2001 Sportsman Lake Stock Assessment Survey: The Warmwater Fish Community of an Isolated Island Lake

by

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Abstract

In fall 2001, we used standard electrofishing and netting techniques to sample fishes of the littoral zone of Sportsman Lake, San Juan Island. Three species were found including (in order of decreasing abundance) largemouth bass, pumpkinseed, and yellow perch. Largemouth bass as old as age 10 and measuring up to 430mm total length (TL) were captured. Individuals measuring 300mm TL or longer captured while electrofishing comprised 23% of largemouth bass measuring 200mm TL or longer (i.e., PSD = 23). However, individuals less than 200mm comprised 88% of all bass sampled. Smaller largemouth bass were highly abundant and displayed a trend of increasing growth and condition up to approximately 200mm TL. Growth and condition then fell to below average levels, suggesting a predator-crowded population. Fish larger than 350mm TL, though still below average in growth, showed improved relative weight. Large numbers of young-of-year largemouth bass and yellow perch were sampled and may represent strong, future year classes. Age 1 and 2 yellow perch occurred in low densities, were fast growing and well fed, but older fish were absent from our samples. While catch rates for pumpkinseed measuring 80mm TL and longer were higher than state averages, few young-of-year fish were found, suggesting a year class failure possibly due to predation by other fish. Smaller pumpkinseed were abundant and showed symptoms of stunting, while larger, older fish displayed faster than average growth. Management options include: mechanical removal of stunted size classes of both largemouth bass and pumpkinseed, management of the lake as a panfish fishery, promoting a juvenile panfish derby, introduction of black crappie to diversify the fishery, introduction of a super predator such as tiger muskellunge to reduce over abundant smaller fish, conducting a creel survey, conducting detailed aquatic plant and water quality surveys, and implementing boat ramp improvements.

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Introduction and Background

Figure 1. Topographic map of Sportsman Lake (San Juan County) and surrounding area (USGS 1985).

Sportsman Lake (Figure 1) on San Juan Island (San Juan County) is a shallow (max depth 2.5m), small (26 ha), natural lake whose basin was formed by glacial scouring. The lake, lying at an elevation of 47 meters above mean sea level, is the primary basin for a drainage area of approximately 818 ha (Bortelson 1976). The watershed is characterized by rolling, terraced hills mixed with occasional steep slopes and bedrock outcrops. Low areas are dominated by wetland marshes, while sloped areas are covered in coniferous forest. Intermittent streams and subsurface flow connect the drainage basin to the lake (WDFW data). The lake is also fed by surface water runoff and springs in and around the lake. Annual precipitation for the area is moderate, averaging about 67cm (26.5 inches). However, poor drainage, due to the bedrock nature of the underlying terrain, helps retain water and sustain local wetlands. Surface water exits the lake to the east, through a marsh and stream with little drop in elevation, and travels approximately 1.8km before reaching the edge of the island. The final 163m of the stream descends a vertical gradient of approximately 44% into the San Juan Channel. This gradient likely precludes anadromous fish passage to the lake, however no records of a salmonid stock assessment stream survey were found to support this statement.

Access to the lake is off Roche Harbor Road, approximately 6.4km (4 mi.) northwest of the City of Friday Harbor. WDFW maintains the only public access to the lake, a relatively steep gravel road that ends as a boat ramp at waters edge. The access site, having no picnic tables or toilet facilities, is otherwise undeveloped. Parking space near the boat ramp is extremely limited. However vehicles may park on the side of the road above the access area. Development around the lake is minimal and includes a few houses widely distributed around the lake.

Sportsman Lake has long been considered by many “in-the-know” anglers as Washington’s finest largemouth bass (*Micropterus salmoides*) fishery (Walls 1981). Several decades of agency catch data, primarily from spot checks starting in 1940, suggest the lake has been a consistent producer of quality largemouth bass (Figure 2). It is unknown when or how largemouth bass were introduced into the lake, but it is likely that they had been there for some time before 1940. Except for an undated note in agency files reporting the presence of black crappie, little data exists on what other fish species might have been in the lake and potentially available as prey items. Gut contents sampled from five age 4 largemouth bass collected in 1952 found the fish were feeding almost exclusively on damselfly larvae (Order *Odonata*) (WDFW data). Early on, Sportsman Lake was recognized as a classic warmwater lake, shallow, soft bottomed and weedy. For more than 60 years, Sportsman Lake has been managed for warmwater species. However, in 1948, trout management plans for neighboring Egg Lake nearly interfered with this long record. Plans called for the rehabilitation of that lake, using a fish toxicant to eliminate warmwater species, for the later stocking of rainbow and cutthroat trout. Rehabilitation of Sportsman Lake, which is connected to Egg Lake by a marsh, was recommended to prevent reinvasion of Egg Lake by warmwater species.

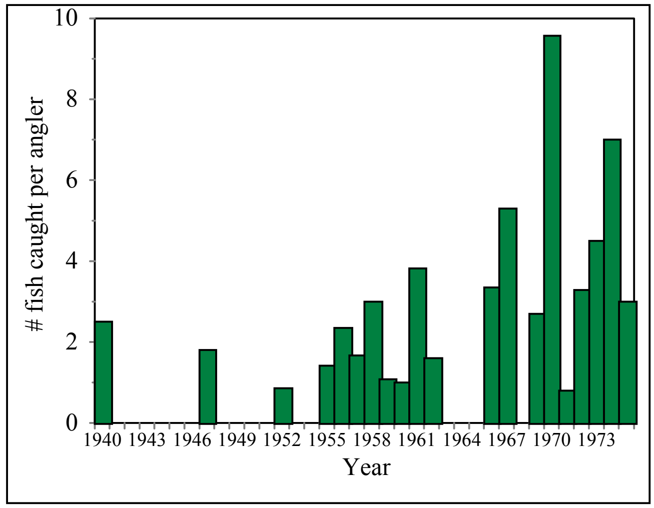

Figure 2. Catch rate per angler per day recorded from spot checks of Sportsman Lake anglers, 1940–1975.

