An Assessment of The Warmwater Fish Community in Leland Lake, September 1999

by

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Abstract

Leland Lake was surveyed by a three–person crew on September 13 and 14, 1999. Multiple gear types (electrofishing, gill netting, and fyke netting) were utilized to reduce the sampling bias associated with each sampling method. Largemouth bass and bluegill were the most abundant species sampled both numerically (47 and 36.5%, respectively) and by weight (70.9 and 10.7%, respectively). Other species sampled during the survey, in order from highest to lowest abundance, include: yellow perch, black crappie, brown bullhead, sculpin, coho, and cutthroat trout. Although few in number, Leland Lake provides the opportunity for anglers to catch largemouth bass that are near trophy size (≥ 630 mm). Bluegill do not appear to be fairing as well as largemouth bass. Bluegill size structure is dominated by fish stock size and smaller. Currently, yellow perch provides angling opportunity for fish up to 250 mm. All warmwater species exhibited good condition and growth above or near the state average. Our management recommendations for Leland Lake include placing the proposed bass slot limit regulation on the lake, promoting the bass and yellow perch fisheries. Additionally, a creel survey is recommended to assess the current level of angler preference, pressure, and harvest on warmwater fish.

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Introduction and Background

Leland Lake is a 110–acre water body located north of Quilcene on Old Leland Valley Road off State Highway 101 in Jefferson County. The lake is fed by an unnamed stream at the northern end and is drained by Leland Creek at the southern end. Leland Creek eventually flows into the Little Quilcene River. There is one access site located on the west shoreline of Leland Lake and is owned by Washington Department of Fish and Wildlife and Jefferson County. The majority (87%) of the land surrounding Leland Lake is forest land and few near shore homes (12) reside on the lake.

Historically, Leland Lake was managed as a opening day lake receiving between 10,000-12,000 catchable rainbow trout annually. In 1994, the season was changed to a year–round fishing so that warmwater fish could be utilized as well as trout by anglers. Today, Leland Lake is managed as a mixed–species water.

Materials and Methods

Data Collection

Leland Lake was surveyed by a three–person team on September 13 and 14, 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 five 1.2–m diameter hoops with two funnels, and an 2.4–m cod end (¼ inch nylon delta mesh). Attached to the mouth of the net were two 5–m wings, and a 30.3–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 74% 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 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 two locations around the lake, whereas fyke nets were set overnight at two locations.

