


2005 Warmwater Fisheries Survey of Alkali Lake, Grant County, WA

A graphic featuring a yellow line that forms a large, stylized letter 'S' or a similar shape. Inside the curve of the line, there are five small illustrations of fish swimming in a blue, wavy water area. The text 'Warmwater Fish' is written in a bold, green, sans-serif font above the fish, and 'Enhancement' is written in the same font below the fish.

Warmwater Fish Enhancement

by Michael R. Schmuck and Marc R. Petersen



Washington Department of
FISH AND WILDLIFE
Fish Program
Fish Management Division

2005 Warmwater Fisheries Survey of Alkali Lake, Grant County, WA

The Warmwater Fish Community in a Central
Washington Lake with a History of Highly Variable
Fish Recruitment and Survival

By

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Abstract

Alkali Lake was surveyed by the Region Two Warmwater Team September 19-21, 2005 using standardized warmwater survey methods. This is the sixth year of surveys conducted to determine long-term trends in the fish community. The most abundant species collected was yellow perch (*Perca flavescens*) followed by bluegill (*Lepomis macrochirus*), pumpkinseed sunfish (*L. gibbosus*) and largemouth bass (*Micropterus salmoides*). The majority of fish collected were age two, and growth was above average for yellow perch, black crappie, and largemouth bass. Relative weights were near the national average ($W_r = 100$) for bluegill and black crappie, below average for yellow perch, and above average for pumpkinseed sunfish. Largemouth bass relative weights increased with length and were above average for large bass. Stock density indices indicate most fish populations are comprised of small fish. Relative abundance of yellow perch has increased in our samples since 1999, while largemouth bass have declined.

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Introduction and Background

Alkali Lake is part of the Sun Lakes chain located in Grant County approximately 14.5 kilometers (9 miles) north of the City of Soap Lake, Washington (Figure 1). Alkali Lake has a surface area of 118.6 hectares (293 acres), a mean depth of 2.6 meters (m)(8.4 ft.), and a volume of 2,449 acre feet. Water drains from Blue Lake into Alkali Lake via Blue Creek. Water discharges, seasonally, from the south end of Alkali Lake through permeable rock-fill under Highway 17 into Lake Lenore. Alkali Lake's shoreline is comprised of approximately 80 percent vegetation and 20 percent cliff and talus (WDFW 1996a). Alkali Lake has a history of summer fish kills due to low dissolved oxygen levels.

Alkali Lake once exhibited pH levels that were too alkaline to support fish populations; however, fish survival was documented by the 1940s. Rehabilitation efforts by the Washington Department of Fish and Wildlife (WDFW) were first conducted on Alkali Lake in 1952 (WDFW 1996a). Yellow perch (*Perca flavescens*), sculpins (*Cottus spp.*), pumpkinseed (*Lepomis gibbosus*), suckers (*Catostomus spp.*), mudminnows (*Novumbra hubbsi*), northern pikeminnow (*Ptychocheilus oregonensis*), and grass pickerel (*Esox americanus vermiculatus*) were observed during the 1952 treatment. Washington Department of Fish and Wildlife managed the lake as a trout fishery from 1952 into the early 1970s through annual stocking (WDFW 1996b). Until the early 1960s, catches of rainbow trout (*Oncorhynchus mykiss*) were good, however, fish growth was poor. Trout management efforts by WDFW included repeated rehabilitations (1959, 1963, 1969). Catches began to decline by the late 1960s and WDFW reduced annual trout stocking. In the early 1970s, illegally introduced largemouth bass (*Micropterus salmoides*) and black crappie (*Pomoxis nigromaculatus*) became the primary target of anglers. However, the bass and crappie populations were soon out of balance, and the lake became dominated by stunted yellow perch and pumpkinseed (WDFW 1996a). In an attempt to replace stunted pumpkinseed populations, WDFW stocked bluegill (*L. macrochirus*) into Alkali Lake in 1979, which was only marginally effective. In addition, WDFW conducted a partial rehabilitation in 1983 and stocked the lake in 1993 with a sterile strain of walleye (*Sander vitreus*) with no success.

Alkali Lake was last rehabilitated in fall 1996 and WDFW stocked the lake with largemouth bass, smallmouth bass (*M. dolomieu*), channel catfish (*Ictalurus punctatus*), bluegill, black crappie, rainbow trout, and Lahontan cutthroat trout (*O. clarki henshawi*) in 1997 (Table 1). Although there is no minimum size or daily limit on small bluegill and crappie, current regulations on Alkali Lake allow anglers to harvest only five bluegill over six inches in length and five crappie over eight inches in length. All bass species are protected by a slot-length limit regulation which allows anglers to harvest five bass less than 12 inches to include no more than

one fish over 17 inches in length. There is no minimum size or daily limit on yellow perch and pumpkinseed, and anglers are allowed to fish in Alkali Lake throughout the entire year.

The shoreline of Alkali Lake supports various shrubs and trees such as willow (*Salix spp.*) and Russian olive (*Elaeagnus angustifolia*). Aquatic vegetation found in the lake include water milfoil (*Myriophyllum spp.*), pondweed (*Potamogeton spp.*), and filamentous algae.



Figure 1. Alkali Lake and surrounding uplands.

Materials and Methods

The Region Two Warmwater Team surveyed Alkali Lake September 6-15, 2005. All fish were collected using a boat electrofisher, gill nets, and fyke nets. The electrofisher unit consisted of a 5.5 m Smith-Root GPP electrofisher boat with a DC current of 60 cycles/sec at 3 to 4 amps power (Bonar et al. 2000). Experimental gill nets (45.7 m x 2.4 m) were constructed of variable size (13, 19, 25, and 51 mm stretched) monofilament mesh. Fyke nets were constructed of a main trap (four 1.2 m aluminum rings), a single 30.3 m lead, and two 15.2 m wings. Fyke net material was constructed of 13 mm nylon mesh.

Sampling locations were selected prior to sampling by dividing the shoreline into 400 m sections and randomly selecting 31 sections from the total. The 31 randomly selected sites were distributed between electrofishing (15 sites), gill nets (8 sites), and fyke nets (8 sites). Electrofishing occurred in shallow water (depth range: 0.2 - 1.5 m), adjacent to the shoreline at a rate of approximately 18.3 m/minute for 600-second intervals (Bonar et al. 2000). Gill nets were set perpendicular to the shoreline with the small-mesh end attached on or near the shore, and the large-mesh end anchored offshore. Fyke nets were set perpendicular to the shoreline with the wings extended at 70° angles from the lead. Gill nets and fyke nets were set overnight prior to electrofishing and were pulled the following morning (1 net-night each). All sampling was conducted during nighttime hours when fish were most numerous along the shoreline thus maximizing the efficiency of each gear type.

