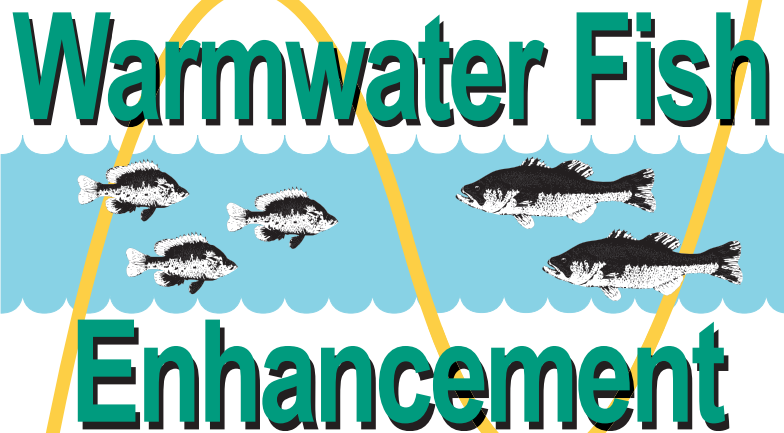


# 2001 Warmwater Fisheries Survey of Hutchinson and Shiner Lakes, Adams County, Washington



## Warmwater Fish Enhancement

by Michael R. Schmuck, Marc R. Petersen,  
and Randall S. Osborne



Washington Department of  
**FISH AND WILDLIFE**  
Fish Program  
Fish Management Division



# **2001 Warmwater Fisheries Survey of Hutchinson and Shiner Lakes, Adams County, Washington**

By

Michael R. Schmuck, Marc R. Petersen, and Randall S. Osborne  
Warmwater Enhancement Program  
Washington Department of Fish and Wildlife  
1550 Alder Street NW  
Ephrata, Washington 98823

**August 2005**



## Acknowledgments

---

We would like to thank Joe Miller and Kamia Knuttgen for their editorial comments on this report. We would also like to thank our Scientific Technician, Brian Jacobs. We are also grateful to Lucinda Morrow, from the WDFW Fish Aging Lab, who aged fish from this survey, and David Bramwell, for formatting the final draft of this report.

## Abstract

---

Hutchinson and Shiner lakes, Adams County, Washington were sampled between October 15-24, 2001, using a boat electrofisher, gill nets, and fyke nets. Six fish species were observed during sampling efforts. Largemouth bass *Micropterus salmoides*, black crappie *Pomoxis nigromaculatus*, bluegill *Lepomis macrochirus*, and pumpkinseed sunfish *L. gibbosus* were found in both lakes. Yellow perch *Perca flavescens* were found in Hutchinson Lake only, while rainbow trout *Onchorhynchus mykiss* were found only in Shiner Lake. Warmwater gamefish comprised 100% of the fish collected in Hutchinson Lake and 99.9% of the fish captured in Shiner Lake. Bluegill was the most abundant species captured in both Hutchinson (75.5%) and Shiner (78.8%) lakes. Bluegill also comprised the majority of the total biomass collected in both Hutchinson (63.4%) and Shiner (65.8%) lakes.

Bluegill age ranged from one to four years in Hutchinson Lake, with the majority being age two. Bluegill in Shiner Lake ranged from 1 to 5 years, however only one age 5 fish was sampled. The majority of bluegill in Shiner Lake were age 2. Bluegill were in good condition in both lakes, with most fish being at or above the national average in relative weight.

Largemouth bass was second in abundance in both lakes. Largemouth bass ranged in age from 1 to 7 years in Hutchinson Lake. The majority of bass were age 1 and 2. Largemouth bass in Shiner Lake ranged from 1 to 4 years of age. As with Hutchinson Lake, the majority of bass were age 1 and 2. Age 2 largemouth bass had relative weights slightly below the national average, but fish younger and older than age 2 had relative weights greater than the national average.

Both Hutchinson and Shiner lakes are managed for panfish fishing. Sampling indicated that predator/prey ratios are in proper proportions for quality panfish fishing (Swingle 1950). We recommend monitoring these lakes every three to four years in order to assure that fish populations do not become unbalanced. In addition, we would encourage that a creel survey be conducted in order to assess exploitation on this fishery.

# Table of Contents

---

Abstract.....	ii
List of Tables .....	iv
List of Figures.....	v
Introduction and Background .....	1
Materials and Methods.....	5
Lake Comparisons .....	7
Results and Discussions.....	8
Species Composition.....	8
Young of the year fish (YOY) .....	9
Catch Per Unit Effort (CPUE) .....	9
Hutchinson Lake .....	10
Shiner Lake .....	10
Stock Density Indices .....	11
Hutchinson Lake .....	11
Shiner Lake .....	12
Lake Comparisons for PSD and Length .....	12
Water Chemistry .....	14
Largemouth Bass .....	15
Bluegill.....	19
Yellow Perch.....	23
Black Crappie.....	25
Pumpkinseed Sunfish.....	29
Conclusions and Management Options .....	32
Literature Cited.....	33
Glossary .....	35

