors likely are responsible for the poor growth of bluegills in Sand Lake. As noted previously, about two-thirds of the lake is less than 10 ft deep and sandy substrates are common in the littoral zone. Thus, there is a large area of suitable nesting habitat in this system. Ehlinger (1997) found that an abundance of nesting habitat in shallow lakes allowed younger, smaller males to spawn successfully and that males from stunted populations matured at younger ages than bluegills in populations without stunting. Thus, bluegills were diverting energy from somatic growth into gonadal growth.

Bluegill growth also is related to the distribution, density, and diversity of aquatic plants in a lake. Growth of rooted aquatic plants is limited by light penetration. Thus, the percentage of lake area covered with aquatic vegetation typically is higher in shallow lakes (such as Sand Lake) than in lakes with steep drop-offs. The density of aquatic vegetation in the lake is influenced by the nutrient supply. When human activities increase nutrient inputs to a lake, the biomass of aquatic plants in the lake typically increases. Fisheries Division files suggest that this scenario occurred in Sand Lake during the 1960s. Once a lake has shifted from a mesotrophic system to a eutrophic system, it is difficult to return the lake to its former state. The use of best management practices can reduce external nutrient loading, but the internal cycling of nutrients between the sediments and the water column continues.

Cheruvelil et al. (2005) found a negative relationship between the percentage of a lake covered with aquatic vegetation and growth of bluegills and largemouth bass. Schneider (1981) and Theiling (1990) also observed that bluegill stunting was most common in shallow weedy lakes. Stunting is caused by a combination of high recruitment of young fish, low natural mortality of young fish, and a scarcity of suitable forage (Theiling 1990; Schneider 1999; Schneider and Lockwood 2002). In southwest Michigan, largemouth bass typically are the most important predators of juvenile bluegills. Dense aquatic vegetation hinders prey detection and movement of largemouth bass, resulting in longer search times and lower attack success (Savino and Stein 1982; Engel 1987; Gotceitas and Colgan 1989; Valley and Bremigan 2002).

The introduction of Eurasian watermilfoil into a lake exacerbates bluegill stunting. Eurasian watermilfoil forms dense mats that are nearly impossible for largemouth bass to penetrate. These mats also can inhibit growth of native plant species, thus reducing the diversity and abundance of macroinvertebrates that are an important food source for bluegills (Cheruvelil et al. 2001). Fisheries Division files do not indicate exactly when Eurasian watermilfoil was first detected in Sand Lake. This species was first observed in many Michigan lakes in the 1960s, which coincides with the complaints of dense vegetation in Sand Lake in the late 1960s and early 1970s. Eurasian watermilfoil was the most abundant plant species observed during the Michigan Department of Environmental Quality's vegetation survey of Sand Lake in October 2001.

As bluegill stunting is most common in lakes with dense vegetation, many researchers have hypothesized that aquatic plant control can produce improvements in bluegill growth. Three general categories of weed control have been examined: mechanical harvesting, biological control, and herbicides. Trebitz and Nibbelink (1996) and Trebitz et al. (1997) used computer simulations to predict how patterns of vegetation removal would affect bluegill growth. In their simulations, cutting narrow channels that totaled 20-40% of a vegetated area yielded the largest improvements in bluegill growth rates. Olson et al. (1998) cut narrow channels in four lakes (approximately 20% of vegetation removed) and found that growth of age-3 and age-4 bluegills improved significantly relative to bluegills in reference lakes. They predicted that these effects would be short-lived unless cutting was repeated. There is one major caveat to this technique. Eurasian watermilfoil can reproduce via fragmentation, so mechanical harvesting could increase relative abundance of Eurasian watermilfoil at the expense of native plant species that do not reproduce via fragmentation.

Biological control involves the introduction of a predator to consume Eurasian watermilfoil. In the Great Lakes region, the species that generally has been employed for this purpose is the milfoil weevil. This insect is native to the area and lives almost exclusively on milfoil (both the Eurasian and native varieties). The larvae feed on stem tissue, whereas the adults consume milfoil leaves. Parsons et al. (2011) observed declines in Eurasian watermilfoil biomass and improvements in the size structure of the pumpkinseed population in a Washington lake several years after introduction of milfoil weevils. However, the survival of milfoil weevils and their effects on aquatic ecosystems have varied widely from lake to lake. Newman (2004) found that survival of milfoil weevils generally declined with increasing densities of predators such as bluegills and other sunfish species. Thus, it may be difficult to establish a robust population of milfoil weevils in Sand Lake.

