An Assessment of the Warmwater Fish Community in Black Lake, October 1999

by

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Abstract

Black Lake was surveyed by a three–person crew on October 4-7, 1999. Multiple gear types (electrofishing, gill nets, and fyke nets) were utilized to reduce the sampling bias associated with each sampling method. In all, twelve species of fish were sampled from Black Lake. Numerically, yellow perch and rainbow trout were the most abundant species comprising 64.0 and 12.9% of the sample, respectively. However, rainbow trout and carp constituted the majority of the biomass at 47.8 and 24.7%, respectively. Other species encountered during the survey included bluegill, black crappie, largemouth bass, sculpin spp., rock bass, smallmouth bass, brown bullhead, pumpkinseed, and chinook. Overall, the quality of the warmwater fish populations in Black Lake is poor. Densities of warmwater fish were either low (i.e., black crappie and smallmouth bass) or when numerous were dominated by smaller fish (i.e., yellow perch, bluegill, and largemouth bass). Except for yellow perch, all warmwater fish exhibited good condition, however most species were slow growing. The hatchery rainbow trout plants appear to be fairing well. The majority of the trout encountered during the survey ranged between 200-250 mm with a few large fish around 400-500 mm. Our management options for Black Lake include changing the current bass regulation to the proposed slot limit regulation (five fish limit, 12-17–inch slot, no more than one fish over 17 inches) and to conduct a creel survey to assess the impact harvest has on the warmwater fish community.

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Introduction and Background

Black Lake is a 570–acre water body located south off State Highway 101 on Black Lake Boulevard in Thurston County. The lake is fed by two unnamed inlets on the east shoreline and one unnamed inlet on the west shoreline. Black Lake is drained by the Black Lake Ditch at the north end. Initially, the ditch was constructed in the 1920s to drain swamp land for agricultural purposes. Instead, the ditch now drains the majority of the lake's excess water reducing the flow out of the Black River on the south end. The Black Lake Ditch flows into Percival Creek which eventually drains into Capitol Lake and ultimately into Puget Sound, while the Black River drains into the Chehalis River. There is approximately twenty–five to thirty near shore homes, two resorts, and an R.V. park along the shorelines of Black Lake. There are four access sites on Black Lake. The first, owned by Washington Department of Fish and Wildlife, is located on the southeast end of the lake. The second and third are located at each resort on the southwest shoreline. The last site is located on the northeast end of the lake at the R.V. park, however, since the park went out of business, this access is no longer available for public use.

Historically, Black Lake has had no anadromous fish connections from the Black River (Jay Hunter, WDFW personal communication). Currently, Black Lake is managed as a mixed–species water. Since the 1970s, Black Lake has received annual rainbow trout plants to sustain a put–and–take fishery. Cutthroat trout and steelhead have been planted, when fish were available, to supplement the fishery in the lake. Black Lake supports a warmwater fishery for largemouth bass, bluegill, black crappie, rock bass, and yellow perch. In 1999, three bass tournaments were held on Black Lake in the early spring and fall hosting upwards of 176 anglers. Black Lake is also a popular destination site for jet skiers, water skiers, and boaters that live in the Olympia area.

Materials and Methods

Data Collection

Black Lake was surveyed by a three–person team from October 4-7, 1999. Fish were captured using three sampling techniques: electrofishing; gill netting; and fyke netting. The electrofishing unit consisted of a Smith-Root SR-16s electrofishing boat, with a 5.0 GPP pulsator unit. The boat was fished using a pulsed DC current of 120 cycles/second at 3-6 amps power. Experimental gill nets (45.7 m long x 2.4 m deep) were constructed of four sinking panels (two each at 7.6 m and 15.2 m long) of variable-size (1.3, 1.9, 2.5, and 5.1 cm stretch) monofilament mesh. Fyke (modified hoop) nets were constructed of 1.2-1.6–m diameter hoops with two funnels, and a 2.5–m cod end (6.4 mm nylon delta mesh). Attached to the mouth of the net were two 7.8–m wings, and a 31–m lead.

In order to reduce the gear induced bias in the data, the sampling time for each gear was standardized so that the ratio of electrofishing to gill netting to fyke netting was 1:1:1. The standardized sample is 1800 seconds of electrofishing (3 sections), two gill net nights, and two fyke net nights. Sampling occurred during the evening hours to maximize the type and number of fish captured. Sampling locations were selected from a map (Figure 1) by dividing the entire shoreline into 400–m sections, and numbering them consecutively. Nightly sampling locations were randomly chosen (without replication) utilizing a random numbers table (Zar 1984). While electrofishing, the boat was maneuvered through the shallows at a slow rate of speed (~18 m/minute, linear distance covered over time) for a total of 600 seconds of "pedal–down" time or until the end of the section was reached, whichever came first. Nighttime electrofishing occurred along 50% of the available shoreline. Gill nets were fished perpendicular to the shoreline; the small–mesh end was tied off to shore, and the large–mesh end was anchored off

