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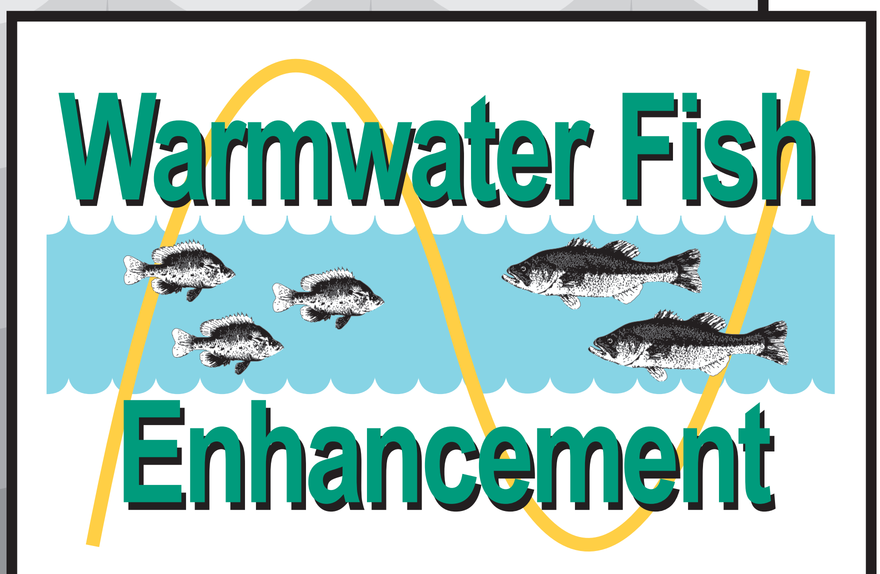
2006 Warmwater Fisheries Survey of Wapato Lake, Chelan County, Washington



by Michael R. Schmuck and Marc R. Petersen

Washington Department of
FISH AND WILDLIFE
Fish Program
Fish Management Division

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2006 Warmwater Fisheries Survey of Wapato Lake, Chelan County, Washington

The fish community in a small, central Washington lake managed for rainbow trout and largemouth bass fishing.

By

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ABSTRACT

Wapato Lake was surveyed by the Washington Department of Fish and Wildlife Region Two Warmwater Team using a boat electrofisher, gill nets, and fyke nets. Largemouth bass *Micropterus salmoides* was the most abundant species collected followed by pumpkinseed sunfish *Lepomis gibbosus*, and yellow perch *Perca flavescens*. Water chemistry data (dissolved oxygen and pH) in the epilimnion were well within acceptable standards for fish growth and survival. Seven game fish species were collected during this survey and with the exception of rainbow trout *Oncorhyncus mykiss*, all species were collected with all gears. Stock density indices reflect that the yellow perch population contains mostly large fish, while the largemouth bass population is comprised mostly of fish less than twelve inches. Length-at-age for all species was at or above average for fish older than age two, but below average for age one and two fish. Wapato Lake, under the current management scenario, appears to be an example of a well-balanced mixed-species fishery.

ACKNOWLEDGMENTS

From WDFW we would like to thank Bruce Bolding, Craig Burley, Steve Jackson, Joe Miller, and Art Viola for their editorial comments. We would also like to thank our Scientific Technician, Megan Steele for her tireless and dedicated assistance in the field. We are also grateful to Lucinda Morrow from the WDFW Fish Aging Lab, who aged fish from this survey, and David Bramwell, for formatting the final draft of this report. This project was funded by the Warmwater Enhancement Program, which is providing greater opportunities to fish for and catch warmwater fish in Washington.

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INTRODUCTION AND BACKGROUND

Wapato Lake is located in Chelan County approximately 3 miles from Manson, WA. Wapato Lake has a surface area of 87 ha (216 acres) and has a maximum depth of 20 m (68 feet). The lake has water control structures for irrigation and flood control. Public access is provided by the Washington Department of Fish and Wildlife (WDFW). The access site has pit toilets, a concrete boat ramp and a dock. There are two private campgrounds, one at each end of the lake. The Kamei Campground/RV Park is located at the north end of the lake, while the Wapato Lake Campground is located at the south end of the lake.

Wapato Lake is primarily managed for rainbow trout *Oncorhynchus mykiss*, and, to a lesser degree, largemouth bass *Micropterus salmoides*. Historically, managers struggled with warmwater fish introductions which caused declines in survival and; therefore, angler harvest of rainbow trout. Wapato Lake was rehabilitated with rotenone in 1976 and 1981 in order to remove undesirable warmwater species (i.e. yellow perch *Perca flavescens*, pumpkinseed sunfish *Lepomis gibbosus* and black crappie *Pomoxis nigromaculatus*). Warmwater species became abundant after each treatment; however, either through illegal introductions or through insufficient rotenone application. Through the stocking of rainbow trout fry and triploids managers have been able to maintain a successful mixed-species fishery.

This survey was conducted to evaluate the warm water fishery, specifically, the relative abundance, size distribution and condition of largemouth bass, bluegill *Lepomis macrochirus*, black crappie, and yellow perch. Findings from this survey will be used by district fisheries biologists to determine if a chemical rehabilitation is necessary in order to reduce impacts to rainbow trout.

Currently (as of June 2012), WDFW fishing regulations are as follows:

Species	**Season**	**Additional Rules**
All Game Fish	4th Sat. in Apr.–July 31	Statewide min. size/daily limit.
Trout	Aug. 1–Oct. 31	Catch-and-release. Selective gear rules.
Other Game Fish	Aug. 1–Oct. 31	Statewide min. size/daily limit. Selective gear rules

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METHODS

Wapato Lake was surveyed by the Region Two Warmwater Team September 11–14, 2006. Fish were collected using a boat electrofisher, gill nets, and fyke nets. The electrofisher unit consisted of a 5.5 m (18 ft.) Smith-Root GPP-5 electrofishing boat, supplying a DC current at a setting of 60 cycles/sec at 3 to 4 amps power. Experimental gill nets (45.7 m x 2.4 m) consisted 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, netting material was constructed of 13 mm nylon mesh.

Water Chemistry

We recorded water chemistry data: dissolved oxygen (DO; mg/L), pH, temperature (C°), and conductivity (microsiemens per centimeter: μS/cm) at one-meter intervals (to eight meters) at the deepest point of the lake. In addition, we also recorded secchi depth (a measure of water clarity). Water chemistry data were recorded from an anchored boat during mid-morning on a slightly overcast day.

Sampling Procedures

We selected sampling locations by dividing the shoreline into 400 m sections and randomly selecting 12 sections from the total. The 12 randomly selected sites were distributed between electrofishing (10 sites), gill nets (4 sites), and fyke nets (4 sites). Due to the low number of sites available some sites were sampled by multiple gear types. We boat electro-fished in shallow water (depth range: 0.2–.5m) adjacent to the shoreline at a rate of approximately 18.3 m/minute for 600-second intervals (Bonar et al. 2000). We set gill nets perpendicular to the shoreline with the small-mesh end attached on or near the shore, and the large-mesh end anchored offshore. We set fyke nets perpendicular to the shoreline with the wings extended at approximately70^{o} angles from the lead. We set gill nets and fyke nets in early evening prior to electrofishing and we pulled them 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 using total length (mm TL) and weighed (g). Total length data (mm TL) were used to construct length-frequency histograms and to evaluate the size structure of the warmwater game fish (yellow perch, bluegill *Lepomis macrochirus*, pumpkinseed sunfish, black crappie, and largemouth bass) populations in the lake.

Scale samples were collected from the first five fish in each 10 mm 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 (n), was determined from fish captured with all gears combined. Fish less than one-year-old were excluded from all analyses.

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, while CPUE of gill netting and fyke netting was determined by dividing the number of fish captured by the number of nights the nets were deployed.

