1999 Warmwater Fisheries Survey of Red Rock Lake, Grant County, Washington

By

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Abstract

Red Rock Lake, Grant County, Washington, was surveyed between October 7-29, 1999, using an electrofisher, gill nets, and fyke nets. A total of 10 fish species were observed during 1999: largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, black crappie *Pomoxis nigromaculatus*, Yellow perch *Perca flavescens*, pumpkinseed *Lepomis gibbosus*, lake whitefish *Coregonus clupeaformis*, brown bullhead *Ictalurus nebulosus*, tiger muskellunge (muskies) *Esox lucius* × *E. masquinongy*, common carp *Cyprinus carpio*, and sculpin *Cottus spp*. Warmwater gamefish comprised approximately 90 percent of the total fish captured. Yellow perch were the most abundant (52%) species sampled and carp accounted for the majority (67%) of the biomass.

Largemouth bass comprised 12 percent of the sample and ranged in age from 1 to 15 years. Of the stock length largemouth bass that were sampled (n = 95), 36 percent were of quality size and 21 percent were of preferred size. Largemouth bass ranged in total length from 111 to 545 mm and appeared to be in good condition (weight); few fish had relative weights less than 90. Relative weights of largemouth bass sampled in 1999 were similar to those found during a 1997 electrofisher survey.

Black crappie comprised 18 percent of the sample and ranged in age from 1 to 6 years. Total lengths of black crappie ranged from 130 to 359 mm and were longer than the Eastern Washington average at all ages. Of the stock length black crappie sampled (n = 190), 17 percent were of quality size and 11 percent were of preferred size. Black crappie were found in slightly below average condition; most fish greater than 160 mm had relative weights between 75 and 90.

Yellow perch ranged in age from 1 to 3 years. Total lengths of yellow perch ranged from 108 to 245 mm. Yellow perch were similar to black crappie in that they exhibited good growth (length) but poor condition. Few yellow perch had relative weights greater than 100. Growth and condition of yellow perch were similar in 1999 and 1997.

Tiger muskies have not appeared to reduce yellow perch abundance as intended, and stocking has been suspended as a result of the removal of the lake outflow standpipe by the Quincy Irrigation District.

Overall, populations of largemouth bass, black crappie, and yellow perch in Red Rock Lake appear to be doing well in terms of growth and reproduction and no regulation or management changes are recommended at this time. Development of a fish migration barrier is recommended to inhibit downstream movement of the tiger muskies in the lake. We recommend that periodic warmwater fish surveys be conducted to monitor the size structure and condition of the largemouth bass, black crappie, pumpkinseed, and yellow perch in Red Rock Lake.

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Introduction and Background

Red Rock Lake is located in Grant County, approximately 4.8 kilometers (km)(3 miles) southeast of Royal City, Washington (Fig. 1). Red Rock Lake originated in 1966 from water used as irrigation. In 1982, the United States Bureau of Reclamation (BOR) constructed the Red Rock Lake Dike as part of the Columbia Basin Project. The dike was intended to be an emergency structure, capable of retaining water during high runoff and preventing the failure of the railroad dike immediately downstream (Willie Lowe, BOR - retired, pers. comm.). The dike was originally constructed of permeable rock-fill which would allow gradual seepage during high water but has since sealed and acts as a dam. Water is supplied to this 87.8 hectare (217 acre) lake from two sources. Water enters the lake from the north and east, both via irrigation return canals. Water exits the lake from the west end through a cement culvert and flows approximately 0.8 km (0.5 miles) before joining Red Rock Creek. A vertical standpipe was attached to the culvert until approximately 1998, but was removed by the Quincy Irrigation District (QID) for two primary reasons. Foremost, the standpipe raised the water level and decreased the emergency storage capacity of the lake. Secondly, water flowing through the standpipe created a vortex which may have been hazardous to recreationists, thus creating liability issues for QID. Land surrounding Red Rock Lake is owned by Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources, and the BOR and is characterized by steep slopes and basalt cliffs.

Since it's inception, Red Rock Lake has been managed primarily as a mixed species fishery. Species such as largemouth bass *Micropterus salmoides*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, and pumpkinseed *Lepomis gibbosus* became established in the lake through irrigation wasteway migration (WDFW 1997). Between 1968-1976, WDFW sporadically stocked the lake with rainbow trout *Oncorhynchus mykiss* (Jeff Korth, WDFW, pers. comm.). Common carp *Cyprinus carpio* first appeared in Red Rock Lake in 1969. In 1997, WDFW introduced tiger muskellunge (muskies) *Esox lucius* × *E. masquinongy* in an attempt to reduce the number of carp and small yellow perch (Table 1). In addition, smallmouth bass *M. dolomieu* were introduced so that the lake's rocky littoral habitat could be utilized more efficiently and more total pounds of bass could be produced. Currently, all fish species are managed under general statewide fishing regulations and anglers are allowed to fish the lake throughout the entire year. Anglers are allowed to harvest a daily limit of five bass of which only bass less than 12 inches or greater than 17 inches may be kept with no more than 1 bass over 17 inches being retained. In addition, each angler may harvest 15 whitefish of any size and one tiger muskie greater than 36 inches in length each day. All other species inhabiting Red Rock Lake are exempt from minimum size or daily harvest limits.

The riparian area of Red Rock Lake hosts various mammals including beaver *Castor canadensis*, coyote *Canis latrans*, and raccoon *Procyon lotor*. Numerous species of waterfowl utilize the lake as a resting area during spring and fall. In addition, prairie falcon *Falco mexicanus* and

sandhill crane *Grus canadensis* are also found in the area. Various aquatic (pondweed *Potamogeton spp.*), sub-aquatic (cattail *Typha latifolia* and bulrush *Scirpus spp.*), and terrestrial (Russian olive *Elaeagnus angustifolia*, sagebrush *Artemisia tridentata*, rabbitbrush *Chrysothamnus nauseosus,* and wheatgrass *Agropyron spp.*) vegetation are common in the area.

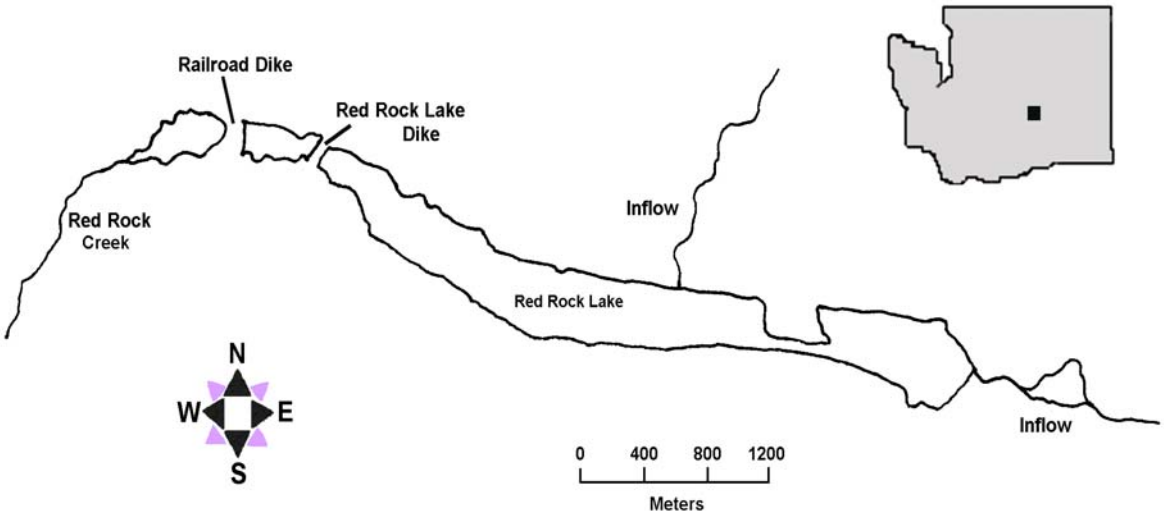

Figure 1. Map of Red Rock Lake, Grant County, Washington.