Fluridone is an herbicide that is frequently applied to lakes with large Eurasian watermilfoil infestations. Pothoven et al. (1999) reported short-term reductions in bluegill abundance and improvements in bluegill growth rates after fluridone treatments in two lakes in Minnesota. Sand Lake was treated with fluridone in May 2008. Vegetation surveys conducted by Weed Patrol, Inc. in 2008 and 2009 indicated that Eurasian watermilfoil abundance had decreased dramatically after the treatment. However, abundance of native plants also was low and only thinleaf pondweed and brittle naiad had cumulative cover percentages greater than 1%. A vegetation survey conducted by Clarke Aquatics Service in August 2012 revealed that Eurasian watermilfoil abundance had rebounded, but had not returned to 2001 levels. No improvements in bluegill growth were observed in Sand Lake after the fluridone treatment. Rather, mean growth indices were lower in 2012 than in 2001.

The abundance of redear sunfish in Sand Lake suggests that large numbers of fish were stocked in 2006 and 2007 without a permit. Because redear sunfish readily hybridize with other sunfish species, it is unlikely that the introduction of a few individuals would result in the production of such a large population of pure redear sunfish. The introduction of these fish only increased competition for scarce resources.

Management Recommendations

Five fisheries management goals have been developed for Sand Lake. Goal 1: Protect and rehabilitate habitat for fish and other aquatic organisms. Goal 2: Establish a healthy predator-prey ratio within the fish community. Goal 3: Improve the growth and size structure of the bluegill population. Goal 4: Create new fishing opportunities. Goal 5: Eliminate an unnecessary fishing regulation.

Several 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 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 cover) on aquatic ecosystems. MDEQ plans to develop a Total Maximum Daily Load (TMDL) for *E. coli* in Sand Lake in 2017. As opportunities arise, Fisheries Division personnel will assist with this process. Any steps taken to reduce *E. coli* inputs also will reduce nutrient inputs to the lake and may result in a decrease in aquatic plant biomass.

Goals 2-4 are interrelated. Schneider and Lockwood (2002) found that stocking fall fingerling walleyes in southern Michigan lakes (which were similar in size and bathymetry to Sand Lake) resulted in increased abundance of bluegills $\geq$ 7 inches. Similarly, Snow and Staggs (1994) noted a positive correlation between walleye abundance and bluegill growth in Wisconsin lakes. A fish stocking request will be submitted to stock 1,000 fall fingerling walleyes (10/acre) in Sand 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 stocking permit) could be used to augment the walleye population until the Division can consistently fill the stocking request for Sand Lake.

Harvest of flathead catfish currently is prohibited in Sand Lake. This regulation is no longer necessary. The flathead catfish introduction did not achieve the desired objectives, and few catfish remain in the lake. A fisheries order change request will be submitted in 2014. If approved, this regulation change would go into effect on April 1, 2015.

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Figure 1.–Aerial view of Sand Lake, showing land use patterns within the watershed. The star indicates the location of the public access site. Image from www.bing.com/maps.

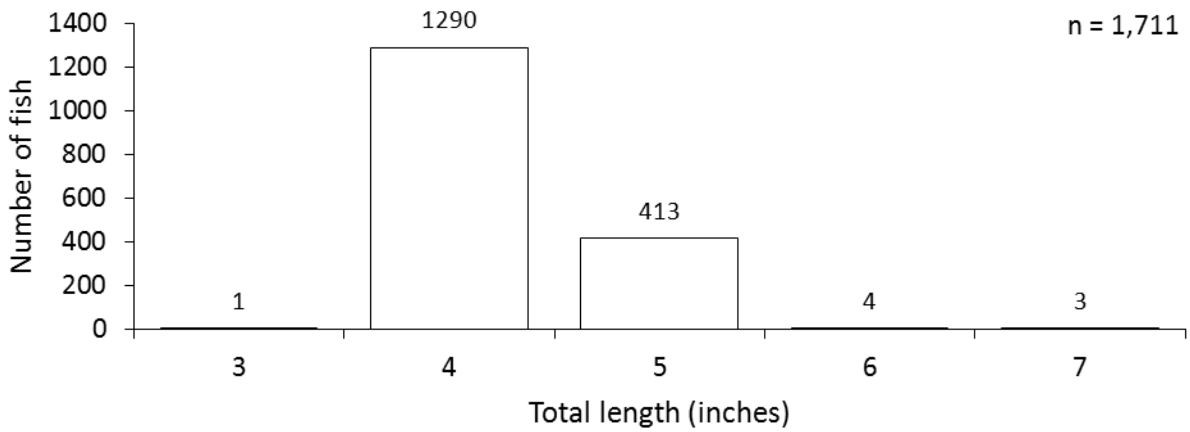

Figure 2.–Length frequency distribution for bluegills captured in Sand Lake during May 29-30, 2012.