Proportional size distribution (PSD) (formerly known as proportional stock density and relative stock density (PSD and RSD, respectively)) (Guy et al. 2006; Guy et al. 2007) is a numerical categorization method used to describe length frequency data collected during fisheries surveys. Originally created as a simple method to assess the size distribution of fish within bass and bluegill communities (Anderson 1976), PSD utilizes four categories (PSD, PSD-P, PSD-M, PSD-T) which allow managers to more precisely determine proportions of larger fish within populations. In each category the PSD determined is the number of fish at least a given length divided by the total number of fish in the sample that are at least stock length (Table 1). Stock length varies by species and is defined as the minimum size of a fish that provides recreational value or the approximate length when fish reach maturity. Quality (PSD) length is defined as the minimum size of a fish that most anglers liked to catch and begin keeping. Preferred (PSD-P) length is 45–55 percent of world record length. Memorable (PSD-M) length is 59–64 percent of world record length and trophy (PSD-T) length is 74–80 percent of world record length.

$$\text{PSD} = \frac{\text{number of fish} \geq \text{quality length}}{\text{number of fish} \geq \text{stock length}} \times 100$$

For management purposes, we consider PSD values from electrofishing samples for bass. Yellow perch and walleye are typically monitored using PSD values from gill net samples. When sample sizes are sufficient (i.e. at least 55 fish), we monitor bluegill and crappie populations using data obtained from fyke net samples. In many cases; however, sample sizes from fyke nets are small, and in these cases we use PSD values from electrofishing.

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
Yellow perch	130	200	250	300	380
Bluegill	80	150	200	250	300
Black crappie	130	200	250	300	380
Largemouth bass	200	300	380	510	630

Age and growth of warmwater game fish in Wapato Lake were evaluated using procedures described by Fletcher et al. (1993). All samples were evaluated using Lee's modification (FL) of the direct proportion method (Carlander 1982). Mean back-calculated length-at-age for all warmwater species were then compared to those of eastern Washington, regional or statewide averages.

A relative weight (W_r) index was used to evaluate the condition of fish in Wapato Lake. Relative weight of a fish is the relationship between the actual weight of a fish at a given length compared 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). That value is displayed as a solid line in all relative weight charts. The index is defined as:

$$Wr = \frac{W}{Ws} \times 100$$

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.

Water Chemistry

Water chemistry data in the epilimnion (the top layer in a thermally stratified lake) were well within acceptable standards for fish growth and survival. Water temperature varied from 19.7 C° at the surface to 6.6 C° at eight meters. A thermocline was evident between five and six meters as temperature declined from 19.5–10.8 C°. Dissolved oxygen ranged from 9.6 mg/L at the surface to 9.3 mg/L at five meters depth. Between five and six meters a chemicline was evident as dissolved oxygen declined from 9.3–0.8 mg/L. The pH was near seven throughout the water column. Secchi depth was 2.3 meters (Figure 1).

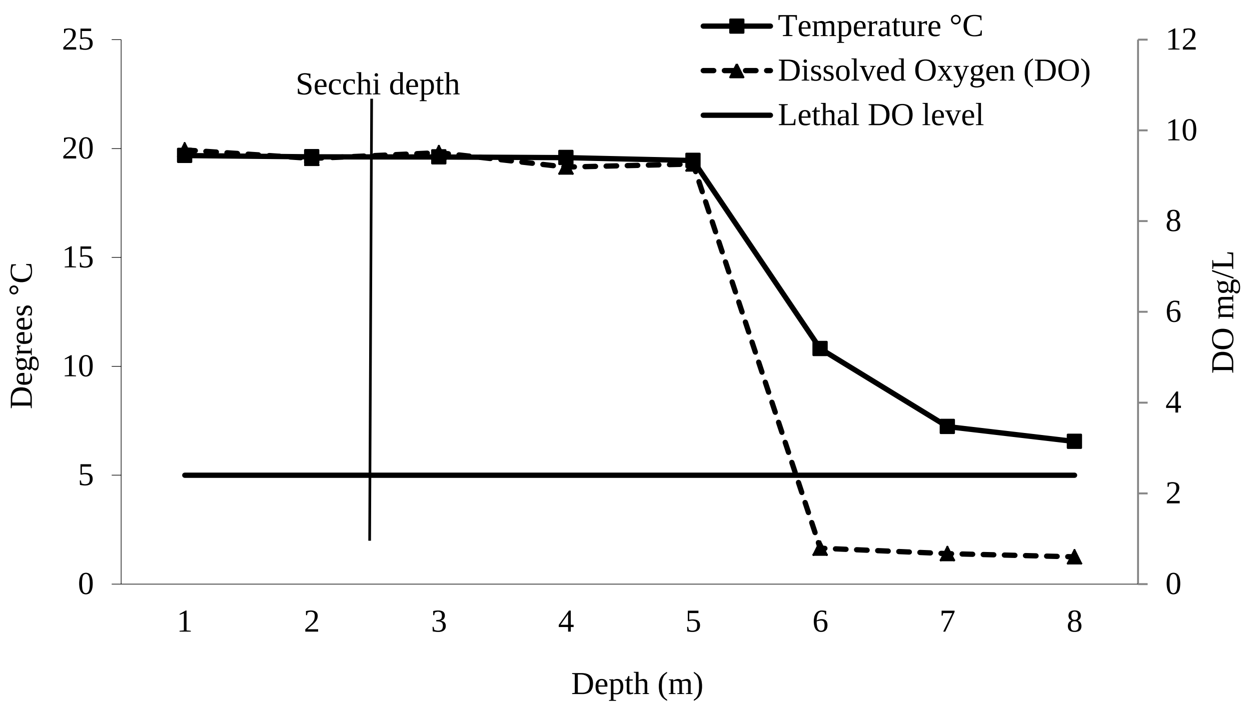


Figure 1. Temperature and dissolved oxygen levels in Wapato Lake, September 14, 2006.

Species Composition

We collected seven fish species during this survey. Warmwater game fish comprised 93 percent, by number, of the fish collected; the remainder was rainbow trout. Largemouth bass was the most abundant species collected, in both number and biomass, followed by pumpkinseed sunfish, yellow perch and bluegill (Table 2).

Table 2. Species composition, by weight (kg), and number (n), including size range (mm TL) of fishes collected during September 11–14, 2006 on Wapato Lake.

	Species Composition					
	Weight		Number		Size Range (mm TL)	
Species	Kg	% of total	n	% of total	Min	Max
Yellow perch	22.6	14.3	141	20.0	142	285
Bluegill	5.2	3.3	78	11.1	100	187
Pumpkinseed sunfish	9.6	6.1	171	24.2	80	182
Black crappie	2.4	1.5	13	1.8	168	290
Largemouth bass	98.2	62.3	226	32.0	145	579
Brown bullhead	8.3	5.3	29	4.1	177	320
Rainbow trout	11.3	7.2	48	6.8	190	445
TOTAL	157.6	100	706	100		

Catch per Unit Effort (CPUE)

Boat electrofisher catch rates were highest for largemouth bass, followed by pumpkinseed sunfish and bluegill. Gill net catch rates were highest for yellow perch, while fyke net catch rates were highest for pumpkinseed sunfish (Table 3).

Table 3. Mean CPUE (± 80% CI) by gear type, for warmwater fish species collected during September 11–14, 2006 on Wapato Lake.

	Gear Type					
	Boat Electrofisher		Gill Nets		Fyke Nets	
Species	Fish / Hour ± CI	No. Sites	No./Net	Net Nights	No./ Net	Net Nights
Yellow perch	4 (± 3)	10	31 (± 14)	4	3 (± 2)	4
Bluegill	42 (± 22)	10	1 (± 1)	4	1 (± 1)	4
Pumpkinseed sunfish	63 (± 24)	10	4 (± 3)	4	13 (± 7)	4
Black crappie	1 (± 1)	10	2 (± 1)	4	1 (± 1)	4
Largemouth bass	127 (± 15)	10	3 (± 2)	4	1 (± .4)	4
Brown bullhead	13 (± 10)	10	1 (± .3)	4	1 (± 2)	4
Rainbow trout	6 (± 8)	10	1 (± 1)	4	0	4

Proportional Size Distribution (PSD)

Approximately 27 percent of bluegill, at least stock length, collected with the boat electrofisher were 150 mm (6 inches) or greater. Approximately 22 percent of largemouth bass, at least stock length, collected with the boat electrofisher were 300 mm (12 inches) or greater. In addition, approximately nine and four percent were 380 mm (15 inches) and 510 mm (20 inches) or greater, respectively. Approximately 91 percent of yellow perch, at least stock length, collected in gill nets were 200 mm (8 inches) or greater, while approximately 7 percent were at least 250 mm (10 inches). We collected very few fish in fyke nets, consequently PSD estimates are highly variable and unreliable indicators of population size distribution (Table 4).

