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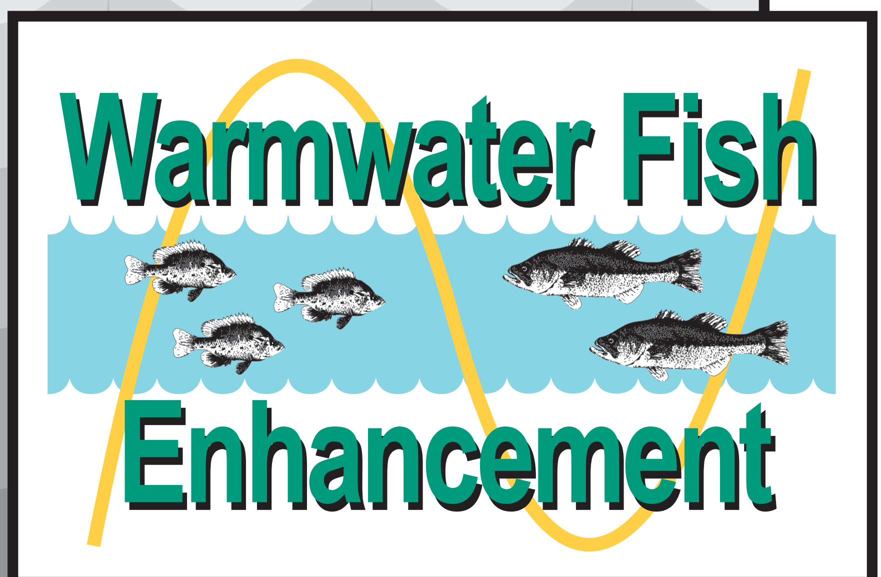
2005 Warmwater Fisheries Survey of Evergreen Reservoir, Grant County, Washington



by Michael R. Schmuck and Marc R. Petersen

Washington Department of
FISH AND WILDLIFE
Fish Program
Fish Management Division

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Abstract

Evergreen Reservoir was surveyed by the Region Two Warmwater Team June 6 – 15, 2005. Approximately 98 percent of fish sampled were warmwater gamefish. In addition, common carp *Cyprinis carpio* were also sampled. Bluegill *Lepomis macrochirus* were most abundant followed by largemouth bass *Micropterus salmoides*, yellow perch *Perca flavescens*, and black crappie *Pomoxis nigromaculatus*. Black crappie, pumpkinseed sunfish *Lepomis gibbosus*, largemouth bass, and smallmouth bass *M. dolomieui* exhibited high growth for all age classes, while yellow perch and bluegill growth varied among age classes. Relative weights were at or above the national average for largemouth bass, bluegill, pumpkinseed sunfish, and black crappie; however, relative weights were below average for walleye *Sander vitreus* and tiger muskie *Esox lucius* × *E. masquinongy*. Relative weights declined with increasing length for yellow perch and smallmouth bass. Yellow perch, walleye, and carp declined in abundance in our samples from 2000 to 2005. Declines in abundance may be due to predation or lack of forage for walleye and perch. Declines in carp are likely the result of sampling bias. Abundance of tiger muskie collected was similar to that collected in 2000.

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Introduction and Background

Evergreen Reservoir lies within the Quincy Wildlife Area in Grant County, Washington, approximately 13 kilometers (8 miles) southwest of Quincy, Washington (Figure 1). Constructed by the U.S. Bureau of Reclamation (BOR) in 1950, Evergreen Reservoir is supplied by irrigation water from the West Canal, and exits through an irrigation pumping station to W44A, W44B, and W44C lateral canals which irrigate block 77. Evergreen Reservoir has a surface area of 100 hectares (247 acres), mean depth of 5.8 meters (19 ft.), and volume of 4,900 acre-ft.

Historically, Evergreen Reservoir was managed as a trout fishery. Rainbow trout *Oncorhynchus mykiss* were stocked from 1958 through 1974, and additionally, the Washington Department of Fish and Wildlife (WDFW) attempted to introduce coho salmon *Oncorhynchus kisutch* (1966), Kamloop strain rainbow trout (1967), kokanee *O. nerka* (1976), and Lahontan cutthroat trout *O. clarki henshawi* (1982) (WDFW 2000). Rainbow trout were stocked nearly every year from 1958 to 1974 (WDFW 1982). In those years, stocking legal-sized fish was economically feasible due to the low number of available trout lakes within the region. In the early 1960's, a large number of new seep lakes were formed in the Columbia Basin, which created new waters that could be stocked more economically with rainbow trout fry. Since 1977, rainbow trout stockings have been abandoned and Evergreen Reservoir is managed solely as a warmwater fishery. Warmwater fish species observed in Evergreen Reservoir include: common carp *Cyprinus carpio*, yellow perch *Perca flavescens*, prickly sculpin *Cottus asper.*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, walleye *Sander vitreum*, lake whitefish *Coregonus clupeaformis*, pumpkinseed sunfish *Lepomis gibbosus*, bluegill *L. macrochirus*, and black crappie *Pomoxis nigromaculatus*. In 1997, tiger muskie *Esox lucius* × *Esox masquinongy* were introduced to prey upon the high densities of yellow perch within the reservoir.

In addition to fish species, Evergreen Reservoir and associated uplands host various birds, such as great blue heron *Ardea herodias*, gulls *Larus spp.*, terns *Sterna spp.*, numerous waterfowl, ring-necked pheasant *Phasianus colchicus*, California quail *Lophortyx californicus*, chukar *Alectoris graeca*, mourning dove *Zenaida macroura*, red-winged blackbird *Agelaius phoeniceus*, meadowlark *Sturnella neglecta*, killdeer *Charadrius vociferus*, and small mammals including beaver *Castor canadensis*, muskrat *Ondatra zibethica*, and raccoon *Procyon lotor* (WDFW 1996). Various aquatic (water milfoil *Myriophyllum spp.*), sub-aquatic (cattail *Typha latifolia* and bulrush *Scirpus spp.*), and terrestrial (Russian olive *Elaeagnus angustifolia*, sagebrush *Artemisia tridentata*, bluebunch wheatgrass *Agropyron spicatum*, cheatgrass *Bromus tectorum*, Sandberg's bluegrass *Poa sandbergii*, sand dock *Rumex spp.*, and rabbitbrush *Chrysothamnus nauseosus*) vegetation are common in the area.

This survey was conducted to measure warmwater gamefish stocking success and to monitor growth, condition, reproduction, and survival of warmwater gamefish species in the reservoir. Moreover, information collected during this survey was used to identify possible management strategies that would improve the quality of fishing in Evergreen Reservoir.

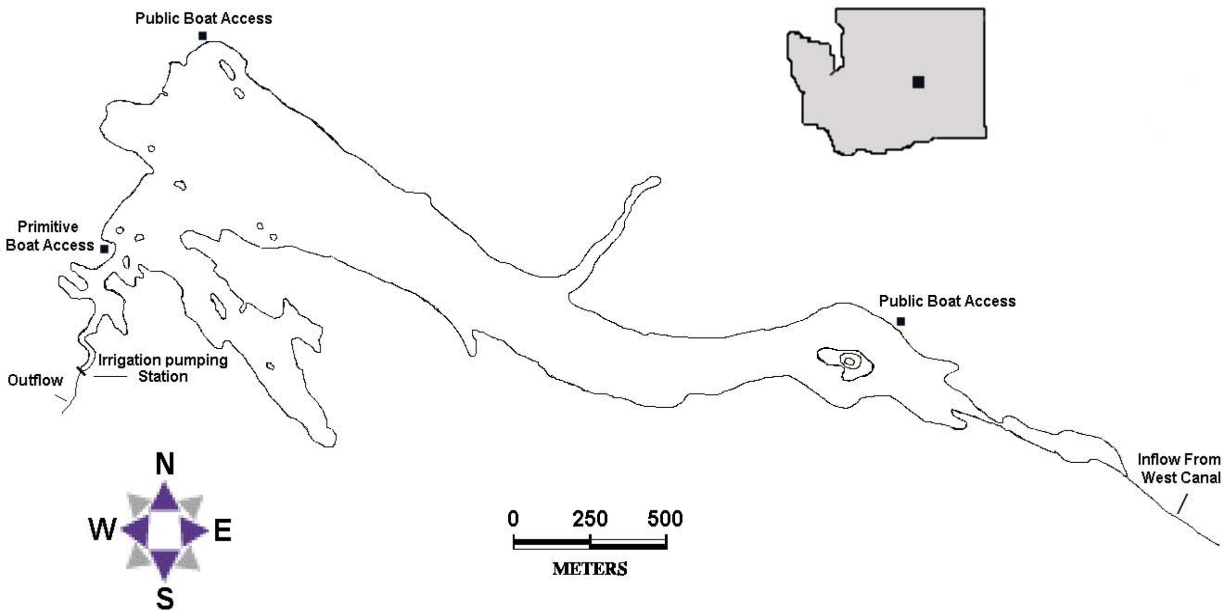

Figure 1 Map of Evergreen Reservoir Grant County, Washington.

Materials and Methods

The Region Two Warmwater Team surveyed evergreen Reservoir June 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^o 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 Red Rock 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 Red Rock 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 centrachids 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).

	Length Category				
Species	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

Ten fish species were collected during sampling efforts on Evergreen Reservoir (Table 2). Bluegill was the most abundant species collected, followed by largemouth bass and yellow perch. Common carp accounted for the majority of biomass collected (29 %); however, this was represented by only 19 fish. Predators accounted for nearly 50 percent of the biomass collected. The most abundant predators collected were largemouth bass, smallmouth bass, and walleye. Black crappie increased from 8 fish collected in 2000, to 151 fish in 2005. In addition, bluegill, pumpkinseed sunfish, largemouth bass, smallmouth bass and tiger muskie increased in overall abundance in our samples from 2000 to 2005 (Figure 2). Brown bullhead, yellow perch, walleye and carp declined in abundance over the same period.

Table 2. Species composition by weight, number, and size range of fish captured at Evergreen Reservoir during a warmwater fish survey June 6-13, 2005.

