1998 Warmwater Fisheries Survey of Jumpoff Joe Lake

by

Marc Divens and Larry Phillips
Fish Program
Fish Management Division
Warmwater Enhancement Program
Washington Department of Fish and Wildlife
600 Capitol Way North
Olympia, WA 98150-1091

December 1999

Acknowledgments

From the Washington Department of Fish and Wildlife (WDFW) we thank John Long, Teresa Nelson, Pat Round, and Curt Vail for data collection; Chris Donley for assisting with data analysis; Doug Fletcher and Teresa Nelson for aging scales; Bruce Bolding, Scott Bonar, Steve Caromile, Mark Downen, William Meyer, and Karl Mueller for technical advice; and Karin Divens, Curt Vail, John Whalen, and Bill Zook for providing invaluable critiques of the manuscript. This project was funded through the WDFW Warmwater Enhancement Program in an effort to provide greater opportunities to fish for and catch warmwater fish in Washington State.

Table of Contents

Acknowledgments i

List of Tables iii

List of Figures iv

Introduction 1

Methods 3
- Sampling 3
- Data Analysis 4

Results 7
- Water Quality 7
- Aquatic Vegetation 7
- Species Composition 7
- CPUE 8
- Stock Density Indices 9
  - Largemouth Bass 10
  - Yellow Perch 11
  - Pumpkinseed Sunfish 13

Discussion 15
- Management Options to Enhance Warmwater Fishing Opportunity 15
  - Largemouth Bass Slot-Limit Regulation 15
  - Channel Catfish 16
  - Trout Stocking 16
  - Shoreline Access 16

Literature Cited 17

List of Tables

Table 1. Morphometry of Jumpoff Joe Lake (Stevens County). 1

Table 2. Length categories for warmwater fish captured at Jumpoff Joe Lake (Stevens County), September 1998. Measurements are minimum total lengths (mm) for each PSD, and RSD category 5

Table 3. Water quality data from Jumpoff Joe Lake (Stevens County) collected at midday September 08, 1998. 7

Table 4. Washington Department of Ecology Aquatic Vegetation Survey Summary, July 29, 1997. 8

Table 5. Species composition by weight (kg) and number of fish captured at Jumpoff Joe Lake (Stevens County) during September 1998 survey. 8

Table 6. Mean catch per unit effort by sampling method including 80% confidence intervals, for fish collected from Jumpoff Joe Lake (Stevens County) during the September 1998 survey. 9

Table 7. Traditional stock density indices, including 80% confidence intervals, of fish collected from Jumpoff Joe Lake (Stevens County) during September 1998 survey by sampling method. 9

Table 8. Age and growth largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998. 10

Table 9. Age and growth of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998. 12

Table 10. Age and growth of pumpkinseed sunfush sampled from Jumpoff Joe Lake (Stevens County) September 1998 13

List of Figures

Figure 1. Map of Jumpoff Joe Lake (Stevens County) with September 1998 survey sections . . 1

Figure 2. Length frequency distribution of stock size largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998. 10

Figure 3. Relative weight (Wr) of largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile. 11

Figure 4. Length frequency distribution of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998. 12

Figure 5. Relative weight (Wr) of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile 13

Figure 6. Length frequency distribution of pumpkinseed sunfish sampled from Jumpoff Joe Lake (Stevens County) September 1998. 14

Figure 7. Relative weight (Wr) of pumpkinseed sunfish sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile 14

Introduction

Jumpoff Joe Lake is a small body of water located in Stevens County, northwest of Spokane (Table 1;Figure 1). Grouse Creek is the only major inlet to the lake. Jumpoff Joe Creek is an intermittent outlet which drains northwest to the Colville River.

Table 1. Morphometry of Jumpoff Joe Lake (Stevens County).

Morphometric Measurement	**Jumpoff Joe Lake (Stevens County)**
Surface Area (acres)	115
Shoreline Length (m)	3,058
Maximum Depth (m)	7.6
Mean Depth (m)	4
Volume (m^3)	1,726,861
Drainage Area (acres)	9,792

