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2004 Warmwater Fisheries Survey of Roses Lake, Chelan County, Washington

Warmwater Fish Enhancement

by Marc R. Petersen, and Michael R. Schmuck

Washington Department of
FISH AND WILDLIFE
Fish Program
Fish Management Division

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Abstract

Roses Lake was surveyed by the Region 2 Warmwater Team September 27-30, 2004. Nine fish species were collected during sampling efforts. Largemouth bass was the most abundant fish species collected, followed by yellow perch. Biomass of largemouth bass (161.6 kg) collected during this survey was among the highest when compared to collections from other regional waters. Stock density indices indicated largemouth bass and panfish were found in the management range described by Gabelhouse et al. (1984) as the panfish option. Nine age classes of largemouth bass were collected. All ages, except age nine, were represented well in our samples, an indication that Roses Lake largemouth bass exhibit consistent recruitment and survival. Relative weights of largemouth bass were well above average for most fish.

Bluegill, pumpkinseed, and yellow perch were present in adequate numbers to provide prey for largemouth bass and harvest for anglers. While these species were present in larger sizes, and, with the exception of yellow perch, were in above average condition, low numbers of young were collected and may be a concern in the future. A total of 49 channel catfish were collected during this survey, averaging 1.2 kg or 2.6 pounds each. These fish were primarily the result of 3,500 channel catfish fingerlings stocked in Roses Lake during 1999.

We recommend stocking channel catfish yearly or bi-yearly depending on channel catfish availability. Warmwater surveys should be conducted every three to four years to monitor the fish community and make timely management decisions.

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Introduction and Background

Roses Lake is located approximately one mile northeast of Lake Chelan and one mile north of the city of Manson in Chelan County, Washington (Figure 1). The lake is 53 ha in surface area, has a maximum depth of approximately 9.1 m, and a volume of 3,075 acre feet (Wolcott 1973; WDFW 1994). Roses Lake is contained in a nearly symmetrical oval-shaped basin surrounded by orchards and residential lots. Roses Lake is fed by two surface and an unknown number of sub-surface springs, and is heavily influenced by agricultural runoff and groundwater seeps. Water flows out of the lake westerly through a small bulrush (*Scirpus spp*.) and cattail (*Typha latifolia*) dominated wetland for approximately ¼ mile before entering Dry Lake. Water movement is mostly seasonal and in many places there is no defined channel. Washington Department of Fish and Wildlife (WDFW) maintains a public access, a boat launch, and a fishing dock on the south shore of the lake.

Management History

Roses Lake has been managed as a winter trout fishing lake since 1950. According to department records, the primary reason for this winter fishery was that rainbow trout, (*Oncorhynchus mykiss*) although large and fast growing, were unfit to eat during warmer months. Additionally, rainbow trout that survived the winter fishing season were exposed to oxygen depletion below the thermocline during summer months coinciding with heavy algal blooms. These conditions forced the remaining trout to co-exist and compete with undesirable fish species in warm surface waters, resulting in increased fry mortality and poor growth.

The first rotenone rehabilitation of Roses Lake occurred during 1957, and was completed in conjunction with Wapato Lake and Dry Lake. Washington Department of Game intended to leave Dry Lake fishless, but illegal stocking of fish in subsequent years was unpreventable. It was considered difficult to achieve a complete fish kill of undesirable fish species (brown bullhead (*Ameiurus nebulosus*) and pumpkinseed (*Lepomis gibbosus*)) in Roses lake due to the numerous sub-surface springs, therefore additional rotenone treatments were needed in 1973, 1979, 1982, 1984, and 1990.

From 1985 to 1993, approximately 5,000 brown trout (*Salmo trutta*) fingerlings were stocked annually in an unsuccessful attempt to control sunfish. Brown trout fry survival was low except following the 1984 rehabilitation, when fish up to 5 lbs were observed prior to the 1990 rehabilitation. Frequent rotenone treatments prevented the development of a trophy brown trout fishery for five to ten year-old fish. Currently, only a limited brown trout fishery exists in Roses Lake. During 1995, WDFW began stocking warmwater gamefish in the lake and in 1999 began managing the lake as a "mixed species" lake, maintaining the winter trout fishery as well as a summer warmwater fishery.