	Species Composition					
	Biomass		Abundance		TL Range (mm)	
Species	Kg	% of total	N	% of total	Min.	Max
Yellow perch	5.5	2.1	166	11.2	64	265
Bluegill	39.3	15.1	679	45.7	65	219
Pumpkinseed sunfish	4.9	1.9	140	9.4	73	155
Black crappie	9.9	3.8	151	10.2	79	344
Brown bullhead	3.4	1.3	15	1.0	80	340
Largemouth bass	54.4	20.9	185	12.5	70	550
Smallmouth bass	10.6	4.1	89	5.9	71	456
Walleye	24.0	9.2	33	2.2	201	765
Tiger muskie	32.2	12.3	9	0.6	350	1010
Common carp	76.5	29.3	19	1.3	580	800
TOTALS	260.7	100.0	1486	100.0		

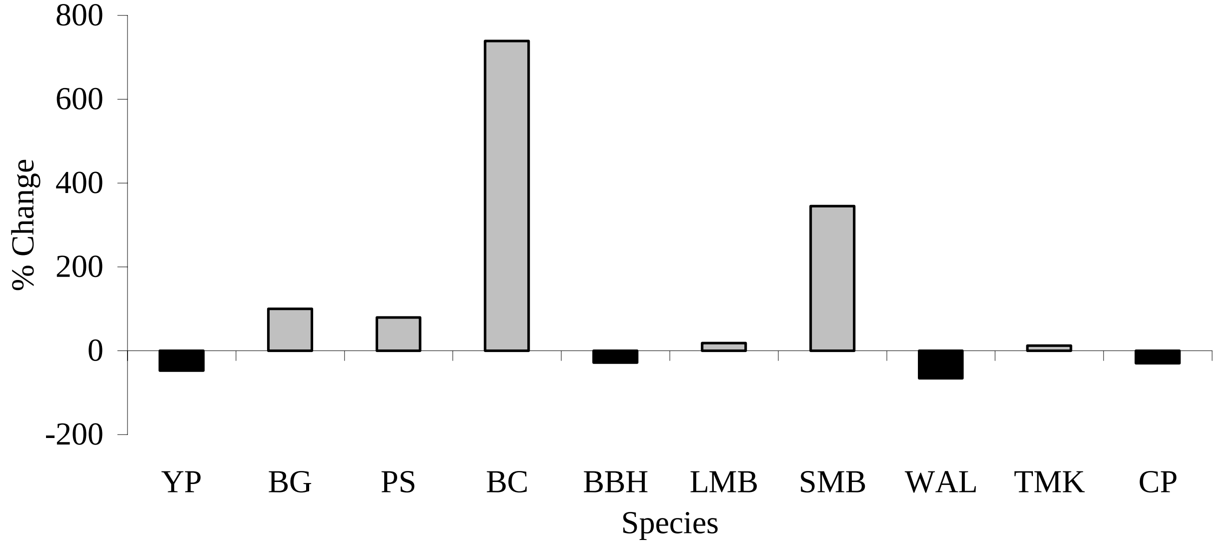

Figure 2. Percent change in abundance of warmwater fishes sampled from 2000 to 2005.

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 is typically the most effective sampling method for collecting large samples of centrarchid fishes, and electrofisher catch rates during this survey were highest for bluegill, largemouth bass, and yellow perch (Table 3). Gill nets are typically the most effective gear for capturing percids; however, gill net catch rates were highest for black crappie and pumpkinseed sunfish. Fyke nets captured black crappie, pumpkinseed sunfish and bluegill more effectively than other species. Comparisons of electrofishing CPUE from three warmwater surveys correspond well with changes in species abundance (Figure 3).

Table 3. Mean catch per unit effort by sampling method, including 80 percent confidence intervals, for fish collected from Evergreen Reservoir June 6-13, 2005.

	Electrofisher		Gill Nets		Fyke Nets	
Species	Fish/ Hour	No. Sites	Fish/ Net Night	Net Nights	Fish/ Net Night	Net Nights
Yellow perch	56 (± 31)	15	3 (± 0.6)	8	0	8
Bluegill	260 (± 82)	15	1 (± 0.8)	8	2 (± 3)	8
Pumpkinseed	32 (± 11)	15	4 (± 2)	8	3 (± 3)	8
Black crappie	24 (± 12)	15	7 (± 4)	8	5 (± 4)	8
Brown bullhead	6 (± 4)	15	0	8	0	8
Largemouth bass	69 (± 12)	15	1 (± 0.5)	8	0	8
Smallmouth bass	36 (± 10)	15	0.1 (± 0.2)	8	0	8
Walleye	11 (± 5)	15	0.6 (± 0.3)	8	0	8
Tiger muskie	0.8 (± 0.7)	15	0.8 (± 0.3)	8	0.1 (± 0.2)	8
Common carp	4 (± 2)	15	1.3 (± 0.7)	8	0	8

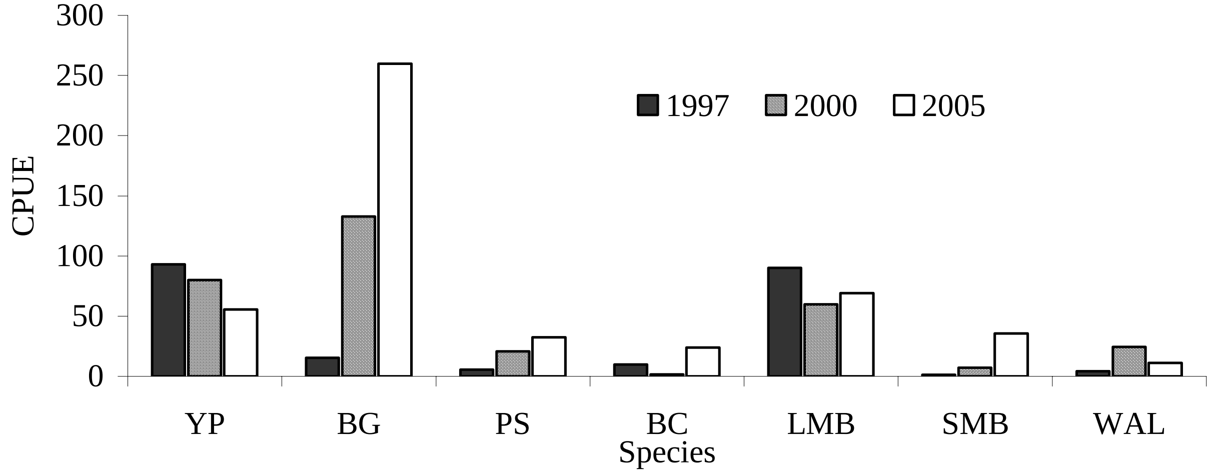

Figure 3. Electrofishing CPUE (fish / hour) for warmwater species collected during three warmwater surveys.

Stock Density Indices

A minimum of 55 stock length fish is necessary for precise estimates of PSD (Gustafson 1988). The PSD for largemouth bass collected with the boat electrofisher was 31, while the RSD-P and RSD-M were 19 and 2, respectively (Table 4). We only collected six stock length largemouth bass in gill nets and none in fyke nets. A large number of stock length bluegill were collected with the boat electrofisher, and the PSD for this species was 29. More stock length bluegill were collected with fyke nets than gill nets; however, neither of these gear types collected sufficient quantities of bluegill for accurate PSD analysis. Typically gill nets collect the largest samples of percids (perch, walleye); however, the boat electrofisher was the only gear type that collected yellow perch in sufficient quantities for PSD analysis. The PSD for yellow perch was 2, and combined with the low number of stock length fish sampled indicates that most yellow perch collected were less than five inches. The boat electrofisher provided the only sample of black crappie large enough for accurate PSD analysis. The PSD for black crappie was 5 and indicates that the majority of black crappie collected were less than 8 inches. Sample sizes from gill net and fyke net data were too small for accurate PSD analysis. It appears that populations of bass and walleye have good size distributions to control, and prevent stunting of bluegill and pumpkinseed. Predator-prey PSDs indicate balance at the time of this survey; however slightly higher PSDs for bluegill would reduce our concern that this population may soon become stunted.

Table 4. Stock density indices (± 80 percent confidence interval) for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Evergreen Reservoir, June 6-13, 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	67	2 (± 2)	2 (± 2)	0	0
Bluegill	641	29 (± 2)	1 (± .4)	0	0
Pumpkinseed sunfish	77	1 (± 2)	0	0	0
Black crappie	59	5 (± 4)	2 (± 2)	2 (± 2)	0
Largemouth bass	93	31 (± 6)	19 (± 5)	2 (± 2)	0
Smallmouth bass	34	21 (± 9)	9 (± 6)	3 (± 4)	0
Walleye	27	19 (± 10)	7 (± 7)	7 (± 7)	4 (± 5)
		Gill Nets			
Yellow perch	25	0	0	0	0
Bluegill	9	0	0	0	0
Pumpkinseed sunfish	33	0	0	0	0
Black crappie	51	4 (± 4)	2 (± 3)	2 (± 3)	0
Largemouth bass	6	83 (± 20)	67 (± 25)	0	0
Smallmouth bass	1	0	0	0	0
Walleye	5	100 (± 0)	80 (± 23)	20 (± 23)	0
		Fyke Nets			
Bluegill	18	22 (± 13)	0	0	0
Pumpkinseed sunfish	26	0	0	0	0
Black crappie	37	5 (± 5)	0	0	0

Yellow Perch

A total of 166 yellow perch ranging from 64-265 mm were collected during this survey. Ages ranged from one to three years and growth of age three fish was above the state average (Table 5). The majority (84%) of yellow perch collected were captured with the boat electrofisher (Figure 4). Yellow perch less than 100 mm were poorly represented and may indicate a weak year class. In 2000, yellow perch ranged from one to four years of age and growth was below the statewide average for age four yellow perch (Petersen and Osborne, in press). During this survey, relative weights of yellow perch less than stock length (65-129 mm) were higher (p = .0001) than relative weights of stock length fish (130-199 mm) (Figure 5). This trend in relative weight is similar to that seen in 2000 (Petersen and Osborne, in press). Declines in relative weight often suggest food resources are limiting and may be indicative of competition. Yellow perch have declined nearly 50 percent in our samples since the 2000 survey and this decline coincides with significant increases of bluegill, black crappie and smallmouth bass (Figure 2).

