1999 Warmwater Fish Survey of Harts Lake, Pierce County

by

Stephen J. Caromile,
Chad S. Jackson and
William Meyer

Washington Department of Fish and Wildlife
Fish Program
Warmwater Enhancement Program
600 Capitol Way North
Olympia, Washington 98501-1091

May 2000

Acknowledgments

This project was funded by the Warmwater Enhancement Program, which is providing greater opportunity to fish for and catch warmwater fish in Washington. We thank Doug Fletcher for reading all of the scales and Steve Jackson and John Pahutski for their help with the field collections. We also thank Jennifer Parsons, Aquatic Plant Specialist, Washington Department of Ecology, for providing us a list of aquatic plants species found during her most recent survey of Harts Lake. We also thank Steve Jackson, Chuck Baranski, and Jay Hunter for providing comments on the draft report.

Abstract

The warmwater fish population of Harts Lake was sampled May 24-25, 1999. A total of eight species of fish were encountered. Harts Lake is currently managed as a mixed–species lake, receiving put–and–take trout plants, as well as channel catfish plants. The warmwater fish survey showed the fish population to be in balance, with above average growth for all species, except black crappie (*Pomoxis nigromaculatus*). The population survey needs to be completed with an angler creel survey to determine angler harvest and pressure, especially of channel catfish. The continued planting of channel catfish is supported, although more work is needed to fine tune stocking numbers and to balance that with annual harvest and mortality.

Table of Contents

List of Tables

List of Figures

Introduction and Background

Harts Lake is a small (48.6 hectare), deep (15.25m) water body located in Pierce County. There are few houses located on the shoreline, and the surrounding land is mostly agricultural. There are three unnamed inlets, one being from Little Lake and one unnamed outflow.

Harts Lake is currently managed as a mixed–species lake. It receives hatchery trout plants to support a put–and–take fishery, and it has also received two plants of channel catfish (*Ictalurus punctatus*), also for a put–and–take fishery.

Materials and Methods

Data Collection

Harts Lake was surveyed by a three–person team during May 24-25, 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 5.0GPP pulsator unit. The boat was fished using a pulsed DC current of 120 cycles/second at 3-4 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 4–foot diameter hoops with two funnels, and an 8–foot cod end (¼ inch nylon delta mesh). Attached to the mouth of the net were two 25–foot wings, and a 100–foot 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 100% 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 1-2 feet below the water surface, this sometimes would require shortening the lead. Gill nets were set overnight at four (4) locations around the lake, whereas fyke nets were also set overnight at four (4) 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 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

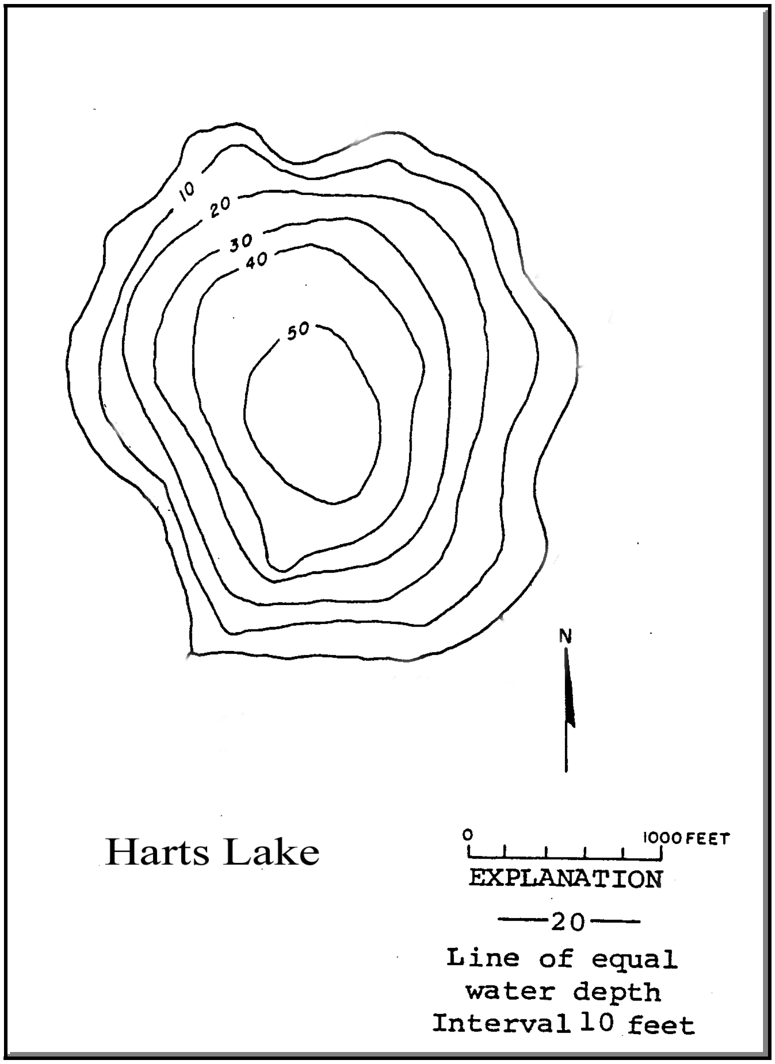

Figure 1. Bathymetric map of Harts Lake, Pierce County, taken from Bortelson et al. (1976).

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 (Table 1) was collected during mid–day from two locations on May 26, 1999. Using a Hydrolab® probe and digital recorder, dissolved oxygen, redox, temperature, pH, and conductivity data was gathered in the littoral zone and in the deepest section of the lake at 1 m intervals through the water column. Secchi disk readings, used to measure transparency, were taken by the methods outlined by Wetzel (1983).

Table 1. Water quality parameters collected from Harts Lake, Pierce County. Water quality data was collected mid-day, May 26, 1999.

	Depth (m)	Temp (°C)	Oxygen (mg/l)	Conductivity μ s / cm^2
Location 1	0	20.2	10.12	152
	1	19.9	10.26	153
	2	14.7	7.34	155
	3	13.26	6	155
	4	11.66	4.38	155
	5	9.78	3.04	155
	6	8.41	2.8	157
	7	7.87	2.29	155
	8	7.7	2.32	158
	9	7.5	1.74	161
	10	7.34	0.75	154
	11	7.06	0.18	163
	12	7.04	0.13	163

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). Percentage of the aggregate biomass for each species provided useful information regarding the balance and productivity of the community (Swingle 1950, Bennett 1962). 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). For example, the length frequency distribution of yellow perch (*Perca flavescens*) may suggest successful spawning during a given year, as indicated by an abundance of fish in the smallest size classes. However, most of these fish would be subject to natural attrition during their first winter, resulting in a different size distribution by the following year.

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 (Appendix A), 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 and is shown in Table 4.

For fishes in which there is no published stock size (i.e., sculpins, suckers, etc.), CPUE is calculated using all individuals captured. Furthermore, since it is standardized, the CPUE is useful for comparing stocks between lakes.

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, mean age one length minus one standard deviation), and calculated as the number of individuals of a species in a given size class, divided by the total individuals of that species sampled. Plotting the histogram this way tends to flatten out large peaks created by an abundant size class, and makes the graph a little easier to read. These length frequency histograms are helpful when trying to evaluate the size and age structure of the fish community and their relative abundance in the lake.