However, a small but vocal group of bass anglers argued for preservation of the largemouth bass fishery. The agency agreed that the lake was best suited for warmwater fish and opted to treat only Egg Lake. The agency has stocked trout in Egg Lake since the 1950s, but never in Sportsman Lake. There may be other reasons why Sportsman Lake has been perceived as such a good largemouth bass fishery. Ostensibly, the location of the lake, on an island in an area with plenty of fishing alternatives, including salmon and bottom fishing, has shielded its fishery from heavy fishing pressure and reduced the likelihood of overharvest. However no up-to-date usage information is currently available. Today the only three fish species found in the lake are largemouth bass, pumpkinseed (*Lepomis gibbosus*), and yellow perch (*Perca flavescens*). The lake is well suited for warm water species. It is shallow, weedy, gets warm in the spring and summer, and rarely freezes, if ever, due to the maritime climate.

Because of its physical characteristics and longstanding popularity as a quality largemouth bass fishery, Sportsman Lake has been managed by WDFW as a warmwater lake, albeit passively (trout have not historically been stocked in the lake). However, other than anecdotal reports, little is known about the current condition of the fishery at the lake. To help determine the status of this fishery and provide data for more active management, the WDFW Warmwater Fish Enhancement Program conducted a stock assessment of Sportsman Lake in fall 2001. We assessed species composition, relative abundance, size structure, growth, and condition of fish in the lake. We also evaluated habitat and access, and then outlined options for enhancing the fishery and fishing opportunities on the lake.

Materials and Methods

Sportsman Lake was surveyed from October 8 to 10, 2001 by a 3-person team consisting of two biologists and one scientific technician. Fish were captured using three sampling techniques: electrofishing, gill netting, and fyke netting. The electrofishing unit consisted of a 4.9m Smith-Root 5.0 GPP ‘shock boat’ set to 250 volts of 6 amp pulsed DC (120 cycles/sec). Experimental gill nets (45.7m long × 2.4m deep) were constructed of four sinking panels (two each at 7.6m and 15.2m long) of variable-size (13, 19, 25, and 51mm stretched) monofilament mesh. Fyke nets were constructed of 1.2m diameter hoops with funnels attached to a 2.5m cod end (6.4mm nylon mesh). Attached to the mouth of the net were two 15.2m wings and a 31m lead.

Sampling locations were selected by dividing the shoreline into five consecutively numbered sections of about 400m each (determined visually from a map). These five sections were systematically sampled to maximize dispersion of gear types. Nighttime electrofishing was done along all five sections, or 100% of the available shoreline (Figure 2). The shock boat was maneuvered through the shallows (depth range: 0.2-1.5m), adjacent to the shoreline, at a rate of 18 m/minute. Gill nets and fyke nets were set overnight at three locations each (=3 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 3m deep with wings extended at 45-90E 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 1mm and assigned to a 10-mm size class based on total length (TL). For example, a fish measuring 156mm TL was assigned to the 150-mm size class for that species, a fish measuring 113mm TL was assigned to the 110-mm size class, and so on. When possible, up to ten fish from each size class were weighed to the nearest 1g. 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 ten 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). Also, for each species, three fish from each 100mm size class were collected whole for later otolith extraction and aging comparison with scale samples.

Water quality data was collected near the deepest part of the lake at 1-m intervals during midday October 9, 2001. Using a Hydrolab® probe and digital recorder, information was gathered on dissolved oxygen, temperature, pH, specific conductance and total dissolved solids. Shoreline characteristics, including littoral substrate types, and aquatic vegetation coverage were estimated visually.

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 inter-specific and intra-specific 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 ± $t_{(, N-1)}$ × SE, where t = Student's t for 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 Sportsman Lake were compared to western Washington State averages for lakes sampled during the same time of year (Table 1 and Appendix A).

Table 1. 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 1997 through fall 2000 (from Appendix A).

	Gear Type					
Species	**Electrofishing (Fish/Hour)**	**# Lakes**	**Gill Netting (Fish/Hour)**	**# Lakes**	**Fyke Netting (Fish/Hour)**	**# Lakes**
Largemouth bass	29.0	22	1.4	16	0.3	2
Pumkinseed	77.1	18	2.9	17	2.8	9
Yellow perch	89.1	17	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, 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 2). 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 of a 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 2. Length categories for cold- and warmwater fish species used to calculate stock density indices (PSD and RSD; Gablehouse 1984) of fish captured at Sportsman Lake (Skagit County) during fall 2001.

	Minimum Size (mm)				
Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Largemouth bass	200	300	380	510	630
Pumkinseed	80	150	200	250	300
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 3).

Table 3. Stock density index ranges for largemouth bass and bluegill under three commonly implemented management strategies (from Willis et al. 1993).

	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 Sportsman 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 Sportsman 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 collected during the survey. 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 Hyatt and Hubert (2000). 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).

Results and Discussion

Water Quality And Habitat

On October 9, Sportsman Lake was completely mixed with respect to dissolved oxygen, temperature, pH, specific conductance, and total dissolved solid (TDS) (Table 4). Dissolved oxygen levels in the lake, sampled at midday under cloudy skies, averaged 5.1 mg/L. This is consistent with the minimum (5 mg/L) required for optimal growth in most fishes (Moore 1942). Water transparency was clear to the bottom with a secchi disk reading of 2.5 m. The color of the water of this tanic lake was brownish, however, no scientifically rigorous assessment of color was made. Conductivity was 215 µS/cm throughout the water column and was within the optimum range (100-400 µS/cm) for electrofishing efficiency outlined by Willis (1998).

Table 4. Water quality from Sportsman Lake (San Juan County). Samples were collected at noon October 9, 2001. DO = dissolved oxygen, TDS = total dissolved solids.

