2000 Warmwater Fisheries Survey of Sacheen Lake (Pend Oreille County)

by

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Abstract

Sacheen Lake was surveyed by a three person investigation team September 11-14, 2000. Fish were sampled by boat electrofishing, gill netting, and fyke netting. Eight fish species were collected. Largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), and brown bullhead (*Ameiurus nebulosus*) were the most abundant game fish species. Tench (*Tinca tinca*) comprised a large portion of the sample by weight and number. Green sunfish (*Lepomis cyanellus*), black crappie (*Pomoxis nigromaculatus*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*) were also collected at lower levels of abundance. The fish community can be described as out of balance and mostly reflects examples of populations managed for panfish. The Sacheen Lake largemouth bass population is robust, exhibiting a high density of mostly small fish. Yellow perch and brown bullhead populations are of high density and offer an abundance of eight to ten inch fish. Green sunfish and black crappie likely offer only limited angling opportunity; green sunfish because of their small size and black crappie because of their limited abundance. Similarly, brook trout and brown trout are limited in abundance. Although largely undesirable to anglers, tench will likely continue as a component of the Sacheen Lake fish community due to the limited feasibility of rotenone rehabilitation because of the lakes connectivity to streams, wetlands, and other lakes in the drainage, as well as limited historic success. Management considerations discussed include: monitoring the recently adopted statewide 12 to 17 inch slot-limit regulation on largemouth bass, which should increase the number of quality length fish in the population and may improve the quality of panfish populations through increased predation; promoting panfish angling opportunities at the lake for abundant yellow perch and brown bullhead catfish, which would likely improve the quality of the populations by reducing overall abundance; considering the stocking of brown trout for their piscivorus nature; and conducting creel surveys to quantify fishery utilization, the return of stocked trout to the creel, anger catch-per-unit-effort, and angler preferences.

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Introduction

Sacheen Lake is a moderately sized body of water located approximately 17.5 kilometers (km) southwest of Newport, Washington, in Pend Oreille County (Table 1; Figure 1). Sacheen Lake has two main year-round inlets, Moon Creek and Cedar Creek, as well as one other unnamed tributary at the north end of the lake, and several other spring creeks. Moon Creek, the only outlet from Diamond Lake located upstream, flows from the southeast into Sacheen Lake. Cedar Creek flows into the lake from the northwest. The outlet of Sacheen Lake forms the beginning of the west branch of the Little Spokane River, which flows south through Trout Lake, Horseshoe Lake, and Eloika Lake before joining the Little Spokane River. Additionally, Fan Lake is connected to the west fork of the Little Spokane River by a short tributary stream 2 km north of Eloika Lake. Flows in Moon Creek and the West Branch Little Spokane River appear to be sufficient to allow for the exchange of fish between Diamond Lake, Sacheen Lake, and Trout Lake. A steep waterfall blocks any upstream migration of fish from Horseshoe Lake. In 1922, a low dam was built in the outlet between Sacheen Lake and Trout Lake to stabilize the lake, but this does not appear to act as an obstruction against downstream fish passage or have any control on lake water levels (Unpublished data, WDFW Region 1).

Table 1. Physical parameters of Sacheen Lake (Pend Oreille County).

Physical Parameters	Sacheen Lake (Pend Oreille County)
Surface Area (acres)	317
Shoreline Length (miles)	6.3
Maximum Depth (meters)	21.3
Mean Depth (meters)	7.3
Volume (acre feet)	7,600
Shoreline Development D_L	2.5

Land around the lake is mostly in private ownership and developed as vacation cabins or year-round residential homes. Historically, Sacheen Lake supported as many as three resorts that provided public access, yet currently, no resorts reside on the lake. Today, recreational access at Sacheen Lake is available to the public at a state owned and operated boat launch located on the southeast side of the lake and a homeowners association boat launch on the southeast shore.

Prior to the mid-1940's, Sacheen Lake was considered to be a fair warmwater fishery with large numbers of yellow perch (*Perca flavescens*) and largemouth bass (*Micropterus salmoides*). In the mid-1940's, to provide greater angling opportunities, stocking of rainbow trout (*Oncorhynchus mykiss*) began with approximately 50,000-75,000 fingerlings being stocked annually for several years (Unpublished data, WDFW Region 1). As Sacheen Lake moved more towards a trout fishery, the lake underwent seven rehabilitations since 1960 to remove “unwanted” fish species, particularly sunfish and panfish. In 1960, many warmwater species and rainbow trout were eliminated, but due to the extensive swamps, inlets and outlet, the treatment was unsuccessful in establishing a consistent trout fishery.

Two more rehabilitations, one in 1964 and one in 1969, also proved ineffective. In 1973, 1974 and 1975, only partial treatments were attempted to control the sunfish population as they moved into the shallows to spawn. These also were unsuccessful. Prior to the last total rehabilitation in 1979, a survey of local landowners showed 85% to be in favor of maintaining a trout fishery in Sacheen Lake (Unpublished data, WDFW Region 1). Due to the difficulty of removing and controlling unwanted fish species, both rainbow trout and eastern brook trout (*Salvelinus fontinalis*) are currently stocked annually to maintain a moderate trout fishery in Sacheen Lake. Most recently, in 1998 and 1999, 10,000 catchable rainbow trout and 15,000 catchable brook trout were stocked, and in 2000 and 2001, 25,000 brook trout fry (fall 2000) and 5,000 catchable rainbow trout and 19,500 catchable brook trout were stocked (WDFW unpublished data).

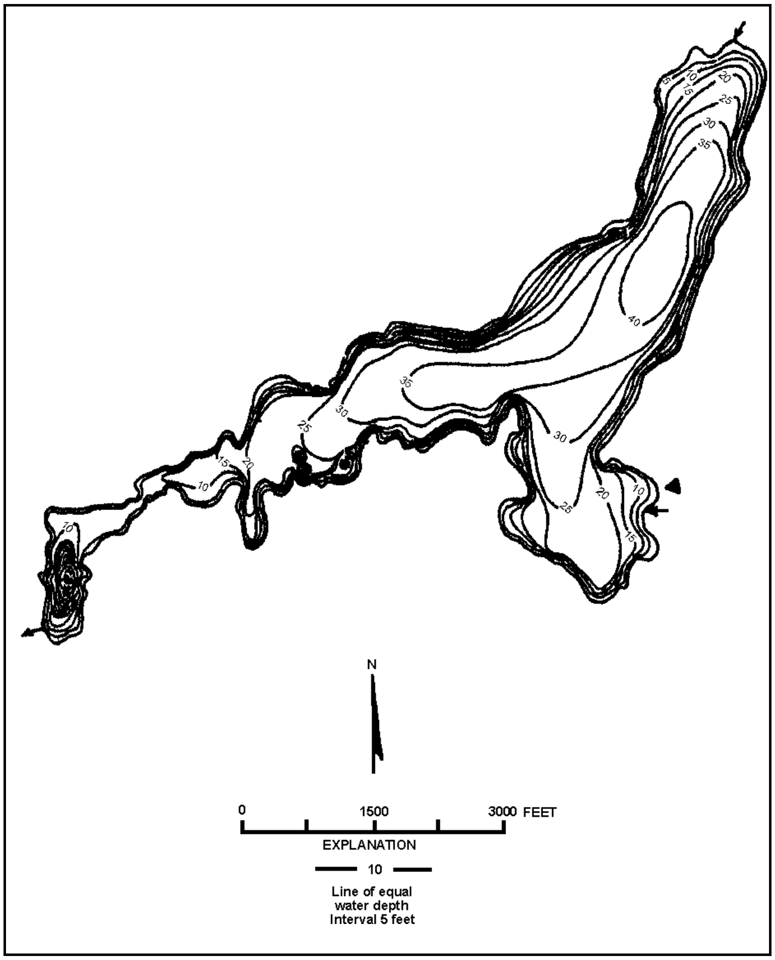

Figure 1. Bathymetric map of Sacheen Lake (Pend Oreille County). From Washington Department of Game Archive.