Stock Density Indices

Stock density indices are used to assess the size structure of fish populations. Proportional stock density (PSD and relative stock density RSD) are calculated as proportions of various size classes of fish in a sample. The size classes are referred to as minimum stock (S), quality (Q), preferred (P), memorable (M), and trophy (T). Lengths have been published to represent these size classes for each species, and were developed to represent a percentage of world–record lengths as listed by the International Game Fish Association (Gablehouse 1984). These lengths are presented in Appendix A.

The indices calculated here are described by Gablehouse (1984) as the traditional approach. The indices are accompanied by an 80% confidence interval (Gustafson 1988) to provide an estimate of statistical precision.

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 1.0 generally indicates a fish in good condition when compared to the national average for that species and size. Furthermore, relative weights are useful for comparing the condition of different size groups within a single population to determine if all sizes are finding adequate forage or food (ODFW 1997). Following Murphy and Willis (1991), the index was calculated as $W_r = W/W_s \times 100$, 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). For the species where data are available, the W_r values from this study are compared to an average W_r value calculated from lakes that have been surveyed across the state by the warmwater enhancement teams (Stephen Caromile, WDFW, unpublished data), and the national standard (W_r=100).

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

Water quality parameters were collected from Harts Lake on May 26, 1999, and are shown in Table 1. Dissolved oxygen levels start to get low at depths greater than four meters, most likely due to low light penetration and decreased photosynthesis. There are few houses along the shoreline of Harts Lake, but these homes undoubtedly are responsible for part of the nutrient input into the lake from lawn fertilizers and septic systems. As well, a large chicken farm and cattle pasture along the south western shore adds to the nutrient input of the lake.

There has been little manipulation of the shoreline; bulkhead and dock construction accounts for less than 1% of the total shoreline. Aquatic plants are abundant along the shoreline, with the fragrant waterlily (*Nymphaea odorata*) being the most abundant emergent plant around the lake. A complete aquatic vegetation survey was completed by Department of Ecology, their findings are presented in Appendix B.

Species Composition and Relative Abundance

A total of eight fish species were encountered at Harts Lake; brown bullhead (*Ameiurus nebulosus*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), black crappie (*Pomoxis nigromaculatus*), rainbow trout (*Oncorhynchus mykiss*), pumpkinseed (*Lepomis gibbosus*), and cutthroat trout (*Oncorhynchus clarki*).

Brown bullhead and yellow perch were the two most abundant species and accounted for almost 70% of the total biomass collected (Table 2). There were also close to four times as many largemouth bass sampled as there were channel catfish, but the bass only accounted for twice the biomass as the channel catfish.

Stock density indices (Table 3) show that the fish community in Harts Lake is in balance. In fact, the largemouth bass population seems to be in between “balanced” and the “big bass” range; though the sample size for fish larger than stock length was extremely low. For a review of stock density index ranges for balanced fish populations, consult Willis et al (1993).

Catch per unit of effort for each species is shown in Table 4, broken out by gear type, and is given for fish that are stock size and greater. Electrofishing proved to be the most effective method of capture for most species; the highest catch rates were for yellow perch and brown bullhead. Gill netting was the only method of capture for channel catfish and rainbow trout.

Table 2. Species composition by weight (kg), and number of fish captured at Harts Lake (Pierce County) during the spring 1999 warm water fish survey.

Species	Species Composition by Weight (kg)	(%w)	by Number (#)	(%n)	Size Range (mm TL) Min	Max
Brown bullhead	51.9	34.4	107	10.1	118	372
Black crappie	8.8	5.8	95	9.0	53	259
Channel catfish	11.7	7.8	20	1.9	280	465
Cutthroat trout	0.1	0.0	1	0.1	192	192
Largemouth bass	20.3	13.5	92	8.7	85	516
Pumpkinseed	3.3	2.2	54	5.1	40	182
Rainbow trout	4.6	3.0	15	1.4	260	419
Yellow perch	50.2	33.3	676	63.8	75	265

Table 3. Stock density indices by gear type and length categories for the fish population at Harts Lake during the spring 1999 warm water fish survey.

Species	# Stock Length	Quality PSD	80% CI	Preferred RSD-P	80% CI	Memorable RSD-M	80% CI	Trophy RSD-T	80% CI
Electrofishing									
Brown bullhead	71	99	2	68	7	0	--	0	--
Black crappie	30	63	11	13	8	0	--	0	--
Largemouth bass	17	59	15	35	15	6	7	0	--
Pumpkinseed	40	53	10	0	--	0	--	0	--
Yellow perch	425	11	2	0	--	0	--	0	--
Gill Netting									
Brown bullhead	25	100	0	84	9	0	--	0	--
Black crappie	26	15	9	0	--	0	--	0	--
Largemouth bass	4	50	32	0	--	0	--	0	--
Rainbow trout	15	13	11	0	--	0	--	0	--
Yellow perch	196	27	4	1	1	0	--	0	--
Fyke Netting									
Brown bullhead	10	100	0	40	20	0	--	0	--
Black crappie	14	93	9	0	--	0	--	0	--
Yellow perch	2	0	--	0	--	0	--	0	--

Table 4. Average catch per unit of effort (number of fish caught/hour of electrofishing and number of fish caught/ net night) for stock sized and larger fish sampled in Harts Lake during the spring 1999 warmwater fish survey.

Species	Electrofishing (# / hour)	80% CI	Sample Sites	Gill Netting #/net night	80% CI	# net nights	Fyke Netting #/net night	80% CI	# net nights
Brown bullhead	49.3	11.0	9	6.3	2.4	4	2.5	1.6	4
Black crappie	24.8	12.8	9	6.5	3.5	4	3.5	3.2	4
Channel catfish	0.0	--	9	5.0	0.9	4	0.0	--	4
Largemouth bass	12.1	3.9	9	1.0	0.5	4	0.0	--	4
Pumpkinseed	29.3	12.1	9	0.3	0.3	4	0.0	--	4
Rainbow trout	0.0	--	9	3.8	2.2	4	0.0	--	4
Yellow perch	289.3	58.6	9	49.0	9.3	4	0.5	0.6	4

Summary by Species

Brown Bullhead (*Ameiurus nebulosus*)

Brown bullhead account for more than one–third of the total biomass of our sample (Table 2). The length frequency distribution (Figure 2) shows that there is nearly a complete lack of smaller fish in the electrofishing sample. The gill net and fyke net samples resembled the electrofishing distribution as well. Brown bullhead can be an important game fish in many lakes.