Location	Depth (m)	DO (mg/L)	Temperature (°C)	pH	Conductance (:S/cm)	TDS (g/L)
	Surface	5.1	13.3	8.1	215.6	0.138
	1	5.1	13.3	8.2	215.1	0.138
Secchi depth = 2.5 m	2	5.2	13.3	8.3	214.9	0.138

Nearshore development around the lake was minimal, consisting of the public boat ramp, an electric irrigation pump, presumed capable of pumping lake water to the farm just east of the lake, and four houses, all perched on bedrock at varying distances above the water line and separated widely (Table 5). Only one dock, a dilapidated wooden structure resting partly in the water on the northwest side of the lake, was observed. Wetlands extend from the shore of the lake to the south, enveloping Egg Lake, and to the east, around the outlet stream. Emergent vegetation in the wetlands and around the lake were dominated by cattail (*Typha lattifolia*), and bulrush (*Scirpus* spp.) which occupied between 70 and 90 percent of the shoreline. Large mats of floating vegetation, primarily spatterdock (*Nuphar polysepala*), the most abundant water lily-like plant, and big leaf pondweed (*Potamogeton amplifolius*) were observed around most of the lake. Floating vegetation occupied between 10 and 40 percent of the nearshore area within the 400m survey sections, with the largest mats occurring in section 3, the south side of the lake. The soft mucky bottom of the lake, composed almost entirely of deep accumulations of decaying organic detritus, supports abundant submersed vegetation throughout the shallow lake basin. Common submersed plants observed include coontail (*Ceratophyllum demersum*), muskgrasses (*Charra* spp.) and, common waterweed (*Elodea canadensis*). No obvious occurrences of noxious aquatic vegetation were observed in our cursory plant survey.

Table 5. Nearshore habitat characteristics of Sportsman Lake during fall 2001. Values were derived from visual estimates made from the surface while traveling by boat along each 400m section of shoreline.												
Section #	**Development**	**% Bulkhead**	**Mean # Docks/100m**	**% Emergent Vegetation**	**% Floating Vegetation**	**% Submergent Vegetation**	**Coarse Woody Debris**	**% Silt**	**% Sand**	**% Gravel**	**% Cobble**	**% Bedrock**
1	natural/agricultural	0	0	90	25	80	Low	80	5	0	0	15
2	natural, one house	0	0	95	10	90	Low	95	0	0	0	5
3	natural, one house	0	0	90	40	70	Low	85	0	0	0	15
4	natural, two houses	0	>1	100	25	75	Low	95	0	0	0	5
5	natural, boat ramp	0	0	95	15	85	Low	80	5	0	0	10
Note: "Silt" = organic detritus												

Species Composition

Three species were sampled during our fall 2001 survey of Sportsman Lake, including largemouth bass, pumpkinseed, and yellow perch (Table 6). Of the 799 fish examined, largemouth bass made up the bulk of our catch accounting for 72.6% of the species composition by weight and 52.2% by number. A total of 417 largemouth bass were sampled. Of these, 125 (30%) were young-of-year fish less than 110mm TL. Yellow perch accounted for 27% of the species composition by number, 14% by weight, and were 93% (202 fish) young-of-year. Pumpkinseed made up 21% of the species composition by number, 13% by weight and included only one young-of-year fish. Black crappie, noted in the lake in the 1950s, were not found during our survey.

Table 6. Species composition by weight (kg) and number of fish captured at Sportsman Lake (San Juan County) during fall 2001.

	Species Composition				
	by Weight		by Number		Size Range
Species	**(kg)**	**(%) weight**	**(#)**	**(%) n**	**(mm TL)**
Largemouth bass (*Micropterus salmoides*)	26.5	72.6	417	52.2	46 – 430
Pumpkinseed (*Lepomis gibbosus*)	4.9	13.5	166	20.8	38 – 210
Yellow perch (*Perca flavescens*)	5.1	13.9	216	27.0	89 – 287
Total	36.5		799		

CPUE

Electrofishing was the most effective sampling method during our survey (Table 7). Electrofishing catch rates for stock-sized fish were highest for pumpkinseed (108 fish/hour), followed by largemouth bass (56 fish/hour), and then yellow perch (13 fish/hour). The electrofishing catch rate for largemouth bass was nearly twice the western Washington average (29 fish/hour), suggesting a relatively high density population as well as environmental conditions conducive to this method. Higher catch rates have been observed in only 3 of 22 largemouth bass lakes surveyed in western Washington to date (Appendix A). Lake Hummel (San Juan County), located on Lopez Island was highest at 175 largemouth bass/hour. The electrofishing catch rate for pumpkinseed (108 fish/hour) also exceeded the western Washington average (77 fish/hour). For pumpkinseed, only 4 lakes of 18 surveyed had greater relative abundance (Appendix A). Alternately, yellow perch were captured at a relatively low rate, 13 fish/hour versus the western Washington state average of 89 fish/hour, suggesting a relatively low-density population.

Table 7. 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 collected from Sportsman Lake (San Juan County) while electrofishing, gill netting, and fyke netting during fall 2001.

	Gear Type					
Species	**Electroshocking (# Fish/Hour)**	**Shock Sites**	**Gill Netting (# Fish/Netnight)**	**N (Net Nights)**	**Fyke Netting (# Fish/Netnight)**	**N (Net Nights)**
Largemouth bass	55.6 " 7.6	5	2.3 " 1.1	3	0.3 [a]	3
Pumpkinseed	107.8 " 25.2	5	1.7 " 0.4	3	2.0 " 2.0	3
Yellow perch	13.0 " 13.0	5	1.3 " 1.1	3	0	3

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

Stock Density Indices

While PSD and RSD-Ps for largemouth bass and pumpkinseed were similar to western Washington state averages, they describe a predator/prey community that is not balanced (Table 8). For balanced communities, Gablehouse (1984) and Anderson (1996), recommend largemouth bass PSDs between 40 and 70, RSD-P between 10 and 25, and panfish PSDs between 20 and 60 (see Table 3). PSDs for predators and prey in our survey were low. Electrofishing, the largemouth bass PSD from our survey was 23 (" 8) suggesting high densities of fish less than quality size. Predation by such largemouth bass populations can effectively produce preferred length and longer panfish (Gabelhouse 1984). Though this may be evident in the yellow perch population (RSD-P 33 ± 17), no preferred-size pumpkinseed were captured while electrofishing (RSD-P = 0). Preferred-size pumpkinseed were captured in gill nets but sample sizes were small, preventing calculation of reliable confidence intervals. Pumpkinseed PSD electrofishing was 15 (" 5) which is consistent with a high density population composed of many small fish. Of stock-size fish, we sampled about twice as many pumpkinseed as largemouth bass. However largemouth bass PSDs were roughly twice those of pumpkinseed.