Once collected, fish were identified to species, measured (total length (TL)) and weighed (g). Total length data were used to construct length-frequency histograms and to evaluate the size structure of the warmwater gamefish (yellow perch, pumpkinseed sunfish, black crappie, largemouth bass, and smallmouth bass) populations in the lake. Warmwater gamefish were assigned to a 10 mm size group based on total length, and scale samples were collected from the first five fish in each size group (Bonar et al. 2000). Scale samples were mounted on adhesive data cards and pressed onto acetate slides using a Carver® laboratory press (Fletcher et al. 1993).

Species composition, by weight (kg) and number, was determined from fish captured. Fish less than one year old were excluded from all analyses. Eliminating fish less than one year of age, i.e., young-of-the-year (YOY), prevents distortions in species composition that fluctuate between sampling locations, sampling method, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE, fish/hour or fish/net night) of each sampling gear was determined for each warmwater fish species collected. Electrofisher CPUE was determined by dividing the number of fish captured by the total amount of time that was electrofished. Similarly, CPUE of

gill netting and fyke netting was determined by dividing the number of fish captured by the total time the nets were deployed.

A relative weight (W_r) index was used to evaluate the condition of fish in Alkali Lake. Relative weight of a fish is the relationship between the actual weight of a fish at a given length to the national average weight (standard weight W_s) of a fish of the same species and length. A W_r of 100 generally indicates that the fish is in a condition similar to the national average for that species and length (Anderson and Neumann 1996). The index is defined as:

$$W_r = W/W_s \times 100;$$

where W is the weight (g) of an individual fish and W_s is the standard weight of a fish of the same total length (mm). The W_s was derived from a standard weight-length (\log_{10}) relationship, which was defined for each species of interest (Anderson and Neumann 1996). Only fish age one and older were used for calculations of W_r , as the variability can be significant for YOY. Relative weights less than ($W_r = 50$) were also excluded from our analysis as we suspected unreliable weight measurements.

Age and growth of warmwater gamefish in Alkali Lake were evaluated using procedures described by Fletcher et al. (1993). All samples were evaluated using both, the direct proportion method (Fletcher et al. 1993) and Lee's modification of the direct proportion method (Carlander 1982). Mean back-calculated lengths-at-age for all warmwater species were then compared to those of statewide, eastern Washington and/or Region Two averages.

The proportional stock density (PSD) of each warmwater gamefish species was determined following procedures outlined in Anderson and Neumann (1996). PSD used two measurements, stock length and quality length, to provide useful information about the proportion of various size fish in a population. Stock length was defined as the minimum size of a fish, which provides recreational value or the approximate length when fish reach maturity (Table 1). Quality length was defined as the minimum size of a fish that most anglers liked to catch and begin keeping. PSD was calculated using the number of quality size fish, divided by the number of stock size fish, multiplied by 100. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths. Stock length was 20-26 percent of world record length, whereas quality length was 36-41 percent of world record length. Gustafson (1988) reported that at least 55 stock-length fish are needed in order to calculate statistically valid PSD estimates. Electrofishing is a useful tool for collecting large samples of centrarchids (bass, panfish) and gill nets are effective for collecting large samples of percids (perch, walleye). Based on these trends, and in order to maintain consistency, we report electrofishing PSDs for centrarchids and gill net PSDs for percids.

Relative stock density (RSD) of each warmwater gamefish species was examined using the five-cell model proposed by Gabelhouse (1984). In addition to stock and quality lengths, preferred, memorable, and trophy categories were added (Table 1). Preferred length (RSD-P) was defined as the minimum size of fish anglers preferred to catch. Memorable length (RSD-M) referred to the minimum size fish anglers remembered catching and trophy length (RSD-T) referred to the minimum size fish worthy of acknowledgment. Preferred, memorable, and trophy length fish were also based on percentages of world record lengths. Preferred length was 45-55 percent of world record length, memorable length was 59-64 percent of world record length, and trophy length was 74-80 percent of world record length. RSD differs from PSD in that it is more sensitive to changes in year class strength. RSD was calculated as the number of fish within the specified length category, divided by the total number of stock length fish, multiplied by 100. Eighty percent confidence intervals for PSD and RSD were selected from tables in Gustafson (1988).

Table 1. Minimum total length (mm) categories of warmwater fish used to calculate PSD and RSD values (Willis et al. 1993).

Species	Length Category				
	Stock	Quality	Preferred	Memorable	Trophy
Black crappie	130	200	250	300	380
White crappie	130	200	250	300	380
Bluegill	80	150	200	250	300
Yellow perch	130	200	250	300	380
Largemouth bass	200	300	380	510	630
Smallmouth bass	180	280	350	430	510
Walleye	250	380	510	630	760
Channel catfish	280	410	610	710	910
Brown bullhead	150	230	300	390	460
Yellow bullhead	150	230	300	390	460

Results

Species Composition

Seven fish species were collected during sampling efforts on Alkali Lake (Table 2). Yellow perch was the most abundant species collected, followed by bluegill, pumpkinseed, and largemouth bass. Yellow perch and largemouth bass represented 82 percent of the biomass collected. Since 1999, yellow perch have significantly increased in relative abundance in our samples, while largemouth bass have shown a noticeable decline (Figure 2). Bluegill reached peak relative abundance in 2002, yet declined significantly in 2003. Since 2003, bluegill have consistently increased in relative abundance. Black crappie have never represented a sizeable proportion of our catch. The peak in relative abundance for black crappie was 2003, yet this was still less than 15 percent (Figure 2).

Table 2. Species composition by weight, number, and size range of fish captured at Alkali Lake during a warmwater fish survey Sept. 6-15, 2005.

Species	Species Composition					
	Biomass		Abundance		TL Range (mm)	
	Kg	% of total	N	% of total	Min.	Max
Yellow perch	54.6	54.4	1,207	72.2	65	262
Bluegill	9.1	9.1	201	12.2	96	204
Pumpkinseed sunfish	6.1	6.1	134	8.0	80	155
Black crappie	2.8	2.8	30	1.8	164	198
Largemouth bass	26.8	26.8	92	5.5	160	460
Smallmouth bass	0.7	0.7	1	0.1	365	365
Prickly Sculpin	0.2	0.1	5	0.3	96	135
<i>TOTALS</i>	100.3	100.0	1,669	100.0		