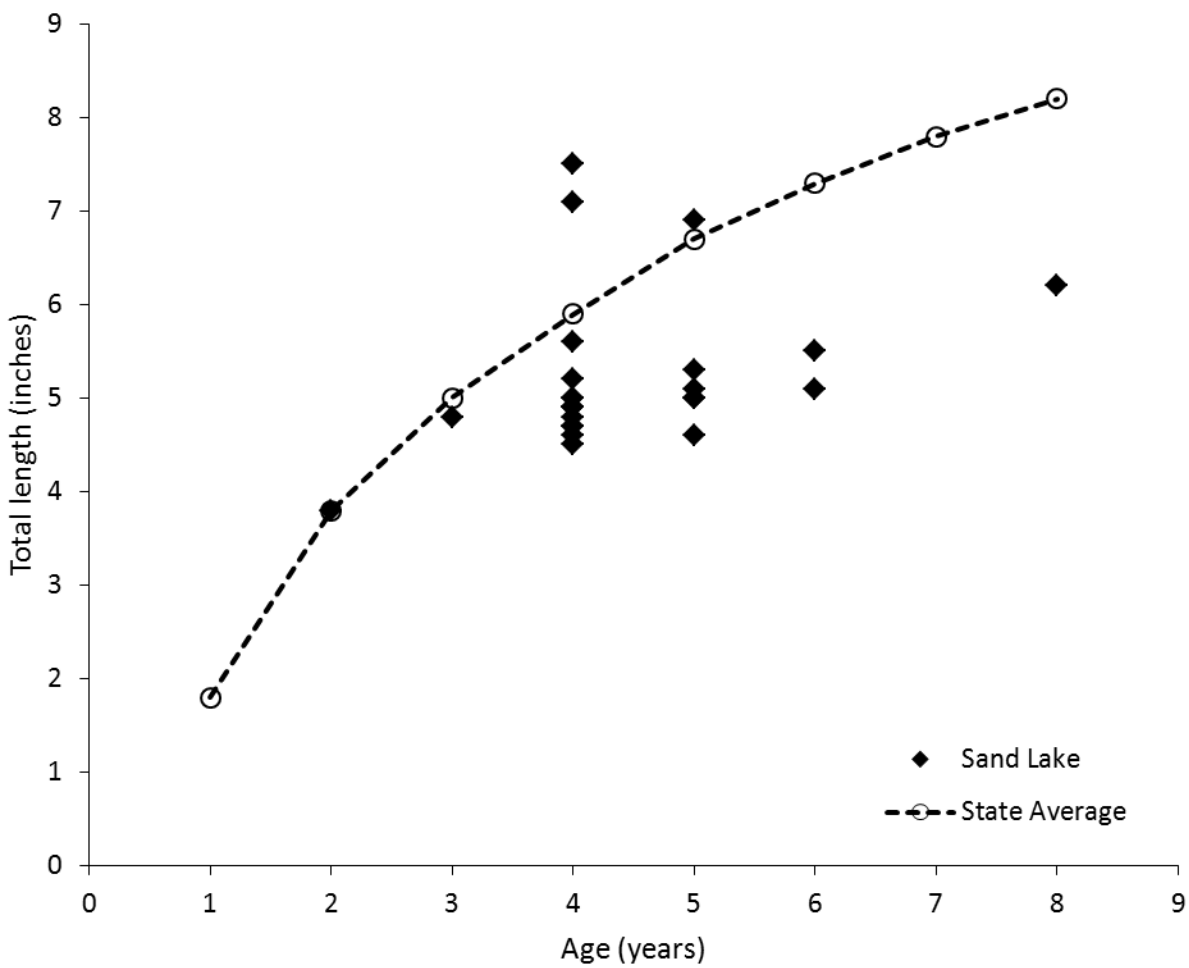

Figure 3.–Growth of bluegills in Sand Lake, as determined from dorsal spine samples collected during May 29-30, 2012. State average lengths from Schneider et al. (2000a).

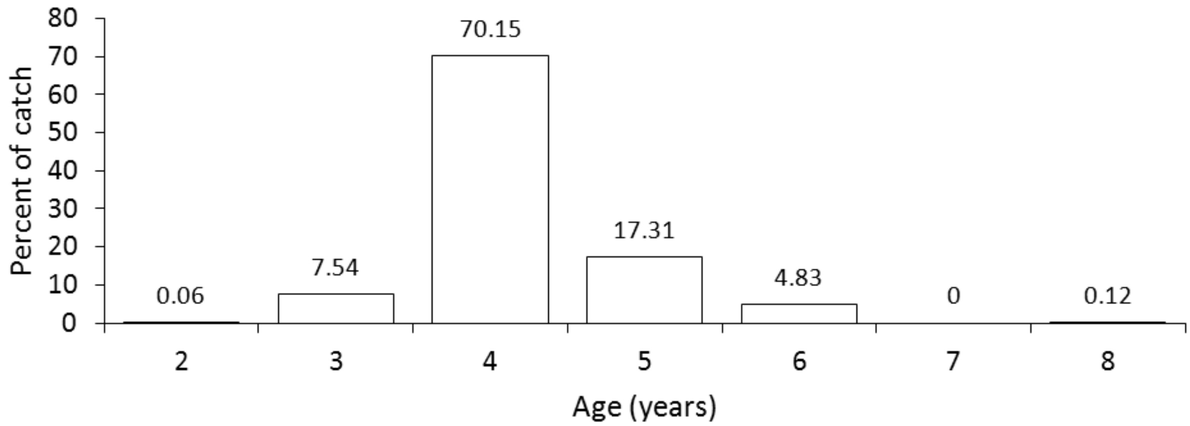

Figure 4.–Age frequency distribution for bluegills captured in Sand Lake during May 29-30, 2012.