Table 8. Traditional stock density indices including 80% confidence intervals for warmwater fish collected from Sportsman Lake (San Juan County) while electrofishing, gill netting and fyke netting during fall 2001. 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
Largemouth bass	EB	48	23 " 8	13 " 6	0	0
	GN	7	57 " 24	29 " 22	0	0
	FN	1	0	0	0	0
Pumpkinseed	EB	93	15 " 5	0	0	0
	GN	5	20 " 23 [a]	20 " 23 [a]	0	0
	FN	6	0	0	0	0
Yellow perch	EB	12	92 " 10	33 " 17	0	0
	GN	4	75 " 28	0	0	0
	FN	0	0	0	0	0

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

Largemouth Bass

Although largemouth bass as old as ten years were sampled, bass age 1 through age 3 were most abundant (Table 9, Figure 3). Individuals from the 1996 year class (age 5) were missing from our samples and may represent a year class failure. Growth of age 1 largemouth bass was slow compared to the western Washington average but improved for each subsequent age class up to age 4, where growth was consistent with or slightly above average. Length at age for older fish, age 6 through age 10, were lower than average, suggesting slow growth at larger sizes. However sample sizes for these older fish were small and observed growth may not adequately represent actual growth. Some evidence suggests a period of low growth in a fish's life can affect length at age for the rest of the lifespan. Comparison of annual instantaneous growth (G), as described by Ricker (1975), of Sportsman Lake largemouth bass to statewide averages show above average growth occurring in fish age 4 through 6, while younger and older fish grew more slowly (Table 9). The best growth was realized by fish between 229 and 330mm TL (9–13 in.). Largemouth bass attained stock size (200mm, 8.2 in) by age 3 and quality size (300m, 12.2 in) by age 6, about one year later than average for western Washington. Fish smaller than 175mm (6.9 in.) appeared well fed displaying relative weights (Wr) both above 100 (the national 75th percentile) and consistent with or slightly higher than state averages (Figure 4). Largemouth bass this size and smaller typically feed on small crustaceans and insects (Wydosky and Whitney 1979) and their robustness suggests a high abundance of these prey items, which is consistent with the diet work from the 1950s, and diet trends observed in high density largemouth bass populations studied in other Washington lakes (Bonar et al. 1994). Subsequent size classes, from about 190mm to 300mm, showed lower than average Wr. The lower end of this range roughly corresponds to the stage of largemouth bass life history where diet shifts from principally invertebrates to fish (Scott and Crossman 1973). Slow growth combined with high Wr may suggest a highly seasonal food supply, possibly resulting from various insect hatches, or changing levels of vegetative cover throughout a growing season. It is possible that, given the extent of submersed aquatic vegetation in the lake which provides abundant hiding and escape structures for smaller prey fishes, young piscivores are having difficulty foraging on fish. Alternatively, availability of adequate sized prey fish may limit condition of largemouth bass between 190 and 300mm. Young-of-year yellow perch, while abundant, may have been too large (100–109mm), at least for some of these fish to consume, or did not coincide with them spatially and/or temporally. Like smaller pumpkinseed, young-of-year largemouth bass were a potentially abundant source of prey, but appear under utilized by larger largemouth bass. Largemouth bass piscivory apparently improved with size as Wr increased with total length. Relative weight of largemouth bass 300 mm and larger were equal to or exceeded 100, indicating good condition, and were only slightly lower than western Washington averages.

Table 9. Age and growth of largemouth bass (*Micropterus salmoides*) captured at Sportsman Lake (San Juan County) during fall 2001. 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**	**6**	**7**	**8**	**9**	**10**
2000	36	69.2									
1999	22	61.5	140.9								
1998	12	64.2	129.6	196.2							
1997	4	66.6	124.6	177.0	236.9						
1996	0										
1995	2	65.4	114.9	150.0	196.8	246.6	294.6				
1994	1	86.6	180.5	236.6	272.9	315.3	356.2	374.4			
1993	5	69.1	136.0	201.5	239.8	264.7	294.1	319.6	349.7		
1992	4	89.5	168.7	232.2	263.2	290.5	328.4	358.7	386.9	402.8	
1991	1	75.6	180.9	202.0	266.6	301.2	328.3	346.3	364.4	389.9	400.5
Weighted mean		67.5	139.2	197.8	243.1	276.6	312.2	341.2	366.1	399.6	400.5
Western WA average (mean of weighted means		77.2	145.3	191.0	242.8	295.7	347.3	371.8	394.3	417.0	442.1
Annual G		1.92	2.72	1.05	0.71	0.47	0.40	0.28	0.16	0.23	0.05
Statewide G *avg*		2.16	2.71	1.30	0.50	0.32	0.30	0.44	0.23	0.32	0.30