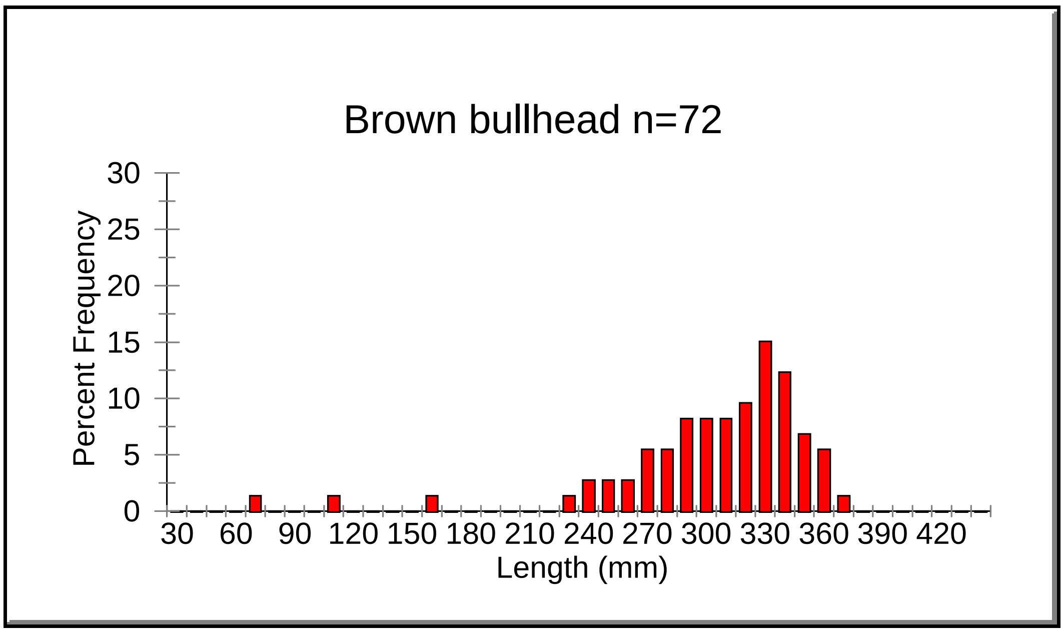

Figure 2. Length frequency distribution of brown bullhead from electrofishing during the spring 1999 warm water fish survey of Harts Lake, Pierce County.

Yellow Perch (*Perca flavescens*)

The length frequency distribution (Figure 3) of yellow perch shows the relative distribution of size classes in our sample. There is a size bias related to gear type; gill nets caught proportionally more larger fish than electrofishing. The peaks in the distribution corresponds pretty closely to back–calculated length at age shown in Table 5.

Relative weight values (W_r) for yellow perch (Figure 3) are pretty standard for western Washington perch. On the average, relative weights for yellow perch in western Washington lakes tend to be slightly below the national standard of 100. The high number sampled in Harts Lake forms a dark band on the graph between roughly 85-95. Figure 4 suggests that prey availability may be slightly limiting the overall growth of yellow perch. The low relative weights are probably an artifact of the timing of our sample. Seasonal variation in relative weight has been shown for many species. Guy and Willis (1991) have shown mean W_r for yellow perch to decrease from March though June, possibly attributed to pre– and post–spawn periods. W_r then increased again through August.

Back–calculated length at age (Table 5) is higher than the average for western Washington lakes. The high growth rates indicate that perch are not crowded and stunting, and that overall conditions in the lake are favorable. Once again, the low relative weights mentioned above are most likely seasonal variability.

Table 5. Back–calculated length at age (Fraser-Lee) for yellow perch sampled from Harts Lake, Pierce County, during the spring 1999 warmwater fish survey. Direct proportion averages are provided for comparison to historical data.

		Mean Length at Age (mm)					
Year Class	**n**	**1**	**2**	**3**	**4**	**5**	**6**
1998	13	84					
1997	14	97	156				
1996	15	97	149	181			
1995	10	98	154	179	200		
1994	4	106	167	193	215	231	
1993	6	96	137	168	194	211	227
Fraser-Lee	62	95	152	180	201	219	227
Direct Proportion		80	145	175	198	217	226
State Average (d.p.)		60	120	152	193	206	197

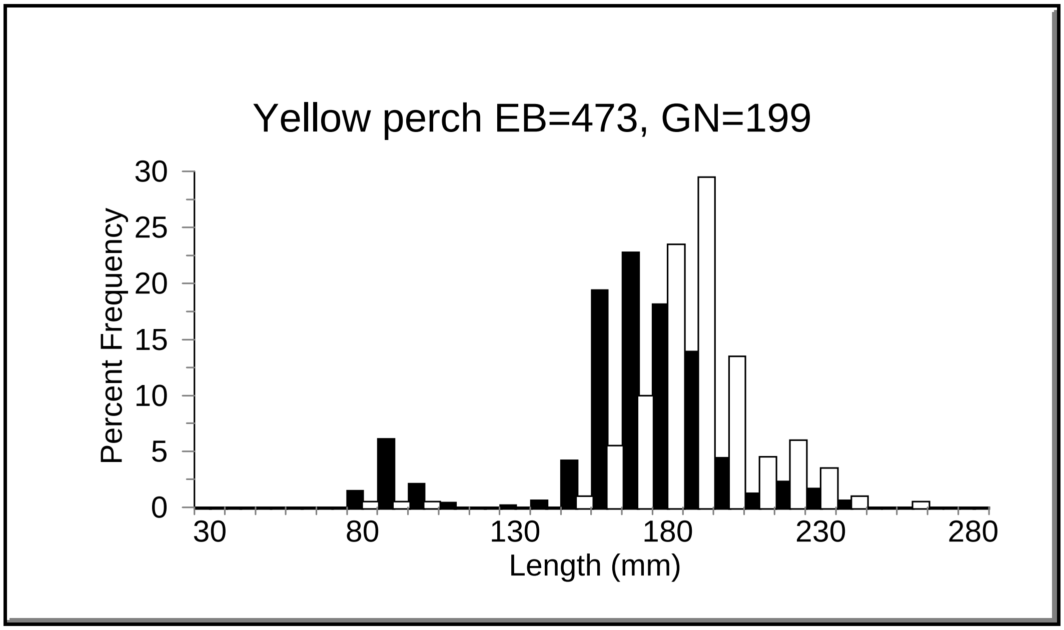

Figure 3. Length frequency distribution of yellow perch from electrofishing (dark bars) and gill netting (light bars) during the spring 1999 warmwater fish survey of Harts Lake, Pierce County.