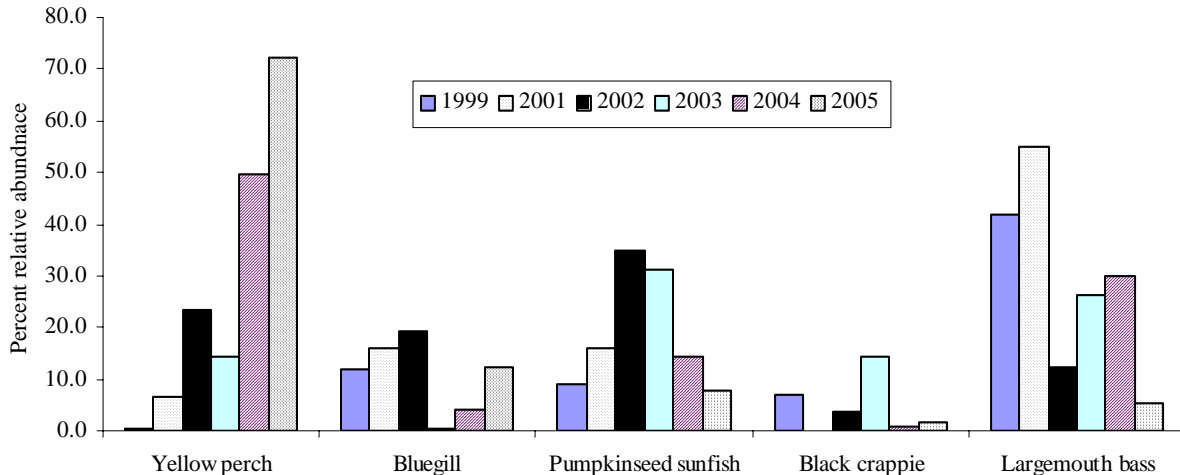


Figure 2. Relative abundance of warmwater fish species collected during warmwater surveys from 1999-2005.

Catch Per Unit Effort (CPUE)

Whether using active (electrofishing) or passive (gill netting or fyke netting) techniques to sample a lake or reservoir, CPUE can be a useful index to monitor size structure and relative abundance (Hubert 1996). Electrofishing catch rates were highest for yellow perch and bluegill, while gill net and fyke net catch rates were highest for yellow perch, followed by pumpkinseed sunfish (Table 3). From 2002 to 2005, electrofishing CPUE for yellow perch increased markedly (Figure 3). Bluegill CPUE also increased, however, to a lesser degree. Largemouth bass CPUE reached a high in 2004 and declined in 2005.

Table 3. Mean catch per unit effort by sampling method, including 80 percent confidence intervals, for fish collected from Alkali Lake September 6-15, 2005.

Species	Electrofisher		Gill Nets		Fyke Nets	
	Fish/ Hour	No. Sites	Fish/ Net Night	Net Nights	Fish/ Net Night	Net Nights
Yellow perch	398 (± 76)	15	16 (± 6)	8	11 (± 7)	8
Bluegill	65 (± 16)	15	3 (± 1)	8	3 (± 1)	8
Pumpkinseed	10 (± 5)	15	5 (± 3)	8	9 (± 5)	8
Black crappie	6 (± 3)	15	.13 (± .16)	8	2 (± 1)	8
Largemouth bass	35 (± 9)	15	1 (± 0.3)	8	0	8
Smallmouth bass	0	15	0.1 (± 0.2)	8	0	8

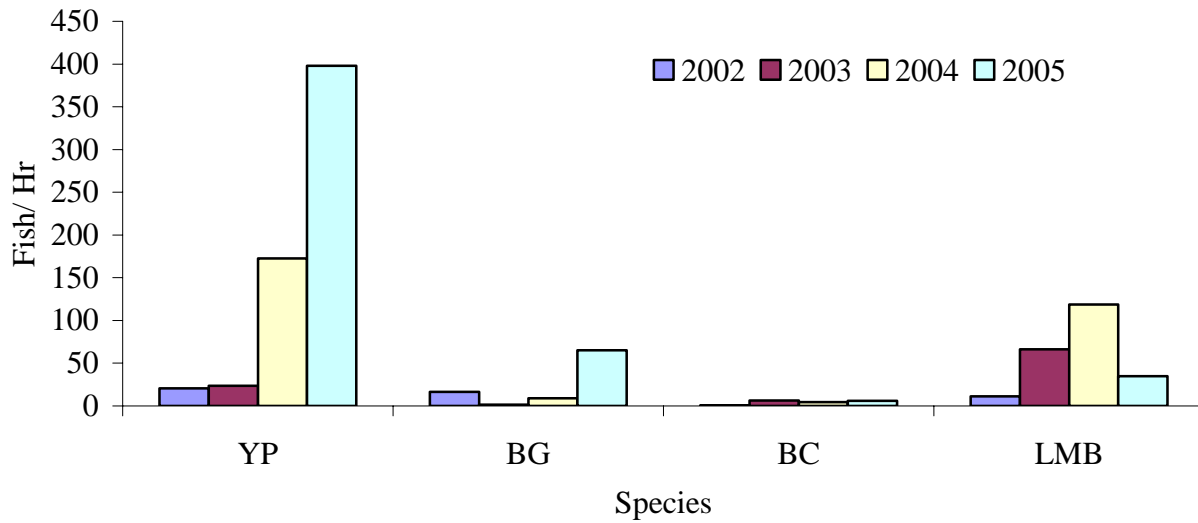


Figure 3. Mean electrofishing catch per unit effort (CPUE) (fish/ hour) for primary management species on Alkali Lake from warmwater surveys conducted from 2002 to 2005.

Stock Density Indices

Stock density indices (PSD, RSD) are a useful management tool to determine balance and relative abundance of size ranges of predator and prey species. Often, managers can manipulate PSD through stocking and harvest regulations. Alkali Lake exhibits highly variable fish recruitment and survival; therefore manipulating PSD will be difficult unless we can control factors affecting these trends. Stock density indices (PSD, RSD) of fish collected during this survey indicate that Alkali Lake is dominated by small fish (Table 2). The largemouth bass population had the highest proportion of large fish; the PSD was 17, while the RSD-P was 4. These indices will likely increase due to the abundance of small fish of multiple species in this community.

Table 4. Stock density indices (+ 80 percent confidence interval) for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Alkali Lake, September 6-15, 2005. PSD = proportional stock density, RSD = relative stock density, RSD-P = relative stock density of preferred fish, RSD-M = relative stock density of memorable fish, and RSD-T = relative stock density of trophy fish.