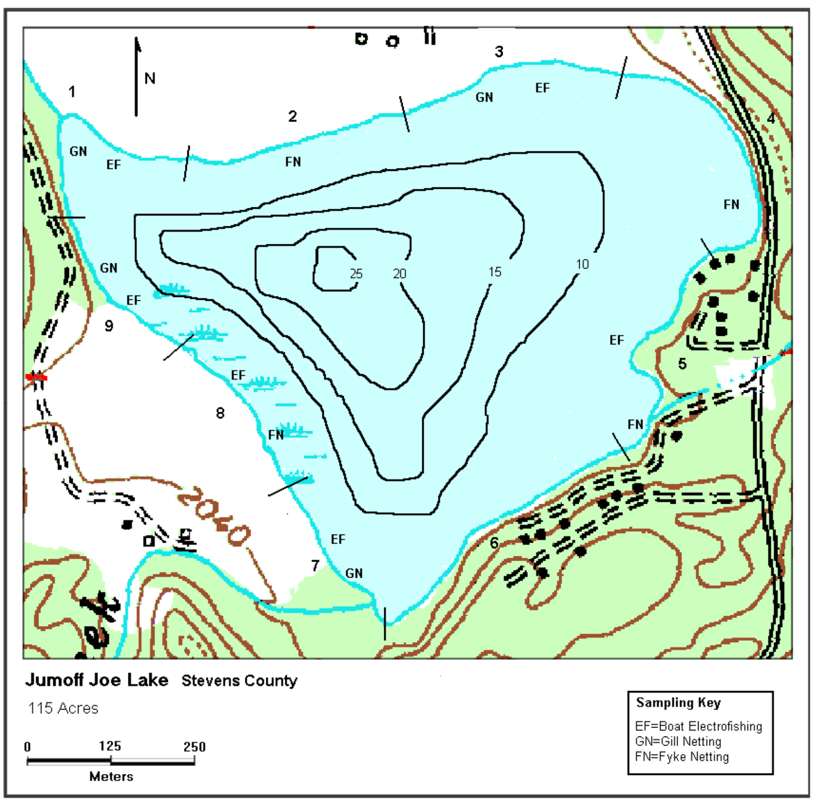

Figure 1. Map of Jumpoff Joe Lake (Stevens County) with September 1998 survey sections.

Lake access is good, with one private resort and a Washington Department of Fish and Wildlife (WDFW) owned and operated boat launch. Development on the lake is relatively low. Approximately 25% of the shoreline has been developed as resort and residential property. However, the majority of the land surrounding the lake is agricultural and used for farming or ranching (Bob Peck, WDFW, personal communication).

Historically the lake has provided some challenges for fishery managers. Aquatic vegetation grows to the surface in many areas. The lake was rehabilitated in 1958, 1962, and 1964 to remove unwanted pumpkinseed sunfish (*Lepomis gibbosus*). Although the treatment in 1964 was successful at removing unwanted pumpkinseed sunfish, the lake was rehabilitated again in 1970 to remove goldfish (*Carassios auratus*). The 1970 rehabilitation failed to completely remove goldfish from Jumpoff Joe Lake and they remain a problem today. Since 1977 Jumpoff Joe Lake has been managed as a mixed species lake (Duff et al. 1977). During the 1990's, Jumpoff Joe Lake has been annually stocked with catchable size eastern brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*). Additionally, some brown trout and rainbow trout (*Oncorhynchus mykiss*) brood fish were stocked.

The physical characteristics of Jumpoff Joe Lake make it well suited for warmwater fish. Therefore, WDFW Warmwater Enhancement Program personnel conducted a survey in September 1998 to evaluate the current warmwater fish community in the lake.

Methods

Sampling

Jumpoff Joe Lake was surveyed by a three person assessment team September 8-10, 1998. Fish were captured using boat electrofishing (EB), gill netting (GN), and fyke netting (FN). 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 net (4.7 m long and 1.2 m diameter), a lead net (30.5 m long x 1.2 m deep) and two wings (7.6 m long x 1.2 m deep).

Sampling locations were selected using a map of the lake by dividing the shoreline into 9 consecutively numbered equidistant sections of approximately 500 meters. Six sections were randomly selected for sampling by boat electrofishing, four were selected for gill netting, and four were selected for fyke netting using a random number generator (Casio fx-991D scientific calculator). While electrofishing, the boat was maneuvered slowly through the shallows (depth range = 0.2 - 1.5 m) following the shoreline. 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 a 45 degree angle to the trap. Length of the lead from shore and depths the fyke nets were set varied with the slope of the shoreline.

Sampling was conducted during evening hours to maximize the type and number of fish captured. Nighttime electrofishing covered roughly 67 percent of the shoreline. Two gill nets and two fyke nets were set overnight at random locations on September 8 and September 10 (Figure 1). Samples were weighted to achieve a standardized 1:1:1 ratio of electrofishing to gill netting to fyke netting (1:1:1 - 1800 seconds boat electrofishing:24 gillnet hours:24 fyke net hours). This methodology is employed to reduce bias between gear types (Fletcher et al. 1993). Total electrofishing time was 4200 seconds ('pedal-down' time), or roughly 2.5 standard units. Total gill net and fyke net time was two standard units of two nets per net night for both gill nets and fyke nets.

Each fish captured was identified by species, measured for total length (TL, mm) and weighed (g). However, if a sample included several hundred young-of-year or small juveniles (TL < 100mm) of a given species, then a sub-sample (N ~ 100 fish) was measured and the remainder counted overboard. Scales were collected to determine fish age and growth. Scale samples (up to five per 10 mm length class) were mounted and pressed, and the fish aged according to Jearld (1983) and Fletcher et al. (1993). Trout and carp were not aged.

Water quality data was collected on the afternoon of September 08, 1998 from the deepest location in the lake. Information was gathered on dissolved oxygen, temperature, specific conductance, total dissolved solids, pH, and salinity 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 fish community (Swingle 1950; Bennet 1962; Fletcher et al. 1993). Species composition by weight (kg) and number was calculated from data collected using boat electrofishing, gill netting, fyke netting. Fish less than one year old were excluded from calculations of species composition because fry numbers can fluctuate dramatically according to sample location, sampling methodology, and time of hatching (Fletcher et al. 1993). Including young-of-year fish in calculations of species composition can give a false impression of year class strength due to an abundance of small fish which can suffer extensive natural mortality during the first winter (Chew 1994).