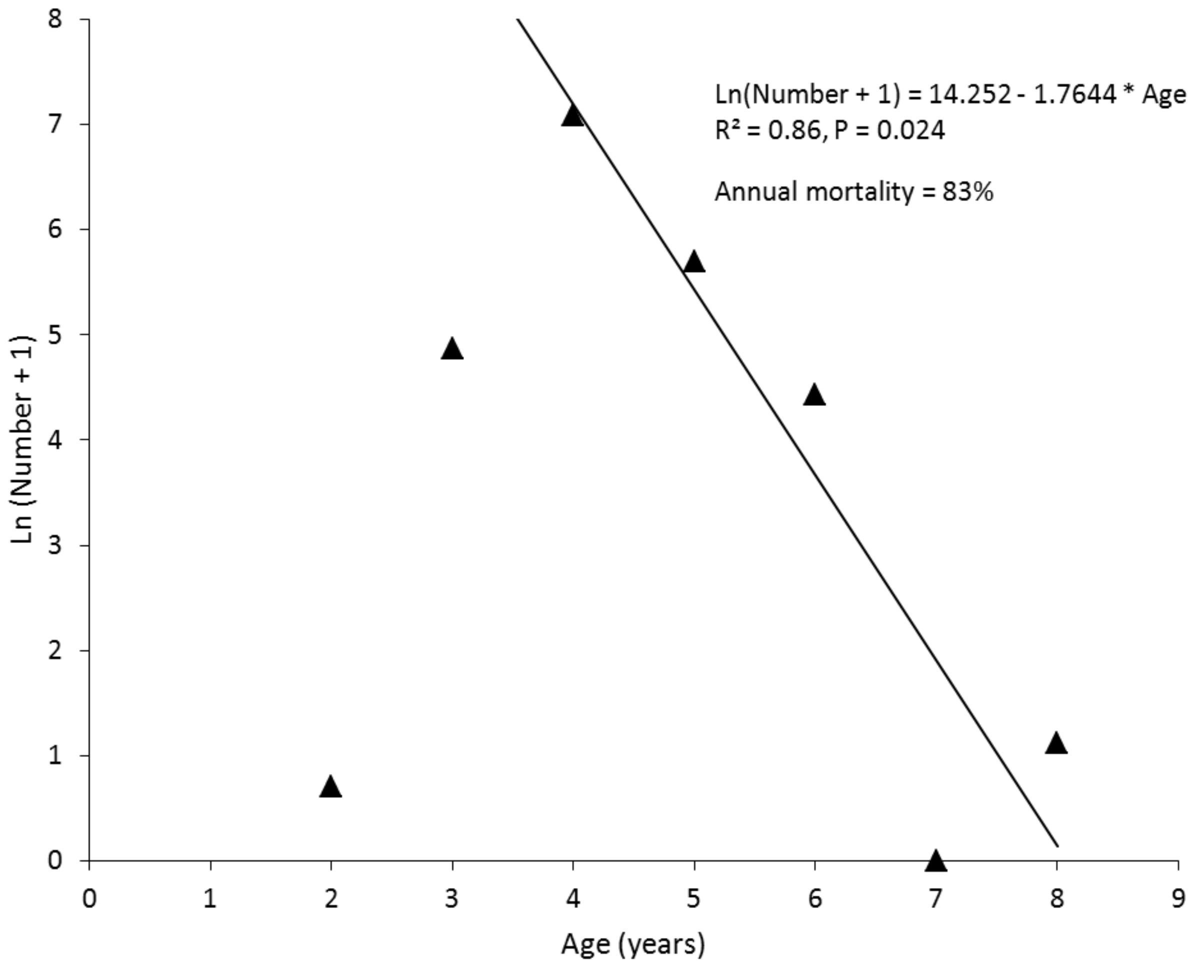

Figure 5.–Natural log of observed numbers of fish plus one versus age for bluegills captured in Sand Lake during May 29-30, 2012.