Table 4. Proportional size distributions (± 80% CI) of warmwater fishes collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher, gill nets, and fyke nets.

Species	Stock Length Fish (n)	PSD	PSD-P	PSD-M	PSD-T
Boat Electrofisher					
Yellow perch	7	86 (± 17)	43 (± 24)	0	0
Bluegill	70	27 (± 7)	0	0	0
Black crappie	2	100 (± 4)	50 (± 45)	0	0
Largemouth bass	180	22 (± 4)	9 (± 3)	4 (± 2)	0
Gill Nets					
Yellow perch	123	91 (± 3)	7 (± 3)	0	0
Bluegill	3	0	0	0	0
Black crappie	9	86 (± 13)	22 (± 18)	0	0
Largemouth bass	10	70 (± 19)	30 (± 19)	0	0
Fyke Nets					
Yellow perch	11	91 (± 11)	18 (± 15)	0	0
Bluegill	5	20 (± 23)	0	0	0
Black crappie	2	50 (± 45)	0	0	0

Yellow Perch

A total of 141 yellow perch were collected during this survey. Yellow perch ranged in age from one to six years with the majority being age-two. Length-at-age was near the state average for all age classes (Table 5, Figure 2). Yellow perch ranged in length from 142–285 mm, (Figure 3), and relative weights averaged 95 (Figure 4).

Table 5. Mean length-at-age of yellow perch collected during September 11–14, 2006 on Wapato Lake. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length-at-age (mm)					
Year Class	# Fish	1	2	3	4	5	6
2005	1	70					
2004	11	69	137				
2003	6	80	148	200			
2002	8	73	148	205	232		
2001	8	73	128	173	197	215	
2000	7	70	128	169	198	219	233
Mean		72	137	187	209	217	233
WA state average		84	145	182	202	219	224

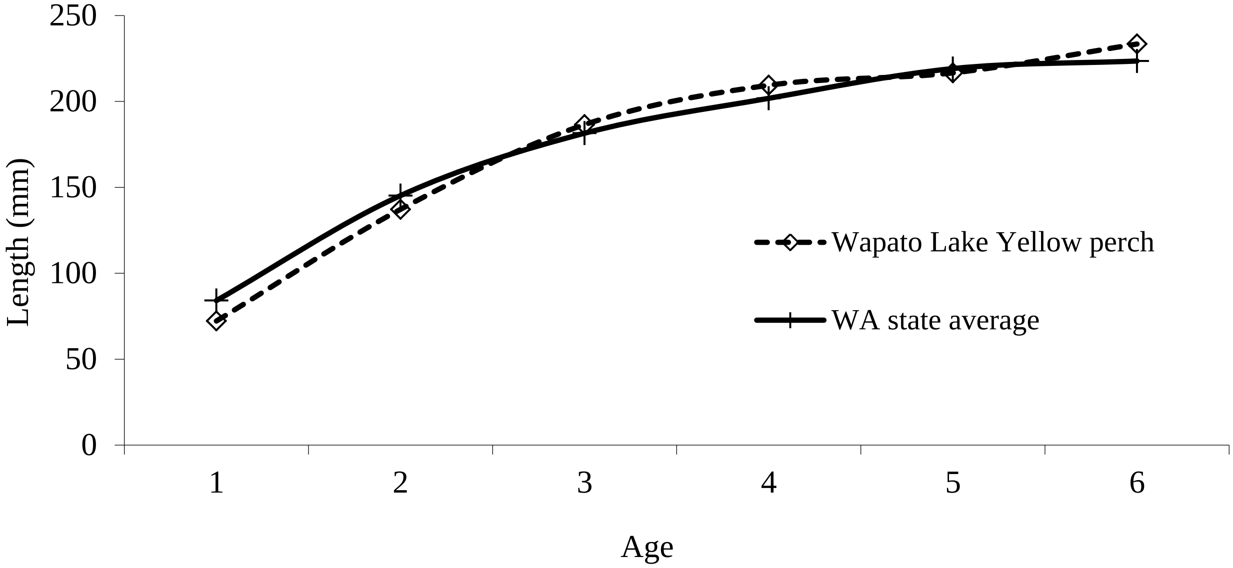


Figure 2. Mean length-at-age of yellow perch collected during September 11–14, 2006 on Wapato Lake compared to the Washington state average.

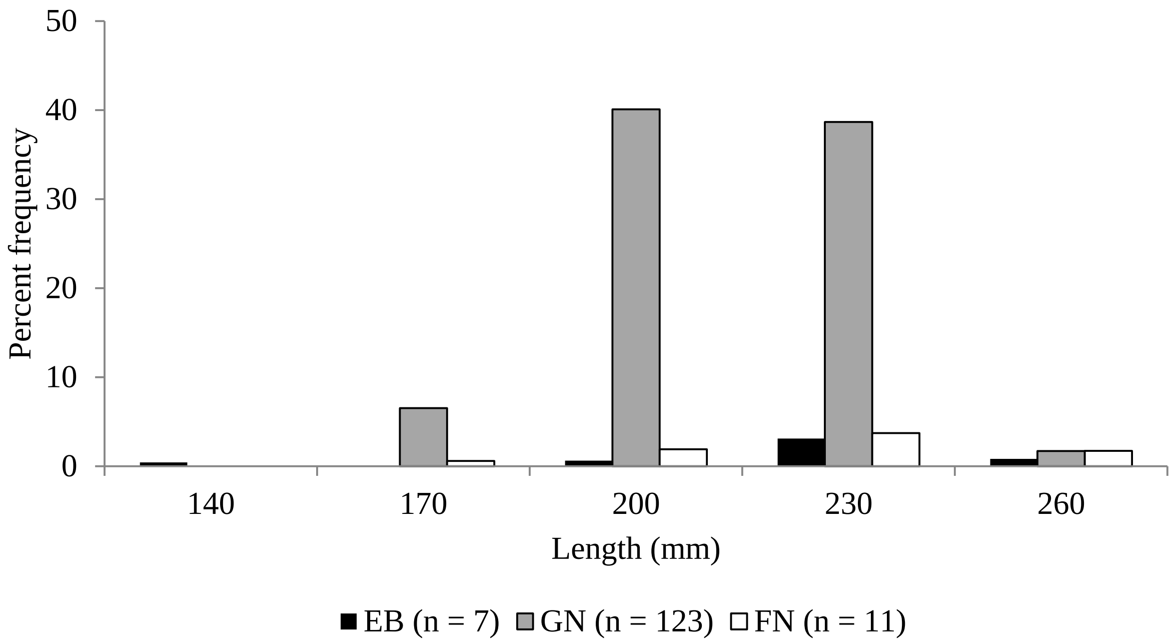
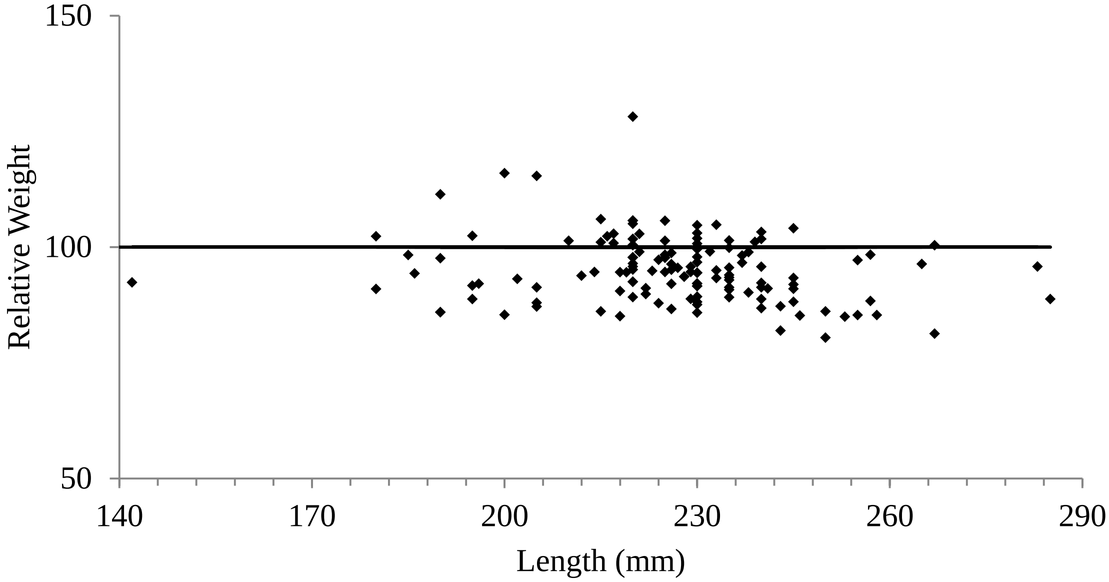


Figure 3. Length frequencies of yellow perch collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN). The n-values are sample sizes of yellow perch collected with each gear type.



n = 141

Figure 4. Relative weights for yellow perch collected during September 11–14, 2006 on Wapato Lake compared to the national standard (*Wr* = 100) (Anderson and Neumann 1996). The n-value is the total number of yellow perch evaluated for relative weight.

