2000 Pine Lake Survey: The Warmwater Fish Community of a Lake Traditionally Managed for Rainbow Trout

by

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December 2001

Acknowledgments

We thank Brian "Ed" Burna of the Washington Department of Fish and Wildlife (WDFW) for his invaluable assistance in the field and lab, and Mark Downen for his contribution to the methods. We also thank Lucinda Morrow of the Warmwater Fish Aging unit for timely processing of scale age data and King County Parks and Recreation for providing easy access to the lake. Chad Jackson and Steve Jackson (WDFW) provided thoughtful criticism of the original draft of the manuscript, whereas Darrell Pruett and Peggy Ushakoff (WDFW) designed the cover. Lauren Munday, Walt Cooper, Everett Latch and Rick Goldsmith (WDFW) proved indispensable when preparing and printing the final report. This project was funded by the Warmwater Fish Enhancement Program, which is providing greater opportunities to fish for and catch warmwater fish in Washington.

Abstract

Pine Lake, six miles north of Issaquah, was surveyed by the Warmwater Enhancement Program from September 5 through 7, 2000. Largemouth bass dominated the species composition which included smallmouth bass, yellow perch, pumkinseed, and brown bullhead. However, catch rates for stock-size warmwater species were low compared to western Washington averages, suggesting low population densities. Although growth rates were relatively high, suggesting little competition for available food resources, size structures were skewed toward smaller fish. Few quality-size largemouth bass were sampled. However, sampling effectiveness for capturing larger fish may have been limited by such things as low conductivity, high transparency, and numerous docks. Low numbers of large fish may also be the result of overfishing in this popular urban lake. Large numbers of young-of-year largemouth bass were found as well as moderate numbers of young-of-year smallmouth bass. Aquatic vegetation coverage appeared sparse and offered little refuge for small fish. The large size of age 1 yellow perch and absence of young-of-year yellow perch and low numbers of pumpkinseed may suggest these fish were particularly vulnerable to predation because of lack of cover. A few rainbow trout and brown trout, stocked by WDFW, and cutthroat trout were captured during the survey. Historically, growth rates for Pine Lake trout generally exceeded those of other lakes in the region managed for trout. Since the mid-1980s, Pine Lake has been managed as a mixed species sport fishery with stocked catchable-size rainbow trout, fry plants of other species of trout, and self-reproducing populations of largemouth bass and other warmwater species. Management options for Pine Lake include but are not limited to the following: implementing a slot limit (12 - 17") for largemouth and smallmouth bass, augmenting aquatic macrophyte coverage to enhance refugia for smaller fish, enhancing littoral zone with artificial structures, conducting creel survey to determine angler effort for warmwater species, and conducting follow-up dive surveys to examine dock use by bass.

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Introduction and Background

Pine Lake (Figure 1) lies on the Sammamish Plateau at an elevation of 375 feet above sea level and approximately two miles east of Lake Sammamish and four miles north of Issaquah. Pine Lake's drainage basin (watershed) covers 259 hectares (ha) (1 square mile), lies within the Lake Sammamish watershed, and is composed mainly of glacial till and includes patches of alluvium and peat (Dion et al. 1983). The lake has a surface area of 34.8 ha and a maximum depth of 11.9 m and a mean depth of 6.1 m (Bortelson 1976). Pine Lake's shoreline is 3,880 m long with a shoreline complexity, D_L, equal to 1.8 (D_L is the ratio of the shoreline length to the circumference of a circle of area equal to that of the lake, D_L of a circle = 1). Residential development covers about 96% of the shoreline (Dion et al. 1983) and approximately 113 docks, or 2.9 docks/100 m, extend into the lake (estimated from 1999 aerial photo, KCWLRD 2001). Access to the lake is through Pine Lake County Park, a 6 ha public park, situated on the east shore. The park provides modern restrooms, a picnic area, swimming area, and a large fishing dock. The state Department of Fish and Wildlife maintains an easement through the park to a shallow gravel boat launch area. There is an 8 mph speed limit on the lake that precludes water skiing.

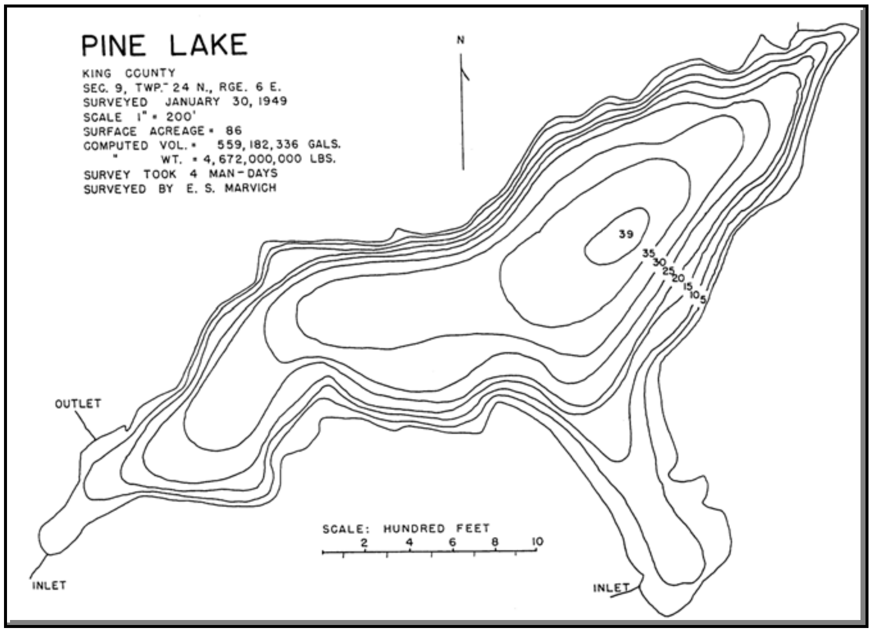

Figure 1. Map of Pine Lake (King County).

Surface water exits the lake through one unnamed outlet stream located on the west side of the lake. The outlet stream flows intermittently, from approximately mid-November to June, across one mile of flats and then steeply into Lake Sammamish. This prevents salmonid migration into the lake. Up to five intermittent inlet streams flow into the lake mainly in response to winter rainfall. Inflow and outflow from groundwater seepage also contribute to the lake's hydrologic budget. Pine Lake has a volume of 790 acre-feet (974,450 m^3) of water and, in 1990 the water renewal time was calculated at 3.2 years (Anderson and Welch 1991). The lake level can fluctuate as much as 0.64 m, increasing steadily throughout the wet season and declining in spring and summer (KCWLRD 1999). The lake undergoes seasonal stratification forming a thermocline typically by the end of May and lasting until lake turnover in the fall. By mid to late summer, the hypolimnion can become oxygen-poor through decomposition of organic matter.

Based on seasonal data, and using criteria established by Carlson (1977), water quality of Pine Lake is characterized as borderline mesotrophic-oligotrophic, meaning it has moderated to low biological activity (KCWLRD 1999). In 1998, summer secchi disc transparency averaged 4.4 m. Chlorophyl *a* concentrations averaged 3.1 ug/L, reaching 7.2 ug/L in early September. Summer total phosphorus concentrations averaged 10.0 ug/L, while nitrogen concentrations averaged 364 ug/L. The nitrogen to phosphorus ratio of 36 indicates that phosphorus levels limit algal growth. The water is slightly discolored by dissolved tanic compounds and was rated as 3.5 to 4 (yellow to green). Water quality data collected in 1998 was consistent with the previous two years (KCWLRD 1999).

Pine Lake has long been prone to intense blue-green algae blooms in the spring and fall and has been the subject of lake rehabilitation studies (Harper-Owes 1981; Dion et al. 1983; Jacoby et al. 1997; Smayda, 1999 and others). Surveys of lake users and residents cited water quality problems associated with excess blue-green algae production including, murkiness and impaired flavor of fish flesh. Spring algae blooms often coincide with opening day trout fishing and may constitute a degradation in sport fishery use (Harper-Owes 1981).

To reduce the quantity of soluble inorganic phosphorus inputs to the lake and thereby limit available nutrients to fuel springtime algae blooms, drainage from an adjacent wetland was diverted from Pine Lake in 1980 (Smayda 1999). Flows from the wetland were tanic (tea-brown), acidic (pH 4-5) and rich in soluble inorganic phosphorous. Although the diversion of wetland flows improved water quality and eliminated spring blue-green algae blooms in 1989 and 1990, lake water quality worsened during late summer and fall between 1980 and 1990. During that time, hypolimnetic phosphorus loading doubled as development in the watershed increased from 9% in 1976 to >50% by 1997, increasing surface water runoff and phosphorus inputs into the lake (Jacoby 1997).

Surveys of Pine Lake's aquatic plant community in 1994 indicated reduced coverage from historic levels (KCSWM 1996). In surveys conducted during four of the five years between 1976 and 1980, floating plant coverage ranged between three and four acres while floating and submerged plant coverage (combined in historic coverage information) ranged from 8.5 to 10.5 ha. In 1994, the floating plant community totaled 1.7 acres while the submergent community comprised 6.3 acres. Plant densities within these coverage areas were typically less than 25% for the floating and submergent communities. Emergent vegetation coverage in 1994 was very limited due to extensive shoreline development (KCSWM 1996).

Prior to the mid-1980s, the Department of Fish and Wildlife managed the lake as a trout-only water, annually stocking 40,000 to 50,000 fry (juveniles) and 3,000 to 6,000 legal-size rainbow trout just prior to the start of the general fishing season.

Some coho salmon and eastern brook trout fry were also stocked. Pine Lake has been considered one of the most popular fishing spots in the Seattle area on opening day of lowland lake fishing (WDFW unpublished data). On opening day between 1975 and 1980, an average of nearly 2,000 anglers were counted at Pine Lake. Growth rates for trout stocked into Pine Lake between 1976 and 1980 were among the highest recorded for King County lowland lakes managed for trout (Table 1). However survival of fry to catchable size, varied from year to year. Fry survival in 1975, 1977 and 1980 were estimated at 41.5%, 5% and 10.%, respectively (WDFW unpublished data). The cause of the variability in fry survival was thought to be related to competition for available food sources with non-native warmwater species, particularly pumpkinseed. For this reason, lakes managed specifically for trout were periodically treated with the piscicide rotenone to rid them of competitive species and then restocked with trout. Pine Lake was treated with rotenone in 1953, 1969, 1974 and in 1980. However, by 1980, concerned citizens questioned this management method citing that children would rather catch yellow perch all summer long than trout for only two weeks in the spring (Segaar 1982).

Table 1. Growth coefficients for rainbow trout stocked as fingerlings in various lakes near Seattle, Washington. All trout were planted in May of the first year and harvested in April of the second year.

	Growth period		
Lake	**1976-1977**	**1978-1979**	**1979-1980**
Pine	1.46	1.57	1.35
Silver			1.11
Lost*		1.24	
Langlois			0.66
Martha			1.34
Serene	1.17	1.17	
Picnic Point Pond		1.44	1.29
Black*	1.29		1.27
Echo*		1.36	
Fontal*		1.38	
Hannon*		1.33	
Joy*	1.45		
Mud*	1.20		1.32
Rattlesnake*			0.90

*asterisks mark lakes that were treated with rotenone at least five years prior to the growth periods noted above.

Since the mid-1980s, Pine Lake has been managed as a mixed species fishery for trout, stocked by WDFW, and naturalized warmwater fish species, including largemouth bass, which were illegally reintroduced after the last rotenone treatment. Because competition between warmwater species and juvenile trout generally resulted in diminished trout survival, annual stocking plans were altered to include more catchable-size trout and fewer fry (Table 2).

Table 2. Hatchery trout and kokanee stocking plans for Pine Lake (King County), 1998 through 2001 (WDFW 1998, 1999, 2000, 2001).

Year	Species	Number fry, 2-4"	Number 8-12 inches	Number 14" or larger	Total Stocked	Approx. time of Stocking
2001	RB	21,420	12,000		33,420	Apr.
	TRB			1,980	1,980	Apr., May
	BT	6,000			6,000	
2000	RB	10,000	12,000		22,000	Mid-late Apr.
	TRB			1,985	1,985	Apr.
	BT	6,000			6,000	
1999	RB		9,000		9,000	Apr., mid-May
1998	RB		13,000		13,000	Apr., mid-May

Species key: RB= rainbow trout, TRB= triploid rainbow trout, BT= brown trout, K= kokanee.

