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2003 Warmwater Fisheries Survey of Sprague Lake, Adams/Lincoln Counties, Washington

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Abstract

Sprague Lake, Adams/Lincoln Counties, Washington, was surveyed Oct. 20-24, 2003, using standard warmwater survey and Fall Walleye Index Netting methods. Black crappie *Pomoxis nigromaculatus* was the most abundant gamefish collected followed by walleye *Sander vitreus*. Largemouth bass *Micropterus salmoides*, Smallmouth bass *M. dolomieui*, bluegill *Lepomis macrochirus*, yellow perch *Perca flavescens*, channel catfish *Ictalurus punctatus*, brown bullhead *Ictalurus nebulosus*, rainbow trout *Oncorhynchus mykiss*, tench *Tinca tinca*, common carp *Cyprinus carpio*, and prickly sculpin *Cottus* asper were also collected during this survey. Growth was above average for species from which growth was determined (i.e. yellow perch, black crappie, bluegill, largemouth and smallmouth bass). Bluegill, black crappie, smallmouth and largemouth bass had above average relative weights, while yellow perch had below average relative weights. Several age classes from multiple species were missing from our samples. This may indicate poor recruitment and could negatively impact sport fisheries in the near future. Walleye had the highest biomass of fish collected and was surpassed only by black crappie in terms of the number of fish collected. Walleye were in good condition and most fish were greater than 16 inches. Abundance of large walleye in this community may be the causative factor of missing age classes of other gamefish.

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Introduction and Background

Sprague Lake is located in Lincoln and Adams Counties, approximately 5 km southwest of Sprague, WA (Fig. 1). The lake has a surface area of 728 ha, a mean depth of 3.5 m, and is approximately 9.6 km in length. Negro Creek is the sole inlet to Sprague Lake and enters at the northeast corner of the lake. Cow Creek is the primary outlet on Sprague Lake and is found along the southwest shore. Dominant vegetation found in and surrounding Sprague Lake includes bulrush *Scirpus spp.*, cattail *Typha latifolia*, water milfoil *Myriophyllum spp.*, and pondweed *Potamogeton spp*. Numerous waterfowl species utilize Sprague Lake for both brood rearing and resting habitat. During fall, thousands of waterfowl utilize Sprague Lake as a roost site on their southward migration. The Washington Department of Fish and Wildlife (WDFW) maintains a public boat ramp at the southeast corner of Sprague Lake. Two resorts and a private access area provide anglers access to the lake for a fee. The Four Seasons Resort is located along the southwest corner of the lake. The Sprague Lake Resort and the private access area are located on the northeast end. Both resorts provide lodging allow camping, bank fishing and maintain a boat launch.

In 1985, the Washington Department of Wildlife (WDW) rehabilitated Sprague Lake in an attempt to remove brown bullhead *Ictalurus nebulosus*, common carp *Cyprinus carpio*, and tench *Tinca tinca*. The lake was subsequently stocked with 2.5 million sport fish over the next three years in order to immediately develop a sport fishery. Approximately half of the fishes stocked were walleye *Sander vitreus* fry; the remainder were primarily rainbow trout *Oncorhynchus mykiss* and Lahontan cutthroat trout *O. clarki henshawi*. The WDW also stocked channel catfish *I. punctatus*, bluegill *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, and smallmouth bass *M. dolomieu*. The last fishery survey of Sprague Lake was conducted in October 1998. Black crappie *Pomoxis nigromaculatus*, bluegill and yellow perch *Perca flavescens* were the most abundant species collected during that survey, and common carp, brown bullhead and tench comprised 1.3 percent of the fish collected.

The fish community in Sprague Lake is currently managed using statewide freshwater species rules with the exception of crappie. Crappie at least 9 inches in length may be retained, and anglers are limited to 10 fish per day.

This survey was conducted, in part, to address concerns by local resort owners and fishermen that walleye in Sprague Lake had declined to a point where angler satisfaction had diminished significantly. In addition, we wanted to determine species abundance, predator/prey ratios, and condition of fishes to assess whether this fishery was balanced and dominated by desirable species (i.e. warmwater species) or undesirable species such as carp and tench.

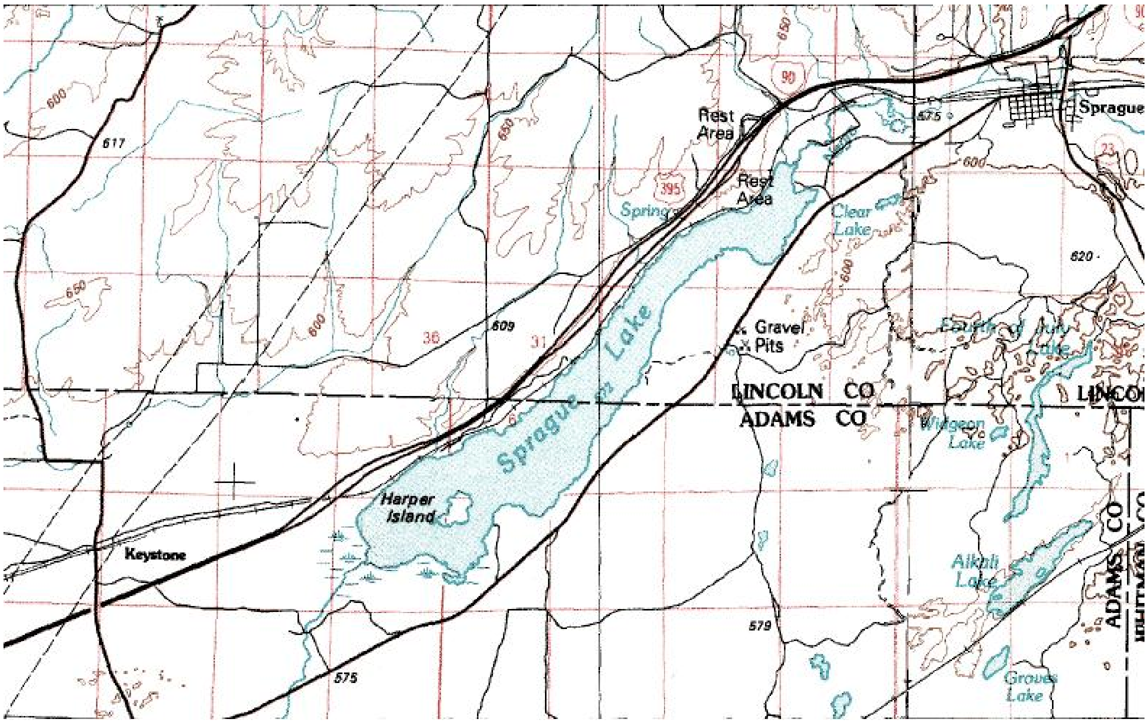

Figure 1. Map of Sprague Lake, Lincoln and Adams Counties, Washington.

Methods and Materials

Sprague Lake was surveyed by two, three-person teams October 20-24, 2003. Fish were collected using a boat electrofisher, gill nets, and fyke nets. The electrofishing unit consisted of a 5.5 m (18 ft) Smith-Root GPP electrofishing boat, supplying a DC current at a setting of 120 cycles/sec at 3 to 4 amps power (Bonar et al. 2000). FWIN gill nets (61 m x 1.8 m) consisted of variable size (25, 38, 51, 64, 76, 102, 127, 152 mm stretched) monofilament mesh. Fyke nets were constructed of a main trap (four 1.2 m aluminum rings), a single 30.3 m lead, and two 15.2 m wings. In addition to our standard warmwater protocol, we also conducted a Fall Walleye Index Netting (FWIN) survey. We utilized FWIN gill nets in place of standard gill nets we typically use on warmwater surveys.

Sampling locations were selected prior to sampling by dividing the shoreline into 400 m sections and randomly selecting 31 sections from the total. The 31 randomly selected sites were distributed between electrofishing (15 sites), gill nets (8 sites), and fyke nets (8 sites). Electrofishing occurred in shallow water (depth range: 0.2 - 1.5 m), adjacent to the shoreline at a rate of approximately 18.3 m/minute for 600-second intervals (Bonar et al. 2000). Gill nets were set perpendicular to the shoreline at randomly selected sites in one of two depth strata. The first depth strata included sites in which the gill net was in water no less than 2m (6.6 feet), and no deeper than 5m (16.4 feet). The second depth strata included sites in which the gill net was in water no less than 5m (16.4 feet), and no deeper than 15m (49.2 feet). The small mesh end of the gill net was nearest shore and the large-mesh end was anchored farthest from shore. Gill nets were set from mid-morning to early afternoon the following day and remained deployed for approximately 24 hours. Fyke nets were set perpendicular to the shoreline with the wings extended at 70^{o} angles from the lead. Fyke nets were set overnight prior to electrofishing and were pulled the following morning (1 net night).