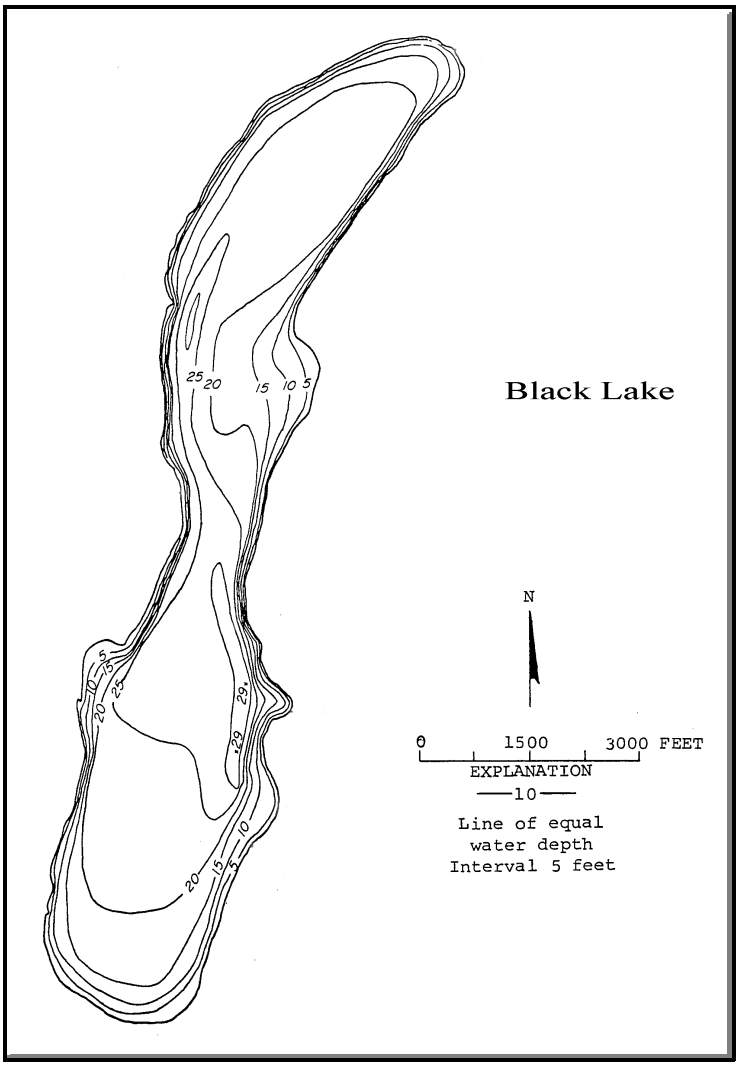

Figure 1. Map of Black Lake, Thurston County.

shore. Fyke nets were fished perpendicular to the shoreline as well. The lead was tied off to shore, and the cod end was anchored off shore, with the wings anchored at approximately a 45° angle from the net lead. We tried to set fyke nets so that the hoops were .3-.6 m below the water surface, this sometimes would require shortening the lead. Gill nets were set overnight at six locations around the lake, whereas fyke nets were set overnight at six locations.

With the exception of sculpin (Cottidae), all fish captured were identified to the species level. Each fish was measured to the nearest millimeter (mm) and assigned to a 10 mm size class based on total length (TL). For example, a fish measuring 156 mm TL was assigned to the 150 mm size class for that species, and a fish measuring 113 mm TL was assigned to the 110 mm size class, and so on. However, if a sample included several hundred young–of–year (YOY) or small juveniles (<100 mm TL) of a given species, then a sub–sample (N ~100 fish) were measured, and the remainder were just counted. The frequency distribution of the sub–sample was then applied to the total number collected. At least ten fish from each size class were weighed to the nearest gram (g); in some instances, multiple small fish were weighed together to get an average weight. Scales were taken from five individuals per size class, mounted, pressed, and aged using the Fraser-Lee method. However, members of the bullhead family (Ictaluridae), and non–game fish like carp (Cyprinidae), were not aged.

Water quality data was collected during mid–day from one location on October 4, 1999. Using a Hydrolab® probe and digital recorder, dissolved oxygen, temperature, pH, and conductivity data was gathered in the deepest section of the lake at 1 m intervals through the water column.

Data Analysis

Species Composition

The species composition by number of fish captured, was determined using procedures outlined by Fletcher et al.(1993). Species composition by weight (kg) of fish captured, was determined using procedures adapted from Swingle (1950). Only fish estimated to be at least one–year old were used to determine species composition. These were inferred from the length frequency distributions described below, in conjunction with the results of the aging process. Young–of–year or small juveniles were not considered because large fluctuations in their numbers may cause distorted results (Fletcher et al. 1993).

Catch Per Unit of Effort

The catch per unit of effort (CPUE) of electrofishing for each species was determined by dividing the total number in all size classes equal to or greater than stock size, by the total electrofishing time (seconds). The CPUE for gill nets and fyke nets was determined similarly, except the number equal to or greater than stock size was divided by the number of net nights for each net (usually one). An average CPUE (across sample sections) with 80% confidence interval was

calculated for each species and gear type. For fishes in which there is no published stock size (i.e., sculpins, suckers, etc.), CPUE is calculated using all individuals captured.

Length Frequency

A length frequency histogram was calculated for each species and gear type in the sample. Length frequency histograms are constructed using individuals that are age one and older (determined by the aging process), and calculated as the number of individuals of a species in a given size class, divided by the total individuals of that species sampled.

Stock Density Indices

Stock density indices (i.e., PSD and RSD) were calculated for warmwater gamefish species encountered during the survey. However, when useful to analyze, PSDs and RSDs were calculated for non–warmwater and non–game species such as trout, carp, or bullheads. Stock density indices calculated here are described by Gabelhouse (1984). The indices are accompanied by an 80% confidence interval (Gustafson 1998) to provide an estimate of statistical precision. Appendix A lists, by species, length categories used to calculated stock density indices.

Relative Weight

A relative weight index (W_r) was used to evaluate the condition (plumpness or robustness) of fish in the lake. A W_r value of 100 generally indicates a fish in good condition when compared to the national average for that species and size. Following Murphy and Willis (1991), the index was calculated as $W_r = W/W_s$ x 100, where W is the weight (g) for an individual fish from the sample and W_s is the standard weight of a fish of the same total length (mm). W_s is calculated from a standard log–weight, log–length relationship defined for the species of interest. The parameters for the W_s equations of many fish species, including the minimum length recommendations for their application, are listed in Anderson and Neumann (1996).

Age and Growth

Age and growth of warmwater fishes were evaluated according to Fletcher et al. (1993). Total length at annulus formation, L_n, was back–calculated using the Fraser-Lee method. Intercepts for the y axis for each species were taken from Carlander (1982). Mean back–calculated lengths at each age for each species were presented in tabular form for easy comparison between year classes. Mean back–calculated lengths at each age for each species were compared to averages calculated from scale samples gathered at lakes sampled by the warmwater enhancement teams.

Results and Discussion

Water Quality and Habitat

Black Lake is a large water body (570 acres) with a maximum depth of 8.8 m and a mean depth of 5.8 m. The shoreline development value is 1.8, which describes Black Lake as oval in shape with few shoreline irregularities. Submergent aquatic macrophytes cover between 1-10% of the surface area depending upon the time of the year. Fishing docks along most of the near shore homes and resorts provide additional habitat for warmwater fish.

Water quality in Black Lake is within optimal limits for warmwater fish (Table 1). However, the lake becomes quite anoxic in the summer during stratification (WDFW, unpublished data). Brown bullhead kills have been observed and are thought to occur annually. Conductivity is low (<100 µs/cm) throughout the water column and is below the optimum range (100-400 µs/cm) for electrofishing efficiency outlined by Willis (1998). Low water conductivity could affect sampling if electricity is not effectively transferred from the water into a fish's body.

Table 1. Water quality measurements taken from Black Lake, October 1999. Measurements taken at mid–day.