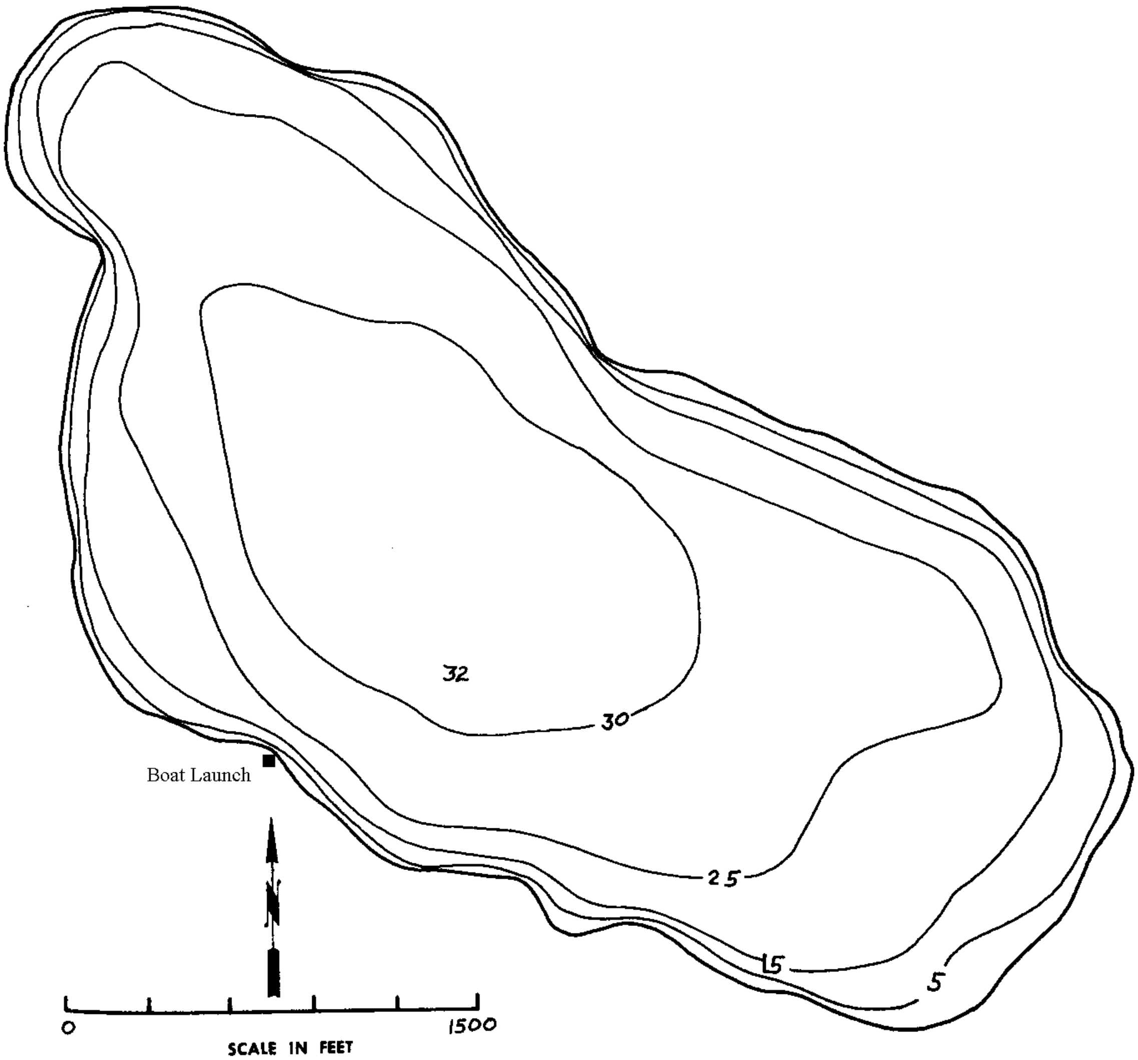

Figure 1. Map of Roses Lake, Chelan County.

Materials and Methods

Roses Lake was surveyed by the Region 2 Warmwater Team September 27-30, 2004. 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 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. All 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 (2 sites). Typically eight fyke nets are set during a standard warmwater survey; however, the shoreline of Roses Lake is steep in many places and only two fyke nets could be set due to this unique feature. 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.

All fish were identified to species, measured in millimeters (mm) to total length (TL) from the anterior-most part of the head to the tip of the compressed caudal fin, and weighed to the nearest gram (g). Total length data were used to construct length-frequency histograms and to evaluate the size structure of the warmwater species in the lake. Warmwater fish species 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 in kilograms (kg) and number, was determined from fish captured. Fish less than one year old, i.e., young-of-the-year (YOY), were excluded from all analyses. Eliminating YOY fish prevents distortions in analyses that may occur due to sampling location, method, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE) 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 electrofished. Gill net and fyke net CPUE's were standardized, and were determined by dividing the total number of fish captured by the total number of nights each gear was deployed. Since CPUE is standardized, it can be useful in comparing catch rates between lakes or between sampling dates on the same water.

A relative weight (W_r) index was used to evaluate the condition of fish. As presented by Anderson and Neumann (1996), a W_r of 100 generally indicates that the fish is in a condition similar to the national average for that species and length. 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). Standard weight was derived from a standard weight-length ($\log_{10}$) relationship that was defined for each species of interest in Anderson and Neumann (1996). Minimum lengths were used for each species as the variability can be significant for small fish (YOY). Relative weights less than 50 were also excluded from our analyses as we suspected unreliable weight measurements.

Age and growth of warmwater fish species were evaluated using procedures described by Fletcher et al. (1993). All samples were evaluated using both the direct proportion method 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 Eastern Washington and statewide averages (Fletcher et al. 1993).

Proportional stock density (PSD) indices require at least 55 stock-length fish by species and gear type be collected to develop a workable estimate (Gustafson 1988). The proportional stock density (PSD) of each warmwater fish species was determined following procedures outlined in Anderson and Neumann (1996). PSD uses two measurements, stock length and quality length, to provide information about the proportion of various size fish in a population. Stock length is defined as the minimum size of a fish that provides recreational value or approximates length when fish reach maturity (Table 1). Quality length is the minimum size of a fish that most anglers like to catch or begin keeping (Table 1). PSD is calculated using the number of quality-sized fish, divided by the number of stock-sized fish, and multiplied by 100. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths (Anderson and Weithman 1978). Stock length is 20-26 percent of the world record length, whereas quality length is 36-41 percent of the world record length.

Relative stock density (RSD) of each warmwater fish species was examined using the five-cell model proposed by Gabelhouse (1984). In addition to stock and quality lengths, the Gabelhouse model adds preferred, memorable, and trophy categories (Table 1). Preferred length (RSD-P) is defined as the minimum size of fish anglers would prefer to catch. Memorable (RSD-M) length refers to the minimum size fish anglers remember catching, and trophy length (RSD-T) refers to the minimum size fish worthy of acknowledgment. Preferred, memorable, and trophy length fish are also based on percentages of world record lengths (Anderson and Weithman 1978). Preferred length is 45-55 percent of world record length, memorable length is 59-64 percent of world record length, and trophy length is 74-80 percent of world record length. RSD differs from PSD in that it is more sensitive to changes in year class strength. RSD is 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 and Discussion

Species Composition

Nine fish species were collected during this survey (Table 2). Largemouth bass was the most abundant species collected, followed by yellow perch. These two species accounted for 68.3 percent of the fish collected during the survey. Largemouth bass contributed the highest biomass (161.6 kg), nearly three times that of channel catfish (58.6 kg). When compared to biomass estimates from other regional waters containing largemouth bass, the total largemouth bass biomass observed at Roses Lake was among the highest, with a total of 458 fish averaging more than ¾ of a pound each. Black crappie, rainbow trout, and brown trout were collected in low numbers and likely contributed little to the fishery during September.

Table 2. Species composition by weight, number, and size range of fish captured at Roses Lake during a warmwater fish survey in September 2004.

	Weight		Number		Size Range (mm TL)	
Species	Kg	%	No.	%	Min	Max
Yellow perch	25.9	9.1	261	24.8	113	268
Bluegill	11.2	3.9	122	11.6	29	225
Pumpkinseed sunfish	7.1	2.5	104	9.9	60	186
Black crappie	2.1	0.7	18	1.7	55	261
Largemouth bass	161.6	56.9	458	43.5	91	488
Channel catfish	58.6	20.7	49	4.7	415	600
Brown bullhead	13.9	4.9	36	3.4	195	323
Rainbow trout	1.5	0.5	1	0.1	486	486
Brown trout	1.8	0.6	3	0.3	415	422

Catch per unit Effort (CPUE)

Electrofisher catch rates were highest for largemouth bass followed by bluegill and pumpkinseed sunfish (Table 3). Gill nets were most effective at collecting yellow perch, while pumpkinseed were more abundant in fyke nets. Both gill and fyke nets had very low catch rates and provided very few fish for analysis.

Table 3. Mean catch per unit effort (± 80% confidence interval) by sampling method (excluding YOY), for fish collected from Roses Lake during September 2004.