All fish were identified to species, measured in millimeters (mm) to total length (TL) from anterior most part of head to the tip of the compressed caudal fin, and weighed to the nearest gram (g). Total length data was used to construct length-frequency histograms and to evaluate the size structure of the warmwater species in the lake. Warmwater fish species (with the exception of walleye) were assigned to a 10 mm size group based on total length, and scale samples were collected from the first five fish in each size group (Bonar et al. 2000). Otoliths were collected from all walleye collected during this survey. Scale samples were mounted on adhesive data cards, and otoliths were stored in trays. Otoliths and scales were aged by the WDFW scale lab in Olympia.

Species composition, by weight in kilograms (kg) and number, was determined from fish captured. Fish less than one year old, i.e. young-of-the-year (YOY), were excluded from all analyses. Eliminating YOY fish prevents distortions in analyses that may occur due to sampling location, inconsistent gear bias, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE) for each sampling gear was calculated for all warmwater fish species collected. The CPUE of electrofishing was determined by dividing the number of fish captured by the total amount of time electrofished. Similarly, CPUE of gill nets and fyke nets was determined by dividing the number of fish captured by the total time that the nets were deployed. Since CPUE is standardized, it can be useful in comparing catch rates between lakes or between sampling dates on the same water.

A relative weight (W_r) index was used to evaluate the condition of fish in Sprague Lake. As presented by Anderson and Neumann (1996), a W_r of 100 generally indicates that a fish is in a condition similar to the national average for that species at the same length. The index is defined 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). Standard weight (W_s) was derived from a standard weight-length ($\log_{10}$) relationship, which was defined for each species of interest in Anderson and Neumann (1996). Minimum lengths were used for each species, since variability can be significant for small fish (YOY). Relative weights less than 50 were also excluded from our analyses as we suspected unreliable weight measurements.

Age and growth of warmwater species, with the exception of walleye were evaluated using procedures described by Fletcher et al. (1993). All samples were evaluated using both the direct proportion method (Fletcher et al. 1993) and Lee's modification of the direct proportion method (Carlander 1982). Mean back-calculated lengths-at-age for all warmwater species were then compared to those of eastern Washington and/or statewide averages (Fletcher et al. 1993). Walleye otoliths were collected in accordance with FWIN procedures in order to determine the age structure of the walleye population in Sprague Lake.

The proportional stock density (PSD) of each warmwater fish species was determined following procedures outlined in Anderson and Neumann (1996). PSD uses two measurements, stock length and quality length, to provide information about the proportion of various size fish in a population. Stock length is defined as the minimum size of a fish, which provides recreational value, or approximate length when fish reach maturity. Quality length is defined as the minimum size of a fish that most anglers like to catch or begin keeping (Table 1). PSD is calculated using the number of quality sized fish, divided by the number of stock sized fish, multiplied by 100. Stock and quality lengths vary by species and are based on percentages of world-record lengths. Stock length is 20-26 percent of the world record length; whereas quality length is 36-41 percent of the world record length.

Relative stock density (RSD) of each warmwater fish species was examined using the five-cell model proposed by Gabelhouse (1984). In addition to stock and quality lengths, the Gabelhouse model adds preferred, memorable, and trophy categories (Table 1). Preferred length (RSD-P) is defined as the minimum size of fish anglers would prefer to catch. Memorable (RSD-M) length refers to the minimum size fish anglers remember catching, and trophy length (RSD-T) refers to the minimum size fish worthy of acknowledgment. Preferred, memorable, and trophy length fish are also based on percentages of world record lengths. Preferred length is 45-55 percent of world record length, memorable length is 59-64 percent of world record length, and trophy length is 74-80 percent of world record length. RSD differs from PSD in that it is more sensitive to changes in year class strength. RSD is calculated as the number of fish within the specified length category, divided by the total number of stock length fish, multiplied by 100. Eighty percent confidence intervals for PSD and RSD are selected from tables in Gustafson (1988).

Table 1. Minimum total length (mm) categories of warmwater fish used to calculate PSD and RSD values (Willis et al. 1993).

	Length Category				
Species	Stock	Quality	Preferred	Memorable	Trophy
Yellow perch	130	200	250	300	380
Bluegill	80	150	200	250	300
Black crappie	130	200	250	300	380
Largemouth bass	200	300	380	510	630
Smallmouth bass	180	280	350	430	510
Walleye	250	380	510	630	760
Channel catfish	280	410	610	710	910
Brown bullhead	150	230	300	390	460

Results and Discussion

Species Composition

Twelve fish species were collected during this survey (Table 2). Warmwater gamefish represented 85 percent of fish collected. Black crappie was the most abundant species collected and represented 50 percent of the number of fish collected yet only 4.8 percent of the total biomass of fish collected. Walleye was second in abundance representing 25 percent of the number of fish collected; however, walleye represented the highest percentage of total biomass. Two invasive species: carp and tench, represented nearly 30 percent of the total biomass of fishes collected during this survey. This number is likely biased low since we don't target these species in our sampling and our gears don't sample them effectively. Largemouth bass, smallmouth bass, bluegill, yellow perch, and channel catfish, combined, represented less than nine percent of the fish collected during this survey and less than eight percent of the total biomass. Samples of these species were dominated by small fish.

Table 2. Species Composition, by weight (g) and number of fish collected during October 20-24, 2003 on Sprague Lake (Lincoln and Adams Counties, Washington).

	Species Composition					
	Weight		**Number**		**Size Range (mm TL)**	
Species	**Kg**	**%**	**N**	**%**	**Min**	**Max**
			Gamefish			
Yellow perch	12.8	1.1	41	1.8	245	341
Bluegill	2.3	0.2	31	1.3	94	222
Black crappie	55.5	4.8	1172	50.1	107	230
Largemouth bass	19.6	1.7	49	2.1	150	445
Smallmouth bass	9.7	0 .8	36	1.6	165	395
Walleye	640.4	54.9	572	24.7	296	722
Channel catfish	41.6	3.6	12	0.5	365	712
Brown bullhead	24.2	2.1	54	2.3	67	418
Rainbow trout	11.7	1.0	15	0.7	378	539
TOTAL	**817.8**	**70.1**	**1982**	**85.7**		
			Non-Gamefish			
Tench	41.8	3.6	23	1.0	455	515
Carp	307.2	26.3	169	7.3	182	813
Prickly sculpin	0.7	0.06	139	6.0	27	170
TOTAL	**349.7**	**29.9**	**331**	**14.3**		

Young of the Year Fish (YOY)

We collected ten YOY bluegill, 14 YOY black crappie, ten YOY smallmouth bass, 148 YOY largemouth bass, 170 YOY walleye, and 330 YOY yellow perch during this survey. Young of the year fish are typically poorly represented in our samples due to gear limitations. Sample sizes of YOY colleted during this survey indicate that there is an ample prey base for predators in Sprague Lake.

Catch Per Unit Effort (CPUE)

Whether using active (boat electrofisher) or passive (gill nets and fyke nets) techniques, CPUE is a useful index to monitor relative abundance of fish in lakes and reservoirs (Hubert 1996). The electrofishing catch rate was significantly higher for black crappie than for any other species, however this rate had a high degree of variation. Walleye and largemouth bass were collected at a similar rate; however, these species were collected at a much lower rate than black crappie (Table 3). Gill net catch rates were highest for black crappie and walleye. Carp was a distant third in terms of abundance and most other species were poorly represented by gill nets (i.e. < 1 fish/net night). Fyke net catch rates were highest for black crappie and brown bullhead; however, neither of these species was collected in high abundance with fyke nets. Bluegill were only captured with our boat electrofisher and was the only species not collected in gill nets. Largemouth bass, smallmouth bass, rainbow trout, and channel catfish were not collected in fyke nets.

Table 3. Mean CPUE by sampling method, including 80 percent confidence intervals for all fish collected on Sprague Lake.