Catch per unit effort (CPUE) by sampling method was determined 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 using only stock sized fish and larger. The length of stock sized fish, which varies by species, are the size of a particular fish species that offer recreational value to an angler (Anderson 1976). CPUE calculations for non-game fish species included all fish captured regardless of size. Although non-game fishes contribute to the biomass, most do not have established stock lengths. Randomly chosen sample sections can contribute to high variability among samples, therefore 80% confidence intervals (CI) were calculated for each mean CPUE by species and by sampling method. Each CI was calculated as the mean $\pm t(\propto, N-1) \times SE$, where t=Student's t for $\propto$ 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 that can be used to compare lakes within the State of Washington and monitor changes in relative abundance over time.

Length frequency histograms (percent frequency captured by different sampling methods) were used to evaluate the size structure of all warmwater fish species collected. For reasons similar to those listed above, only fish one year old and greater were included in the length frequency histograms.

Proportional stock density (PSD), calculated as the number of fish$\geq$quality length/number of fish$\geq$stock size length$\times$100, was determined for each warmwater fish species collected (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 used in the calculation of PSD are based on a percentage of world record catch size and vary depending on fish species (Table 2). Stock lengths (20-26% of the world record) refer to the minimum size fish with recreational value, and quality lengths (36-41% of the world record) refer to the minimum size fish anglers prefer catching. In addition to stock and quality length, Gabelhouse (1984b) introduced preferred, memorable, and trophy length categories (Table 2). Preferred length (45-55% of world record length) refers to the size fish anglers would prefer to catch when given a choice. Memorable length (59-64% of the world-record length) refers to the minimum size fish most anglers remember catching, whereas trophy length (74-80% of world record length) refer to the minimum size fish worthy of acknowledgment. Relative Stock Density (RSD), calculated as the number of fish $\geq$ specific length/number of fish $\geq$ stock length $\times$ 100, was also calculated for each game fish species. Like PSD, it can also provide useful information regarding population dynamics and is more sensitive to changes in year-class strength. For example, RSD P was the percentage of stock length fish greater than or equal to preferred length, RSD M, the percentage of stock length fish that are greater than or equal to memorable length, and so on. 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. Length categories for warmwater fish captured at Jumpoff Joe Lake (Stevens County), September 1998. Measurements are minimum total lengths (mm) for each PSD, and RSD category .

			Size		
Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Largemouth Bass	200	300	380	510	630
Yellow Perch	130	200	250	300	380
Pumpkinseed Sunfish	80	150	200	250	300

Age and growth of warmwater fishes sampled were evaluated using the direct proportion 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, Ln, was back-calculated as Ln=(A×TL)/S, were 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, Ln was back-calculated as Ln=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 for each species were presented in tabular form for easy comparison of growth between year classes within Jumpoff Joe Lake and with other lakes in the State of Washington (Fletcher et al. 1993).

Relative weight (Wr) index was used to evaluate the condition of fish in the lake. Relative weight is useful for comparing the condition of different size groups within a single population to determine if all sizes are finding adequate nutrition (ODFW 1997). A Wr value of 100 generally indicates that a fish is in good condition when compared to the national average for that species.

This index was calculated as Wr=W/Ws×100, where W is the weight (g) of an individual fish and Ws is the standard weight of a fish of the same length (mm) (Murphy and Willis 1991). Ws is calculated from the standard log10 weight-log10 length relationship defined for the species of interest. Anderson and Neumann (1996) list the parameters for the Wr equations of many warmwater fish species, including the minimum length recommendations for their application. Wr values calculated from this survey were compared to the national average (Wr=100) for each species.

Results

Water Quality

Water temperature data collected showed no noticeable thermocline. Dissolved oxygen readings show adequate levels for warmwater fish at all depths (Table 3).

Table 3. Water quality data from Jumpoff Joe Lake (Stevens County) collected at midday September 08, 1998.

Depth (m)	Temp (C)	D O	Conductivity	Total Dissolved Solids	pH	Salinity
0	21.33	11.04	218.7	.1399	8.97	.10
1	21.35	11.41	218.6	.1402	8.98	.10
2	21.31	11.68	218.6	.1398	8.99	.10
3	20.64	12.29	232.7	.1489	8.94	.11
4	19.49	12.09	232.2	.1486	8.86	.11
5	18.92	9.95	242.7	.1550	8.71	.11
5.3	18.92	10.10	243.8	.1558	8.74	.12

* Secchi Disk Reading 3.8 meters

Aquatic Vegetation

Jumpoff Joe Lake supports a diverse plant community throughout the littoral zone. A 1997 Washington Department of Ecology (DOE) aquatic plant survey found 15 different species, with Chara, or muskwort, the dominant plant (Jennifer Parsons, DOE, personal communication; Table 4). Visual observations of aquatic plants during this survey found that submerged aquatic plants covered approximately 75% of the lake bottom, and floating vegetation covered 25% of the surface. Approximately 50 % of the shoreline had emergent vegetation.