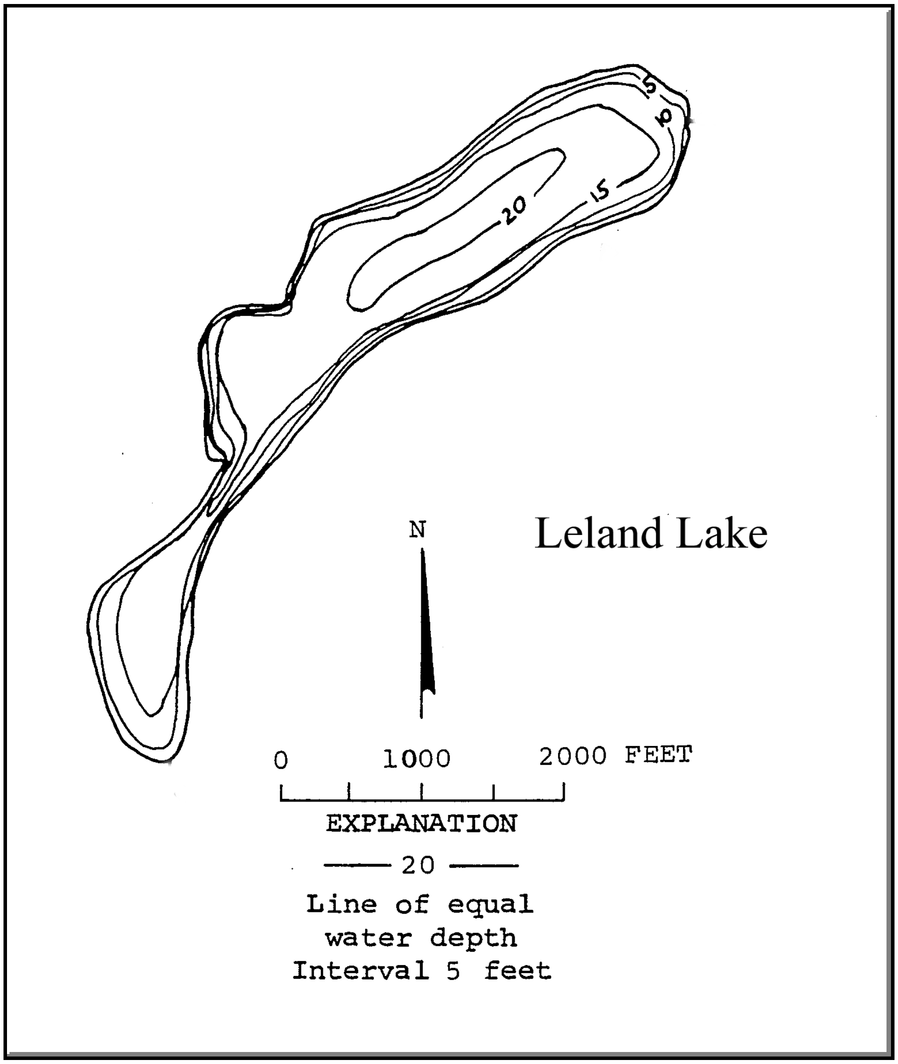

Figure 1. Map of Leland Lake, Jefferson County.

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 subsample (N ~100 fish) were measured, and the remainder were just counted. The frequency distribution of the subsample 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 usually aged.

Water quality data was collected during mid–day from one location on September 14, 1999. Using a Hydrolab® probe and digital recorder, dissolved oxygen, temperature, pH, and conductivity data was gathered from 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. YOY 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 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 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 an 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 1988) to provide an estimate of statistical precision. Appendix A lists, by species, length categories used to calculate 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

Leland Lake is a small water body (110 acres) with a maximum depth of 6.1 m and a mean depth of 4.0 m. The shoreline development value is 1.9, which describes Leland Lake as oval in shape with few shoreline irregularities. Submergent and floating vegetation surrounds the entire shoreline, but covers only 10% of the surface area on the lake.

The water quality in Leland Lake is within optimal limits for warmwater fish (Table 1). However, below 4 m the lake becomes quite anoxic with DO levels below 1 ppm. Conductivity is low (<100 µs/cm) throughout the water column and below the optimum range (100-400 µs/cm) for electrofishing efficiency outlined by Willis (1998). Low conductivity could affect sampling if electricity is not effectively transferred from the water into a fishes body.

Table 1. Water quality measurements taken from Leland Lake, September 14, 1999. Measurements taken at noon from mid–lake.

Location	Depth (m)	Temp (C)	Ph	DO mg/l	Cond µs/cm
Mid-Lake	Surface	19.9	6.5	8.9	65.5
	1	18.2	7.0	9.2	65.2
	2	17.7	7.2	9.5	64.9
	3	17.4	6.8	7.4	64.8
	4	16.2	6.1	0.4	72.8
	5	13.3	6.1	0.2	86.5
	6	12.2	6.4	0.2	145.9

Species Composition and Relative Abundance

In all, eight species of fish were sampled from Leland Lake (Table 2). Of those, largemouth bass and bluegill were the most abundant numerically at 47.0 and 36.5%, respectively. Together, largemouth bass and bluegill accounted for 81.6% of the total biomass (70.9 and 10.7%, respectively). Following bass and bluegill in order of highest to lowest abundance was yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), brown bullhead (*Ictalurus nebulosus*), coho (*Oncorhynchus kisutch*), cutthroat (*Oncorhynchus clarki*), and sculpin spp.