Table 5. Length at age of yellow perch captured at Evergreen Reservoir 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).

		Mean length (mm) at age		
Year Class	# Fish	1	2	3
2004	11	63.3		
		71.0		
2003	26	52.7	109.7	
		69.8	113.0	
2002	18	54.8	122.5	162.6
		74.8	130.3	163.1
Direct Proportion mean		56.9	116.1	162.6
Fraser Lee mean		71.7	120.1	163.1
WA State Average (DP)		59.7	119.9	152.1

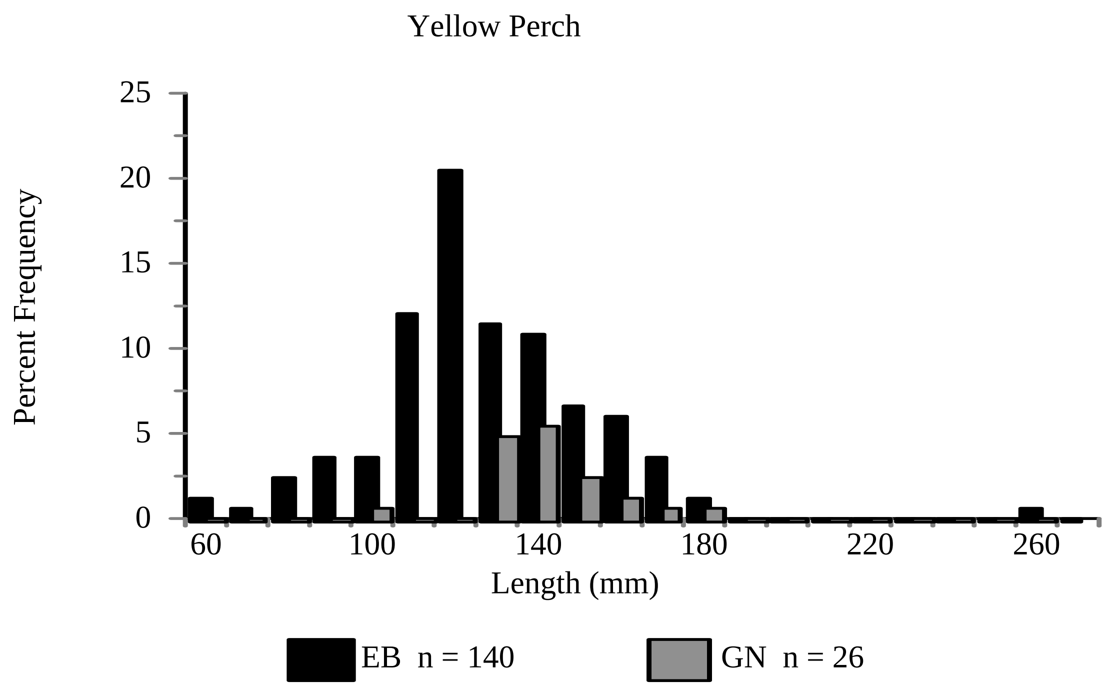

Figure 4. Length frequencies of yellow perch sampled using a boat electrofisher (EB), and gill nets (GN) on Evergreen Reservoir during June 2005.

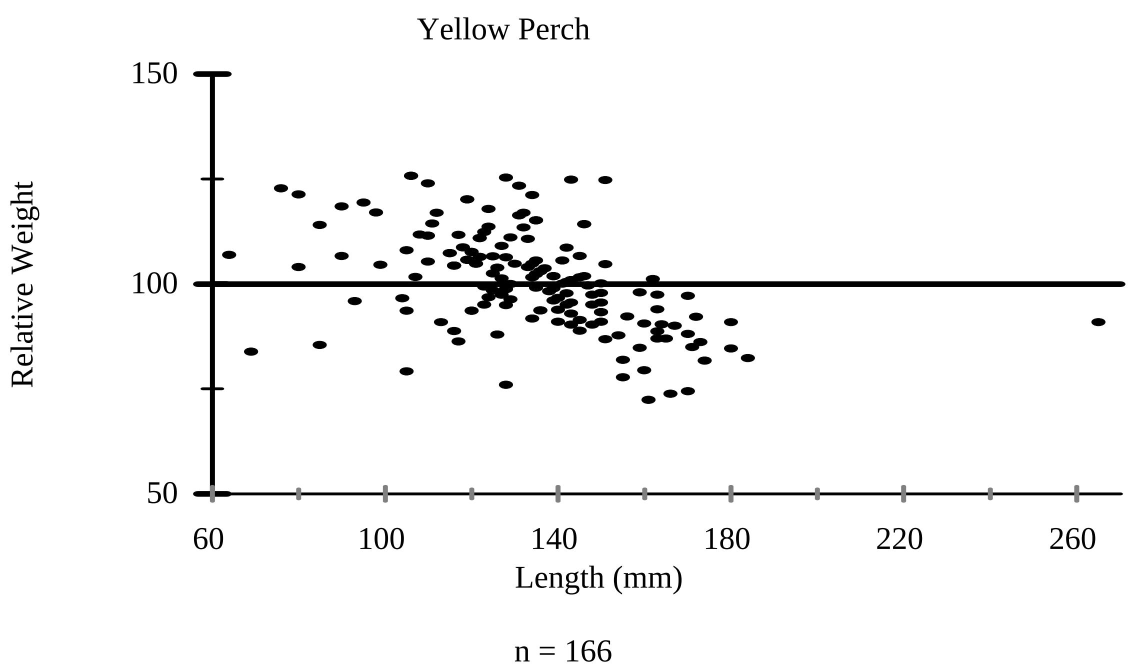

Figure 5. Relative weights for yellow perch sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Bluegill

A total of 679 bluegill ranging from 65-219 mm were collected during this survey. Ages ranged from two to seven years, with the majority age two and three (Table 6). Growth of age four, five, and seven bluegill was above average, while growth of other ages was below average. Similar to the results from our 2000 survey, the majority (~96%) of bluegill were collected with the boat electrofisher (Figure 6)(Petersen and Osborne, in press). Relative weights for stock length bluegill were higher ($p < .001$) than those for quality length bluegill; however, both size ranges had relative weights well above the national average indicating that food resources are not limiting this population (Table 4; Figure 7). We collected twice as many quality length (150-199 mm)(6-8 inches) bluegill during this survey as during the 2000 survey. Age one bluegill were not collected during this survey or during the 2000 survey. Overall, bluegill have doubled in our samples from 2000 to 2005 (Figure 2).

Table 6. Length at age of bluegill captured at Evergreen Reservoir 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).

		Mean length (mm) at age						
Year Class	# Fish	1	2	3	4	5	6	7
2004	0							
2003	30	30.1	85.9					
		44.0	88.9					
2002	15	25.0	76.1	143.3				
		41.7	86.1	144.3				
2001	6	24.7	73.8	136.4	172.7			
		41.8	85.1	140.3	172.3			
2000	6	19.7	52.8	105.7	163.2	184.3		
		37.6	67.0	114.1	165.5	184.3		
1999	4	17.0	46.3	93.1	156.2	185.8	200.6	
		35.3	61.8	104	160.9	187.6	200.9	
1998	2	15.9	57.7	106.3	146.2	170.7	189.7	202.0
		34.3	71.9	115.8	151.7	173.8	190.9	202.0
Direct Proportion mean		22.1	65.4	117	159.6	180.3	195.2	202.0
Fraser Lee mean		41.8	83.5	131.5	165.2	183.7	197.6	202.0
WA State Average (DP)		37.3	96.8	132.1	148.3	169.9	200.9	195.8

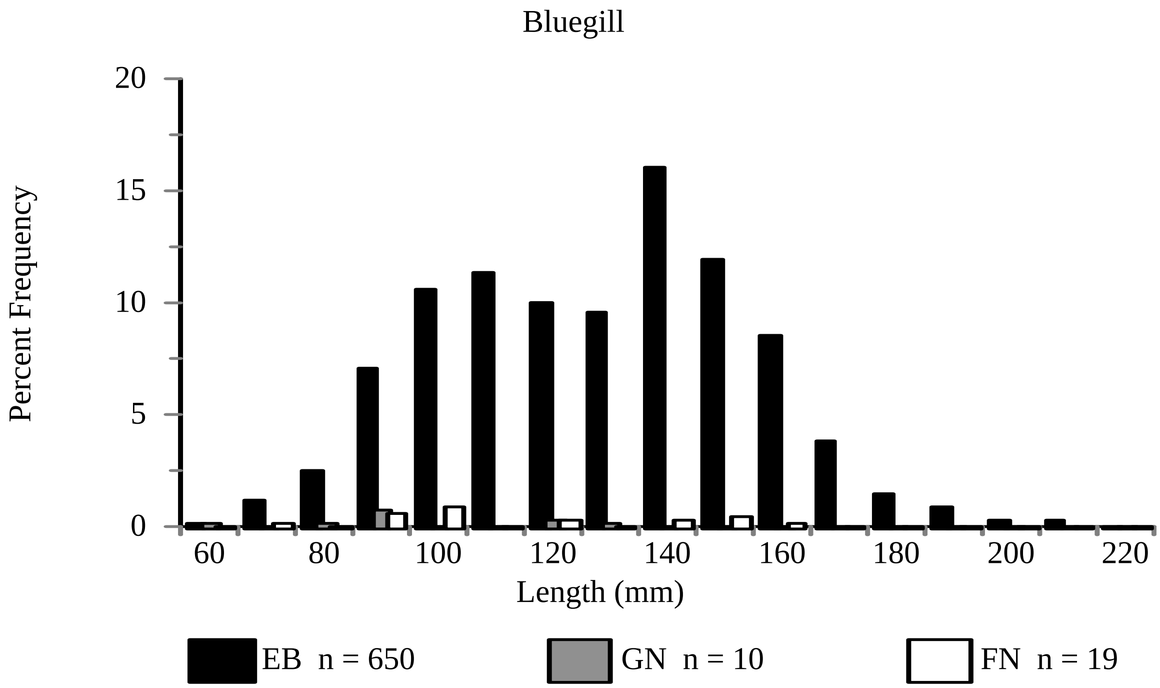

Figure 6. Length frequencies of bluegill sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Evergreen Reservoir during June 2005.