Table 1. Fish stocked in Red Rock Lake between 1997 and 1999. No fish were stocked in Red Rock Lake in 1998 and 2000.

Year	Species	No. Stocked	Size
1999	Tiger muskie	400	12 inches
1997	Tiger muskie	1,500	6-8 inches
1997	Tiger muskie	144	15 inches
1997	Smallmouth bass	178	adults

Methods and Materials

Red Rock Lake was surveyed by a three-person team between October 7-29, 1999. All 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 electrofishing boat, supplying a DC current at a setting of 120 cycles/sec at 3 to 4 amps power. Experimental gill nets (45.7 m x 2.4 m) 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 netting material was constructed of 6.35 mm nylon mesh.

Sampling locations were selected by dividing the shoreline into 400 m sections determined from a map. The number of randomly selected sections surveyed were as follows: electrofishing - 15, gill nets - 8, and fyke nets - 8. 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 70E 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 night-time hours when fish are most numerous along the shoreline thus maximizing the efficiency of each gear type.

All fish were identified to species, measured (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 gamefish 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).

Water chemistry data were collected at 1 m increments from the area of greatest depth. A Hydrolab® was used to collect information on dissolved oxygen (milligrams per liter)(mg/l), temperature (degrees Celsius)(EC), pH, and conductivity (micro-siemens per centimeter)(FS/cm).

Species composition, by weight in kilograms (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 fluctuates between sampling locations, sampling method, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE, fish/hour) of each sampling gear was determined for each warmwater fish species collected. Electrofishing 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. 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 (W_s) was derived from a standard weight-length ($\log_{10}$) relationship which 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 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 Eastern Washington and/or statewide averages.

The proportional stock density (PSD) of each warmwater gamefish species was determined following procedures outlined in Anderson and Neumann (1996). Proportional stock density uses two measurements, stock length and quality length, to provide useful information about the proportion of various size fish in a population. Stock length is defined as the minimum size of a fish which provides recreational value or the approximate length when fish reach maturity (Table 2). Quality length is 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.

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, the Gabelhouse model adds preferred, memorable, and trophy categories (Table 2). Preferred length (RSD-P) is defined as the minimum size of fish anglers preferred to catch. Memorable length (RSD-M) refers to the minimum size fish anglers remembered catching, and trophy length (RSD-T) refers 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 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. Relative stock density differs from PSD in that it is more sensitive to changes in year class strength. Relative stock density 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).

Certain analyses, such as species composition, relative weight, and age and growth, were compared to information collected from Red Rock Lake in 1997 (Fletcher 1997). It is uncertain whether the sampling protocols used in 1997 were the same as those used in 1999, although it is unlikely. Regardless, the information collected in 1997 may be used to identify trends in species composition, fish condition, and growth.

Table 2. 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

A total of 10 fish species were observed in 1999 at Red Rock Lake (Table 3). Warmwater gamefish comprised 91.7 percent of the total fish captured. Yellow perch (51.8%) and black crappie (18.6%) were the most, and second most, abundant species encountered in the samples, respectively. Although less abundant, carp comprised 66.6 percent of the total biomass sampled.

Six fish species were observed in 1997 (Fletcher 1997, Table 4). Smallmouth bass, lake whitefish *Coregonus clupeaformis*, carp, and sculpin *Cottus spp*. were sampled in 1999 but not in 1997. These species were most likely present when the lake was sampled in 1997. However due to possible differences in protocols, these species may have been observed but not collected during sampling.

Table 3. Species composition, by weight and number, of fish sampled at Red Rock Lake, Washington during October 1999. Analyses do not include young-of-year.

	Species Composition					
	Weight		Number		Size Range (mm TL)	
Type of Fish	kg	%	No.	%	Min.	Max.
Brown bullhead	0.3	0.10	3	0.24	185	225
Black crappie	19.7	6.59	228	18.55	130	359
Sculpin	0.2	0.05	19	1.55	43	122
Carp	199.3	66.56	85	6.92	147	680
Largemouth bass	53.2	17.77	144	11.72	111	545
Lake whitefish	2.2	0.72	3	0.11	415	455
Pumpkinseed	3.8	1.26	113	9.19	80	145
Smallmouth bass	1.0	0.33	1	0.08	425	425
Tiger muskie	2.3	0.76	3	0.13	484	580
Yellow perch	17.4	5.81	638	51.75	108	245

Table 4. Species composition, by weight and number, of fish sampled at Red Rock Lake, Grant County, Washington during November 1997 (Fletcher 1997).

	Species Composition					
	Weight		Number		Size Range (mm TL)	
Type of Fish	kg	%	No.	%	Min.	Max.
Brown bullhead	0.29	0.93	2	0.51	158	265
Black crappie	5.93	18.67	50[a]	12.69	86	397
Largemouth bass	22.40	70.46	248[b]	62.94	84	523
Pumpkinseed	0.22	0.71	6	1.52	102	152
Tiger muskie	1.55	4.88	3	0.76	378	480
Yellow perch	1.37	4.34	85[c]	21.57	89	207

[a] Includes 19 black crappie which were not measured, weighed, or included in the weight and size range reported for this species.

[b] Includes 187 largemouth bass which were not measured, weighed, or included in the weight and size range reported for this species.

[c] Includes 53 yellow perch which were not measured, weighed, or included in the weight and size range reported for this species.

Catch Per Unit Effort (CPUE)

Whether using an electrofisher, gill nets, or fyke nets, CPUE can be used as an index to monitor size structure and relative abundance of fish species in a lake or reservoir (Hubert 1996). Red Rock Lake CPUE results from this survey will provide baseline information which will allow fishery managers to monitor the effectiveness of management efforts for this lake in the future. Overall, we captured more fish during our survey using a boat electrofisher than gill nets or fyke nets. Similarly, more fish were collected using gill nets than fyke nets. Electrofishing catch rates of warmwater species were highest on yellow perch (128.4 fish/hr) and black crappie (74.6 fish/hr)(Table 5). Gill net catch rates were highest for yellow perch (2.9 fish/net-night) and black crappie (2.63 fish/net-night). Fyke nets were effective at capturing only two species; black crappie (2.1 fish/net-night) and sculpin (0.1 fish/net-night). While multiple sampling gears are commonly used to help eliminate a species or size bias that may be associated with a single gear, we found that species observed by multiple gears during this survey were of the same sizes. Generally fyke nets are a useful means of sampling juvenile black crappie (Maceina and Stimpert 1998, Pope and Willis 1998). Although fyke nets were used to sample small black crappie in Red Rock Lake during 1999, they were collected in lower numbers than expected and lower numbers than collected by electrofishing.

Table 5. Mean catch per unit effort and 80 percent confidence intervals (CI), by gear type, of fish sampled at Red Rock Lake, Washington, in October 1999.