Table 2. Species composition by weight and number for fish sampled (age 1 and older) from Leland Lake, September 1999.						
	Species Composition					
	by Weight		**by Number**		**Size Range (mm TL)**	
Species	**(kg)**	**(%w)**	**(#)**	**(%n)**	**Min**	**Max**
Brown bullhead	2.4	3.4	10	1.5	143	317
Black crappie	4.3	6.1	21	3.2	103	276
Bluegill	7.4	10.7	240	36.5	26	213
Coho	0.1	0.2	1	0.2	223	223
Sculpin	0.0	0.1	3	0.5	92	123
Cutthroat trout	0.1	0.1	1	0.2	200	200
Largemouth bass	49.2	70.9	309	47.0	30	561
Yellow perch	5.9	8.5	73	11.1	47	242

Similar to species composition, largemouth bass and bluegill exhibited the highest catch per unit efforts (CPUE) at 67 fish/hour and 122 fish/hour, respectively for electrofishing (Table 3). With the exception of yellow perch (16 fish/net night, ± 4.5), gill and trap nets were ineffective at capturing warmwater fish.

Table 3. Average catch per unit effort for fish sampled from Leland Lake, September 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	7	4	8	0	0	2	0	0	2
Black Crappie	11	4	8	2	2	2	0	0	2
Bluegill	122	56	8	0	0	2	3	3	2
Coho	0	0	8	0.5	0.6	2	0	0	2
Sculpin, Unknown	2	1	8	0	0	2	0	0	2
Cutthroat	0	0	8	0.5	0.6	2	0	0	2
Largemouth Bass	67	14	8	2	1	2	0	0	2
Yellow Perch	23	10	8	16	5	2	0	0	2

Summary by Species

Largemouth Bass (*Micropterus salmoides*)

Largemouth bass size structure is good with a number of different size classes represented in the sample (Figure 2). A fair number of bass stock size and larger (n = 89) were captured during the survey. Largemouth bass PSD is 26 (± 6), which suggests a fair number of quality size and larger fish exist in Leland Lake and that the predator population is balanced with the prey population (Table 4). Densities of bass quality size and larger may be underestimated. Due to either low conductivity or sampling season, some bass may have avoided capture during our survey. Low conductivity reduces the efficiency in which electricity is transferred from the water into a fishes body. Even though fall is an appropriate time to sample warmwater fish, quality size and larger largemouth bass capture is greatest during the spring due to warmer water temperatures following the winter and pre–spawning activities.

Largemouth bass condition is good with nearly all individuals above the national average (Figure 3). With the exception of a few age classes, largemouth bass growth is below the state average (Table 5). With condition above the national average, it seems unlikely that forage base is the cause of slow growth in bass, especially in the presence of a dense bluegill population. A more plausible explanation would be the short growing season northern latitude lakes exhibit.

Table 4. Stock density indices (electrofishing and gill netting) for fish sampled from Leland Lake, September 1999.

		Quality		Preferred		Memorable		Trophy	
Species	**# Stock Length**	**PSD**	**80% CI**	**RSD-P**	**80% CI**	**RSD-M**	**80% CI**	**RSD-T**	**80% CI**
Electrofishing									
Brown Bullhead	9	89	13	22	18	0	0	0	0
Black Crappie	15	100	0	60	16	0	0	0	0
Bluegill	163	13	3	2	1	0	0	0	0
Largemouth Bass	89	26	6	18	5	2	2	0	0
Yellow Perch	30	20	9	0	0.0	0	0	0	0
Gill Netting									
Black Crappie	3	67	35	0	0	0	0	0	0
Largemouth Bass	4	0	0	0	0	0	0	0	0
Yellow Perch	31	42	11	0	0	0	0	0	0

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

		Mean Length at Age (mm)													
Year Class	**n**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1998	24	66													
1997	18	70	120												
1996	18	73	145	189											
1995	25	63	116	178	217										
1994	7	73	128	193	248	239									
1993	3	61	140	188	237	277	311								
1992	4	84	169	225	264	296	333	355							
1991	4	74	148	232	280	322	354	390	422						
1990	6	80	171	214	259	319	351	386	408	432					
1989	3	93	167	223	273	341	366	393	421	447	466				
1988	-	-	-	-	-	-	-	-	-	-	-	-			
1987	-	-	-	-	-	-	-	-	-	-	-	-	-		
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1985	1	73	118	150	168	206	245	319	385	424	452	477	508	533	547
Average		70	134	193	238	290	339	377	413	435	456	477	508	533	547
Direct Pro.		55	124	186	233	286	336	375	411	434	461	474	506	532	546
St. Average		60	146	222	261	289	319	368	396	440	485	472	496	N/A	N/A