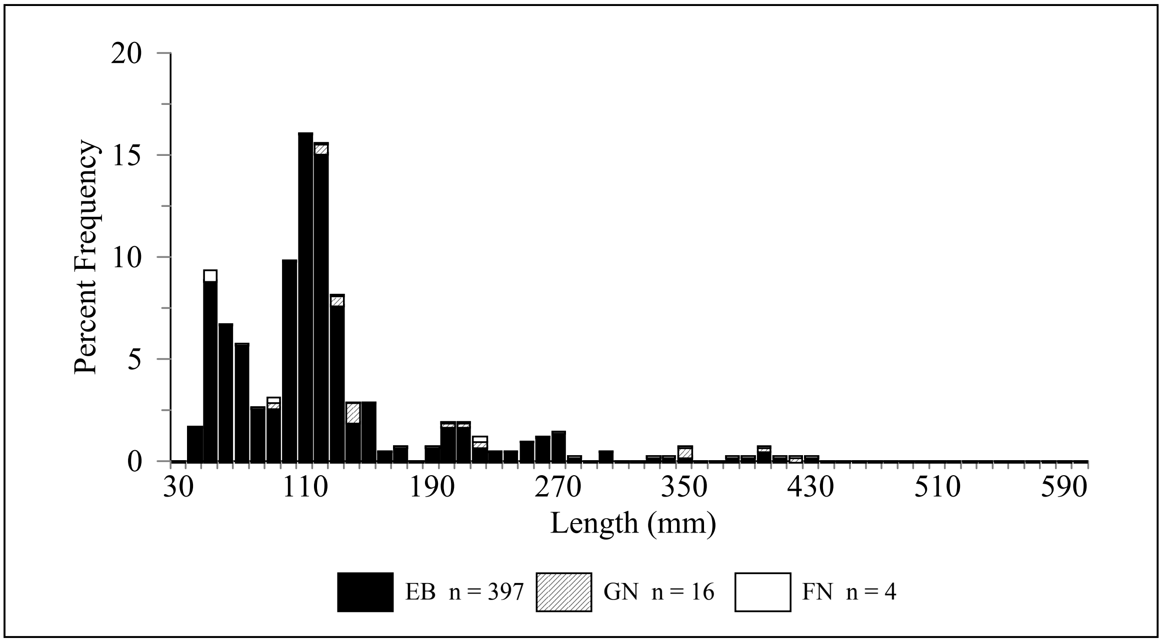

Figure 3. Length frequency histogram of largemouth bass sampled from Sportsman Lake (San Juan County) in fall 2001. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

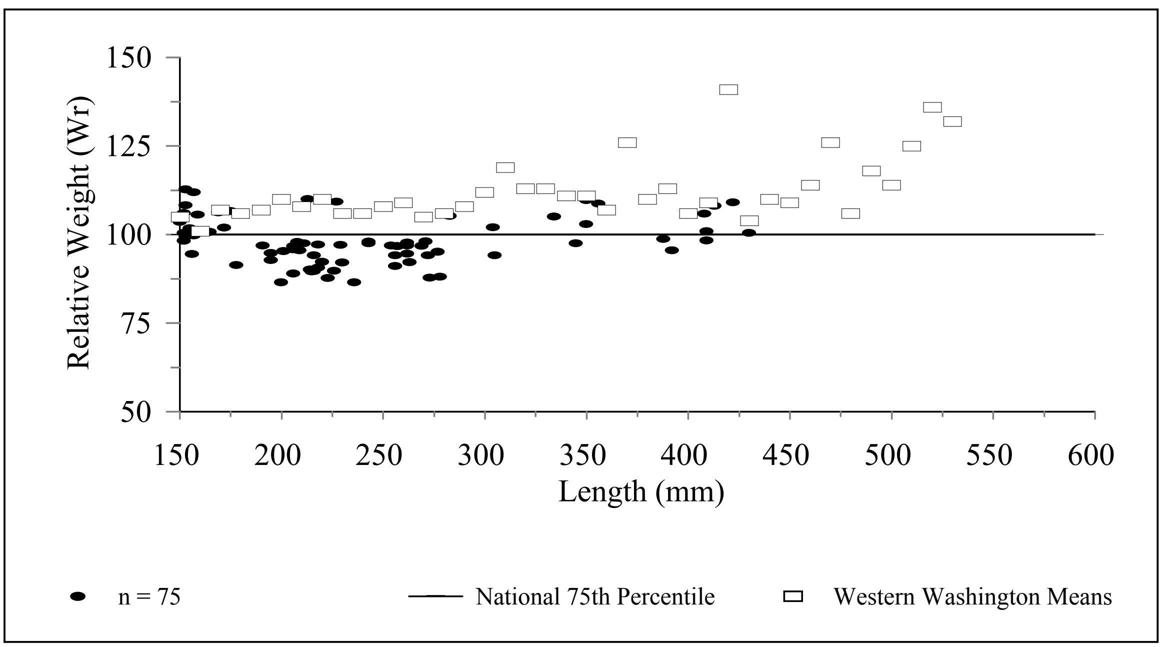

Figure 4. Relationship between total length and relative weight (Wr) of largemouth bass from Sportsman Lake (San Juan County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Pumpkinseed

Growth of pumpkinseed increased with age across the five year-classes sampled (Table 10). Age 1, 2 and 3 pumpkinseed growth was slow compared to western Washington averages, while growth for fish age 4 and 5 exceeded state averages. Growth of age 2 fish was extremely slow and showed the greatest length at age disparity compared to state averages, lagging behind by nearly 20mm in total length. Sportsman Lake pumpkinseed at age 3 take about a year longer than average to attain stock size (80mm, 3.1 in.), but reach quality size (150mm, 5.9 in.) about one year sooner than average at age 5. Young-of-year pumpkinseed (≤ 50mm total length) were rare in our samples while fish 60 to 95mm, corresponding to fish age 1, were most abundant accounting for 54% of pumpkinseed sampled (figure 5). Relative weight (Wr) for pumpkinseed increased with increasing total length. Smaller, more abundant fish had below average Wr, suggesting limited foraging success and competition, while Wr of larger less abundant fish exceeded state averages (Figure 6). Stunting of smaller pumpkinseed may be made worse by inter-specific competition with similar sized and highly abundant largemouth bass and abundant young-of-year yellow perch. Though larger pumpkinseed sometimes feed on small fish, which may be significant in the presence of abundant largemouth bass fry, insects, crustaceans and small molluscs comprise their principal forage base (Wydoski and Whitney 1979). The fast growth and high Wr of larger pumpkinseed suggests these aggressive feeders are finding abundant forage. Since pumpkinseed forage on the same food across year classes, the failure of smaller fish to realize better growth may be less related to forage availability than to foraging success. These fish must forage in the presence of superior numbers of similar-size and larger largemouth bass and yellow perch and may experience significant harassment. At smaller sizes, pumpkinseed might likely spend a lot of energy just avoiding being eaten.