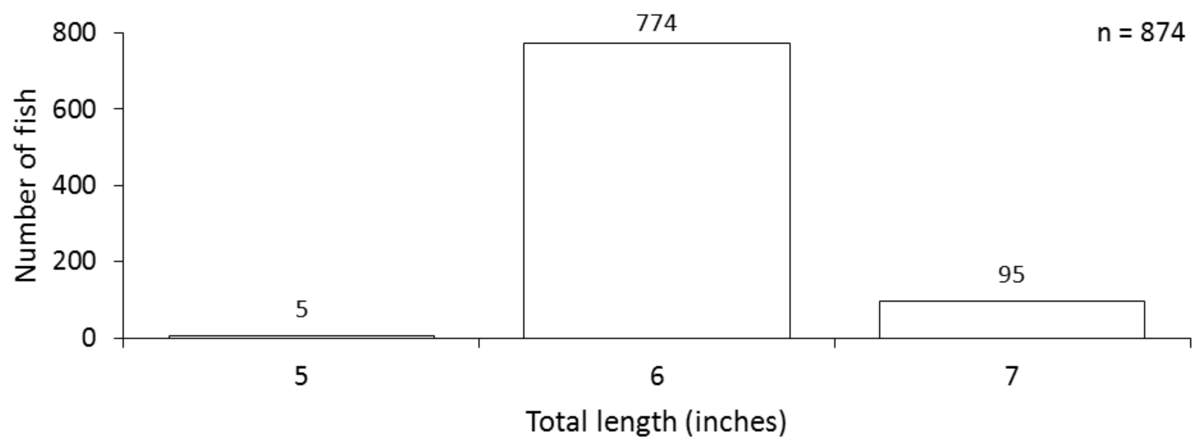

Figure 6.–Length frequency distribution for redear sunfish captured in Sand Lake during May 29-30, 2012.

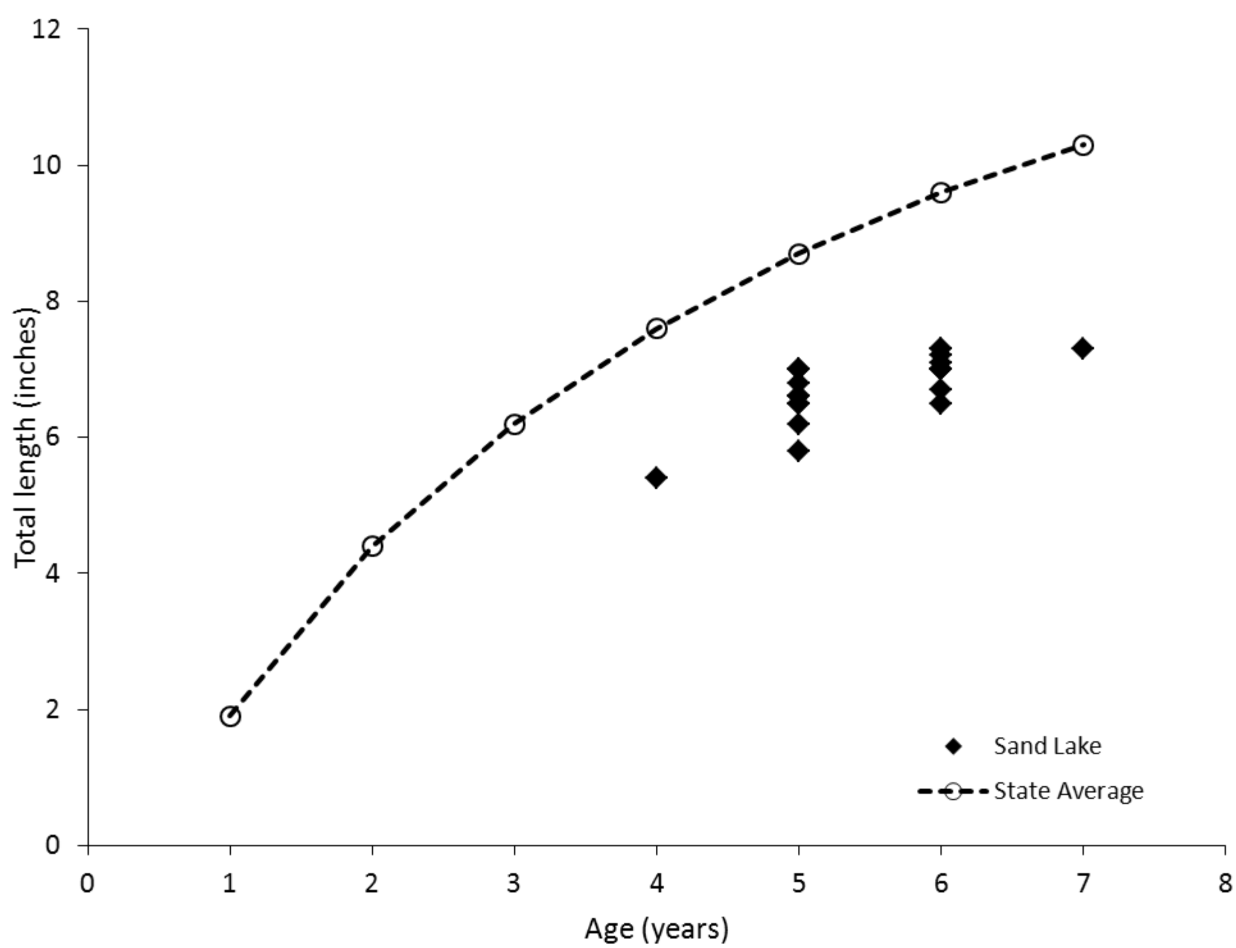

Figure 7.–Growth of redear sunfish in Sand Lake, as determined from dorsal spine samples collected during May 29-30, 2012. State average lengths from Schneider et al. (2000a).