Under statewide WDFW angling regulations, the following rules applied on Sacheen Lake at the time of this survey: anglers were allowed to retain five largemouth bass, but only three over 15 inches; a combination of five rainbow trout (no minimum length) or brown trout (*Salmo trutta*) (no minimum length) may be retained; a total of five eastern brook trout (no minimum length) may also be retained in the daily creel. There is no minimum length or bag limit on black crappie (*Pomoxis nigromaculatus*), green sunfish (*Lepomis cyanellus*), yellow perch, brown bullhead (*Ameiurus nebulosus*), or tench (*Tinca tinca*). As of May 2002, a new statewide 12 to 17 inch slot-limit regulation on largemouth bass is in effect prohibiting the retention of bass from 12 to 17 inches in length. Under the newly adopted regulation, anglers are allowed a 5 bass daily limit and may only keep bass less than 12 inches or over 17 inches in length. Additionally, only one bass over 17 inches may be retained.

Sacheen Lake was identified by regional fisheries biologists as a body of water to be surveyed under the Warmwater Fish Enhancement Program. To evaluate warmwater fish populations, and to identify ways to improve the quality of fishing, personnel from the WDFW Warmwater Enhancement Program conducted a fisheries survey on Sacheen Lake during September, 2000. This report is intended to assist regional fisheries biologists in identifying management options which could improve the quality of warmwater fish angling in Sacheen Lake.

Methods

Sacheen Lake was surveyed by a three person investigation team September 11 - 14, 2000. Fish were captured using boat electrofishing, gill netting, and fyke netting. The electrofishing unit consisted of a 5.5 m Smith-Root 5.0 GPP "shock boat" using a DC current of 120 cycles / sec $^{-1}$ at 5 to 6 amps power. Experimental gill nets (45.7 m long x 2.4 m deep) were constructed of four sinking panels (two each at 7.6 m and 15.2 m long) of variable size (1.3, 1.9, 2.5, and 5.1 cm stretched mesh) monofilament. Fyke nets were constructed of a main trap (4.7 m long and 1.2 m in diameter), a lead net (30.5 m long x 1.2 m), and two wings (7.6 m long x 1.2 m deep).

Sampling locations were selected by dividing the shoreline into 30 sections of approximately 400 meters each. Twelve sections were randomly selected for sampling by boat electrofishing, eight by gill netting, and eight by fyke netting. Sampling was conducted so as to achieve a standardized 1:1:1 ratio of electrofishing to gill netting to fyke netting (1:1:1 - 1800 seconds of boat electrofishing:2 nights of gill netting:2 nights of fyke netting) (Fletcher et al. 1993). Boat electrofishing samples consisted of sampling each section for 10 minutes (600 seconds) "pedal-down" time. While electrofishing, the boat was maneuvered through the shallows (depth range = 0.2 - 2 m), adjacent to the shoreline. This sampling was conducted during evening hours to maximize the size and number of fish captured. Electrofishing is more effective at night because some fish species seek shelter during the day and move freely at night (Helfman 1983). The total electrofishing time during the survey was 7200 seconds. Gill nets and fyke nets were set in the evening and retrieved the following morning. Gill nets were set perpendicular to the shoreline with the small mesh end attached onshore and the large mesh end anchored offshore. Fyke nets were set perpendicular to the shore with the lead net anchored onshore and the wing nets set at 45 degree angles to the trap. Fyke nets were set so that the trap was no deeper than three meters (Bonar et al. 2000).

Each fish captured was identified to species, measured to total length (mm TL) and weighed (g). Scales were collected for age and growth analysis from largemouth bass, black crappie, yellow perch, green sunfish, and pumpkinseed sunfish. Scale samples (up to five per 10 mm length class for each species) were mounted, pressed, and aged according to Jearld (1983) and Fletcher et al. (1993). Brown trout, eastern brook trout, brown bullhead, and tench were not aged.

Water quality data was collected from the deepest location in the lake on three separate occasions. The first on June 23, 2000 at 4:00 PM, the second on July 25, 2000 at 3:00 PM, and the third on August 24, 2000 at 12:59 PM. Information was gathered on dissolved oxygen, temperature, specific conductance, total dissolved solids, and pH using a Hydrolab® probe and digital recorder. Water clarity was measured using a Secchi disc.

Data Analysis

Percentages of the total biomass and number of fish collected for each species provides useful information regarding the balance and productivity of the community (Swingle 1950; Fletcher et al. 1993). Species composition by weight (kg) and number were calculated from data collected using boat electrofishing, gill netting, and fyke netting. Species composition calculated from all fish sampled and calculated excluding young-of-the-year are presented for comparison. Fish determined to be less than one year old were excluded from the calculations for species composition because fry numbers can fluctuate dramatically according to sampling location, sampling methodology, and time of hatches (Fletcher et al. 1993). Including young-of-the-year fish in the calculation of species composition can give a false impression of year class strength due to the abundance of small fish which can suffer extensive mortality during the first winter (Chew 1974).

Catch-per-unit-effort (CPUE), by gear type, was calculated for each fish species collected (number of fish/hour electrofishing, number of fish/gill net night, and number of fish/fyke net night). The CPUE for each fish species was calculated and presented for all fish sampled and using only stock length fish and longer. Stock length fish, which varies by species, is the length of a particular fish species that offers a threshold recreational value to an angler (Anderson 1976). Randomly chosen sample sections can contribute to high variability among samples, therefore, 80 percent confidence intervals (CI) were calculated for each mean CPUE by species and gear type. Each 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. When standardized sampling is used, CPUE is a useful index to compare lakes within the state of Washington and to monitor changes in relative abundance over time.

Length frequency histograms (percent frequency captured by each gear type) were created to evaluate the size structure of largemouth bass, black crappie, yellow perch, green sunfish, brown bullhead, tench, and eastern brook trout. With the exception of brown bullhead, tench, and eastern brook trout, which were not aged, only fish greater than one year old were included in the length frequency histograms for reasons similar to those listed above.

Proportional stock density (PSD), calculated as the number of fish$quality length/number of fish$stock length×100, was determined for each warmwater fish species collected that have established stock lengths (Anderson and Neuman 1996). PSD can provide information about the proportion of various size fish in a population and can be a useful tool when sample size is adequate (Willis et al. 1993; Divens et al. 1998). Stock and quality lengths are based on percentages of world record catch size and vary depending on fish species (Table 2). Stock length (20-26 percent of the world record) refers to the minimum size of fish with recreational value, and quality length (36-41 percent of the world record) refers to the minimum size of fish anglers would like to catch. In addition to stock and quality length, Gabelhouse (1984b) introduced relative stock density (RSD), which includes preferred, memorable, and trophy lengths. Preferred length (45-55 percent of world record length) refers to the length of fish anglers would prefer to catch. Memorable length (59-64 percent of the world record length) refers to the minimum length of fish most anglers remember catching, whereas trophy length (74-80 percent of world record length) refers to the minimum length of fish worthy of acknowledgment. RSD, calculated as the number of fish$specific length/number of fish$stock length×100, was also calculated for each game fish species. Like PSD, RSD can also provide useful information regarding population dynamics and is more sensitive to changes in year class strength. For example, relative stock density preferred (RSD-P) is the percentage of stock length fish that are preferred length and longer, RSD-M is the percentage of stock length fish that are memorable length and longer, and RSD-T is the percentage of stock length fish that are trophy size and longer. Bister et al. (2000) developed and proposed additional length categories for 83 more species, including brown bullhead, which were previously uncategorized. Eighty-percent confidence intervals for PSDs and RSDs are provided as an estimate of statistical precision and were calculated using normal approximation (Conover 1980; Gustafson 1988).

Table 2. PSD/RSD length categories for fish species collected from Sacheen Lake (Pend Oreille County) in September 2000. Measurements are total length (mm) for each category (Anderson and Neumann 1996; Bister et al. 2000). Numbers in parenthesis represent percentages of world record lengths (Gabelhouse 1984b).