Species Composition

Six species were collected at Jumpoff Joe Lake in September 1998. Pumpkinseed sunfish (58%) and largemouth bass (*Micropterus salmoides*) (15%) were the most abundant species by weight and by number (Table 5). Largemouth bass, pumpkinseed sunfish, and yellow perch (*Perca flavescens*) together totaled 84% of the biomass and over 98% by number of all fish collected. Brown trout, eastern brook trout, and goldfish were sampled at lower densities. However, the effectiveness of warmwater sampling techniques used are largely restricted to the littoral zone of the lake and species such as trout may be under represented in our sampling.

Table 4. Washington Department of Ecology Aquatic Vegetation Survey Summary, July 29, 1997.

Common Name	Scientific Name	Value	Comments
coontail; hornwort	*Ceratophyllum demersum*	3	some dense patches, southwest end
muskwort	*Chara sp.*	4	dense in northwest end and east side
common elodea	*Elodea canadensis*	2	some denser growth near boat launch
yellow flag	*Iris psedacorus*	2	few patches
northern watermilfoil	*Myriophyllum sibiricum*	2	
common naiad	*Najas flexilis*	2	
leafy pondweed	*Potamogeton foliosus*	2	
flat-stalked pondweed	*Patomegeton friesii*	2	to 5 m deep
sago pondweed	*Potamogeton pectinatus*	2	
pondweed	*Potamogeton sp.*	2	looks like a hybrid of *P. illinoensis*
eel-grass pondweed	*Potamogeton zosteriformis*	2	
water-buttercup	*Ranunculus aquatilis*	1	few plants at southeast end
bulrush	*Scirpus sp.*	2	
nightshade	*Solanum sp.*	1	on shore
common cattail	*Typha latifolia*	3	rings much of shoreline on north side

Distribution Value Definitions
0 the value was not recorded (plant may not be submersed)
1 few plants in only one or a few locations in the lake
2 few plants, but with a wide patchy distribution throughout littoral zone
3 plants growing in large patches, co-dominant with other plants
4 plants in nearly monospecific patches, dominant in much of littoral zone
5 thick growth covering the substrate at the exclusion of other species

Table 5. Species composition by weight (kg) and number of fish captured at Jumpoff Joe Lake (Stevens County) during September 1998 survey.

Species Composition Excluding Young-of-Year

Species	by Weight		by Number		Size Range (mm TL)	
	(kg)	(%)	(#)	(%)	Min	Max
Pumpkinseed Sunfish	34.2	58.8	1285	77.6	43	174
Largemouth Bass	8.9	15.2	256	15.5	81	357
Yellow Perch	6.1	10.6	90	5.4	72	234
Brown Trout	3.7	6.5	2	0.1	495	610
Goldfish	3.2	5.5	3	0.2	355	399
Eastern Brook Trout	2.1	3.6	20	1.2	211	274

CPUE

Electrofishing catch rates were higher than both gill nets and fyke nets for all species collected (Table 6). Additionally, gill nets were more effective than fyke nets for all species. Pumpkinseed sunfish were captured at the highest rate by electrofishing at over 800 fish per hour. In contrast, the CPUE for brown trout and eastern brook trout were relatively low.

Table 6. Mean catch per unit effort by sampling method including 80% confidence intervals, for fish collected from Jumpoff Joe Lake (Stevens County) during the September 1998 survey.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	(# /hour)	Sites	#/Net Night	Nights	#/Net Night	Nights
Pumpkinseed Sunfish	810.0 ± 172.2	6	14.2 ± 6.5	4	42.7 ± 18.1	4
Yellow Perch	38.0 ± 28.0	6	7.5 ± 3.4	4	4.5 ± 3.4	4
Largemouth Bass	9.0 ± 4.7	6	1.5 ± 0.8	4	0	4
Eastern Brook Trout	4.0 ± 1.6	6	3.2 ± 2.4	4	0.7 ± 0.6	4

Stock Density Indices

Few quality size fish were collected from Jumpoff Joe Lake except for pumpkinseed sunfish, . This resulted in broad confidence limits for Proportional Stock Density (PSD) values making their interpretation difficult. Additionally, no preferred, memorable, or trophy size fish were collected so RSD values were 0 and therefore not presented in the table (Table 7). The relatively few stock sized largemouth bass (≥200 mm) collected may indicate low recruitment of largemouth bass to quality size (≥300 mm) in Jumpoff Joe Lake or over harvest of catchable largemouth bass by anglers. More adequate sample sizes of stock sized yellow perch (≥130 mm) and pumpkinseed sunfish (≥80 mm) were collected. Low PSD values typically indicate a crowded population. Crowding of panfish populations are often the result of extensive competition for limited food resources and/or low predation rates due to a low abundance of predators.

Table 7. Traditional stock density indices, including 80% confidence intervals, of fish collected from Jumpoff Joe Lake (Stevens County) during September 1998 survey by sampling method.