	Gear Type					
	Electrofisher		Gill Nets		Fyke Nets	
Species	Fish/ Hr (± 80% CI)	Sites	Fish/ Net Night (± 80% CI)	Net Nights	Fish/ Net Night (± 80% CI)	Net Nights
Yellow perch	3 (± 1)	15	2 (± 1)	8	.03 (± .04)	2
Bluegill	46 (± 14)	15	.01 (± .01)	8	.03 (± .04)	2
Pumpkinseed	36 (± 8)	15	.05 (± .02)	8	.06 (± .08)	2
Black crappie	4 (± 2)	15	.06 (± .03)	8	0	2
Largemouth bass	151 (± 31)	15	.56 (± .18)	8	.03 (± .04)	2
Channel catfish	5 (± 5)	15	.31 (± .12)	8	0	2
Brown bullhead	12 (± 4)	15	.04 (± .02)	8	0	2
Rainbow trout	0	15	.01 (± .01)	8	0	2

Stock Density Indices (PSD, RSD)

The largemouth bass PSD (boat electrofisher) was 35 and the RSD-P was 24. No memorable or trophy sized largemouth bass were collected during the survey. The relatively high percentage of quality and preferred sizes of largemouth bass captured, given the number of stock length fish (n = 260), indicates this population was favorably balanced between smaller and larger size fish. Bluegill PSD by electrofisher was 68 and RSD-P was 6, and considering the low number of bluegill collected, indicates this population was not in high density and fish were reaching sizes suitable for angler harvest. Pumpkinseed PSD by electrofisher was 46, and while slightly less abundant than bluegill, may also reach sizes desired by anglers. Yellow perch PSD by gill nets was 40 and RSD-P was 3, also indicating these fish have grown to sizes desirable by anglers. It’s likely that the high PSD values for bluegill, pumpkinseed, and yellow perch were a result of predation by largemouth bass. The Roses Lake largemouth bass and panfish populations were found in the management range described by Gabelhouse et al. (1984) as a panfish option.

Table 4. Stock density indices, (± 80 percent confidence interval), for warmwater fishes collected by boat electrofisher, gill nets, and fyke nets from Roses Lake during September 2004. 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	No. Stock Length	PSD	RSD-P	RSD-M	RSD-T
Boat Electrofisher					
Black crappie	10	90 (± 12)	20 (± 16)	0	0
Bluegill	117	68 (± 6)	6 (± 3)	0	0
Pumpkinseed sunfish	95	42 (± 6)	0	0	0
Largemouth bass	260	35 (± 4)	24 (± 3)	0	0
Yellow perch	8	38 (± 22)	0	0	0
Gill Nets					
Black crappie	3	0	0	0	0
Largemouth Bass	20	10 (± 9)	10 (± 9)	0	0
Pumpkinseed sunfish	6	0	0	0	0
Yellow perch	251	40 (± 4)	3 (± 1)	0	0
Fyke Nets					
Pumpkinseed sunfish	2	0	0	0	0

Largemouth Bass

Largemouth bass ranged in age from one to nine years with ages one and two being the most abundant of those analyzed for age and growth (Table 5). With the exception of age-one fish, all age classes of largemouth bass were above the Region 2 average for growth. Largemouth bass ranged in length from 91 mm to 488 mm, with most fish from 150-250 mm (age one and two fish) (Figure 2). Relative weights of largemouth bass were above the national standard (W_r = 100) for most fish; however, those between 200 mm and 390 mm total length were below the national standard (Figure 3). A possible explanation for this may be the lack of smaller sizes of prey species (bluegill, pumpkinseed, and yellow perch) observed in our samples, potentially creating some intraspecific competition for these sized largemouth bass. Smaller largemouth bass that still depend on invertebrates for food and larger fish that were able to consume larger prey fish appeared to be in excellent condition.

Table 5. Age and growth of largemouth bass captured at Roses Lake during September 2004. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and 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	No. Fish	1	2	3	4	5	6	7	8	9
2003	37	64								
		79								
2002	33	57	172							
		72	178							
2001	15	62	196	266						
		78	203	269						
2000	8	63	161	256	300					
		80	172	261	301					
1999	10	67	172	243	313	366				
		83	181	248	314	364				
1998	15	88	184	266	317	362	399			
		103	193	273	321	363	398			
1997	22	77	165	268	332	376	403	426		
		94	178	276	337	378	404	426		
1996	13	66	154	252	320	372	405	430	453	
		83	167	261	326	376	408	431	453	
1995	2	66	146	231	331	397	419	439	454	470
		83	160	242	337	400	421	441	455	471
Direct Proportion Mean		68	169	255	319	374	407	431	453	470
Lee's Mean		82	181	266	324	373	404	428	453	471
Eastern Wash. Average		68.8	135.6	189.2	248.9	300	351.5	421.6	437.6	NA

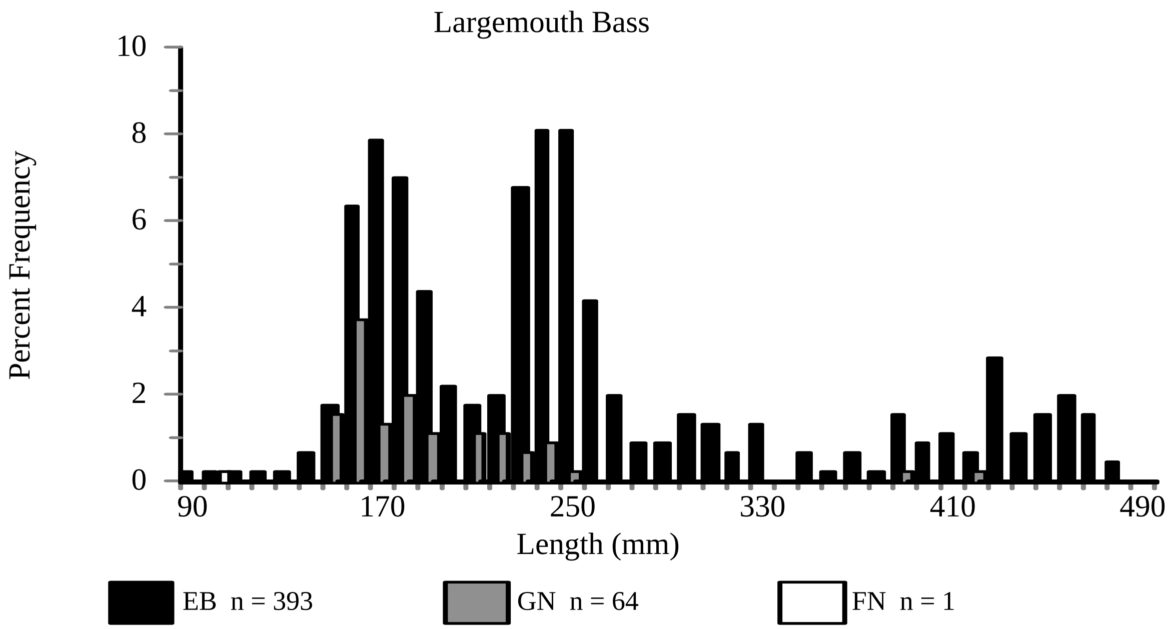

Figure 2. Length frequency of largemouth bass captured by boat electrofisher (EB), gill nets (GN), and fyke nets (FN) in Roses Lake during September 2004.