## List of Tables

---

Table 1.	Summary of fish stocked in Hutchinson and Shiner lakes from 1998 to 2000.....	4
Table 2.	Minimum total length (mm) categories of warmwater fish used to calculate PSD and RSD values (Willis et al. 1993).....	7
Table 3.	Species composition by weight, number, and size range of fish captured at Hutchinson Lake during a warmwater fish survey October 15-24, 2001 .....	8
Table 4.	Species composition by weight, number, and size range of fish captured at Shiner Lake during a warmwater fish survey October 15-24, 2001. ....	8
Table 5.	Mean catch per unit effort by sampling method, including 80% confidence intervals (CI), for fish collected from Hutchinson Lake October 15-24, 2001.....	10
Table 6.	Mean catch per unit effort by sampling method, including 80% confidence intervals (CI), for fish collected from Shiner Lake October 15-24, 2001.....	10
Table 7.	Stock density indices, including 80% confidence interval, for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Hutchinson Lake during October 15-24, 2001 .....	11
Table 8.	Stock density indices, including 80% confidence intervals, for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Shiner Lake during October 15-24, 2001 .....	12
Table 9.	Water chemistry data from Hutchinson Lake collected during a warmwater fish survey in October 2001.....	14
Table 10.	Water chemistry data from Shiner Lake collected during a warmwater fish survey in October 2001.....	14
Table 11.	Age and growth of largemouth bass captured at Hutchinson Lake during October 2001.....	15
Table 12.	Age and growth of largemouth bass captured at Shiner Lake during October 2001 ...	16
Table 13.	Age and growth of bluegill captured at Hutchinson Lake during October 2001 .....	19
Table 14.	Age and growth of bluegill captured at Shiner Lake during October 2001 .....	20
Table 15.	Age and growth of yellow perch captured at Hutchinson Lake during October 2001.....	23
Table 16.	Age and growth of black crappie captured at Hutchinson Lake during October 2001.....	25
Table 17.	Age and growth of black crappie captured at Shiner Lake during October 2001.....	26
Table 18.	Age and growth of pumpkinseed sunfish captured at Hutchinson Lake during October 2001.....	29
Table 19.	Age and growth of pumpkinseed sunfish captured at Shiner Lake during October 2001.....	29



## List of Figures

---

Figure 1.	Map of Hutchinson and Shiner lakes near Othello, WA. ....	3
Figure 2.	Length frequencies of largemouth bass sampled using a boat electrofisher (EB), and gill nets (GN) on Hutchinson Lake during October 2001.....	17
Figure 3.	Length frequencies of largemouth bass sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.....	17
Figure 4.	Relative weights for largemouth bass sampled at Hutchinson Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	18
Figure 5.	Relative weights for largemouth bass sampled at Shiner Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	18
Figure 6.	Length frequency of bluegill captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Hutchinson Lake during October 2001. ....	21
Figure 7.	Length frequency of bluegill captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001. ....	21
Figure 8.	Relative weights for bluegill sampled at Hutchinson Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	22
Figure 9.	Relative weights for bluegill sampled at Shiner Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	22
Figure 10.	Length frequency of yellow perch captured while using fyke nets (FN) on Hutchinson Lake during October 2001. ....	24
Figure 11.	Relative weights for yellow perch sampled at Hutchinson Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	24
Figure 12.	Length frequency of black crappie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Hutchinson Lake during October 2001.....	27
Figure 13.	Length frequency of black crappie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.....	27
Figure 14.	Relative weights for black crappie sampled at Hutchinson Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	28
Figure 15.	Relative weights for black crappie sampled at Shiner Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). ....	28
Figure 16.	Length frequency of pumpkinseed sunfish captured while using a boat electrofisher (EB), and gill nets (GN) on Hutchinson Lake during October 2001. ....	30
Figure 17.	Length frequency of pumpkinseed sunfish captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.....	30
Figure 18.	Relative weights for pumpkinseed sunfish sampled at Hutchinson Lake, October 2001, compared to the national average $W_r = 100$ (Anderson and Neumann 1996). .	31

Figure 19. Relative weights for pumpkinseed sunfish sampled at Shiner Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996). ..... 31