Location	Depth (m)	Temp (C)	Ph	DO mg/l	Cond µs/cm
Mid–lake	Surface	17.3	10.1	10.1	81.2
	1	17.0	10.3	10.1	81.2
	2	16.7	10.0	9.6	81.4
	3	16.6	10.0	9.3	81.0
	4	16.6	10.0	9.2	81.3
	5	16.5	9.9	9.0	81.1
	6	16.5	9.8	9.0	81.2
	7	16.4	9.7	8.0	81.8
	8	16.4	9.6	6.9	81.4
	9	16.3	9.6	6.4	82.8

Species Composition and Relative Abundance

In all, twelve species of fish were sampled from Black Lake (Table 2). Of those, yellow perch (*Perca flavescens*) and rainbow trout (*Oncorhynchus mykiss*) were the most abundant numerically at 64.0 and 12.9%, respectively. However, rainbow trout and carp accounted for nearly 73% of the biomass in the lake (47.8 and 24.7%, respectively). Following yellow perch and rainbow trout in order of highest to lowest abundance was bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*), sculpin spp., rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieui*), brown bullhead (*Ictalurus nebulosus*), carp (*Cyprinus carpio*), pumpkinseed (*Lepomis gibbosus*), and chinook (*Oncorhynchus tshawytscha*).

Dissimilar to species composition, bluegill and sculpin exhibited the highest catch per unit efforts (CPUE) at 69 fish/hour (± 25) and 30 fish/hour (± 13), respectively, for electrofishing

(Table 3). Gill and fyke nets were fairly effective at capturing warm and non–warmwater fish. Gill and fyke nets were most effective at sampling bluegill (1 ± .6 fish/gill net night and 4 ± 3 fish/fyke net night).

Table 2. Species composition by weight and number for fish sampled (age 1 and older) from Black Lake, October 1999.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	(kg)	(%w)	(#)	(%n)	Min	Max
Brown bullhead	2.5	2.2	9	0.3	90	342
Black crappie	2.9	2.6	176	6.1	40	253
Bluegill	4.4	4.0	217	7.5	60	197
Sculpin	1.0	0.9	64	2.2	36	160
Carp	24.7	22.5	7	0.2	192	753
Largemouth bass	15.7	14.3	150	5.2	39	475
Pumpkinseed	0.1	0.1	4	0.1	105	110
Rainbow trout	47.8	43.5	373	12.9	56	502
Rock bass	2.0	1.8	29	1.0	41	248
Smallmouth bass	1.5	1.4	12	0.4	63	345
Yellow perch	7.3	6.7	1850	64.0	42	295

Table 3. Average catch per unit effort for fish sampled from Black Lake, October 1999.

	Electrofishing			Gill Netting			Fyke Netting		
Species	(# / hour)	80% CI	Sample Sites	#/net night	80% CI	# net nights	#/net night	80% CI	# net nights
Brown bullhead	1	1	12	1	1	6	0.2	0.2	6
Black crappie	6	3	12	0.5	0.4	6	-	-	6
Bluegill	69	25	12	1	0.6	6	4	3	6
Chinook	-	-	12	0.2	0.2	6	-	-	6
Sculpin spp.	30	13	12	0.2	0.2	6	0.3	0.4	6
Carp	2	2	12	-	-	6	-	-	6
Largemouth bass	16	5	12	0.5	0.4	6	0.2	0.2	6
Pumpkinseed	2	2	12	-	-	6	0.2	0.2	6
Rainbow trout	5	3	12	2	0.6	6	-	-	6
Rock bass	4	2	12	1	1	6	0.5	0.4	6
Smallmouth bass	1	1	12	1	1	6	-	-	6
Yellow perch	1	1	12	1	0.6	6	-	-	6

Summary by Species

Rainbow Trout, (*Oncorhynchus mykiss*)

Rainbow trout size structure is dominated by the spring 1999 hatchery fingerling plant (Figure

2). Rainbow trout PSD is 50 (± 20) which suggests a high number of quality size fish in the lake (Table 4). However, a small sample size (n = 10) was used to calculate PSD and may not accurately represent the population as a whole. It appears the trout plants are fairing well and are providing opportunity to catch fish between 200-250 mm and for carryovers up to 500 mm.

Rainbow trout condition is poor with most individuals exhibiting relative weights below the national average (Figure 3). Growth analysis was not performed for rainbow trout in Black Lake. Rainbows encountered during the survey are most likely age 0 spring plants and age 1 and 2 carryovers.

Table 4. Stock density indices (electrofishing) for fish sampled from Black Lake, October 1999.

		Quality		Preferred		Memorable		Trophy	
Species	# Stock Length	PSD	80% CI	RSD-P	80% CI	RSD-M	80% CI	RSD-T	80% CI
Black crappie	12	92	10	0	0	0	0	0	0
Bluegill	139	4	2	0	0	0	0	0	0
Largemouth bass	32	28	10	9	7	0	0	0	0
Pumpkinseed	3	0	0	0	0	0	0	0	0
Rainbow trout	10	50	20	20	16	0	0	0	0
Rock bass	9	78	18	0	0	0	0	0	0
Smallmouth bass	2	0	0	0	0	0	0	0	0
Yellow perch	3	33	35	0	0	0	0	0	0

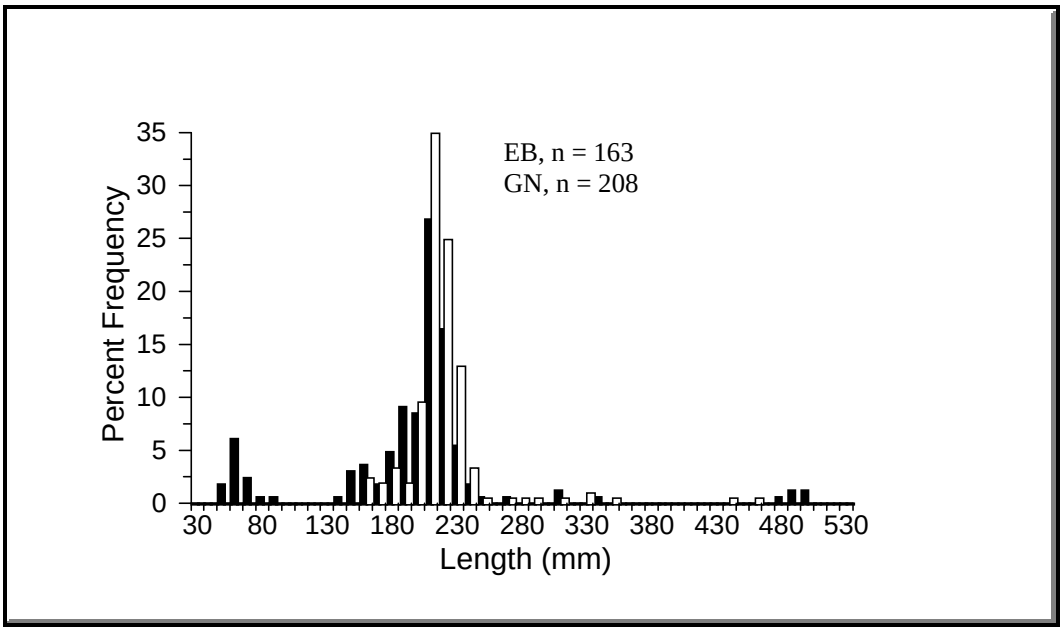

Figure 2. Electrofishing (dark bars) and gill netting (light bars) length frequency distribution of rainbow trout from Black Lake, October 1999.