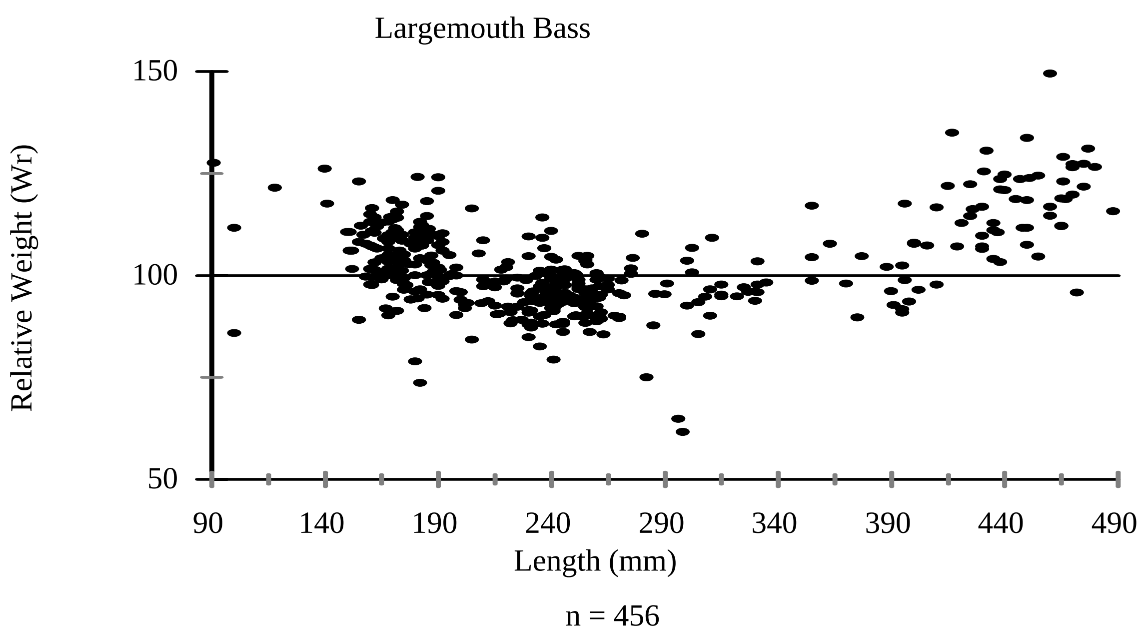

Figure 3. Relative weights of largemouth bass captured by a boat electrofisher, gill nets, and fyke nets in Roses Lake during September 2004, as compared to the national average, *Wr* =100 (Anderson and Neumann 1996).

Black Crappie

Black crappie ranged in age from one to three years with age two being the most abundant of those analyzed for age and growth (Table 6). All age classes were above the statewide average for growth, though samples sizes were small. The length frequency histogram shows black crappie ranging in length from 55 mm to 261 mm, though no clear delineation between age classes is observable due to the low number of fish (n = 18) in this sample (Figure 4). Relative weights of black crappie were found above the national average indicating the few that were present were not experiencing food competition (Figure 5). Due to the low number of black crappie observed in our samples, it is unlikely this species was abundant and contributed much as prey or to angler harvest at the time of this survey.

Table 6. Age and growth of black crappie captured at Roses Lake during September 2004. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and 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	No. Fish	1	2	3
2003	4	50		
		74		
2002	7	40	148	
		68	159	
2001	2	52	159	232
		80	172	235
Direct Proportion Mean		47	153	232
Lee's Mean		72	162	235
State Average		46	111	157

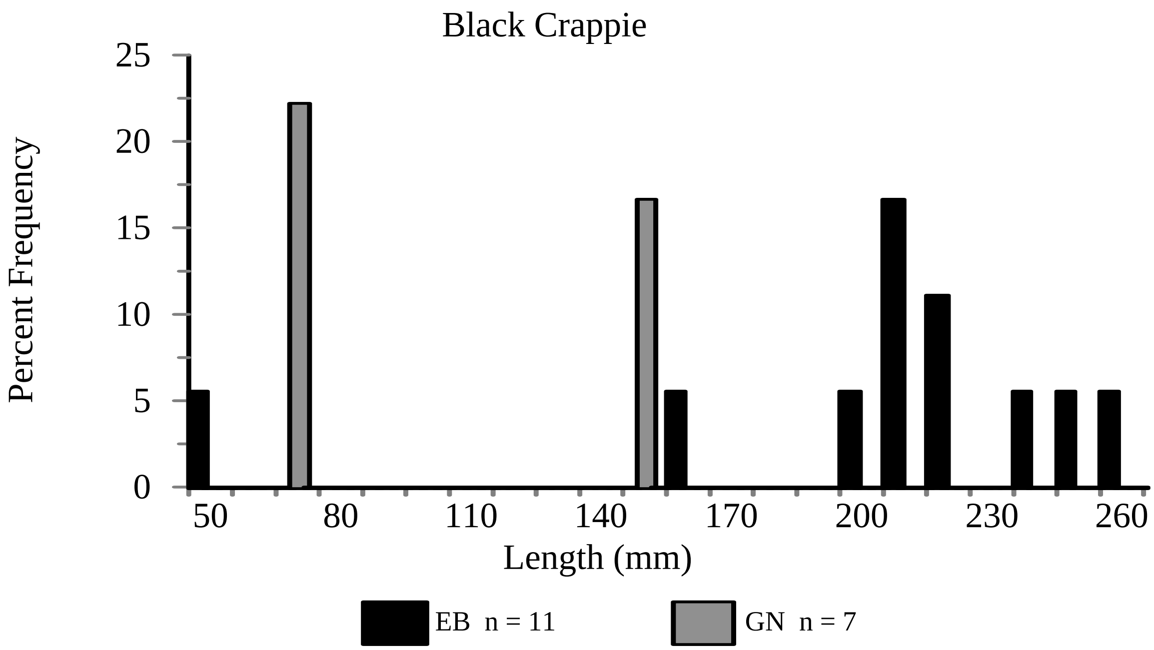

Figure 4. Length frequency of black crappie captured by boat electrofisher (EB) and gill nets (GN) in Roses Lake during September 2004.