# Introduction and Background

---

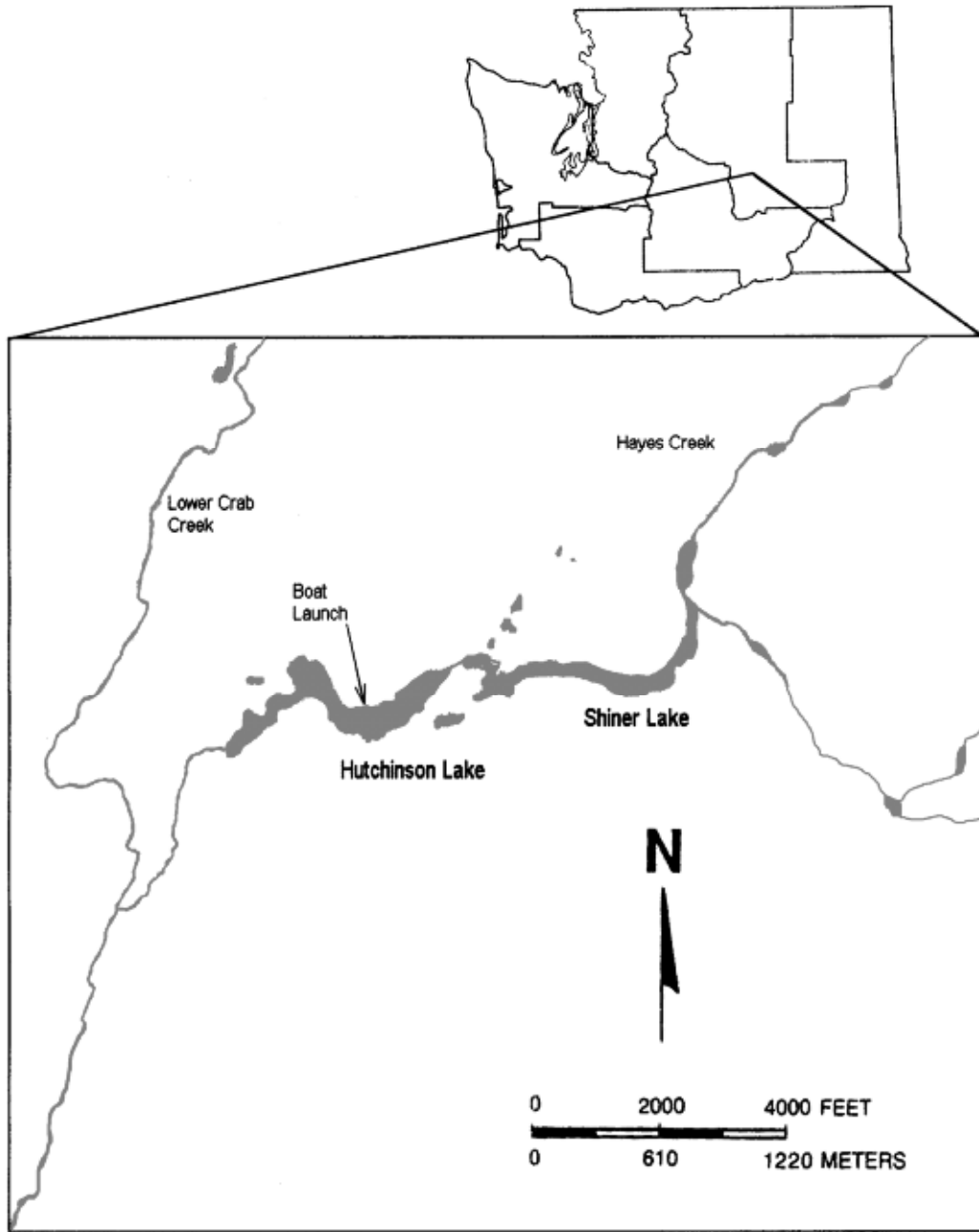
Hutchinson and Shiner lakes are located approximately four miles west of Othello, WA. These lakes are fed by Hayes and Coyote creeks and are a part of the Seep Lakes chain that originates south of Potholes Reservoir. Hutchinson and Shiner lakes, combined, have a surface area of 33.6 ha, a mean depth of 3.5 m and a volume of 616,741 m<sup>3</sup>. Water drains from Shiner Lake into Hutchinson Lake via a small channel approximately 50 m long. Fish can easily move from one lake to the other over much of the year, except under low water conditions. The shoreline of both lakes is comprised of emergent vegetation, bulrush *Scirpus spp.*, cattail *Typha latifolia*, sedge *Carex spp.* and talus cliffs in approximately equal amounts. Aquatic vegetation found in the lake include water milfoil *Myriophyllum spp.*, pondweed *Potamogeton spp.*, and filamentous algae. The soil surrounding Hutchinson and Shiner lakes is alkaline and supports plants such as saltgrass *Distichlis stricta*, and greasewood *Sarcobatus vermiculatus* as well as many other common shrub-steppe species such as big sagebrush *Artemisia tridentata*, green and grey rabbitbrush *Ericameria spp.*, and a variety of grass species. In addition to fish species, Hutchinson and Shiner lakes host various birds, such as great blue heron *Ardea herodias*, gulls *Larus spp.*, and terns *Sterna spp.*, and small mammals including beaver *Castor canadensis* and raccoon *Procyon lotor*.

From 1998 to 2000, the Washington Department of Fish and Wildlife (WDFW) stocked largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, rainbow trout *Onchorhynchus mykiss*, and Lahontan cutthroat trout *O. clarki henshawi* in Hutchinson and Shiner Lake (Table 1).

Hutchinson and Shiner lakes are managed using statewide general freshwater species rules set forth by the WDFW. Both lakes open for fishing on April 1 and close on September 30 each year. Anglers are authorized to operate boats on both lakes; however, the use of gas engines is prohibited.