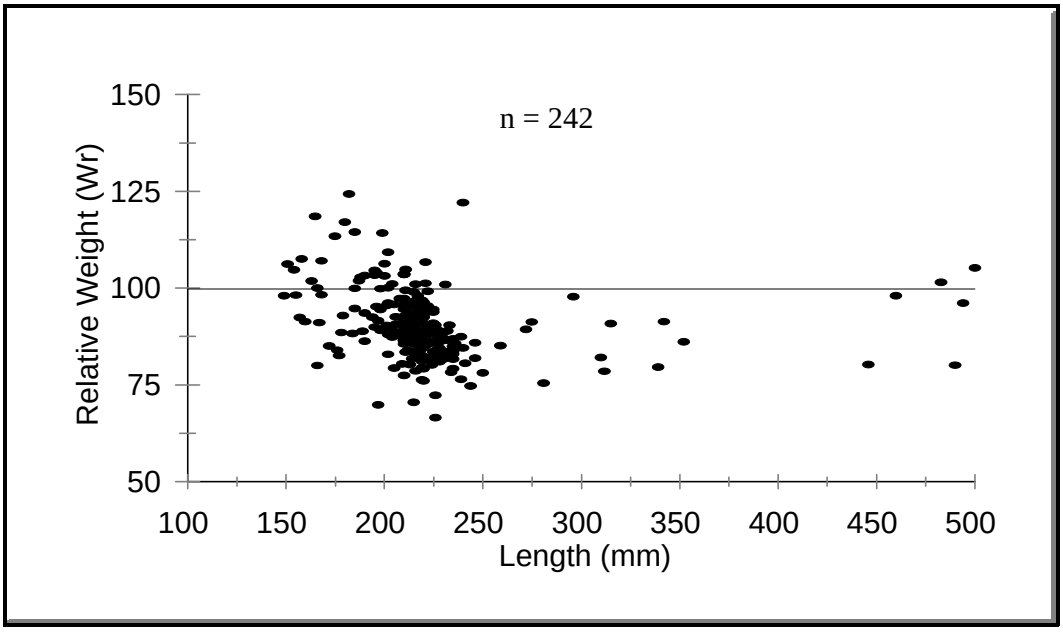

Figure 3. Condition (Wr), as compared to the national average (100), of rainbow trout from Black Lake, October 1999.

Common Carp, (*Cyprinus carpio*)

Although carp accounted for 22.5% of the biomass in Black Lake, only seven fish were captured during the survey (Table 2). Of those fish sampled, their lengths averaged 562 mm and ranged from 192-753 mm. Weights averaged 3531 g and ranged between 129-5893 g. Growth and condition calculations were not performed for carp. Carp probably account for most of the biomass in Black Lake and that these fish probably didn't recruit to our sampling gear effectively.

Largemouth bass, (*Micropterus salmoides*)

The size structure of our largemouth bass sample is dominated by fish smaller than stock size (Figure 4). Bass PSD is 28 (± 10), which suggests a fair number of quality size and larger fish exist in Black Lake and that the predator population is balanced with the prey population (Table 4). However, due to the small sample size (n = 32) of stock size and larger fish, PSD may not accurately represent the population as a whole. PSD calculated from the 1994 population estimate (PSD = 26) on Black Lake was similar to PSD from our fall survey. It appears that the bass population has remained relatively stable over the past five years. However, this comparison should be viewed with caution due to dissimilar survey methodologies. Densities of stock and larger bass may be underestimated due to either low conductivity or sampling season. The effect low conductivity has on sampling fish is explained in the water quality and habitat portion of the results and discussion section. Although fall is an appropriate time to sample warmwater fish, the capture of large bass is greatest during the spring due to warmer water temperatures following the winter and pre–spawning activities.

Largemouth bass condition is good with most individuals exhibiting relative weights above the national average (Figure 5). Growth, with the exception of age 1 fish, is below the western Washington state average (Table 5). In the presence of a dense population of small yellow perch and bluegill, it seems unlikely that forage is limiting largemouth bass growth. Above average condition further supports that food resources are not lacking in Black Lake.

Table 5. Fraser-Lee back–calculated length at age of largemouth bass from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)							
		I	II	III	IV	V	VI	VII	VIII
1998	7	80							
1997	9	62	106						
1996	9	73	139	179					
1995	16	86	128	166	200				
1994	8	93	156	197	231	265			
1993	2	78	189	235	303	340	374		
1992	1	146	239	342	377	413	430	449	
1991	1	154	190	229	278	312	368	402	446
Average		82	137	186	225	294	386	425	446
Direct Proportion		69	129	181	222	291	384	423	445
State Average		60	146	222	261	289	319	368	396