	Standard Length Categories				
Species	**Stock (20-26%)**	**Quality (36-41%)**	**Preferred (45-55%)**	**Memorable (59-64%)**	**Trophy (74-80%)**
Black Crappie	130	200	250	300	380
Brown Bullhead	130	200	280	360	430
Easter Brook Trout	200	330	—	—	—
Green Sunfish	80	150	200	250	300
Largemouth Bass	200	300	380	510	630
Yellow Perch	130	200	250	300	380

Age and growth of warmwater fishes sampled were evaluated using the direct proportional method (Fletcher et al. 1993) and Lee's modification of the direct proportional method (Carlander 1982). Using the direct proportional method, total length at annulus formation, L_n, was back–calculated as L_n=(A×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×(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 are presented in tabular form for easy comparison of growth between year classes, as well as between the lake average and what has been reported for other lakes in the state of Washington for the same species (Fletcher et al. 1993). Fletcher et al. (1993) calculated state averages from data collected for select warmwater fish populations throughout the state using the direct proportion method. These growth rates are referred to as the state average in the results section and although they are not a true state average they are likely representative of fish growth for lakes sampled within the state.

Fish condition was evaluated using the Relative Weight (W_r) index which shows the relationship between the lengths and weights of fish collected. W_r is calculated as the actual weight of a fish divided by the standard weight (W_s) for the same species at the same length times 100 ($W_r = W/W_s \times 100$, where W is the weight (g) of an individual fish and W_s is the standard weight of a fish of the same length (Murphy and Willis 1991). W_s is calculated from the standard log 10 weight-log10 length relationship defined for the species of interest. Standard weight equations have been established for many freshwater game and non-game fish species (Anderson and Neumann 1996; Bister et al. 2000). Relative weights are useful for comparing the condition of different size groups within a single population to determine if all sizes are getting adequate nutrition (ODFW 1997). A W_r value of 100 generally indicates that a fish is in average condition when compared to the national average for that species (Anderson and Gutreuter 1983). Fish collected with relative weights below 85 are underweight and may be an indication of too many fish for their food supply (Flickinger and Bulow 1993). Anderson and Neumann (1996) list the parameters for the W_r equations of many warmwater fish species, including the minimum length recommendations for their application. Relative weight (W_r) values calculated from this survey are presented in comparison to the national average (W_r=100) for each species.

Results

Water Quality

Sacheen Lake measured water temperature ranged from 7.1EC in June, 2000, to 23.5EC in August, 2000, and were within the acceptable range of warmwater fish species (Boyd 1990) (Table 3). Temperatures were within the range for optimal warmwater fish growth (20EC - 28EC) only during the warmest months. Measured pH values ranged from 7.8 to 8.9 which is within the desired range (pH 6.5 - 9) for warmwater fish species (Swingle 1969). Warmwater fish species thrive in waters with dissolved oxygen levels above 2.5 mg/l and require dissolved oxygen above 1.0 mg/l to survive. Dissolved oxygen levels were adequate for warmwater fish in a majority of the lake throughout the summer. However, dissolved oxygen levels were below the required level for warmwater fish species in the hypolimnion in July and August, limiting habitat available to fish at times. Additional water quality monitoring should be conducted to better quantify water quality limitations.

Table 3. Water quality collected from June through August 2000 at Sacheen Lake (Pend Oreille County).

Date	Depth (m)	Temp (EC)	pH	DO (mg/l)	TDS	Conductivity	Secchi (m)
06/23/00	0.0	19.9	8.7		0.044	70.0	
	2.0	19.9	8.8				
	4.0	14.7	8.9				
	6.0	9.2	8.8				
	8.0	8.1	8.7				
	10.0	7.6	8.5				
	12.0	7.2	8.5				
	12.8	7.1	8.3		0.052	81.4	
07/25/00	0.0	23.5	8.1	7.7	0.045	71.2	
	2.0	23.2	8.1	7.3			
	4.0	16.2	8.3	7.0			
	6.0	11.2	8.4	0.9			
	8.0	9.1	8.3	0.4			
	10.0	7.6	7.8	0.3	0.046	74.0	
08/24/00	0.0	21.1	8.4	7.1	0.047	73.8	5
	2.0	20.0	8.4	6.9			
	4.0	18.6	8.3	4.8			
	6.0	13.5	8.4	0.7			
	8.0	9.7	8.6	0.6			
	9.0	9.5	8.7	0.5	0.049	77.8	

Species Composition

Eight fish species were collected from Sacheen Lake. Brown bullhead was the most abundant gamefish species, comprising 43 percent of the sample by weight and 43 percent by number (Table 4). Largemouth bass and yellow perch were gamefish also sampled in a relatively high proportion of the sample. Tench was the second most abundant species by weight comprising 23 percent of the sample; however, tench comprised only 5 percent of the sample by number. In contrast, green sunfish comprised a relatively high proportion of the sample by number (10 %), yet they comprised only two percent of the sample by weight. Eastern brook trout, black crappie and brown trout were sampled at lower levels. Largemouth bass was the only species of which a substantial portion of the sample consisted of young-of-the-year fish (Table 5).

Table 4. Species composition by weight (kg) and number for all fish collected at Sacheen Lake (Pend Oreille County) in September 2000.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	**(kg)**	**(%w)**	**(#)**	**(%n)**	**Min**	**Max**
Brown Bullhead	112.10	43.10	892	43.81	130	285
Tench	60.49	23.25	109	5.35	187	460
Largemouth Bass	43.52	16.73	424	20.83	47	490
Yellow Perch	26.89	10.34	303	14.88	65	268
Eastern Brook Trout	5.39	2.07	39	1.92	200	297
Green Sunfish	4.00	1.54	209	10.27	44	182
Black Crappie	3.94	1.51	58	2.85	40	233
Brown Trout	3.75	1.44	1	0.05	670	670

Table 5. Species composition (excluding young-of-the-year) by weight (kg) and number for fish collected at Sacheen Lake (Pend Oreille County) in September 2000.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	**(kg)**	**(%w)**	**(#)**	**(%n)**	**Min**	**Max**
Brown Bullhead	112.10	43.11	892	44.51	130	285
Tench	60.49	23.26	109	5.44	187	460
Largemouth Bass	43.52	16.70	394	19.66	75	490
Yellow Perch	26.89	10.34	302	15.07	107	268
Eastern Brook Trout	5.39	2.07	39	1.95	200	297
Green Sunfish	4.00	1.54	209	10.43	44	182
Black Crappie	3.93	1.51	57	2.84	76	233
Brown Trout	3.75	1.44	1	0.05	670	670

CPUE

Largemouth bass were sampled at the highest rate by boat electrofishing followed by yellow perch and green sunfish (Table 6). Yellow perch and tench comprised the highest proportion of fish sampled by gill netting. Brown bullhead comprised the highest proportion of the catch by fyke netting. Catch rates for stock-length fish were only slightly lower than those observed for all fish, excluding young-of-the-year, with the exception of largemouth bass (Table 7). A substantial portion of the largemouth electrofishing catch was comprised of fish less than stock-length (200 mm).