	Species	# Stock Length	PSD
Electrofishing	Largemouth Bass	9	22 ± 18
	Pumpkinseed Sunfish	810	4 ± 1
	Yellow Perch	38	3 ± 3
Gill Netting	Largemouth Bass	6	0
	Pumpkinseed Sunfish	57	0
	Yellow Perch	30	67 ± 11
Fyke Netting	Pumpkinseed Sunfish	171	16 ± 4
	Yellow Perch	18	6 ± 7

Largemouth Bass

Jumpoff Joe largemouth bass ranged in size from 81 to 357mm TL (age 1 to 4) and displayed stable year-class strength (Figure 2). However, no preferred size (≥ 380 mm) largemouth bass were observed. Largemouth bass growth rates were higher than the known Washington state average at all ages. Growth rates were also higher than observed for 1998 samples from two nearby eastern Washington lakes. At age 4, twenty-eight Newman Lake largemouth bass averaged 266 mm whereas five Liberty Lake largemouth bass averaged 307 mm (WDFW 1998, unpublished data). Comparatively, two age 4 largemouth bass from Jumpoff Joe averaged 351 mm (Table 8). Relative weights were generally low at all sizes (Figure 3). Bass that remain in the lake seem to do well as indicated by growth rates. However, the presence of few bass of quality or larger size likely indicates over harvest of these fish from the population.

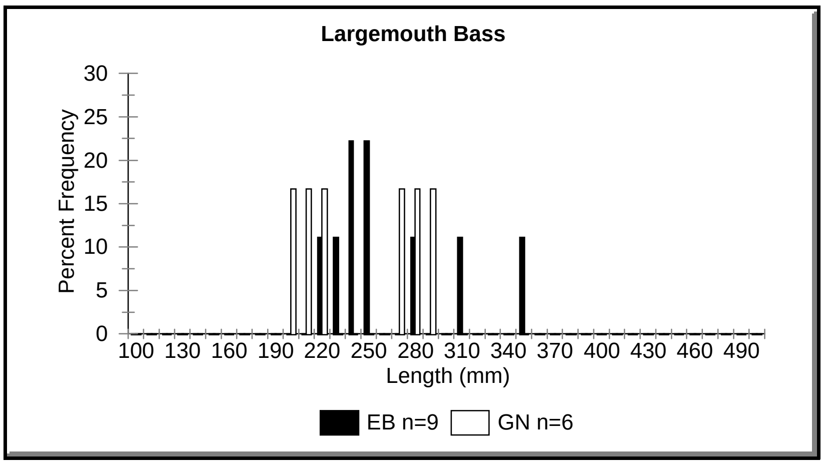

Figure 2. Length frequency distribution of stock size largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998.

Table 8. Age and growth largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998. Unshaded values are mean back-calculated length at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age			
		1	2	3	4
1997	13	64			
		76			
1996	12	69	153		
		82	160		
1995	2	69	159	210	
		83	167	214	
1994	2	79	207	286	349
		95	217	292	351
Direct Proportion Overall Mean		70	173	248	349
Lee's Weighted Mean		81	168	253	351
Direct Proportion State Average		60	146	222	261

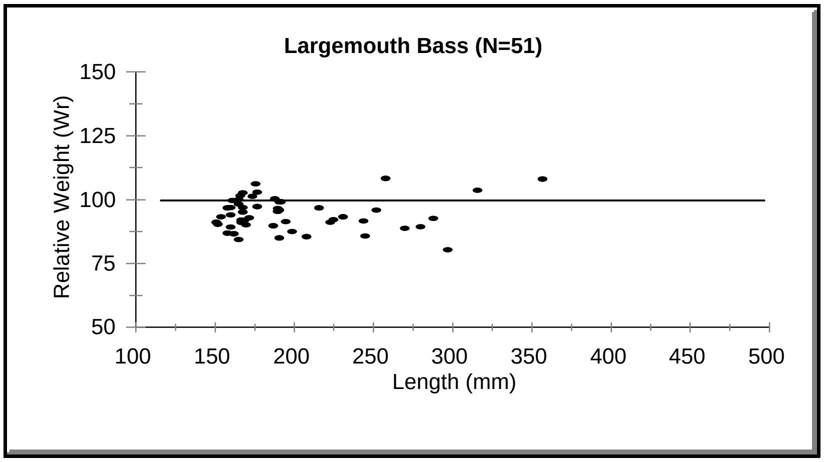

Figure 3. Relative weight (Wr) of largemouth bass sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile.

Yellow Perch

Jumpoff Joe Lake yellow perch ranged in size from 72 to 234 mm TL (age 1 to 4). Scale age analysis showed variable year-class strength (Table 9). Although the 1995 year class was represented in the sample by twenty-two yellow perch, the 1997, 1996, and 1994 year classes was represented by only one, three, and two yellow perch respectively. Overall, yellow perch growth rates were lower than the known state average and also lower than in other lakes in eastern Washington State. For example, 1998 surveys showed, the average length of 3 year old yellow perch from Liberty Lake (Spokane County) was 183 mm and the average length of 4 year old yellow perch from Newman Lake (Spokane County) was 192 mm (WDFW unpublished data, 1998). Comparatively, the average length of age 3 and 4 year old yellow perch from Jumpoff Joe was 152 and 176 mm respectively (Table 9). In addition to slow growth rates, the relative weights of yellow perch collected are low (Figure 5). The absence of preferred size yellow perch (≥ 250) (Figure 4), slow growth (Table 9), and low condition (Figure 5) likely indicate extensive inter- and/or intraspecific competition. Harvest of quality size (>200 mm) yellow perch by anglers may also contribute to their low relative abundance.