Species	Stock Length Fish (n)	PSD	RSD-P	RSD-M	RSD-T
Electrofisher					
Yellow perch	786	3 (± 1)	.5 (± .3)	0	0
Bluegill	161	6 (± 2)	.6 (± .8)	0	0
Pumpkinseed sunfish	25	4 (± 5)	0	0	0
Black crappie	14	0	0	0	0
Largemouth bass	82	17 (± 5)	4 (± 3)	0	0
Gill Nets					
Yellow perch	103	3 (± 2)	0	0	0
Bluegill	20	0	0	0	0
Pumpkinseed sunfish	41	0	0	0	0
Black crappie	1	0	0	0	0
Largemouth bass	6	0	0	0	0
Smallmouth bass	1	100	0	0	0
Fyke Nets					
Yellow perch	66	0			
Bluegill	20	0	0	0	0
Pumpkinseed sunfish	68	6 (± 4)	0	0	0
Black crappie	37	0	0	0	0

Yellow perch

A total of 1,207 yellow perch were collected during this survey. Most yellow perch collected were less than eight inches in length and only two age classes were sampled (Table 5). Perch ranged in size from 65-262 mm, and the majority of fish were collected with the boat electrofisher (Figure 4). Growth was well above the state average; however, relative weights were well below the national average ($W_r = 100$) (Figure 5).

Table 5. Length at age of yellow perch captured at Alkali Lake during September 2005. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age	
		1	2
2004	15	51.0	
		68.1	
2003	43	88.6	132.4
		103.2	139.6
Direct Proportion mean		69.8	132.4
Fraser Lee mean		94.2	139.6
WA State Average (DP)		59.7	119.9

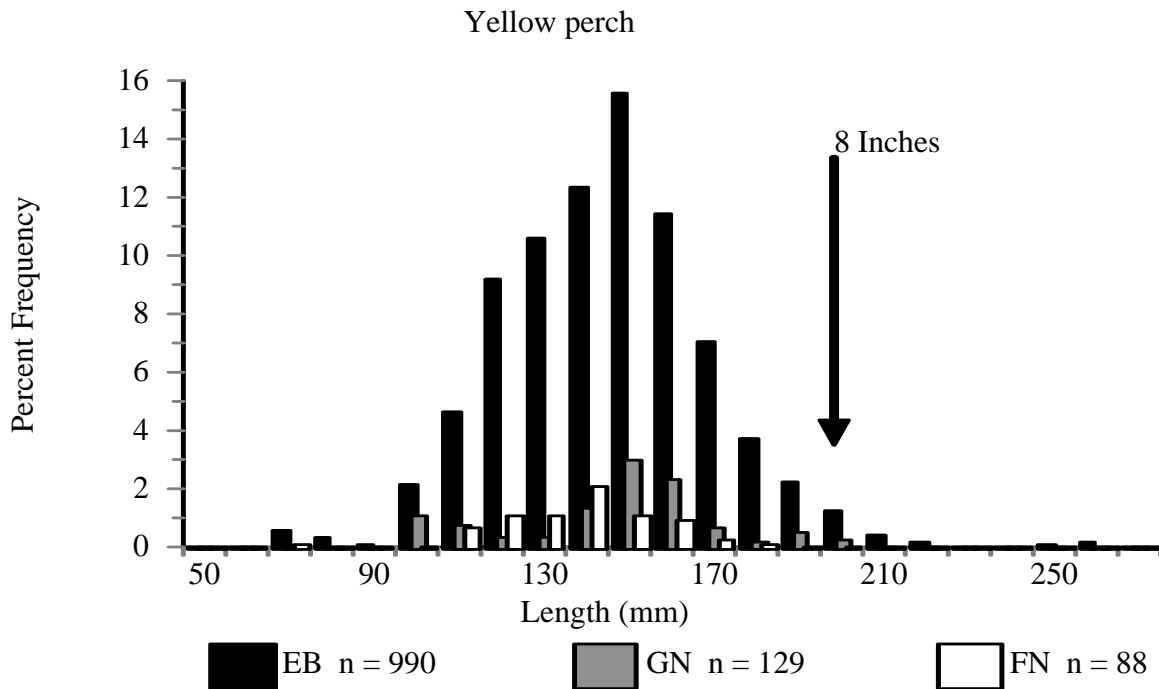


Figure 4. Length frequencies of yellow perch sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) at Alkali Lake during September 2005.

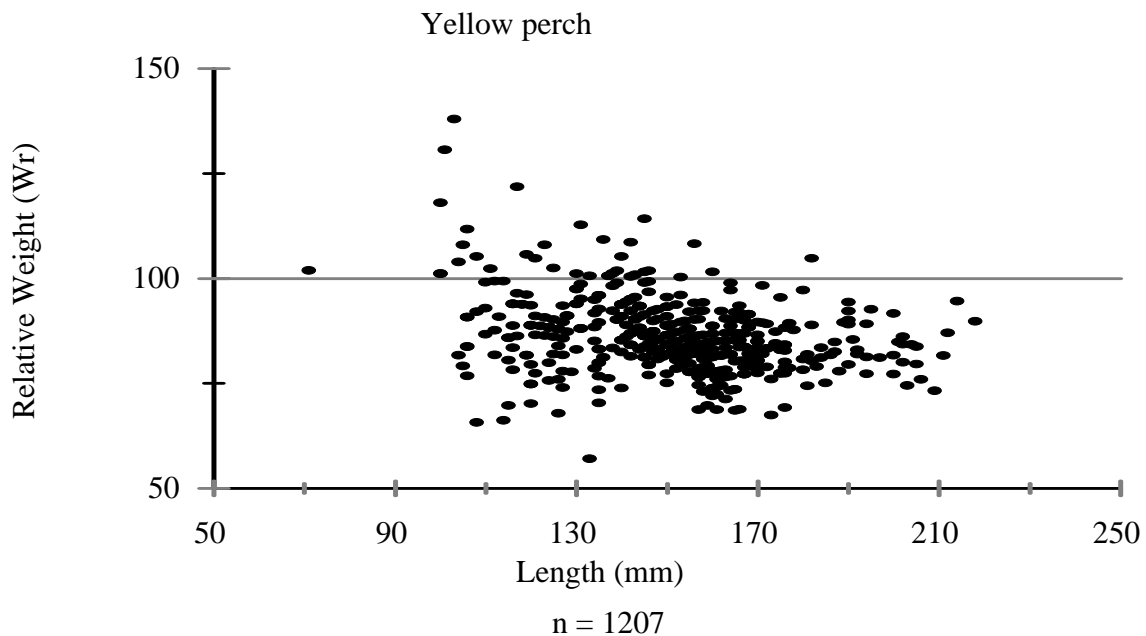


Figure 5. Relative weights for yellow perch sampled at Alkali Lake, September 2005, compared to the national average ($W_r = 100$) Anderson and Neumann 1996).

Bluegill

A total of 201 bluegill were collected during this survey. Most fish collected were age-two, no age-one or three fish were collected, and only one age-four fish was collected (Table 6). Growth of age-two fish was below the state average. The age-four fish exhibited poor growth at age one and two; however, from age two to four it exhibited above average growth. Bluegill ranged in size from 96-204 mm, the majority were collected with the boat electrofisher and most fish were less than six inches (Figure 6). Relative weights were near the national average ($W_r = 100$) however they were highly variable (Figure 7).