Bluegill

A total of 78 bluegill were collected during this survey. Bluegill ranged in age from one to three years with the majority being age-two (Table 6). Length-at-age was below the state average for age one and two fish, and above average for age-three fish (Figure 5). Bluegill ranged in length from 100–187 mm (Figure 6), and relative weights averaged 119 (Figure 7).

Table 6. Mean length-at-age of bluegill collected during September 11–14, 2006 on Wapato Lake. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length-at-age (mm)		
Year Class	# Fish	1	2	3
2005	1	30		
2004	28	18	67	
2003	3	12	67	156
Mean		20	67	156
WA state average		37	97	132

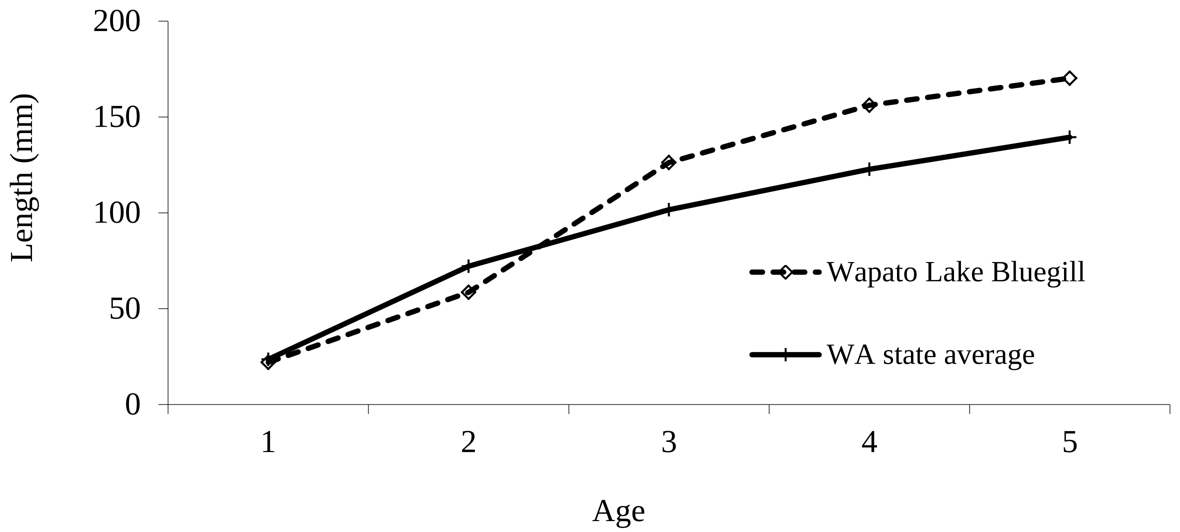


Figure 5. Mean length-at-age of bluegill collected during September 11–14, 2006 on Wapato Lake compared to the Washington state average.

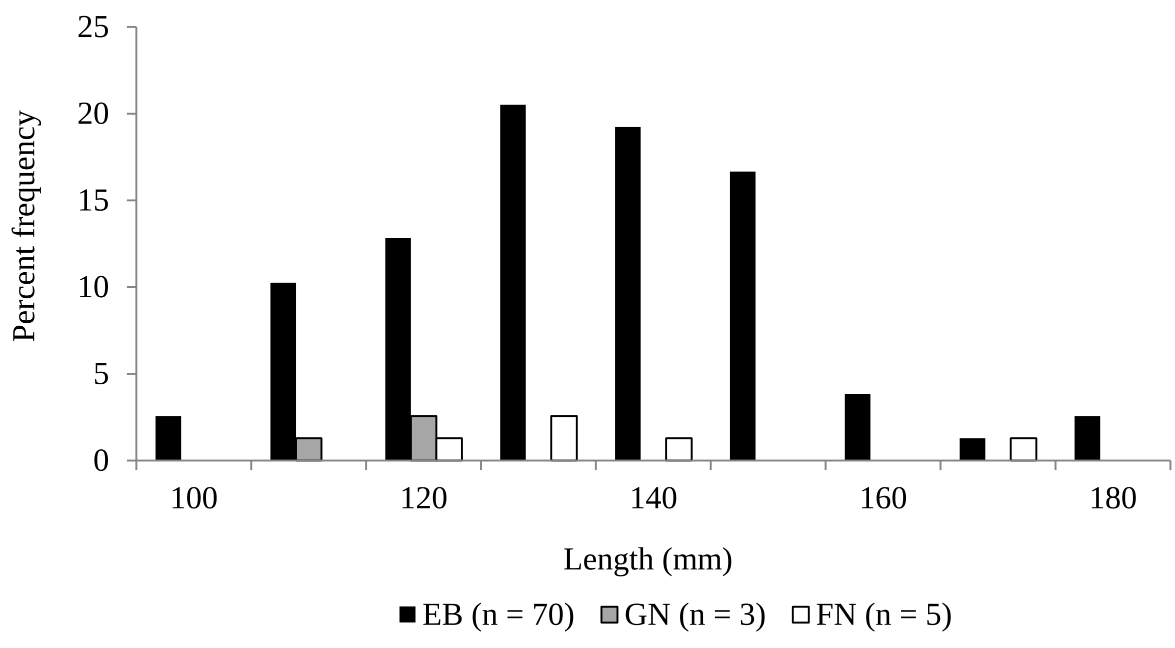
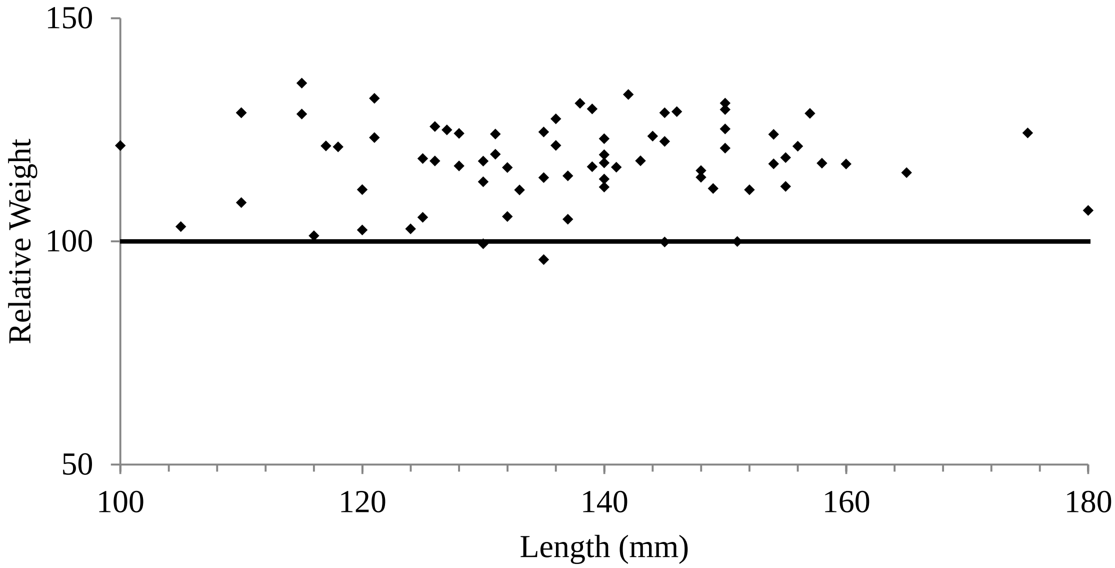


Figure 6. Length frequencies of bluegill collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN). The n-values are sample sizes of bluegill collected with each gear type.



n = 78

Figure 7. Relative weights for bluegill collected during September 11–14, 2006 on Wapato Lake compared to the national standard (*Wr* = 100) (Anderson and Neumann 1996). The n-value is the total number of bluegill evaluated for relative weight.