The last rehabilitation of both Hutchinson and Shiner lakes occurred in March 1998. After the rehabilitation, fish barriers were installed on Hayes Creek (Hutchinson Lake outlet) to prevent the migration of carp into Hutchinson Lake. This work was completed by Doug Fletcher (WDFW), Chad Jackson (WDFW), and U.S. Fish and Wildlife Service (USFWS) personnel. The WDFW and USFWS continue to work together with landowners to make improvements around the barriers.

Both Hutchinson and Shiner lakes are contained almost entirely within the Columbia National Wildlife Refuge (CNWR). The land at the west end of Hutchinson Lake is owned by Dwayne Michaels, Othello, WA. The WDFW manages the fishery within these lakes; however, the boat launch and associated infrastructure is managed and maintained by USFWS.



**Figure 1.** Map of Hutchinson and Shiner lakes near Othello, WA.

**Table 1.** Summary of fish stocked in Hutchinson and Shiner lakes from 1998 to 2000.

Year	Species	Size	Number
1998	Largemouth bass	Adults	10
		Juveniles	1,010
	Bluegill	Adults	17
		Fingerlings	94
		Fry	22,845
	Black crappie	Adults	583
		Fingerlings	11,270
	Rainbow trout	Fingerlings	8,037
	Lahontan cutthroat	Fingerlings	6,392
1999	Largemouth bass	Adults	242
		Juveniles	1,348
		Fry	912
	Bluegill	Adults	1,435
		Juveniles	1,068
		Fry	53,021
	Black crappie	Adults	1
		Juveniles	5
		Fry	2,030
2000	Rainbow trout	Fingerlings	20,264

## Materials and Methods

---

Hutchinson and Shiner lakes were surveyed by a three-person team October 15-24, 2001. All fish were collected using a boat electrofisher, gill nets, and fyke nets. The electrofisher unit consisted of a 5.5 m Smith-Root GPP electrofisher boat with a DC current of 60 cycles/sec at 3 to 4 amps power (Bonar et al. 2000). Experimental gill nets (45.7 m x 2.4 m) were constructed of variable size (13, 19, 25, and 51 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. Fyke net material was constructed of 13 mm nylon mesh.

Sampling locations were selected by dividing the shoreline into 400 m sections determined from a map. The number of randomly selected sections surveyed in each lake are as follows: electrofisher 8, gill nets 4, and fyke nets 4. 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 with the small mesh end attached on or near the shore and the large-mesh end anchored offshore. Fyke nets were set perpendicular to the shoreline with the wings extended at 70° angles from the lead. Gill nets and fyke nets were set overnight, prior to electrofishing, and were pulled the following morning (1 net night each). All sampling was conducted at night, when fish are typically found along the shoreline, thus maximizing the efficiency of each gear type.

Fish were identified to species, measured in millimeters (mm) to total length (TL) from the anterior most part of head to the tip of the compressed caudal fin, and weighed to the nearest gram (g). Total length data were used to construct length-frequency histograms and to evaluate the size structure of the warmwater species in the lake. Warmwater fish species 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). Scale samples were mounted on adhesive data cards and pressed onto acetate slides using a Carver® laboratory press (Fletcher et al. 1993). Lucinda Morrow (WDFW Scale Lab) aged fish from this survey using scales that were collected.

Water chemistry data were collected in both lakes at 1 m increments from the area of greatest depth. A Hydrolab® was used to collect information on dissolved oxygen (milligrams per liter, mg/l), temperature (degrees Celsius, °C), pH, and conductivity (micro siemens per centimeter,  $\mu\text{S}/\text{cm}$ ). In addition, we measured water clarity using a secchi disc.

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, method, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE) of each gear type was determined for each warmwater fish species collected. Electrofisher CPUE was determined by dividing the number of fish captured by the total amount of time electrofished. The CPUE's for gill nets and fyke nets were standardized, and determined by dividing the total number of fish captured by the total number of nights each gear was 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. As presented by Anderson and Neumann (1996), a  $W_r$  of 100 indicates that the fish is in a condition similar to the national average for that species and 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). The standard weight 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, as the 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 fish species were evaluated using procedures described by Fletcher et al. (1993). Fish from which scales were taken 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).

Proportional stock density (PSD) of each warmwater fish species was determined following procedures outlined in Anderson and Neumann (1996). Proportional stock density 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 (Table 2). Quality length is the minimum size of a fish that most anglers like to catch or begin keeping (Table 2). Proportional stock density is calculated using the number of quality sized fish, divided by the number of stock sized fish, multiplied by 100. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths (Anderson and Weithman 1978). Stock length is 20-26% of the world record length, whereas quality length is 36-41% 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 2). 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 (Anderson and Weithman 1978). Preferred length is 45-55% of world record length, memorable length is 59-64% of world record length, and trophy length is 74-80% of world record length. Relative stock density differs from PSD in that it is more sensitive to changes in year class strength. Relative stock density 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 were selected from tables in Gustafson (1988).