Table 9. Age and growth of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998. Unshaded values are mean back-calculated length at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification (Carlander 1982).

		Mean length (mm) at age			
Year Class	**# Fish**	**1**	**2**	**3**	**4**
1997	1	64			
		80			
1996	3	45	100		
		66	110		
1995	22	36	89	146	
		60	105	153	
1994	2	37	83	126	169
		62	101	139	176
Direct Proportion Overall Mean		46	91	136	169
Lee's Weighted Mean		62	105	152	176
Direct Proportion State Average		60	120	152	193

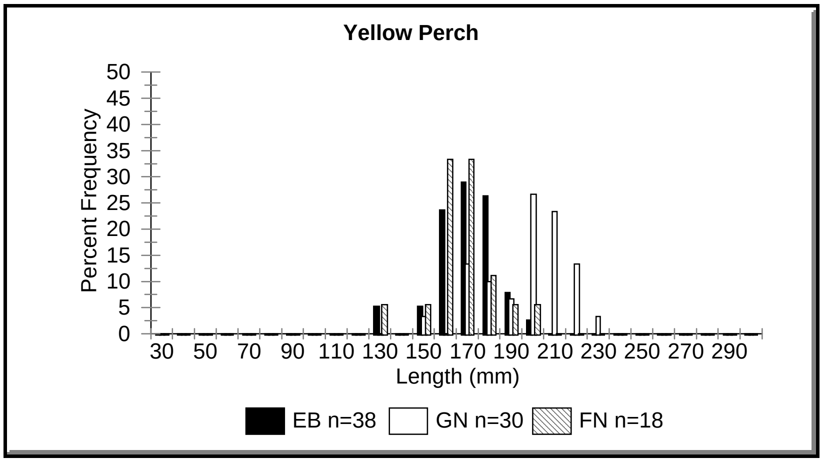

Figure 4. Length frequency distribution of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998.

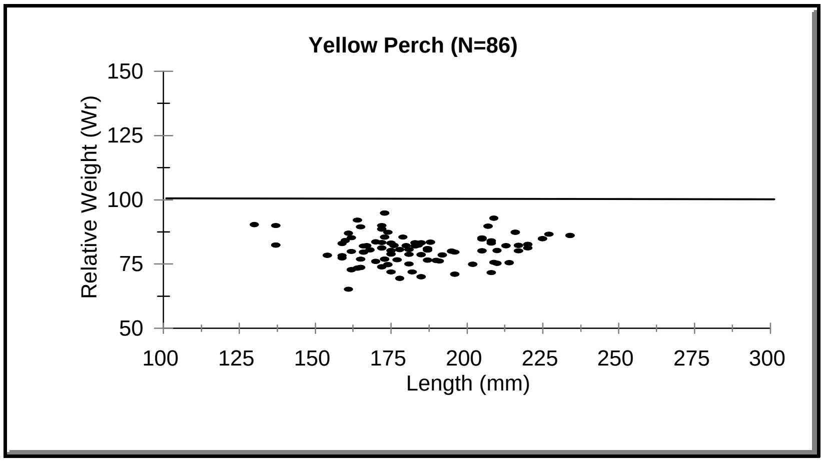

Figure 5. Relative weight (Wr) of yellow perch sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile.

Pumpkinseed Sunfish

Pumpkinseed sunfish ranged in size from 43 to 174 mm TL (age 2 to 6) (Table 10). 1995 and 1996 showed relatively strong year classes. However, 1997 showed no contribution to the population indicating some variability in year-class strength. The growth of pumpkinseed sunfish collected was slightly lower than the known state average but higher than in other eastern Washington lakes. For example, the average length of 6 year old fish collected from Clear Lake (Spokane County) and Newman Lake (Spokane County) in 1998, were 138 mm and 130 mm respectively (Figure 6). By comparison, age 6 pumpkinseed sunfish from Jumpoff Joe averaged 156 mm. The relative weights of pumpkinseed sunfish were similar to the national average (Figure 7). Although the pumpkinseed sunfish population in Jumpoff Joe is apparently doing well, their high abundance is likely contributing to extensive inter-specific competition with more desirable gamefish species such as young largemouth bass and yellow perch.

Table 10. Age and growth of pumpkinseed sunfush sampled from Jumpoff Joe Lake (Stevens County) September 1998. Unshaded values are mean back-calculated length at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification (Carlander 1982).