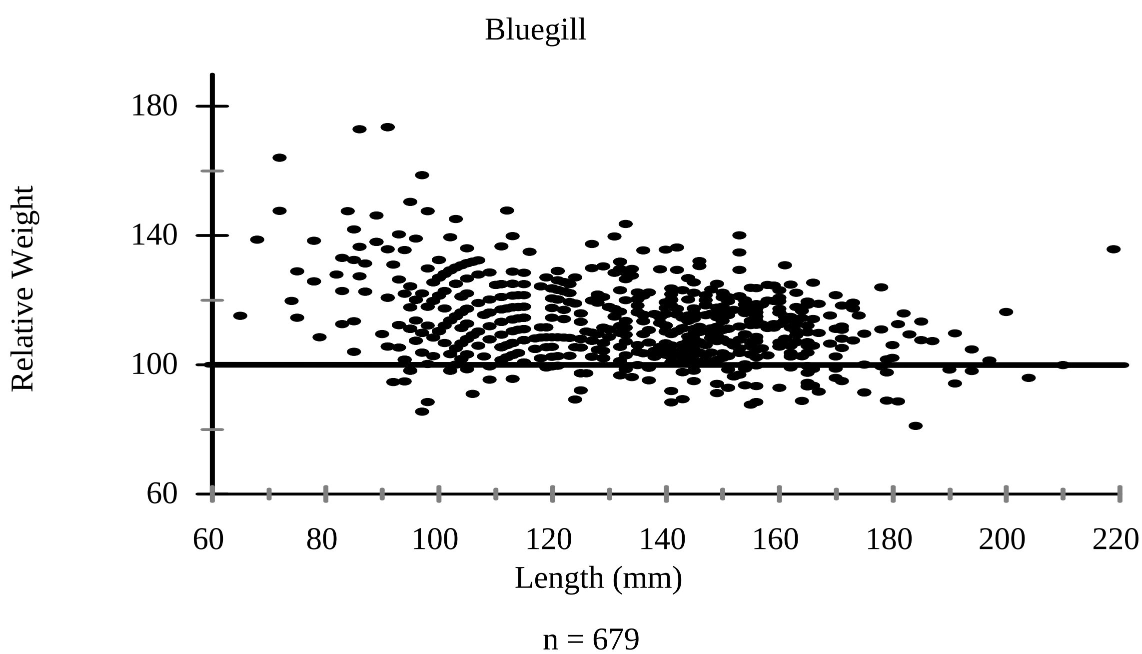

Figure 7. Relative weights for bluegill sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Pumpkinseed Sunfish

A total of 140 pumpkinseed sunfish ranging from 73-155 mm were collected during this survey. Ages ranged from two to six years and only age five pumpkinseed had below (state) average growth (Table 7). No age one pumpkinseed were collected during this survey. Pumpkinseed were collected with all gear types; however, the majority of fish were collected with the boat electrofisher (Figure 8). Pumpkinseed sunfish have doubled in our samples since the 2000 fisheries survey (Figure 2), and similar to the 2000 survey relative weights were above average for the majority of fish collected (Figure 9).

Table 7. Length at age of pumpkinseed sunfish captured at Evergreen Reservoir 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).

		Mean length (mm) at age					
Year Class	# Fish	1	2	3	4	5	6
2004	0						
2003	16	32.9	82.9				
		49.1	85.4				
2002	11	24.8	74.8	117.1			
		44.7	84.4	118.1			
2001	2	22.8	72.5	122.8	135.8		
		43.7	84.5	125.8	136.5		
2000	1	22.9	62.9	87.5	118.1	130.0	
		43.5	75.7	95.7	120.4	130.0	
1999	1	29.7	73.9	109.2	134.1	147.0	155.0
		49.9	86.9	116.6	137.5	148.3	155.0
Direct Proportion mean		26.6	73.4	109.2	129.3	138.5	155.0
Fraser Lee mean		46.7	84.7	117.5	132.7	139.1	155.0
WA State Average (DP)		23.6	72.1	101.6	122.7	139.4	N/A

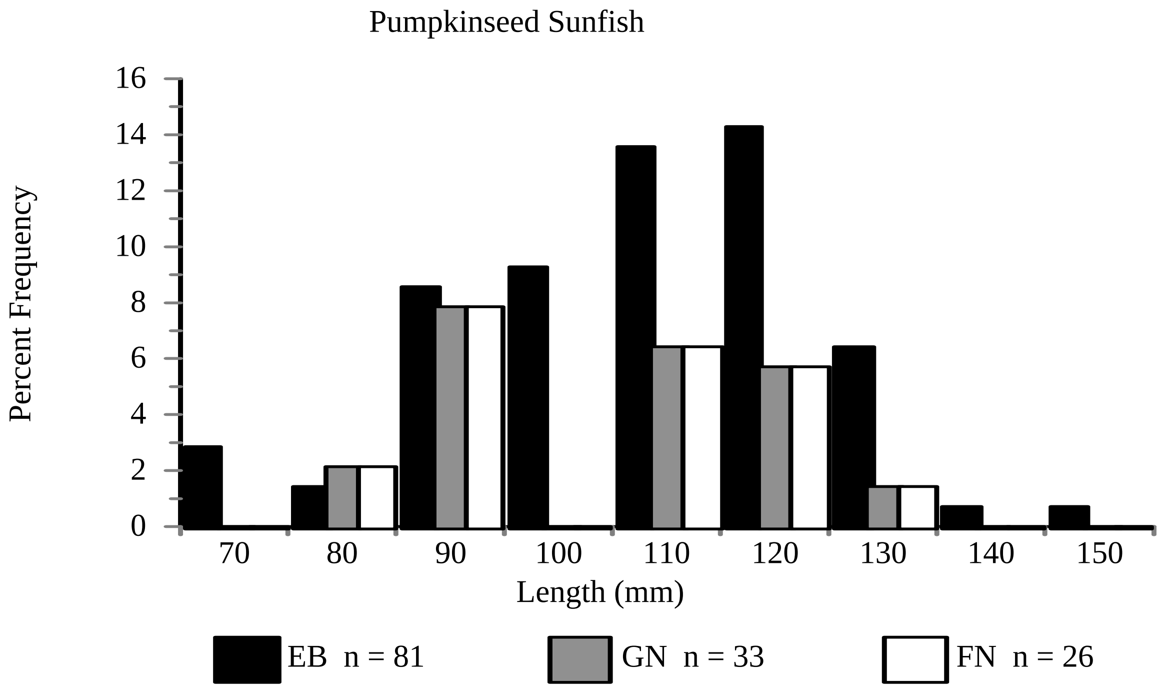

Figure 8. Length frequencies of pumpkinseed sunfish sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Evergreen Reservoir during June 2005.

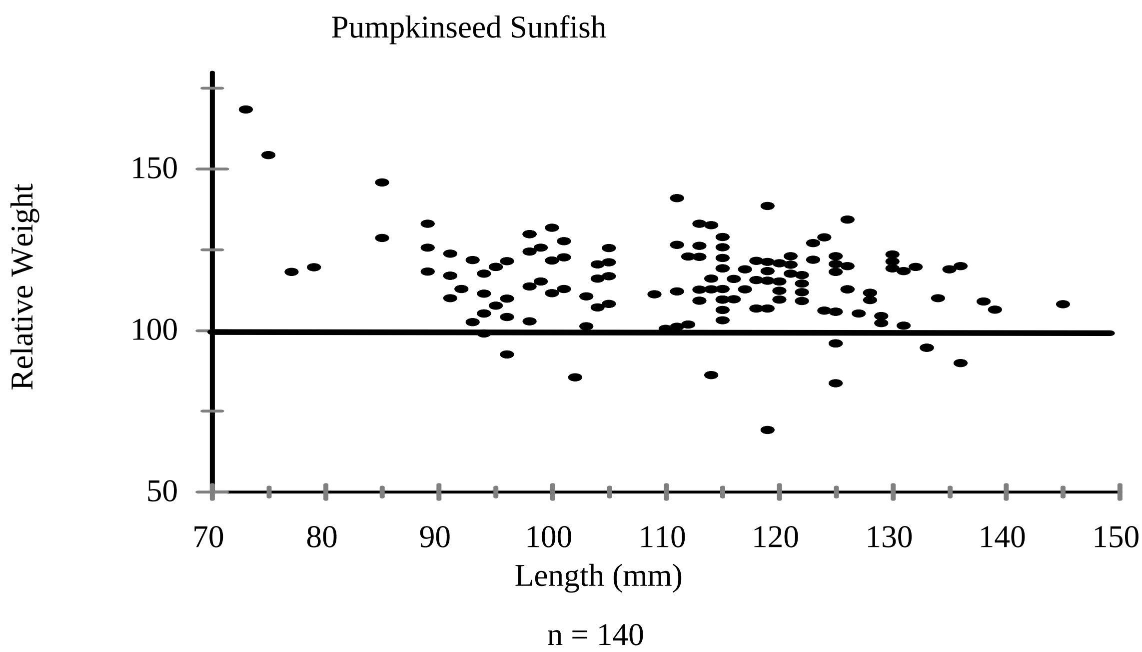

Figure 9. Relative weights for pumpkinseed sunfish sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Black Crappie

A total of 151 black crappie ranging from 79-344 mm were collected during this survey. Ages ranged from one to five years; however age two and three black crappie were most abundant (Table 8). Growth of black crappie was well above the statewide average for all age classes collected. In 2000, only 18 black crappie were collected, age two fish were the most abundant age class collected and growth and condition were above average. As in 2000, very few age one fish were collected during this survey. Black crappie were collected with all gear types; however, most were collected with the boat electrofisher and gill nets (Figure 10). Relative weights were well above the national average for the majority of fish collected (Figure 11). In 2000, all black crappie had above average relative weights. From 2000 to 2005 black crappie increased in our samples more than any other species (Figure 2).

Table 8. Length at age of black crappie captured at Evergreen Reservoir 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).