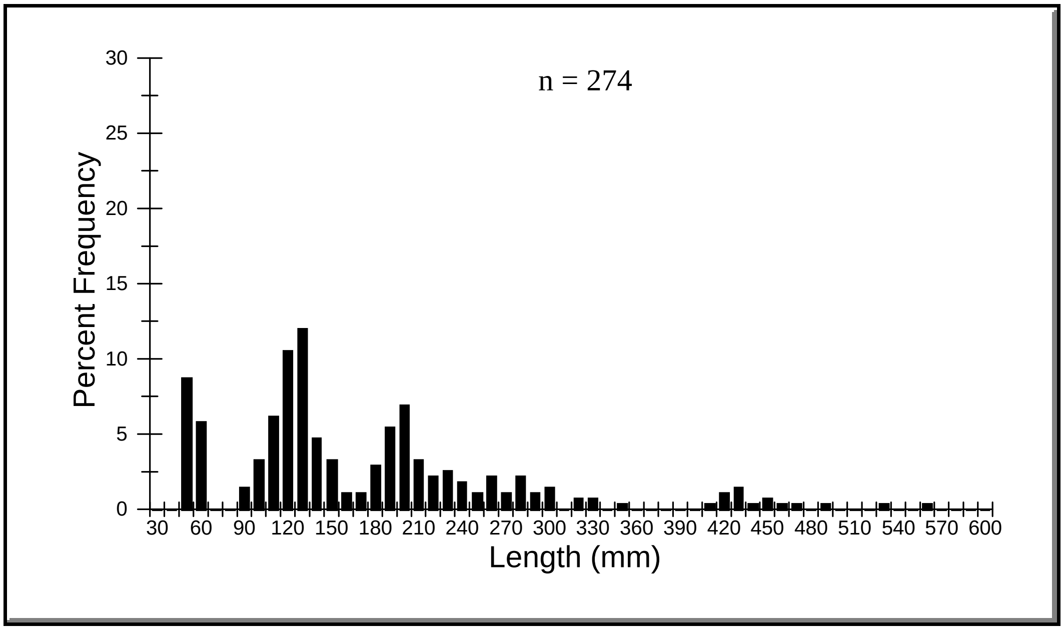

Figure 2. Electrofishing length frequency distribution of largemouth bass from Leland Lake, September 1999.