Year Class	# Fish	Mean length (mm) at age					
		1	2	3	4	5	6
1997	0	0					
1996	12	26	61				
		44	70				
1995	8	21	54	68			
		42	68	98			
1994	17	17	52	88	123		
		39	68	98	127		
1993	1	29	49	77	115	148	
		50	67	91	123	151	
1992	1	24	49	70	114	134	154
		46	66	84	122	139	156
Direct Proportion Overall Mean		24	53	82	117	141	154
Lee's Weighted Mean		42	68	97	127	145	156
Direct Proportion State Average		24	72	102	123	139	

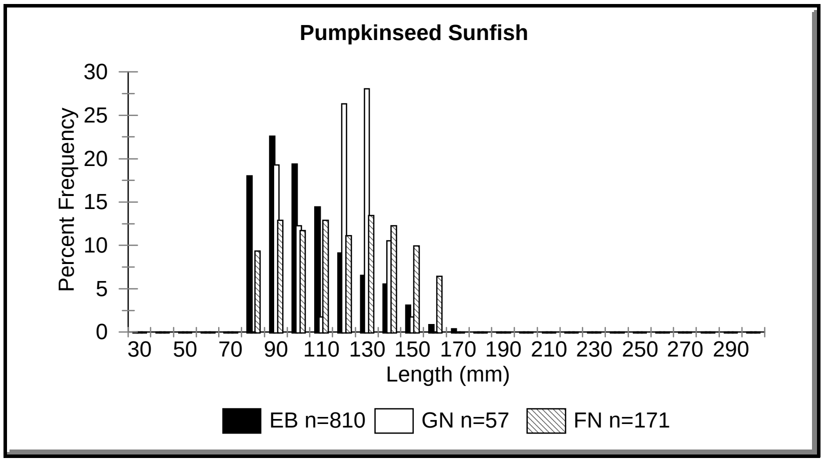

Figure 6. Length frequency distribution of pumpkinseed sunfish sampled from Jumpoff Joe Lake (Stevens County) September 1998.

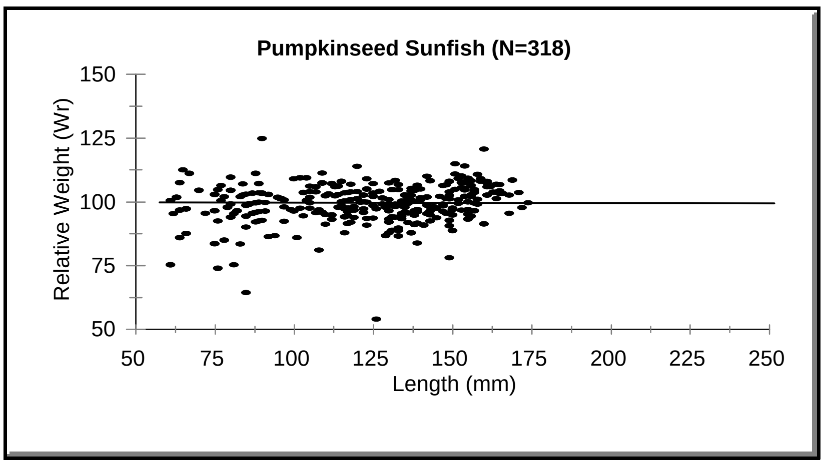

Figure 7. Relative weight (Wr) of pumpkinseed sunfish sampled from Jumpoff Joe Lake (Stevens County) September 1998 compared with the national 75th percentile.

Discussion

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

During September 1998, Jumpoff Joe Lake showed indications of having a prey crowded fish community. The lake was dominated by pumpkinseed sunfish and stunted yellow perch. Although the lake supports largemouth bass, the abundance of larger fish capable of preying upon panfish are not present in densities high enough to control stunting. Additionally, the low condition of small fish (≤ 100 mm) and their relatively high density is an indication of strong interspecific competition for limited forage. Therefore, the fish community at Jumpoff Joe should benefit by increasing the number of predator fish in the lake. Increasing the number of predatory fish in a prey crowded lake should increase the average size and condition in the panfish populations as well as increase the angling opportunity for quality size predators such as largemouth bass.

Management Options to Enhance Warmwater Fishing Opportunity

The following management options are provided for Jumpoff Joe Lake, if the lake is to managed for a quality warmwater fishery. It is our belief that the following, used in combination, will provide the best chance of enhancing current warmwater fishing opportunities at Jumpoff Joe Lake. It allows for continued stocking of brown trout in the lake to continue providing diversity of fishing opportunity. However, it is our opinion that the continued stocking of eastern brook trout in Jumpoff Joe Lake would result in greater interspecific competition and less than optimum growth rates for desired warmwater fish populations in the lake.

Largemouth Bass Slot-Limit Regulation

Jumpoff Joe Lake data suggests that it would be a good candidate for inclusion under the current recommended WDFW slot limit regulation for largemouth bass. This regulation consists of a five fish limit, fish 12"-17" are to be released, and only one fish over 17" may be retained. The intent of this regulation would be to increase the number of quality size (≥300mm, 12") largemouth bass in the lake. Under this regulation the number of largemouth bass predators in the lake should increase and prey upon the now stunted perch population as indicated by few quality perch ($\geq$ 200mm, 8"), low condition, and slow growth rate. Additionally, this regulation would increase the number of larger bass available for catch and release angling opportunities. Slot limits have been used successfully in other states and some lakes in Washington to improve the quality of both bass and panfish angling (Rasmussen and Michaelson 1972; Eder 1984; Wilde 1997). Glass and Maughan (1984) suggested that angler compliance with newly established regulations increased with angler awareness. Therefore, if a new regulation is adopted for Jumpoff Joe largemouth bass, adequate signing at the WDFW access site explaining the regulation change should be a priority.