Pine Lake continues to support an active sports fishery composed of seasonally stocked rainbow trout and brown trout, as well as persistent populations of largemouth and smallmouth bass, yellow perch, pumpkinseed sunfish, and cutthroat trout. Pine Lake is a well known and popular trout fishing lake located close to home for many urban anglers. Also the lake has been noted as one of the top 10 largemouth bass waters in King County (Johansen 1999). To help manage these fisheries more effectively, the WDFW Warmwater Fish Enhancement Program conducted a stock assessment in fall 2000. We assessed species composition, relative abundance, size structure, growth, and condition of fish in the lake. We also evaluated habitat and access, then outlined options for enhancing the fishery and fishing opportunities on the lake.

Materials and Methods

Pine Lake was surveyed from September 5 to 7, 2000 by a three-person team. Fish were captured using three sampling techniques: electrofishing, gill netting, and fyke netting. The electrofishing unit consisted of a 4.9 m Smith-Root 5.0 GPP 'shock boat' set to 250 volts of 6 amp pulsed DC (120 cycles/sec). Experimental gill nets (45.7 m long × 2.4 m deep) were constructed of four sinking panels (two each at 7.6 m and 15.2 m long) of variable-size (13, 19, 25, and 51 mm stretched) monofilament mesh. Fyke nets were constructed of 1.2 m diameter hoops with funnels attached to a 2.5 m cod end (6.4 mm nylon mesh). Attached to the mouth of the net were two 15.2 m wings and a 31 m lead.

Sampling locations were selected by dividing the shoreline into 11 consecutively numbered sections of about 400 m each (determined visually from a map). Nine of these sections were then systematically sampled to maximize dispersion of gear types. Nighttime electrofishing was done along 6 sections, or 56% of the shoreline (Figure 1). The shock boat was maneuvered through the shallows (depth range: 0.2 -1.5 m), adjacent to the shoreline, at a rate of 18.3 m/minute. Gill nets and fyke nets were set overnight at four locations each (=4 net nights for each gear type). Gill nets were set perpendicular to the shoreline. The small-mesh end was attached onshore while the large-mesh end was anchored offshore. The fyke nets were set in water less than 3 m deep with wings extended at 45E to 90E angles from the lead. Sampling occurred during evening hours to maximize the type and number of fish captured.

All fish captured were identified to the species level. Each fish was measured to the nearest 1 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, a fish measuring 113 mm TL was assigned to the 110-mm size class, and so on. When possible, up to 10 fish from each size class were weighed to the nearest 1 g. However, if a sample included several hundred individuals of a given species, then a sub-sample (n ' 100 fish) was measured and weighed while the remainder was counted overboard. The length frequency distribution of the sub-sample was then applied to the total number collected. Weights were estimated for fish not individually weighed using a linear regression of $\log_{10}$-length on $\log_{10}$-weight of fish from the sub-sample. Scales were removed from up to 10 fish from each size class for aging. Scale samples were mounted, pressed, and the fish aged according to Jearld (1983) and Fletcher et al. (1993). However, brown bullhead (*Ameiurus nebulosus*) were not aged.

Water quality data was collected near the deepest part of the lake at 1-m intervals during midday September 6, 2000. Using a Hydrolab® probe and digital recorder, information was gathered on dissolved oxygen, temperature, pH, specific conductance and total dissolved solids.

Data Analysis

Balancing predator and prey fish populations is the hallmark of warmwater fisheries management. According to Bennett (1962), the term 'balance' is used loosely to describe a system in which omnivorous forage fish maximize food resources to grow to harvestable-size and become abundant enough to feed predators. Predators must reproduce and grow to control overproduction of prey and predator species, as well as provide adequate fishing. To maintain balance, predator and prey fish must be able to forage effectively. Evaluations of species composition, catch rates, size structure, growth, and condition (plumpness or robustness) of fish provide useful information on the adequacy of the food supply (Kohler and Kelly 1991), as well as the balance and productivity of the community (Swingle 1950; Bennett 1962).

Species Composition

We determined species composition by weight (kg) of fish captured using procedures adapted from Swingle (1950). The species composition by number of fish captured was determined using procedures outlined in Fletcher et al. (1993) with one exception. While young-of-year or small juveniles are often not considered because large fluctuations in their numbers may lead to misinterpretation of results (Fletcher et al. 1993), we chose to include them since their relative contribution to total species biomass was small. Moreover, the overall length frequency distribution of fish species may suggest successful spawning and initial survival during a given year, as indicated by a preponderance of fish in the smallest size classes. Many of these fish would be subject to natural attrition during their first winter (Chew 1974), resulting in a different length frequency distribution by the following year. However, the presence of these fish in the system relates directly to fecundity, forage base for larger fish, and interspecific and intraspecific competition at lower trophic levels (Olson et al. 1995). We therefore rely on species composition as an ecological indicator and catch per unit effort (CPUE) and proportional stock density (PSD) as stock indicators.

The percent species composition by weight was calculated as the weight of fish captured of a given species divided by the total weight of all fish captured × 100. The species composition by number was calculated as the number of fish captured of a given species divided by the total number of all fish captured × 100.

Catch Per Unit Effort

Catch per unit effort (CPUE) by gear type was determined for all species (number of fish/hour electrofishing and number of fish/net night). Only stock-size fish and larger were used to determine CPUE for the warmwater species and salmonids, whereas CPUE for non-game fish were calculated for all sizes. Stock length, which varies by species (Table 4), refers to the minimum size of fish having recreational value. Since sample locations were randomly selected, which might introduce high variability due to habitat differences within the lake, 80% confidence intervals (CI) were determined for each mean CPUE by species and gear type. CI was calculated as the mean ± $t_{(\alpha, N\text{-}1)} \times SE$, where t = Student's t for α confidence level with N-1 degrees of freedom (two-tailed) and SE = standard error of the mean. Because it is standardized, CPUE is a useful way to compare relative abundance of stocks between lakes. Furthermore, the confidence intervals reflect the relative uniformity of species distributions throughout a given lake. CPUE values for Pine Lake were compared to western Washington State averages for lakes sampled during the same time of year (Table 3 and Appendix A).

Table 3. Mean catch per unit effort (number of fish/hr electrofishing and number of fish/net night) for stock size fish collected from several western Washington State lakes while electrofishing, gill netting, and fyke netting during fall, from 1997 through 2000 (Appendix A).

	Gear Type					
Species	**Electrofishing (fish/hr)**	**# lakes**	**Gillnetting (fish/hr)**	**# lakes**	**Fykenetting (fish/hr)**	**# lakes**
Brown bullhead	6.3	18	2.8	10	1.7	7
Brown trout	11.3	2	0.8	2		
Cutthroat trout	8.2	3	1.0	7	0.3	1
Largemouth bass	29.0	22	1.4	16	0.3	2
Pumpkinseed	77.1	18	2.8	17	2.8	9
Rainbow trout	5	6	1.0	12		
Smallmouth bass	3.8	8	2.3	7	0.5	1
Yellow perch	92.4	19	13.9	19	2.5	4

Stock Density Indices

The proportional stock density (PSD) of each fish species was determined following procedures outlined in Anderson and Neumann (1996). PSD was calculated as the number of fish \$ quality length/number of fish \$ stock length × 100, is an index of length frequency data that gives the percentage of fish in a population that are of recreational value to anglers. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths. Again, stock length (20-26% of world-record length) refers to the minimum size fish with recreational value, whereas quality length (36-41% of world-record length) refers to the minimum size fish most anglers like to catch.

The relative stock density (RSD) of each fish species was examined using the five-cell model proposed by Gabelhouse (1984). In addition to stock and quality length, Gabelhouse (1984) introduced preferred, memorable, and trophy length categories (Table 4). Preferred length (45-55% of world-record length) refers to the minimum size fish anglers would prefer to catch when given a choice. Memorable length (59-64 % of world-record length) refers to the minimum size fish most anglers remember catching, whereas trophy length (74-80 % of world-record length) refers to the minimum size fish considered worthy of acknowledgment. Like PSD, RSD provides useful information regarding population dynamics, but is more sensitive to changes in year-class strength. RSD was calculated as the number of fish $ specified length/number of fish $ stock length × 100. For example, RSD P was the percentage of stock length fish that also were longer than preferred length, RSD M, the percentage of stock length fish that also were longer than memorable length, and so on. Eighty-percent confidence intervals for PSD and RSD were selected from tables in Gustafson (1988).

Table 4. Length categories for cold- and warmwater fish species used to calculate stock density indices (PSD and RSD; Gablehouse 1984) of fish captured at Pine Lake (King County) during fall 1999. Measurements are minimum total lengths (mm) for each category (Anderson and Neumann 1996; Bister et al. 2000; Hyatt and Hubert, Wyoming Cooperative Fish and Wildlife Unit, University of Wyoming, unpublished data).

	Minimum size (mm)				
Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Bluegill	80	150	200	250	300
Brown bullhead	130	200	280	360	430
Brown trout	150	230	300	380	460
Channel catfish	280	410	610	710	910
Kokanee	200	250	300	400	500
Largemouth bass	200	300	380	510	630
Pumpkinseed	80	150	200	250	300
Rainbow trout	250	400	500	650	800
Smallmouth bass	180	280	350	430	510
Yellow perch	130	200	250	300	380

PSD and RSD have become important tools for assessing size structures of warmwater fish populations and determining management options for warmwater fish communities (Willis et al. 1993). Three major management options commonly implemented for these communities include the panfish option, balanced predator-prey option, and big bass option and each of these has associated ranges of PSD and RSD values (Table 5).

Table 5. Stock density index ranges for largemouth bass and bluegill under three commonly implemented management strategies (from Willis et al. 1993). PSD = proportional stock density, whereas RSD = relative stock density of preferred length fish (RSD-P), and memorable length fish (RSD-M).

	Largemouth bass			Bluegill	
Option	**PSD**	**RSD-P**	**RSD-M**	**PSD**	**RSD-P**
Panfish	20 - 40	0 - 10		50 - 80	10 - 30
Balanced	40 - 70	10 - 40	0 - 10	20 - 60	5 - 20
Big bass	50 - 80	30 - 60	10 - 25	10 - 50	0 - 10

Age and Growth

Scale samples from fish sampled at Pine Lake were evaluated to determine age and growth characteristics using Lee's modification of the direct proportion method (Carlander 1982). The direct proportion method (Jearld 1983, Fletcher et al. 1993) back-calculates total length at annulus formation, L_n, using the formula, $L_n = (A \times TL)/S$, where A is the radius of the fish scale at age n, TL is the total length of the fish captured, and S is the total radius of the scale at capture. Using Lee's modification, L_n was back-calculated as $L_n = a + A \times (TL - a)/S$, where a is the species-specific standard intercept from a scale radius-fish length regression. Mean back-calculated lengths at age n for each species were presented in tabular form for easy comparison of growth between year classes, as well as between Pine Lake fish and the state average for the same species (Appendix B).

Length Frequency

The size structure of each species captured was evaluated by constructing a stacked length frequency histogram (percent frequency of fish in a given size class captured by each gear type). Although length frequencies are generally reported by gear type, we report the length frequency of our catch with combined gear types which is then broken down by the relative contribution each gear type makes to each size class. Selectivity of gear types not only biases species catch based on body form, and behavior, but also based on size classes and subsequent habitat use within species (Willis et al. 1993). Therefore, an unbiased assessment of length frequency is unlikely under any circumstance. Our standardized 1:1:1 gear type ratio adjusts for differences in sampling effort between sampling times and locations. Furthermore, differences in size selectivity of gear types may in some circumstances result in offsetting biases (Anderson and Neumann 1996). Length frequency proportions for each gear type are divided by the total numbers of fish caught by all gear types for each size class. This changes the scale but not the shape of the length frequency percentages by gear type. If concern arises that pooled gear does not represent the least biased assessment of length frequency for a given species, then the shape of the gear type-specific distributions is still represented on the graphs, and these may be interpreted independently.

Relative Weight

A relative weight (W_r) index was used to evaluate the condition of all species except sculpin. A W_r value of 100 generally indicates that a fish is in good condition when compared to the national standard (75th percentile) for that species. Furthermore, W_r is 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) of an individual fish and W_s is the standard weight of a fish of the same total length (mm). W_s is calculated from a standard $\log_{10}$weight-$\log_{10}$length relationship defined for the species of interest. The parameters of the W_s equations for many cold- and warmwater fish species, including the minimum length recommendations for their application, have been compiled by Anderson and Neumann (1996), Bister et al. (2000), as well as Mathew W. Hyatt and Wayne A. Hubert (Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, unpublished data). With the exception of sculpin, the W_r values from this study were compared to the national standard (W_r = 100) and, where available, the mean W_r values from up to 25 western Washington lakes sampled during 1997 and 1998 (Steve Caromile, WDFW, unpublished data). Plotting relative weights of individual fish provides a snapshot of how their "plumpness" compares to the national 75th percentile and western Washington state averages.