Table 6. Length at age of bluegill captured at Alkali Lake during September 2005. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age			
		1	2	3	4
2004	0				
2003	32	29.9	76.2		
		45.4	84.5		
2002	0				
2001	1	28.2	78.0	138.2	187.1
		45.4	90.4	144.6	188.7
Direct Proportion mean		29.1	77.1	138.2	187.1
Fraser Lee mean		45.4	84.6	144.6	188.7
WA State Average (DP)		37.3	96.8	132.1	148.3

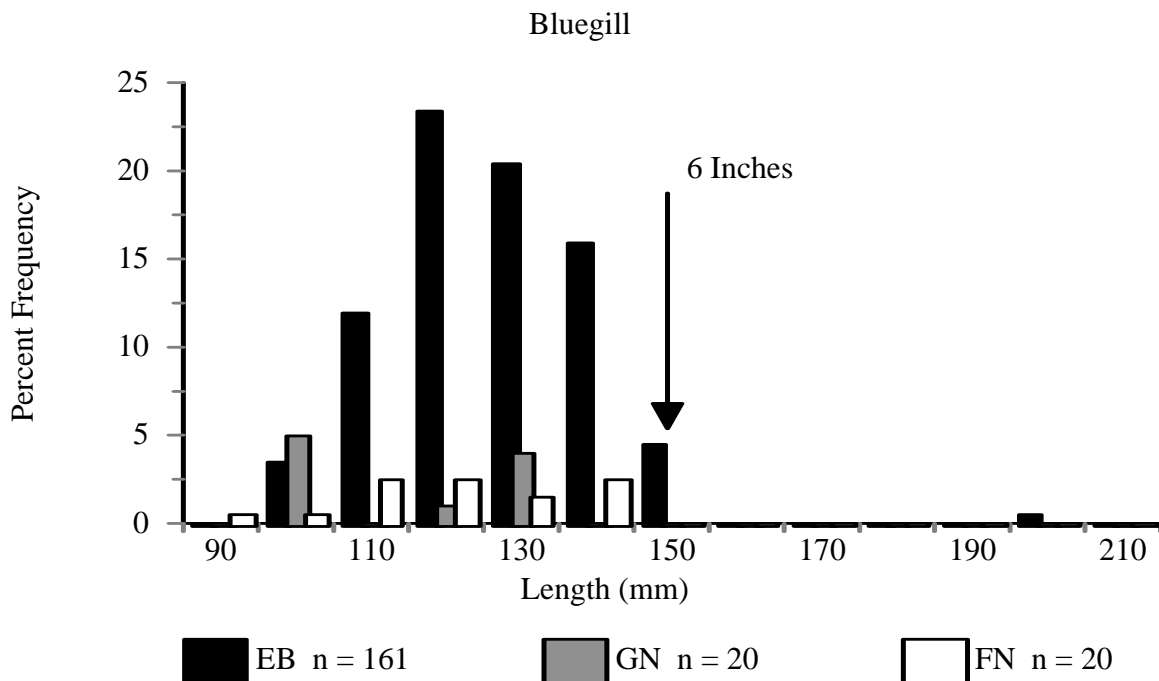


Figure 6. Length frequencies of bluegill sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) at Alkali Lake during September 2005.

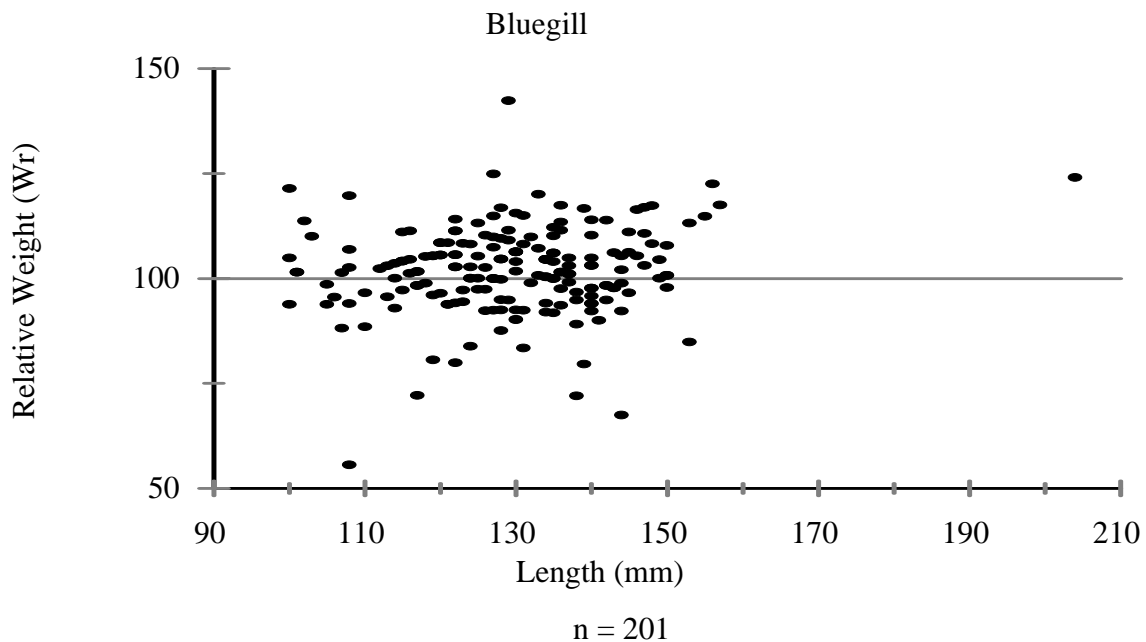


Figure 7. Relative weights for bluegill sampled at Alkali Lake, September 2005, compared to the national average ($W_r = 100$) Anderson and Neumann 1996).

Pumpkinseed sunfish

A total of 134 pumpkinseed sunfish were collected during this survey. Scales were not collected; therefore, ages could not be determined; however, fish ranged in size from 80-155 mm. Most pumpkinseed sunfish were less than five inches, and the majority were collected with gill and fyke nets (Figure 8). Relative weights were above average ($W_r = 100$) for most fish, however, relative weights were highly variable for the largest and smallest fish (Figure 9).