	Electrofishing		Gill Nets		Fyke Nets	
	No. / Hour ± CI	**No. Sites**	**No. Net Night**	**Net Nights**	**No./ Net Night**	**Net Nights**
Yellow perch	0	16	3 (± 1)	14	0	8
Bluegill	13 (± 12)	16	0	14	0	8
Black crappie	160 (± 118)	16	51 (± 15)	14	4 (± 4)	8
Largemouth bass	27 (± 10)	16	0.4 (± 0.2)	14	0	8
Smallmouth bass	13 (± 7)	16	0.1 (± 0.1)	14	0	8
Walleye	31 (± 6)	16	35 (± 4)	14	0.3 (± 0.2)	8
Channel catfish	0.4 (± .05)	16	0.8 (± 0.4	14	0	8
Brown bullhead	6 (± 0)	16	0.8 (± 0.5)	14	3 (± 4)	8
Rainbow trout	0.8 (± 1)	16	1 (± 0.5)	14	0	8
Tench	0.8 (± 0.7)	16	1 (± .04)	14	0.9 (± 0.6)	8
Carp	14 (± 6)	16	9 (± 2)	14	0.1 (± 0.2)	8
Prickly sculpin	51 (± 29)	16	0.1 (± .01)	14	0.3 (± 0.3)	8

Stock Density Indices

Electrofishing is considered the most effective method for obtaining large samples of ≥ stock length centrarchid fishes (i.e. bass, bluegill, pumpkinseed, and crappie) (Divens et al. 1996); however, during this survey more stock length black crappie were collected in FWIN gill nets. Black crappie and walleye were the only species collected in sufficient quantities to generate useful PSDs. The PSD for black crappie was 1, based on gill net data, while the PSD for walleye was 87 based on both electrofisher and gill net data (Table 4). In addition, the RSD-P was 20 for walleye collected in gill nets. These indices indicate that 87 percent of the stock length walleye captured were ≥ quality length (380 mm) and 20 percent were preferred length (≥ 510 mm). The PSD of 1 for black crappie indicates that this population is dominated by small fish (≤ 200 mm).

Table 4. Stock density indices, including 80 percent confidence interval, for warmwater fishes collected during this survey. PSD = proportional stock density, RSD-P = relative stock density of preferred fish, RSD-M = relative stock density of memorable fish, and RSD-T = relative stock density of trophy fish.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
			Electrofisher		
Yellow perch	1	100 (± 0)	0	0	0
Bluegill	35	* 31 (± 10)	3 (± 4)	0	0
Black crappie	320	* 0 (± 0.4)	0	0	0
Largemouth bass	37	* 24 (± 9)	24 (± 9)	0	0
Smallmouth bass	28	* 29 (± 11)	14 (± 8)	0	0
Walleye	83	87 (± 5)	17 (± 5)	1 (± 2)	0
			Gill Nets		
Yellow perch	46	* 96 (± 4)	85 (± 7)	26 (± 8)	0
Black crappie	603	1 (± 0.4)	0	0	0
Largemouth bass	4	0	0	0	0
Smallmouth bass	1	100 (± 0)	0	0	0
Walleye	487	* 87 (± 2)	20 (± 2)	2 (± 1)	0
			Fyke Nets		
Black crappie	29	0	0	0	0
Walleye	2	100 (± 0)	0	0	0

***** Preferred gear type for this species for determining PSD.

Yellow perch

A total of 41 yellow perch ranging from 245-341mm were collected during this survey. The majority of adult yellow perch collected were age two and growth was above the state average (Table 5). Several yellow perch were collected that were likely age one; however, scales were not taken on these fish and they were not aged. All yellow perch identified as adults were collected in gill nets (Figure 2). Yellow perch relative weights averaged 91 indicating that food may be limiting for adult fish (Figure 3).

Table 5. Age and growth of yellow perch collected at Sprague Lake during Oct. 2003. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age				
Year Class	# Fish	1	2	3	4	5
2002	0					
2001	9	76.2	180.6			
		97.6	190.2			
2000	1	53.1	180.0	262.7		
		77.9	192.3	266.8		
1999	0					
1998	5	78.7	165.5	225.5	267.0	293.9
		101.1	179.6	233.7	271.2	295.6
DP mean		69.3	175.4	244.1	267.0	293.9
Weighted FL mean		97.4	186.8	239.2	271.2	295.6
Washington Average		59.7	119.9	152.1	192.5	206

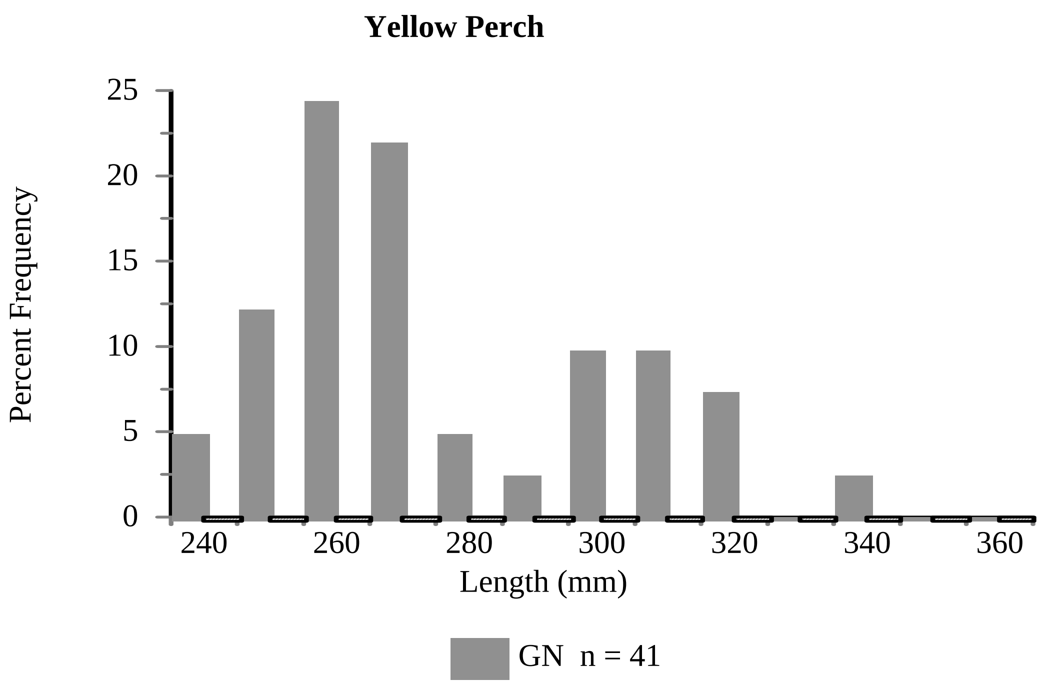

Figure 2. Length frequencies of yellow perch collected using gill nets (GN), on Sprague Lake, October 2003.

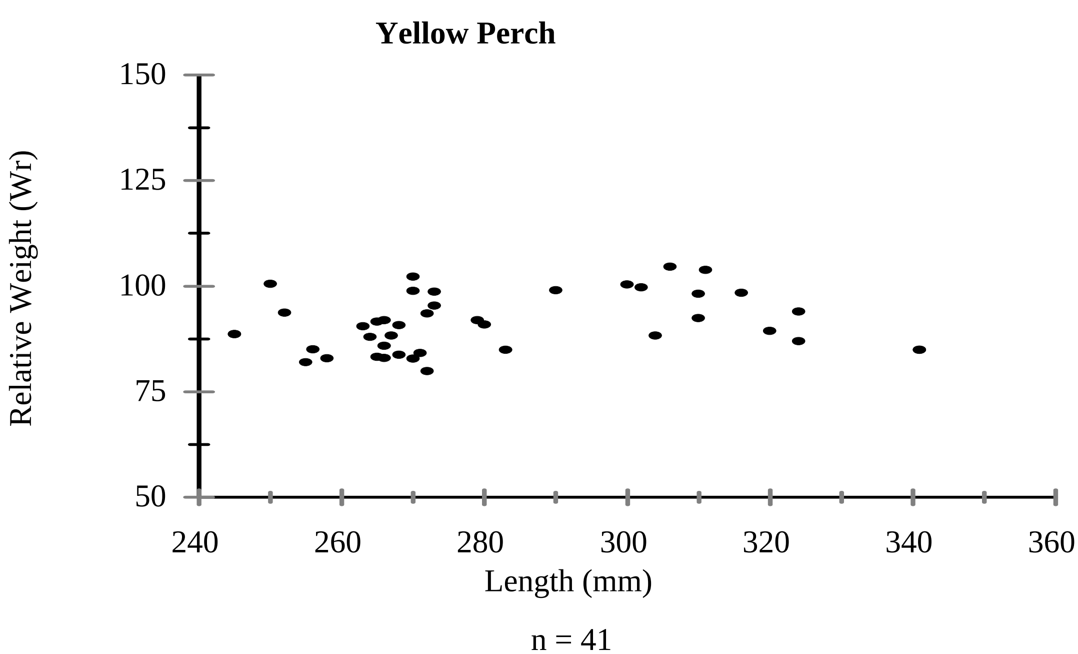

Figure 3. Relative weights for yellow perch collected at Sprague Lake, October 2003, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Bluegill

A total of 31 bluegill ranging from 94-222mm were collected during this survey. The majority of bluegill collected were age one and two; and these fish were below the state average for growth (Table 6). Age three and four fish were above the state average for growth; however, only one fish was analyzed from each of these classes. Bluegill were only collected with the boat electrofisher and most fish were less than six inches (Figure 4). Bluegill were in excellent condition and relative weights averaged 110, which is above the national average, and indicates that food is not limiting this small population (Figure 5).