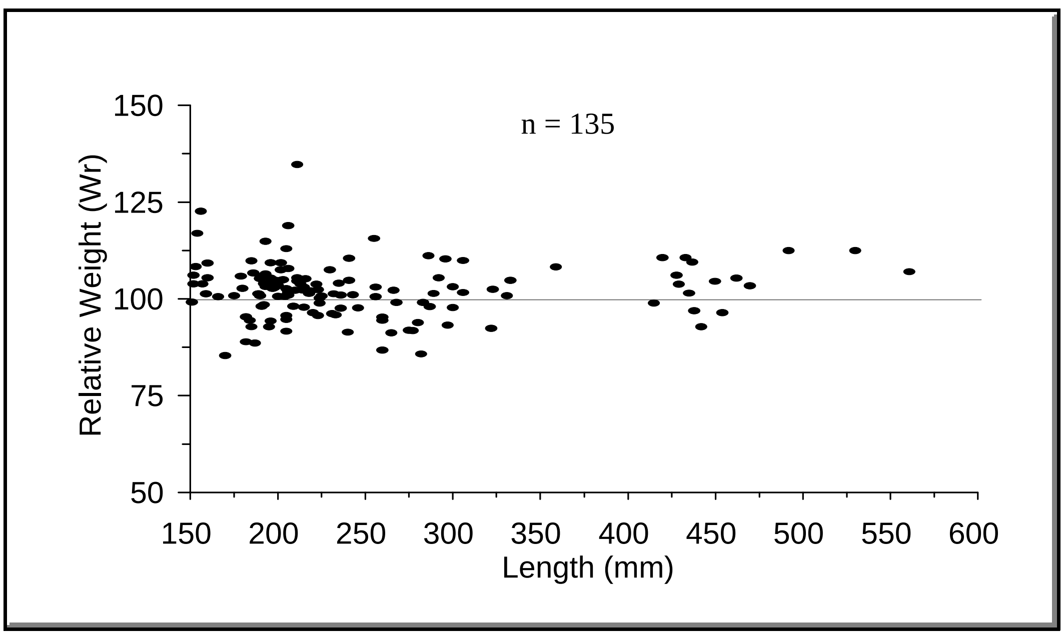

Figure 3. Condition (Wr), as compared to the national average (100), of largemouth bass from Leland Lake, September 1999.

Bluegill (*Lepomis macrochirus*)

Bluegill size structure is weighted towards fish stock size and smaller (Figure 4). Few fish greater than150 mm were encountered during the survey. Furthermore, a PSD of 13 (± 3) suggests that the bluegill population is out of balance with the predator population (Table 4). Bluegill condition is good with the majority of individuals above the national average (Figure 5). Growth is similar to the state average (Table 6). With near average growth and good condition, it's unlikely that competition for food resources or space is limiting bluegill from becoming a viable fishery. One explanation for the apparent lack of quality and larger size bluegills may be overharvest, assuming Leland Lake receives enough angler pressure.

Table 6. Fraser-Lee back–calculated length at age of bluegill from Leland Lake, September 1999.

		Mean Length at Age (mm)				
Year Class	**n**	**1**	**2**	**3**	**4**	**5**
1998	11	48				
1997	19	63	97			
1996	18	51	98	130		
1995	7	53	93	136	161	
1994	2	65	99	136	176	199
1993	1	56	86	113	132	143
Average		55	96	131	161	180
Direct Proportion		42	90	128	159	178
State Average		37	97	132	148	170

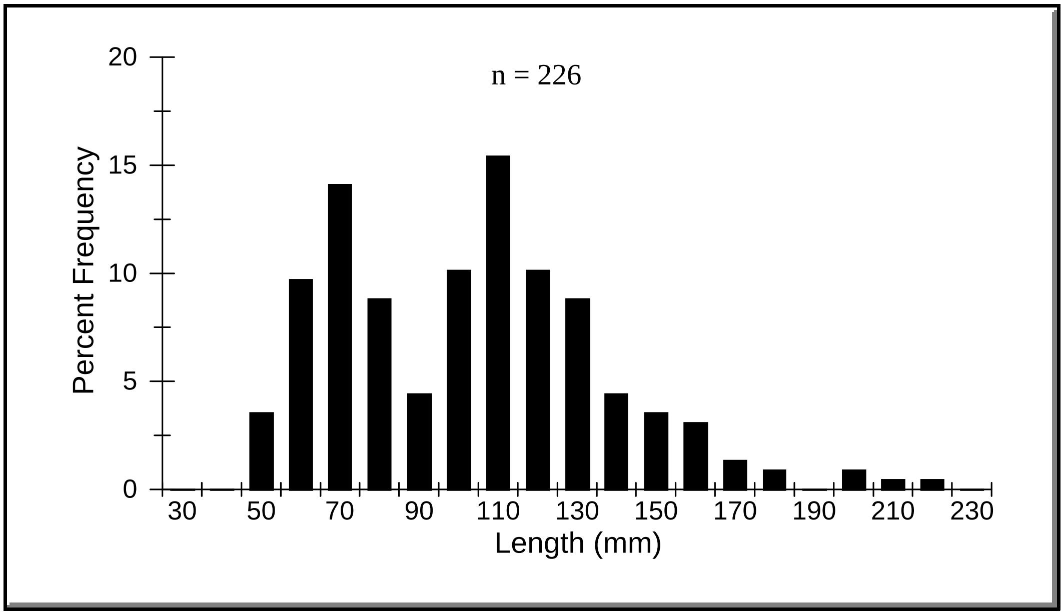

Figure 4. Electrofishing length frequency distribution of bluegill from Leland Lake, September 1999.