Pumpkinseed sunfish

A total of 171 pumpkinseed sunfish were collected during this survey. Pumpkinseed sunfish ranged in age from one to five years with the majority being age-two and three (Table 7). Length-at-age was below the state average for age one and two fish, but above average for older age classes (Figure 8). Pumpkinseed sunfish ranged in length from 80–182 mm (Figure 9), and relative weights averaged 114 (Figure 10).

Table 7. Mean length-at-age of pumpkinseed sunfish collected during September 11–14, 2006 on Wapato Lake. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length-at-age (mm)				
Year Class	# Fish	1	2	3	4	5
2005	1	24				
2004	11	21	60			
2003	19	17	53	113		
2002	1	15	55	126	153	
2001	1	33	66	140	159	171
Mean		22	59	126	156	170
WA state average		24	72	102	123	139

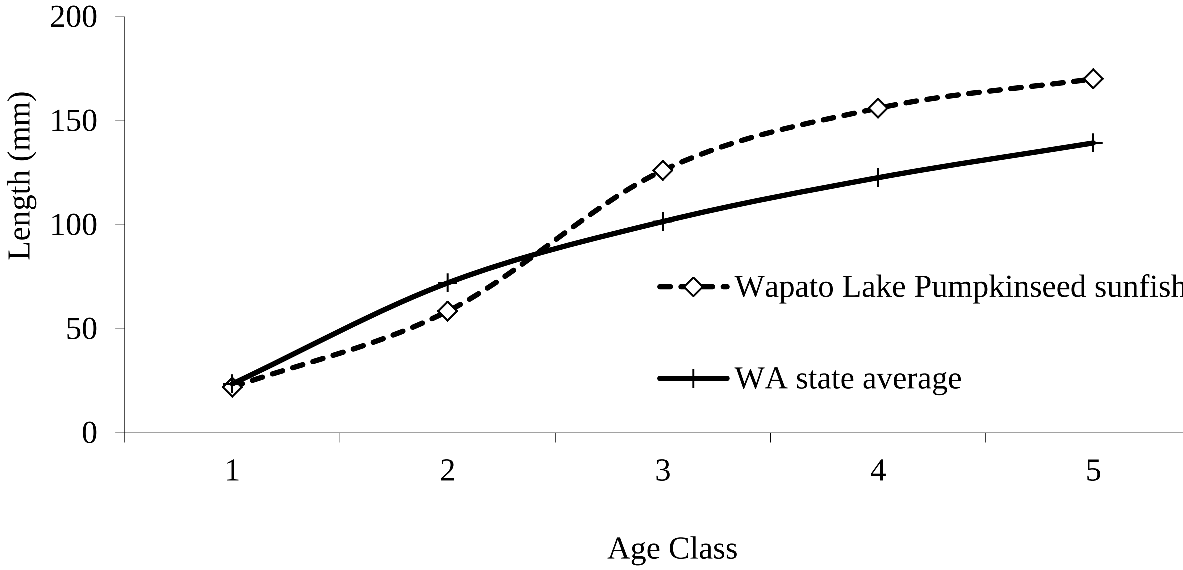


Figure 8. Mean length-at-age of pumpkinseed sunfish collected during September 11–14, 2006 on Wapato Lake compared to the Washington state average.

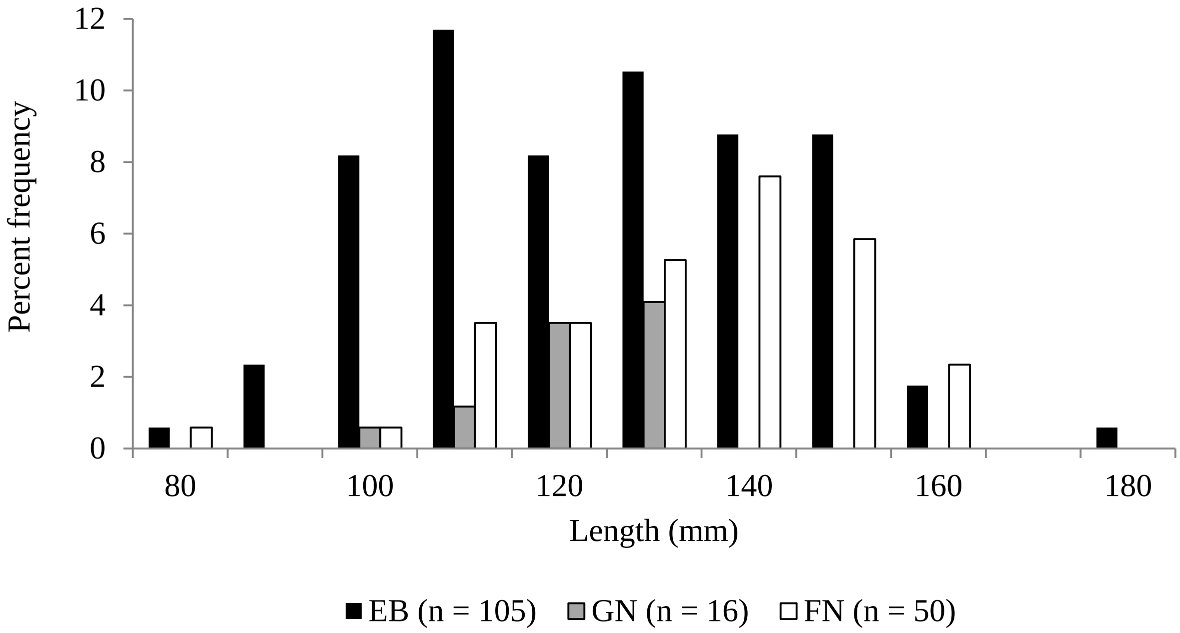
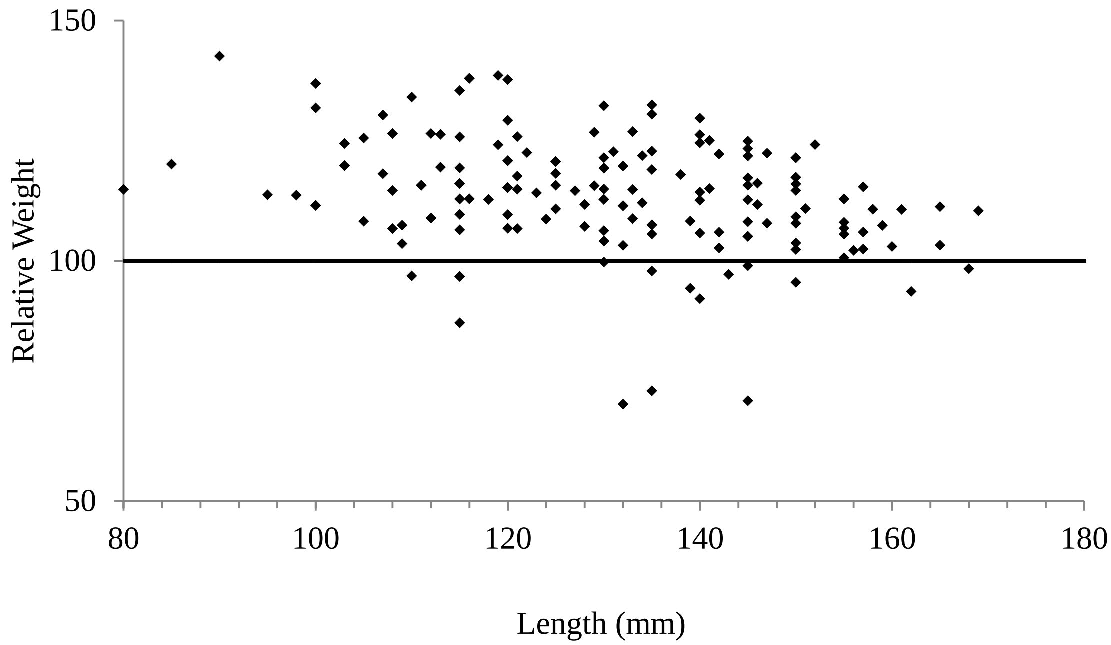


Figure 9. Length frequencies of pumpkinseed sunfish collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN). The n-values are sample sizes of pumpkinseed sunfish collected with each gear type.



n = 171

Figure 10. Relative weights for pumpkinseed sunfish collected during September 11–14, 2006 on Wapato Lake compared to the national standard (*Wr* = 100) (Anderson and Neumann 1996). The n-value is the total number of pumpkinseed sunfish evaluated for relative weight.