Table 6. Age and growth of bluegill collected at Sprague Lake during Oct. 2003. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age			
Year Class	# Fish	1	2	3	4
2002	16	31.8			
		46.4			
2001	12	22.5	84.8		
		39.7	94.1		
2000	1	15.8	70.6	155.4	
		34.0	82.7	157.8	
1999	1	41.6	130.4	189.6	210.0
		57.9	138.7	192.5	211.1
DP mean		27.9	95.3	172.5	210.0
Weighted FL mean		43.7	96.4	175.2	211.1
Washington Average		37.3	96.8	132.1	148.3

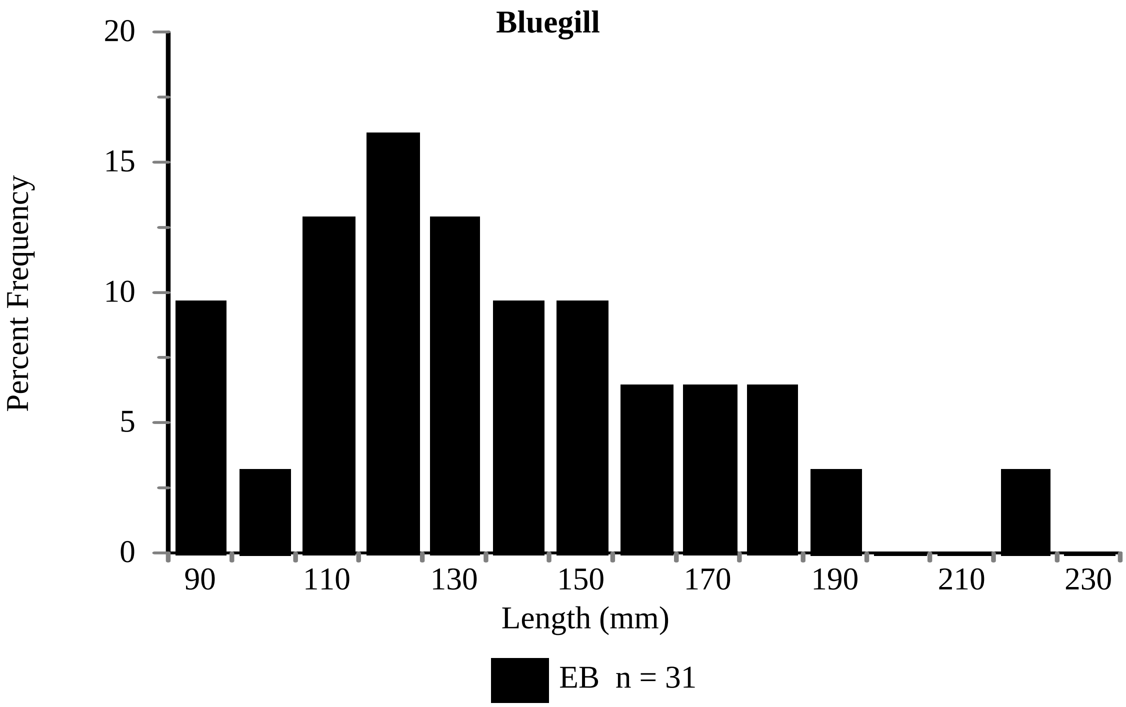

Figure 4. Length frequencies of bluegill collected using a boat electrofisher (EB) on Sprague Lake, October 2003.

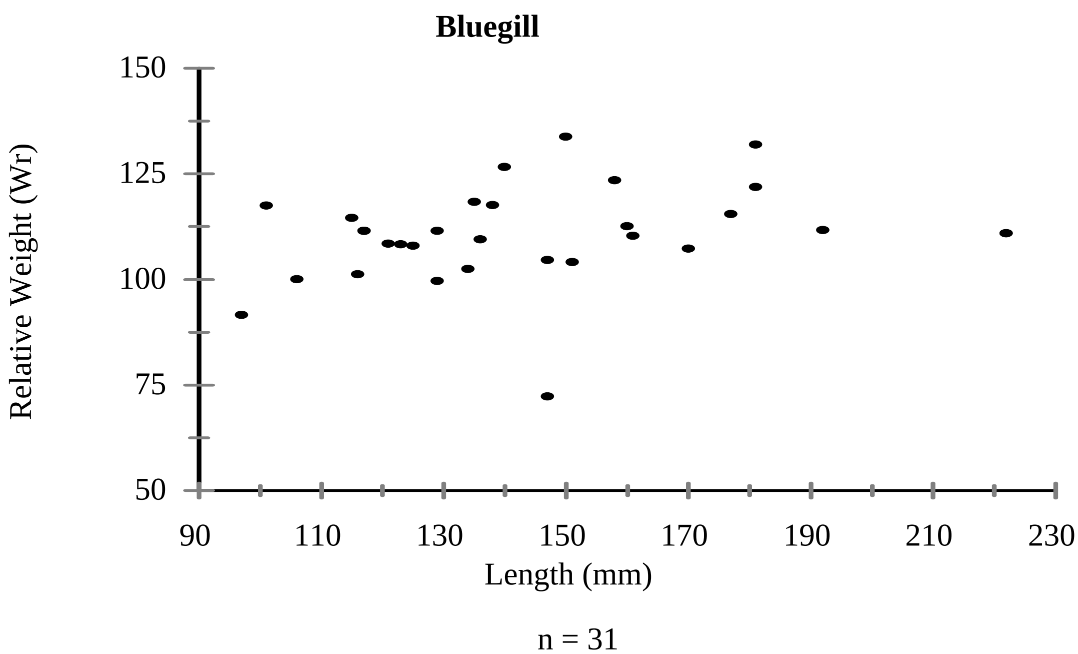

Figure 5. Relative weights for bluegill collected at Sprague Lake, October 2003, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Black crappie

A total of 1,172 black crappie ranging is size from 107-230 mm were collected during this survey. Growth was above the Washington average; however, no fish older than age two were collected (Table 7). Black crappie were collected with all gear types yet most were collected with gill nets and the boat electrofisher (Figure 6). Relative weights averaged 109, indicating that black crappie are in good condition and are not limited by food resources (Figure 7).

Table 7. Age and growth of black crappie collected at Sprague Lake during October 2003. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age	
Year Class	# Fish	1	2
2002	46	53.1	
		74.9	
2001	1	39.2	122.2
		67.8	137.2
DP mean		46.1	122.2
Weighted FL mean		74.8	137.2
Washington Average		46	111.2

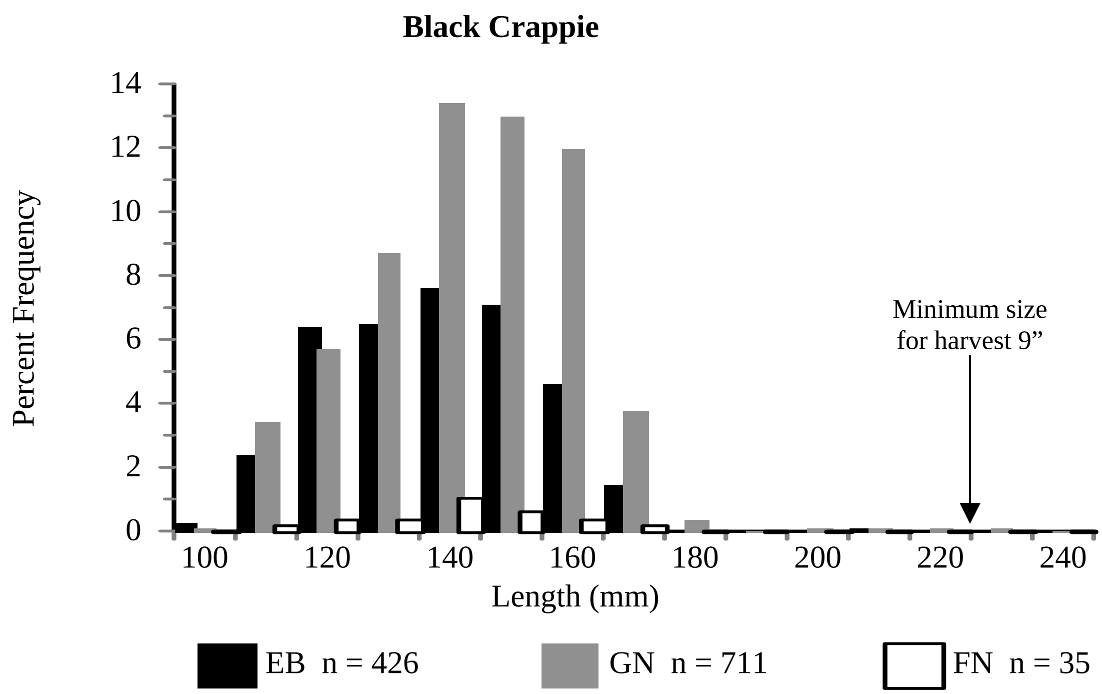

Figure 6. Length frequencies of black crappie collected using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Sprague Lake, October 2003.