Table 10. Age and growth of pumpkinseed (*Lepomis gibbosus*) captured at Sportsman Lake (San Juan County) during fall 2001. Values are mean back-calculated lengths at annulus formation 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**
2000	19	44.7				
1999	18	38.5	68.9			
1998	21	43.4	67.9	108.3		
1997	1	45.1	68.4	106.1	150.3	
1996	3	43.9	69.1	98.8	126.9	169.9
Weighted mean		42.4	68.4	107.1	132.7	169.9
Western WA average (mean of weighted means)		50.1	88.8	111.2	129.8	137.1

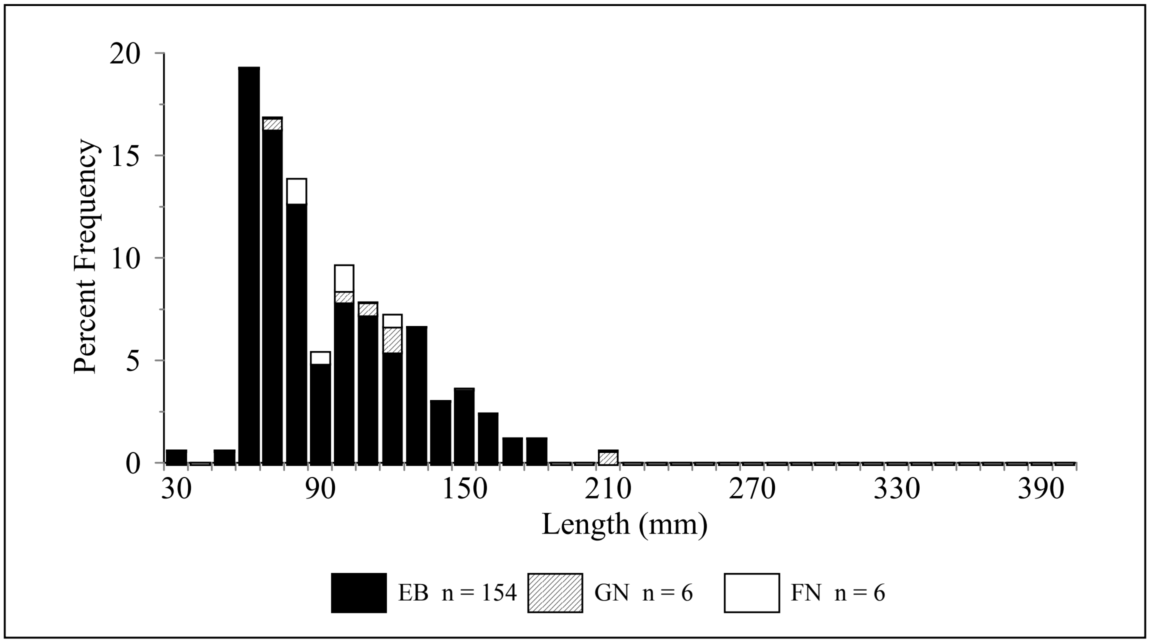

Figure 5. Length frequency histogram of pumpkinseed sampled from Sportsman Lake (San Juan County) in fall 2001. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

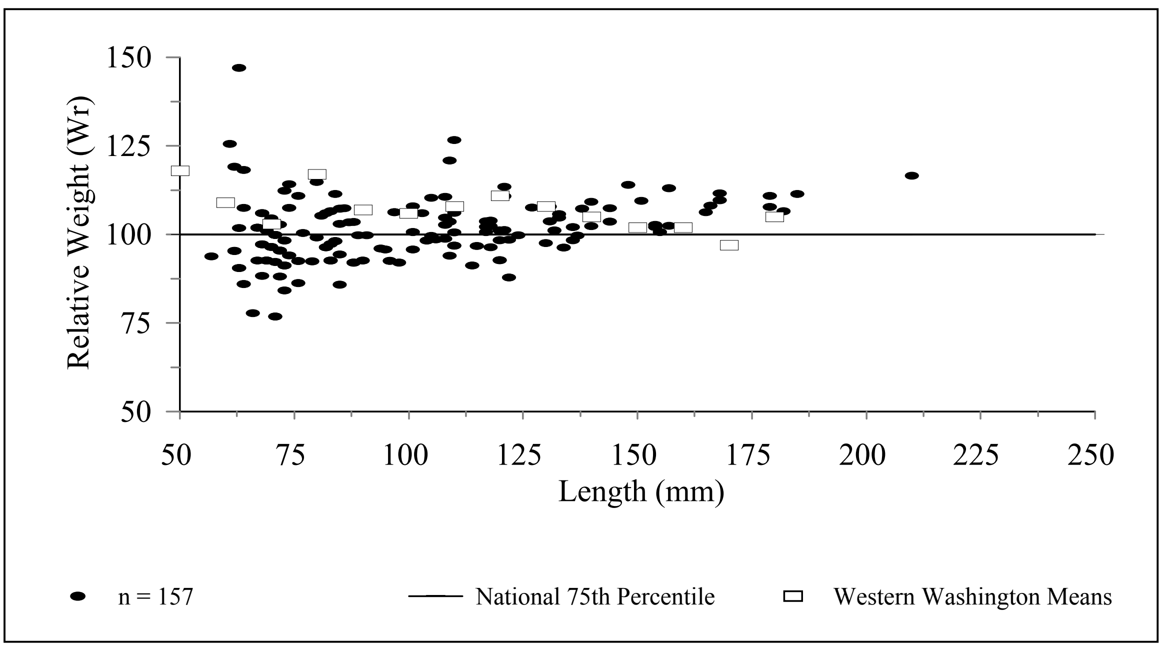

Figure 6. Relationship between total length and relative weight (Wr) of pumpkinseed from Sportsman Lake (San Juan County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Yellow Perch

Catch rates of stock-size yellow perch (130mm, 5.1 in.) were much lower (13 fish/hour) than the western Washington average (89 fish/hour), suggesting low abundance. However, those captured were large, with high electrofishing PSD and RSD-P, 92 " 10, and 33 " 17, respectively. (Thus, of the stock-size fish captured, about 92% were also quality size (200mm, 8.2 in.) or larger and about 33% were at least preferred size (250mm, 9.8 in.) Size at age for age 1 and age 2 yellow perch exceeded the western Washington average by several centimeters (Table 11.). Maximum length was 287mm (11.3 in.) (age 2). Although recruitment past age 2 seems limited, no older fish were captured, young-of-year yellow perch dominated the 90 through 109mm size classes and may represent a strong future year class (figure 7). Young-of-year yellow perch were relatively large, averaging 100mm TL, and may challenge similar sized largemouth bass (age 1) and pumpkinseed (age 1 and 2) competitively. Low relative weights (Wr) observed in young-of-year yellow perch indicates competition for available food (Figure 8). Alternately, larger yellow perch display higher than average Wr and appear able to forage effectively.