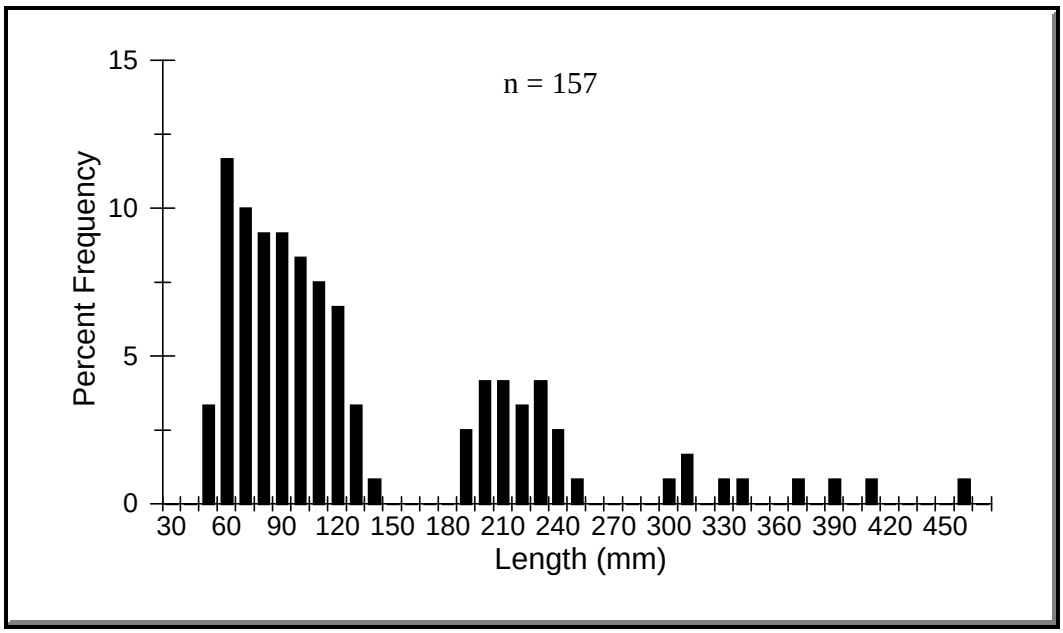

Figure 4. Electrofishing length frequency distribution of largemouth bass from Black Lake, October 1999.

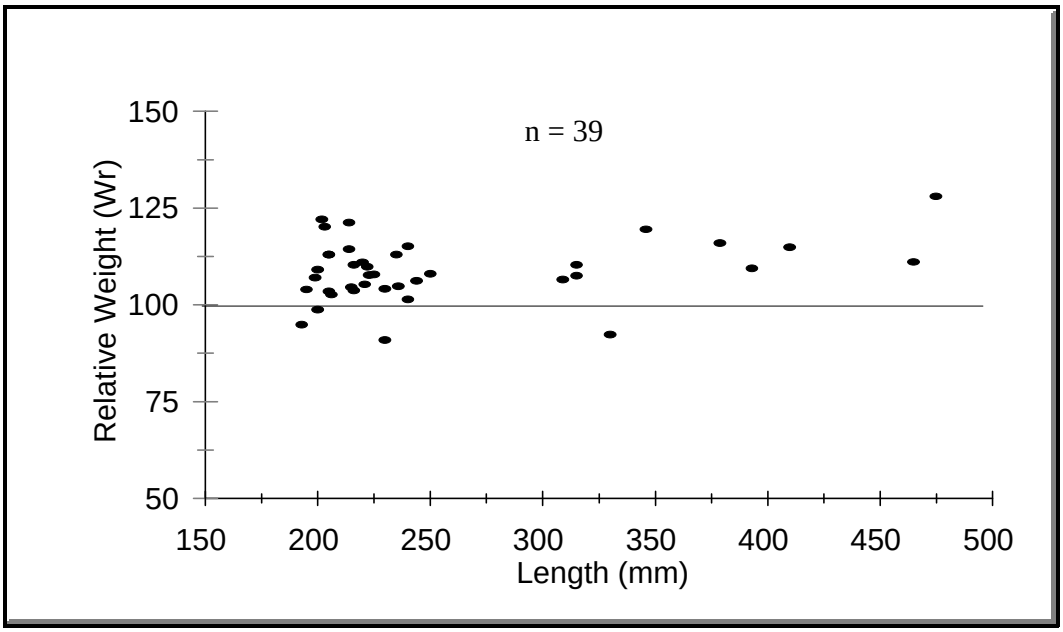

Figure 5. Condition (Wr), as compared to the national average (100), of largemouth bass from Black Lake, October 1999.

Yellow Perch, (*Perca flavescens*)

Yellow perch size structure is weighted heavily towards small age 1 fish (Figure 6). Gill nets sampled a few quality size yellow perch (n = 7), but too few to describe the quality of the fishery. Perch electrofishing PSD is 33 (± 35) which suggests a fair number of quality size fish (Table 4). However, due to the small sample size (n = 3) of stock size and larger fish, PSD may not accurately represent the population as a whole. Similar to our fall survey, the population estimate performed on Black Lake in 1994 yielded a high catch of small yellow perch. This may suggest that the yellow perch population has changed little in the past five years. However, this comparison should be viewed with caution due to dissimilar survey methodologies.

Yellow perch condition is below the national average (Figure 7), but is average according weight-length relationships developed for western Washington perch (Steve Caromile WDFW, unpublished data). However, only nine fish from a sample of 1850 met minimum length requirements to calculate a relative weight which probably does not represent the population as a whole. Perch growth exceeded the state average for most year classes (Table 6).

Table 6. Fraser-Lee back–calculated length at age of yellow perch from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)				
		I	II	III	IV	V
1998	2	54				
1997	2	67	114			
1996	4	86	144	171		
1995	5	85	122	155	184	
1994	1	100	192	217	252	279
Average		79	134	168	195	279
Direct Proportion		60	123	161	191	277
State Average		60	120	152	193	206

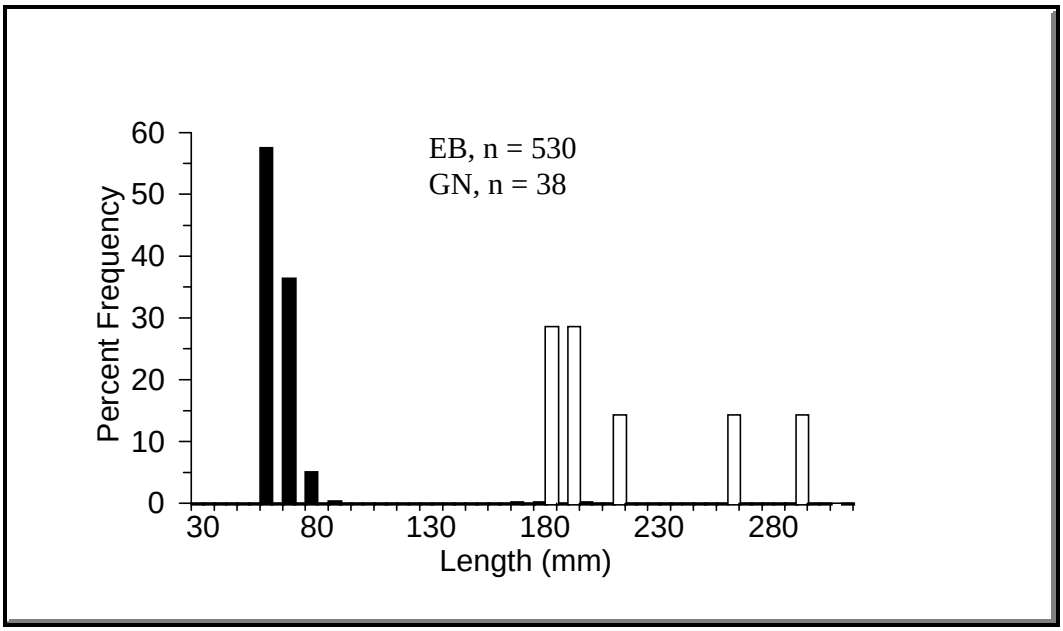

Figure 6. Electrofishing (dark bars) and gill netting (light bars) length frequency distribution of yellow perch from Black Lake, October 1999.