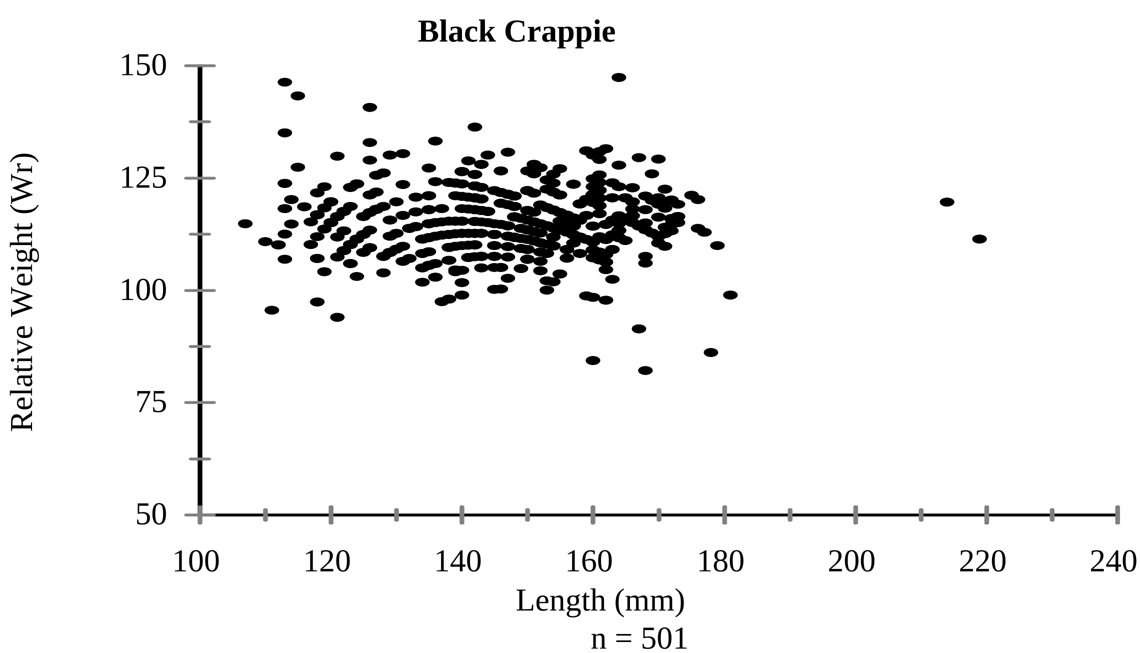

Figure 7. Relative weights for black crappie collected at Sprague Lake, October 2003, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Largemouth bass

A total of 49 largemouth bass ranging from 150-445mm were collected during this survey. The majority of fish collected were age one; however, several age classes were missing (Table 8). Growth of largemouth bass was above the eastern Washington average for all but one fish. Largemouth bass were collected with the boat electrofisher and in gill nets; however, the majority, and largest, were collected with the boat electrofisher (Figure 8). Relative weights averaged 111, which is well above the national average (100), and is likely due to the abundance of juvenile prey fish in Sprague Lake and low intraspecific competition due to small population size (Figure 9).

Table 8. Age and growth of largemouth bass collected at Sprague Lake during Oct. 2003. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age							
Year Class	# Fish	1	2	3	4	5	6	7	8
2002	29	86.3							
		98.8							
2001	0								
2000	0								
1999	0								
1998	2	78.1	223.2	336.9	360.5	384.0			
		94.1	231.9	339.9	362.2	384.5			
1997	5	104.9	250.6	336.4	370.4	394.2	408.0		
		119.9	258.7	340.5	372.9	395.7	409.6		
1996	0								
1995	1	93.7	205.8	300.8	344.4	374.7	398.2	415.6	428.8
		109.4	216.5	307.2	348.8	377.8	400.4	416.8	429.4
DP mean		90.7	226.5	324.7	358.4	384.3	403.6	415.6	428.8
Weighted FL mean		101.7	246.8	336.2	367.2	390.6	408.1	416.8	429.4
E. Washington Average		68.8	155.6	189.2	248.9	299.9	351.5	421.6	437.6

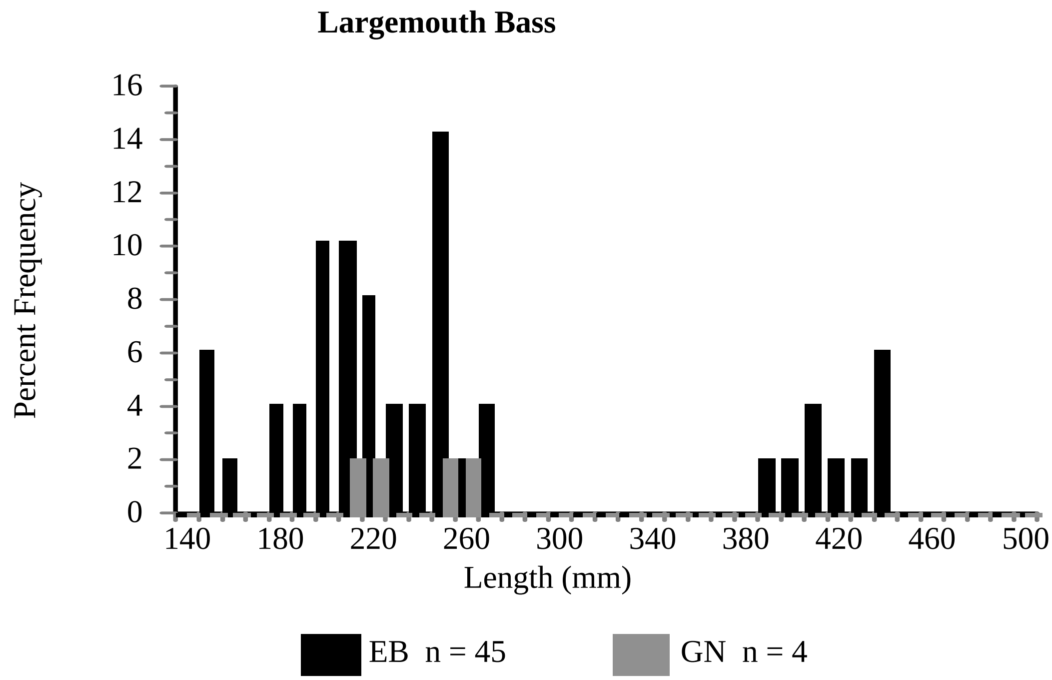

Figure 8. Length frequencies of largemouth bass collected using a boat electrofisher (EB), and gill nets (GN), on Sprague Lake, October 2003.