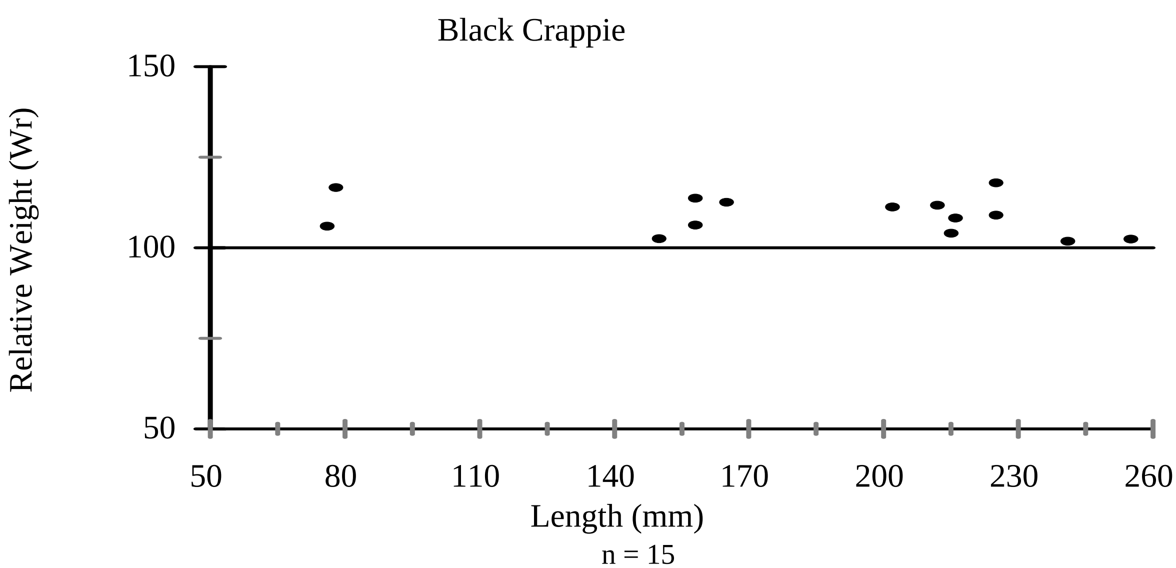

Figure 5. Relative weights of black crappie captured by a boat electrofisher and gill nets in Roses Lake during September 2004, as compared to the national average, W_r =100 (Anderson and Neumann 1996).

Bluegill

Bluegill ranged in age from one to five years with age two being the most abundant of those analyzed for age and growth (Table 7). Bluegill age one and two were found below the statewide average for growth and age three to five bluegill were found above average. Length frequency histogram of bluegill showed most fish ranged from 130 mm to 200 mm total length (Figure 6). This is of some concern as both bluegill and pumpkinseed were found in low numbers below 100 mm total length. Typically, the smaller, younger fish are found more numerous in populations, and abundance decreases as fish grow larger and become older. The apparent lack of smaller size bluegill (<100 mm) in Roses Lake may be contributing to the below average condition of 200 mm to 350 mm largemouth bass that likely forage on this size prey. Relative weights of bluegill were found above the national average for most fish, and suggest this population is not experiencing competition for the available food (Figure 7).

Table 7. Age and growth of bluegill captured at Roses Lake during September 2004. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and 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	No. Fish	1	2	3	4	5
2003	5	25				
		39				
2002	26	22	79			
		39	88			
2001	14	15	67	159		
		33	79	144		
2000	2	23	71	152	199	
		41	85	81	200	
1999	2	17	64	143	173	199
		35	78	170	177	201
Direct Proportion Mean		20	70	151	186	199
Lee's Mean		37	85	140	188	201
State Average		37	97	132	148	170

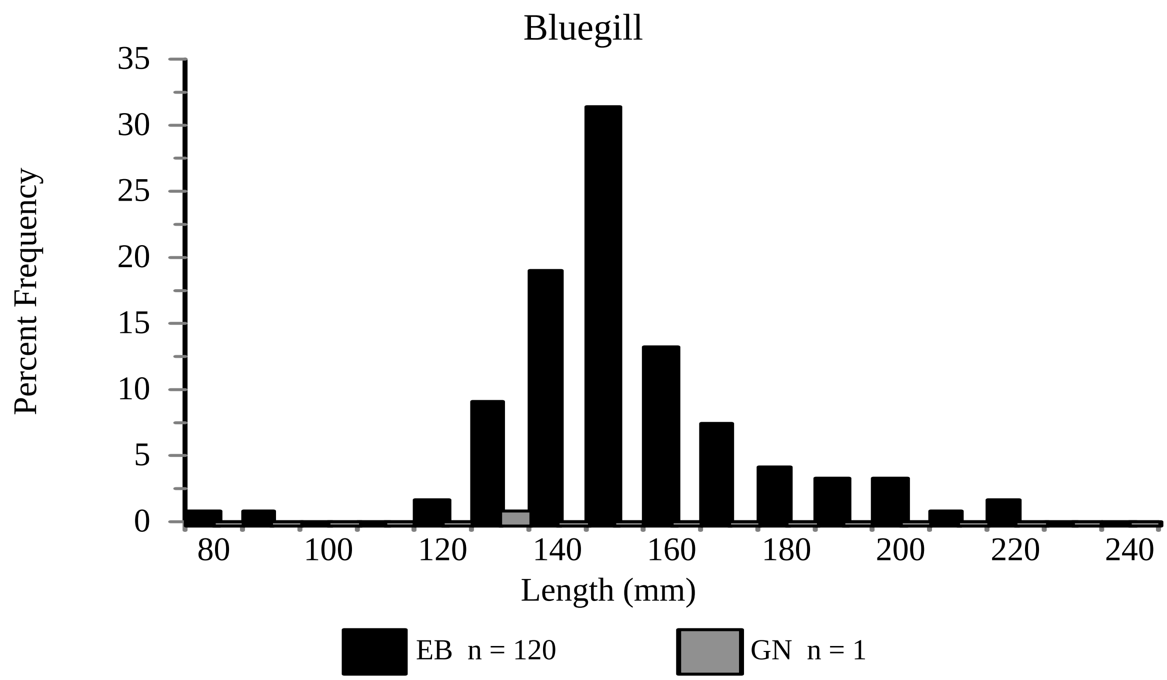

Figure 6. Length frequency of bluegill captured by boat electrofisher (EB) and gill nets (GN) in Roses Lake during September 2004.