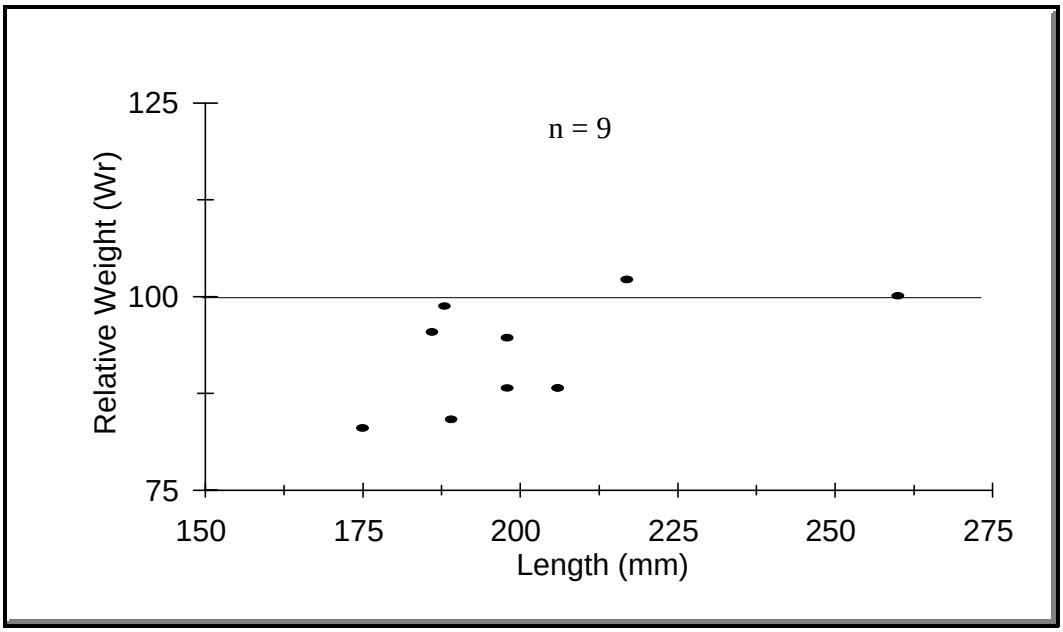

Figure 7. Condition (Wr), as compared to the national average (100), of yellow perch from Black Lake, October 1999.

Bluegill, (*Lepomis macrochirus*)

Bluegill size structure is dominated by stock size and smaller fish (Figure 8). PSD is 4 (± 2) which suggests that few quality size and larger bluegill exist in Black Lake and that this prey population is out of balance with the predator population (Table 4). PSD calculated from the 1994 population estimate (PSD = 25) on Black Lake is higher than the PSD from our fall survey. It appears that the bluegill population has shifted towards stock size and smaller fish over the past five years. However, like largemouth bass, this comparison should be viewed with caution due to dissimilar survey methodologies.

Bluegill condition is fair with individuals exhibiting either above or below relative weights (Figure 9). Growth of bluegill is below the state average until their fourth year of life, when growth surpasses the state average (Table 7).

Table 7. Fraser-Lee back–calculated length at age of bluegill from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)			
		I	II	III	IV
1998	13	35			
1997	10	48	102		
1996	11	44	84	112	
1995	3	70	117	146	169
Average		44	96	119	169
Direct Proportion		29	90	116	167
State Average		37	97	132	148

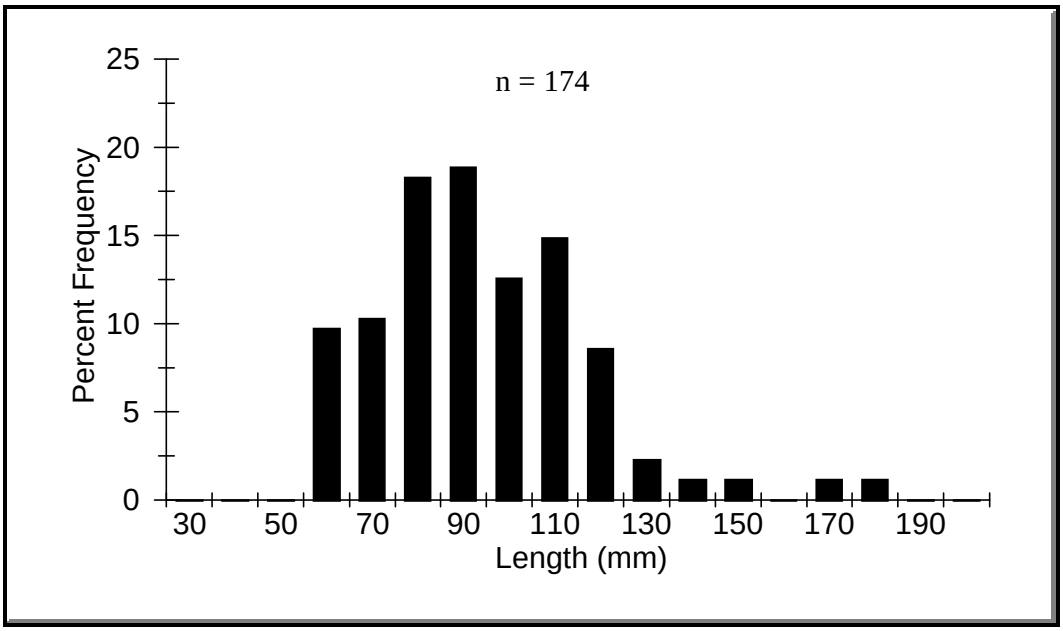

Figure 8. Electrofishing length frequency distribution of bluegill from Black Lake, October 1999.