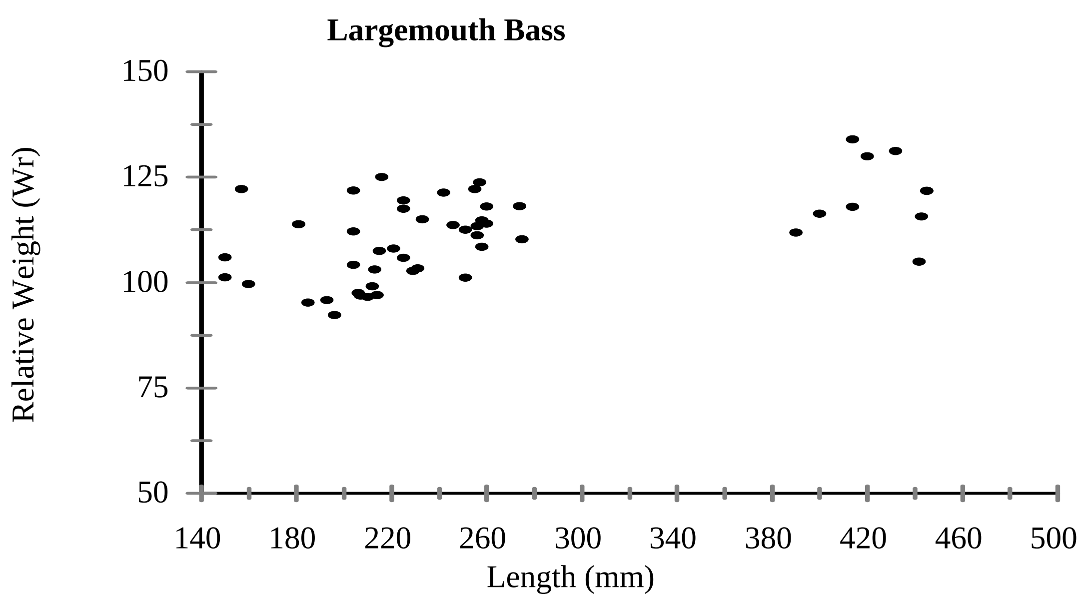

Figure 9. Relative weights for largemouth bass collected at Sprague Lake, October 2003, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Smallmouth bass

A total of 36 smallmouth bass ranging from 150-445mm were collected during this survey. Growth was above the state average for most age classes; however, older age classes were weakly represented (Table 9). Most smallmouth were collected with the boat electrofisher, however we did collect one fish in a gill net (Figure 10). Relative weights averaged 104, which is slightly above the national average (W_r = 100) (Figure 11). As with largemouth bass, smallmouth bass likely prey on the highly abundant YOY panfish found in this lake. Several factors may be limiting the smallmouth population in Sprague Lake. Lack of adequate habitat, as well as predation are both possible limiting factors for this population. We will likely see this population decline in abundance due to low numbers of adult fish.

Table 9. Age and growth of smallmouth bass collected at Sprague Lake during Oct. 2003. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993). Unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age				
Year Class	# Fish	1	2	3	4	5
2002	18	53.5				
		78.7				
2001	9	62.2	164.1			
		89.5	178.6			
2000	1	64.7	161.7	256.0		
		93.2	180.4	265.1		
1999	0					
1998	3	81.5	168.5	250.2	313.7	351.0
		109.0	188.1	262.3	320	353.9
DP mean		65.5	164.8	253.1	313.7	351.0
Weighted FL mean		85.2	180.9	263.0	320.0	353.9
Washington Average		70.4	146.3	211.8	268	334

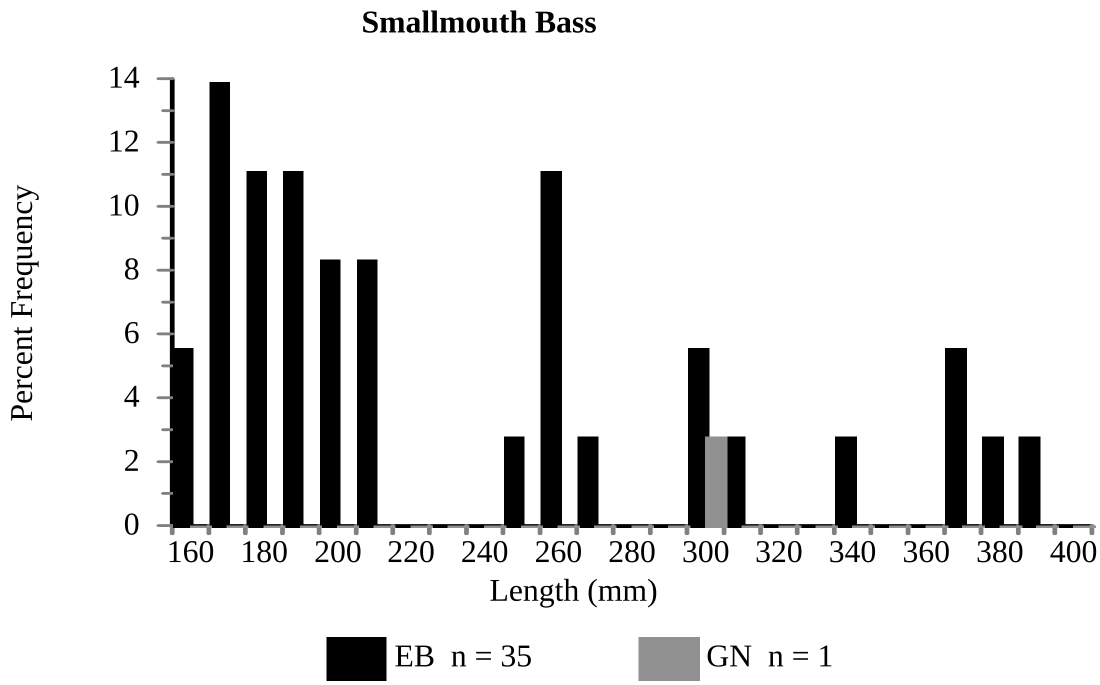

Figure 10. Length frequencies of smallmouth bass collected using a boat electrofisher (EB) and gill nets (GN) on Sprague Lake, October 2003.

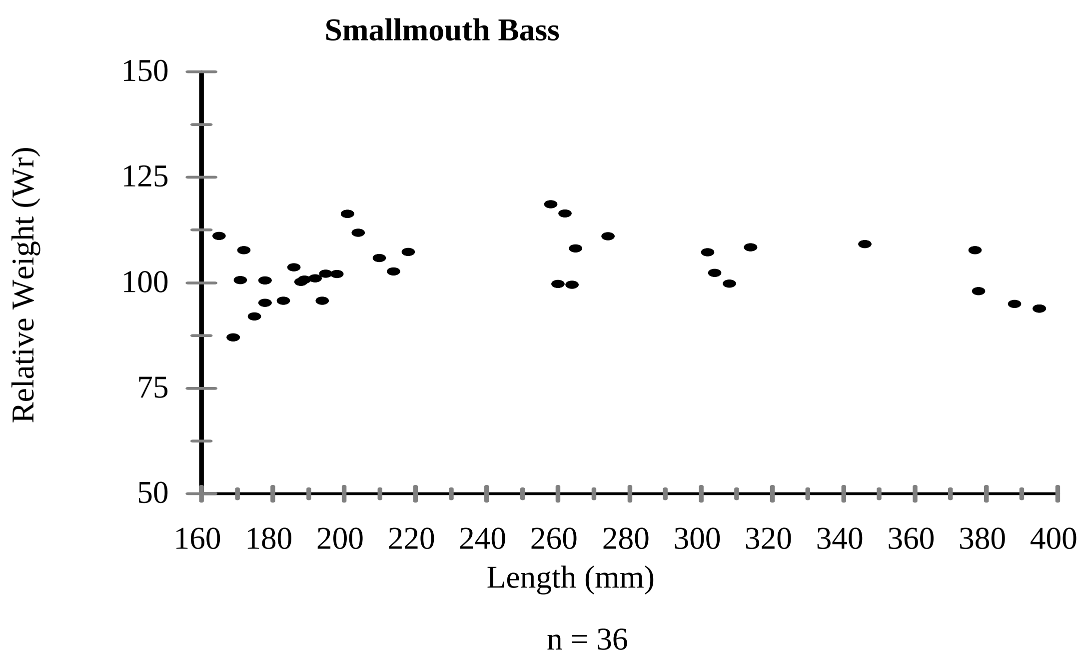

Figure 11. Relative weights for smallmouth bass collected at Sprague Lake, October 2003, compared to the national average W_r = 100 (Anderson and Neumann 1996).

Walleye

A total of 572 walleye were collected during this survey; the majority (85%), and the largest fish were collected in gill nets (Figure 12). Walleye ranged in size from 296-722 mm and most fish (86%) were of harvestable size ($\geq$ 16 in.) (Figure 12). Walleye ranged in age from 1 to 15 years; however, no age 12 or 13 walleye were collected and the majority (65%) were age 5 or 6 (Figure 13). Walleye were in fair condition and relative weights averaged 98, slightly below the national average (Figure 14). We were unable to determine the sex of 32 walleye. These fish were YOY, and gonad and visceral fat weights were less than 1 gram. Of fish in which the sex could be determined, 64 percent (n = 313) were male and 36 percent (n = 177) were female. Female walleye were larger than males (with regard to length and weight), had more visceral fat, and had heavier gonads ($p < .0005$). While collecting and weighing visceral fat, we noted that a large number of walleye had crappie in their stomach, which appeared to be age zero and one fish.