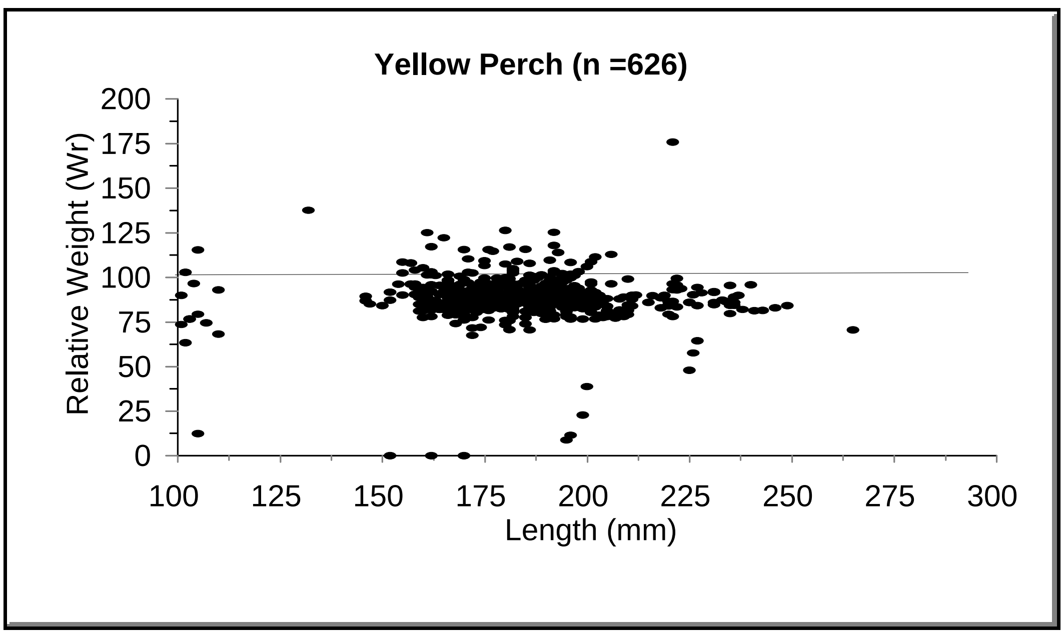

Figure 4. The relationship between total length and relative weight (Wr) for yellow perch sampled at Harts Lake during the spring 1999 warmwater fish survey.

Largemouth Bass (*Micropterus salmoides*)

The length frequency distribution of the largemouth bass sampled at Harts Lake is shown in Figure 5. The frequency distribution shows that there was a single year class that was dominant in the sample, and most other year classes were demonstrated by only a few individuals. It is probable that this does not reflect the true distribution of size classes in the population, but what was close to shore during our sampling.

Figure 6 shows the relative weights of largemouth bass in Harts Lake during the spring. Though the plot is pretty scattered, especially for the smaller size classes, it shows a gradual upward trend; W_r increases gradually with increasing length. This could be attributed to the fact that larger fish use less energy reserves through the winter and enter the spring in better overall condition. Another possible explanation is that some of the smaller size classes are using more of their energy reserves during the spawning season, resulting in a lower overall W_r.

Back–calculated length at age (Table 6) for largemouth bass is higher than the average for western Washington lakes for all age classes. This would suggest that prey is not limiting, and that fish are not in a crowded situation. The missing 1993 year class could be due to poor survival of that particular year class, but is more probably related to the overall low sample size of bass.

Table 6. Back–calculated length at age (Fraser-Lee) for largemouth bass sampled from Harts Lake, Pierce County, during the spring 1999 warmwater fish survey. Direct proportion averages are provided for comparison to historical data.

		Mean Length at Age (mm)								
Year Class	**n**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1998	1	101								
1997	24	92	161							
1996	11	79	149	211						
1995	4	85	180	259	305					
1994	4	80	162	242	286	307				
1993	0									
1992	2	142	192	268	310	370	404	427		
1991	1	104	188	259	317	379	423	467	498	
1990	2	116	157	224	281	344	393	428	450	466
Fraser-Lee	49	91	162	232	297	337	403	435	466	466
Direct Proportion		78	156	228	294	334	400	434	465	466
State Average (d.p.)		60	146	222	261	289	319	368	396	440

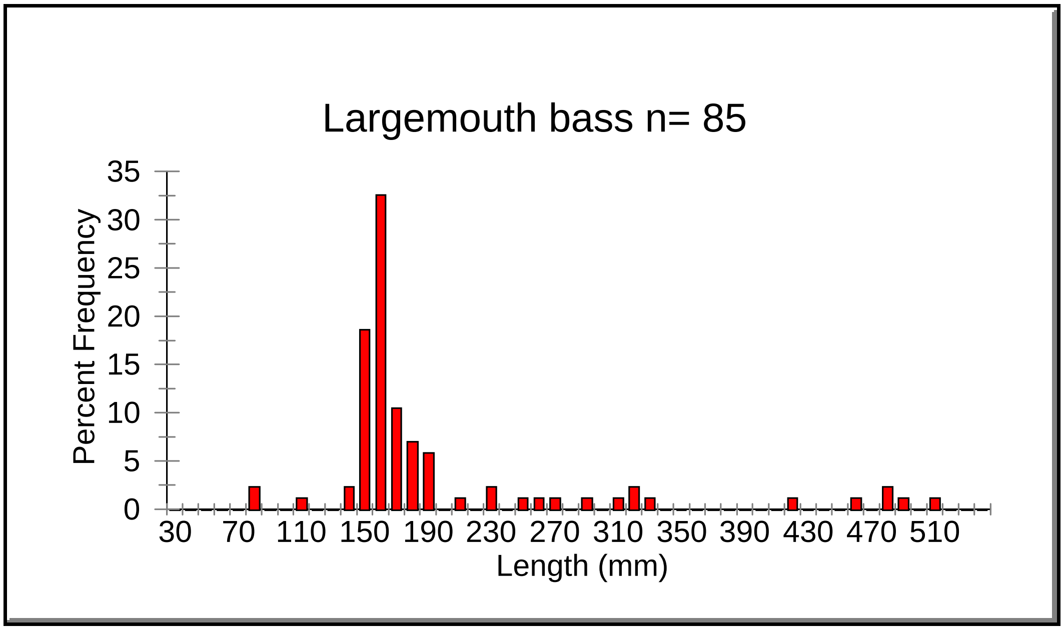

Figure 5. Length frequency distribution of largemouth bass from electrofishing during the spring 1999 warmwater fish survey of Harts Lake, Pierce County.

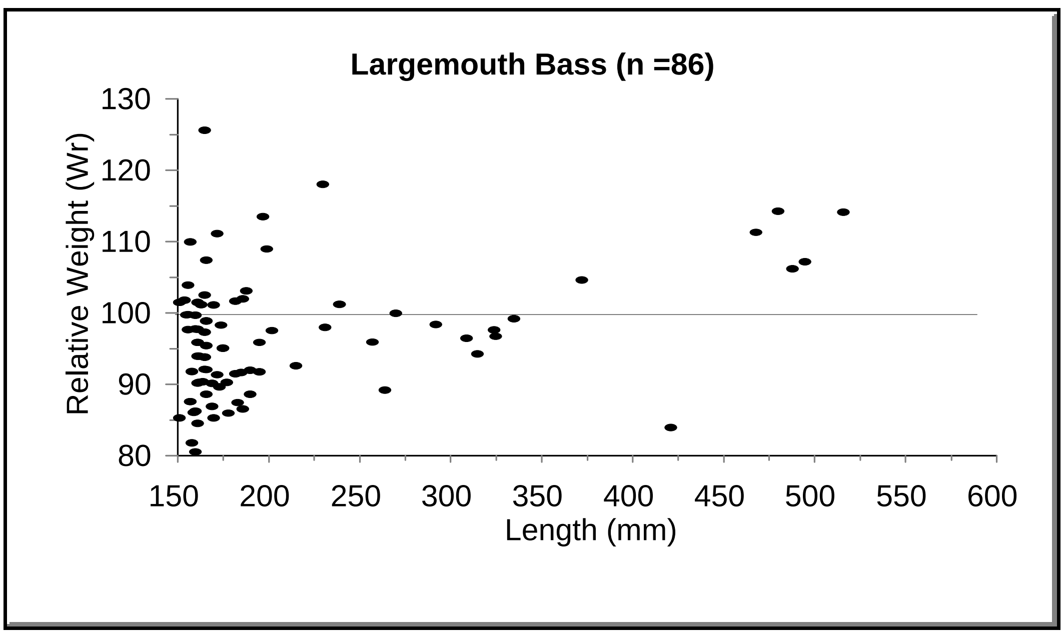

Figure 6. The relationship between total length and relative weight (Wr) for largemouth bass sampled at Harts Lake during the spring 1999 warmwater fish survey.