Species	Gear Type								
	Electrofisher			Gill Nets			Fyke Nets		
	No. hour	CI (+/-)	No. Sites	No. per Night	CI (+/-)	No. Net Nights	No. per Night	CI (+/-)	No. Net Nights
Brown bullhead	0.40	0.51	15	0.25	0.32	8	0.00	–	8
Black crappie	74.57	32.24	15	2.63	2.00	8	2.13	2.20	8
Sculpin	7.17	3.19	15	0.00	–	8	0.13	0.16	8
Carp	30.71	9.77	15	0.75	0.40	8	0.00	–	8
Largemouth bass	37.78	6.64	15	0.25	0.32	8	0.00	–	8
Pumpkinseed	44.63	29.79	15	0.13	0.16	8	0.00	–	8
Smallmouth bass	0.40	0.51	15	0.00	–	8	0.00	–	8
Yellow perch	128.41	35.56	15	2.88	1.38	8	0.00	–	8

Stock Density Indices

Numerous quality length largemouth bass and black crappie were observed during the 1999 survey at Red Rock Lake (Table 6). Of the stock length largemouth bass that were sampled (n = 95), 21 percent were of preferred length and 2 percent were of memorable length (Table 6). The majority of the largemouth bass, of quality length or greater, were captured using an electrofisher. Petersen et al. (In prep.) observed that most fish of preferred or memorable size sampled at Potholes Reservoir in 1999 were collected using gill nets. The PSD of black crappie sampled using by electrofishing was (17 ± 4). Of the stock length black crappie that were sampled (n = 190), 11 percent were of preferred size and 2 percent were of memorable size. The PSD for yellow perch sampled by electrofishing was low (2 ± 1) indicating that few fish are surviving to quality size.

Table 6. Proportional (PSD) and relative (RSD, P = preferred, M = memorable, T = trophy) stock densities, by gear type and including 80 percent confidence intervals, of fish collected from Red Rock Lake, Washington. Fish were sampled in October, 1999.

Species	#Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofisher			
Black crappie	190	17 ± 4	11 ± 3	2 ± 1	0
Largemouth bass	95	36 ± 6	21 ± 5	2 ± 2	0
Yellow perch	322	2 ± 1	0	0	0
		Gill Nets			
Black crappie	21	19 ± 11	19 ± 11	10 ± 8	0
Largemouth bass	2	100	50 ± 45	0	0
Yellow perch	23	26 ± 12	0	0	0
		Fyke Nets			
Black crappie	17	12 ± 10	6 ± 7	0	0

Although the sample size of stock length black crappie, largemouth bass, and yellow perch were below the minimum required (n = 55) for a sound PSD estimate (Bonar et al. 2000), the stock density indices calculated in 1997 (Fletcher 1997, Table 7) may provide some insight into the size structure of those populations. When compared to 1999 data, the 1997 stock density indices were much different. The number of stock length fish collected for each species was significantly lower than collected during the 1999 survey. Additionally, while PSD and RSDs are expressed as a percentage of the number of stock length fish, these values were much higher in 1997 than 1999. These higher values were due to the low number of stock length fish collected for the 1997 analysis. When the PSD and RSD percentage was actually applied to the number of stock length fish collected in 1997, the result showed that the actual number of fish in the RSD categories was less than observed during 1999. The results of this comparison suggest the overall population has expanded slightly in Red Rock Lake since 1997; however, many more fish were collected during the 1997 survey than were represented in this analysis, but data was only available on a sub-sample.

Table 7. Proportional (PSD) and relative (RSD, P = preferred, M = memorable, T = trophy) stock densities, by gear type, of fish collected from Red Rock Lake, Washington. Fish were sampled in November 1997 (Fletcher 1997).

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofisher			
Black crappie	28	68	50	11	4
Largemouth bass	25	56	32	7	0
Yellow perch	29	7	0	0	0

Water Chemistry

The water column of Red Rock Lake was relatively homogeneous in terms of temperature, dissolved oxygen, ph, and conductivity (Table 8). Water temperatures ranged from 8.7 to 8.9 EC (Table 8). Dissolved oxygen ranged from 8.9 to 10.6 mg/l. The pH levels of Red Rock Lake were within the range (6.5 - 9) desirable for warmwater fish as reported by Swingle (1969). Water chemistry data indicate that open water habitat was not limited in the lake in October 1999. Since water chemistry data were collected during October, thermal stratification and lower dissolved oxygen concentrations that may occur during summer months could not be determined. If necessary, additional sampling could be conducted throughout the year to develop a more comprehensive understanding of the water quality dynamics of Red Rock Lake.

Table 8. Water chemistry data collected from Red Rock Lake, Washington in October, 1999.

Location	Depth (m)	Temp (EC)	pH	Dissolved O_2 (mg/l)	Conductivity (FS/cm)
Mid-Lake	0	8.91	8.08	10.63	340.3
	1	8.88	8.17	10.38	340.0
	2	8.84	8.20	10.38	339.8
	3	8.82	8.24	10.38	339.4
	4	8.80	8.30	10.09	339.1
	5	8.78	8.32	10.11	339.4
	6	8.77	8.34	9.76	339.3
	7	8.75	8.36	9.99	340.9
	8	8.74	8.36	9.85	341.0
	9	8.70	8.37	9.8	340.3
	10	8.67	8.38	9.83	340.0
	11	8.68	8.39	8.85	340.2

Largemouth Bass

Largemouth bass ranged in age from 1 to 15 years with age 2 fish being the most abundant of those fish analyzed for age and growth (Table 9). The number of largemouth bass evaluated for age and growth older than age 8 were too few for an accurate analysis. Additionally, accuracy of the age analysis for fish older than age 8 declines due to difficulty identifying individual annuli. Until age 3, growth (length) of Red Rock Lake largemouth bass was above the eastern Washington average. Growth of age 1 largemouth bass observed in 1997 (Fletcher 1997) and 1999 was similar. However, age 2 largemouth bass observed in 1997 were approximately 70 mm greater than those collected in 1999. Only four largemouth bass were analyzed for age and growth in 1997 which may explain this difference.

Total lengths of largemouth bass sampled at Red Rock Lake ranged from 111 to 545 mm in 1999 (Table 3, Fig. 2) and from 84 to 523 mm in 1997 (Table 4, Fig. 3). Age 2 largemouth bass observed in 1999 appear to be the dominant year class. Moderate numbers of age 1 largemouth bass observed in 1997 (Fletcher 1997, ~75-115 mm) recruited to age 3 (~220-280 mm) in 1999. A total of 262 YOY largemouth bass were observed in 1999.

Overall, largemouth bass sampled in both 1999 (Fig. 4) and 1997 (Fig. 5) were in good condition. Few fish had relative weights less than 90 indicating that largemouth bass were not limited by food or fish density. Although relative weights of largemouth bass were similar in both years, those reported for 1999 exhibited less variability which was probably due to the larger sample size.