Results and Discussion

Water Quality and Habitat

During fall 2000, Pine Lake was thermally stratified with water temperatures of 19.4° C at the surface and 8.7° C at the bottom. The metalimnion, the region of most rapid vertical temperature change, was between 6 and 9 m (Table 6). Dissolved oxygen in the top half of the lake was within optimal limits for most fishes (Moore 1942). However, below 6 m, dissolved oxygen was less than 5 mg/L, and was as low as 0.7 mg/L at the bottom of the lake. Water transparency was high with a secchi disk reading of 5.3 m. Conductivity was low (<100 µS/cm) throughout the water column and was below the optimum range (100-400 µS/cm) for electrofishing efficiency outlined by Willis (1998). Low water conductivity can reduce sampling efficiency if power is not effectively transferred from the water into the fish.

Table 6. Water quality at Pine Lake (King County). Samples were collected mid-afternoon September 11, 2000. DO = dissolved oxygen, TDS = total dissolved solids.

Secchi depth	Depth (m)	DO (mg/L)	Temperature (EC)	pH	Conductance (µS/cm)	TDS (g/L)
	1	8.4	19.4	8.1	66.1	0.0422
	2	8.0	19.4	8.0	66.2	0.0424
	3	7.6	19.3	7.9	66.4	0.0423
	4	7.3	19.3	7.9	66.1	0.0423
5.3 m	5	7.2	19.3	7.9	66.4	0.0425
	6	5.8	18.8	7.9	67.3	0.0430
	7	3.5	15.4	7.6	68.1	0.0435
	8	2.3	11.7	7.5	70.3	0.0452
	9	1.7	9.7	7.4	73.1	0.0469
	10	1.3	9.0	7.2	85.8	0.0550
	11	0.9	8.7	7.0	94.9	0.0602
	12	0.7	8.7	6.9	99.8	0.0678

Percent cover was less than 5% for floating aquatic vegetation. The lake was devoid of submergent vegetation. Emergent vegetation coverage was limited due to extensive shoreline development and covered 5% or less of shoreline in most survey sections examined (KCSWM 1996).

Species Composition

Eight fish species were captured during our fall 2000 survey of Pine Lake (Table 7 and Figure 2). Of these, largemouth bass were the most abundant by number (87%) and by weight (64%). However, approximately 90% of the largemouth bass were juvenile fish less than 100 mm (2.5 inches) in length. Smallmouth bass made up nearly 9% of the species composition by number and 7% by weight and were dominated by fish less than 100 mm. Pumpkinseed were third most abundant contributing 2.3% to the species composition of our samples by number and 1.6% by weight and were also mainly juvenile fish. Yellow perch accounted for less than one percent by number and less than two percent by weight and were all greater than 190 mm total length. Brown bullhead were present in our samples but contributed little to the species composition by number (0.2%) or by weight (<0.3%). Brown trout (*Salmo trutta*), cutthroat trout (*Oncorhynchus clarki*), and rainbow trout (*O. Mykiss*) were also sampled from the lake and accounted for 8.7%, 2.6% and 6.7% by weight, respectively, but less than 0.5% each by number. However, these fish do not typically inhabit the littoral zone where our gear types are most effective. Crayfish, often an import prey item for bass, were observed in the lake while sculpin (*Cottus* sp.) were not detected. In addition to indigenous signal crayfish (*Pacifastacus leniusculus*), three red swamp crayfish (*Procambarus clarkii*), an exotic species, were captured during our survey. Red swamp crayfish were likely introduced illegally into the lake as escaped live bait or as discarded aquaria fauna. Whatever the source, the presence of red swamp crayfish is of concern because their interaction with native crayfish populations is unknown (Mueller 2001). Several tadpoles were also observed in the lake.

Table 7. Species composition by weight (kg) and number of fish captured at Pine Lake (King County) during fall 2000.

	Species composition				
	by weight		by number		Size range
Species	**(kg)**	**(%) weight**	**(#)**	**(%) n**	**(mm TL)**
Brown bullhead (*Ameiurus nebulosus*)	0.26	1.07	3	0.22	163 - 230
Brown trout (*Salmo trutta*)	2.16	8.76	2	0.15	444 - 472
Cuttroat trout (*Oncorhynchus clarki*)	0.64	2.62	4	0.29	255 - 265
Largemouth bass (*Micropterus salmoides*)	15.85	64.36	1,195	86.78	43 - 486
Pumpkinseed (*Lepomis gibbosus*)	0.38	1.56	32	2.32	29 - 159
Rainbow trout (*Oncorhynchus mykiss*)	1.66	6.75	6	0.44	258 - 365
Smallmouth bass (*Micropterous salmoides*)	1.74	7.06	122	8.86	55 - 185
Yellow perch (*Perca flavescens*)	1.92	7.84	13	0.94	198 - 241
Total	24.62		1,377		

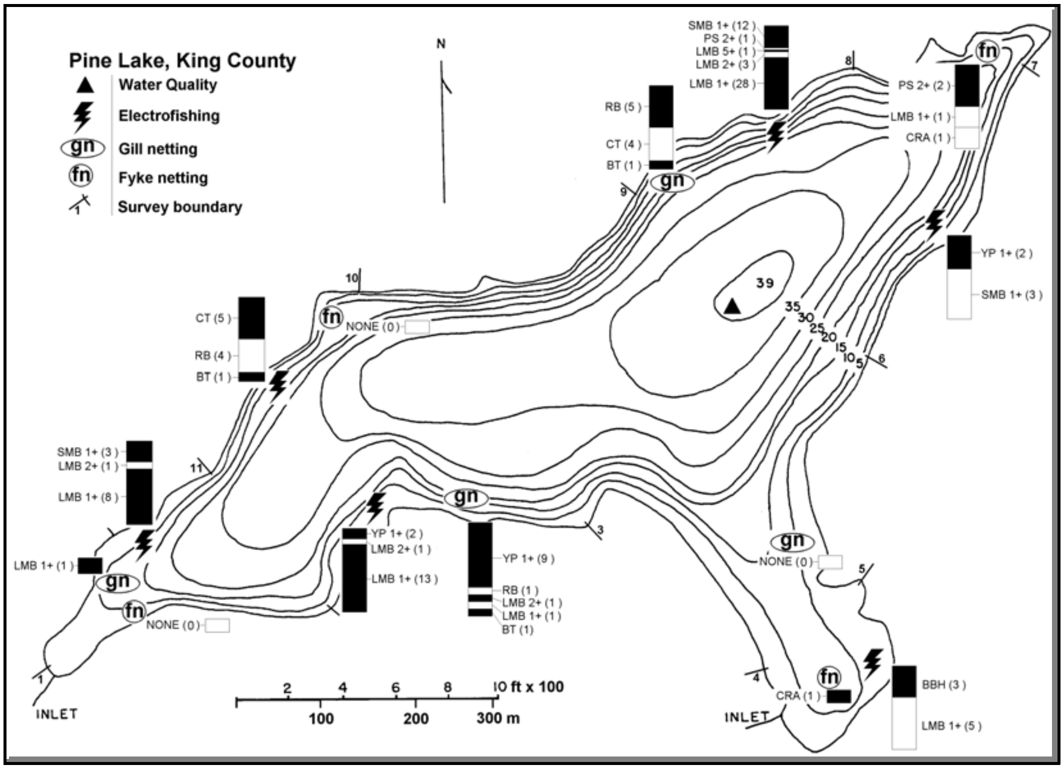

Figure 2. Map of Pine Lake (King County) showing sample sites by gear type and catch data. Bar charts indicate number of fish by species, excluding young-of-year, captured in each survey section September, 2000. Species key: BBH = brown bullhead, BT = brown trout, CRA = crayfish, CT = cutthroat trout, LMB = largemouth bass, PS = pumkinseed, RB = rainbow trout, SMB = smallmouth bass, YP = yellow perch. Age classes: 1+ = greater than one year old and less than 2.

CPUE

Catch rates for stock size game fish sampled in our fall 2000 survey were low compared to average catch rates of western Washington lakes sampled in fall (Table 8, Table 4 and Appendix A). Electrofishing CPUE for largemouth bass (11 fish per hour) was less than half the western Washington average of 29.7 fish per hour and comparable to rates found in Lake Sawyer in King County and Lake Vancouver in Clark County (Appendix A). Similarly, catch rates for stock size pumpkinseed, smallmouth bass, and yellow perch were low compared to their western Washington state averages of 77.1, 3.8 and 92 fish per hour, respectively (Appendix A). So few game fish were captured while gillnetting that calculation of reliable 80% confidence interval was not possible. The brown trout, rainbow trout, and cutthroat trout were captured only while gillnetting, but in low numbers. No stock size fish were captured while fyke netting.

Table 8. Mean catch per unit effort (number of fish/hour electrofishing and number of fish/net night), including 80% confidence intervals for stock size warmwater fish, salmonids, and non-game fish collected from Pine Lake (King County) while electrofishing, gill netting, and fyke netting during fall 2000.

Species	Gear type					
	Electroshocking (#fish/hour)	**Shock Sites**	**Gill netting (# fish/hour)**	**n (net nights)**	**Fyke netting (# fish/hour)**	**n (net nights)**
Brown bullhead	3[a]	6	0	4	0	4
Brown trout	0	6	0.5 ± 0.37	4	0	4
Cutthroat trout	0	6	1[a]	4	0	4
Largemouth bass	11.6 ± 6.14	6	0.25[a]	4	0	4
Pumpkinseed	2.91 ± 2.53	6	0	4	0	4
Rainbow trout	0	6	1.5[a]	4	0	4
Smallmouth bass	0.91[a]	6	0	4	0	4
Yellow perch	3.83 ± 3.11	6	2.3[a]	4	0	4

[a] Sample size too small or catch rates too variable to permit calculation of reliable confidence intervals

Stock Density Indices

Few stock-size fish were captured during our fall survey, making calculation of reliable stock density indices difficult (Divens et al. 1998). At best, we may surmise a rough PSD estimate for largemouth bass (14 fish electrofishing) and yellow perch (9 fish gill netted) of 25 and 100 respectively. Stock density indices suggest a predator and prey population out of balance (Table 5 and 9). Gill netting PSD and RSD values for yellow perch and electrofishing PSD for largemouth bass were similar to those of populations managed under the "panfish" option (Table 5). For predators such as largemouth bass, the generally accepted stock density index ranges for "panfish" option fish populations are PSD values of 20 to 40, and RSD-P values of 0 to 10 (Gabelhouse 1984; Willis et al. 1993). The PSD and RSD values should be viewed with caution, especially given the low catch rates for stock-size fish and small sample sizes used to determine these indices (Divens et al. 1998).

Table 9. Traditional stock density indices including 80% confidence intervals for cold and warmwater fishes collected from Pine Lake (King County) while electrofishing, gill netting and fyke netting during fall 1999. PSD = proportional stock density, whereas RSD = relative stock density of preferred length fish (RSD-P), memorable length fish (RSD-M), and trophy length fish (RSD-T). EB = electrofishing, GN = gill netting and FN = fyke netting.

Species	Gear type	# Stock length fish	PSD	RSD-P	RSD-M	RSD-T
Brown bullhead	EB	3	33 [a]			
	GN					
	FN					
Brown trout	EB					
	GN	2	100	100		
	FN					
Cutthroat trout	EB					
	GN	4				
	FN					
Largemouth bass	EB	12	25 ± 16	8 ± 10		
	GN	1				
	FN					
Pumpkinseed	EB	3	67 ± 35			
	GN					
	FN					
Rainbow trout	EB					
	GN	6				
	FN					
Smallmouth bass	EB	1				
	GN					
	FN					
Yellow perch	EB	4	75 ± 28			
	GN	9	100			
	FN					

[a] Sample size too small or catch rates too variable to permit the calculation of reliable confidence intervals.

Brown Bullhead

Three brown bullhead ranging in size from 163 to 230 mm TL were captured while electrofishing (Figure 3). Age and growth rate data were not collected for brown bullhead. Relative weights were below the national standard for this species (Figure 4).