Table 6. Mean catch-per-unit-effort by sampling method, including 80% confidence intervals, for all fish, excluding young-of-the-year, collected at Sacheen Lake (Pend Oreille County) in September 2000.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	**(#/hour)**	**Sites**	**#/Net Night**	**Net Nights**	**# Net/Night**	**Net Nights**
Brown Bullhead	42.00 ± 14.75	12	1.88 ± 0.45	8	99.13 ± 44.82	8
Black Crappie	13.50 ± 4.14	12	3.00 ± 0.91	8	0.75 ± 0.63	8
Brown Trout	0.50 ± 0.64	12	0.00	8	0.00	8
Eastern Brook Trout	6.00 ± 3.79	12	3.38 ± 0.90	8	0.00	8
Green Sunfish	93.50 ± 24.54	12	1.38 ± 0.54	8	1.38 ± 0.84	8
Largemouth Bass	195.00 ± 30.90	12	0.25 ± 0.21	8	0.38 ± 0.34	8
Tench	22.00 ± 3.58	12	6.13 ± 2.28	8	2.00 ± 0.87	8
Yellow Perch	96.50 ± 36.07	12	13.25 ± 3.42	8	0.38 ± 0.48	8

Table 7. Mean catch-per-unit-effort by sampling method, including 80% confidence intervals, for stock-length fish collected at Sacheen Lake (Pend Oreille County) in September 2000.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	**(#/hour)**	**Sites**	**#/Net Night**	**Net Nights**	**# Net/Night**	**Net Nights**
Brown Bullhead	42.00 ± 14.75	12	1.88 ± 0.45	8	99.13 ± 44.82	8
Black Crappie	10.50 ± 3.80	12	2.88 ± 0.89	8	0.75 ± 0.63	8
Brown Trout	0.50 ± 0.64	12	0.00	8	0.00	8
Eastern Brook Trout	6.00 ± 3.79	12	3.38 ± 0.90	8	0.00	8
Green Sunfish	73.50 ± 16.51	12	1.25 ± 0.58	8	1.38 ± 0.84	8
Largemouth Bass	41.50 ± 12.57	12	0.13 ± 0.16	8	0.00	8
Tench	22.00 ± 3.58	12	6.13 ± 2.28	8	2.00 ± 0.87	8
Yellow Perch	89.00 ± 34.44	12	13.25 ± 3.42	8	0.38 ± 0.48	8

Stock Density Indices

Sample sizes of stock-length fish were adequate for evaluating stock density indices for largemouth bass and green sunfish caught by electrofishing, yellow perch caught by gill netting, and brown bullhead caught by fyke netting (Table 8). Largemouth bass PSD and RSD-P were reflective of a population managed for panfish. Yellow perch and brown bullhead population PSD's were relatively high and also reflective of populations managed for panfish. Green sunfish PSD's on the other hand were low, which is common for this species where it has been introduced in western waters (Wydoski and Whitney 1979). Brook trout sampled were all less than quality-length (330 mm) resulting in PSD and RSD values of zero. Due to the small sample size of black crappie, interpretation of resulting PSD values is limited.

Table 8. Traditional stock density indices, including 80% confidence intervals, for fish collected at Sacheen Lake (Pend Oreille County) in September 2000 by sampling method.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
Electrofishing					
Black Crappie	21	14 ± 10	0	0	0
Brown Bullhead	84	77 ± 6	0	0	0
Eastern Brook	12	0	0	0	0
Trout	147	4 ± 2	0	0	0
Green Sunfish	83	20 ± 6	11 ± 4	0	0
Largemouth Bass	178	33 ± 5	2 ± 1	0	0
Yellow Perch					
Gill Netting					
Black Crappie	23	13 ± 9	0	0	0
Brown Bullhead	15	80 ± 13	0	0	0
Eastern Brook	27	0	0	0	0
Trout	10	30 ±19	0	0	0
Green Sunfish	106	64 ± 6	0	0	0
Yellow Perch					
Fyke Netting					
Black Crappie	6	17 ± 19	0	0	0
Brown Bullhead	793	86 ± 2	0	0	0
Green Sunfish	11	18 ± 15	0	0	0
Yellow Perch	3	33 ± 35	0	0	0

Largemouth Bass

Sacheen Lake largemouth bass sampled ranged in length from 47 to 490 mm TL (Table 4; Figure 2). The age of largemouth bass sampled ranged from one to eight years (Table 9). Largemouth bass growth rates for age one to age three bass were at or below the known Washington state average (Fletcher et al. 1993). Growth rates of largemouth bass age four and older were higher than the know Washington state average. In general, bass less than 200 mm TL exhibited slower than average growth, whereas bass greater than 200 mm TL exhibited higher growth rates. Length frequency distribution indicates stable year-class strength (Figure 2). The condition of largemouth bass less than 300 mm TL was less than the national average (Figure 3). The condition of largemouth bass greater than 300 mm TL was scattered above and below the national average.

Table 9. Age and growth of largemouth bass sampled from Sacheen Lake (Pend Oreille County) in September 2000. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths at annulus using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age							
Year Class	**# of Fish**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1999	18	55							
		66							
1998	26	62	127						
		75	132						
1997	47	63	138	185					
		77	146	189					
1996	13	56	133	197	247				
		72	144	204	250				
1995	6	51	121	185	244	295			
		68	134	194	250	298			
1994	4	60	122	191	265	329	382		
		77	136	202	273	333	384		
1993	3	73	146	233	317	377	412	436	
		90	159	243	324	381	414	437	
1992	1	75	139	186	263	331	393	439	456
		91	153	198	272	337	397	440	457
Direct Proportion Overall Mean		62	132	196	267	333	396	437	456
Lee's Weighted Mean		74	141	195	262	329	397	438	457

368 396

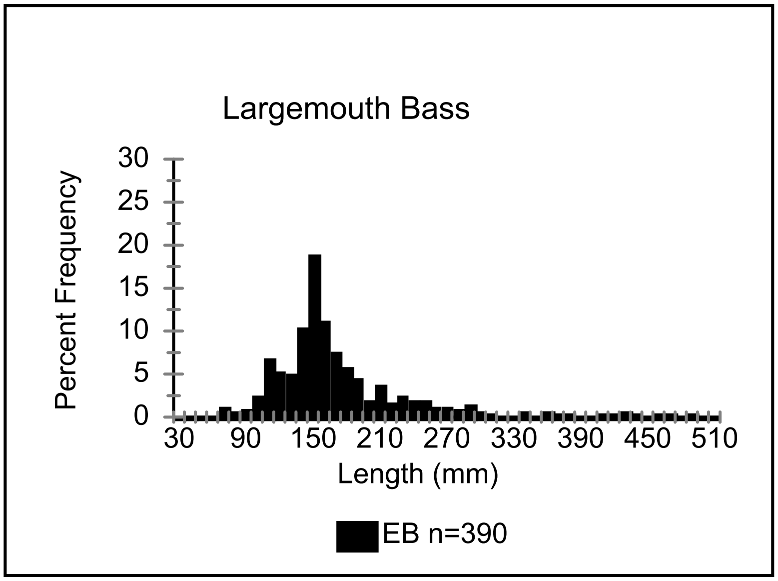

Figure 2. Length frequency distribution of largemouth bass, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB).

Direct Proportion State Average	60	146	222	261	289	319

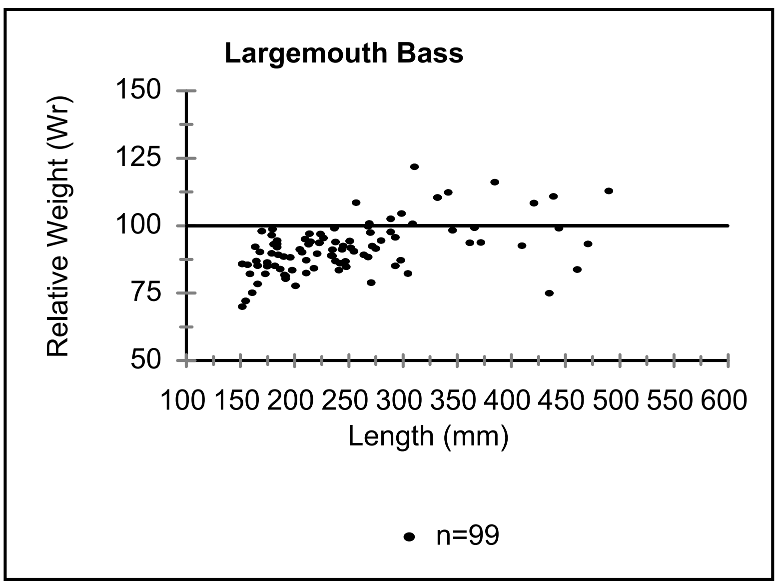

Figure 3. Relative weight (Wr) of largemouth bass, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Yellow Perch

Sacheen Lake yellow perch sampled ranged in length from 65 to 268 mm TL (Table 4; Figure 4). The age of yellow perch sampled ranged from one to six years (Table 10). Yellow perch growth rates were higher than the known Washington state average except for age one fish. Length frequency distribution indicates variable year-class strength (Figure 4). The condition of yellow perch was generally below the national average and appeared to decrease with length and age (Figure 5).