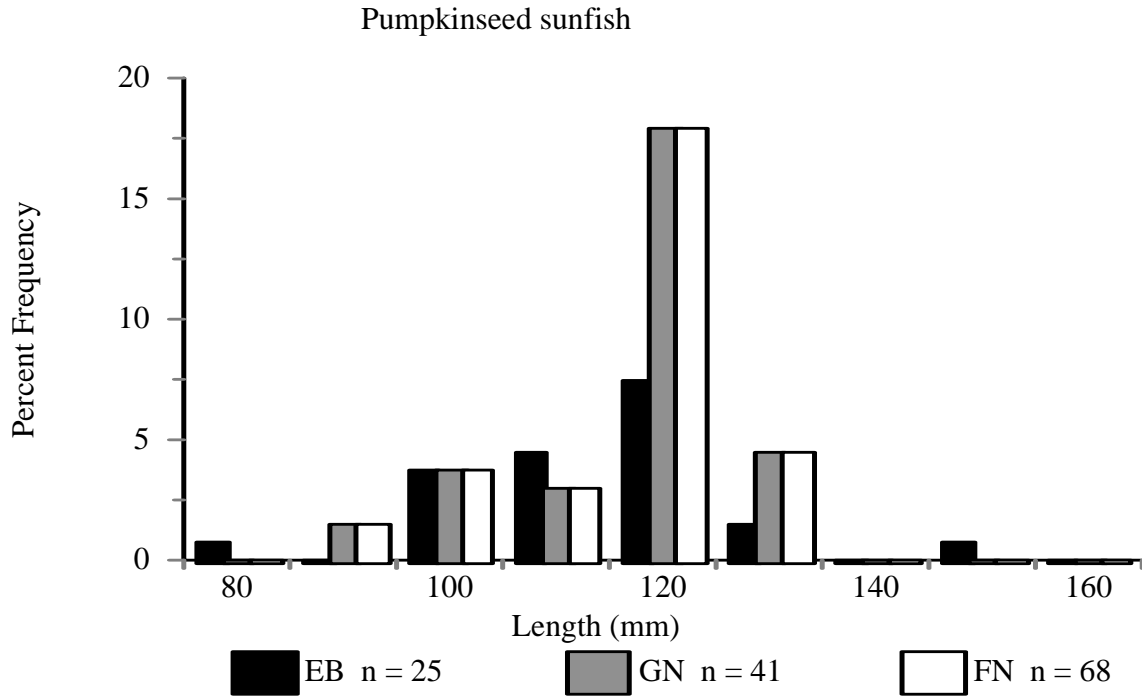


Figure 8. Length frequencies of pumpkinseed sunfish sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) at Alkali Lake during September 2005.

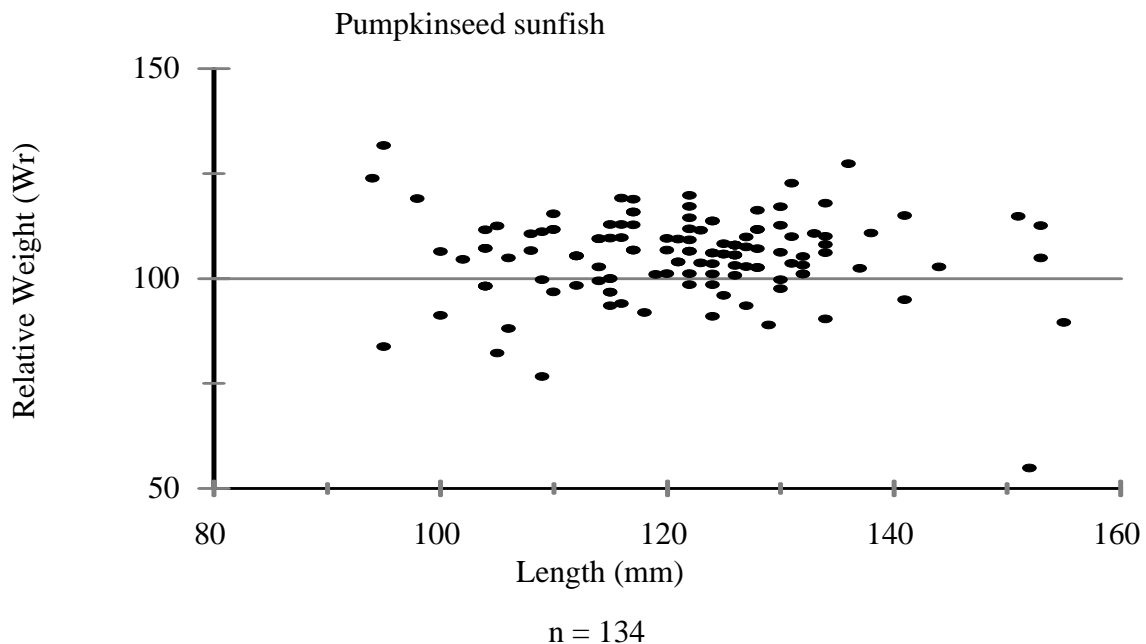


Figure 9. Relative weights for pumpkinseed sunfish sampled at Alkali Lake, September 2005, compared to the national average (Wr = 100) Anderson and Neumann 1996).

Black crappie

Only 30 black crappie were collected during this survey. All black crappie from which scales were taken were age two, and growth was above the state average (Table 7). Black crappie ranged in size from 168-198 mm and most fish were collected with the boat electrofisher and fyke nets (Figure 10). Relative weights were near the national average ($W_r = 100$) for most fish (Figure 11).

Table 7. Length at age of black crappie captured at Alkali Lake during September 2005. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age	
		1	2
2004	0		
2003	16		
		55.7	121.4
		80.1	133.3
Direct Proportion mean		55.7	121.4
Fraser Lee mean		80.1	133.3
WA State Average (DP)		46.0	111.2