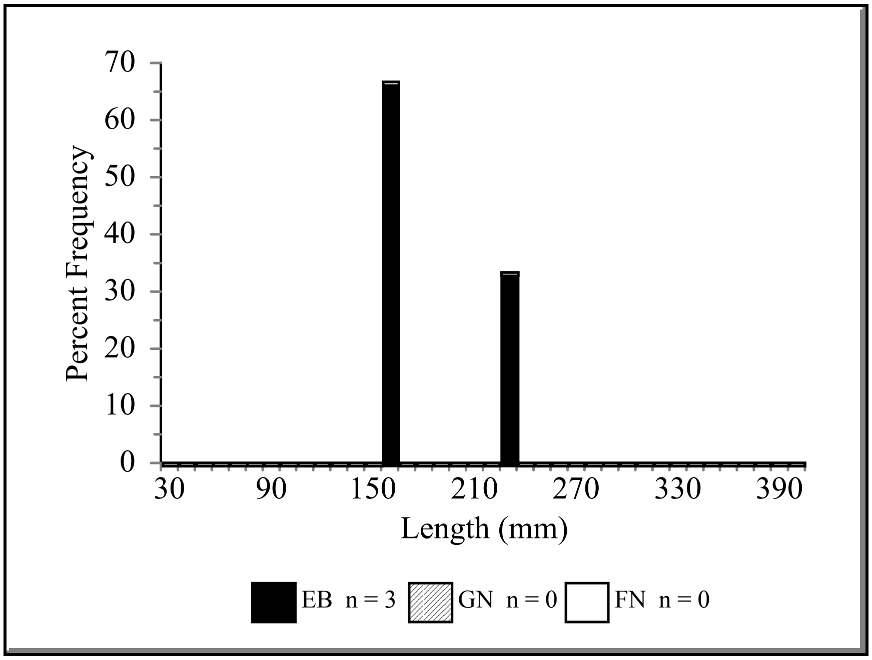

Figure 3. Length frequency histogram of brown bullhead sampled from Pine Lake (King County) during fall 2000. EB = electrofishing, GN = gill netting, and FN = fyke netting.

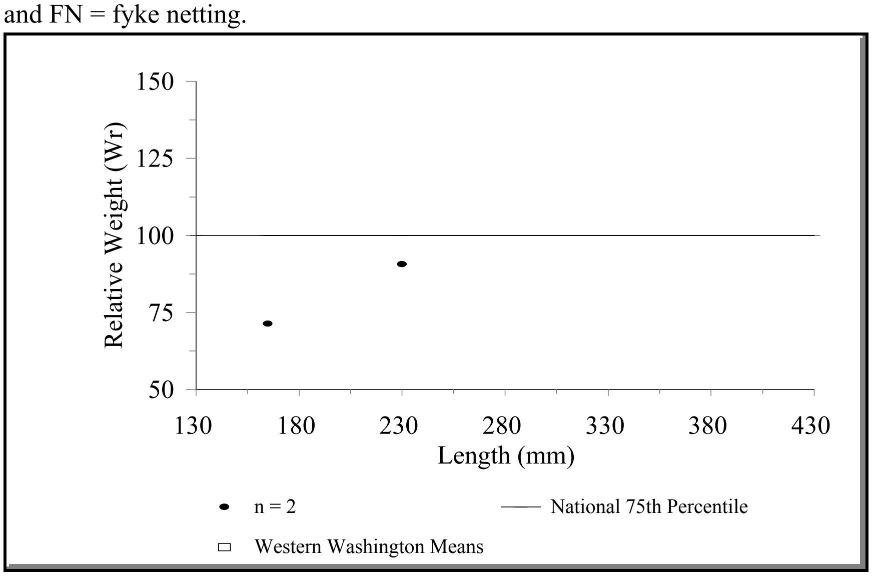

Figure 4. Relationship between total length and relative weight (*Wr*) of brown bullhead from Pine Lake (King County) compared with means from up to 25 western Washington lake and the national 75th percentile.

Brown Trout

Two brown trout (444 and 470 mm FL) were captured while gillnetting (Figure 5). Relative weights were consistent with or below the national 75th percentile (Figure 6). Age and growth rate information was unavailable because the scale samples taken from these fish were regenerated and unreadable. However, WDFW has stocked brown trout fry in the lake for several years. Brown trout are fast growing, typically reaching 12 to 15 inches (305 to 381 mm FL) within two years (WDFW data). The brown trout sampled from Pine Lake are likely between two and three years old.

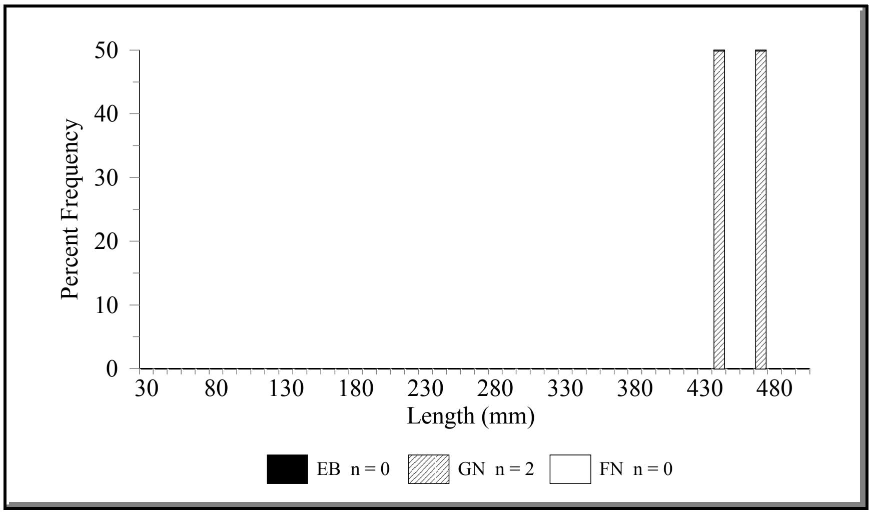

Figure 5. Length frequency histogram of brown trout sample from Pine Lake (King County) during fall 2000. EB = electrofishing, GN = gill netting, and FN = fyke netting.

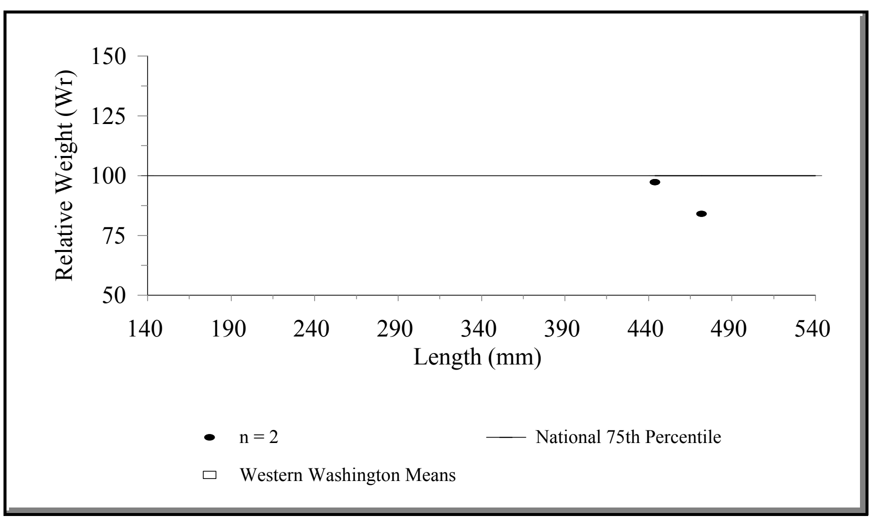

Figure 6. Relationship between total length and relative weight (*Wr*) of brown trout from Pine Lake (King County) compared with the national 75th percentile.

Cutthroat Trout

A total of four cutthroat trout (255 - 265 mm FL) were capture while gillnetting (Figure 7.) Relative weights were below the national 75th percentile (Figure 8). It is not clear how cutthroat trout came to be in the lake, however agency records do not include fry plants of less than 5,000 fish. Thus, it is possible they were stocked as a small group of fry.

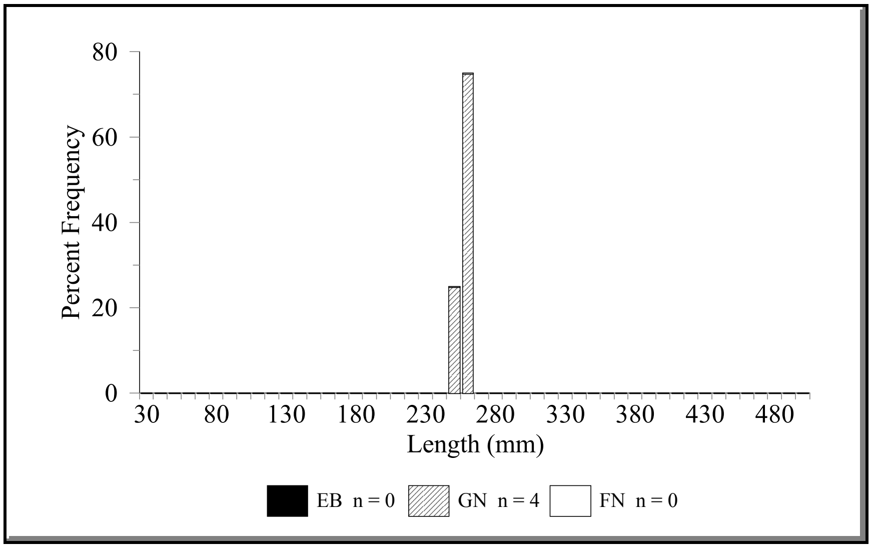

Figure 7. Length frequency histogram of cutthroat trout sampled from Pine Lake (King County) during fall 2000. EB = electrofishing, GN = gill netting, and FN = fyke netting.

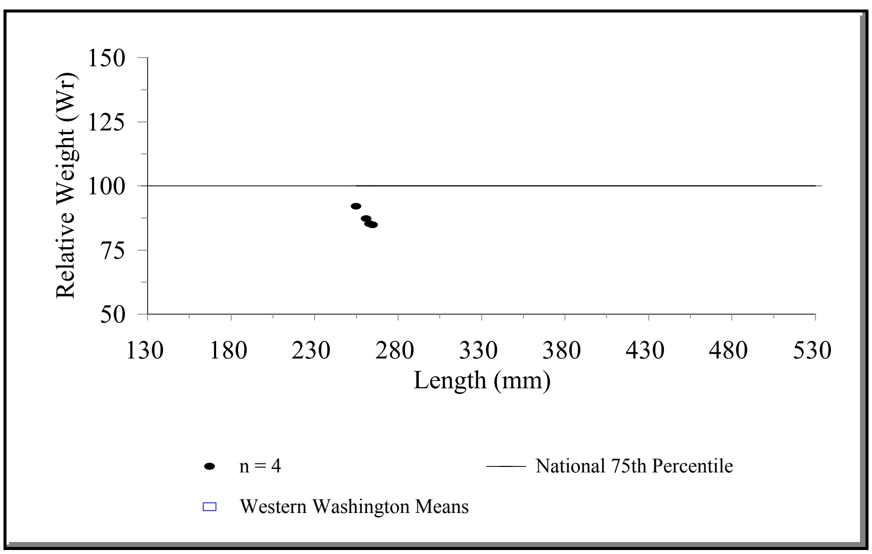

Figure 8. Relationship between total length and relative weight (*Wr*) of cutthroat trout from Pine Lake (King County) compared with the national 75th percentile

Largemouth Bass

Successful reproduction of largemouth bass in Pine Lake was evident given the numerous young -of-year (YOY) captured during our survey. Of the 1,195 largemouth bass captured, 1,095 or 91% were YOY ranging in size from 43 to 110 mm TL. The remaining 100 fish included 91 age-1 fish (115 - 211 mm TL), eight age-2 fish (225 - 300 mm TL) and one age-5 fish (485 mm TL). Survival of older, larger fish seems to be limited.

Although catch rates were low, suggesting low abundance, length frequencies were skewed towards smaller size fish (Figure 9) and growth rates were above average (Table 10). Mean length at age back-calculated from scale samples of age 1 fish were consistent with western Washington state averages while mean length of age 2 fish exceeded state averages age-2 largemouth bass (Appendix B). Age-2 largemouth bass from Pine Lake were over 20 mm longer than the state average. The single age-5 largemouth bass captured exhibited extreme fast growth, exceeding the state average by nearly 180 mm (7 inches). However, Pine Lake sample sizes were small and this assessment should be viewed with caution.

For age-1 largemouth bass relative weights were consistent with the national 75th percentile and similar to or slightly below western Washington averages (Figure 10). Relative weights of older fish were higher than the national 75th percentile and consistent with western Washington averages. These findings suggest the fish are able to find adequate forage and do not appear to suffer from overcrowding or excessive competition. However, largemouth bass were found to be resorting to cannibalism, suggesting a limited prey base for this species In one instance we found an age-1, 178 mm TL largemouth bass with a young-of-year, 74 mm TL largemouth bass in its gut.