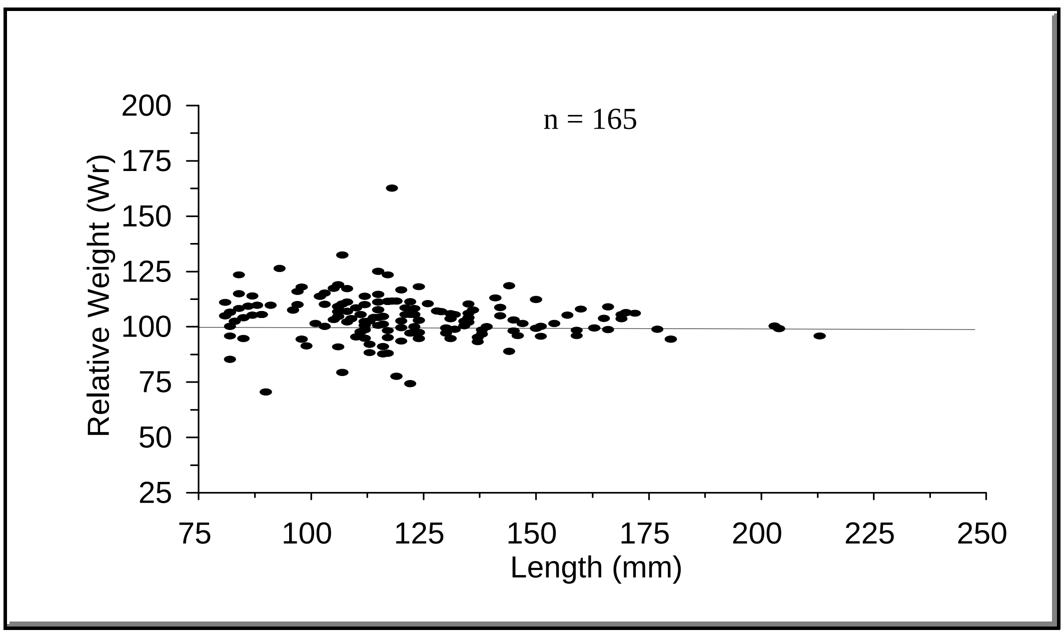

Figure 5. Condition (Wr), as compared to the national average (100), of bluegill from Leland Lake, September 1999.

Yellow Perch (*Perca flavescens*)

Yellow perch size structure is comprised of stock and quality size fish (Figure 6). Between electrofishing (20 ± 9) and gill netting (42 ± 11) PSD, Leland Lake appears to support a fishable population of yellow perch (Table 4). However, judging from CPUE and species composition, it appears that yellow perch densities are low.

Yellow perch condition is good with the majority of the individuals ranging between 90-105 (Figure 7). Growth is greater than the state average (Table 7). Even in the presence of a dense bluegill population, it appears that yellow perch are fairing well and providing a viable fishery.

Table 7. Fraser-Lee back–calculated length at age of yellow perch from Leland Lake, September 1999.

		Mean Length at Age (mm)			
Year Class	**n**	**1**	**2**	**3**	**4**
1998	4	85			
1997	17	80	135		
1996	17	87	150	175	
1995	7	97	149	183	211
1994	1	87	130	167	190
Average		86	143	177	208
Direct Proportion		67	136	173	206
State Average		60	120	173	193