Table 10. Age and growth of yellow perch sampled from Sacheen Lake (Pend Oreille County) in September 2000. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths at annulus using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year Class	**# of Fish**	**1**	**2**	**3**	**4**	**5**	**6**
1999	16	52					
		69					
1998	22	54	129				
		74	137				
1997	18	51	145	197			
		74	155	199			
1996	3	51	141	206	230		
		75	154	211	232		
1995	1	51	139	196	221	236	
		75	152	202	224	238	
1994	1	66	119	141	169	193	242
		89	136	155	180	202	245
Direct Proportion Overall Mean		54	134	185	207	215	242
Lee's Weighted Mean		73	145	199	220	220	245
Direct Proportion State Average		60	120	152	193	206	

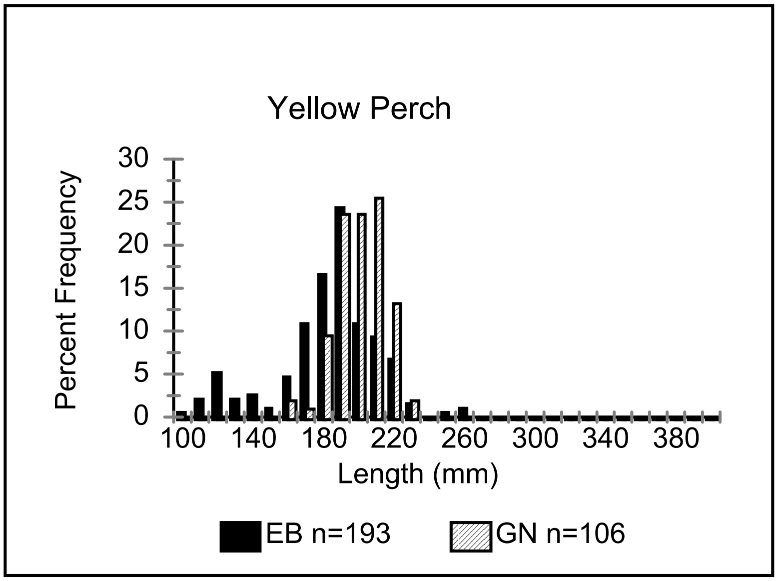

Figure 4. Length frequency distribution of yellow perch, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB) and gill nettting (GN).

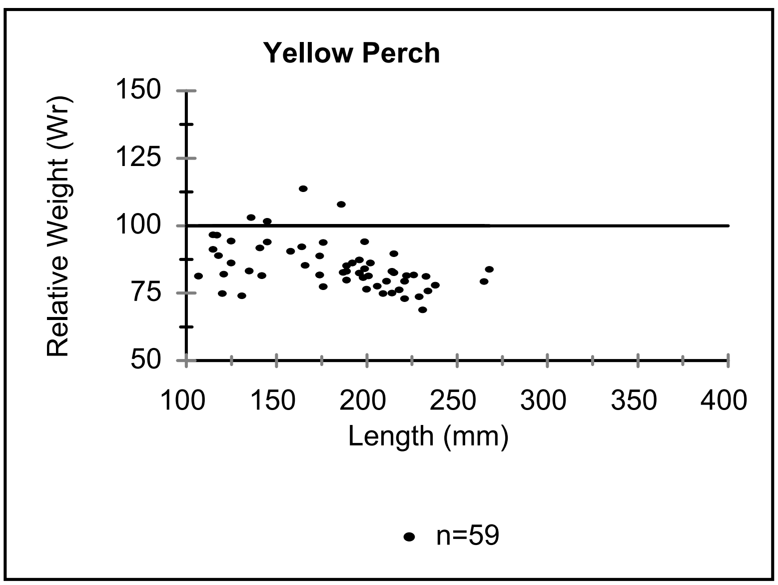

Figure 5. Relative weight (Wr) of yellow perch, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Green Sunfish

Sacheen Lake green sunfish ranged in length from 44 to 182 mm TL (Table 4; Figure 6). The age of green sunfish sampled ranged from two to six years (Table 11). Although no Washington state average for green sunfish is available for comparison, the growth of Sacheen Lake green sunfish was lower than the average of mid-western populations (Wydoski and Whitney 1979). Slow growth rates are common for green sunfish populations in western states (Wydoski and Whitney 1979). Length frequency distribution and age data suggest variable year-class strength (Figure 6). The condition of green sunfish sampled was lower than the national average (Figure 7).

Table 11. Age and growth of green sunfish sampled from Sacheen Lake (Pend Oreille County) in September 2000. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths at annulus using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year Class	**# of Fish**	**1**	**2**	**3**	**4**	**5**	**6**
1999	0						
1998	18	27	66				
		34	69				
1997	13	23	67	102			
		31	72	104			
1996	4	27	68	109	140		
		35	74	112	141		
1995	3	23	57	86	109	125	
		31	63	89	111	126	
1994	6	27	62	81	105	127	145
		36	68	86	108	129	146
Direct Proportion Overall Mean		25	64	94	118	126	145
Lee's Weighted Mean		33	70	99	119	128	146
Direct Proportion State Average		n/a					

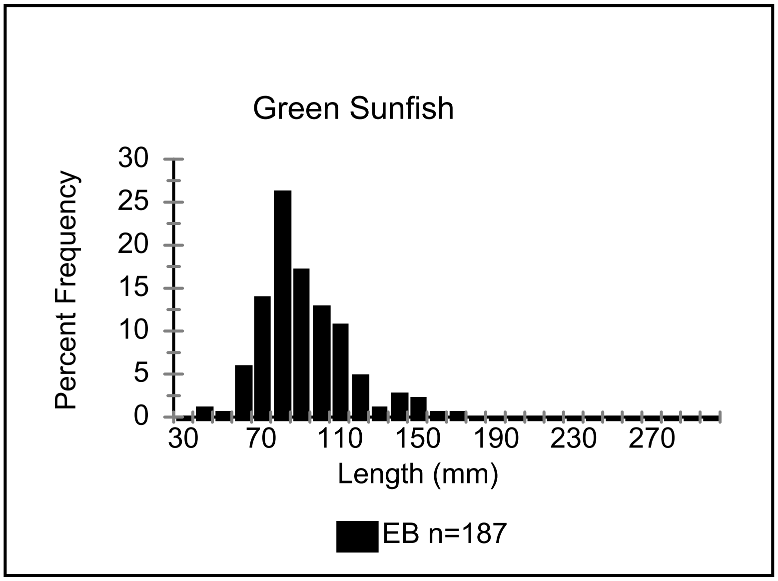

Figure 6. Length frequency distribution of green sunfish, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB).