Table 9. Back calculated length at age (mm) of largemouth bass sampled at Red Rock Lake, Washington, during October, 1999. Shaded values represent length at age calculated using the direct proportion method (Fletcher et al. 1993). Unshaded values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age														
Year	# Fish	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1998	11	93.8														
		99.5														
1997	26	61.3	160.5													
		75.3	164.7													
1996	12	69.3	126.9	210.8												
		83.7	136.6	213.8												
1995	5	82.2	197.2	261.4	319.8											
		97.5	205.8	266.3	321.4											
1994	3	88.4	162.7	272.0	311.1	327.9										
		103.	173.3	276.3	313.1	329.0										
1993	1	86.2	154.0	218.2	265.8	311.7	344.7									
		101.	166.0	226.8	272.0	315.5	346.8									
1992	3	65.5	136.2	223.1	261.2	329.7	377.7	406.8								
		82.3	149.7	232.3	268.6	333.8	379.4	407.1								
1991	4	66.9	120.9	185.3	247.2	315.9	365.1	403.6	430.1							
		83.9	135.4	196.9	256.0	321.5	368.4	405.2	430.5							
1990	1	76.4	140.9	191.9	254.7	317.6	385.5	407.6	438.1	455.1						
		93.1	154.9	203.7	263.8	324.0	389.0	410.1	439.4	455.6						
1989	1	84.9	246.2	275.1	322.6	343.0	399.0	421.1	444.9	475.4	483.9					
		101.	256.1	283.8	329.4	349.0	402.7	423.9	446.7	476.0	484.1					
1988	1	71.8	129.3	167.0	201.1	276.5	298.0	362.7	395.0	427.3	430.9	457.8				
		88.7	143.7	179.8	212.4	284.6	305.2	367.1	398.0	428.9	432.4	458.1				
1987	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
1986	1	87.6	184.8	264.6	317.2	346.3	365.8	391.1	414.4	432.0	449.5	470.9	482.5	492.3		
		104.	197.5	274.1	324.5	352.5	371.2	395.5	417.9	434.7	451.6	472.1	483.3	492.7		
1985	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1984	1	55.2	132.8	229.5	274.3	317.4	341.6	384.7	421.0	448.6	467.5	490.0	502.0	512.4	521.0	531.4
		73.2	147.9	241.0	284.2	325.7	348.9	390.5	425.4	451.9	470.2	491.8	503.5	513.4	521.7	531.7
Overall		72.3	153.4	196.3	282.9	321.8	358.5	400.2	426.0	447.7	457.9	472.9	492.3	502.3	521.0	531.4
		85.7	161.5	201.7	288.7	326.6	362.4	402.4	427.7	449.4	459.6	474.0	493.4	503.0	521.7	531.7
E.Wa.Average		68.8	135.6	189.2	248.9	300.0	351.5	421.6	437.6	NA	NA	NA	NA	NA	NA	NA

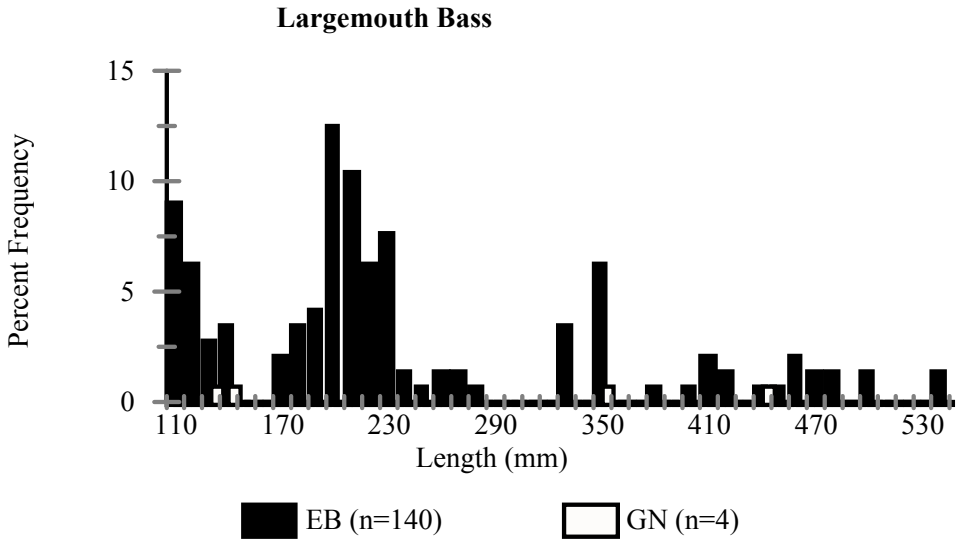

Figure 2. Length frequency distribution of largemouth bass sampled at Red Rock Lake, Washington during October 1999. Largemouth bass were collected using an electrofisher (EB) and gill nets (GN).

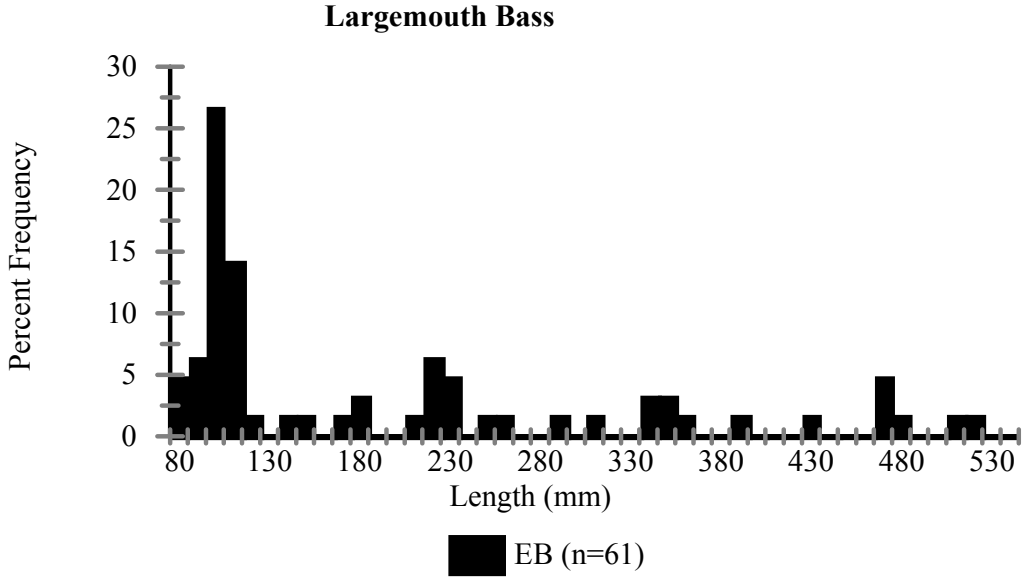

Figure 3. Length frequency distribution of largemouth bass sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997). Largemouth bass were collected using an electrofisher (EB) only.

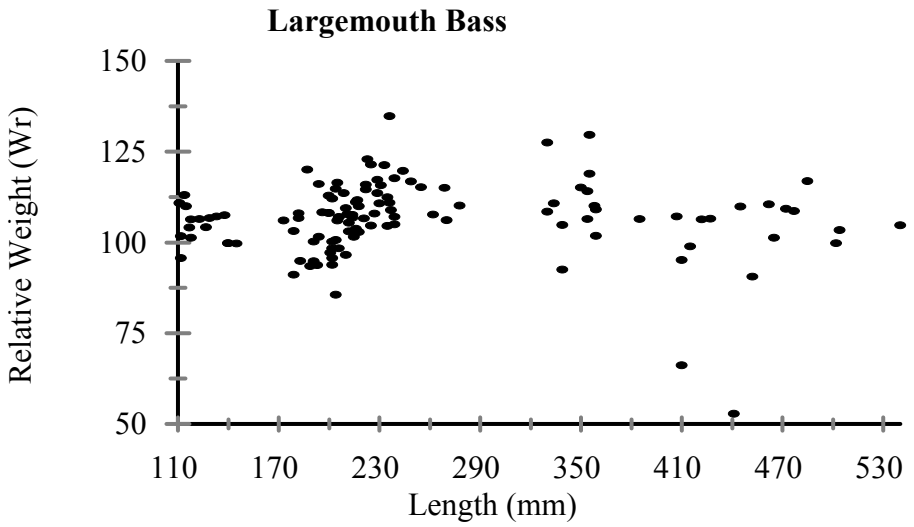

Figure 4. Relative weights of largemouth bass (n = 119) sampled at Red Rock Lake, Washington during October 1999, as compared to the national average, W_r=100 (Anderson and Neumann 1996).