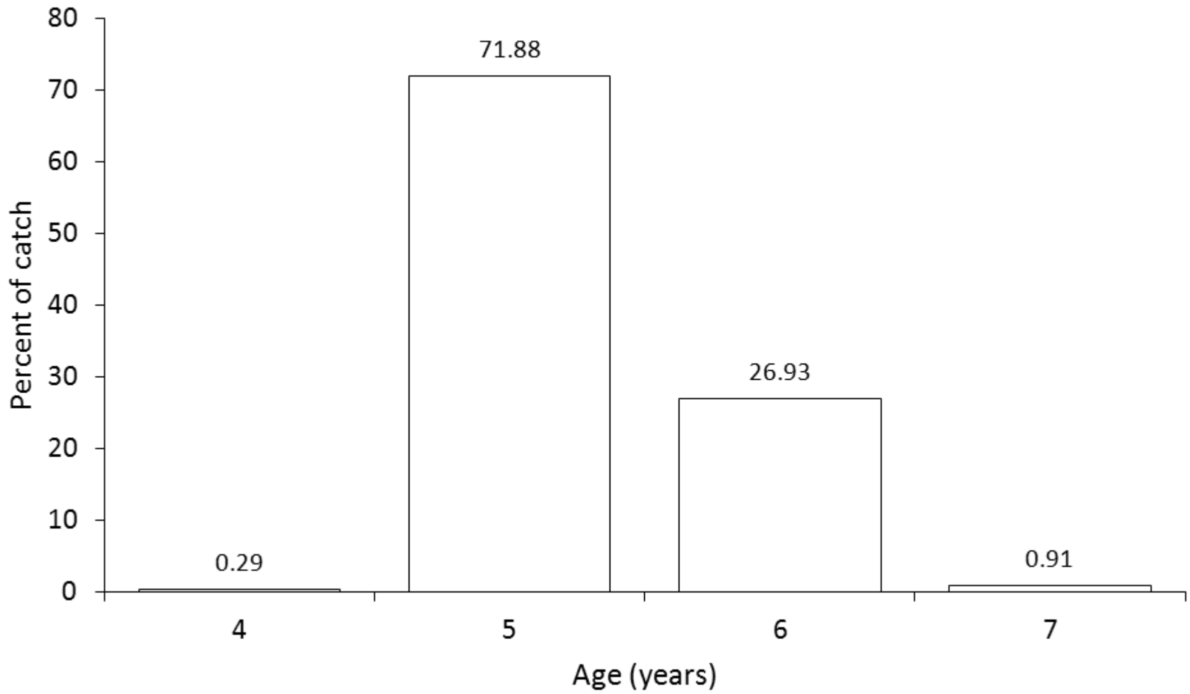

Figure 8.–Age frequency distribution for redear sunfish captured in Sand Lake during May 29-30, 2012.