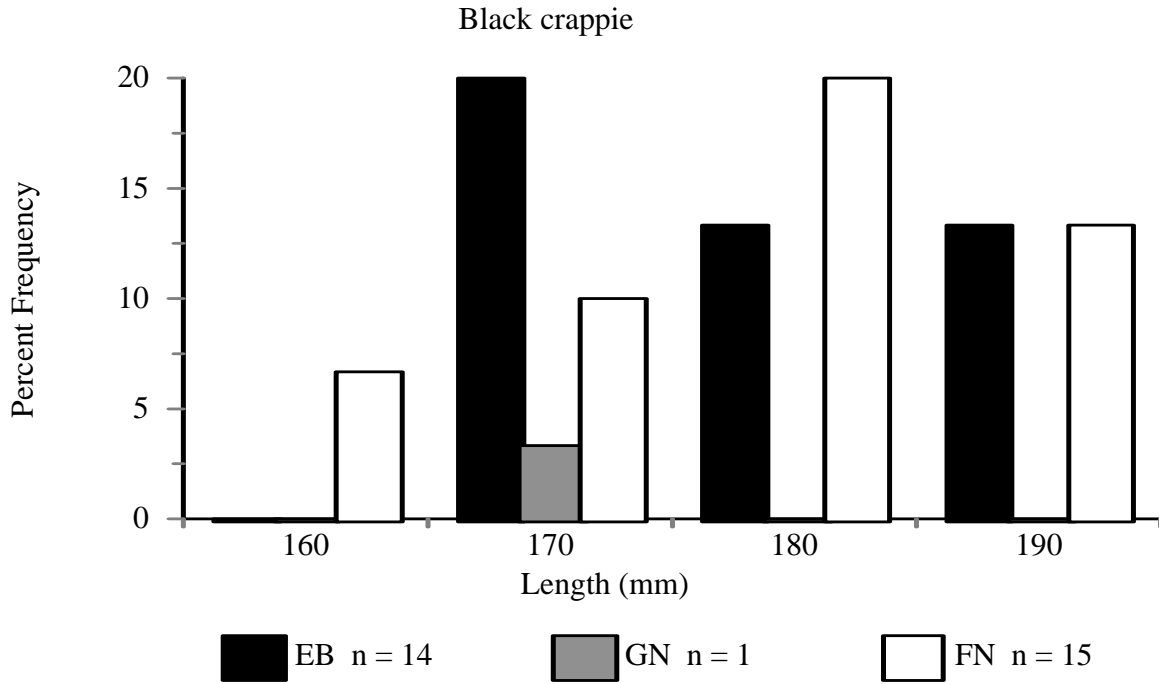


Figure 10. Length frequencies of black crappie sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) at Alkali Lake during September 2005.

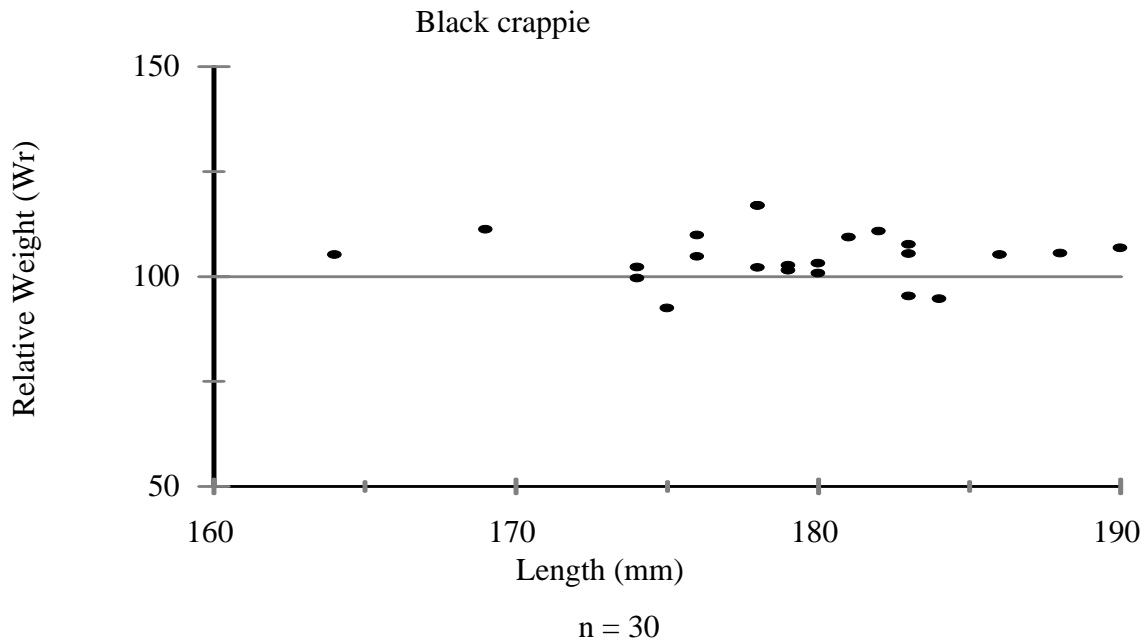


Figure 11. Relative weights for black crappie sampled at Alkali Lake, September 2005, compared to the national average (Wr = 100) Anderson and Neumann 1996).

Largemouth bass

A total of 92 largemouth bass were collected during this survey. Age-two bass were most abundant followed by age-one fish. Very few fish collected were older than age two (Table 8). Growth was well above the Region Two average for all age classes collected. Most bass were captured with the boat electrofisher and were less than 12 inches in length (Figure 12). Relative weights were below average ($W_r = 100$) for stock size (200-300 mm) bass, and increased as length increased (Figure 13).

Table 8. Length at age of largemouth bass captured at Alkali Lake during June 2005. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age				
		1	2	3	4	5
2004	3	68.7				
		80.8				
2003	34	98.9	202.4			
		111.6	207.4			
2002	0					
2001	1	49.2	160.4	325.6	374.7	
		66.7	172.4	329.2	375.9	
2000	1	83.6	187.1	273.3	366.2	388.8
		99.5	197.9	279.9	368.2	389.6
Direct Proportion mean		75.1	183.3	299.4	370.5	388.8
Fraser Lee mean		107.8	206.2	304.5	372.0	389.6
Region Two Average (FL)		85.2	154.5	161.1	265.4	320.7

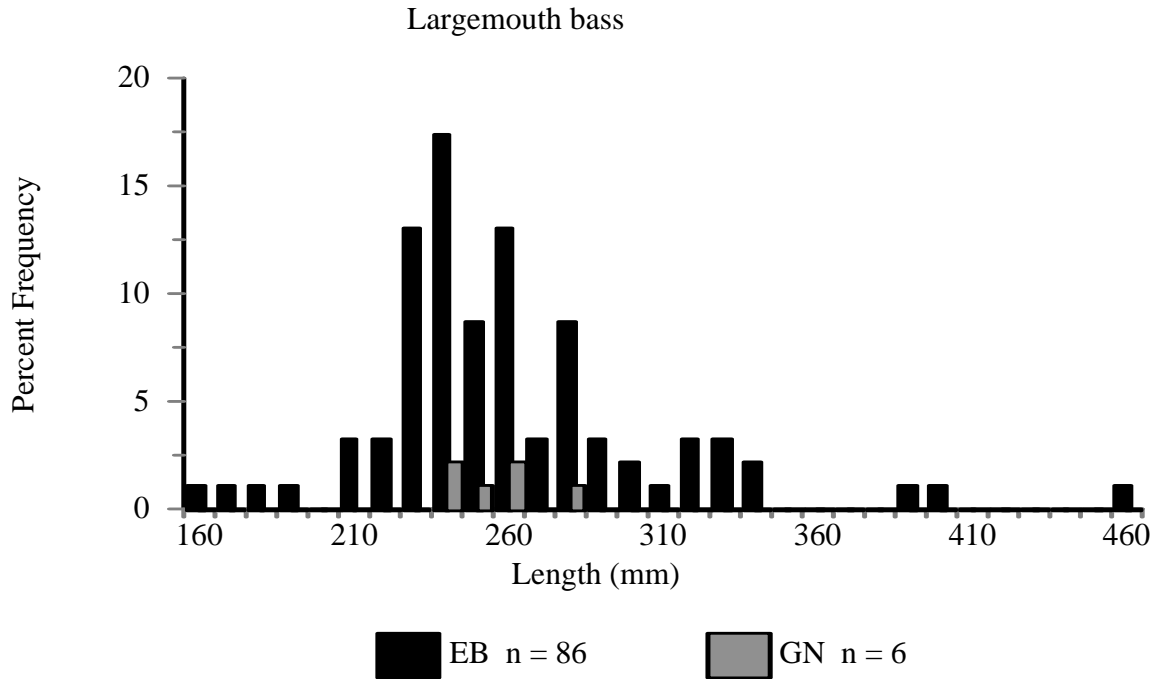


Figure 12. Length frequencies of largemouth bass sampled using a boat electrofisher (EB), and gill nets (GN) at Alkali Lake during September 2005.