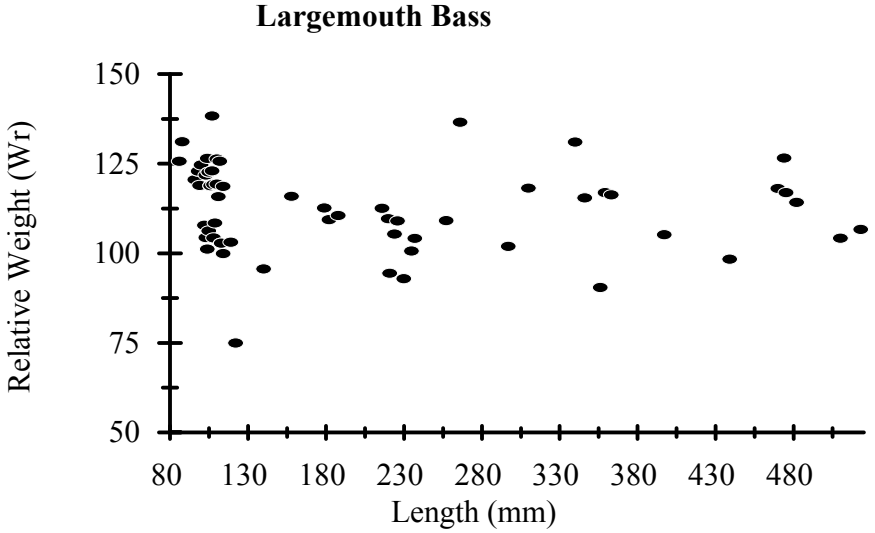

Figure 5. Relative weights of largemouth bass (n = 61) sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997), as compared to the national average, W_r=100 (Anderson and Neumann 1996).

Smallmouth Bass

Only one smallmouth bass was sampled at Red Rock Lake in October 1999 (Table 3) and was likely one of the 178 adults stocked in 1997 (Table 1). The fish was 425 mm long, weighed 1000 g, and had a W_r of 83. Due to the small sample size, no further analyses were performed on smallmouth bass in Red Rock Lake. Smallmouth bass were not observed in Red Rock Lake during the 1997 survey and prior to being stocking. Although adult smallmouth bass were stocked in low numbers, the numbers were adequate for at least low levels of natural reproduction. However, no juvenile smallmouth bass were observed which may be due to poor adult survival and/or spawning success.

Black Crappie

Black crappie sampled in both 1997 (Fletcher 1997) and 1999 (Table 10) ranged in age from 1 to 6 years. Of those black crappie analyzed for age and growth, age 1 fish were most abundant in 1997 and age 3 fish were most abundant in 1999. With the exception of age 1 fish, black crappie collected in 1997 were slightly longer at age than those collected in 1999. However, growth of black crappie sampled in both years were above the eastern Washington average. The sample size of black crappie analyzed for age and growth in both years was low and the results should be viewed with caution.

Total lengths of black crappie sampled at Red Rock Lake ranged from 130 to 359 mm in 1999 (Table 3, Fig. 6) and from 86 to 397 mm in 1997 (Table 4, Fig. 7). Age 3 black crappie (~130-140 mm) observed in 1999 appeared to be the dominant year class. It is uncertain why that year class was dominant in 1999 and was not represented as such in 1997, but may have been due to time of year or amount of effort electrofishing.

Although they exhibited good growth, black crappie sampled in both 1999 (Fig. 8) and 1997 (Fig. 9) were in relatively poor condition. Most fish greater than 160 mm had relative weights between 75 and 90. This anomaly was also observed in yellow perch (see Yellow Perch section) and since both species forage primarily on the same food items (Wydoski and Whitney 1979), these two species may be in direct competition for food. However, since both species increased in abundance from 1997 (Fletcher 1997) to 1999, relative weights of both species should have been lower in 1999 than in 1997. Relative weights were similar in both years of sampling which may indicate that the contradiction in growth and condition was due to food availability at the time of sampling. Both years of sampling was conducted during late fall (1997 - November, 1999 - October) and forage (macroinvertebrates) may have been less available. Had the tiger muskies reduced the number of yellow perch in the lake as intended, relative weights of black crappie would likely have been higher in 1999.

Table 10. Back calculated length at age (mm) of black crappie sampled at Red Rock Lake, Washington, during October, 1999. Shaded values represent length at age calculated using the direct proportion method (Fletcher et al. 1993). Unshaded values represent length at age calculated 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
1998	4	54.2					
		75.3					
1997	7	66.5	112.1				
		85.7	120.4				
1996	13	65.5	115.9	156.5			
		87.4	128.0	160.5			
1995	7	60.3	121.9	168.2	191.5		
		85.0	136.2	174.8	194.0		
1994	7	66.0	137.0	184.7	208.5	229.6	
		91.4	152.3	193.2	213.6	231.7	
1993	1	60.1	126.8	178.9	213.6	229.6	241.6
		86.8	144.4	189.3	219.3	233.1	243.5
Overall mean		63.5	120.9	167.3	200.9	229.6	241.6
		86.1	133.5	173.3	204.8	231.9	243.5
E. Washington Average		46.0	111.2	156.7	183.4	220.0	224.0

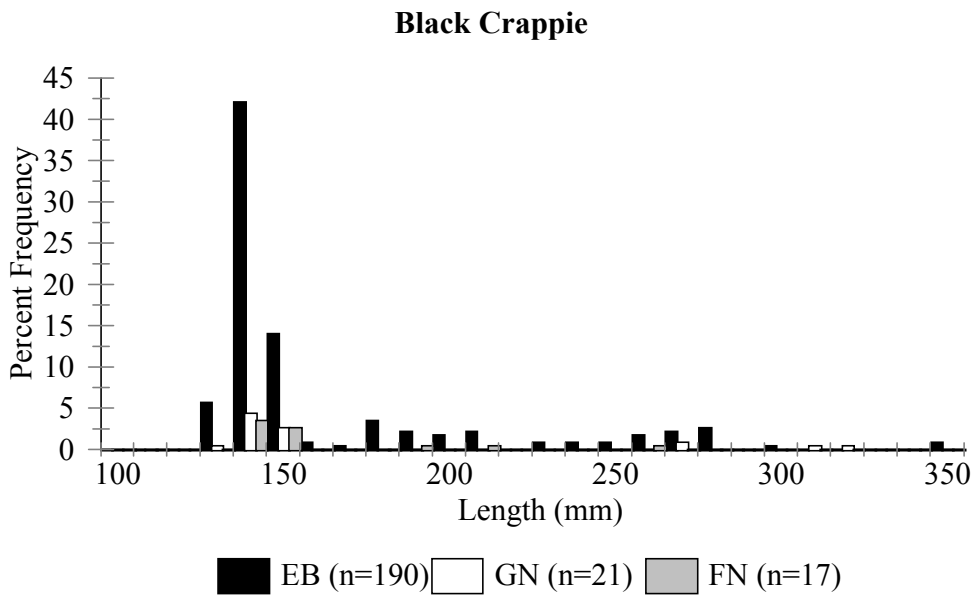

Figure 6. Length frequency distribution of black crappie sampled at Red Rock Lake, Washington during October 1999. Black crappie were collected using an electrofisher (EB), gill nets (GN), and fyke nets (FN).