		Mean length (mm) at age				
Year Class	# Fish	1	2	3	4	5
2004	2	62.9				
		70.9				
2003	19	58.5	142.3			
		80.5	145.7			
2002	10	44.7	127.4	196.0		
		71.7	140.2	196.7		
2001	0					
2000	1	57.4	132.9	210.5	270.1	302.0
		85.7	152.5	221.1	273.8	302.0
Direct Proportion mean		55.8	134.2	203.3	270.1	302.0
Fraser Lee mean		77.3	144.1	198.9	273.8	302.0
WA State Average (DP)		46.0	111.2	156.7	183.4	220.0

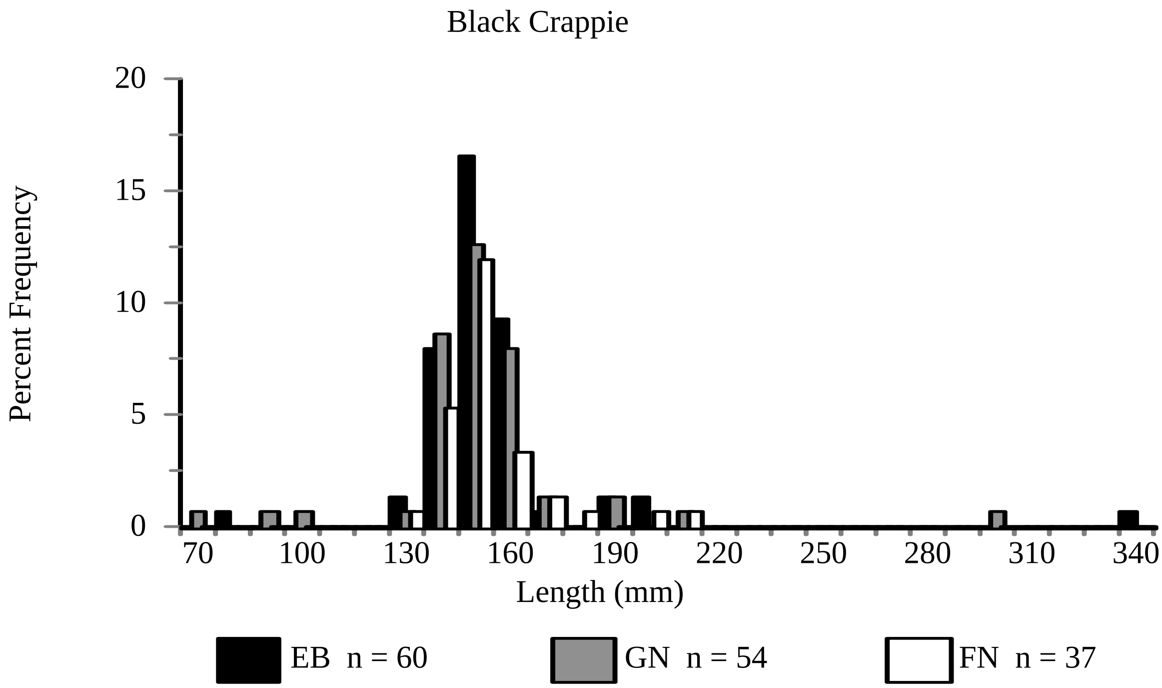

Figure 10. Length frequency of black crappie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Evergreen Reservoir during June 2005.

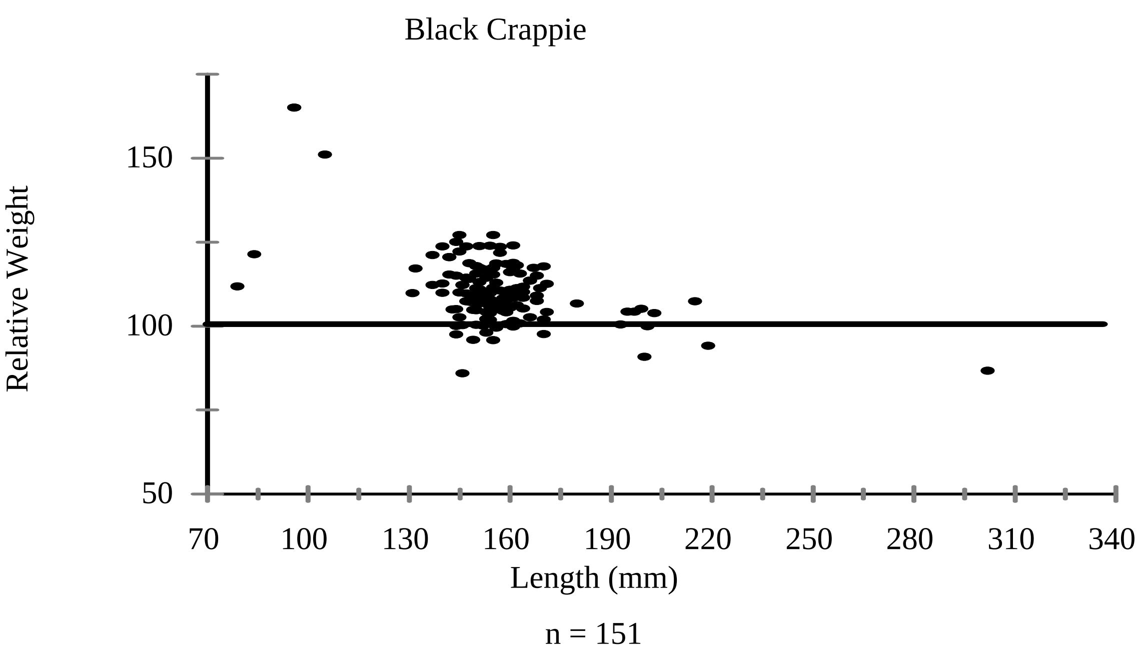

Figure 11. Relative weights for black crappie sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Largemouth Bass

A total of 185 largemouth bass were collected during this survey and lengths ranged from 70-550 mm. Largemouth bass ranged in age from one to twelve, growth was above average; however, many age classes were poorly represented (Table 9). The majority of largemouth bass collected were captured with the boat electrofisher, and no bass were collected in fyke nets (Figure 12). In 2000, largemouth bass ranged in age from 1 to 12 years, and age 2 fish were the most abundant sampled (Petersen and Osborne, in press). During this survey 53 percent of largemouth bass collected were at least stock length, the PSD was 31, and the RSD-P was 19. The majority of largemouth bass collected were of harvestable size (i.e. <305 mm; 12 inches); however, we also collected significant numbers of largemouth in the protected slot (quality and preferred size fish, 305-432 mm; 12-17 inches). The average relative weight for largemouth bass was (W_r =100) and relative weights were similar for all size ranges (p = .192)(Figure 13). In 2000, very few stock length largemouth bass were collected, and relative weights were slightly below the national average. Largemouth bass have increased slightly in our samples since 2000 (Figure 2).

Table 9. Length at age of largemouth bass captured at Evergreen Reservoir 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).

		Mean length (mm) at age											
Year Class	# Fish	1	2	3	4	5	6	7	8	9	10	11	12
2004	8	87.4											
		89.1											
2003	47	74.2	156.1										
		85.1	156.8										
2002	43	59.0	182.2	263.1									
		74.6	188.6	263.6									
2001	3	51.7	173.8	304.6	360.7								
		68.9	184.3	308.0	361.1								
2000	3	51.5	169.6	272.8	339.3	375.3							
		68.8	180.7	278.3	341.4	375.4							
1999	6	53.1	163.3	255.8	330.1	378.0	403.2						
		70.5	175.2	263.1	333.8	379.2	403.2						
1998	5	58.0	160.3	273.3	352.5	395.5	425.2	441.8					
		75.4	173.1	280.9	356.5	397.6	426.0	441.8					
1997	3	64.6	201.8	309.8	384.2	440.0	460.4	476.5	489.3				
		81.9	213.6	317.1	388.5	442.0	461.6	477.0	489.3				
1996	1	80.5	192.2	268.8	309.0	355.8	392.1	409.0	424.6	435.0			
		96.8	203.3	276.4	314.8	359.4	394.1	410.2	425.1	435.0			
1995	1	80.0	213.9	282.1	343.8	392.3	410.7	433.0	451.4	464.5	475.0		
		96.7	224.9	290.2	349.3	395.8	413.4	434.8	452.4	464.9	475.0		
1994	0												
1993	1	62.7	158.7	238.1	359.2	427.5	449.7	469.2	495.7	513.8	527.7	540.3	550.0
		80.4	173.0	249.4	366.2	431.9	453.4	472.2	497.7	515.1	528.5	540.6	550.0
Direct Prop. mean		65.7	177.2	274.3	347.4	394.9	423.6	445.9	465.3	471.1	501.4	540.3	550.0
Fraser Lee mean		79.8	174.6	270.4	351.7	395.2	423.2	450.7	473.9	471.7	501.8	540.6	550.0
Region Two Average (Fraser Lee)		87.6	168.6	239.2	291.7	336.3	367.3	394.1	412.5	434.4	483.5	505.6	533.3

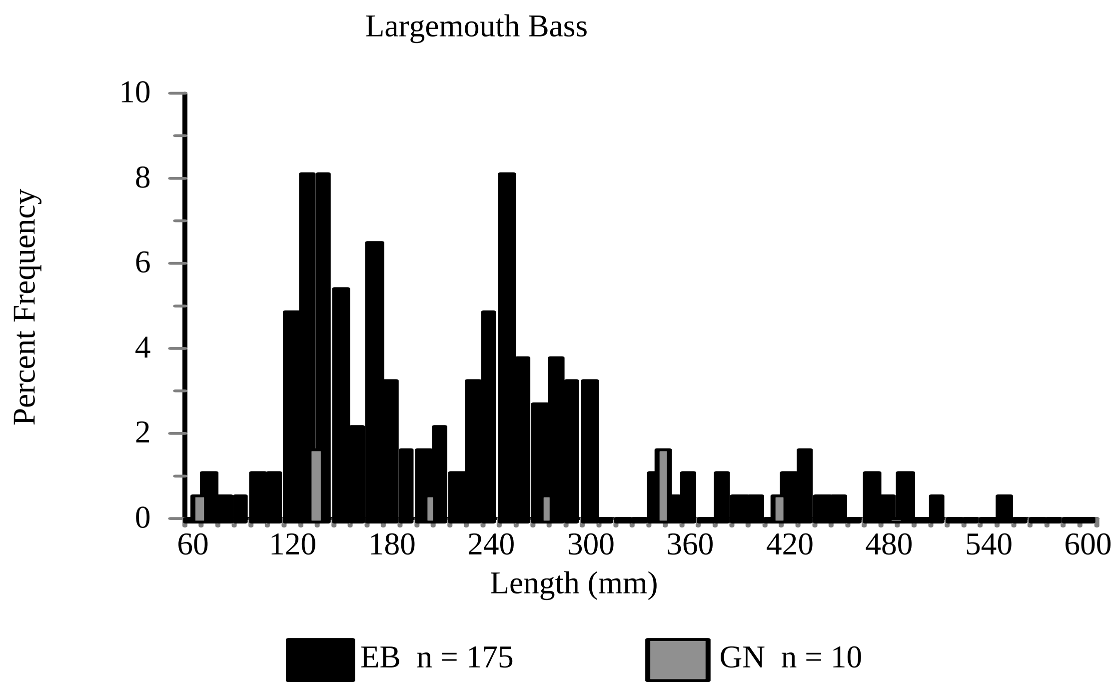

Figure 12. Length frequency of largemouth bass captured while using a boat electrofisher (EB) and gill nets (GN) on Evergreen Reservoir during June 2005.