Channel Catfish (*Ictalurus punctatus*)

Channel catfish were introduced into Harts Lake by the Washington Department of Fish and Wildlife during 1998. The initial introduction was a total of 500 fish at approximately 2.9 fish/kg (about 20 cm). Fish were stocked again, after our survey, in November 1999, 64 fish (1.1 fish/kg or 25-45 cm) and 1,200 (34 fish/kg or 10-12 cm) were stocked. The channel catfish were a stock purchased from Chico, California.

The length frequency distribution of the channel catfish in our gill net sample is shown in Figure 7. The channel catfish sample was comprised of about twenty fish which, in general, is not enough fish to create a meaningful length frequency distribution. But this figure is interesting in that it shows a wide variability in growth rates from the 1998 stocking.

The relative weights of the stocked channel catfish (Figure 8) were higher than the national standard of 100. This shows that the channel catfish are not limited by prey availability.

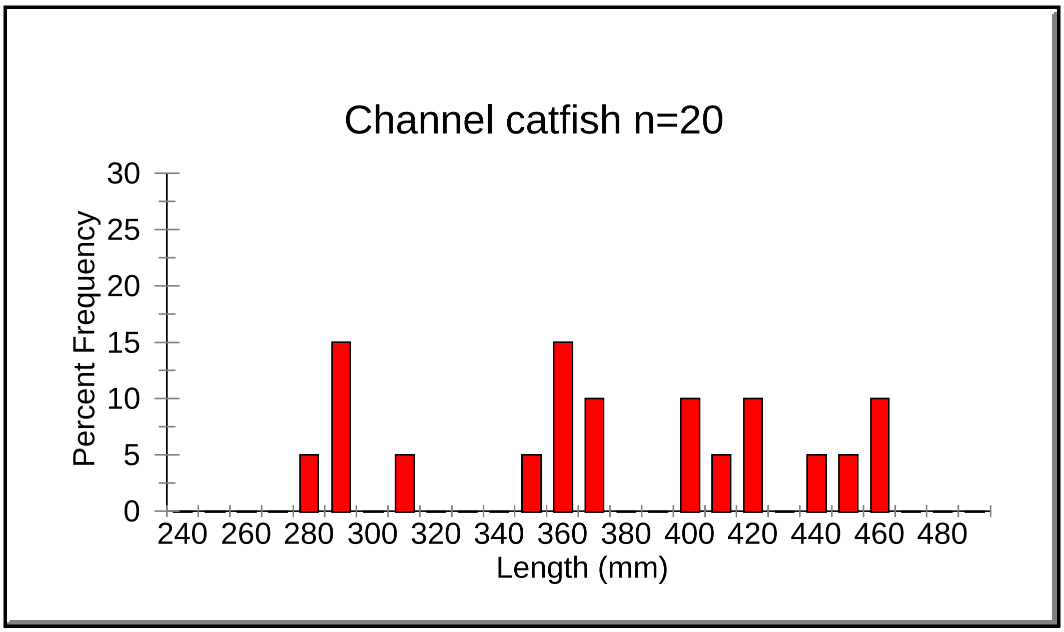

Figure 7. Length frequency distribution of channel catfish sampled by gill net during the spring 1999 warmwater fish survey of Harts Lake, Pierce County.

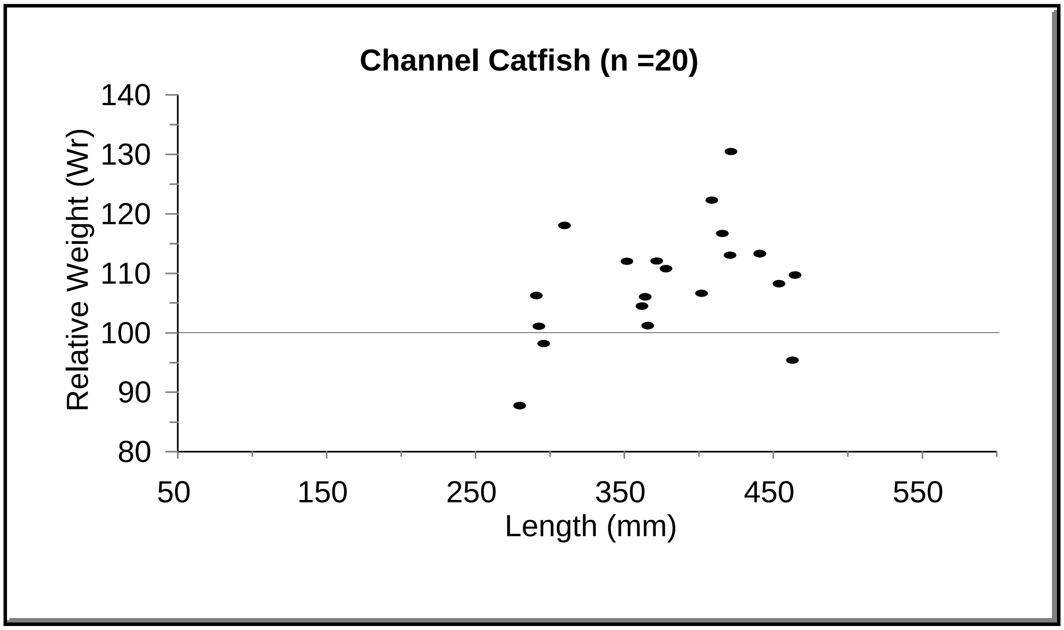

Figure 8. The relationship between total length and relative weight (Wr) for channel catfish sampled at Harts Lake during the spring 1999 warmwater fish survey.

Black Crappie (*Pomoxis nigromaculatus*)

The length frequency distribution of black crappie sampled in Harts Lake is shown in Figure 9. The figure shows the size distribution of the catch from electrofishing and fyke netting. Sometimes there is a size bias related to gear type, but it appears that fyke nets and electrofishing sampled the same portion of the population, possibly because our nets were set very close to shore.

Figure 10 shows the relative weights of black crappie sampled in Harts Lake. Relative weights start off higher than the standard, but decrease as growth increases. Viewing the back–calculated length at age (Table 7), you also see that crappie start off growing a little faster than the average for western Washington, but this soon drops off to below average growth. It appears that crappie are hitting some sort of bottleneck which is limiting their overall growth and health. It is possible that they are limited by prey, especially the larger crappie, which prefer small fish over zooplankton as prey. It is probable that the crappie population in Harts Lake is being out–competed by the spring plants of rainbow trout for food.

Table 7. Back–calculated length at age (Fraser-Lee) for black crappie sampled from Harts Lake, Pierce County, during the spring 1999 warmwater fish survey. Direct proportion averages are provided for comparison to historical data.