Black crappie

Only 13 black crappie were collected during this survey. Black crappie ranged in age from one to six years; although, no age-five fish were collected (Table 8). Length-at-age was well above the state average for fish aged three to six, and near or below the state average for age one and two fish (Figure 11). Black crappie ranged in length from 168–290 mm (Figure 12) and relative weights averaged near the national standard (*Wr* = 100) (Figure 13).

Table 8. Mean length-at-age of black crappie collected during September 11–14, 2006 on Wapato Lake. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length-at-age (mm)					
Year Class	# Fish	1	2	3	4	5	6
2005	1	52					
2004	5	30	118				
2003	4	33	134	211			
2002	1	34	112	207	245		
2001	0						
2000	1	24	81	154	208	248	278
Mean		34	111	191	227	248	278
WA state average		46	111	157	183	220	224

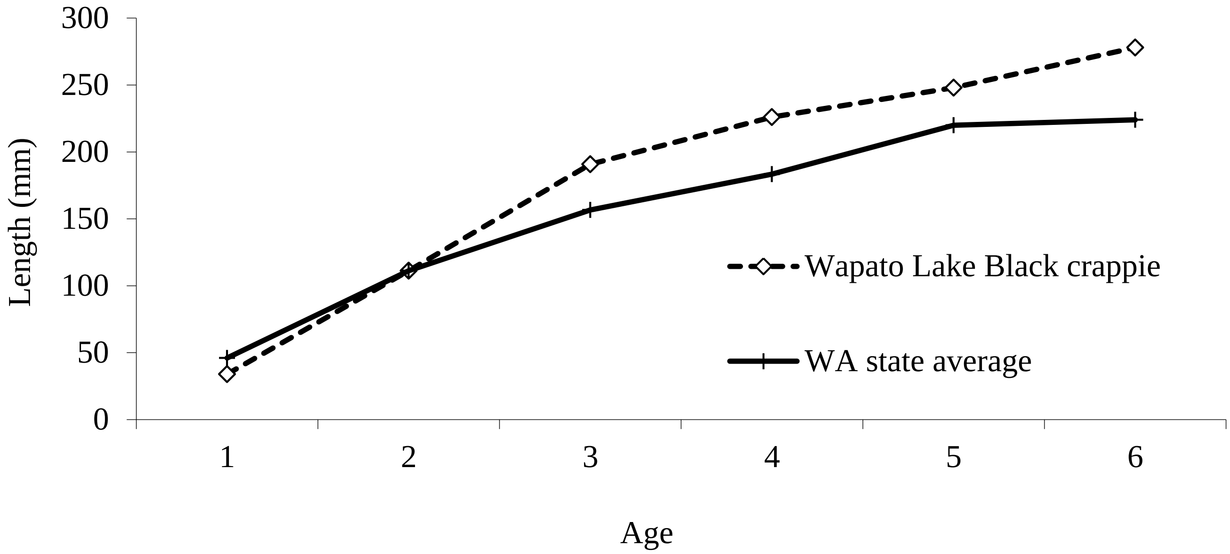


Figure 11. Mean length-at-age of black crappie collected during September 11–14, 2006 on Wapato Lake compared to the Washington state average.

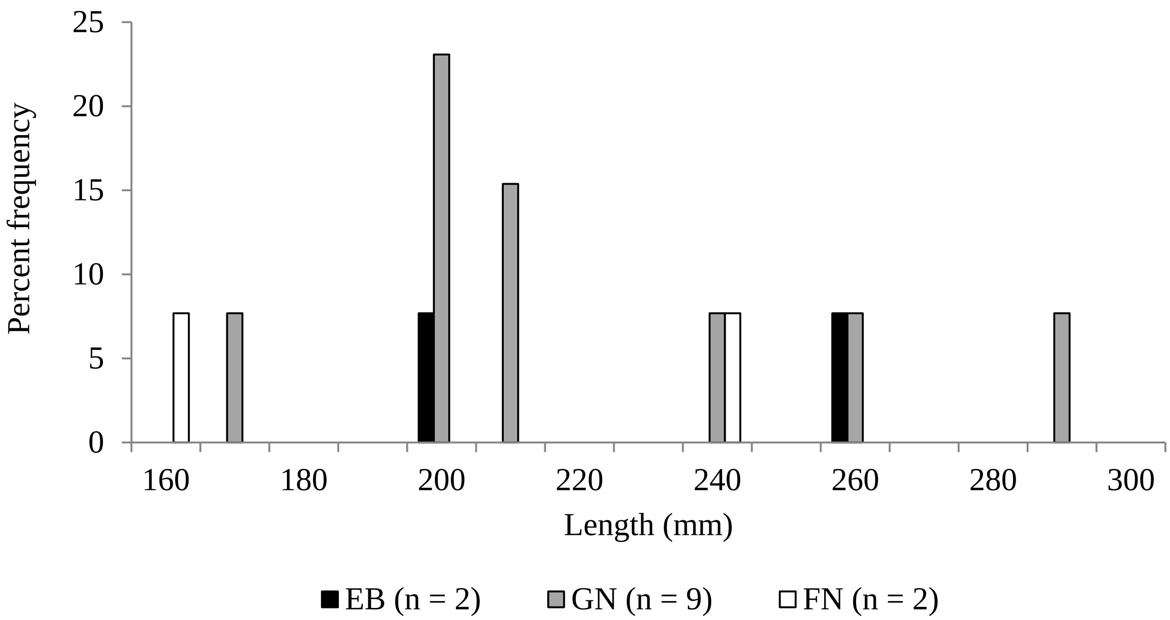
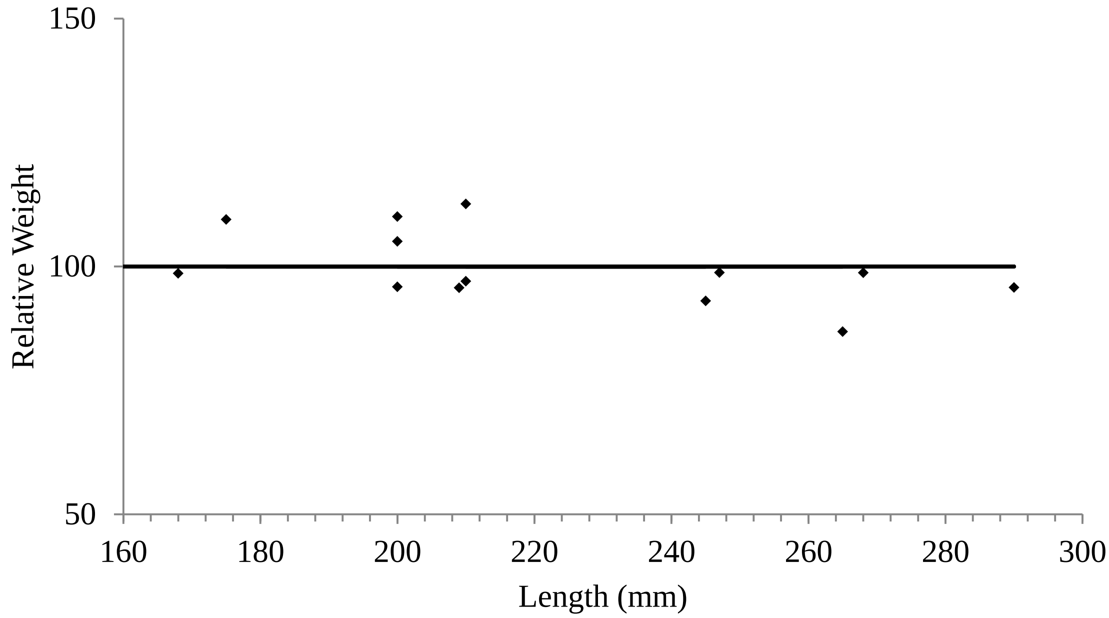


Figure 12. Length frequencies of black crappie collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN). The n-values are sample sizes of black crappie collected with each gear type.



n = 13

Figure 13. Relative weights for black crappie collected during September 11–14, 2006 on Wapato Lake compared to the national standard (*Wr* = 100) (Anderson and Neumann 1996). The n-value is the total number of black crappie evaluated for relative weight.