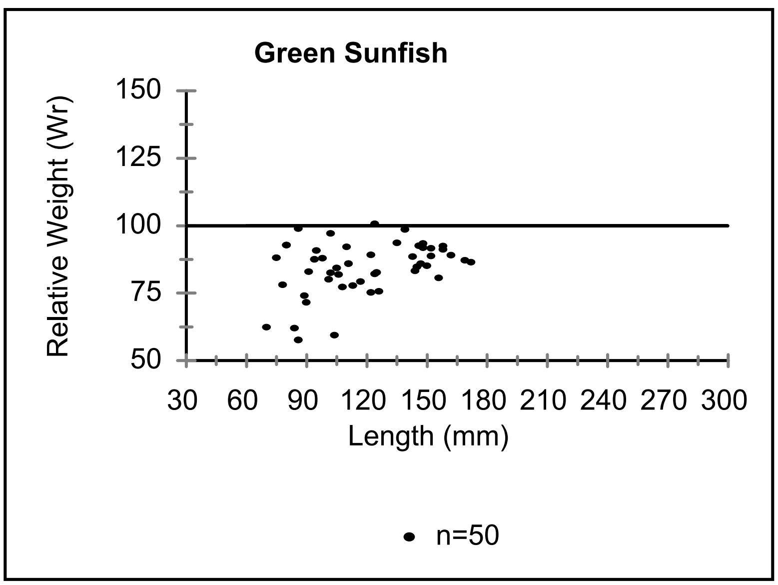

Figure 7. Relative weight (Wr) of green sunfish, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Black Crappie

Sacheen Lake black crappie ranged in length from 40 to 233 mm TL (Table 4; Figure 8). The age of black crappie sampled ranged from one to six years (Table 12). Black crappie growth rates were lower than the known Washington state average (Fletcher et al. 1993). Black crappie length frequency distribution and age data suggest variable year-class strength (Figure 8). Although a few black crappie exhibited condition higher than the national average, the condition of most fish was below the national average and in general, condition declined with fish length and age (Figure 9).

Table 12. Age and growth of black crappie sampled from Sacheen Lake (Pend Oreille County) in September 2000. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths at annulus using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year Class	# of Fish	1	2	3	4	5	6
1999	7	23					
		49					
1998	15	29	91				
		58	106				
1997	16	23	88	156			
		54	107	162			
1996	2	26	86	136	168		
		56	105	146	172		
1995	1	48	80	151	192	219	
		76	103	163	198	221	
1994	1	34	70	94	144	203	216
		64	94	115	157	207	218
Direct Proportion Overall Mean		31	83	134	168	211	216
Lee's Weighted Mean		55	106	158	175	214	218
Direct Proportion State Average		46	111	157	183	220	

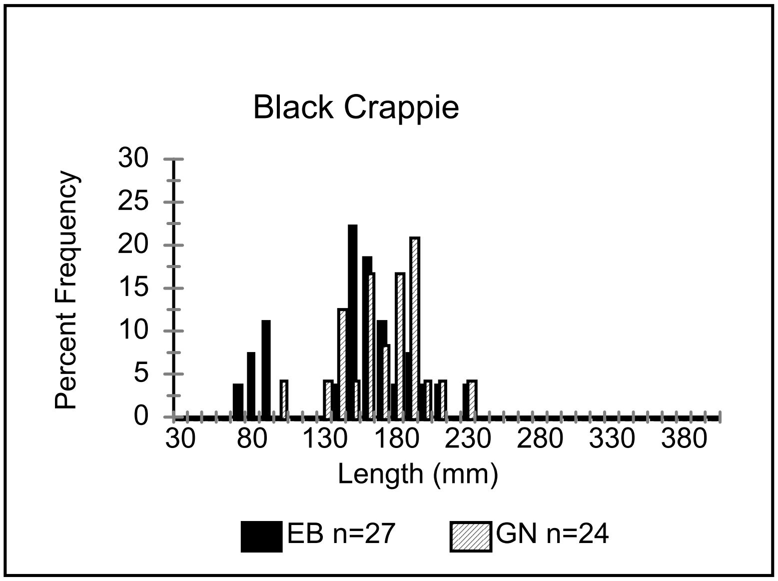

Figure 8. Length frequency distribution of black crappie, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB) and gill nettting (GN).

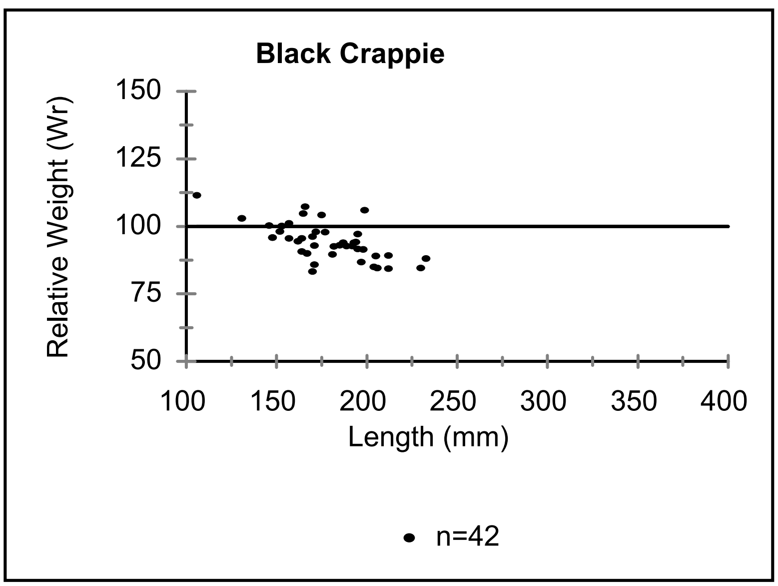

Figure 9. Relative weight (Wr) of black crappie, excluding young-of-the-year, sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Brown Bullhead

Sacheen Lake brown bullhead ranged in length from 130 to 285 mm TL (Table 4; Figure 10). Brown bullhead length frequency distribution indicates variable year-class strength (Figure 10). In general, brown bullhead condition was below the national average (Figure 11).

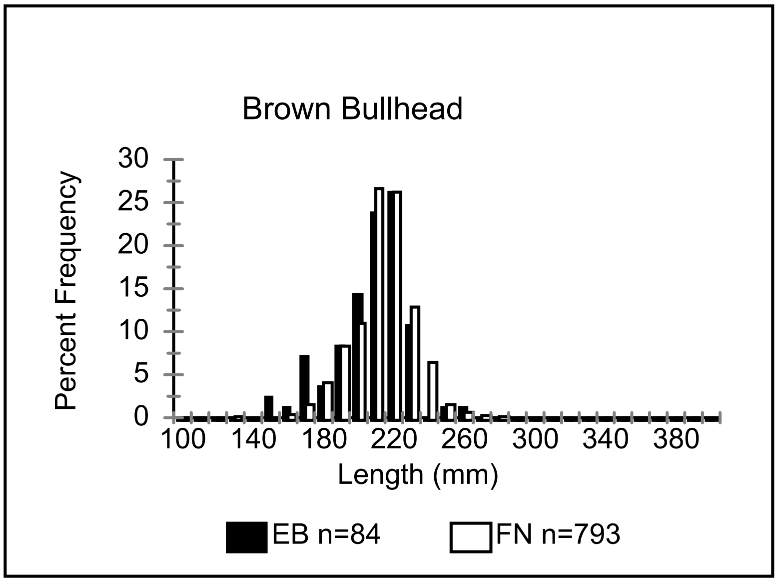

Figure 10. Length frequency distribution of brown bullhead sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB) and fyke nettting (FN).

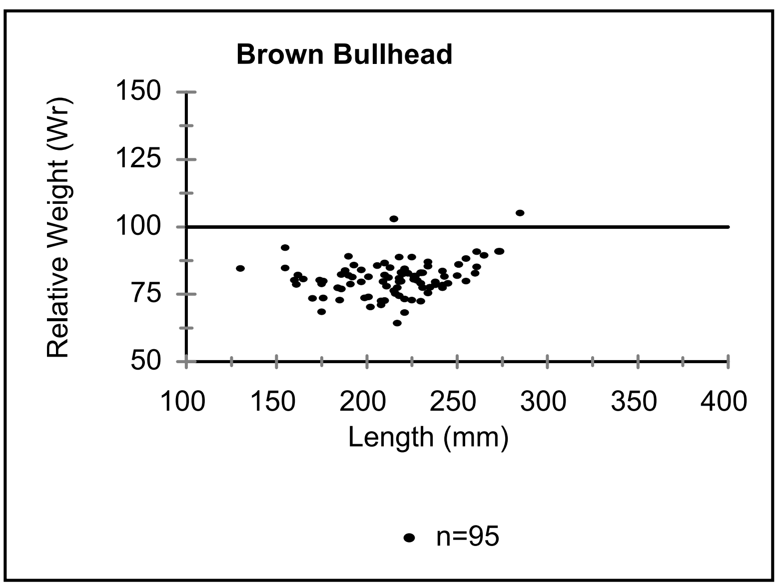

Figure 11. Relative weight (Wr) of brown bullhead sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Eastern Brook Trout

Sacheen Lake brook trout sampled ranged in length from 200 to 297 mm TL (Table 4; Figure 12). Brook trout length frequency distribution is illustrative of a stocked "put-and-take" population and does not indicate natural reproduction (Figure 12). The condition of brook trout sampled was below the national average (Figure 13).