Table 10. Age and growth of largemouth bass (*Micropterous salmoides*) captured at Pine Lake (King County) during fall 2000. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age				
Year class	# fish	1	2	3	4	5
1999	45	75.2				
1998	8	80.9	167.4			
1997	0					
1996	0					
1995	1	98.6	258.7	368.8	436.0	474.6
Weighted mean		76.5	177.5	368.8	436.0	474.6
Western WA average		77.3	145.3	191.0	242.7	295.7

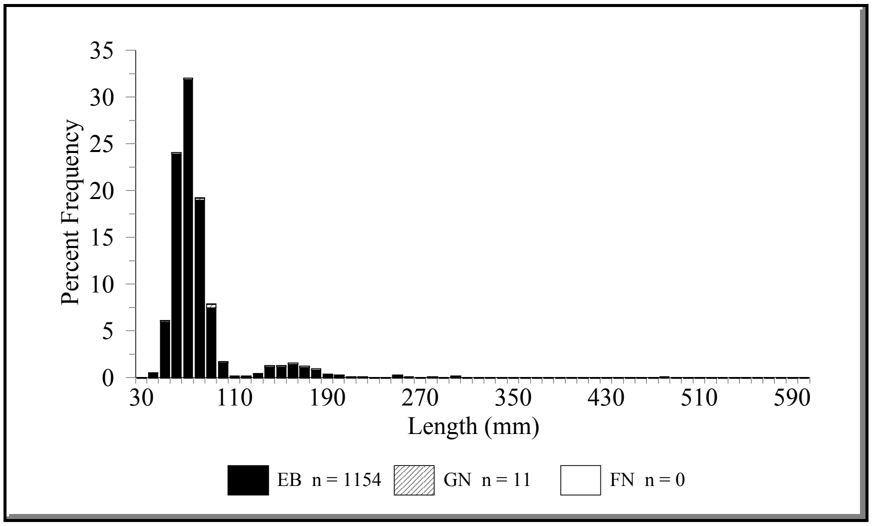

Figure 9. Length frequency histogram of largemouth bass sampled from Pine Lake (King County) in fall 2000. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

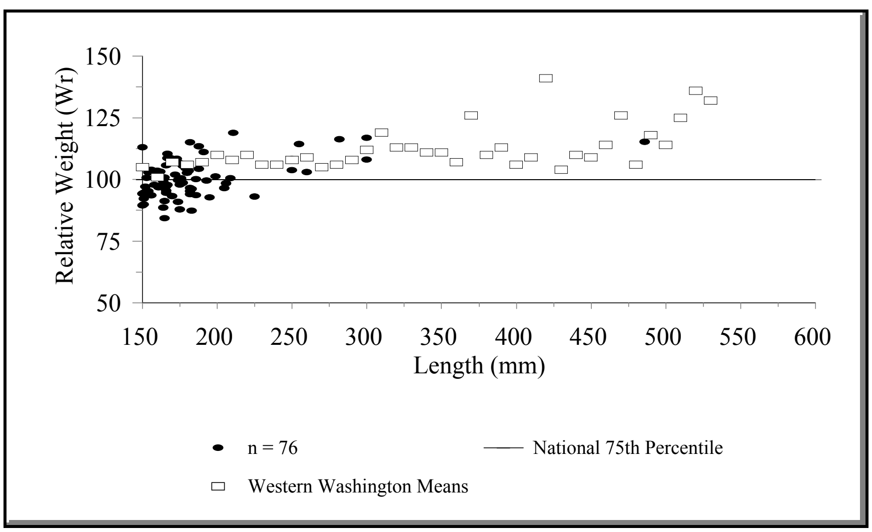

Figure 10. Relationship between total length and relative weight (*Wr*) of largemouth bass from Pine Lake (King County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Pumpkinseed

A total of 32 pumpkinseed were captured while electrofishing (Figure 11). Eighty-seven percent (n=28) were less than one-year old and ranged in size from 34 to 91 mm TL. The remaining four fish were determined to be age-2 and were between 150 and 159 mm TL. The presence of young-of-year fish indicates successful reproduction, however small sample sizes and low catch rates suggests low abundance and limited reproduction for this species.

Besides young-of-year, only 2-year-old pumkinseed were found in samples at Pine Lake (Table 11). Though no age-1 fish were sampled, back-calculated lengths at age-1 from scale samples removed from fish age-2, suggest slow growth during the first year of life for these fish. However, growth of Pine Lake pumpkinseed at age-2 exceeded western Washington State averages. Relative weights were consistent with western Washington State averages (Figure 12).

Pumpkinseed survival appears limited. No 1-year-old fish were found, suggesting a year class failure. The lack of significant patches of cover, in the form of submersed aquatic vegetation or complex woody debris, limits predator evasion options, or hiding places, for this species and may be one cause of their low relative abundance.

Table 11. Age and growth of pumpkinseed (*Lepomis gibosus*) captured at Pine Lake (King County) during fall 2000. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age	
Year class	# fish	**1**	**2**
1999	0		
1998	4	38.6	111.8
Weighted mean		38.6	111.8
Western WA average		50.1	86.7

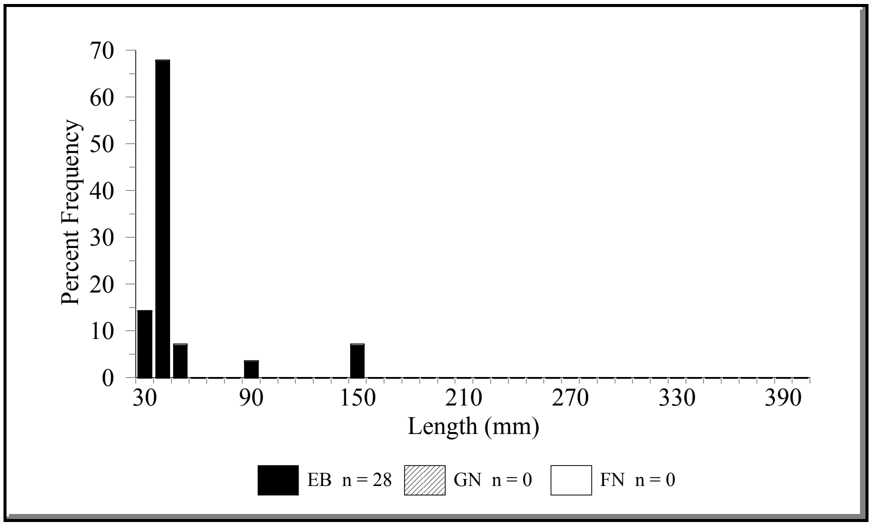

Figure 11. Length frequency histogram of pumpkinseed sampled from Pine Lake (King County) in fall 2000. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

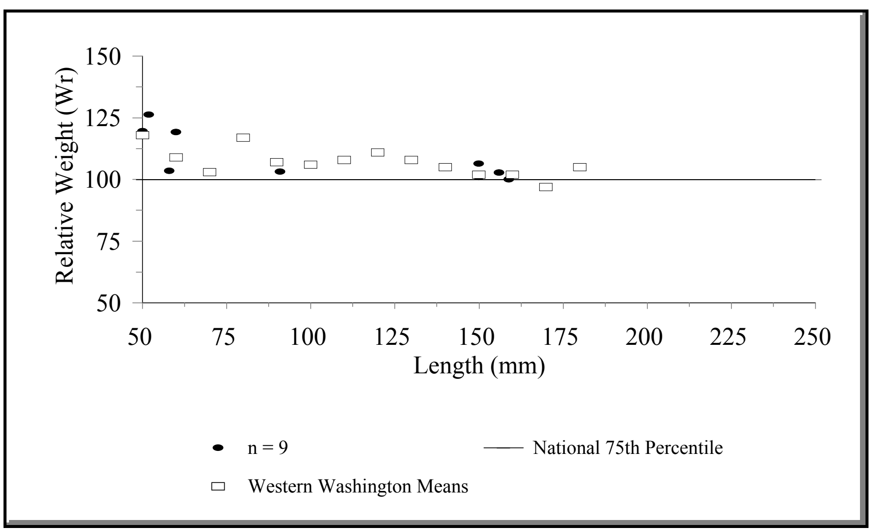

Figure 12. Relationship between total length and relative weight (*Wr*) of pumpkinseed from Pine Lake (King County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Rainbow Trout

Two rainbow trout were captured while gill netting (Figure 13). These fish were determine to be age 1+ and were likely planted in the lake by WDFW in April of 1999. Relative weights for rainbow trout were below the national 75th percentile (Figure 14).

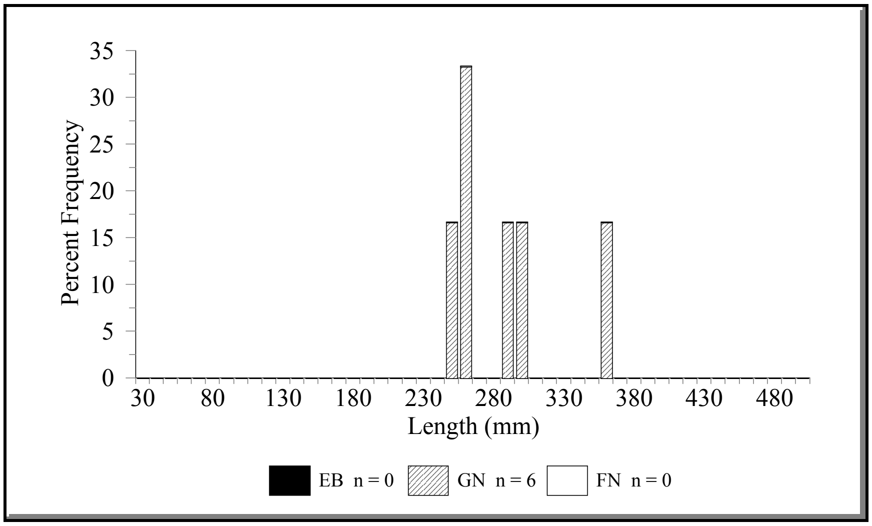

Figure 13. Length frequency histogram of cutthroat trout sampled from Pine Lake (King County) in fall 2000. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, FN = fyke netting.

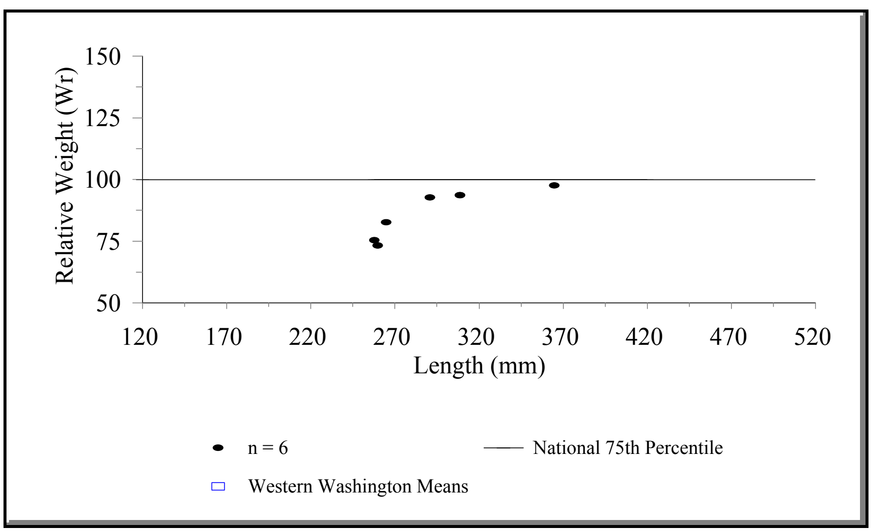

Figure 14. Relationship between total length and relative weight (*Wr*) of rainbow trout from Pine Lake (King County) compared with the national 75th percentile.

Smallmouth Bass

A total of 122 smallmouth bass were captured while electrofishing (Figure 15). Eighty-five percent (n=104) were young-of-year ranging in size from 55 to 100 mm TL. The remaining 18 fish were all aged 1 (Table 12). The back-calculated mean length at age for these fish was low compared to the western Washington average, suggesting slow growth for the first year of life for this species. Mean length at one year for Pine Lake smallmouth bass (78.2 mm) was nearly 6 mm less than the state average. Relative weights were slightly below the national 75th percentile and state averages (Figure 16).