## Lake Comparisons

Throughout this paper we report data from each lake separately. We compared length, and PSD between lakes for species that provided adequate samples (i.e. largemouth bass and bluegill) in order to determine if we could combine data from each lake in the future, and treat both lakes as one system. There are size and species biases associated with each gear type (Pope and Willis 1996); therefore, we analyzed length and PSD data for each species separately by gear type. Lengths were compared using a two-sample t-test, and PSD's were compared using a Chi-square test for proportions. An alpha level of .05 was selected for all statistical tests (Zar 1996).

**Table 2.** Minimum total length (mm) categories of warmwater fish used to calculate PSD and RSD values (Willis et al. 1993).

Species	Stock	Quality	Length Category		
			Preferred	Memorable	Trophy
Black crappie	130	200	250	300	380
White crappie	130	200	250	300	380
Bluegill	80	150	200	250	300
Yellow perch	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
Yellow bullhead	150	230	300	390	460

## Results and Discussions

### Species Composition

A total of six fish species were collected during sampling efforts on Hutchinson and Shiner lakes (Tables 3 and 4). Five species were found in both lakes. Yellow perch were sampled in Hutchinson Lake only, while rainbow trout were only found in Shiner Lake. Warmwater gamefish comprised 100% of the total fish captured on Hutchinson Lake. Warmwater gamefish comprised 99.8% of the total fish captured and 97.9% of the total biomass on Shiner Lake. Bluegill was the most abundant species present in both Hutchinson (75.5%) and Shiner (78.8%) lakes. Largemouth bass was second in abundance, comprising 21.3% of the catch in Hutchinson Lake and 18.7% of the catch in Shiner Lake.

**Table 3.** Species composition by weight, number, and size range of fish captured at Hutchinson Lake during a warmwater fish survey October 15-24, 2001.

Species	Species Composition					
	Weight		Number		Size Range (mm TL)	
	kg	%	No.	%	Min.	Max
Black crappie	2.55	2.24	30	2.51	149	222
Bluegill	72.79	63.97	902	75.48	66	222
Largemouth bass	37.23	32.72	254	21.26	129	473
Pumpkinseed sunfish	0.14	0.13	4	0.33	105	130
Yellow perch	1.08	0.95	5	0.42	203	276

**Table 4.** Species composition by weight, number, and size range of fish captured at Shiner Lake during a warmwater fish survey October 15-24, 2001.

Species	Species Composition					
	Weight		Number		Size Range (mm TL)	
	kg	%	No.	%	Min.	Max
Black crappie	0.36	0.38	7	0.61	119	183
Bluegill	62.73	65.88	907	78.80	62	204
Largemouth bass	29.57	31.06	215	18.68	123	393
Pumpkinseed sunfish	0.59	0.62	20	1.74	83	136
Rainbow trout	1.96	2.06	2	0.17	427	457

In 2001, bluegill were found in higher proportion to which they were stocked in Hutchinson and Shiner lakes from 97-99 (Table 1). Bluegill represented 80% of our sample, of fish that were stocked (i.e. black crappie, bluegill, and largemouth bass); bluegill represented 60% of the fish stocked in Hutchinson and Shiner lakes between 1998 and 2000. Black crappie represented 0.6% of our sample, of stocked fish, in 2001, while they represented 10.6% of fish stocked between 1998 and 2000. Largemouth bass comprised 19% of our sample, of stocked fish, in 2001, while they represented 2.7% of the number of fish stocked from 1998 to 2000. The most noticeable difference between stocking rate and our sampling was found with rainbow trout. Between 1998 and 2000, rainbow trout comprised 21.7% of the fish stocked in Hutchinson and Shiner lakes. Rainbow trout accounted for only 0.08% of our total catch of stocked fish. This may be accounted for by the fact that rainbow trout were stocked in 1998 and 2000 as fingerlings. These fish may have simply been forage for the 2,610 largemouth bass that were stocked during the same time period. These trout may have also been harvested by anglers or simply suffered from some unknown mortality.

## **Young of the year fish (YOY)**

We exclude YOY fish from our analyses due to distortions that may occur due to sampling location, method, and specific timing of hatches (Fletcher et al. 1993). Abundance of YOY fish gives us an indication of the amount of natural reproduction that is occurring in a system. Relatively few YOY fish were collected during this survey. We collected 57 YOY largemouth bass, and 2 YOY yellow perch in Hutchinson Lake. In Shiner Lake we collected 19 YOY largemouth bass and 4 YOY bluegill. This may be an indication that very little production is occurring, or that we are not sampling YOY effectively.

## **Catch Per Unit Effort (CPUE)**

Whether using active (electrofishing) or passive (gill netting or fyke netting) techniques to sample a lake or reservoir, CPUE can be a useful index to monitor size structure and relative abundance (Hubert 1996). With the exception of yellow perch, more fish were captured by electrofishing in both Hutchinson and Shiner lakes than by gill or fyke nets. Typically, yellow perch are captured more effectively in gill nets; however, during this survey yellow perch were only caught in fyke nets. This was likely due to their limited distribution, not a bias among particular gear.