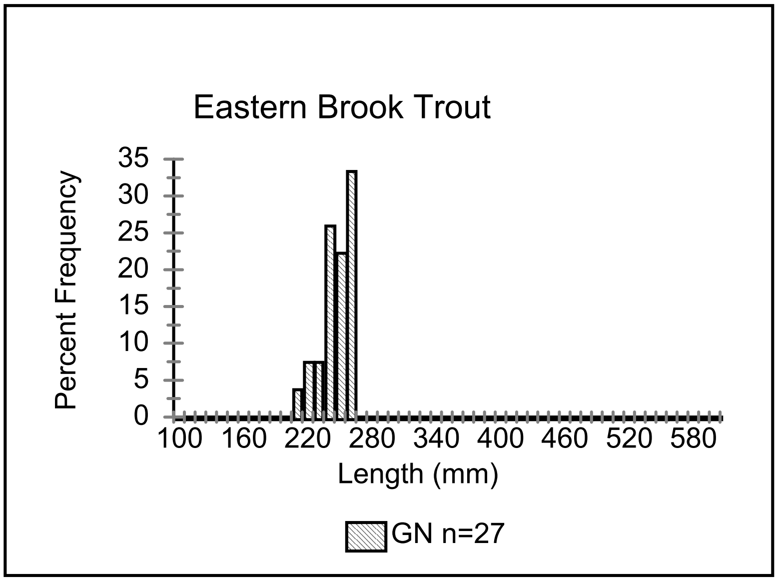

Figure 12. Length frequency distribution of eastern brook trout sampled at Sacheen Lake (Pend Oreille County) in September 2000 by gill nettting (GN).

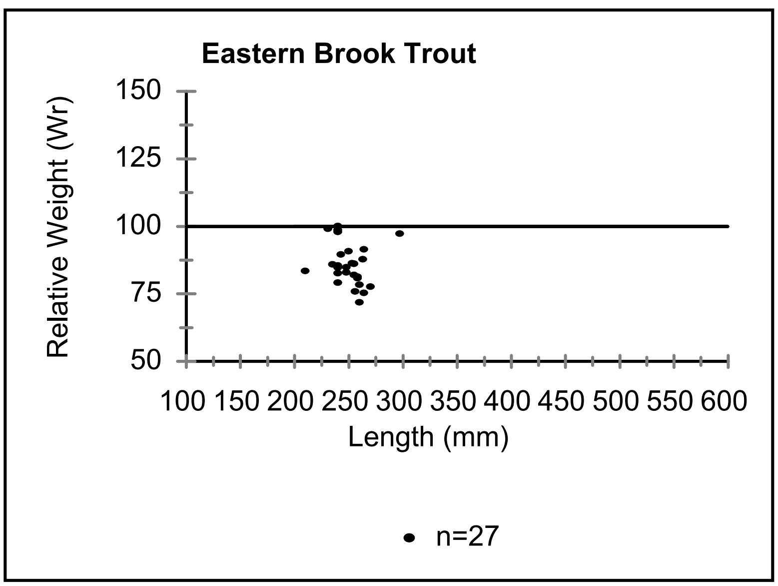

Figure 13. Relative weight (Wr) of eastern brook trout sampled at Sacheen Lake (Pend Oreille County) in September 2000 compared to the national 75th percentile.

Tench

Sacheen Lake tench sampled ranged in length from 187 to 460 mm TL (Table 4; Figure 14). Although tench were not aged, length frequency distribution indicates variable year-class strength (Figure 14).

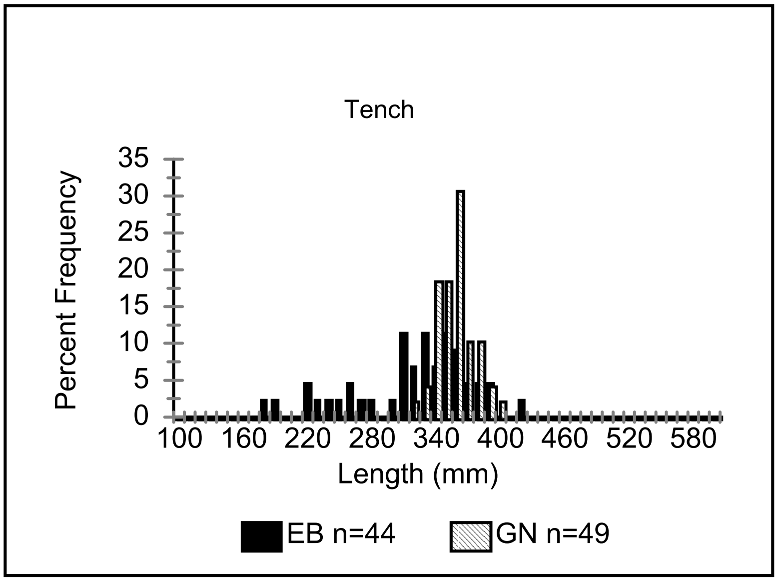

Figure 14. Length frequency distribution of tench sampled at Sacheen Lake (Pend Oreille County) in September 2000 by boat electrofishing (EB) and gill nettting (GN).

Discussion

Warmwater fisheries managers typically consider the "balance" between predator and prey species when assessing warmwater fish communities. The term balance is used loosely to describe a system in which omnivorous prey panfish species maximize food resources to produce harvestable-size fish stocks for anglers and an adequate forage base for piscivorus predator species (Bennett 1962). Fish communities may otherwise be described as being prey-crowded or predator-crowded. To provide quality warmwater fishing opportunities, predator gamefish species such as largemouth bass must be able to reproduce and grow to control overpopulation of both predator and prey species.

At the time of this survey, stock density indices for warmwater fish populations indicated an unbalanced fish community. Overall, the community was prey crowded. Abundant, but small largemouth bass exhibiting low growth rates and condition indicate extensive inter- and intraspecific competition among young bass, and possibly with panfish and tench. Panfish species including brown bullhead, yellow perch and green sunfish, as well as non-game tench, are relatively abundant. These populations are made up of mostly small fish of low condition, variable recruitment, and except for yellow perch exhibit slower than average growth. Older, larger bass, however, appear to experience reduced competition as growth rates and condition of these fish tend to increase with size. Largemouth bass may experience reduced interspecific competition at a larger size as they become increasingly piscivorus.

Sacheen Lake mostly offers angling opportunities for largemouth bass, although most are small, as well as abundant yellow perch and brown bullhead catfish of small to average size. Considering the current status of the warmwater fish community, populations of all fish species would likely benefit by increased predation or angler harvest of over-abundant panfish.

Trout populations are apparently low density, although low catch rates may be an artifact of sampling bias towards warmwater fish species. Additional pelagic sampling or creel survey data would bolster efforts to quantify the contribution of stocked trout to the lake's fishery. The brown trout sampled were of large size and may offer some opportunity for quality trout angling. Brown trout appear to be more desirable in warmwater fisheries management schemes than rainbow trout due to their piscivorus nature and their ability to survive in warmer water. Brown trout more readily prey on panfish species, which may contribute to the quality of panfish in the lake. Additionally, brown trout are more likely to grow to large size by utilizing panfish as prey.