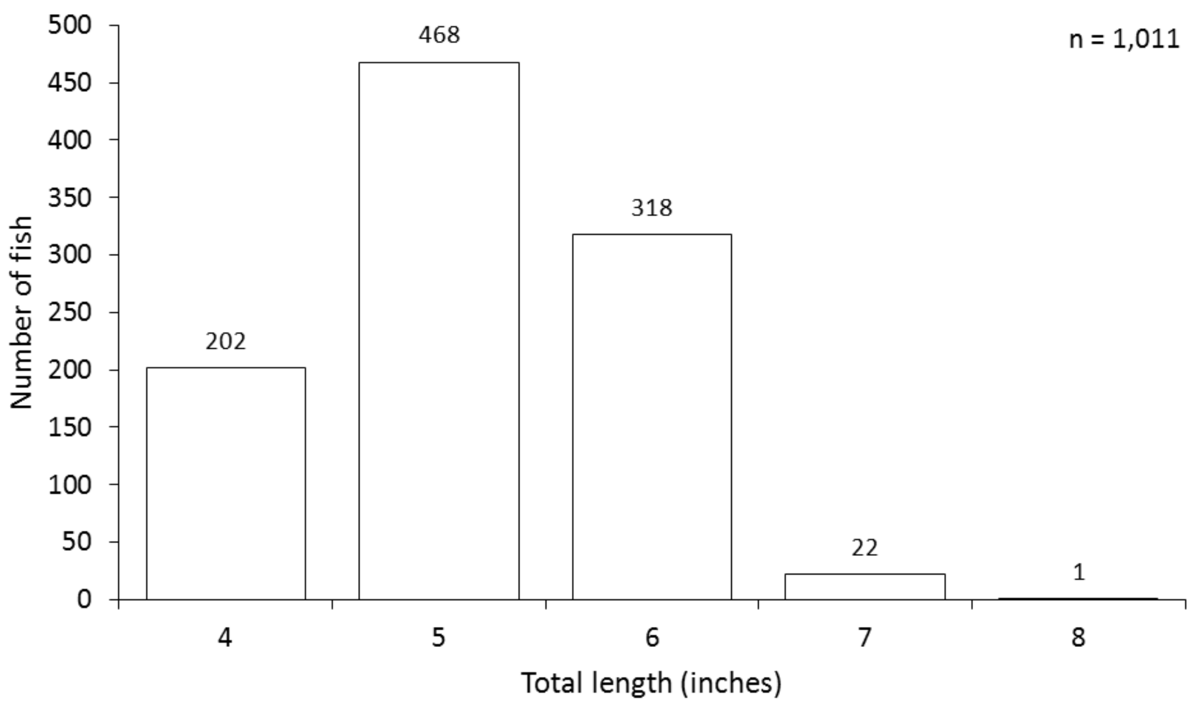

Figure 9.–Length frequency distribution for hybrid sunfish captured in Sand Lake during May 29-30, 2012.

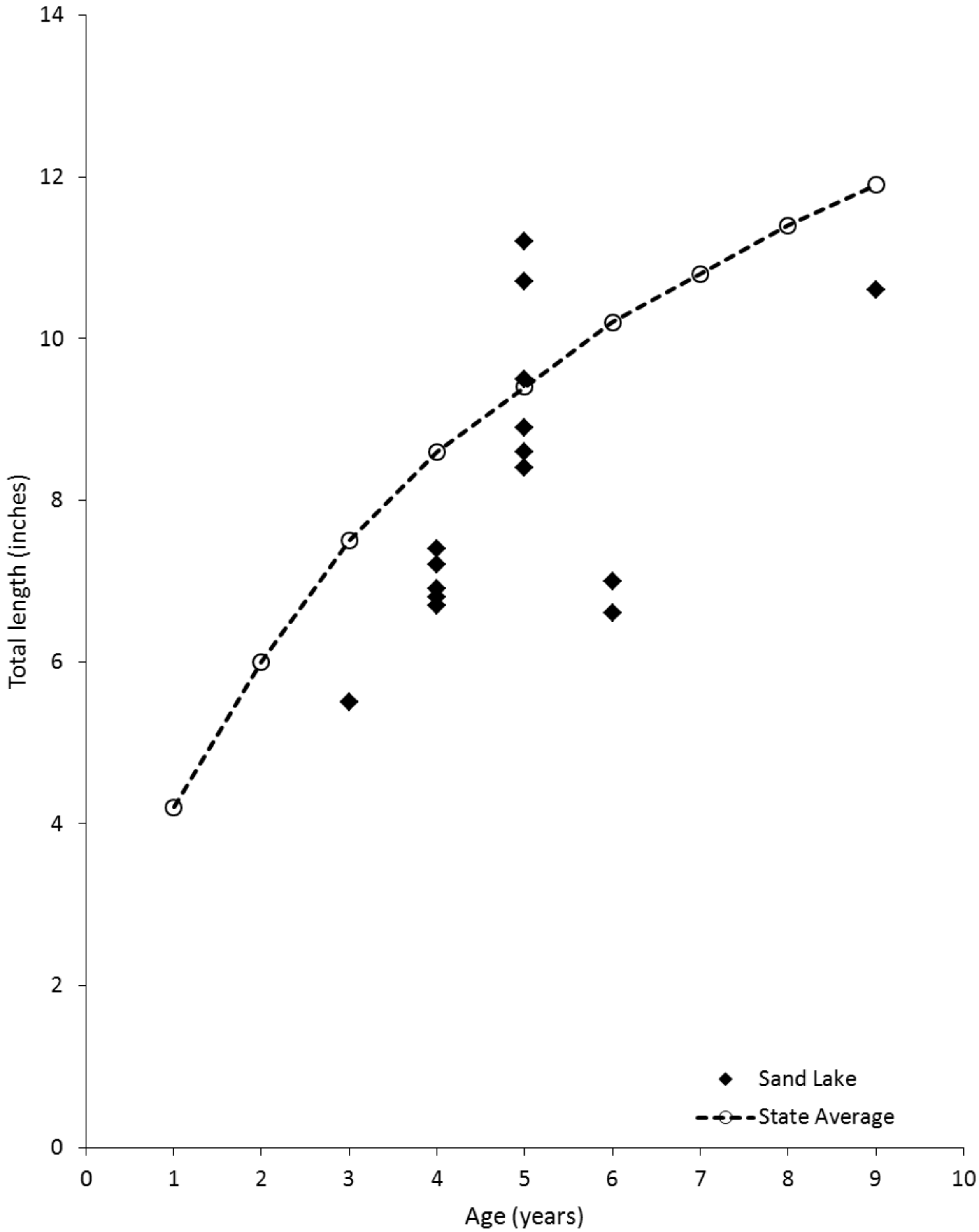

Figure 10.–Growth of black crappies in Sand Lake, as determined from dorsal spine samples collected during May 29-30, 2012. State average lengths from Schneider et al. (2000a).