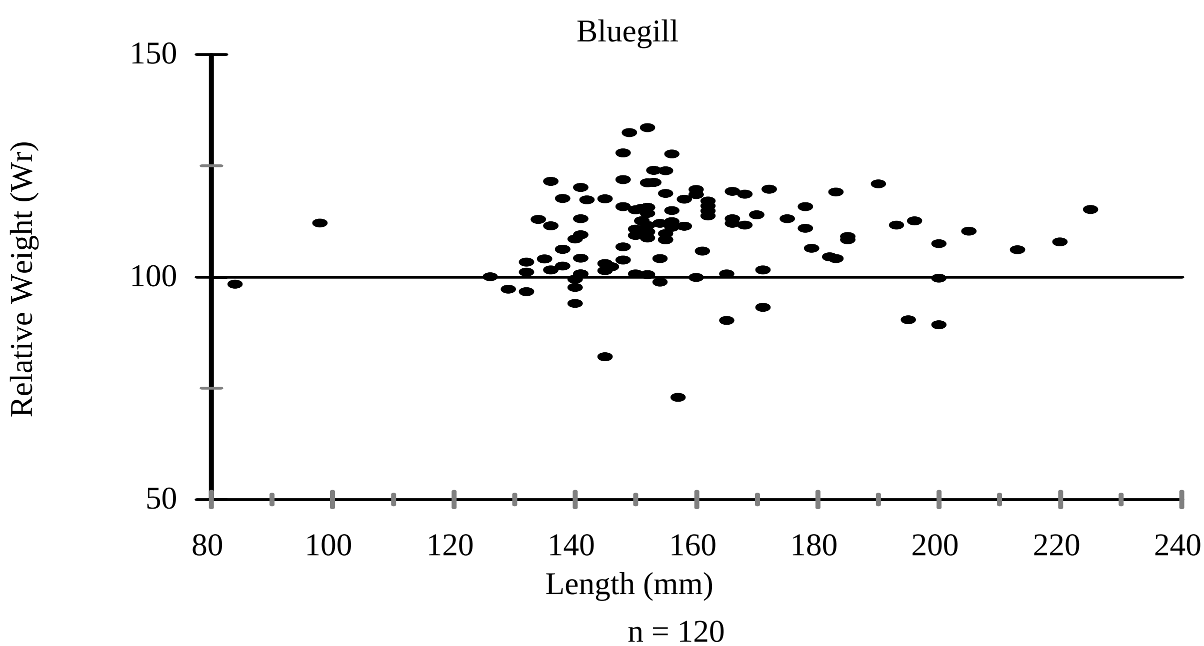

Figure 7. Relative weights of bluegill captured by a boat electrofisher and gill nets in Roses Lake during September 2004, as compared to the national average, W_r =100 (Anderson and Neumann 1996).

Pumpkinseed Sunfish

Pumpkinseed ranged in age from one to nine years with age two being the most abundant of those analyzed for age and growth (Table 8). Age-seven pumpkinseed were absent from our samples and the number of age one, eight, and nine fish collected were inadequate for a confident analysis. The statewide average for growth had only been developed for pumpkinseed to age five, and when compared, growth of Roses Lake pumpkinseed was below average at all ages. The length frequency histogram of pumpkinseed shows most fish were between 100 mm and 180 mm total length (Figure 8). As with bluegill, very few fish less than 100 mm in length were collected during the survey. Relative weights of pumpkinseed were better than the national average for most fish indicating low competition for the available food resources (Figure 9).

Table 8. Age and growth of pumpkinseed captured at Roses Lake during September 2004. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year class	No. Fish	Mean length (mm) at age								
		1	2	3	4	5	6	7	8	9
2003	2	32								
		48								
2002	10	23	64							
		43	75							
2001	4	16	54	100						
		38	68	105						
2000	7	19	50	89	126					
		41	67	98	129					
1999	5	23	59	96	126	147				
		44	74	106	131	149				
1998	3	19	44	72	107	139	152			
		41	63	86	115	142	154			
1997	0	0	0	0	0	0	0	0		
		0	0	0	0	0	0	0		
1996	1	16	46	66	92	112	133	147	156	
		38	64	81	102	120	137	149	157	
1995	1	26	57	75	95	102	113	128	143	163
		47	74	90	107	112	122	135	148	165
Direct Proportion Mean		19	47	71	91	100	100	92	149	163
Lee's Mean		42	71	99	124	140	144	142	152	165
State Average		24	72	102	123	139	NA	NA	NA	NA

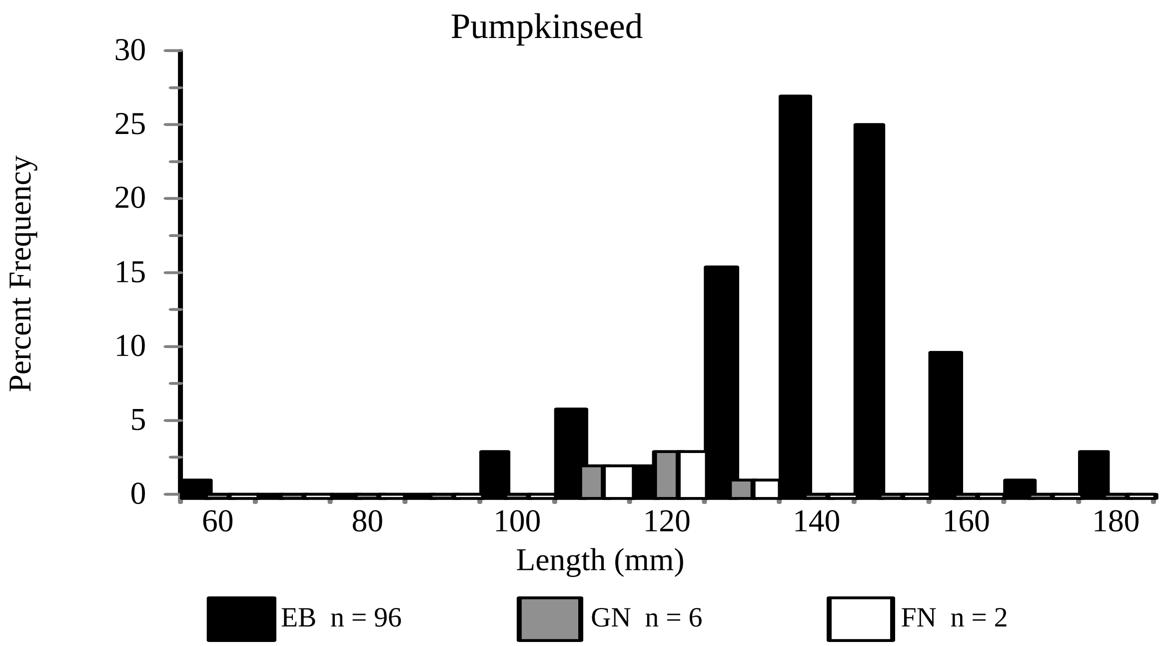

Figure 8. Length frequency of pumpkinseed captured by boat electrofisher (EB), gill nets (GN), and fyke nets (FN) in Roses Lake during September 2004.