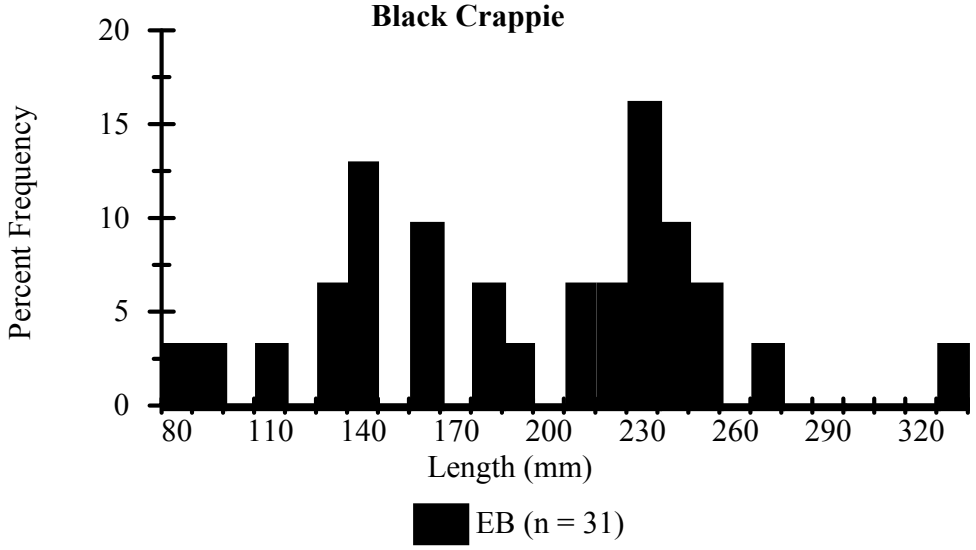

Figure 7. Length frequency distribution of black crappie sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997). Black crappie were collected using an electrofisher (EB) only.

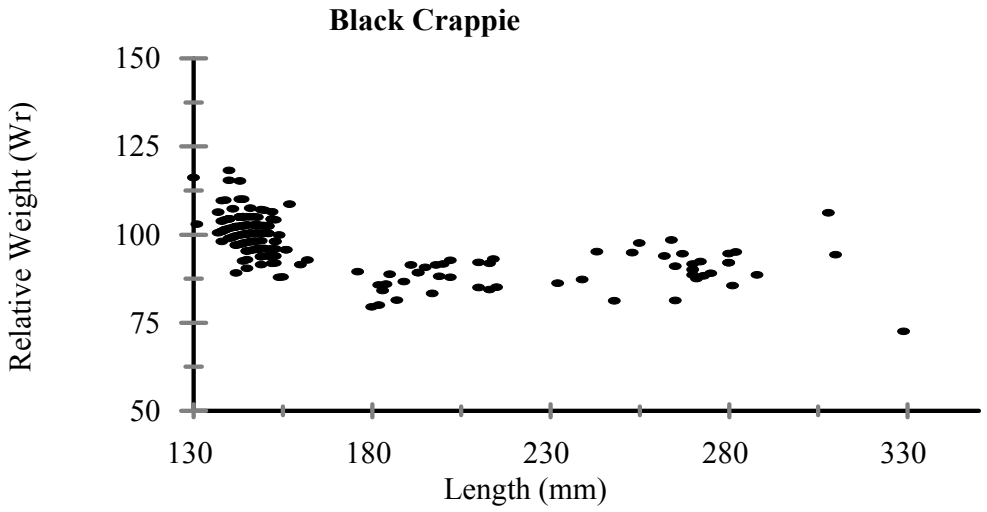

Figure 8. Relative weights of black crappie (n = 195) sampled at Red Rock Lake, Washington during October 1999, as compared to the national average, W_r=100 (Anderson and Neumann 1996).

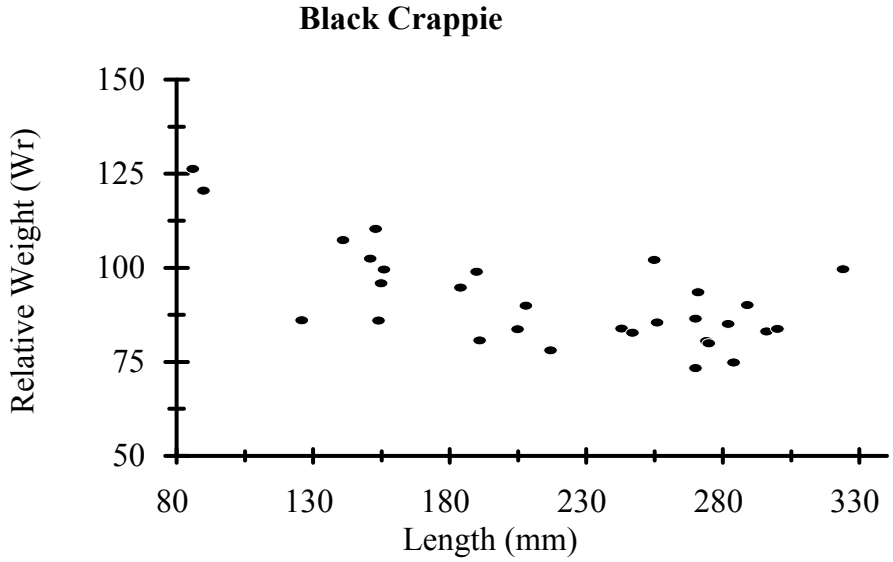

Figure 9. Relative weights of black crappie (n = 30) sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997), as compared to the national average, W_r=100 (Anderson and Neumann 1996).

Yellow Perch

Yellow perch sampled in 1999 ranged in age from 1 to 3 years with age 1 fish being the most abundant of those fish analyzed for age and growth (Table 11). Yellow perch sampled in both 1997 (Fletcher 1997) and 1999 were longer than the eastern Washington average at all ages. Growth of age 1 yellow perch in 1999 was similar to that in 1997. Age 2 yellow perch sampled in 1999 exhibited slightly better growth than those in 1997. However, only ten yellow perch were analyzed for age and growth in 1997 and similarities and/or differences may be due to the low sample size.

The tiger muskies stocked in 1997 and 1999 (Table 1) did not appear to reduce numbers but they may have changed the size structure of the yellow perch population in the lake as of 1999. In 1999, yellow perch was, by far, the most abundant species sampled (638 excluding YOY) and ranged in size from 108 to 245 mm (Table 3, Fig. 10). In 1997, yellow perch were the second most abundant (n = 85) fish species observed and ranged in size from 89 to 207 mm (Table 4, Fig. 11). Although the size ranges of yellow perch observed in 1997 and 1999 were similar, the size structures were quite different. Most yellow perch sampled in 1999 were greater than 110 mm whereas most yellow perch sampled in 1997 (Fletcher 1997) were less than 150 mm.