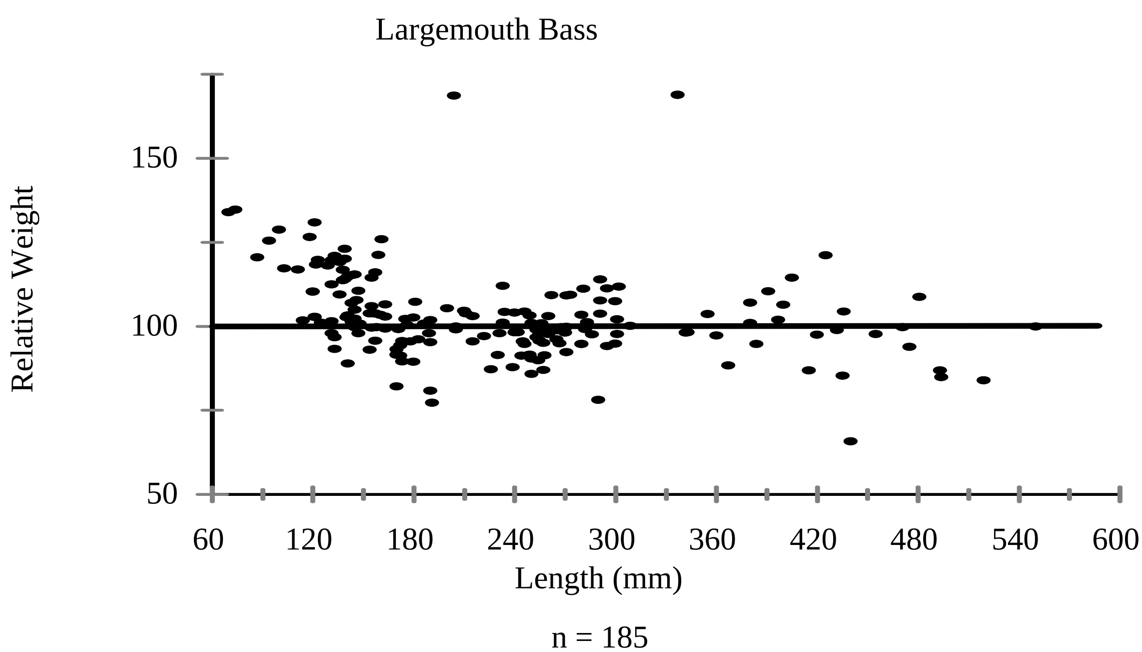

Figure 13. Relative weights for largemouth bass sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Smallmouth Bass

A total of 89 smallmouth bass ranging from 71 – 456 mm were collected during this survey. Ages ranged from one to five, with age two and three being the most abundant age classes collected (Table 10). Growth was below average for age one smallmouth bass and above average for all other age classes. All but one smallmouth bass were collected with the boat electrofisher and the majority of fish collected were between 110 – 260 mm (4 – 10 inches)(Figure 14). These results are similar to those observed during our 2000 warmwater survey (Petersen and Osborne, in press). Relative weights for smallmouth bass less than stock length (110 – 179 mm) were above average; however, relative weights were lower ($p < .001$) for stock and quality (180 – 349 mm) length smallmouth bass (Figure 15). During the 2000 warmwater fisheries survey we collected 20 smallmouth bass; however, relative weights were above average for all but the largest two fish. Smallmouth bass relative weight trends from this survey indicate that food resources may be limiting for larger smallmouth bass. With the exception of bluegill, smallmouth bass have increased in our samples (from 2000 to 2005) more than any other species (Figure 2).

Table 10. Age and growth of smallmouth bass captured at Evergreen Reservoir 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).

		Mean length (mm) at age				
Year Class	# Fish	1	2	3	4	5
2004	2	69.6				
		74.6				
2003	36	67.0	152.5			
		87.8	155.2			
2002	14	53.5	153.7	237.1		
		80.8	166.8	238.3		
2001	3	53.0	154.3	239.2	312.3	
		82.1	172.2	247.6	312.3	
2000	1	51.3	142.9	232.6	324.2	370.0
		81.4	164.4	245.6	328.5	370.0
Direct Proportion mean		58.9	150.8	236.3	318.3	370.0
Fraser Lee mean		85.2	159.3	240.2	316.4	370.0
WA Average (DP)		70.4	146.3	211.8	268.0	334.0

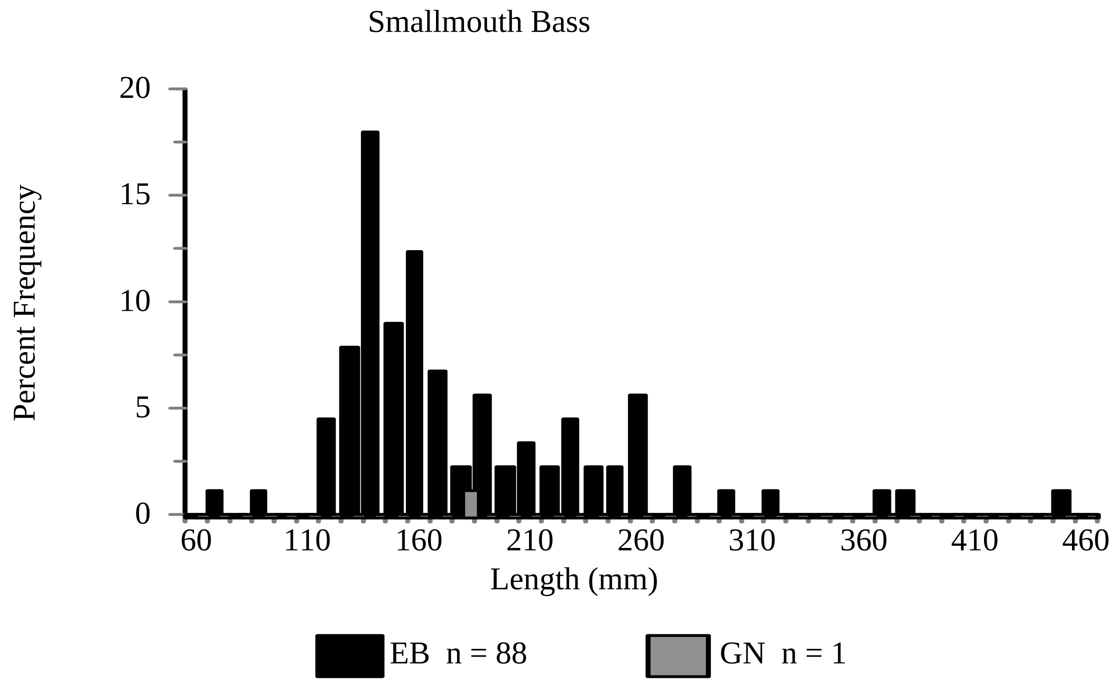

Figure 14. Length frequency of smallmouth bass captured while using a boat electrofisher (EB) and gill nets (GN) on Evergreen Reservoir during June 2005.

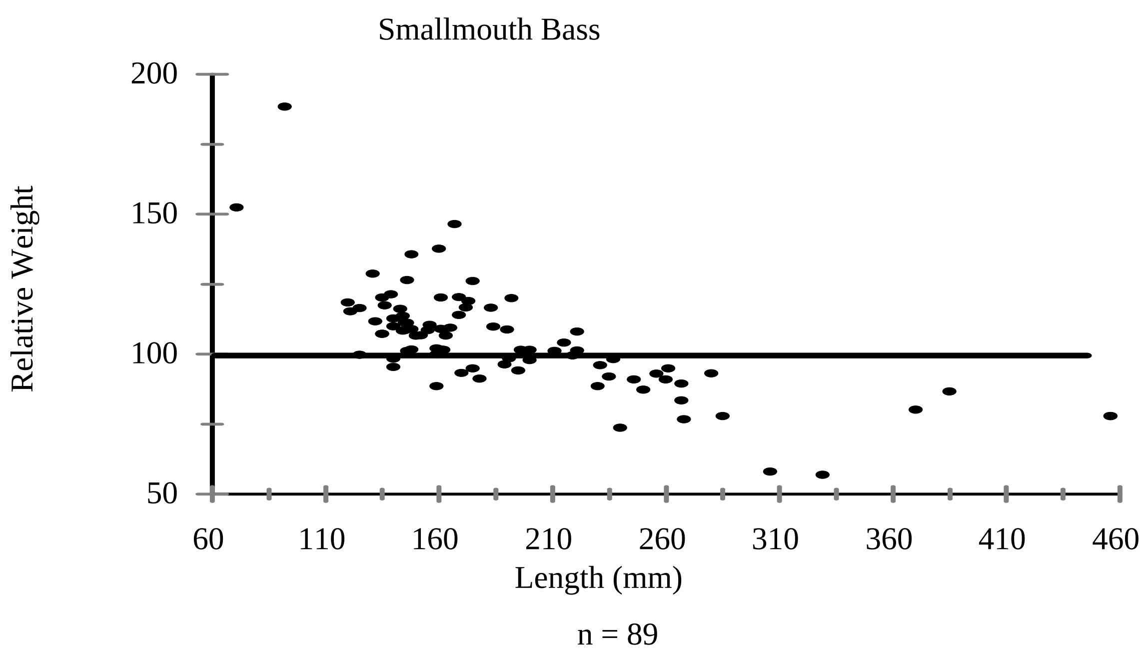

Figure 15. Relative weights for smallmouth bass sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Walleye

A total of 33 walleye ranging from 201-765 mm were collected during this survey. Ages ranged from one to nine years; however, most age classes were weakly represented (Table 11). Most walleye were collected with the boat electrofisher; however, gill nets collected the largest walleye (Figure 16). In 2000, walleye lengths ranged from 185-710mm, approximately 46 percent were of harvestable size and multiple age classes were represented well. During this survey only nine walleye collected were of harvestable size and most year classes were weakly represented. Relative weights for walleye were below the national average for all fish collected indicating that food resources are limited for all size ranges of walleye (Figure 17). Based on data collected during our 2000 survey walleye have declined in our samples more than any other species (Figure 2) (Petersen and Osborne, in press).