Tench comprised a large proportion of the sample by weight and should be considered an important player in the Sacheen Lake fish community. This introduced minnow likely competes with warmwater gamefish species for food resources, but may be preyed upon by largemouth bass (Wydoski and Whitney 1979). The actual effect of tench introductions in Washington has not been measured. Tench were originally imported from Europe, where it is highly regarded as a sport fish, and introduced in many states, including Washington, during the late 1800's by the U.S. Fish Commission for food and as a sport fish (Baughman 1947). Records show that tench were stocked into several Spokane area lakes, including Diamond Lake upstream of Sacheen, at that time. The species now inhabits the Columbia River and the Spokane River as well (Wydoski and Whitney 1979). Today this species is typically considered undesirable by fisheries managers in the United States. The removal of tench from some local lakes using rotenone has been used to reduce interspecific competition with more desirable game fish species. Considering the connectivity of Sacheen Lake to other waters, removing tench from the fish community using chemical or biological controls would likely be difficult.

Management Considerations

Whole or Partial Lake Rehabilitation

As in the past, if the management objective is to manage Sacheen Lake primarily as a trout fishery, whole or partial lake rehabilitation using rotenone is always an option to consider. However, due to the lakes connectivity to stream, wetland, and lake habitats in the drainage, achieving lasting results will be difficult to attain. Past rehabilitation efforts have all had only limited success and the benefits to trout fisheries have been short lived. Partial rehabilitation is likely to have minimal success and may even lead to a decrease in the quality of the warmwater community as green sunfish, bullhead, and tench are the most likely species to survive the effort.

Largemouth Bass Slot-limit Regulation

With the states adoption of the proposed statewide 12 to 17 inch slot-limit regulation for Washington's largemouth bass populations in 2002, Sacheen Lake's warmwater fish populations will be managed under the new regulation beginning May 1, 2002. Under the new regulation, the daily limit for bass is five fish of which only bass less than 12 inches or greater than 17 inches may be kept, with no more than one over 17 inches. The intention of the regulation is to improve the size structure of largemouth bass populations across the state which are generally limited in the number of quality-length (300 mm TL or 12 inches) and larger. In addition to increasing the number of quality bass available to anglers for catch and release, it is believed that increasing the number of predators in warmwater fish communities will have the additional benefit of improving the quality of panfish populations by reducing the density of generally over-abundant and low-condition panfish. The quality of angling opportunities available at Sacheen Lake should improve under this new regulation.

As the 12-17 inch slot-limit was not yet in effect at the time of this survey, the indices of population structure from this September 2000 survey are likely representative of the population under the previous, less restrictive, regulation. Therefore, this survey may serve as a baseline for documenting changes over time in the Sacheen Lake fish community. Considering this, management biologists should consider developing a long-term monitoring plan to document changes in the fish community over time. Objectives of such a program should focus on documenting changes in largemouth bass population density, changes in largemouth bass population structure with a particular interest in the number of fish greater than quality-length, and changes in panfish population structures possibly due to increased predation by largemouth bass. Additionally, creel survey data should be collected regularly to evaluate angler compliance.

Promoting Panfish Angling Opportunity

Sacheen Lake appears to offer ample angling opportunity for eight to ten inch yellow perch and brown bullhead catfish. Considering that few of the lake's fish are greater than quality size, all of the fish populations should benefit by an increase in harvest and an overall reduction in the numbers of these abundant species. Management biologists should consider promoting the panfish opportunities available at Sacheen Lake through the WDFW Weekender Report (an agency public information publication), WDFW warmwater fish publications, and the WDFW Warmwater Enhancement Program website.

Trout Stocking

Past department reports and anecdotal angler reports indicate that Sacheen Lake has a history of offering only fair trout angling. Intense competition with warmwater fish and non-game species has continually thwarted management biologists attempts to improve the quality of trout fishing at the lake. Brook trout and rainbow trout have been stocked over the years to provide trout fishing opportunity with limited success. If trout fishing is to remain a component of the fishery management objectives for Sacheen Lake, management biologists should consider stocking brown trout in future years. Brown trout are considered by many to be better suited to warmwater fish communities than rainbow trout. Brown trout are known to be more piscivorus than other trout species, which are more oriented to macroinvertebrates. Because of this, brown trout are more likely to be a predator in the community instead of a competitor with young bass and abundant panfish.

Creel Survey

Warmwater fisheries surveys can provide management biologists with useful information on the state of a fish community; however, they provide only circumstantial evidence as to the effects of angler harvest. Biological information collected from the anglers creel can provide information not typically colleted during standard surveys in which fish are released back into the lake unharmed. For example, otoliths collected from harvested fish are highly accurate for determining fish age. Detailed and well planned creel surveys can provide more conclusive information. Creel surveys can provide information on fishing effort, angler catch-per-unit-effort (e.g., # fish/hour fishing), and numbers of fish caught or harvested. Creel surveys can also be used to determine angler preferences with regard to management actions and regulations, as well as species and sizes of fish desired (Hahn et al. 1993).

Creel survey objectives for Sacheen Lake should include documenting fishery utilization throughout the open season, stocked trout return to the creel, angler catch-per-unit-effort, angler regulation compliance, and angler preferences. Otoliths should be collected from dead fish retained by anglers for more definitive aging of warmwater populations in the lake. Over time, creel information should aid management biologists in evaluating whether or not current regulations are effectively working to achieve current fishery objectives.

Aquatic Vegetation

Aquatic vegetation offers important foraging, spawning, and refuge habitat for warmwater fish communities (Willis et al. 1997). Shifts in the composition and balance of the warmwater fish community are likely following the altering of aquatic vegetation levels (Bettoli et al. 1993). Studies have shown that intermediate levels of aquatic vegetation are desirable for thriving warmwater fish communities (Savino and Stein 1982; Durocher et al. 1984; Wiley et al. 1984; Dibble et al. 1996; Olson et al. 1998). Some species may benefit from the removal of aquatic plants in lakes with high plant densities. Crappie growth can be impaired in lakes densely populated with aquatic plants (Maceina and Shireman 1982). The condition of certain age classes of largemouth bass and bluegill has been reported to improve following the mechanical removal of aquatic plants in lakes with dense aquatic vegetaion (Colle and Shireman 1980; Olson et al. 1998). Too much aquatic vegetation reduces the forage efficiency of largemouth bass by forming a visual barrier between bass and forage fish (Savino and Stein 1982). Bettoli et al. (1992) reported that young bass especially benefitted by reductions in aquatic vegetation abundance as their diet became more piscivorus earlier at a smaller size. This allowed young bass to grow more in the first year of life, enabling them to better survive their first winter. On the other hand, too little aquatic vegetation is not optimal.

Residents and lake users of Sacheen Lake have expressed concern about the high density of aquatic vegetation that develops during summer months. Best visual estimate data shows that submergent aquatic vegetation can cover much of the shoreline areas of the lake at peak times. The major complaint from lake residents and users has been the difficulty of boating on the lake in summer.

Removing vegetation from lakes for boating, water sports and aesthetics is often manageable; however, the effects on fish communities are complex and not always predictable. Although some species may benefit from reductions in plant abundance, other species may not (Bettoli et al. 1993). Aquatic vegetation control plans should include careful consideration of potential impacts to all fish and wildlife species.

A well planned and executed plant control program may improve the quality of boating, the warmwater fish community, and the overall sportfishing opportunity at Sacheen Lake (Engel 1995). Many techniques are used to control aquatic weeds including chemical, mechanical, and biological controls (Summerfelt 1999). Considering that Sacheen Lake is not a closed system, but connected directly to the Little Spokane River via its west branch, aquatic vegetation management options are limited to mechanical or possibly chemical methods. Biological aquatic weed controls, such as introducing grass carp (*Ctenopharyngodon idella*), are not feasible. Controlling plants in Sacheen Lake may require a combination of mechanical and chemical methods. It is important to consider that the benefits of aquatic plant control measures can be short lived and annual treatment efforts are required (Pothoven et al. 1999). A comprehensive aquatic plant management plan with specific objectives should be developed in a cooperative effort by lakeside residents, lake users, and management agencies.

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