Largemouth bass

A total of 226 largemouth bass were collected during this survey. Largemouth bass ranged in age from one to thirteen years; although, no age-seven or twelve bass were collected (Table 9). The majority of bass collected were age one to five and length-at-age was close to the Region Two average (Figure 14). Largemouth bass ranged in length from 149–579 mm (Figure 15) and relative weights averaged 109 (Figure 16).

Table 9. Mean length-at-age of largemouth bass collected during September 11–14, 2006 on Wapato Lake. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length-at-age (mm)												
Year Class	# Fish	1	2	3	4	5	6	7	8	9	10	11	12	13
2005	19	72												
2004	22	71	150											
2003	37	74	152	200										
2002	10	73	166	232	313									
2001	4	68	160	232	296	359								
2000	1	77	176	268	325	391	429							
1999	0													
1998	2	94	219	285	340	413	448	477	497					
1997	1	98	191	246	356	412	444	480	512	530				
1996	4	71	156	233	287	334	393	424	459	477	487			
1995	1	73	186	238	280	371	402	429	452	473	489	504		
1994	0													
1993	1	66	155	207	250	322	383	425	459	478	490	504	516	526
Mean		74	158	217	311	369	417	447	472	484	488	504	516	526
Region Two average		89	175	256	318	360	394	427	445	454	497	515	529	527

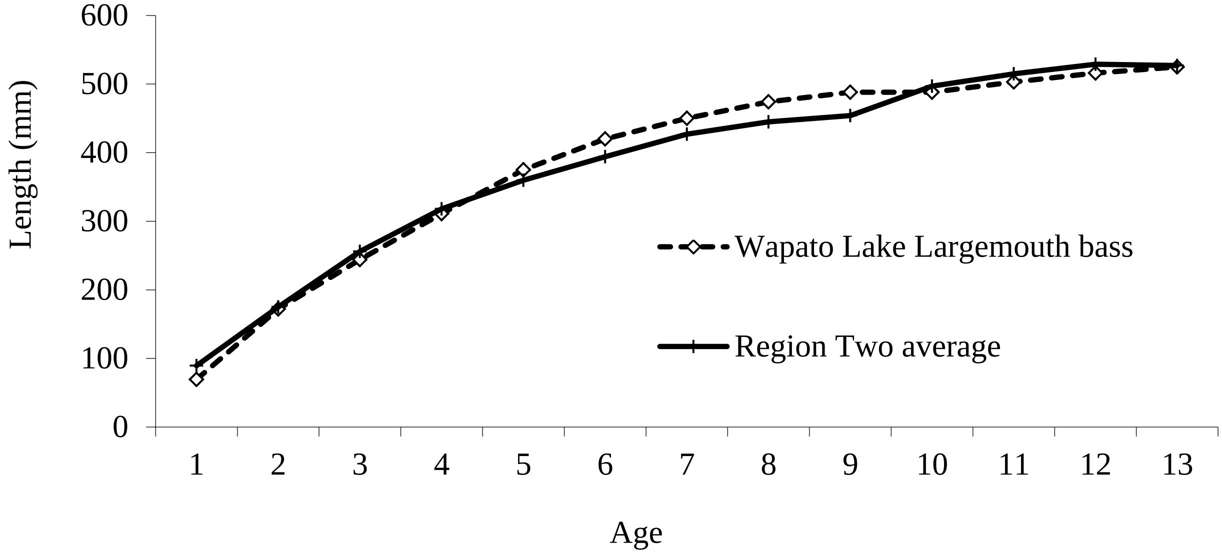


Figure 14. Mean length-at-age of largemouth bass collected during September 11–14, 2006 on Wapato Lake compared to the Region Two average.

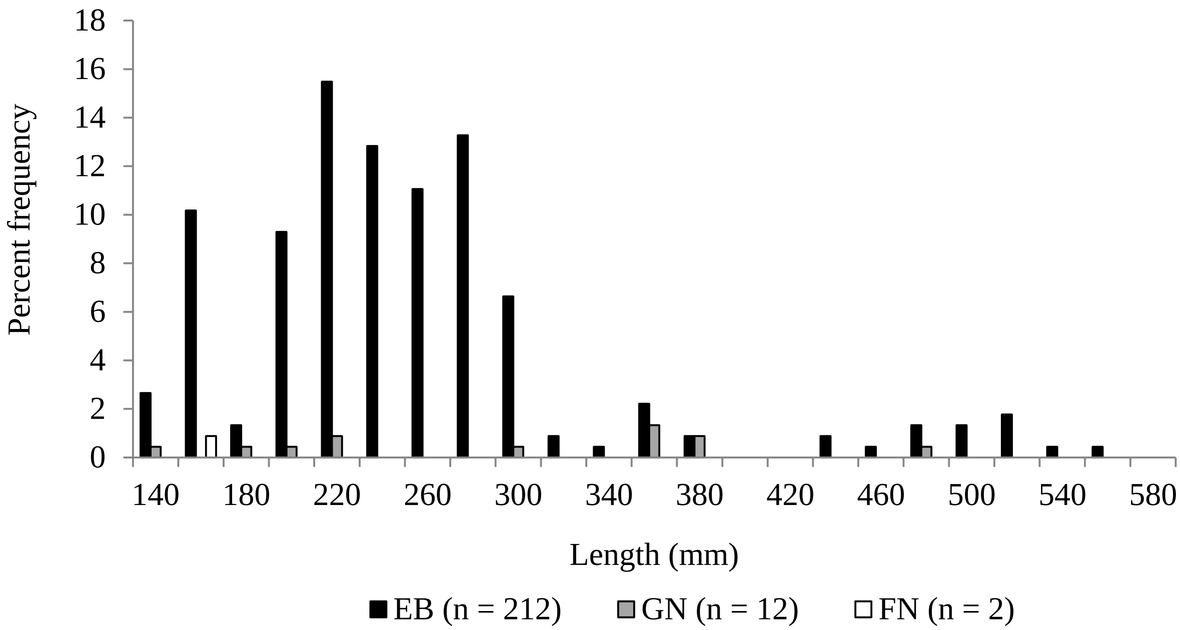


Figure 15. Length frequencies of largemouth bass collected during September 11–14, 2006 on Wapato Lake using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN). The n-values are sample sizes of largemouth bass collected with each gear type.