		Mean Length at Age (mm)						
Year Class	**n**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1998	1	89						
1997	23	72	125					
1996	10	80	121	146				
1995	7	74	126	178	218			
1994	10	69	113	145	187	221		
1993	1	80	127	175	200	225	239	
1992	4	62	104	131	161	188	213	231
Fraser-Lee	56	73	121	152	193	213	218	231
Direct Proportion		49	110	142	186	209	215	230
State Average (d.p.)		46	111	157	183	220	224	261

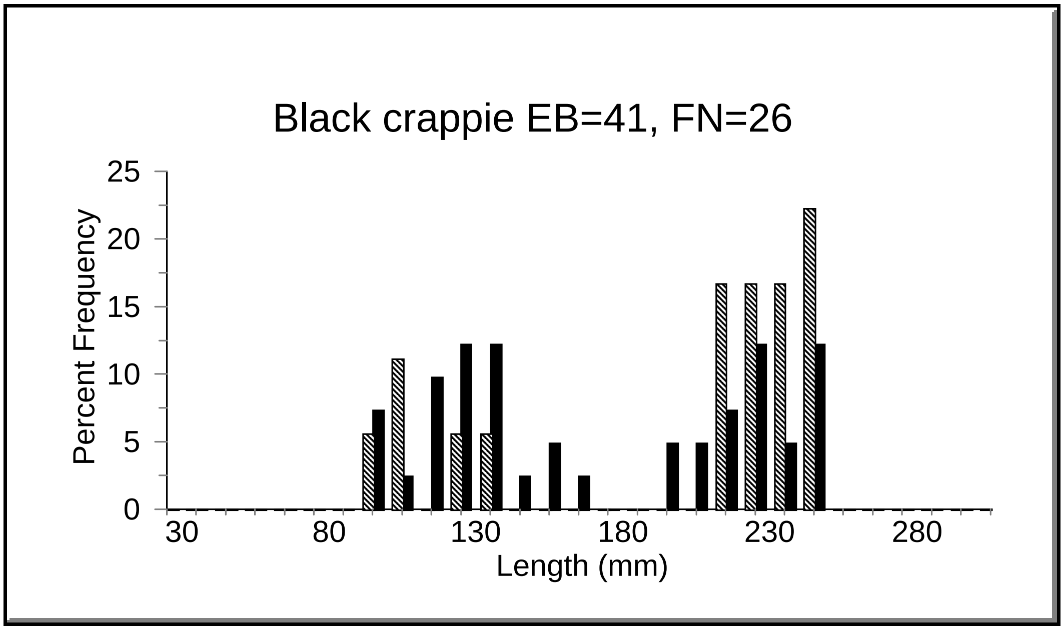

Figure 9. Length frequency distribution of black crappie from electrofishing (dark bars) and fyke netting (hatched bars) during the spring 1999 warmwater fish survey of Harts Lake, Pierce County.

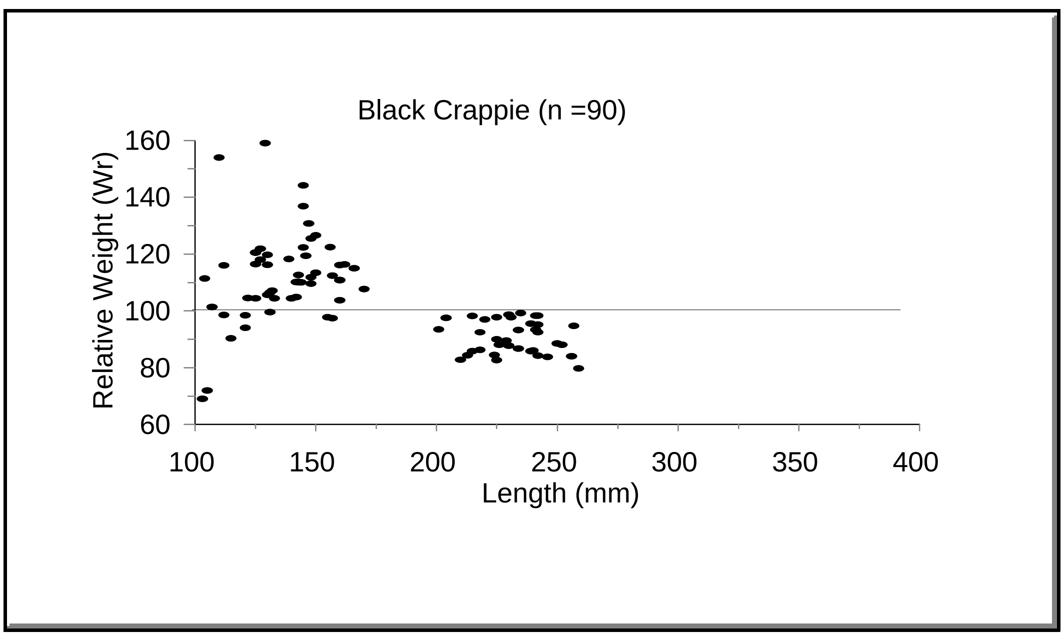

Figure 10. The relationship between total length and relative weight (Wr) for black crappie sampled at Harts Lake during the spring 1999 warmwater fish survey.

Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout are stocked yearly into Harts Lake to support a put–and–take fishery. As shown by the relative weight graph (Figure 11), hatchery trout of the same size can exhibit a wide range of fitness, depending on how well the individual has adapted to living in the wild.

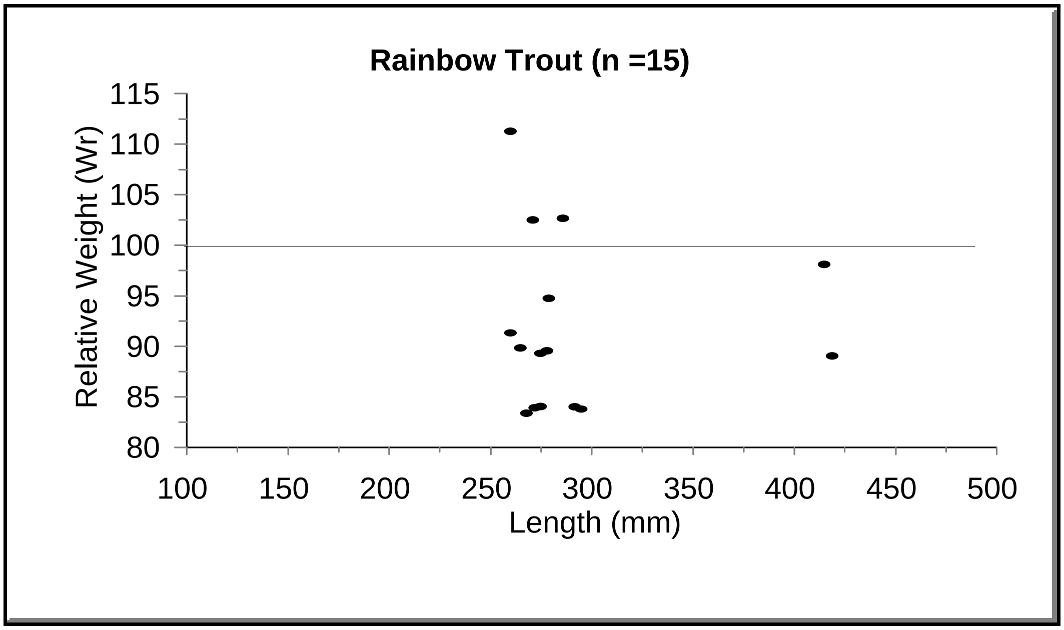

Figure 11. The relationship between total length and relative weight (Wr) for rainbow trout sampled at Harts Lake during the spring 1999 warmwater fish survey.