Channel Catfish

Jumpoff Joe is a good candidate for the stocking of channel catfish. Channel catfish stocking has been used successfully to increase angling opportunities in lakes and ponds in many areas provided the proper conditions exist and appropriate stocking rates are used (Mitzner 1990, Santucci et al. 1994). Stocking channel catfish in Jumpoff Joe Lake would increase the diversity of warmwater fishing opportunity in the area and should increase the number of predator fish in the lake. Survey data suggests that Jumpoff Joe Lake should produce channel catfish exhibiting good growth, condition, and survival if 6" fish are stocked at (30 / acre) 3150 every other year (Storck and Newman 1988; Bonar et al. 1995). If stocked, channel catfish should be managed under the current statewide regulation. Under the current regulation, anglers could retain 5 channel catfish over 12 inches in length.

Trout Stocking

Stocking brown trout of catchable size could be continued to provide trout angling opportunities at Jumpoff Joe Lake. Brown trout are known to prey upon panfish and should help to improve the quality of yellow perch without hindering efforts to enhance the quality of the warmwater fish community at Jumpoff Joe. One of the most difficult problems to control when managing warmwater fisheries is extensive intraspecific competition for available food resources in warmwater lakes. Unlike brown trout, eastern brook trout of the size stocked into Jumpoff Joe Lake typically feed on food items similar to those preferred by panfishes and young bass. Stocking eastern brook trout potentially decreases the warmwater fish production potential of Jumpoff Joe Lake and should be discontinued.

Shoreline Access

Jumpoff Joe Lake currently has limited access for angling from shore. A fishing pier built at the WDFW access site would increase the opportunity for anglers without boats.

Literature Cited

Anderson, R. O. 1976. Management of small impoundments. Fisheries (Bethesda) 1(6):5-7.

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

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

Bonar, S. A., J. Pahutski, B. Bolding, and J. Webster. 1995. Factors related to the survival and growth of stocked channel catfish in Washington lakes. Washington Department of Fish and Wildlife, Technical Report Number IF95-03.

Carlander, K. D. 1982. Standard intercepts for calculation lengths from scale measurements for some centrarcid and percid fishes. Transaction of the American Fisheries Society 111:332-336.

Chew, R. L. 1974. Early life history of the Florida largemouth bass. Florida Game and Freshwater Fish Commission, Fishery Bulletin No. 7.

Conover, W. J. 1980. Practical nonparametric statistics, 2nd Edition. John Wiley and Sons, Inc., New York.

Divens, M. J., S. A. Bonar, B. D. Bolding, E. Anderson, and P. W. James. 1998. Monitoring warm-water fish populations in north temperate regions: sampling considerations when using proportional stock density. Fisheries Management and Ecology 5:383-391.

Duff, R. L., J. R. Nielsen, C. Vail, and R. Peck. 1977. *Annual Report Region One*, Washington Department of Game, Fishery Mgmt Report No. 78-4.

Eder, S. 1984. Effectiveness of an imposed slot length limit of 12.0-14.9 inches on largemouth bass. North American Journal of Fisheries Management 4:469-478.

Fletcher, D., S. Bonar, B. Bolding, A. Bradbury, and S. Zeylmaker. 1993. Analyzing warmwater fish populations in Washington state. Washington Department of Fish and Wildlife, Warmwater Fish Survey Manual.

Gabelhouse, D. W., Jr. 1984b. A length categorization system to assess fish stocks. North American Journal of fisheries Management 4:273-285.

Glass, R. D. and O. E. Maughan. 1984. Angler compliance with length limits on largemouth bass in an Oklahoma reservoir. North American Journal of Fisheries Management 4:457-459.

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

Jearld, A. 1983. Age determination. Pages 301-324 *in* Nielsen, L. A., and D.L. Johnson (eds.), Fisheries Techniques, 2nd Edition. American Fisheries Society, Bethesda, MD.

Mitzner, L. 1990. Assessment of maintenance stocked channel catfish in Iowa lakes. Federal Aid to Fish Restoration Completion Report, Reservoir Investigations Project F-94-R.

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

ODFW (Oregon Department of Fish and Wildlife). 1997. Fishery biology 104-Body condition. Oregon Department of Fish and Wildlife, Warmwater Fish News 4(4):3-4.

Rasmussen, J. L. and S. M. Michaelson. 1972. Attempts to prevent largemouth bass overharvest in three northwest Missouri lakes. Symposium on overharvest and management of largemouth bass in small impoundments. American Fisheries Society, Special Publication Number 3.

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

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

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

Wilde, G. R. 1997. Largemouth fishery responses to length limits. Fisheries 22(6):14-23.

Willis, D. W., B. R. Murphy, and C. S. Guy. 1993. Stock density indicies: development, use, and limitations. Review in Fisheries Science 1(3):203-222.