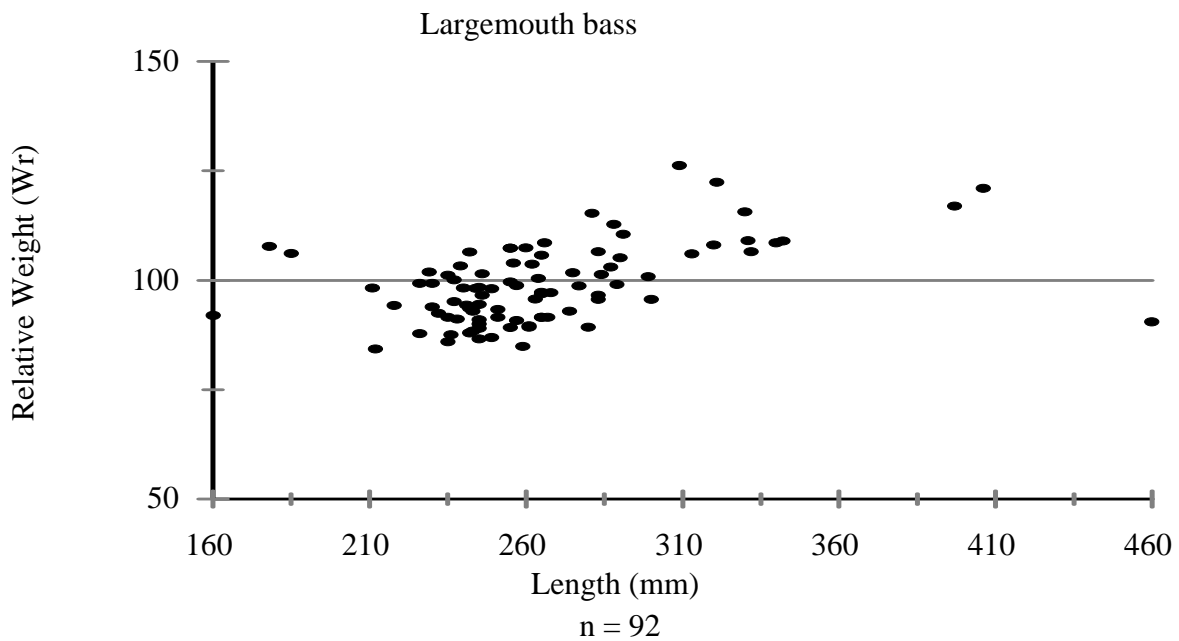


Figure 13. Relative weights for largemouth bass sampled at Alkali Lake, September 2005, compared to the national average ($W_r = 100$) Anderson and Neumann 1996).

Discussion

Summary

The last full survey of Alkali Lake was conducted in 1999. During that survey, only 168 warmwater fish (primarily largemouth bass) were collected. In 2002, 121 warmwater fish (primarily pumpkinseed and perch) were collected during a one-night survey. In 2003, we found that largemouth bass, pumpkinseed sunfish, black crappie, and yellow perch had significantly increased in abundance and some large fish were collected. During this survey, we collected large samples of yellow perch, pumpkinseed sunfish, and bluegill; however, 85 percent of the fish from which scales were collected were determined to be age two.

Variable survival of fishes in Alkali Lake has been reported since the 1930s. Managers suspected water chemistry (i.e. pH, dissolved oxygen (DO), etc); however, we do not have data to support this idea. During 2006, we will deploy a DO meter on Alkali Lake in order to monitor oxygen levels throughout summer and fall. In addition, we will monitor pH at regular intervals. If pH levels are found at levels lethal to warmwater fishes Alkali Lake may need to be managed as a Lahontan cutthroat fishery, since these fish tend to tolerate more alkaline waters (Wilkie et al. 1993).

Management Options

No management recommendations are offered at this time. Water chemistry should be monitored during spring and summer 2006 in order to determine if factors such as low DO or pH are limiting fish survival.

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Glossary

Catch Per Unit Effort (CPUE): The number of fish captured by a sampling method (i.e., electrofisher, gill nets, or fyke nets) divided by the amount of time sampled (e.g. hr, net night).

Confidence Interval (CI): The range of values that is likely to include an unknown population parameter with a percentage or degree of confidence.

Memorable Size: The size fish anglers remember catching, and also identified as 59-64 percent of the world record length. Memorable length varies by species.

Preferred Size: The size fish anglers preferred to catch when given a choice, and also identified as 45-55 percent of world record length. Preferred length varies by species.

Proportional Stock Density (PSD): The number of quality length fish and larger, divided by the number of stock sized fish and larger, multiplied by 100.

Quality Length: Is defined as the length at which anglers begin keeping fish. Also identified as 36-41 percent of world record length. Quality length varies by species.

Relative Stock Density (RSD): Is defined as the number of fish of a specified length category (preferred, memorable, or trophy) and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Preferred Fish (RSD-P): Is defined as the number of fish in the preferred size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Memorable Fish (RSD-M): Is defined as the number of fish in the memorable size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Trophy Fish (RSD-T): Is defined as the number of fish in the trophy size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Weight (W_r): The comparison of the weight of a fish at a given size to the national average weight ($W_r = 100$) of fish of the same species and size.

Standard Weight (W_s): Is defined as a standard or average weight of a fish species at a given length determined by a national length-weight regression.

Stock Length: Is defined by the following: 1) approximate length of fish species at maturity, 2) the minimum length effectively sampled by traditional sampling gears, 3) minimum length of fish that provide recreational value, and 4) 20-26 percent of world record length. Stock length varies by species.

Total Length (TL): Length measurement from the anterior most part of the fish to the tip of the longest caudal (tail) fin ray (compressed).

Trophy Size: Minimum size fish worthy of acknowledgment, and also identified as 74-80 percent of world record length. Trophy length varies by species.



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