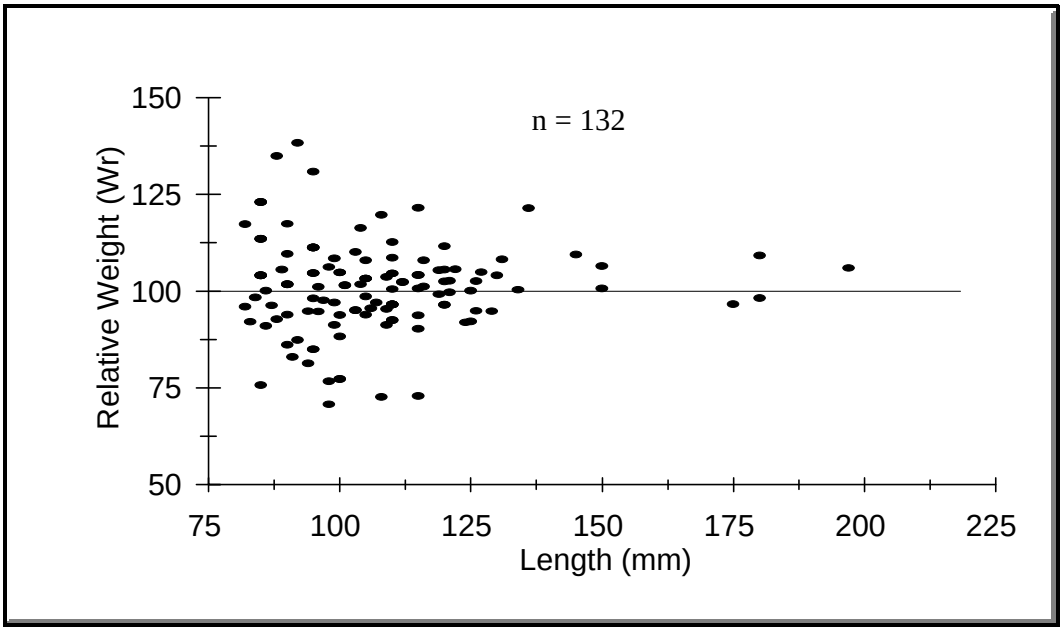

Figure 9. Condition (Wr), as compared to the national average (100), of bluegill from Black Lake, October 1999.

Black Crappie, (*Pomoxis nigromaculatus*)

The size structure of black crappie in our sample is dominated by fish smaller than stock size (Figure 10). PSD is 92 (± 10) which suggest a high number of quality size and larger black crappie exist is Black Lake (Table 4). However, due to the small sample size (n = 12) of stock size and larger fish, PSD may not accurately represent the population as a whole. Similar to our fall survey, the population estimate performed in 1994 on Black Lake yielded a high catch of small black crappie. Due to their schooling tendencies and unequal distribution around the lake (Scott and Crossman, 1998), large black crappie can be difficult to capture and may be under represented in our sample.

Black crappie condition is good with most individuals exhibiting relative weights above the national average (Figure 11). Growth exceeds the state average for most age classes (Table 8).

Table 8. Fraser-Lee back–calculated length at age of black crappie from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)		
		I	II	III
1998	1	72		
1997	4	70	146	
1996	9	68	151	202
Average		68	149	202
Direct Proportion		40	137	198
State Average		46	111	157

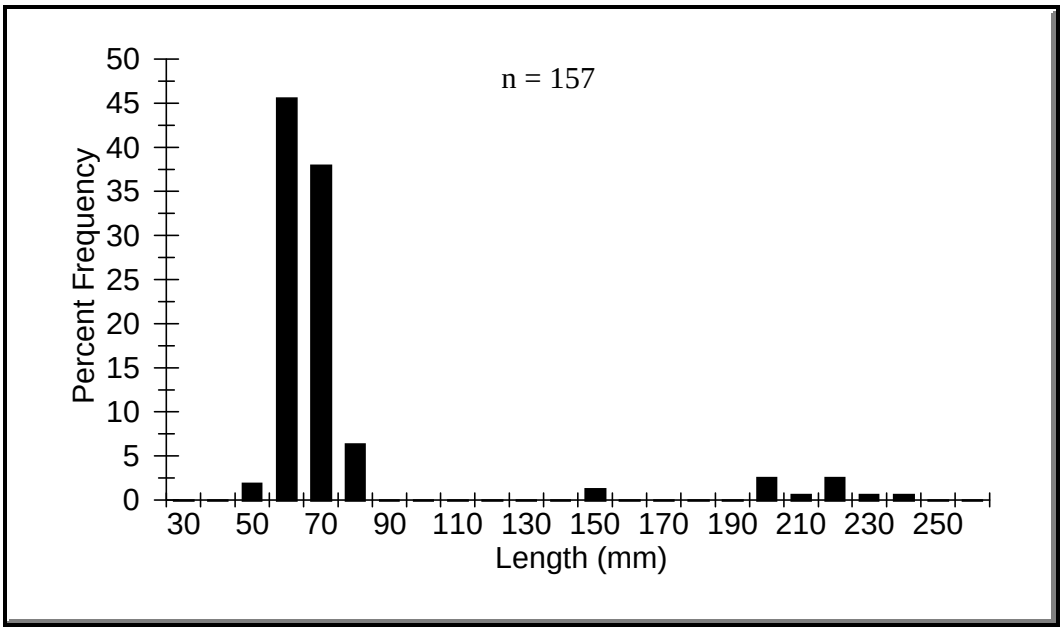

Figure 10. Electrofishing length frequency distribution of black crappie from Black Lake, October 1999.

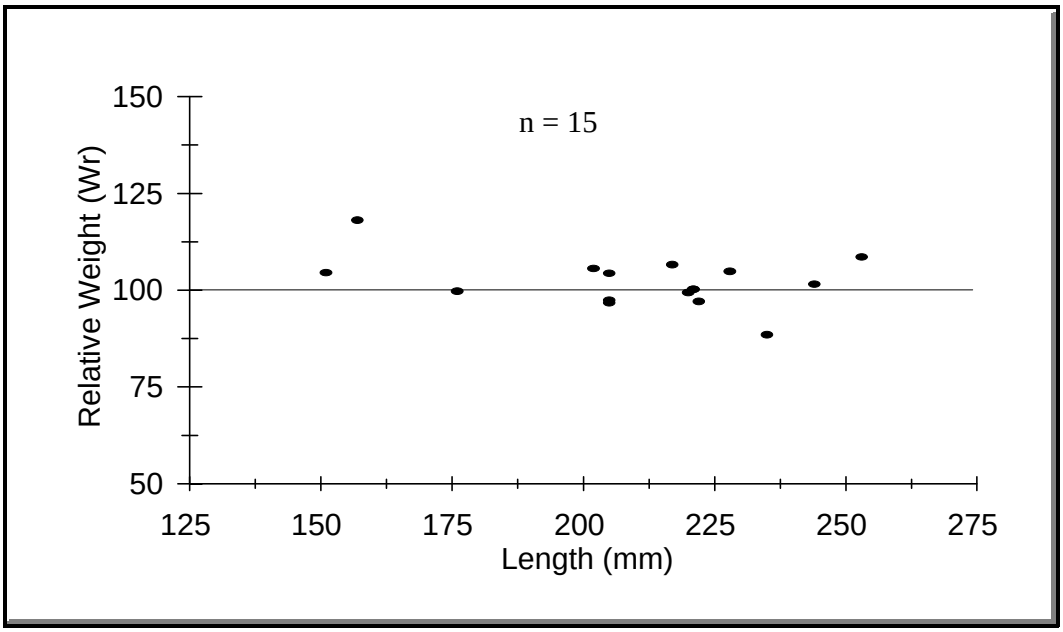

Figure 11. Condition (Wr), as compared to the national average (100), of black crappie from Black Lake, October 1999.