Table 12. Age and growth of smallmouth bass (*Micropterus dolomieu*) captured at Pine Lake (King County) during fall 2000. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age
Year class	**# fish**	age 1
1999	18	78.2
Weighted mean		78.2
Western WA average		84.1

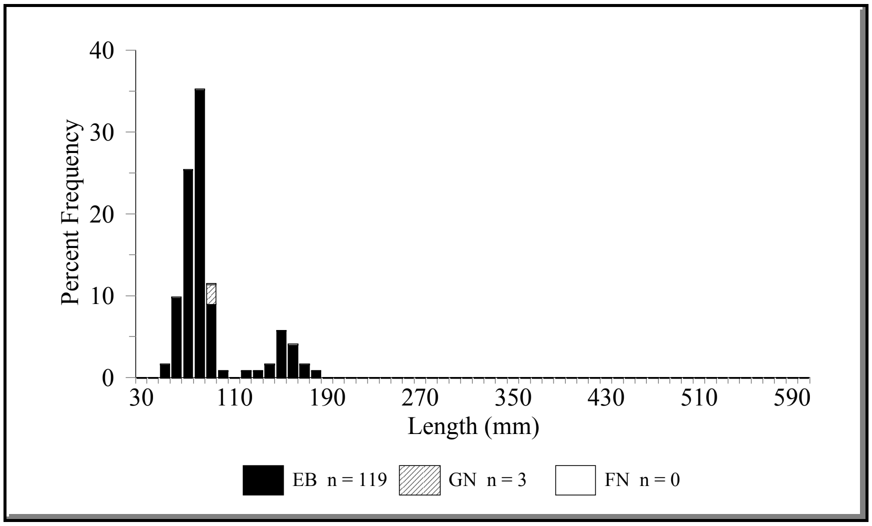

Figure 15. Length frequency histogram of smallmouth bass sampled from Pine Lake (King County) in fall 2000. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

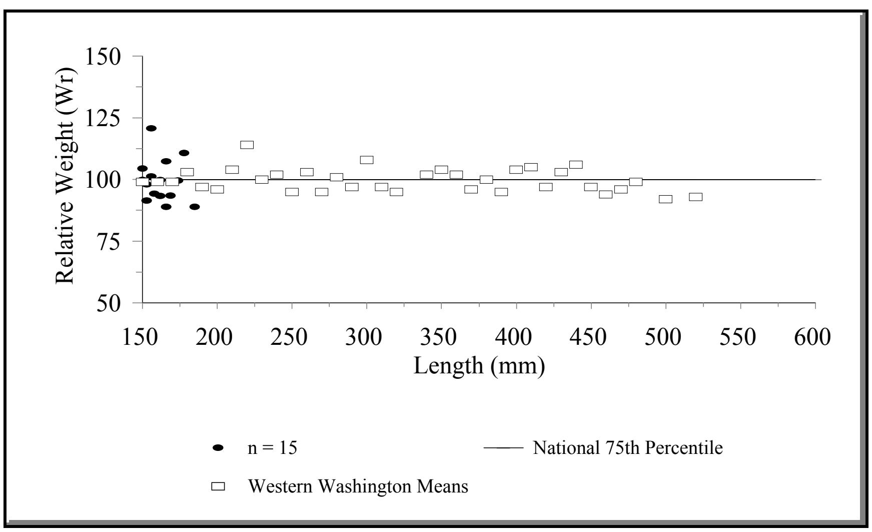

Figure 16. Relationship between total length and relative weight (*Wr*) of smallmouth bass from Pine Lake (King County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Yellow Perch

A total of 13 yellow perch, ranging in size from 198 to 241 mm, were collected while electrofishing and gillnetting (Figure 17). All were determined to be age-1 (Table 13). Yellow perch were large for their age. Mean length at age of fish age-1 (129.1 mm) exceeded the western Washington state average (83 mm) by nearly 65 mm. Relative weights were low when compared with the national standard but consistent with western Washington averages (Figure 18).

Table 13. Age and growth of yellow perch (*Perca flavescens*) captured at Pine Lake (King County) during fall 2000. Values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

Year class	# fish	Mean total length (mm) at age age 1
1999	13	129.1
Weighted mean		129.1
Western WA average		83.0

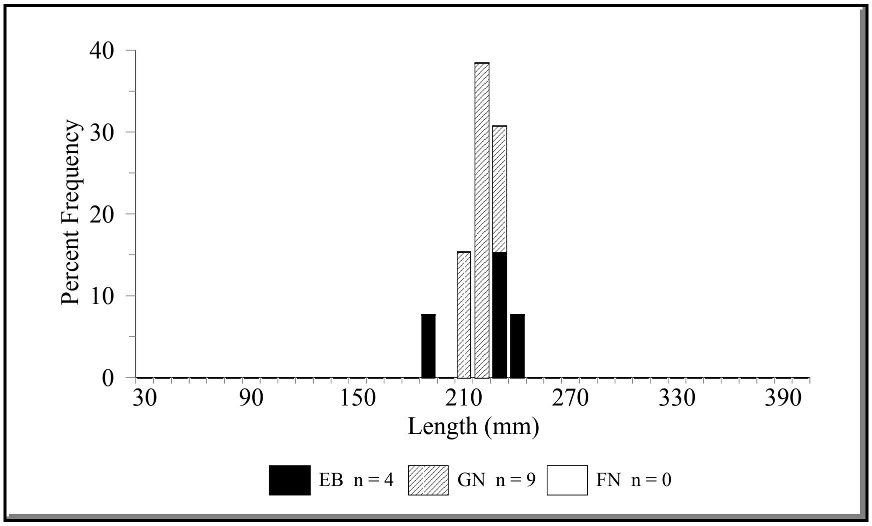

Figure 17. Length frequency histogram of yellow perch sampled from Pine Lake (King County) in fall 2000. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

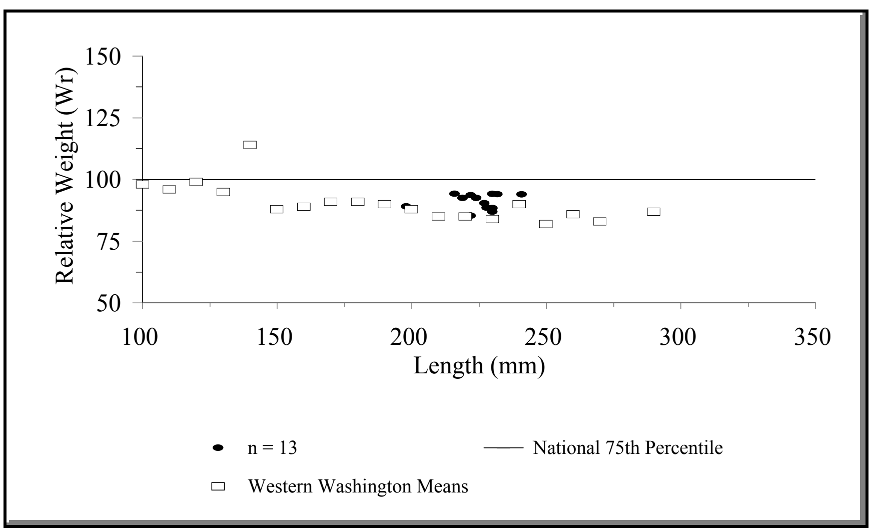

Figure 18. Relationship between total length and relative weight (*Wr*) of yellow perch from Pine Lake (King County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Warmwater Enhancement Options

The Pine Lake fish population sampled in the littoral zone during fall 2000 was characterized by low density and above average growth rates. Largemouth and smallmouth bass size structure was skewed toward smaller fish with few quality size and larger fish. However, several factors may have contributed to low catch rates for stock-size and larger fish, including: high number of docks (3 per 100 m), providing abundant refuge for larger fish from our sampling methods; low water conductivity limiting electrofishing efficiency; and, high water transparency affording fish increased opportunity to flee electrofishing gear at greater distances. Yellow perch were large for their age but limited to the 1999 year class. Where smaller age 1+ yellow perch were lacking, largemouth bass were plentiful (Table 14). Besides small largemouth bass, no species stood out as the abundant forage species. Largemouth bass were found to be resorting to cannibalism, suggesting a limited prey base for this species. However, crayfish were evident in our samples and larger fish may include them in their diet.

Table 14. Length frequency distribution in 10-mm increments of largemouth bass (LMB), smallmouth bass (SMB), pumpkinseed (PS), and yellow perch (YP), between 30 and 300 mm total length, sampled at Pine Lake (King County) during fall 2000.

mm	LMB	SMB	PS	YP
30-39			4	
40-49	6		19	
50-59	71	2	3	
60-69	286	12	1	
70-79	382	31		
80-89	234	43		
90-99	94	14	1	
100-109	22	1		
110-119	2			
120-129	2	1		
130-139	5	1		
140-149	15	2		
150-159	15	7	4	
160-169	18	5		
170-179	14	2		
180-189	12	1		
190-199	4			1
200-209	3			
210-219	1			2
220-229	1			5
230-239				4
240-249				1
250-259	3			
260-269	1			
270-279				
280-289	1			
290-299				

Stock density indices for the fish populations in Pine Lake during our survey suggest a community out of balance. Proportional stock density indices for largemouth bass (PSD = 25 electrofishing) and yellow perch (PSD = 75 electrofishing and 100 gillnetting) are consistent with fish populations managed for panfish (PSD for largemouth between 20 and 40, and the prey species between 50 and 80). However, low RSD-P values for panfish species are more suggestive of a predator population managed for 'big bass'.

Management options that might improve the warmwater fishery at Pine Lake include, but are not limited to, the following:

Change Existing Fishing Rules to Improve Size Structure of Largemouth and Smallmouth Bass

Currently, Pine Lake anglers are allowed to harvest five largemouth bass daily. Although there is no minimum size limit, no more than three fish can measure over 381 mm (15") TL. Implementing a 305 – 432 mm (12 – 17") slot limit for bass might succeed where the current rule failed to achieve balance in Pine Lake. The main objective of a slot limit is to improve the size structure of bass. Under this rule, only fish less than 305 or greater than 432 mm TL may be kept. Decreasing the creel limit from three fish over 381 mm TL to one fish over 432 mm TL would stimulate harvest of small fish while still protecting large fish. A reduction of small fish may improve growth and production of predator and prey species alike (McHugh 1990). In Arkansas, an outstanding largemouth bass fishery was developed by adjusting the slot and the creel limits to stimulate harvest of small fish while protecting large fish (Turman and Dennis 1998).

A simpler alternative to protect bass would be to implement catch-and-release fishing on the lake. Under this rule, all bass captured must be released back into Pine Lake alive. This measure may increased numbers of larger fish. Furthermore, the rule is simpler for anglers and easier for fish and wildlife agents to enforce.

The success of any rule change, though, depends upon angler compliance. Reasons for non-compliance include lack of angler knowledge of the rules for a particular lake, a poor understanding of the purpose of the rules, and inadequate enforcement (Glass 1984). Therefore, clear and concise multilingual posters or signs should be placed at the lake describing the new regulations. Press releases should be sent to local papers, magazines, and sport fishing groups detailing the changes to, and purpose of, the rules. Furthermore, increasing the presence of WDFW enforcement personnel at Pine Lake during peak harvest periods would encourage compliance.

Consider Increasing the Density of Aquatic Plants and Enhancing Littoral Zone with Natural or Artificial Structures

Little submersed aquatic vegetation was detected in Pine Lake during our survey. Most researchers agree that a low or moderate level of aquatic vegetation is better than none or too much (Savino and Stein 1982: Durocher et al. 1984; Wiley et al. 1984; Killgore et al. 1989; Davies and Rwangano 1991). For example, in Virginia, Killgore et al. (1989) collected up to seven times more fish in areas with aquatic plants than in areas lacking plants. Underwater structure provides warmwater fish with food and shelter (or refuge from predation). By increasing aquatic plant densities, production of epiphytic invertebrates should increase (Wiley et al. 1984), resulting in more food available to forage fish, in turn improving conditions for predaceous bass. Although Hoyer and Canfield (1996) demonstrated that largemouth bass in small Florida lakes can exist without submersed or emergent aquatic vegetation, Colle et al. (1989) found that Florida largemouth bass had significant preferences for natural and artificial structures, such as water tupelo (*Nyssa aquatica*) and piers, after removal of all aquatic vegetation. Furthermore, largemouth bass and bluegill were rapidly attracted to artificial vegetation (green polypropylene ribbons tied to square plastic mesh mats) placed in a small Ohio lake lacking natural plants (Hayse and Wissing 1996).

Given the reduction of Pine Lake's natural cover in recent years (KCSWM 1996), the fish community would probably benefit by increasing the amount of underwater structure (vegetation or otherwise) in the littoral zone. It may be possible to introduce or encourage expansion of native vegetation in Pine Lake (Fischer et al. 1999). If artificial structures such as the 'vegetation' used by Hayse and Wissing (1996) are cost-prohibitive, then natural structures such as tree stumps or root wads should be considered.