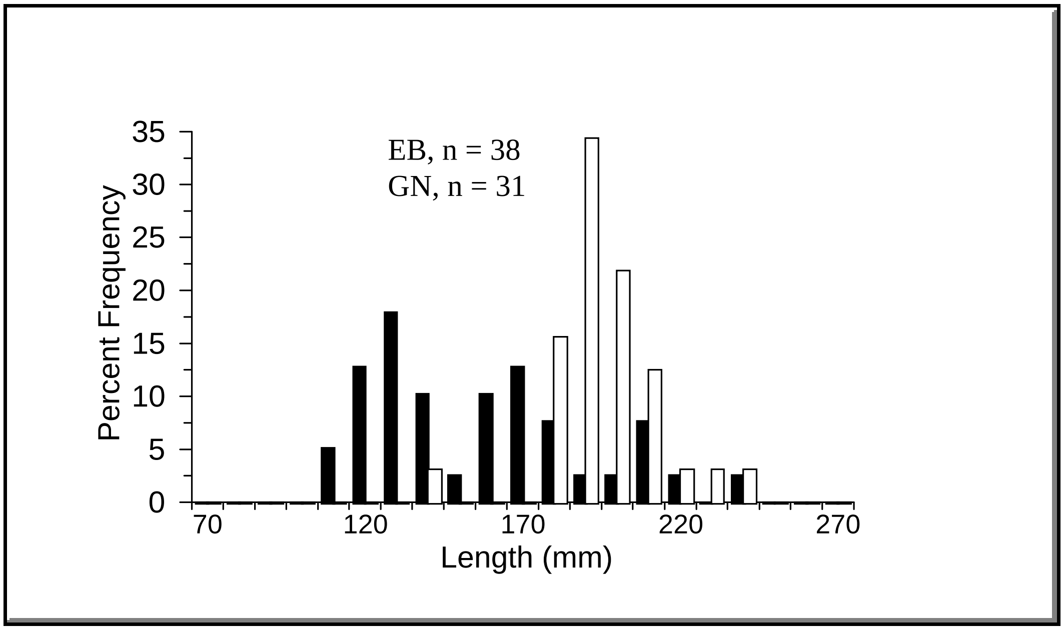

Figure 6. Electrofishing (dark bars) and gill netting (light bars) length frequency distribution of yellow perch from Leland Lake, September 1999.

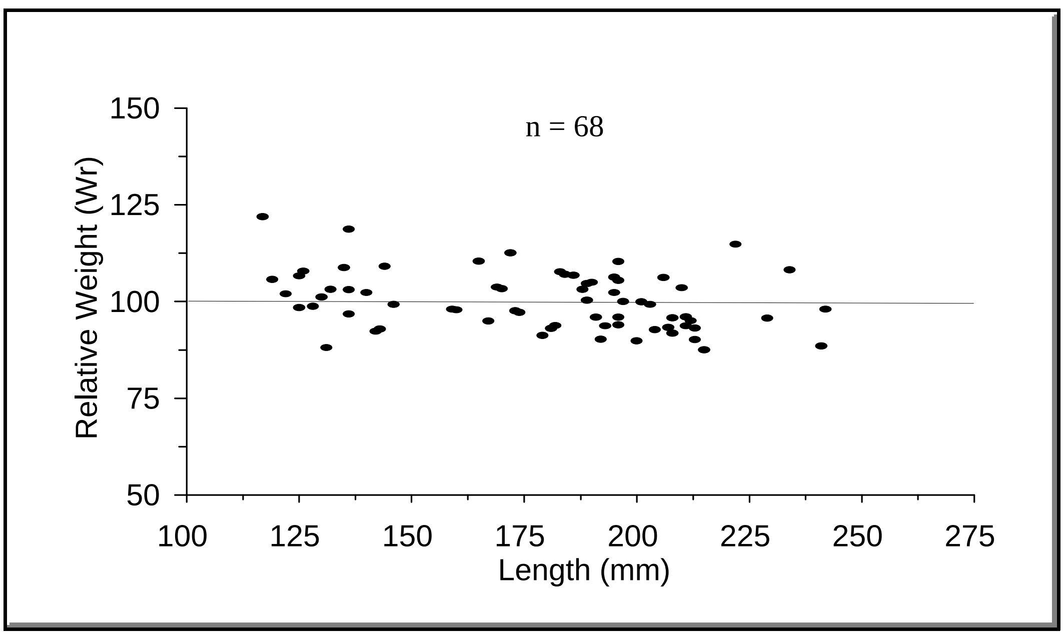

Figure 7. Condition (Wr), as compared to the national average (100), of yellow perch from Leland Lake, September 1999.