Table 11. Age and growth of yellow perch (*Perca flavescens*) captured at Sportsman Lake (San Juan County) during fall 2001. Values are mean back-calculated lengths at annulus formation using Lee's modification of the direct proportion method (Carlander 1982).

		Mean Total Length (mm) at Age	
Year Class	**# Fish**	**1**	**2**
2000	9	120.8	
1999	6	109.7	206.9
Weighted mean		116.4	206.9
Western WA average (mean of weighted means)		83.0	133.9

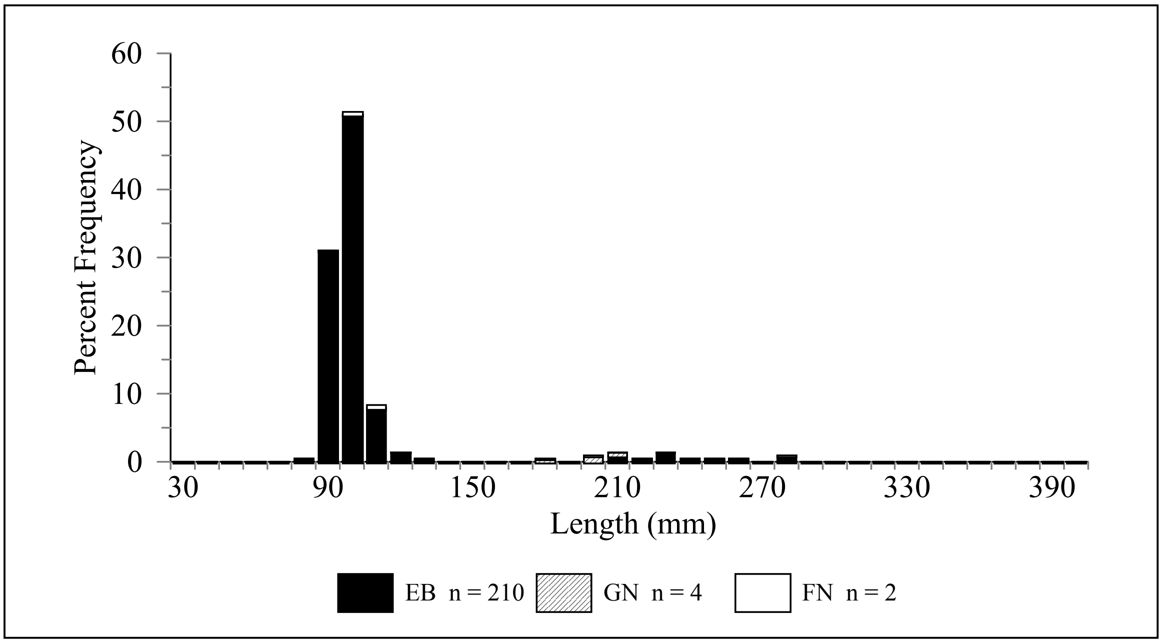

Figure 7. Length frequency histogram of yellow perch sampled from Sportsman Lake (San Juan County) in fall 2001. Stacked bars show relative contribution of each gear type to size classes. Length frequencies can be viewed collectively or by gear type. EB = electrofishing, GN = gill netting, and FN = fyke netting.

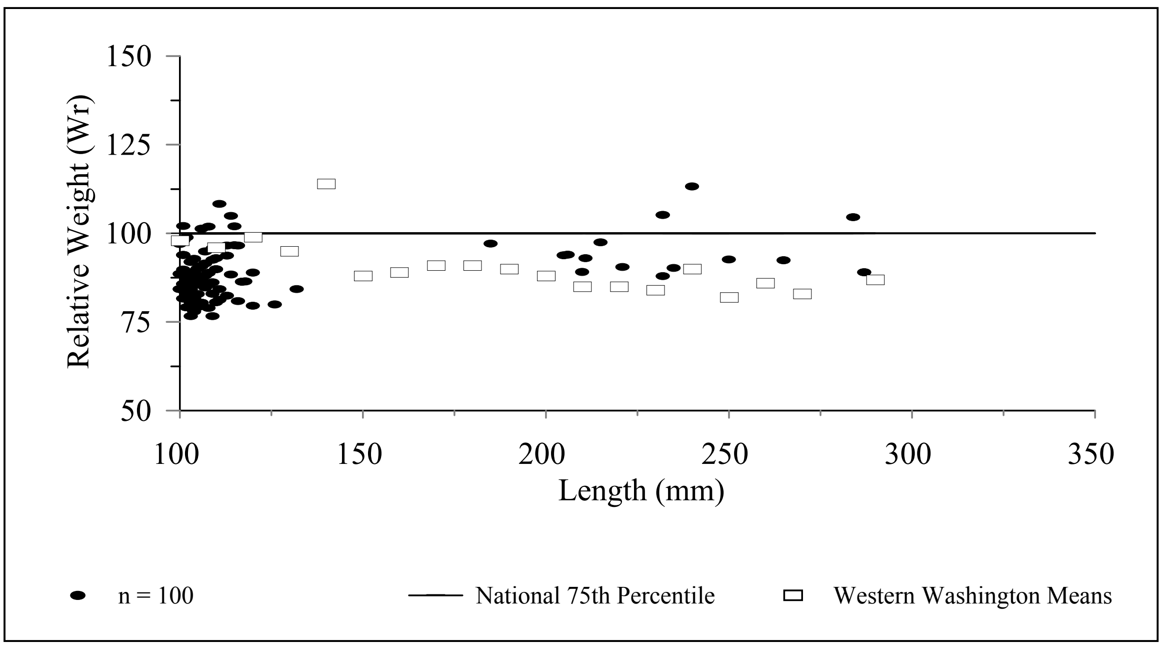

Figure 8. Relationship between total length and relative weight (Wr) of yellow perch from Sportsman Lake (San Juan County) compared with means from up to 25 western Washington lakes and the national 75th percentile.