Overall, yellow perch sampled in both 1999 (Fig. 12) and 1997 (Fig. 13) were in poor condition. Most fish had relative weights less than 100 which would normally indicate that the yellow perch may be limited by food. However, yellow perch were similar to black crappie in that both species exhibited good growth but poor condition. As mentioned previously (see Black Crappie section), forage shared by both species may have been less available during late fall when both surveys were conducted. Relative weights of yellow perch sampled in 1999 probably would have been higher had their numbers been reduced by tiger muskie predation.

Table 11. Back calculated length at age (mm) of yellow perch sampled at Red Rock Lake, Washington, during October, 1999. Shaded values represent length at age calculated using the direct proportion method (Fletcher et al. 1993). Unshaded values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age		
Year Class	**# Fish**	**1**	**2**	**3**
1998	19	69.9		
		83.4		
1997	12	82.0	131.9	
		96.6	137.1	
1996	10	94.7	158.3	194.1
		111.1	165.7	196.5
Overall mean		79.5	143.9	194.1
		94.0	150.1	196.5

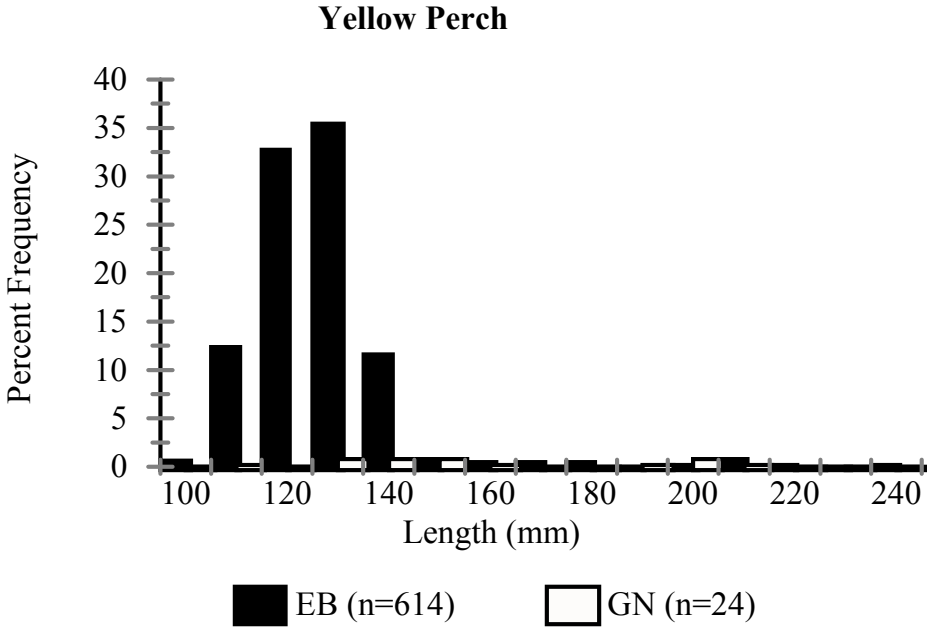

Figure 10. Length frequency distribution of yellow perch sampled at Red Rock Lake, Washington during October 1999. Yellow perch were collected using an electrofisher (EB) and gill nets (GN).

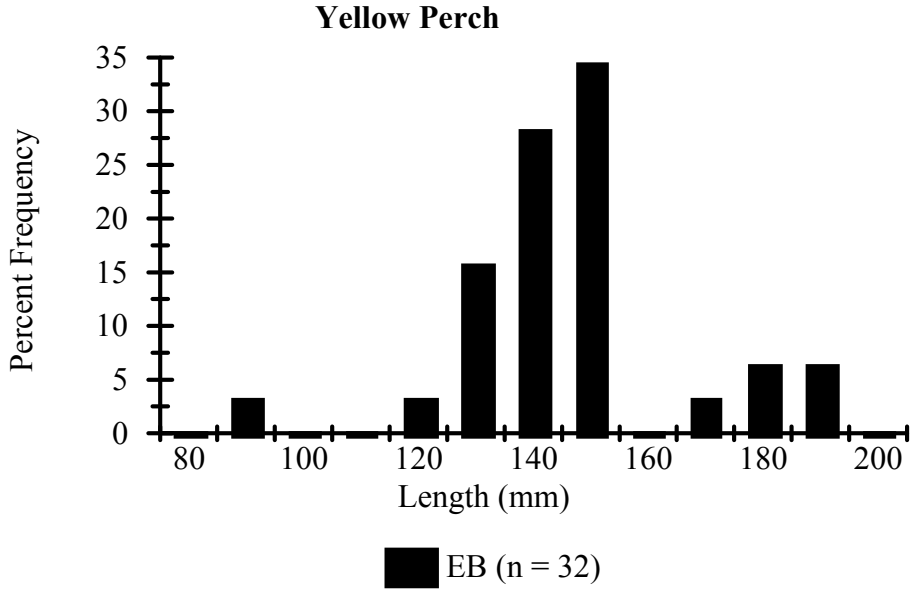

Figure 11. Length frequency distribution of yellow perch sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997). Yellow perch were collected using an electrofisher (EB) only.

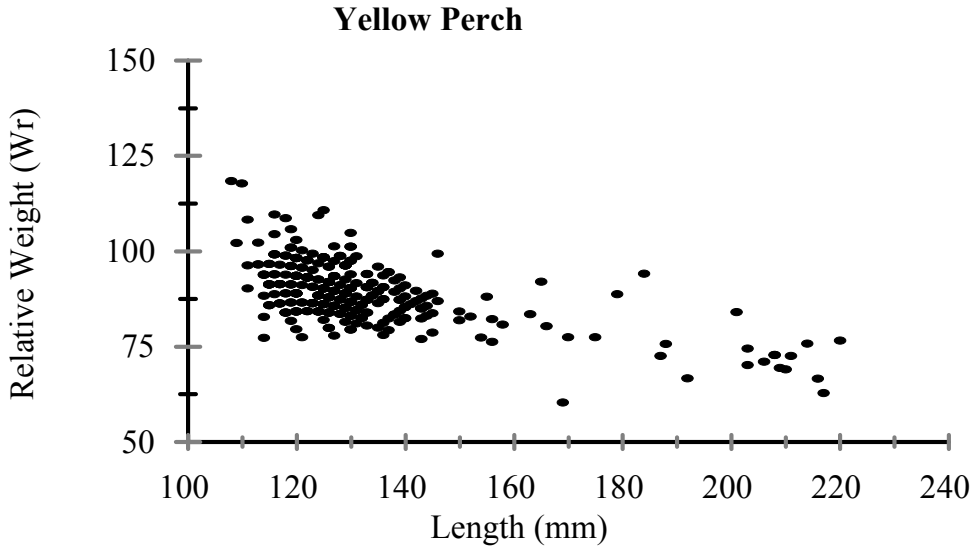

Figure 12. Relative weights of yellow perch (n = 329) sampled at Red Rock Lake, Washington during October 1999, as compared to the national average, W_r=100 (Anderson and Neumann 1996).