Conduct Creel Survey to Assess Angling Pressure on Warmwater Fish Populations

Pine Lake has been noted as one of the top 10 bass fishing waters in King County. Anecdotal reports have indicated Pine Lake has been home to strong populations of bass and that anglers shouldn't be surprised hook "a real lunker in the 5-, 6-, or even 7-pound class" (Johansen 1999). Although our findings suggest that of the warmwater species in the lake, largemouth bass are dominant in terms of numbers and biomass, no memorable or trophy-size fish were captured and RSD for preferred-size fish (RSP-P=8) was low with unreliable 80% confidence intervals. Only one preferred size largemouth bass was captured, a 4.5 pound (2,084 g) fish. There appears to be a discrepancy between what we found and anecdotal reports. Whether the disparity is a result of limitations in our sampling methods or an actual disparity of larger fish, a creel or angler survey might reveal helpful fishery information, including: angler pressure, preference, harvest, and satisfaction as it relates the warmwater fish community in Pine Lake. A creel survey may provide information on the number of quality and larger size panfish either harvested or caught that appear to absent from our samples.

Conduct Underwater Survey of Dock Use by Bass

A large number of closely spaced docks, such as in Pine Lake, can interfere with electrofishing. Maneuvering the boat is more difficult and docks and pilings, offering cover to fish, can obscure stunned fish and allow them to escape dip-netting. These impediments may have contributed to the low PSD and RSDs for largemouth and smallmouth bass found in our survey. Given the clear water in Pine Lake (secchi transparency = 4m), an underwater visual census may be appropriate. A survey of dock use by bass in Pine Lake may reveal additional information on larger fish not available through our standard sampling methods. Combined with other standard sample methods, underwater surveys may provide more accurate data in areas where docks are numerous.

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Appendix A

Appendix A. Catch rates (CPUE), stock density indices (PSD and RSD-P), and average relative weights (Wr) of fish sampled during surveys of select western Washington State lakes.

Lake	County	Size (acres)	Trophic status	Season	Year	Species	CPUE EB	CPUE GN	CPUE FN	PSD EB	RSD-P EB	PSD GN	RSD-P GN	PSD FN	RSD-P FN	Avg Wr	Source
Sunset	Whatcom	12		Fall	1998	BBH	2		1	100	100						Downen & Mueller; FPT99-02
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	BBH	2.1	0.1									Mueller et al; FPT99-12
Hummel	San Juan	36	Eutrophic	Fall	1998	BBH	6	2	2	100		100	25	100			Downen & Mueller; FPT00-03
Campbell	Skagit	360	Mesotrophic	Fall	1999	BBH	5.9	8.5	1.3	67	33	74	35	100		95	Downen & Mueller; FPT00-13
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	BBH	0.7										Downen & Mueller; FPT00-02
Cassidy	Snohomish	115	Eutrophic	Fall	1998	BBH	2	0.3	4.5	100				94	33		Downen & Mueller; FPT99-07
Stevens	Snohomish	1039	Mesotrophic	Fall	1997	BBH	10.7	12.5		14		19					Mueller; April 1999
Leland	Jefferson	110	Eutrophic	Fall	1999	BBH	7			89	22						Jackson & Caromile; FPT00-22
Green	King	255	Eutrophic	Fall	1997	BBH	3	1.2		33		40				84	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	BBH	1.6									89	Verhey & Mueller; FPT01-11
Sawyer	King	291	Mesotrophic	Fall	1999	BBH	4			50	25					96	Downen & Mueller; FPT00-23
Limerick	Mason	132	Meso/Eu	Fall	1998	BBH	6.1	0.6	1.6	29		25	25	50	10		Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Meso	Fall	1998	BBH	0.7										Caromile & Meyer; FPT00-11
Black	Thurston	570	Eutrophic	Fall	1999	BBH	1	1	0.2								Jackson & Caromile; FPT00-16
Kapowsin	Pierce	590		Fall	1999	BBH	0.4	0.5									Jackson & Caromile; FPT00-18
SLCRP Pond	Lewis	17		Fall	1997	BBH	6.3			50						82	Mueller & Downen; FPT00-09
Black	Pacific	32		Fall	1997	BBH	2.3			33						86	Mueller & Downen; FPT00-05
Rowland	Klickitat	87		Fall	1999	BBH		1	1								Jackson & Caromile; FPT00-15
Vancouver	Clark	2286	Eutrophic	Fall	1998	BBH	52	73	65	4		1		6			Caromile et al; FPT00-19
						Avg	6.3	9.2	9.58	55.6	45.0	43.2	28.3	70.0	21.5	88.7	
						Median	3.0	1.1	1.60	50.0	33.0	40.0	26.7	82.0	21.5	88.7	
Green	King	255	Eutrophic	Fall	1997	BT		0.5				100	100			101	Mueller & Downen; FPT00-25
SLCRP Pond	Lewis	17		Fall	1997	BT	20.6										Mueller & Downen; FPT00-09
Rowland	Klickitat	87		Fall	1999	BT	2	1									Jackson & Caromile; FPT00-15
						Avg	11.3	0.8									
						Median	11.3	0.8				100.0	100.0			101.0	
																101.0	
Sunset	Whatcom	12		Fall	1998	CT	21.9	2.5								111	Downen & Mueller; FPT99-02
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	CT	1.7	1.1				18				91	Mueller et al; FPT99-12
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	CT		0.2								94	Downen & Mueller; FPT00-02
Cassidy	Snohomish	115	Eutrophic	Fall	1998	CT			0.3							83	Downen & Mueller; FPT99-07
Leland	Jefferson	110	Eutrophic	Fall	1999	CT		0.5									Jackson & Caromile; FPT00-22
Mason	Mason	1000	Oligo/Meso	Fall	1997	CT		0.2									Mueller; February 1999
Sawyer	King	291	Mesotrophic	Fall	1999	CT		0.8								110	Downen & Mueller; FPT00-23

Appendix A. (Continued)

Lake	County	Size (acres)	Trophic status	Season	Year	Species	CPUE EB	CPUE GN	CPUE FN	PSD EB	RSD-P EB	PSD GN	RSD-P GN	PSD FN	RSD-P FN	Avg Wr	Source
American	Pierce	1070	Mesotrophic	Fall	1997	CT		1.5								93	Mueller & Downen; FPT99-14
Rowland	Klickitat	87		Fall	1999	CT	1										Jackson & Caromile; FPT00-15
						Avg	8.2	1.0	0.3			18.0				97.0	
						Median	1.7	0.8	0.3			18.0				93.5	
Sunset	Whatcom	12		Fall	1998	LMB	41.8			24	19					100	Downen & Mueller; FPT99-02
Hummel	San Juan	36	Eutrophic	Fall	1998	LMB	174.8	2.5		14	13	40	20			108	Downen & Mueller; FPT00-03
Campbell	Skagit	360	Mesotrophic	Fall	1999	LMB	40.3	2.3		34	32	56	44			107	Downen & Mueller; FPT00-13
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	LMB	5.3	0.2		75	25	100	100			99	Downen & Mueller; FPT00-02
N. Twin	Snohomish	7		Fall	1998	LMB	18	2.5		13	7					105	Downen & Mueller; FPT00-04
S. Twin	Snohomish	10		Fall	1998	LMB	19.9			10						97	Downen & Mueller; FPT00-04
Cassidy	Snohomish	115	Eutrophic	Fall	1998	LMB	68.7	2		17	9	25				101	Downen & Mueller; FPT99-07
Stevens	Snohomish	1039	Mesotrophic	Fall	1997	LMB	0.7	0.2									Mueller; April 1999
Leland	Jefferson	110	Eutrophic	Fall	1999	LMB	67	2		26	18						Jackson & Caromile; FPT00-22
Green	King	255	Eutrophic	Fall	1999	LMB	1	0.5								109	Mueller & Downen; FPT00-25
Green	King	255	Eutrophic	Fall	1997	LMB										112	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	LMB	14.5	0.5								106	Verhey & Mueller; FPT01-11
Mason	Mason	1000	Oligo/Meso	Fall	1997	LMB	4	0.2								117	Mueller; February 1999
Sawyer	King	291	Mesotrophic	Fall	1999	LMB	10.9	0.5		18	9					104	Downen & Mueller; FPT00-23
Limerick	Mason	132	Meso/Eu	Fall	1998	LMB	4.7	1.4		40	10	90	20				Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Meso	Fall	1998	LMB	68.7	3.2	0.3	33	14	23	15				Caromile & Meyer; FPT00-11
American	Pierce	1070	Mesotrophic	Fall	1997	LMB	0.7									123	Mueller & Downen; FPT99-14
Black	Thurston	570	Eutrophic	Fall	1999	LMB	16	0.5	0.2	28	9						Jackson & Caromile; FPT00-16
Kapowsin	Pierce	590		Fall	1999	LMB	31	1		12	7						Jackson & Caromile; FPT00-18
SLCRP Pond	Lewis	17		Fall	1997	LMB	3.2									97	Mueller & Downen; FPT00-09
Black	Pacific	32		Fall	1997	LMB	21.7	3		38	13	67	25			105	Mueller & Downen; FPT00-05
Rowland	Klickitat	87		Fall	1999	LMB	15										Jackson & Caromile; FPT00-15
Vancouver	Clark	2286	Eutrophic	Fall	1998	LMB	10			80	30						Caromile et al; FPT00-19
						Avg	29.0	1.4	0.3	30.8	15.4	57.3	37.3			106.0	
						Median	15.5	1.2	0.3	26.0	13.0	56.0	22.5			105.0	
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	RB	0.2									77	Mueller et al; FPT99-12
Hummel	San Juan	36	Eutrophic	Fall	1998	RB	12	1.5									Downen & Mueller; FPT00-03
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	RB		1.5				11					Downen & Mueller; FPT00-02
N. Twin	Snohomish	7		Fall	1998	RB	8	2.5									Downen & Mueller; FPT00-04

Appendix A. (Continued)

Lake	County	Size (acres)	Trophic status	Season	Year	Species	CPUE EB	CPUE GN	CPUE FN	PSD EB	RSD-P EB	PSD GN	RSD-P GN	PSD FN	RSD-P FN	Avg Wr	Source
S. Twin	Snohomish	10		Fall	1998	RB		0.5								70	Downen & Mueller; FPT00-04
Green	King	255	Eutrophic	Fall	1997	RB		1.5				33	33			91	Mueller & Downen; FPT00-25
Green	King	255	Eutrophic	Fall	1999	RB	3.9	0.5								90	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	RB		0.5								84	
Sawyer	King	291	Mesotrophic	Fall	1999	RB	1					100				104	Downen & Mueller; FPT00-23
Limerick	Mason	132	Meso/eu	Fall	1998	RB		0.6				25					Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Meso	Fall	1998	RB		0.2									Caromile & Meyer; FPT00-11
American	Pierce	1070	Mesotrophic	Fall	1997	RB		1				17				91	Mueller & Downen; FPT99-14
Black	Thurston	570	Eutrophic	Fall	1999	RB	5	2		50	20						Jackson & Caromile; FPT00-16
						Avg	5.0	1.0		50.0	20.0	37.2	33.0			86.7	
						Median	4.6	0.8		50.0	20.0	25.0	33.0			90.0	
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	PS	10.9	0.7		7						106	Mueller et al; FPT99-12
Campbell	Skagit	360	Mesotrophic	Fall	1999	PS	34.5	4.5	2.3	3		6		22		103	Downen & Mueller; FPT00-13
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	PS	353.3	4.2	0.2	5		8		100		94	Downen & Mueller; FPT00-02
N. Twin	Snohomish	7		Fall	1998	PS	39.8	2	15					3		103	Downen & Mueller; FPT00-04
S. Twin	Snohomish	10		Fall	1998	PS	125	6	0.5							105	Downen & Mueller; FPT00-04
Cassidy	Snohomish	115	Eutrophic	Fall	1998	PS	15.9	0.3		50						107	Downen & Mueller; FPT99-07
Stevens	Snohomish	1039	Mesotrophic	Fall	1997	PS	101.3	6.7		1							Mueller; April 1999
Green	King	255	Eutrophic	Fall	1999	PS	140.2	2	0.5	4			100			113	Mueller & Downen; FPT00-25
Green	King	255	Eutrophic	Fall	1997	PS	208.8	3.2								113	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	PS	24.7	1		7						98	Verhey & Mueller; FPT01-11
Sawyer	King	291	Mesotrophic	Fall	1999	PS	22.8	0.8	4					6		108	Downen & Mueller; FPT00-23
Limerick	Mason	132	Meso/Eu	Fall	1998	PS	0.5	0.4									Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Meso	Fall	1998	PS	91.1	2.8	0.7	24		7					Caromile & Meyer; FPT00-11
American	Pierce	1070	Mesotrophic	Fall	1997	PS	156.6	7.5								119	Mueller & Downen; FPT99-14
Black	Thurston	570	Eutrophic	Fall	1999	PS	2		0.2								Jackson & Caromile; FPT00-16
Kapowsin	Pierce	590		Fall	1999	PS	4	0.3									Jackson & Caromile; FPT00-18
SLCRP Pond	Lewis	17		Fall	1997	PS	11.1									99	Mueller & Downen; FPT00-09
Rowland	Klickitat	87		Fall	1999	PS	46	3	2								Jackson & Caromile; FPT00-15
Vancouver	Clark	2286	Eutrophic	Fall	1998	PS		3									Caromile et al; FPT00-19
						Avg	77.1	2.9	2.8	12.6		7.0	100.0	32.7		105.7	
						Median	37.2	2.8	0.7	6.0		7.0	100.0	14.0		105.5	