Table 11. Age and growth of walleye captured at Evergreen Reservoir 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).

		Mean length (mm) at age								
Year Class	# Fish	1	2	3	4	5	6	7	8	9
2004	1	161.8								
		172.5								
2003	18	168.4	307.2							
		194.6	309.6							
2002	5	142.0	318.9	403.6						
		178.1	331.3	404.6						
2001	1	132.4	365.8	443.6	490.0					
		172.6	379.8	448.9	490.0					
2000	3	112.5	244.3	347.5	416.6	455.0				
		154.4	270.4	361.0	422.0	455.8				
1999	2	166.5	313.9	436.5	516.0	564.6	596.8			
		206.5	340.6	451.9	524.2	568.4	597.6			
1998	0									
1997	1	141.6	307.6	413.8	520.0	555.4	608.5	635.1	648.4	
		184.7	336.8	434.1	531.4	563.8	612.4	636.8	648.9	
1996	1	173.1	351.1	464.0	581.9	644.6	684.7	722.4	750.0	765.0
		215.6	380.9	485.7	595.1	653.3	690.5	725.4	751.0	765.0
Direct Proportion mean		149.8	315.6	418.2	504.9	554.9	630.0	678.7	699.2	765.0
Fraser Lee mean		188.0	316.7	413.7	491.4	531.6	624.5	681.1	700.0	765.0

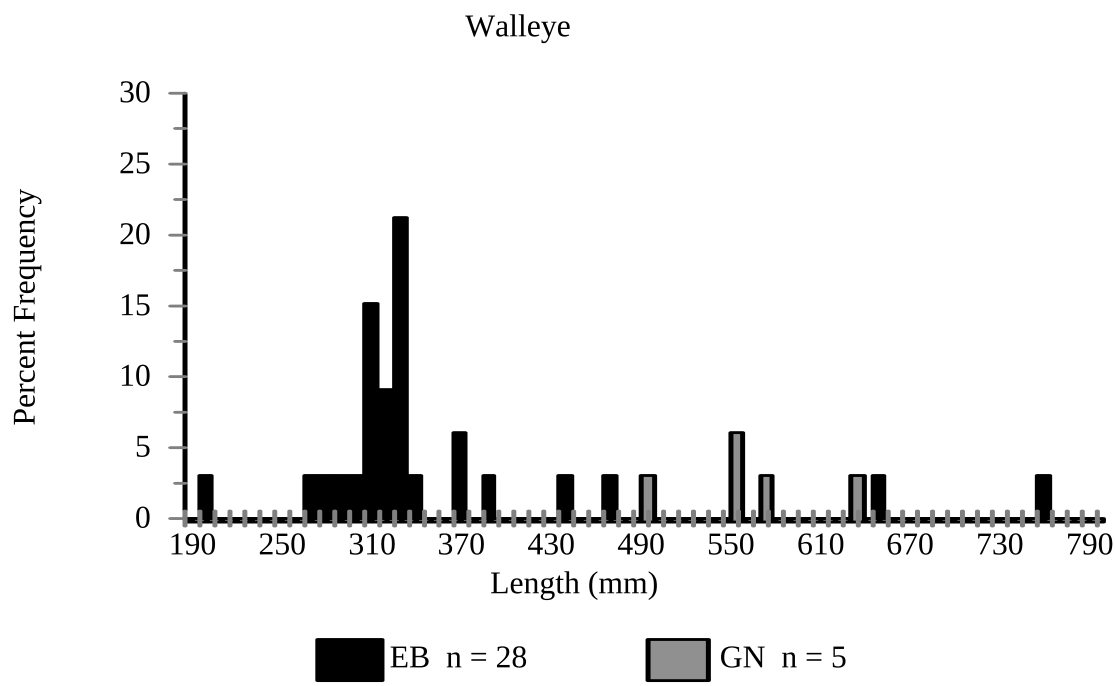

Figure 16. Length frequency of walleye captured while using a boat electrofisher (EB) and gill nets (GN) on Evergreen Reservoir during June 2005.

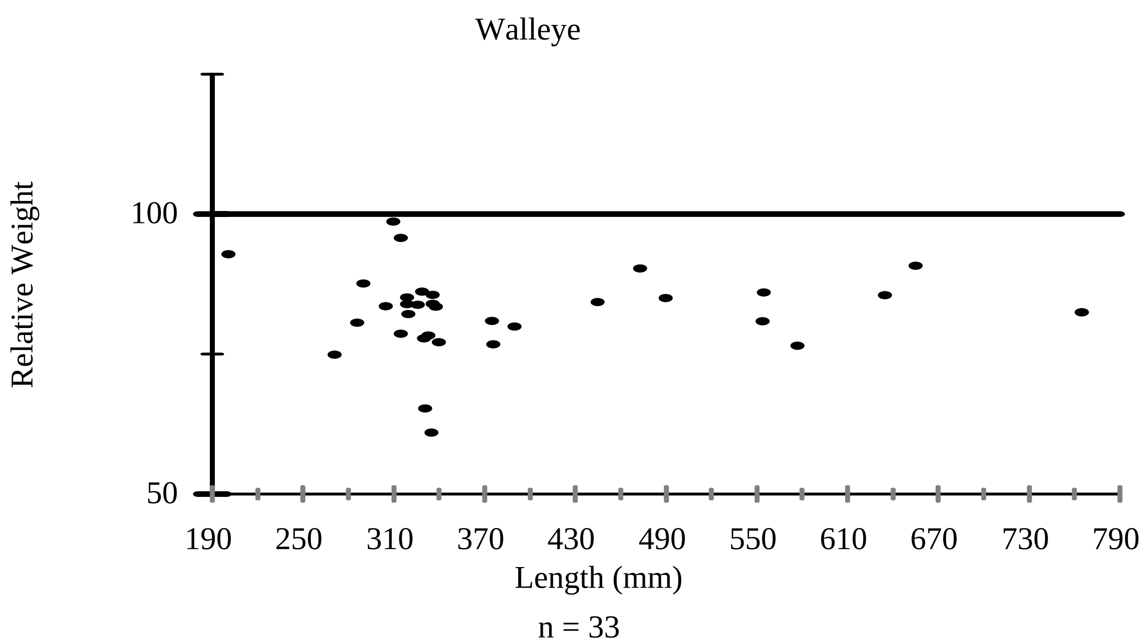

Figure 17. Relative weights for walleye sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Tiger Muskie

Nine tiger muskie ranging from 350-750 mm were collected during this survey. Ages ranged from five to eight years. In 2000, eight tiger muskie were collected. Approximately 200 juvenile tiger muskie are stocked in Evergreen Reservoir annually, and survival of these fish is unknown.

Table 12. Length at age of tiger muskie captured at Evergreen Reservoir during June 2005. Values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993).

		Mean length (mm) at age							
Year Class	# Fish	1	2	3	4	5	6	7	8
2004	0								
2003	0								
2002	0								
2001	0								
2000	1	177.2	332.5	490.3	645.6	750.0			
1999	1	195.3	344.0	521.5	685.7	761.2	790.0		
1998	4	206.8	344.1	506.1	638.7	730.4	799.9	840.0	
1997	1	178.1	318.7	520.2	700.7	799.1	906.9	965.5	1010.0
Direct Proportion mean		189.3	334.8	509.5	667.7	760.2	832.3	902.7	1010.0

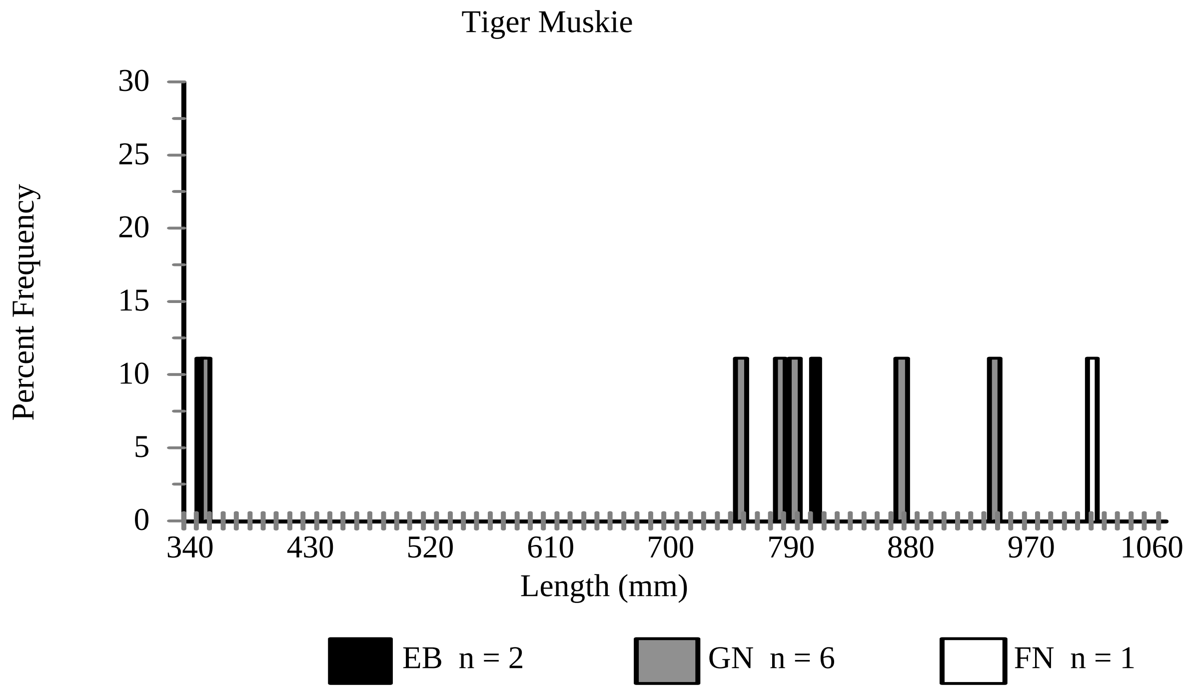

Figure 18. Length frequency of tiger muskie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Evergreen Reservoir during June 2005.