Pumpkinseed (*Lepomis gibbosus*)

The length frequency distribution of pumpkinseed sampled by electrofishing at Harts Lake is shown in Figure 12. The highest density of pumpkinseed is in the 130-180mm (5-8 inches) size range. Pumpkinseed are probably the major forage for largemouth bass and channel catfish and could account for the lower density of the smaller size classes.

The relative weights for pumpkinseed in Harts Lake (Figure 13) are slightly higher than the national standard. Values start off low for the smaller size classes, and increase as length increases. A possible explanation for low W_r for the smaller size classes is that they had to utilize more of their energy reserves through the winter. The first winter is a major source of natural mortality, due to low food availability, and smaller fish are less robust. In general, the higher relative weights show that pumpkinseed are not limited by prey.

Back–calculated length at age for pumpkinseed (Table 8) shows growth to be above average for lakes in western Washington. Pumpkinseed often are prone to overpopulation, causing stunted growth. The pumpkinseed population in Harts Lake is probably held in check by the major predators, bass and channel catfish. The above average relative weights, again, point to a readily available food supply for these fish which is translated into growth.

Table 8. Back–calculated length at age (Fraser-Lee) for pumpkinseed sampled from Harts Lake, Pierce County, during the spring 1999 warmwater fish survey. Direct proportion averages are provided for comparison to historical data.

		Mean Length at Age (mm)					
Year Class	**n**	**I**	**II**	**III**	**IV**	**V**	**VI**
1998	2	51					
1997	6	60	110				
1996	11	54	92	129			
1995	8	46	85	126	152		
1994	4	45	76	99	127	145	
1993	1	47	75	95	122	142	168
Fraser-Lee	32	51	91	122	142	145	168
Direct Proportion		33	81	117	139	143	168
State Average (d.p.)		24	72	102	123	139	147

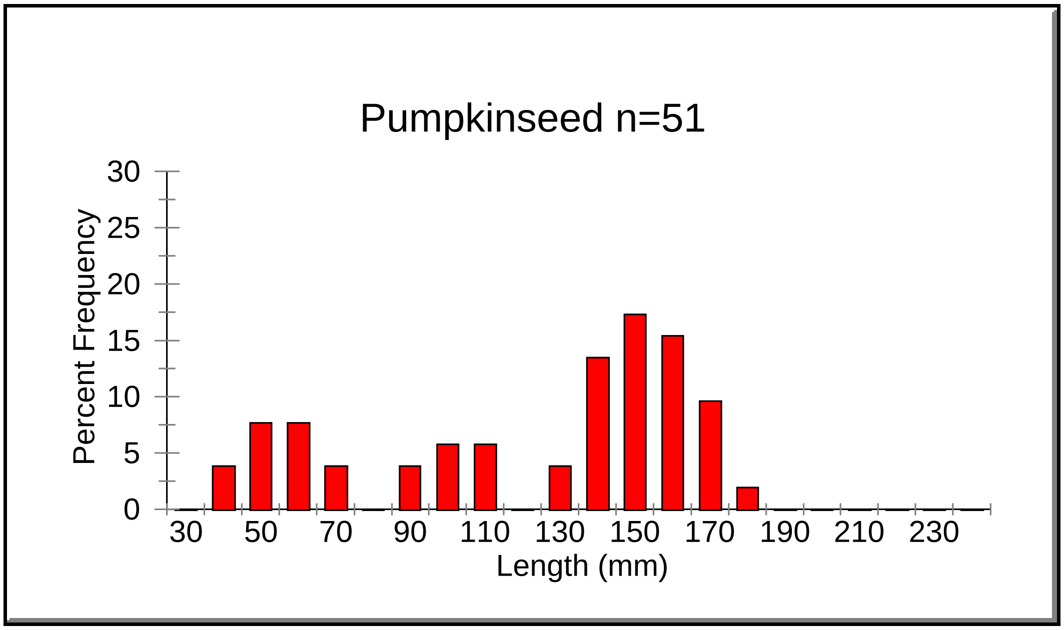

Figure 12. Length frequency distribution of pumpkinseed from electrofishing during the spring 1999 warmwater fish survey of Harts Lake, Pierce County.

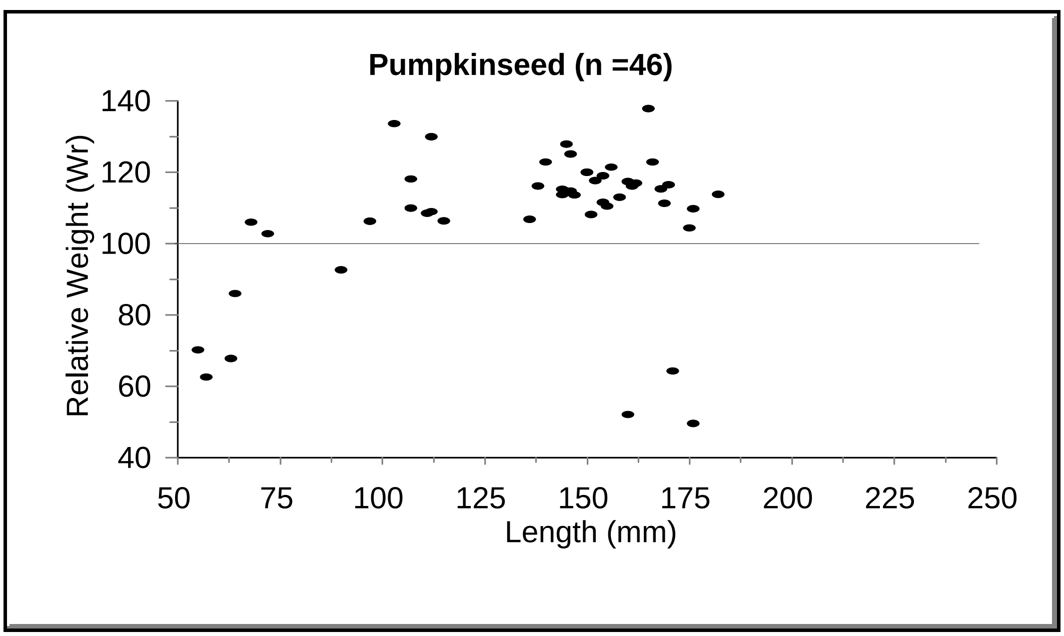

Figure 13. The relationship between total length and relative weight (Wr) for pumpkinseed sampled at Harts Lake during the spring 1999 warmwater fish survey.

Cutthroat Trout (*Oncorhynchus clarki*)

A single cutthroat trout was sampled in Harts Lake. It is unclear if this fish was a hatchery plant or a wild fish. This fish had a relative weight of 90.