Black Crappie (*Pomoxis nigromaculatus*)

Too few black crappie were sampled during the survey (n = 21, CPUE = 11 fish/hour ± 4) to warrant any analysis. Of those fish captured, their lengths ranged from 103-276 mm. Black crappie condition is good with most relative weights ranging between 95-100. Growth is average for most age classes (Table 8).

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

		Mean Length at Age (mm)					
Year Class	**n**	**1**	**2**	**3**	**4**	**5**	**6**
1998	1	57					
1997	2	97	133				
1996	4	75	137	178			
1995	6	69	106	170	219		
1994	3	94	143	185	217	247	
1993	2	68	96	119	154	193	237
Average		77	122	168	207	225	237
Direct Proportion		51	104	157	200	220	234
State Average		46	111	157	183	220	224

Brown Bullhead (*Ictalurus nebulosus*)

Too few brown bullhead were sampled during the survey (n = 10, CPUE = 7 fish/hour ± 4) to warrant any analysis. Of this fish captured, their lengths ranged from 143-317 mm. Growth and condition calculations were not performed for brown bullhead.

Sculpin Spp*.*

Too few sculpin were sampled during the survey (n = 3, CPUE = 2 fish/hour ± 1) to warrant any analysis. Of those fish captured, their lengths ranged from 92-123 mm. Growth and condition calculations were not performed for brown bullhead.

Coho (*Oncorhynchus kisutch*)

Too few coho were sampled during the survey (n = 1, CPUE = <1 fish/net night ± .6) to warrant any analysis. The singular coho sampled measured 223 mm. Growth and condition calculations were not performed for coho. The presence of this fish in our sample suggests that coho are spawning in the inlet, however, the extent of spawning activity that occurs is unknown. Furthermore, the use of Leland Lake by rearing coho is probably minimal due the extensive weed beds during the summer (Dan Collins WDFW, personnel communication).

Cutthroat Trout (*Oncorhynchus clarki*)

Too few cutthroat trout were sampled during the survey (n = 1, CPUE = <1 fish/net night ± .6) to warrant any analysis. The singular cutthroat trout sampled measured 200 mm. Growth and condition calculations were not performed for cutthroat. The origin of this fish is most likely from the spawn of two adult cutthroat from the last hatchery plant still present in Leland Lake (Dan Collins WDFW, personnel communication).

Management Options

Even though densities of largemouth bass quality size and above appear low, Leland Lake still provides opportunity to catch large fish up to 600 mm. A means to increase densities and maintain the fishery would be to change the bass regulation to one that limits harvest. The proposed bass regulation (12-17–inch slot, five fish daily and no more than one fish over 17 inches) should provide adequate protection for fish within the slot from harvest.

Overall, with the exception of yellow perch, panfish populations do not appear to be fairing as well as largemouth bass. Currently, it is unclear why panfish do not consistently produce viable fisheries in this state. One area worth investigating would be the angler creel. Assuming that Leland Lake receives enough angling pressure, it is possible the lack of quality size and larger panfish may be related to harvest.

The following are management options that are within the best interest of Leland Lake:

1. Change the present largemouth bass regulation on Leland Lake (five fish daily limit with no more than three fish over 15 inches) to the proposed slot limit (12-17 inches mm slot, five fish daily limit, but no more than one fish over 432). This regulations should provide the protection necessary for fish within the slot against harvest.

2. Promote the largemouth bass fishery. Currently, the Leland Lake bass population provides the opportunity to catch fish stock size and chance to catch a few that are memorable size (510-629 mm).

3. Conduct a creel survey to understand angler pressure, preference, harvest, and satisfaction as it relates to the warmwater fish community in Leland Lake. A creel survey may provide information on the number of quality and larger size panfish either harvested or caught that appear to be absent from our samples.

4. Although quality size yellow perch appear to be few in number, Leland Lake may provide some of the best angling opportunity for perch in the region. Promoting the yellow perch fishery would be permissible, however, if angling pressure and harvest increases, the population structure may shift towards smaller individuals in short time.

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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).