Brown Bullhead, (*Ictalurus nebulosus*)

Too few brown bullhead were sampled during the survey (n = 9, CPUE = 1 ± 1 fish/hour and gill net night) to warrant any analysis. Of those fish captured, their lengths ranged from 90-342 mm. Growth and condition calculations were not performed for brown bullhead.

Rock Bass, (*Ambloplites rupestris*)

Too few rock bass were sampled during the survey (n = 29, CPUE = 4 ± 2 fish/hour) to warrant any analysis. Of those fish captured, their lengths ranged from 41-248 mm. Rock bass condition is fair with most relative weights ranging between 90-100. Growth is above average until age 4 where growth falls below the state average (Table 9).

Table 9. Fraser-Lee back–calculated length at age of rock bass from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)					
		I	II	III	IV	V	VI
1998	0	-					
1997	2	52	73				
1996	4	60	93	116			
1995	8	54	96	129	150		
1994	5	57	93	130	159	182	
1993	2	54	97	123	153	176	194
Average		56	93	126	154	180	194
Direct Proportion		37	81	119	150	177	193
State Average		29	70	118	152	178	193

Smallmouth Bass, (*Micropterus dolomieui*)

Too few smallmouth bass were sampled during the survey (n = 12, CPUE = 1 ± 1 fish/hour) to warrant any analysis. Of those fish captured, their lengths ranged from 63-345 mm. Smallmouth bass condition is good with most relative weights ranging between 95-115. Growth is below the state average (Table 10).

Table 10. Fraser-Lee back–calculated lengths at age of smallmouth bass from Black Lake, October 1999.

Year Class	n	Mean Length at Age (mm)					
		I	II	III	IV	V	VI
1998	1	92					
1997	2	79	180				
1996	6	79	132	169			
1995	-	-	-	-	-		
1994	-	-	-	-	-	-	
1993	1	88	131	171	216	277	322
Average		81	143	169	217	277	322
Direct Proportion		57	130	161	202	269	320
State Average		70	146	212	268	334	356

Sculpin Spp.

A fair amount of sculpin were sampled (n = 64, CPUE = 30 ± 13 fish/hour) from Black Lake. Lengths for these fish ranged from 36-160 mm. Growth and condition calculations were not performed for sculpin.

Pumpkinseed, (*Lepomis gibbosus*)

Too few pumpkinseed were sampled during the survey (n = 4, CPUE = 2 ± 2 fish/hour) to warrant any analysis. Of those fish captured, their lengths ranged from 105-110 mm. Pumpkinseed condition is good with relative weights ranging between 95-105. Growth is above average for the three fish aged (all age 2).

Chinook, (*Oncorhynchus tshawytscha*)

Only one chinook was sampled during the survey. Its length was 420 mm. A weight was not taken, but assuming good condition the relative weight formula for chinook yielded a weight of 889 g. No growth calculations were performed for chinook.

Management Options

Overall, the quality of the warmwater fish populations in Black Lake appears poor. Densities of warmwater fish were either low (i.e., black crappie and smallmouth bass) or if numerous they were dominated by small fish (i.e., yellow perch, bluegill, largemouth bass). Since Black Lake receives a high level of use, it is plausible that harvest may be impacting warmwater fishery. An angler creel survey may help us better understand whether harvest is impacting the quality of the warmwater fishery The following are management options that are in the best interest of warmwater fishery in Black Lake:

1. Change the current regulation of five fish limit with no more than three fish over 15 inches to the proposed slot limit regulation (protective 12-17–inch slot with no more than five fish below or one fish above the slot). This regulation should provide protection from overharvest and improve the number of quality size fish in the population; and

2. Conduct a year–long creel survey to obtain information on angler pressure, preference, harvest, and satisfaction as it relates to the warmwater fish community in Black Lake. Knowing what is removed from the lake will help determine if harvest limits warmwater fish from producing a viable fishery or it some other factor is to blame.

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Appendix A

Table A1. Length categories that have been proposed for various fish species. Measurements are for total lengths (updated from Neumann and Anderson 1996).

	Category									
	Stock		Quality		Preferred		Memorable		Trophy	
Species	(in)	(cm)	(in)	(cm)	(in)	(cm)	(in)	(cm)	(in)	(cm)
Black bullhead[a]	6	15	9	23	12	30	15	38	18	46
Black crappie	5	13	8	20	10	25	12	30	15	38
Bluegill [a]	3	8	6	15	8	20	10	25	12	30
Brook trout	5	13	8	20						
Brown bullhead[a]	5	13	8	20	11	28	14	36	17	43
Brown trout	6	15	9	23	12	30	15	38	18	46
Burbot	8	20	15	38	21	53	26	67	32	82
Channel catfish	11	28	16	41	24	61	28	71	36	91
Common carp	11	28	16	41	21	53	26	66	33	84
Cutthroat trout	8	20	14	35	18	45	24	60	30	75
Flathead catfish	11	28	16	41	24	61	28	71	36	91
Green sunfish	3	8	6	15	8	20	10	25	12	30
Largemouth bass	8	20	12	30	15	38	20	51	25	63
Pumpkinseed	3	8	6	15	8	20	10	25	12	30
Rainbow trout	10	25	16	40	20	50	26	65	31	80
Rock bass	4	10	7	18	9	23	11	28	13	33
Smallmouth bass	7	18	11	28	14	35	17	43	20	51
Walleye	10	25	15	38	20	51	25	63	30	76
Warmouth	3	8	6	15	8	20	10	25	12	30
White catfish[a]	8	20	13	33	17	43	21	53	26	66
White crappie	5	13	8	20	10	25	12	30	15	38
Yellow bullhead	4	10	7	18	9	23	11	28	14	36
Yellow perch	5	13	8	20	10	25	12	30	15	38

[a] As of this writing, these new, or updated length classifications have yet to go through the peer review process, but a proposal for their use will soon be in press (Timothy J. Bister, South Dakota State University, personal communication).