## Hutchinson Lake

Electrofisher catch rates on Hutchinson Lake were highest for bluegill and largemouth bass (Table 5). Gill net and fyke net catch rates were highest for bluegill. Fyke nets captured the only yellow perch collected during this survey.

**Table 5.** Mean catch per unit effort by sampling method, including 80% confidence intervals (CI), for fish collected from Hutchinson Lake October 15-24, 2001.

Species	Electrofisher			Gear Type Gill Nets			Fyke Nets		
	No./	CI	No.	No./ Net	CI	Net	No./ Net	CI	Net
	Hour	(+/-)	Sites	Night	(+/-)	Nights	Night	(+/-)	Nights
Black crappie	13.49	7.08	8	0.25	0.32	4	2.75	2.42	4
Bluegill	579.98	108.05	8	5.25	1.21	4	26.75	14.32	4
Largemouth bass	184.24	40.09	8	2.00	0.91	4	0.00	0.00	4
Pumpkinseed sunfish	2.25	2.02	8	0.25	0.32	4	0.00	0.00	4
Yellow perch	0.00	0.00	8	0.00	0.00	4	1.25	0.61	4

## Shiner Lake

Electrofisher catch rates were highest for bluegill and largemouth bass (Table 6). Gill net catch rates were low, but similar, for all species with the exception of largemouth bass. The gill net catch rate for largemouth bass was slightly higher than for other species in our sample (Table 6). The fyke net catch rate for bluegill was higher than for any other species (Table 6). Catch rates for all three gear types were similar for both lakes.

**Table 6.** Mean catch per unit effort by sampling method, including 80% confidence intervals (CI), for fish collected from Shiner Lake October 15-24, 2001.

Species	Electrofisher			Gear Type Gill Nets			Fyke Nets		
	No./	CI	No.	No./ Net	CI	Net	No./ Net	CI	Net
	Hour	(+/-)	Sites	Night	(+/-)	Nights	Night	(+/-)	Nights
Black crappie	1.69	1.40	7	0.50	0.37	4	0.75	0.61	4
Bluegill	710.40	131.06	7	0.75	0.96	4	17.00	8.00	4
Largemouth bass	175.21	31.21	7	2.00	1.17	4	0.25	0.32	4
Pumpkinseed sunfish	13.63	8.00	7	0.50	0.64	4	0.50	0.37	4
Rainbow trout	0.00	0.00	7	0.50	0.37	4	0.00	0.00	4

## Stock Density Indices

### Hutchinson Lake

Sample sizes of bluegill captured with the boat electrofisher and fyke nets allowed useful PSD estimates to be calculated. The PSD for bluegill captured while electrofishing was 40, while the PSD for bluegill captured with fyke nets was 82. These PSD's indicate that 40% of bluegill (at least stock length) captured with our electrofisher and 82% of bluegill (at least stock length) captured in fyke nets were at least 6 inches. Largemouth bass were sampled effectively with our boat electrofisher, and this gear provided the only adequate sample of stock length fish for effective PSD analysis. The PSD for largemouth bass was 16, while the RSD-P was 11 (Table 7). An RSD-P of 11 indicates that 11% of largemouth bass (at least stock length) collected were at least 15 inches. Gabelhouse et al. (1982) suggested that bass PSD's in the range of 20-40, and bluegill PSD's in the range of 50-80 were optimal if a lake or pond is being managed for a panfish fishery. Largemouth bass and bluegill PSD's are slightly outside these ranges; however, these species appear to be in proper balance.

**Table 7.** Stock density indices, including 80% confidence interval, for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Hutchinson Lake during October 15-24, 2001. PSD = proportional stock density, RSD = relative 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
<b>Electrofisher</b>					
Black crappie	18	28± 14	0	0	0
Bluegill	742	40± 2	2 ± 0.6	0	0
Largemouth bass	82	16± 5	11 ± 4.4	0	0
Pumpkinseed sunfish	3	0	0	0	0
<b>Gill Nets</b>					
Black crappie	1	0			
Bluegill	18	5.5± 7	0	0	0
Largemouth bass	1	0	0	0	0
Pumpkinseed sunfish	1	0			
<b>Fyke Nets</b>					
Black crappie	11	0	0	0	0
Bluegill	107	82± 5	11 ± 4	0	0
Yellow perch	5	100± 0	80 ± 23	0	0

## Shiner Lake

The PSD for bluegill captured with the boat electrofisher was 39, while the PSD for largemouth bass was 16 (Table 8). These PSD's are lower than desired for the panfish option described by Gabelhouse et al. (1982); however, ratios of bluegill and bass abundance are within an acceptable range. Fyke net sampling produced small sample sizes, with the exception of bluegill; however, the bluegill PSD generated from electrofishing data is likely more precise. Stock density indices, including 80% confidence intervals, for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Shiner Lake during October 15-24, 2001. PSD = proportional stock density, RSD = relative 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.