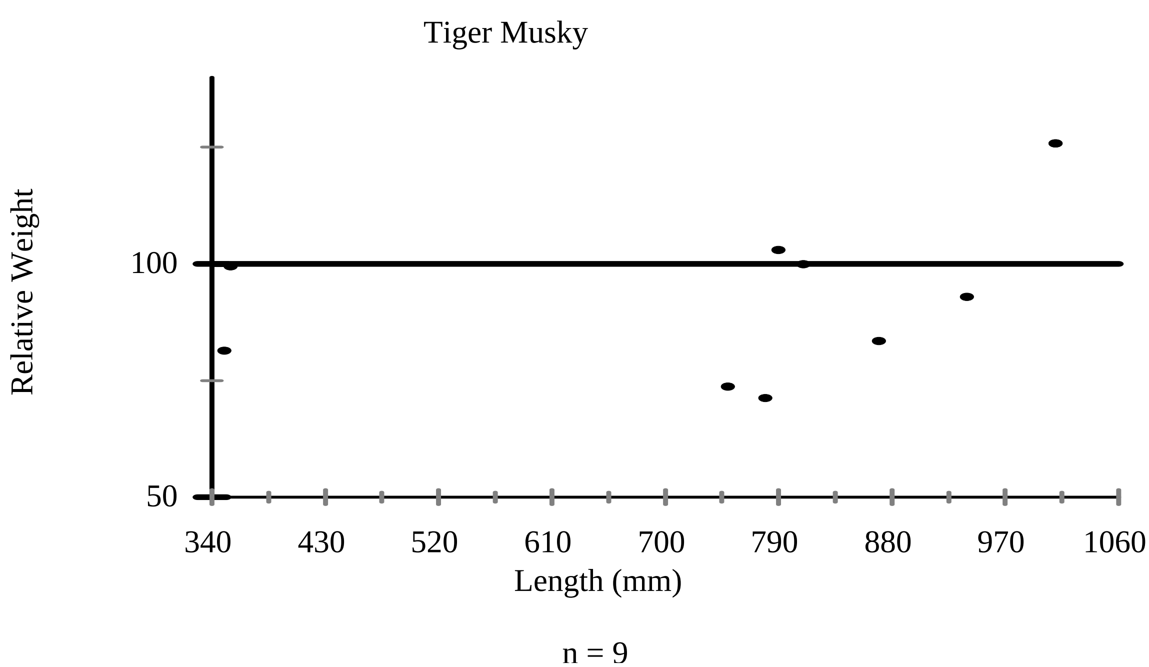

Figure 19. Relative weights for tiger muskie sampled at Evergreen Reservoir, June 2005, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Discussion and Management Options

Since 2000, bluegill, pumpkinseed sunfish, black crappie, largemouth bass, smallmouth bass and tiger muskie increased in abundance in our samples while yellow perch, brown bullhead, walleye and carp have declined. These increases are likely due to the diverse habitat available to these species in Evergreen Reservoir. Largemouth bass, smallmouth bass, black crappie, and pumpkinseed exhibited high growth rates, while yellow perch and bluegill had variable growth. Relative weights varied between size ranges; however, bluegill, pumpkinseed and black crappie had above average relative weights for most fish. Walleye exhibited low relative weights, which is likely due to declines in yellow perch, especially age one fish.

One of the most notable results from this survey was the lack of age one fish collected. Typically, age one fish are the largest age class collected; however, during this survey only 24 age one fish were aged from all species. This is likely due to sampling bias based on habitat availability rather than a particular gear bias. Evergreen Reservoir undergoes frequent and highly variable water level fluctuations based on irrigation needs. Low water conditions were seen during this survey that likely forced small fish into deep water where none of our gears sample small fish effectively.

From 2000 to 2005, bluegill PSD increased from 13 to 29; however, no increase occurred in the number of preferred length bluegill. No age one bluegills were collected during this survey, which may be due to sampling bias.

Declines in yellow perch correspond with increases in bluegill, black crappie, and smallmouth bass. This decline may be due to interspecific competition, predation, or low recruitment due to highly variable water levels that occur in Evergreen Reservoir during spring.

Very few age one black crappie were collected in 2000 or 2005. This may be an indication that we are not sampling age one black crappie effectively since this population appears to be increasing and fish are in excellent condition. Fyke nets are an excellent sampling gear for collecting large samples of young black crappie; however, we had a difficult time setting fyke nets during this survey due to steep shorelines and limited littoral habitat in many sampling sections. In the future we may need to assess sampling sections more critically in order to sample black crappie effectively. Establishing non-random index sites may be necessary in order to sample black crappie effectively.

The number of smallmouth bass in our samples has increased significantly since 2000. Evergreen Reservoir has abundant smallmouth bass habitat (i.e. rip-rap shoreline and large boulder substrate within the reservoir); therefore, we may see this population continue to grow in size provided adequate food resources remain available. Relative weights for smallmouth bass were low for the largest smallmouth in our samples indicating that food may be limited for these fish.

From 2000 to 2005 walleye declined in our samples more than any species. Tiger muskie, largemouth and smallmouth bass are preferred species in Evergreen Reservoir and prey populations are likely not sufficient to support another top predator such as walleye. Declines in walleye abundance may be due to inconsistent recruitment as the result of fluctuations in Evergreen Reservoir in spring, or predation on juvenile walleye by panfish. Quist et al. (2003) found that recruitment of walleye was negatively correlated with high densities of 130-199 mm white crappies due to predation on walleye YOY. While only black crappie were found in Evergreen Reservoir, diets of black and white crappie overlap (Wydoski and Whitney 2003) and the majority of crappie collected during this survey were 130-210mm.

Reservoirs are dynamic ecosystems in which biological conditions can change over relatively short temporal scales. Warmwater surveys of Evergreen Reservoir should be conducted at regular intervals in order to evaluate relative abundance, growth, size structure, and condition of warmwater fish populations, and make timely management decisions. We recommend conducting a one or two-night survey in order to determine if age classes missing in our samples are missing from these populations or were missed due to sampling bias.

Acknowledgements

We would like to thank Patrick Verhey (WDFW) and our Scientific Technician, Heather Stiegelmeyer, for their assistance during this survey. We are also grateful to Lucinda Morrow, from the WDFW Fish Aging Lab, who aged fish from this survey, as well as David Bramwell who formatted the final draft of this report.

Literature Cited

Anderson, R.O. and R.M. Neumann. 1996. Length, weight and associated structural indices. Pages 447-482 *in* Murphy, B.R. and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Bonar, S.A., B.D. Bolding, and M.J. Divens. 2000. Standard fish sampling guidelines for Washington State pond and lake surveys. Report No. FTP 00-28, Washington Department of Fish and Wildlife, Olympia, Washington. 24 pp.

Carlander, K.D. 1982. Standard intercepts for calculation lengths from scale measurements for centrarchid and percid fishes. Transactions of the American Fisheries Society 111:332-336.

Fletcher, D., S.A. Bonar, B.D. Bolding, A. Bradbury, and S. Zeylmaker. 1993. Analyzing warmwater fish populations in Washington State. Warmwater Fish Survey Manual. Washington Department of Fish and Wildlife, Olympia, Washington. 164 pp.

Gabelhouse, D.W., Jr. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gustafson, K.A. 1988. Approximating confidence intervals for indices of fish population size structure. North American Journal of Fisheries Management 8:139-141.

Hubert, W.A. 1996. Passive capture techniques. Pages 157-192 in B.R. Murphy and D. W. Willis, eds. Fisheries Techniques, 2nd edition. AFS, Bethesda, MD.

Petersen, M.R. and R. S. Osborne. In Press. 2000 Evergreen Reservoir Warmwater Survey Grant County, Washington. Washington Department of Fish and Wildlife. Olympia, WA

Quist, M.C., C.S. Guy, and J.L. Stephen. 2003. Recruitment dynamics of walleyes (*Stizostedion vitreum*) in Kansas reservoirs: generalities with natural systems and effects of a centrarchid predator. Canadian Journal of Fisheries and Aquatic Sciences. 60:830-839.

WDFW. 1982. Department of Game correspondence. Washington Department of Fish and Wildlife fisheries management files. Region 2, Ephrata, Washington. 2 pp.

WDFW. 1996. Priority habitats and species data. Washington Department of Fish and Wildlife fisheries management files. Region 2, Ephrata, Washington. 9 pp.

WDFW. 2000. Fish stocking records for Grant and Adams Counties. Washington Department of Fish and Wildlife fisheries management files. Region 2, Ephrata, Washington. 141 pp.

Willis, D.W., B.R. Murphy, and C.S. Guy. 1993. Stock density indices: development, use, and limitations. Reviews in Fisheries Science 1:203-222.

Wydoski, R.S., and R.R. Whitney. 2003. Inland fishes of Washington. University of Washington Press, Seattle. 322 pp.

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.