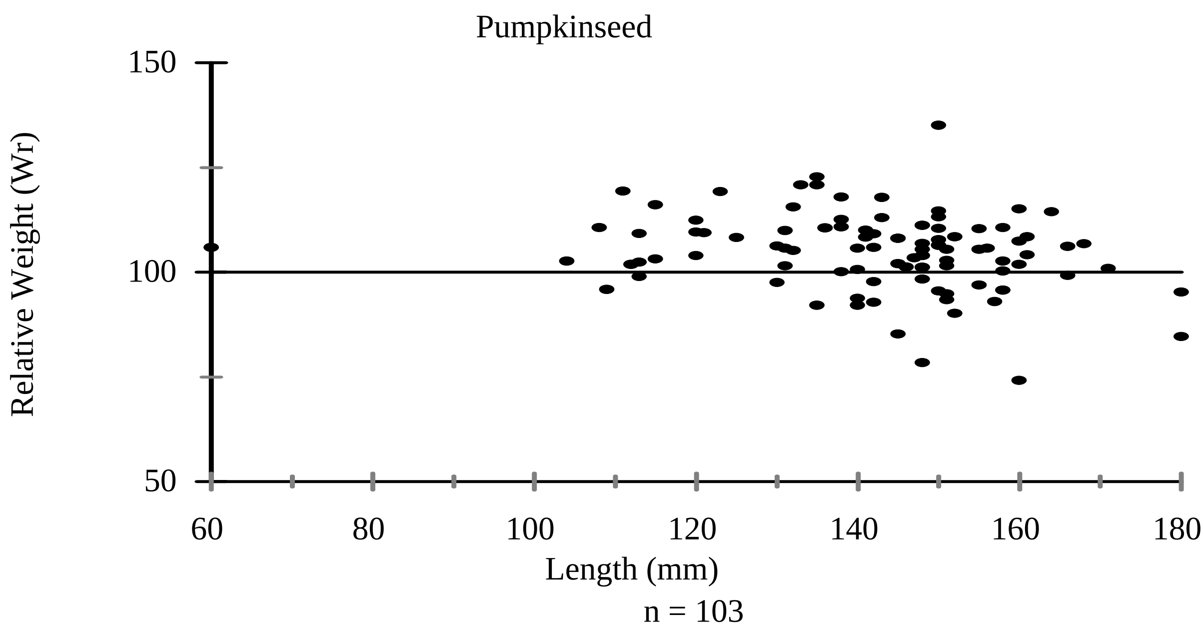

Figure 9. Relative weights of pumpkinseed captured by a boat electrofisher, gill nets, and fyke nets in Roses Lake during September 2004, as compared to the national average, W_r =100 (Anderson and Neumann 1996).

Yellow Perch

Yellow perch ranged in age from one to three years with age two being the most abundant of those analyzed for age and growth (Table 9). Age-one yellow perch was the only age of the three age classes evaluated that was below the statewide average. The length frequency histogram of yellow perch shows most fish between 175 mm and 210 mm total length, and no yellow perch less than 110 mm were collected (Figure 10). The absence of smaller-size yellow perch was consistent with the findings of bluegill and pumpkinseed in Roses Lake, though the cause is speculative and the long-term effect is unknown. Relative weights of yellow perch were below the national average for most fish (Figure 11). While below-average relative weights of yellow perch are common in many regional waters, it is surprising to observe this at Roses Lake since other panfish species exhibited above average condition.

Table 9. Age and growth of yellow perch captured at Roses Lake during September 2004. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and 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	No. Fish	1	2	3
2003	6	53		
		71		
2002	25	66	152	
		86	159	
2001	15	54	137	205
		77	151	211
Direct Proportion Mean		58	145	205
Lee's Mean		81	156	211
State Average		60	120	152

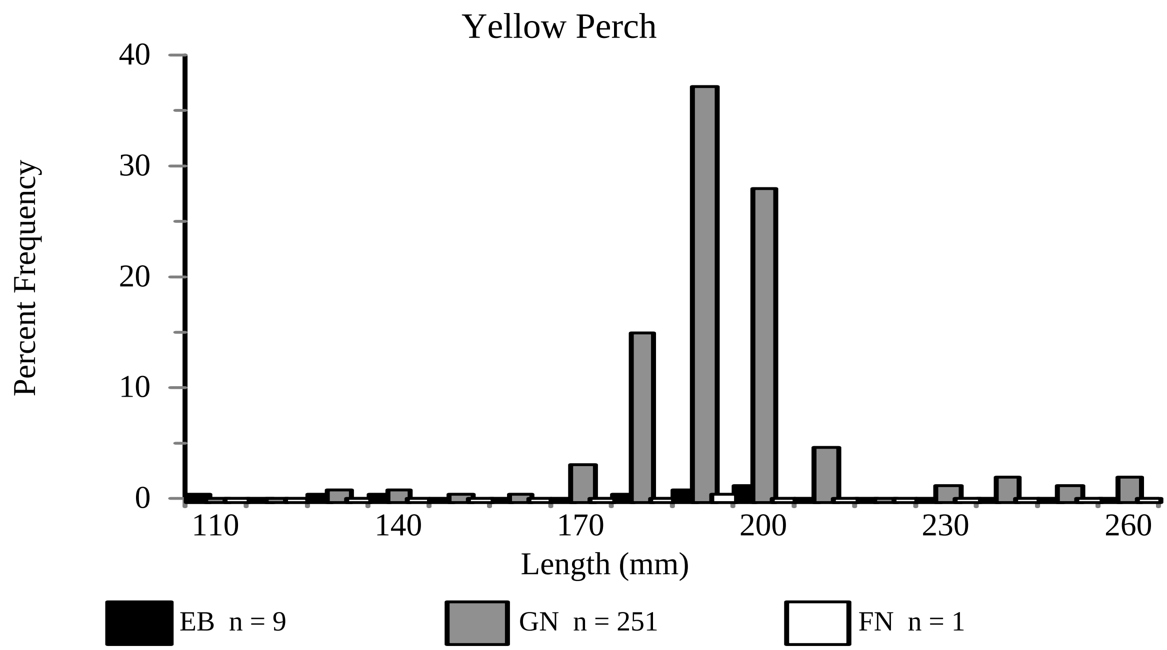

Figure 10. Length frequency of yellow perch captured by boat electrofisher (EB), gill nets (GN), and fyke nets (FN) in Roses Lake during September 2004.