**Table 8.** Stock density indices, including 80% confidence intervals, for warmwater fishes collected using boat electrofisher, gill nets, and fyke nets in Shiner Lake during October 15-24, 2001. PSD = proportional stock density, RSD = relative 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
<b>Electrofisher</b>					
Black crappie	2	0	0	0	0
Bluegill	804	39 ± 2.2	0.87 ± 0.4	0	0
Largemouth bass	78	16 ± 5.4	1.3 ± 1.6	0	0
Pumpkinseed sunfish	16	0	0	0	0
<b>Gill Nets</b>					
Black crappie	1	0	0	0	0
Bluegill	2	0	0	0	0
Largemouth bass	3	67 ± 34.8	33 ± 34.8	0	0
Pumpkinseed sunfish	2	0	0	0	0
Rainbow trout	2	100	0	0	0
<b>Fyke Nets</b>					
Black crappie	3	0	0	0	0
Bluegill	66	33 ± 7.4	0	0	0
Pumpkinseed sunfish	2	0	0	0	0

## Lake Comparisons for PSD and Length

Bluegill and largemouth bass were the only species sampled in sufficient quantities to allow analysis. Bluegill PSDs generated from electrofishing data were similar ( $Z = 0.153$ ;  $P > 0.05$ ) for both lakes. The PSD of bluegill collected with fyke nets was higher ( $Z = 4.70$ ;  $P < 0.05$ ) in Hutchinson Lake than in Shiner Lake. Largemouth bass PSDs generated from electrofishing data were similar ( $Z = -0.075$ ;  $P > 0.05$ ) for both lakes.

Lengths of bluegill ( $t = -1.02$ ;  $P = 0.306$ ) and largemouth bass ( $t = -1.27$ ;  $P = 0.201$ ) collected while electrofishing were similar for both lakes, while lengths of bluegill collected with fyke nets were greater ( $t = 9.9$ ;  $P < 0.001$ ) in Hutchinson Lake.

Similarities in size between fish in Hutchinson and Shiner lakes, as well as connectivity, suggests that these lakes should be managed and assessed as one lake in future surveys.

## Water Chemistry

Both Hutchinson and Shiner lakes were relatively homogeneous in terms of temperature, dissolved oxygen, pH, and conductivity throughout the entire water column (Tables 9,10). Water chemistry was similar in both lakes and is combined for our assessment of the fishery; however, we report our results in two tables. Water temperature varied slightly, ranging from 12.59 to 13.44°C. Similarly, dissolved oxygen ranged from 9.93 to 11.87 mg/L and is well above the 5.0 mg/L threshold at which warmwater fish thrive (Willis et al. 1990). The pH of Hutchinson-Shiner lakes was slightly basic and ranged from 9.22 to 9.75. This is outside the desired range (7.8 - 8.9) for warmwater fish species (Swingle 1969); however, only slightly, and seems to be having no negative impact on bluegill and bass populations.

**Table 9.** Water chemistry data from Hutchinson Lake collected during a warmwater fish survey in October 2001.

Location	Depth (m)	Temp (C)	pH	Dissolved O2	Conductivity
Center lake	Surface	13.44	9.67	11.47	636
	1	12.85	9.69	11.57	636
	2	12.64	9.73	11.87	636
	3	12.60	9.75	11.47	634
	3.7	12.59	9.75	10.73	635

**Table 10.** Water chemistry data from Shiner Lake collected during a warmwater fish survey in October 2001.

Location	Depth (m)	Temp (C)	pH	Dissolved O2	Conductivity
Center lake	Surface	13.38	9.27	11.33	636
	1	13.00	9.25	10.71	638
	2	12.93	9.22	9.97	638
	3	12.90	9.22	9.93	637
	4	12.68	9.24	10.31	638