Management Options

Harts Lake has been managed as a mixed–species lake, receiving hatchery trout plants as well as providing a quality warm water fish angling experience. The warm water fish community of Harts Lake is, in general terms, balanced. Most of the fish species are exhibiting good growth, good fitness, and the bass have a good size distribution that includes older, larger fish. Protecting the quality of this fishery should be a high priority for the Regional staff.

Channel Catfish Stocking

The introduction of channel catfish has been a benefit to anglers at Harts Lake. There have been anecdotal reports of the introduced channel catfish showing up in anglers' creels and that there is a fishery developing for them. A short literature review has shown that the size at stocking greatly influences the overall survival, and how many fish enter the creel (Spinelli et al. 1985; Storck and Newman 1988; and Santucci et al. 1994). The larger the fish at stocking, the better their survival and return to the creel, but it comes to a point where larger fish are no longer cost effective. We have no hard data showing how many fish have been harvested or how the stocked catfish are surviving.

We support the continuation of catfish stocking in Harts Lake. But, more work needs to be done to fine–tune the stocking rates and stocking size of the fish.

Creel Survey

Angler harvest and angler pressure are important pieces of information to a management biologist, yet we are lacking this information for most of our lakes. A well–designed angler creel survey can give a lot of insight to angler pressure, harvest, and preference. For Harts Lake, we could use this information for helping us to manage the largemouth bass and channel catfish populations.

Monitoring harvest is the only way to determine how successful the channel catfish have been and may help in planning stocking rates and size. The current information we have on this particular fishery is minimal and a creel survey is one of the best ways to gain more information.

Although their population structure is nicely defined, largemouth bass in Harts Lake are low in density. It is easy to overharvest a population that is low in density, if there is sufficient angler pressure. By monitoring the size structure of the harvest, a biologist can determine if special regulations may help protect or enhance the population structure.

Largemouth Bass Slot Limit

Currently, there is a proposal to change the harvest regulations for bass (both largemouth and smallmouth) in some Washington lakes. This proposal, a slot limit regulation, would require that the larger fish (within the slot length) be released alive, while still allowing harvest of older and younger fish (above and below the slot length). The problem with many regional lakes is that bass density is low, and that these populations can be easily decimated by angler harvest. Harts Lake may be a good candidate to receive this regulation. Though the size distribution of the population reflects that it is in balance, it is still pretty low density. A slot limit would provide an extra measure of protection from overharvest.

Literature Cited

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 *in* Murphy, B. R., and D. W. Willis (eds.), Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, MD.

Bennett, G. W. 1962. Management of Artificial Lakes and Ponds. Reinhold Publishing Corporation, New York, NY.

Bortleson, G. C., N. P. Dion, and J. B. McConnell. 1976. Reconnaissance Data on Lakes in Washington, Volume 3, Kitsap, Mason, and Pierce Counties. State of Washington Department of Ecology, Water-Supply Bulletin 43, Vol. 3.

Carlander, K.D., 1982. Standard Intercepts for Calculating Lengths from Scale Measurements for Some Centrarchid and Percid Fishes. Transactions of the American Fisheries Society 111:332-336.

DeVries, D., and R. Frie. 1996. Determination of Age and Growth. Pages 483-512 *in* Murphy, B. R., and D. W. Willis (eds.), Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, MD.

Fletcher, D., S. Bonar, B. Bolding, A. Bradbury, and S. Zeylmaker. 1993. Analyzing Warmwater Fish Populations in Washington State. Washington Department of Fish and Wildlife, Warmwater Fish Survey Manual, 173 p.

Gablehouse, D. W. 1984. A Length-Categorization System to Assess Fish Stocks. North American Journal of Fisheries Management 4:273-285.

Gablehouse, D. W. 1991. Seasonal Changes in Body Condition of White Crappies and Relations to Length and Growth in Melvern Reservoir, Kansas. North American Journal of Fisheries Management 11:50-56.

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

Guy, C. S., and D. W. Willis. 1991. Evaluation of Largemouth Bass - Yellow Perch Communities in Small South Dakota Impoundments. North American Journal of Fisheries Management 11:43-49.

Guy, C. S., and D. W. Willis. 1991.Seasonal variation in catch rate and body condition of four fish species in a South Dakota natural lake. Journal of Freshwater Ecology 6:281-292.

Murphy, B. R., and D. W. Willis. 1991. Application of relative weight (*Wr*) to western warmwater fisheries. Pages 243-248 *in* Proceedings of the Warmwater Fisheries Symposium I, June 4-8, 1991, Scottsdale, Arizona. USDA Forest Service, General Technical Report RM-207.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations Fisheries Research Board of Canada Bulletin 191.

Santucci, V., Wahl, D., and T. Storck. 1994. Growth, mortality, and cost-effectiveness of stocked channel catfish in a small impoundment. North American Journal of Fisheries Management 14:781-789.

Spinelli, A., Whiteside, B., and D. Huffman. 1985. Aquarium studies on the evaluation of stocking various sizes of channel catfish with established largemouth bass. North American Journal of Fisheries Management 5:138-145.

Storck, T., and D., Newman. 1988. Effects of size at stocking on survival and harvest of channel catfish. North American Journal of Fisheries Management 8:98-101.

Swingle, H. S. 1950. Relationships and dynamics of balanced and unbalanced fish populations. Auburn University, Alabama Agricultural Experiment Station Bulletin No 274, 74 p.

Westerdahl , H. E., K. D. Getsinger, eds. 1988. Aquatic Plant Identification and Herbicide Use Guide; Volume 1: Aquatic Herbicides and Application Equipment. Technical ReportA-88-9, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Wetzel, R. G. 1983. Limnology, 2nd edition. Saunders College Publishing, Philadelphia, PA.

Willis, D. W., B. R. Murphy, C. S. Guy. 1993. Stock Density Indices: Development, Use, and Limitations. Reviews in Fisheries Science, 1(3):203-222.

Zar, J. H. 1984. Biostatistical Analysis, 2nd edition. Prentice-Hall, Englewood Cliffs, NJ.

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).

Appendix B

Table B1. Identified aquatic plants species from Harts Lake, Pierce County, from a June 17, 1996 aquatic plant survey completed by Washington Department of Ecology.

Scientific name	Common name	Distribution	Comments
Ceratophyllum demersum	coontail; hornwort	2	
Iris pseudacorus	yellow flag	1	
Lemna minor	duckweed	2	
Myriophyllum spicatum	Eurasian water-milfoil	2	saw rooted plants in two locations
Nuphar polysepala	spatter-dock,yellow waterlily	2	
Nymphaea odorata	fragrant waterlily	4	rings shore
Phalaris arundinacia	reed canarygrass	2	
Potamogeton amplifolius	large-leaf pondweed	2	
Potamogeton crispus	curly leaf pondweed	2	brighter green than usual
Potamogeton sp.	thin leaved pondweed	2	no achenes for ID to species
Scirpus sp.	bulrush	2	
Typha sp.	cat-tail	2	
Unknown plant	unknown	1	another thin leaf pondweed
Vallisneria americana	Water celery	2	mostly on east side

Data in this table provided by Jennifer Parsons, Aquatic Plant Specialist, Washington Department of Ecology.