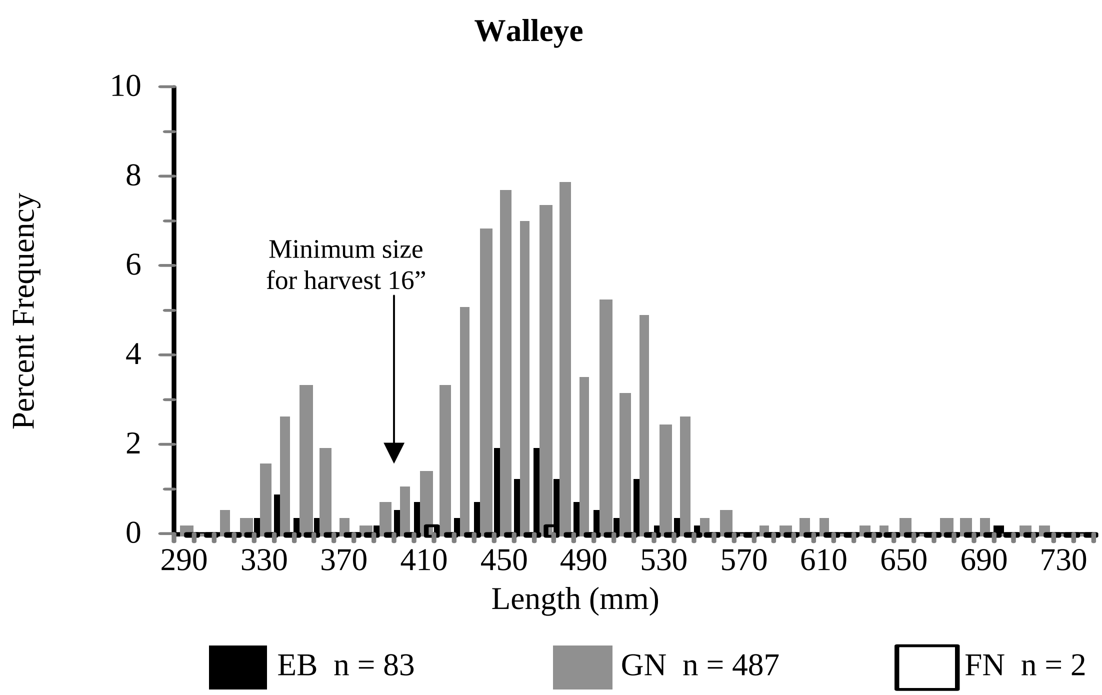

Figure 12. Length frequencies of walleye collected using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Sprague Lake, October 2003.

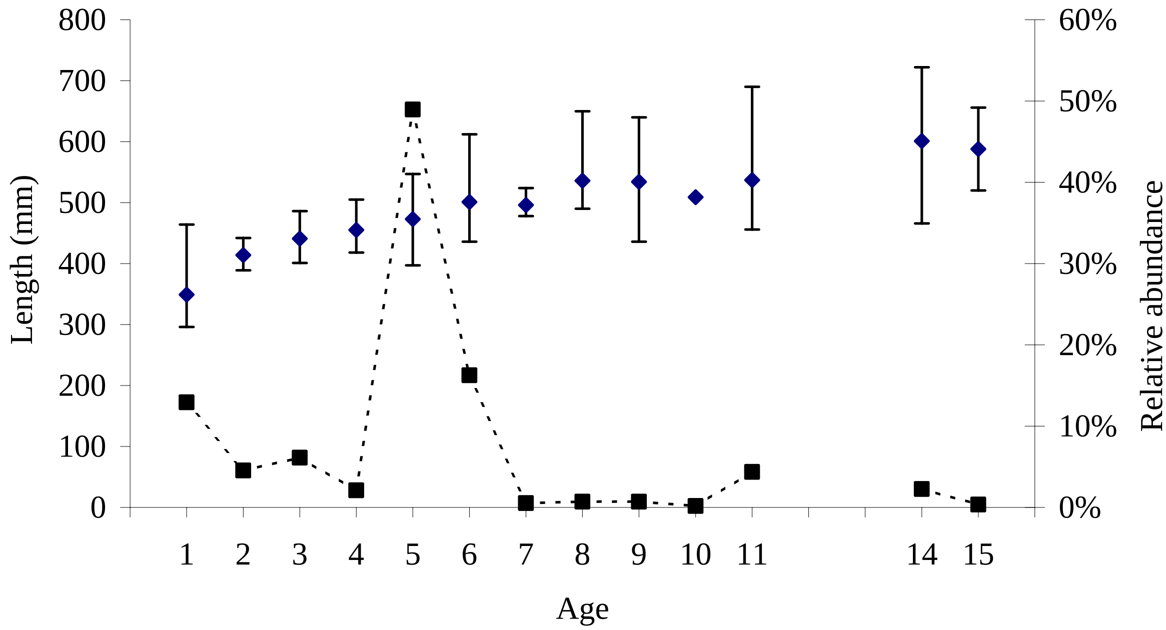

Figure 13. Average length of walleye collected at Sprague Lake, October 2003. Diamonds indicate mean length for each age class while bars indicate minimum and maximum length of each age class. Dashed lines indicate relative abundance of each age class (no age 12 or 13 fish were collected).

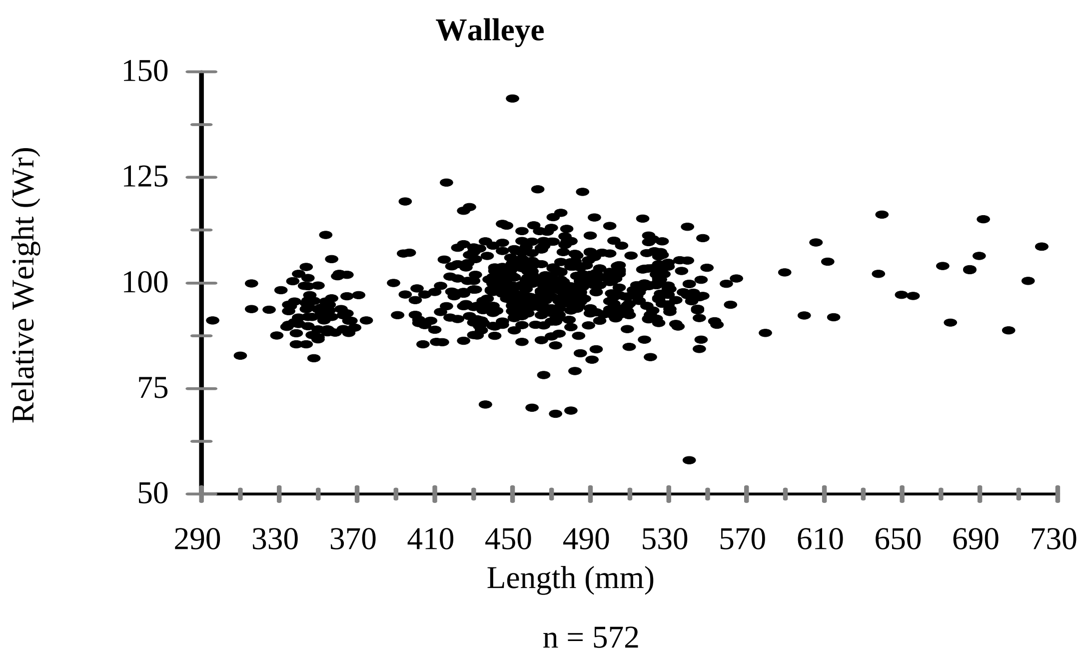

Figure 14. Relative weights for walleye collected at Sprague Lake compared to the national average W_r = 100 (Anderson and Neumann 1996).

Rainbow trout, brown bullhead, channel catfish, and carp

Only 15 rainbow trout were collected during this survey despite the fact that approximately 25,000 catchables and 45,000 fingerlings were stocked between 2002 and 2003. Rainbow trout ranged in size from 378-539mm, and the majority were collected in gill nets. Rainbow trout are difficult to capture using a boat electrofisher due to erratic swimming behavior when in the electrical field, therefore electrofishing CPUE does not provide an accurate index of this population's abundance. Rainbow trout may serve as forage for walleye, undergo high rates of exploitation, and exhibit low survival rates. The rainbow trout fishery in Sprague Lake is managed as a put-and-take fishery; therefore, we are not concerned by low abundance of rainbow trout in the fall.