Appendix A. (Continued)

Lake	County	Size (acres)	Trophic status	Season	Year	Species	CPUE EB	CPUE GN	CPUE FN	PSD EB	RSD-P EB	PSD GN	RSD-P GN	PSD FN	RSD-P FN	Avg Wr	Source
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	SMB	12.4	4.1		42	18	89	86			104	Mueller et al; FPT99-12
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	SMB	1.3	5				100	100			96	Downen & Mueller; FPT00-02
Stevens	Snohomish	1039	Mesotrophic	Fall	1997	SMB	2	1.3				37	37				Mueller; April 1999
Green	King	255	Eutrophic	Fall	1997	SMB	1									130	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	SMB	3.9	1				100	100			97	
Sawyer	King	291	Mesotrophic	Fall	1999	SMB	8	3.3		25	25	100	100			101	Downen & Mueller; FPT00-23
Island	Mason	110	Oligo/Meso	Fall	1998	SMB	0.7	0.2									Caromile & Meyer; FPT00-11
Black	Thurston	570	Eutrophic	Fall	1999	SMB	1	1	0.5								Jackson & Caromile; FPT00-16
						Avg	3.8	2.3	0.5	33.5	21.5	85.2	84.6			105.6	
						Median	1.7	1.3	0.5	33.5	21.5	100.0	100.0			101.0	
Sunset	Whatcom	12		Fall	1998	YP	41.8	11			19	91	9			98	Downen & Mueller; FPT99-02
Whatcom	Whatcom	4872	Oligo/Meso	Fall	1998	YP	29.5	2.3		7	1	79	4			93	Mueller et al; FPT99-12
Campbell	Skagit	360	Mesotrophic	Fall	1999	YP	91.2	48.5	3.8	4		26	1			103	Downen & Mueller; FPT00-13
Goodwin	Snohomish	537	Mesotrophic	Fall	1998	YP	61	4		3		29				85	Downen & Mueller; FPT00-02
Cassidy	Snohomish	115	Eutrophic	Fall	1998	YP	441.2	37	0.3	14		3	1			86	Downen & Mueller; FPT99-07
Stevens	Snohomish	1039	Mesotrophic	Fall	1997	YP	98	21.7		10		25	2				Mueller; April 1999
Leland	Jefferson	110	Eutrophic	Fall	1999	YP	23	16		20		42					Jackson & Caromile; FPT00-22
Green	King	255	Eutrophic	Fall	1997	YP		0.5				100				89	Mueller & Downen; FPT00-25
Meridian	King	150	Oligotrophic	Fall	2000	YP	145.9	28.3		35	1	84	2			85	Verhey & Mueller, FPT01-11
Mason	Mason	1000	Oligo/Meso	Fall	1997	YP	15.2	8.5								88	Mueller; February 1999
Sawyer	King	291	Mesotrophic	Fall	1999	YP	335	11.8	5.8	3	1	85	9	4	4	86	Downen & Mueller; FPT00-23
Limerick	Mason	132	Meso/Eu	Fall	1998	YP	81.7	6.6	0.1	90		83	7				Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Meso	Fall	1998	YP	68.3	22.2		17	1	57					Caromile & Meyer; FPT00-11
American	Pierce	1070	Mesotrophic	Fall	1997	YP	2	29				79	3			96	Mueller & Downen; FPT99-14
Black	Thurston	570	Eutrophic	Fall	1999	YP	1	1		33							Jackson & Caromile; FPT00-16
Kapowsin	Pierce	590		Fall	1999	YP	73	7		16							Jackson & Caromile; FPT00-18
Black	Pacific	32		Fall	1997	YP	52.8	0.8								87	Mueller & Downen; FPT00-05
Rowland	Klickitat	87		Fall	1999	YP		1									Jackson & Caromile; FPT00-15
Vancouver	Clark	2286	Eutrophic	Fall	1998	YP	11	7									Caromile et al; FPT00-19
						Avg	89.1	13.9	2.5	25.2	4.6	60.2	4.2	4.0	4.0	90.5	
						Meridian	61.0	8.5	2.1	16.0	1.0	79.0	3.0	4.0	4.0	88.0	

Appendix B

Appendix B. Total length (mm) at age of select warmwater species sampled during surveys of western Washington State lakes.

Lake	County	Year	Species	Length at 1	Length at 2	Length at 3	Length at 4	Length at 5	Length at 6	Length at 7	Length at 8	Length at 9	Length at 10	Length at 11	Length at 12	Length at 13	Length at 14	Source
Sunset	Whatcom	1998	LMB	89	187	241	308	373	411									Downen & Mueller; FPT99-02
Hummel	San Juan	1998	LMB	84	147	191	237	309	343	367	392	419	443	463	482			Downen & Mueller; FPT00-03
Campbell	Skagit	1999	LMB	65	109	156	198	256	300	348	376	393	417	496				Downen & Mueller; FPT00-13
Goodwin	Snohomish	1998	LMB	83	150	208	270	309	358	393	419	442	459	472	507			Downen & Mueller; FPT00-02
N. Twin	Snohomish	1998	LMB	75	128	162	200	325	350	362	382							Downen & Mueller; FPT00-04
S. Twin	Snohomish	1998	LMB	76	154	214												Downen & Mueller; FPT00-04
Cassidy	Snohomish	1998	LMB	65	141	229	308	366										Downen & Mueller; FPT99-07
Stevens	Snohomish	1997	LMB	79	104	126	151	183										Mueller; April 1999
Leland	Jefferson	1999	LMB	70	134	193	238	290	339	377	413	435	456	477	508	533	547	Jackson & Caromile; FPT00-22
Green	King	1999	LMB	91														Mueller & Downen; FPT00-25
Meridian	King	2000	LMB	71	165													Verhey and Mueller; FPT01-11
Mason	Mason	1997	LMB	68	106	134	160	213	249	279	301	355	415					Mueller; February 1999
Sawyer	King	1999	LMB	80	173	239	288	353	403	442	462	487	502					Downen & Mueller; FPT00-23
Limerick	Mason	1998	LMB	79	178	213	280	307	364	413								Meyer & Caromile; FPT00-10
Island	Mason	1998	LMB	68	123	188	255	319	351	384	423	450	484					Caromile & Meyer; FPT00-11
American	Pierce	1997	LMB	88	217													Mueller & Downen; FPT99-14
Black	Thurston	1999	LMB	82	137	186	225	294	386	425	446							Jackson & Caromile; FPT00-16
Kapowsin	Pierce	1999	LMB	69	128	176	232	307	340	383	409	433						Jackson & Caromile; FPT00-18
Black	Pacific	1997	LMB	68	116	157	196	227	259	289	315	339	361	388	411	453		Mueller & Downen; FPT00-05
Rowland	Klickitat	1999	LMB	83	137	177	228	251										Jackson & Caromile; FPT00-15
Vancouver	Clark	1998	LMB	88	172	248	352	345	408									Caromile et al; FPT00-19
			Average	77.2	145.3	191.0	242.8	295.7	347.3	371.8	394.3	417.0	442.1	459.0	476.9	493.1	547.0	
			Median	77.3	137.0	188.0	234.7	307.0	350.1	380.0	409.0	433.0	449.4	471.7	494.2	493.1	547.0	
Whatcom	Whatcom	1998	PS	42	96	113	131											Mueller et al; FPT99-12
Campbell	Skagit	1999	PS	44	70	91	110	126	136									Downen & Mueller; FPT00-13
Goodwin	Snohomish	1998	PS	66	87	115	131	144	152	162								Downen & Mueller; FPT00-02
N. Twin	Snohomish	1998	PS	58	87	106	118	135										Downen & Mueller; FPT00-04
S. Twin	Snohomish	1998	PS	59	98	112												Downen & Mueller; FPT00-04
Cassidy	Snohomish	1998	PS	40	89	119	149											Downen & Mueller; FPT99-07
Stevens	Snohomish	1997	PS	57	76	92	111	123	136									Mueller; April 1999
Green	King	1999	PS	40	111	131												Mueller & Downen; FPT00-25
Meridian	King	2000	PS	43	97													Verhey and Mueller; FPT01-11
Sawyer	King	1999	PS	47	116	162	173											Downen & Mueller; FPT00-23
Limerick	Mason	1998	PS	53	99													Meyer & Caromile; FPT00-10

Appendix B. (Continued)

Lake	County	Year	Species	Length at 1	Length at 2	Length at 3	Length at 4	Length at 5	Length at 6	Length at 7	Length at 8	Length at 9	Length at 10	Length at 11	Length at 12	Length at 13	Length at 14	Source
Island	Mason	1998	PS	45	81	119	148	160	168									Caromile & Meyer; FPT00-11
American	Pierce	1997	PS	52	78	99	122											Mueller & Downen; FPT99-14
Kapowsin	Pierce	1999	PS	51	77	113	125	139										Jackson & Caromile; FPT00-18
Rowland	Klickitat	1999	PS	48	73	95	112	132										Jackson & Caromile; FPT00-15
Vancouver	Clark	1998	PS	56	86	90												Caromile et al; FPT00-19
			Average	50.1	88.8	111.2	129.8	137.1	147.9	161.8								
			Median	49.5	86.8	112.3	125.0	135.3	143.8	161.8								
Whatcom	Whatcom	1998	SMB	89	157	227	299	346	386	411	461							Mueller et al; FPT99-12
Goodwin	Snohomish	1998	SMB	102	170	231	292	342	376	414	443	461	486					Downen & Mueller; FPT00-02
Stevens	Snohomish	1997	SMB	87	188	245	289	348	384	414								Mueller; April 1999
Meridian	King	2000	SMB	81	189	299	372	397	481									Verhey and Mueller; FPT01-11
Sawyer	King	1999	SMB	78	158	237	323	371	410									Downen & Mueller; FPT00-23
Black	Thurston	1999	SMB	81	143	169	217	277	322									Jackson & Caromile; FPT00-16
			Average	86.2	167.3	234.8	298.7	346.9	393.1	413.0	452.1	461.4	485.6					
			Median	84.1	164.0	234.4	295.7	346.9	385.0	413.9	452.1	461.4	485.6					
Sunset	Whatcom	1998	YP	88	149	195	235	263										Downen & Mueller; FPT99-02
Whatcom	Whatcom	1998	YP	75	124	178	206	262										Mueller et al; FPT99-12
Campbell	Skagit	1999	YP		134	167	178	187										Downen & Mueller; FPT00-13
Goodwin	Snohomish	1998	YP	85	121	158	180	198	213									Downen & Mueller; FPT00-02
Cassidy	Snohomish	1998	YP	72	123	168	202	215	234									Downen & Mueller; FPT99-07
Stevens	Snohomish	1997	YP	80	104	130	154	179	205	224	236	248	257					Mueller; April 1999
Leland	Jefferson	1999	YP	86	143	177	208											Jackson & Caromile; FPT00-22
Meridian	King	2000	YP	75	143	187	220	242										Verhey and Mueller; FPT01-11
Mason	Mason	1997	YP	95	132	156	178	197	212	229								Mueller; February 1999
Sawyer	King	1999	YP	84	163	203	234											Downen & Mueller; FPT00-23
Limerick	Mason	1998	YP	117	187	207												Meyer & Caromile; FPT00-10
Island	Mason	1998	YP	82	118	152	171	181										Caromile & Meyer; FPT00-11
American	Pierce	1997	YP	80	132	172	204	232	262	277								Mueller & Downen; FPT99-14
Black	Thurston	1999	YP	79	134	168	195	279										Jackson & Caromile; FPT00-16
Kapowsin	Pierce	1999	YP	67	123	164	175											Jackson & Caromile; FPT00-18
Black	Pacific	1997	YP	82	127	154	180	190										Mueller & Downen; FPT00-05
Vancouver	Clark	1998	YP	82	119	142												Caromile et al; FPT00-19
			Average	83.0	133.9	169.2	194.6	218.8	225.2	243.1	236.1	247.8	257.1					
			Median	82.0	131.7	168.0	195.0	206.6	213.1	228.5	236.1	247.8	257.1					