Table 1.–Fish stocking in Sand Lake, 1933-2012.

Year	Species	Life stage	Number	Number/acre	Average length (inches)
1933	Bluegill	Fall fingerling	14,000	137	---
	Largemouth bass	Fall fingerling	500	5	---
1934	Bluegill	Fall fingerling	15,000	147	---
1935	Bluegill	Fall fingerling	20,000	196	---
	Largemouth bass	Fall fingerling	1,000	10	---
1936	Bluegill	Fall fingerling	10,000	98	---
	Largemouth bass	Fall fingerling	500	5	---
1937	Bluegill	Fall fingerling	30,000	294	---
1938	Bluegill	Fall fingerling	50,000	490	---
	Largemouth bass	Fall fingerling	1,000	10	---
	Yellow perch	Fall fingerling	10,000	98	---
1939	Bluegill	Fall fingerling	5,000	49	---
	Largemouth bass	Fall fingerling	2,000	20	---
	Yellow perch	Fall fingerling	5,000	49	---
1940	Bluegill	Fall fingerling	20,000	196	---
	Largemouth bass	Fall fingerling	1,000	10	---
1941	Bluegill	Fall fingerling	20,000	196	---
	Largemouth bass	Fall fingerling	500	5	---
1942	Bluegill	Fall fingerling	10,000	98	---
	Largemouth bass	Fall fingerling	500	5	---
1943	Bluegill	Yearling	1,000	10	---
	Largemouth bass	Fall fingerling	1,000	10	---
1944	Largemouth bass	Fall fingerling	1,500	15	3.00
1945	Bluegill	Fall fingerling	10,000	98	2.00
	Largemouth bass	Fall fingerling	1,000	10	4.00
1974	Hybrid sunfish	Fall fingerling	40,000	392	---
	Largemouth bass	Fall fingerling	17,255	169	---
	Rainbow trout	Yearling	15,000	147	---
1975	Largemouth bass	Fall fingerling	13,900	136	---
1977	Tiger muskellunge	Fall fingerling	400	4	---
1978	Tiger muskellunge	Fall fingerling	400	4	---
1979	Tiger muskellunge	Fall fingerling	400	4	5.74
1980	Tiger muskellunge	Fall fingerling	400	4	9.12
1997	Flathead catfish	Adult	20	0.2	34.04
2008	Walleye*	Fall fingerling	800	8	7.11

* Private fish stocking under permit from MDNR

Table 2.–Numbers, weights, lengths, and growth indices for fish species collected during the fish community survey on Sand Lake, May 29-30, 2012. Fish were captured using trap nets.

Species	Number	Percent by number	Weight (lbs)	Percent by weight	Length range (inches)	Percent legal or harvestable[1]	Growth index[2]
Bluegill	1,711	46.7	123.5	23.5	3-7	0	-1.5
Hybrid sunfish	1,011	27.6	141.4	26.9	4-8	34	---
Redear sunfish	874	23.9	173.3	33.0	5-7	99	-2.5
Pumpkinseed	29	0.8	4.8	0.9	4-7	34	---
Black crappie	15	0.4	4.8	0.9	5-11	67	-0.7
Spotted gar	6	0.2	11.4	2.2	20-26	---	---
Warmouth	4	0.1	0.7	0.1	5-6	50	---
Common carp	3	0.1	14.6	2.8	12-25	---	---
Flathead catfish	1	0.0	33.1	6.3	41	100	---
Channel catfish	1	0.0	8.9	1.7	29	100	---
Golden redhorse	1	0.0	6.3	1.2	26	---	---
Largemouth bass	1	0.0	2.4	0.5	16	100	---
Yellow perch	1	0.0	0.3	0.0	8	100	---
Green sunfish	1	0.0	0.2	0.0	6	100	---
Golden shiner	1	0.0	0.1	0.0	7	---	---
Total	3,660		525.7				

[1] Harvestable size is 6 inches for bluegills, pumpkinseeds, redear sunfish, green sunfish, hybrid sunfish, and warmouths, and 7 inches for black crappies 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.

Table 3.–Mean growth indices for bluegills captured in Sand Lake during 1958-2012. Mean growth indices were calculated using the methods described by Schneider et al. (2000a).

	Age					
Year	1	2	3	4	5	6
1958		+0.8	+0.8	+0.6		
1960	+0.4	+0.2	+0.3	+0.7		
1972				-1.3	-1.1	
1973		-0.8	-1.3	-1.6		
1976	+0.4	+0.8	+1.5			
1977	-1.2	0				
1979	-1.2	-1.1	-0.3			
1990	+0.8	-0.4	-1.1	-1.5	-1.5	-1.0
1997			+0.4	+0.3		-1.5
2001			-0.7	-0.3		
2012				-1.1	-1.8	