A total of 54 brown bullhead were collected during this survey. Brown bullhead ranged in size from 67-418 mm, and the majority (51%) were collected in fyke nets. Brown bullhead were stocked in Sprague Lake in the 19th and early 20th century along with yellow perch, largemouth bass, black crappie, tench, and carp (Duff 1977). A 1979 electrofishing survey found that brown bullhead were second in abundance behind yellow perch (Willms et al. 1989). From 1977 to 1982, desirable warmwater gamefish (i.e. largemouth bass, black crappie) declined in abundance based on creel surveys conducted by Jackson (1984), while brown bullhead increased in the creel from 50 percent to 90 percent in 1981. In October 1985, WDW rehabilitated Sprague Lake in order to reduce undesirable species (i.e. carp, tench, brown bullhead). In addition, WDW began an intensive stocking program in order to re-establish desirable species and to reduce undesirable species that survived the rehabilitation (Willms 1989). It was hoped that stocking adult predatory gamefish (i.e. walleye, largemouth bass) would help reduce undesirable species. It appears as though brown bullhead have failed to establish a sizeable population in Sprague Lake and likely contribute little to this fishery.

Only 12 channel catfish were collected during this survey. Catfish ranged in size from 365-712 mm, and all but one fish were collected in gill nets. Among the three gear types we use, gill nets are the most efficient gear type for collecting channel catfish. Electrofishing is not a preferred method for capturing channel catfish because catfish do not respond in the same manner as most other fishes. Catfish often rise to the anode slowly, and are often seen floating behind the boat; therefore, electrofishing catch rates are often low. Catfish averaged 3.5 kg and most fish were greater than 620 mm (24 inches) (Table 3). Channel catfish were originally stocked to control undesirable species and to provide angling opportunity. Catfish are no longer stocked in Sprague Lake and likely make up a small part of the creel.

We collected 169 carp during this survey. A total of 307 Kg of carp were collected which made up 26 percent of the biomass of fish collected (Table 3). Carp are problematic in lakes due, in part, to their feeding habits. Carp disturb the substrate when they feed and spawn which decreases water clarity. This often has a negative impact on fish that rely on sight to feed (i.e. bass and panfish species) and reduces available sunlight for submergent plant species. In addition, carp are highly fecund and large year classes can quickly over-utilize available resources. Carp need to be monitored in order to detect changes in abundance and predict future problems before they arise. Springtime carp removal efforts (e.g. gill netting or seining in spawning areas) may setback this population and prevent carp from becoming problematic. Tench are problematic in lakes for the same reasons as carp. In addition, tench also negatively impact other fish species due to their wide-ranging diet. A study conducted by Bekliogu & Moss (1998) showed that selective predation by tench on gastropods can cause an increase in periphyton (algal) abundance. Gastropods keep periphyton under control by grazing. If this behavior occurs significantly, it can have a negative impact on aquatic communities. Tench were not collected in large quantities during this survey; however, we likely don't sample tench in relation to their abundance.

Conclusions

This survey was conducted, in part, to address concerns that the walleye population in Sprague Lake had declined significantly. Anglers reported that walleye catch rates had declined and resort owners were reporting that fewer anglers were utilizing their facilities (likely because of poor fishing). Based on the results of this survey, walleye are abundant and most fish in the population are of harvestable size (16 inches). Anglers may have a difficult time catching walleye if prey is abundant. The majority of bluegill, black crappie and largemouth bass collected were less than five inches, which is an optimal size range for walleye to consume.

The lack of age one yellow perch may be an indication that YOY over-winter survival is extremely low. This may be due to predation by walleye, smallmouth and largemouth bass, or another limiting factor such as zooplankton abundance. These gaps in data may be an accurate reflection of this population or simply an indication of inadequate sampling for this small population. As mentioned previously, black crappie was the most abundant species collected during this survey, and it is possible that black crappie are out-competing yellow perch for food which would result in below average condition.

During this survey, we collected no black crappie older than age two. The paucity of black crappie above age two is due to either exploitation of large fish, or predation. Exploitation on black crappie in Sprague Lake from December 2000 to February 2001 was estimated between 77,000 and 128,000 fish. These data indicated that nearly all black crappie were 170mm - 210mm, and were likely age two fish. (Korth, unpublished data 2001). In 1999, Taylor and Scholz found the majority of black crappie in Sprague Lake were < 170 mm and were age two or less. In 2004, a creel limit of ten fish a day and a nine-inch minimum size was placed on black crappie in Sprague Lake in order to allow more fish to recruit to older age classes. Future warmwater surveys will help us determine if natural mortality is limiting abundance of large black crappie since more fish will escape harvest and recruit to older age classes.

The largemouth bass population in Sprague Lake should be monitored in order to determine if three missing age classes of fish results in the loss of this species from the lake. At the time of this survey the largemouth bass population was comprised primarily of age one fish. Very few mature fish were collected and it may take several years for this species to recover if it does at all.

The fish community in Sprague Lake may be regulated by a bottom-up food chain. If so, macro invertebrate abundance, carp and panfish populations need to be monitored in order to determine and predict effects on the walleye population. Walleye abundance is likely linked to panfish abundance. Panfish populations contained few fish; however, relative weights were above average, indicating that food resources are not limiting. If panfish populations continue to decline, we may see an increase in catch of walleye. However, if harvest does not remove adequate numbers of walleye we may see panfish numbers decline severely which could soon be followed by a decline in walleye due to a lack of forage. If the walleye population is the primary determinant controlling prey fish populations (i.e. yellow perch, bluegill, black crappie) these populations will continue to decline until the walleye population lacks adequate forage. Once this occurs we will, at best, see missing or weak year classes that will affect the size distribution of the walleye population. At worst, we will see the walleye population crash due to reduced forage. Lower adult walleye densities will allow prey populations to recover unless carp and tench reduce primary and secondary productivity to a point that inhibits this recovery.

Anglers should be informed about the negative effects of excessive catch-and-release angling on walleye and other primary predators. An increase in the carp population will have detrimental effects on the panfish population due to negative impacts on vegetation and increased water turbidity. Carp monitoring and periodic removal efforts may remove the need for future rehabilitations of Sprague Lake. Commercial carp fishermen can target carp effectively; in addition, cove rotenone operations are effective at reducing carp when they are congregated in shallow water in spring. We recommend a follow-up survey be conducted in fall 2005 to coincide with the FWIN walleye collection in order to compare catch rates and other data from this survey.

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Glossary

Catch Per Unit Effort (CPUE): Is defined as the number of fish captured by a sampling method (i.e., electrofisher, gill nets, or fyke nets) divided by the amount of time sampled.

Confidence Interval (CI): Is defined as an estimated range of values which is likely to include an unknown population parameter with a percentage or degree of confidence.

Memorable Size: Is defined as fish anglers remember catching, and also identified as 59-64 percent of the world record length. Memorable length varies by species.

Preferred Size: Is defined as the size fish anglers preferred to catch when given a choice, and also identified as 45-55 percent of world record length. Preferred length varies by species.

Proportional Stock Density (PSD): Is defined as the number of quality length fish and larger, divided by the number of stock sized fish and larger, multiplied by 100.

Quality Length: Is defined as the length at which anglers begin keeping fish. Also identified as 36-41 percent of world record length. Quality length varies by species.

Relative Stock Density (RSD): Is defined as the number of fish of a specified length category (preferred, memorable, or trophy) and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Preferred Fish (RSD-P): Is defined as the number of fish in the preferred size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Memorable Fish (RSD-M): Is defined as the number of fish in the memorable size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Trophy Fish (RSD-T): Is defined as the number of fish in the trophy size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Weight (W_r): The comparison of the weight of a fish at a given size to the national average weight (W_r = 100) of fish of the same species and size.

Standard Weight (W_s): Is defined as a standard or average weight of a fish species at a given length determined by a national length-weight regression.

Stock Length: Is defined by the following: 1) approximate length of fish species at maturity, 2) the minimum length effectively sampled by traditional sampling gears, 3) minimum length of fish that provide recreational value, and 4) 20-26 percent of world record length. Stock length varies by species.

Total Length (TL): Length measurement from the anterior most part of the fish to the tip of the longest caudal (tail) fin ray (compressed).

Trophy Size: Minimum size fish worthy of acknowledgment, and identified as 74-80 percent of world record length. Trophy length varies by species.

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