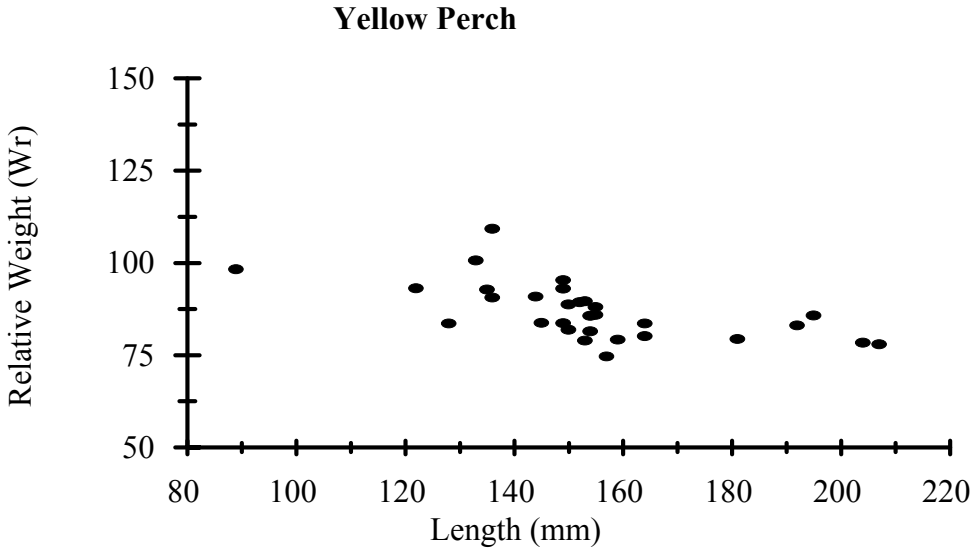

Figure 13. Relative weights of yellow perch (n = 31) sampled at Red Rock Lake, Washington during November 1997 (Fletcher 1997), as compared to the national average, W_r=100 (Anderson and Neumann 1996).

Brown Bullhead

Low numbers of brown bullhead were collected in both 1997 (Fletcher 1997, n = 2) and 1999 (n = 3). Total lengths of brown bullhead ranged from 185 to 225 mm in 1999 (Table 3) and from 158 to 265 mm in 1997 (Table 4). Low numbers of brown bullhead observed during these surveys may have been due, in part, to use of an electrofisher only during the 1997 survey, fish avoiding the sampling gear, or low densities of this species present in the lake.

Pumpkinseed

Scale samples were not collected from pumpkinseed during 1999, thus age and growth comparisons were not made. Pumpkinseed ranged in length from 80 to 145 mm (Table 3) and from 102 to 152 mm in 1997 (Fletcher 1997, Table 4). Pumpkinseed sampled in both 1997 and 1999 at Red Rock Lake were in good condition. Relative weights, for most fish, were above the national average during both years of sampling. Pumpkinseed appeared to have increased in abundance since 1997 and, as of 1999, did not appear to be affected by the introduction of tiger muskies.

Tiger Muskies

A total of three tiger muskies were captured at Red Rock Lake during 1999 (Table 3). All fish were collected using an electrofisher. Tiger muskies ranged in ages from 2 to 3 years and were likely those stocked in 1997 (Table 1). Total lengths and weights ranged from 484 to 580 mm, and 630 to 1,000 g, respectively. In addition to those that were collected, several additional tiger muskies were observed, but escaped capture.

Although the tiger muskies did not appear to reduce abundance of yellow perch and pumpkinseed as of 1999, their predatory potential most likely has not been met. The largest tiger muskie sampled in 1999 was 580 mm (23 inches) in length and weighed 1,000 g (2.2 lbs), far smaller than the size they can achieve (Casselman and Crossman 1986). As the tiger muskies in Red Rock Lake grow larger, they are expected to have a more significant impact on the yellow perch and pumpkinseed in the lake.

Tiger muskies were stocked in Red Rock Lake in 1997 and in 1999 (Table 1). At least one tiger muskie was retrieved near Priest Rapids Dam by Grant County Public Utility District (GCPUD) personnel following the removal of the vertical stand-pipe at the outlet of Red Rock Lake. In response to this discovery, and the removal of the vertical stand-pipe, tiger muskies are no longer stocked in the lake.

Conclusions and Management Options

With the exception of smallmouth bass and tiger muskies, WDFW has not stocked warmwater gamefish in Red Rock Lake. Despite the fish populations being established solely by the irrigation canal system, largemouth bass, black crappie, and yellow perch populations in the lake appear to be self-sustaining and doing well. Although abundance of largemouth bass appeared to have decreased slightly between 1997 and 1999, different sampling methods and data analysis techniques employed for the surveys may account for this decrease. Growth and condition of largemouth bass were above average during both years and natural reproduction was evident in 1999, when 262 YOY were observed.

Since 1997, black crappie and yellow perch increased in abundance and were similar in terms of growth and condition during both years surveyed. Both species exhibited good growth, but slightly below average condition. While above average growth is typically associated with average or better condition, the below average condition, for reasons unknown, may be associated with a period of lower food availability. Both surveys were conducted in the fall when cooler water temperatures may have reduced the abundance of zooplankton and/or benthic invertebrates. However, we are unsure of the effects a short-term decrease in food supply would have on overall fish condition, since the metabolism of fish would also be decreasing. Young-of-the-year black crappie (n = 350) and yellow perch (n = 493) were observed in 1999 which was evidence these species were successfully reproducing.

Recommendation 1:

No regulation or management changes are recommended at this time. Red Rock Lake yields largemouth bass and black crappie throughout most RSD categories (preferred and memorable) and although water levels fluctuate seasonally, natural reproduction and growth of largemouth bass, black crappie, and yellow perch appear to be at adequate levels. Although abundance of yellow perch and pumpkinseed appears to have increased since 1997, and these species are prone to over-population, they are not currently at alarming levels. Tiger muskies were first stocked in the lake in 1997 as juveniles (150-381 mm, 6-15 inches) and have grown to approximately 584 mm (23 inches) as of 1999. As the tiger muskies continue to grow, they would be expected to prey upon yellow perch and pumpkinseed. Since tiger muskies are no longer stocked in Red Rock Lake, their abundance will decrease as will predation on yellow perch and pumpkinseed by this species. We recommend that periodic warmwater fish surveys be conducted to monitor the size structure and condition of the largemouth bass, black crappie, pumpkinseed, and yellow perch in Red Rock Lake.

Recommendation 2:

Currently, there are no structures that would prohibit downstream migration of tiger muskies inhabiting Red Rock Lake. Although the vertical standpipe that was removed in 1998 did not prohibit downstream movement, most fish would avoid entrainment into such a device unless they were injured or sick. We recommend that a structure be investigated and constructed that would restrict downstream movement of tiger muskies and minimize potential negative impacts on fish species listed under the Endangered Species Act. Such a device could not restrict water flow more than the cement culvert currently in place. One possibility may be a grated addition to the present culvert that would extend out into the lake and would be fully submerged during low water conditions. This possibly would allow water to exit the lake at present rates without being obstructed by floating debris. Should such a structure be developed, the tiger muskie stocking program for Red Rock Lake could be continued. The aforementioned is only a concept which would require investigation and approval by the Quincy Irrigation District and Bureau of Reclamation, operators of Red Rock Lake.

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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 which 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 (quality, 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: Considered a trophy, and also identified as 74-80 percent of world record length. Trophy length varies by species.