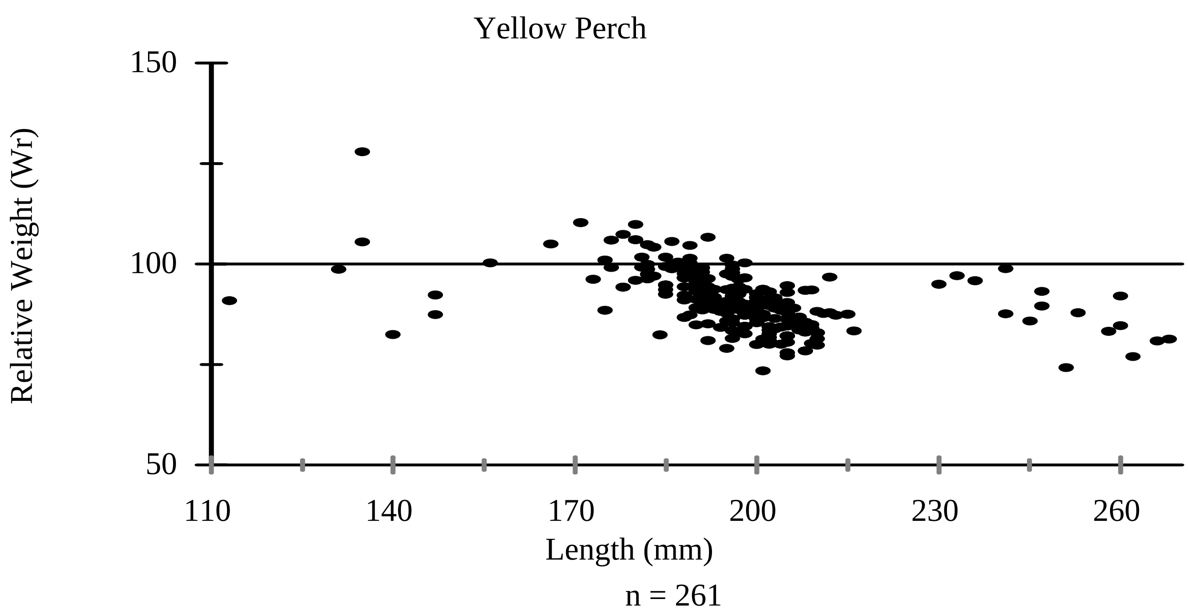

Figure 11. Relative weights of yellow perch captured by a boat electrofisher, gill nets, and fyke nets in Roses Lake during September 2004, as compared to the national average, W_r =100 (Anderson and Neumann 1996).

Channel Catfish

A total of 49 channel catfish were collected from Roses Lake (Table 2). Channel catfish ranged from 415 mm to 600 mm total length, and averaged 1,197g (2.6 lbs) each. Relative weights of channel catfish averaged 92, below the national average of 100. A total of 3,500 channel catfish fingerlings were stocked in Roses Lake during 1999, and likely comprised the majority of the fish captured during this survey. Only a few channel catfish were stocked during subsequent years, and likely contributed little to the fishery at the time of this survey.

Summary and Management Strategies

A total of nine fish species were observed during the September 2004 warmwater fish survey. Largemouth bass was the most abundant fish species observed, followed by yellow perch. Total biomass of largemouth bass (161.6 kg) collected during the survey was among the highest when compared to collections from other regional waters. While multiple sampling gears were used during this survey, boat electrofisher was the most effective sampling technique. Stock density indices indicated largemouth bass were found in the management range described by Gabelhouse et al. (1984) as a panfish option. Supporting this finding were higher PSD values for bluegill, pumpkinseed, and yellow perch, and low numbers of younger, smaller sizes observed of these three species. Given the size of Roses Lake, this lake contains an above-average population of larger-size largemouth bass. Largemouth bass likely seek cover and protection from anglers during the summer and fall in the dense macrophytes and bulrush surrounding the perimeter of Roses Lake, possibly contributing to the better than average survival of older age largemouth bass.

A total of nine age classes of largemouth bass were collected during this survey. Surprisingly, all ages, except age nine, were represented well in our samples, an indication that Roses Lake largemouth bass appeared to exhibit consistent recruitment and survival within each year class through time. Relative weights of largemouth bass were well above average for most fish, and only in the mid-range sizes (200 mm to 350 mm) were relative weights lower, possibly indicating competition for suitable size prey.

Bluegill, pumpkinseed, and yellow perch were present in adequate numbers to provide prey for most largemouth bass and harvest for anglers. While these species were present in larger sizes, and, with the exception of yellow perch, were in above average condition, the low numbers of young may be a concern in the future. It is likely the numerous largemouth bass have eaten many of the young; or some other unknown factor may have contributed to their low abundance. In either scenario, recruitment of panfish to age one in Roses Lake appeared low during 2004, and may affect the number of adults present in the future, if recruitment does not improve.

A total of 49 channel catfish were collected during this survey, averaging 1,197g (2.6 lbs) each. These fish were primarily the result of 3,500 channel catfish fingerlings stocked in Roses Lake during 1999, and provide an immediate angling opportunity for quality size fish.

Strategy 1: Channel Catfish Stocking and Monitoring

The stocking program for channel catfish in Roses Lake is relatively young. Most stocking occurring in one year (1999), and few fish were stocked in subsequent years. The program appears very promising, though the fishery will not maintain itself without a consistent stocking plan. We recommend continued stocking on a yearly or bi-yearly basis depending on channel catfish availability. If stocking continues on a yearly basis, we recommend a maintenance stocking of approximately 750 channel catfish per year, or 1,000 to 1,500 fish every other year. Since Roses Lake is currently predator dominated, and channel catfish fish densities will increase over time by accumulation of stocked fish, it may be best to stock less fish that can grow to larger sizes than risk creating food competition by overstocking. Green et al (2004) found that mean weights of channel catfish at harvest declined linearly as stocking rates increased. Periodic surveys should be conducted to monitor the success of future stockings so adjustments may be made if necessary.

Strategy 2: Population Monitoring

Warmwater fish surveys are a very useful tool to aid management biologist in detecting changes in the fish community structure associated with fish stocking, regulation changes, or fish removal. We recommend a survey be conducted every three to four years to specifically monitor the status of the largemouth bass population, monitor recruitment of Roses Lake panfish species, and evaluate the success of future channel catfish stocking.

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.

Anderson, R.O. and A.S. Weithman. 1978. The concept of balance for coolwater fish populations. American Fisheries Society Special Publication 11:371-381.

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. Bonar, B. 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.

Green, B.W., Engle, C.R. 2004. Growth Of Stocker Channel Catfish At Three Stocking Rates. Arkansas Aquaculture 2004 Book Of Abstracts: 8. Catfish Farmers Of Arkansas And Arkansas Bait And Ornamental Fish Growers Association. Hot Springs, Ar.

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

WDFW. 1994. Roses Lake Management Plan, Chelan County, Washington. Washington Department of Fish and Wildlife fisheries management files. Region 2, Ephrata, Washington. 11 pp.

Willis, D.W., B.R. Murphy, and C.S. Guy. 1993. Stock density indices: development, use, and limitations. Reviews in Fisheries Science 1(3):203-222.

Glossary

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

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

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

Preferred Size: Is defined as 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): Is defined as 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): Is defined as the length measurement from the anterior most part of the fish to the tip of the longest caudal (tail) fin ray (compressed).

Trophy Size: Is defined as the minimum size fish worthy of acknowledgment. Is also identified as 74-80 percent of world record length. Trophy length varies by species.