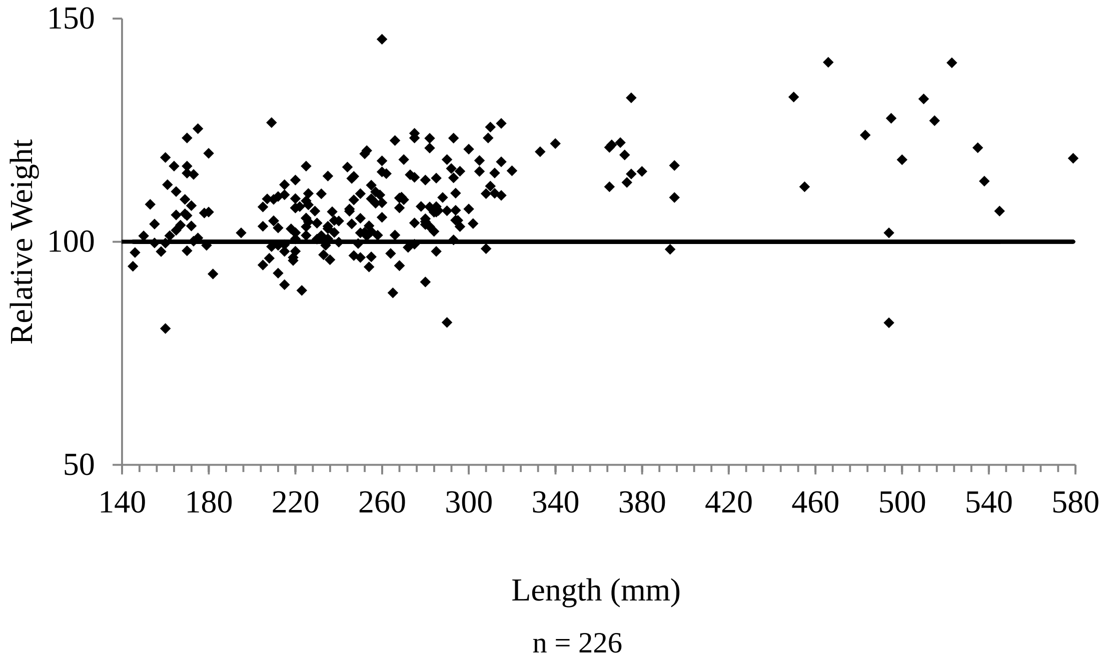


Figure 16. Relative weights for largemouth bass collected during September 11–14, 2006 on Wapato Lake compared to the national standard (*Wr* = 100) (Anderson and Neumann 1996). The n-value is the total number of largemouth bass evaluated for relative weight.

DISCUSSION

The fish community of Wapato Lake was reasonably well balanced, and most species were well represented throughout several age classes. Most species were collected with all gear types and several populations were comprised primarily of harvestable-size fish. Growth was at or near the statewide average for most species and it appeared that predation and harvest were at appropriate levels to maintain sustainable fisheries. This indicates a well-balanced mixed-species fish community and fishery opportunity.

Water chemistry data collected during this survey indicated that there were no chemical limitations to fish survival in the epilimnion. Dissolved oxygen declined to toxic levels in the hypolimnion; however; this is a common occurrence in deep, stratified lakes with protection from wind (Boyd 1982) and does not present a serious problem for this fish community.

Catch rates varied considerably between the three gear types. We collected our largest samples of fish with the boat electrofisher. This is not surprising since the majority of fishes collected were concentrated in the littoral zone (shallow water) where they are effectively collected with a boat electrofisher. Gill nets are an effective tool for collecting yellow perch and low catch rates, combined with high PSD (~91 percent at least 8 inches) indicate a small population. Fyke nets are an effective tool for sampling bluegill and black crappie (Krueger et al. 1998). However, fyke nets are significantly more effective in areas with low sloping shorelines and during times when bluegill and black crappie are active in the littoral zone (e.g. spawning times). Wapato Lake is dominated by steep shorelines and this survey was conducted in the fall, consequently fyke net catch rates were low.

Yellow perch represented 20 percent of the total number of fish collected (14.3 percent of the biomass) and approximately 91 percent of those collected were at least 8 inches. Relative weights were below average; however, it appeared that predation and/or harvest were maintaining this population at appropriate levels. It is important for anglers to harvest as many yellow perch as they are legally allowed without wasting fish. Yellow perch populations can quickly stunt resulting in higher competition with other panfish species (bluegill, crappie) for food and a decrease in angling opportunity for larger yellow perch.

Bluegill represented 11 percent of the total number of fish collected (3 percent of the biomass) and approximately 27 percent of these were over six inches. In lakes that contain bass and bluegill we strive for a bluegill PSD between 20 and 40. This indicates adequate predation and/or harvest and also indicates that anglers can expect a good bluegill fishery. Above average relative weights for bluegill indicated that food resources were not limiting at the time of this survey. Bluegill are also prone to over-population and stunting without adequate predation and/or angler harvest.

Pumpkinseed sunfish represented 24 percent of the total number of fish collected (6 percent of the total biomass) in Wapato Lake. However, pumpkinseed sunfish is not a species WDFW manages as a sporting opportunity in Washington waters because they typically exhibit slow growth, compete directly with bluegill for food and habitat resources, and typically do not grow to a size most anglers want to harvest. It is likely that pumpkinseed sunfish are inadvertently stocked during stocking of bluegill, as the two species share similar physical characteristics.

Black crappie were found in low numbers during this survey (n = 13); however, catches of crappie can vary significantly both temporally and spatially (McInerny and Cross 2006) and crappie, although present in the lake, may not have been susceptible to our sampling gear. This survey was conducted September 11–14. A fisheries survey conducted in late fall or spring (when water temperature is lower) would likely increase our catch of black crappie (Guy and Willis 1991). Fyke nets are generally an excellent sampling gear for monitoring crappie populations (Krueger et al. 1998.); however, due to the random selection of sampling sites and low sampling effort (4 net sets) we may have missed optimum crappie sampling habitat (i.e. low gradient shorelines, brush piles). Establishing index sites for fish species that are low in abundance might allow us to reduce statistical variability around CPUE estimates caused by the effects of site selection.

Largemouth bass was the most abundance species collected, both in number (32%) and biomass (62%). Largemouth bass growth and condition were above average, indicating abundant forage for this species. The size structure of the largemouth bass population indicated excellent opportunities for anglers to catch bigger largemouth bass. However, we recommend anglers release largemouth bass over 20 inches in order to maintain a quality fishery. Most bass; however, were under 12 inches which indicates good recruitment and large numbers of bass that prey on smaller panfish. Adequate predation on small panfish is required to maintain a higher percentage of large panfish in a population. This is the justification for our slot-limit regulations on largemouth bass (no retention of bass between 12–17 inches). Approximately nine percent of the largemouth bass collected were in the 'preferred' category (PSD-P) (15–20 inches) and approximately four percent were over 20 inches. The largemouth bass PSD was 22, very close to our management goal (20).

Rainbow trout comprised approximately seven percent of all the fish collected (both in numbers and biomass) during this survey. Rainbow trout are a pelagic species and are most effectively sampled with gill nets offshore. Gill nets set during this survey were set in the littoral zone so it is likely that they did not accurately represent the portion of trout in the fish community. Also, since Wapato Lake relies on stocking in order to create a rainbow trout fishery small samples of trout are not a cause for concern. The trout collected were in good condition and we found no reason to believe that this population has been negatively impacted by another species through competition for food resources.

During future surveys we may wish to focus sampling efforts on one or two species, as determined by district biologists. In order to monitor any fish population effective sampling is necessary for valid data analysis. The current WDFW standard methodologies are based on a ratio of 3-electrofishing sections, 2-gill net sets, and 2-fyke net sets. While this methodology provides us with valid between-lake comparisons, it does not necessarily provide us with valid samples for within-lake, between-year comparisons. Minimum sample sizes for primary management species and the proper comparison (e.g. CPUE, PSD) to be measured could be a future consideration (Divens et al. 1996).

Lakes managed primarily for rainbow trout fishing periodically require chemical rehabilitation (rotenone) due to competing fish species that reduce survival and growth of fry-planted trout. While it is difficult to determine 'balance' in a complex fish community we found no reason for concern that this fishery was in jeopardy or in need of chemical rehabilitation. Fishes are reasonably well distributed over several age classes, relative weights were above average for a majority of the fish collected, and growth was near or above average. Wapato Lake, under the current management scenario, appeared to be an example of a well-balanced mixed-species fishery.

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GLOSSARY

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

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

Memorable Size: Fish that 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 Size Structure (PSS): The number of quality length fish and larger, divided by the number of stock sized fish and larger, multiplied by 100.

Quality Length: The length at which anglers begin keeping fish. Also identified as 36–41 percent of world record length. Quality length varies by species.

Proportional Size Distribution (PSD): The number of fish in the quality length category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Proportional Size Distribution of Preferred Fish (PSD-P): The number of fish in the preferred size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Proportional Size Distribution of Memorable Fish (PSD-M): The number of fish in the memorable size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Proportional Size Distribution of Trophy Fish (PSD-T): 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 (*Wr*): The comparison of the weight of a fish at a given size to the national average weight (*Wr* = 100) of fish of the same species and size.

Standard Weight (W_s): The 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 identified as 74–80 percent of world record length. Trophy length varies by species.