Warmwater Enhancement Options

The fish community in Sportsman Lake was characterized by a slow growing, high density largemouth bass population that appears unable to forage effectively. Poor predator growth at smaller sizes appears to result from insufficient forage due to inter- and intra-specific competition, or difficulty capturing forage fish within the abundant vegetation in the lake (Mittelbach 1988), or a variable food supply. While slow growth in largemouth bass was evident in older fish, Sportsman Lake largemouth bass took six years to reach quality size (300mm, 12 in.) compared to the western Washington average of five years, growth of larger, less abundant pumpkinseed and yellow perch exceeded state averages.

Management options include: mechanical removal of stunted size class of both largemouth bass and pumpkinseed, management of the lake as a panfish fishery, promoting a juvenile panfish fishery, introduction of black crappie to diversify the fishery, introduction of a super predator such as tiger muskellunge to reduce over abundant smaller fish, conducting a creel survey, conducting detailed aquatic plant and water quality surveys, and implementing boat ramp improvements.

Selective Removal of Small Largemouth Bass

Mechanical removal of fish from stunted size classes may allow those that remain to grow larger and provide for an improved largemouth bass fishery. Using electrofishing to capture large numbers of smaller largemouth bass would accelerate the effects of the statewide slot limit rule on this relatively isolated lake.

Manage Lake For Panfish

The dense largemouth bass population should be able to thin panfish populations enough that the few that survive should be left with abundant forage and grow to sizes preferred by anglers. This seems to be the case with the not-so-abundant-but-large-for-their-age yellow perch, but not with the pumpkinseed. Pumpkinseed were highly abundant but small in size. However, few young of year pumpkinseed were found, suggesting a strong thinning has occurred, which may allow for increased growth of those that remain.

Promote Juvenile Panfish Derby

A juvenile panfish fishery could help decrease densities of smaller pumpkinseed (and small largemouth bass), thereby augmenting largemouth bass predation and contributing to management of the lake for large largemouth bass.

Introduce Black Crappie To Diversify The Fishery

Reports of black crappie caught from the lake date back to the 1950s. Although it is unlikely that crappie could become established for a long period of time, they would likely make an interesting addition to the fishery while they lasted. Since they've been in the lake before, we shouldn't need any special permits to stock them again.

Introduce Tiger Muskellunge Or Channel Catfish To Reduce Over Abundant Smaller Fish

Perhaps the introduction of a super-predator such as tiger (hybrid) muskellunge (*Esox lucius x Esox masquinongy*) could help thin stocks of overabundant small largemouth bass and smaller pumpkinseed, thereby allowing others to realize improved growth. Tiger muskellunge are sterile hybrids so they won't perpetuate themselves, but are fairly long lived. Stocking them in the lake would require special permitting since they would be a new introduction

However, there is evidence that Esosids (including tiger muskellunge) would not do well in systems such as Sportsman Lake where their diet would be limited to "spiny-rayed" prey. Some researchers suggest that where the desire is to maximize growth and survival of esosids, they should be stocked in systems with soft-rayed or fusiform prey, such as cyprinids or shad, rather than in centrarchid-dominated systems (Wahl and Stein 1988, Tomcko et al 1984).

Channel catfish have been successfully introduced in some western Washington lakes to enhance fishery diversity (Mueller 1997, Downen and Mueller 1999). Channel catfish young feed mainly on aquatic insects while older fish will eat a wide variety of items including available fish (Scott and Crossman 1973). This species would add an interesting new quarry for anglers and may help control overabundant smaller fishes in the lake. It is questionable though, whether these visual predators fare very well in this shallow weedy lake.

Conduct Creel Survey

We know little of the angling pressure this fishery receives. Anecdotal reports from local county workers who have fished the lake suggest that at least a small group of anglers use the lake fairly consistently

Conduct Detailed Aquatic Plant And Water Quality Surveys

Dense aquatic vegetation may inhibit predation on abundant pumpkinseed by largemouth bass. To assess this possibility we should conduct a detailed survey of the plant community in the lake and compare our results to research in the literature where predator efficiency is tested against varying degrees of plant density.

Improve Boat Ramp

The agency maintains a gravel boat launch on the north shore of Sportsman Lake. The boat launch, which features a long and steep approach to the ramp, is composed mainly of gravel with some sand. This material extends down the ramp and into the water to a depth of about one foot where the substrate then becomes bedrock. The ramp is relatively steep for its composition and is subject to deterioration by wheel spin-out from trailer towing vehicles. Although it is unlikely that 4-wheel drive vehicles would encounter much difficulty hauling trailered craft out of the lake, 2-wheel drive vehicles may tend to have trouble. This access could be improved by the addition of a concrete ramp or concrete planks, or possibly large-size compacted gravel, or broken quarry rock.

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Appendix A

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	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/Mesotrophic	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/Eutrophic	Fall	1998	LMB	4.7	1.4		40	10	90	20				Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Mesotrophic	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/Mesotrophic	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

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	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/Eutrophic	Fall	1998	PS	0.5	0.4									Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Mesotrophic	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	
Sunset	Whatcom	12		Fall	1998	YP	41.8	11			19	91	9			98	Downen & Mueller; FPT99-02
Whatcom	Whatcom	4872	Oligo/Mesotrophic	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/Mesotrophic	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/Eutrophic	Fall	1998	YP	81.7	6.6	0.1	90		83	7				Meyer & Caromile; FPT00-10
Island	Mason	110	Oligo/Mesotrophic	Fall	1998	YP	68.3	22.2		17	1	57					Caromile & Meyer; FPT00-11

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	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	
						Median	61.0	8.5	2.1	16.0	1.0	79.0	3.0	4.0	4.0	88.0	

Appendix B

Lake	County	Year	Species	Mean Length at Age (mm) 1	2	3	4	5	6	7	8	9	10	11	12	13	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

				Mean Length at Age (mm)														
Lake	County	Year	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Source
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
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								
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					