## Largemouth Bass

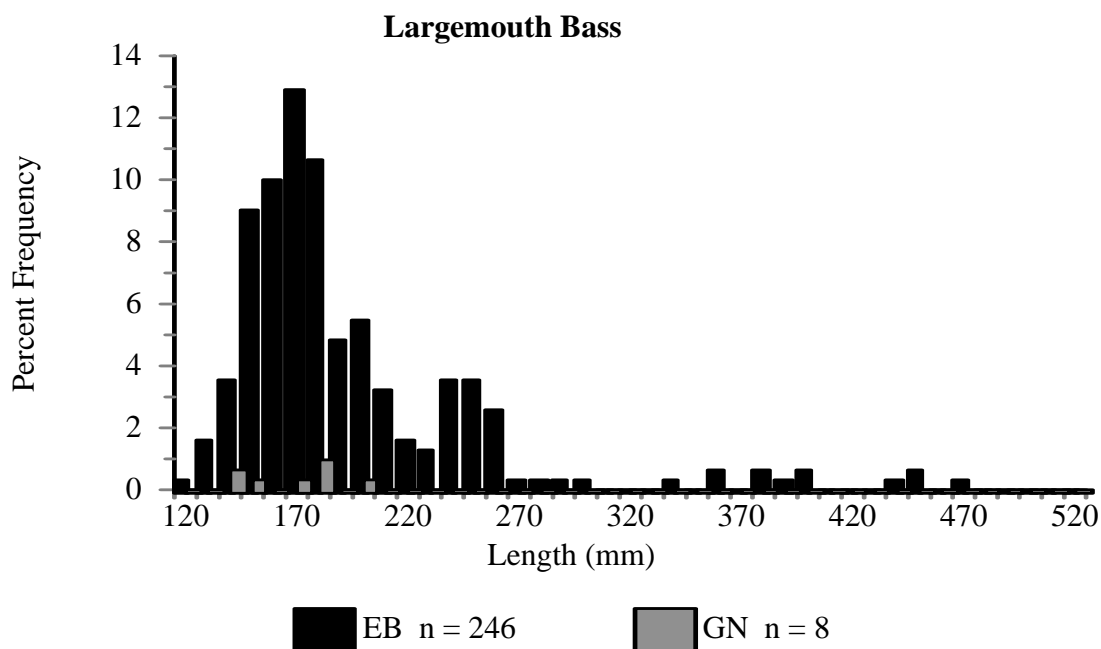
A total of 254 and 215 largemouth bass were sampled in Hutchinson and Shiner lakes, respectively, in October 2001. In Hutchinson Lake, largemouth bass ranged from 1 to 7 years of age; however, age 4 fish were absent (Table 11). In Shiner Lake, largemouth bass ranged in age from 1 to 4 years (Table 12). Age 1 fish were the most abundant age class sampled in both Hutchinson (n = 41) and Shiner Lake (n = 38), and length frequency data indicate that most fish are of harvestable size (< 12 inches)(Figures 2,3). From 1997 to 1999, 3,522 largemouth bass were stocked in Hutchinson and Shiner lakes combined (Table 1). Largemouth bass relative weights averaged 101 and 100 in Hutchinson and Shiner Lake, respectively (Figures 4,5). Growth of bass of all ages was at or above the eastern Washington average despite the fact that relative weights for bass between 2 and 3 years of age were slightly below the national average.

**Table 11.** Age and growth of largemouth bass captured at Hutchinson Lake during October 2001. 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).

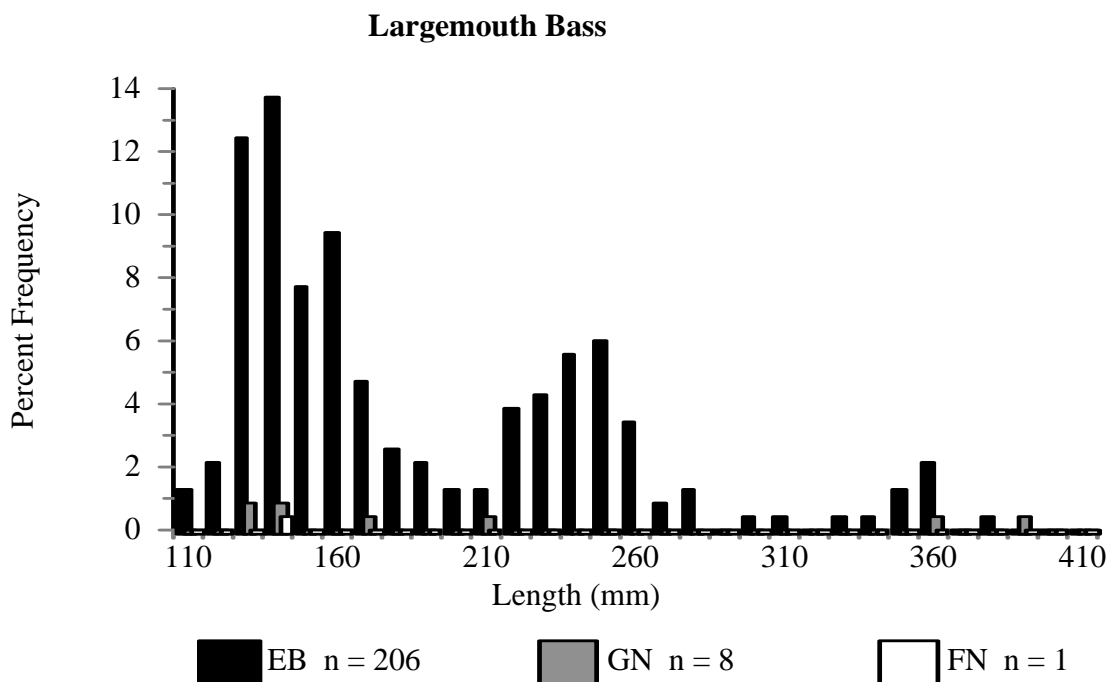
Year Class	# Fish	Mean length (mm) at age						
		1	2	3	4	5	6	7
2000	41	75.9						
		87.4						
1999	26	57.5	161.6					
		72.9	168.8					
1998	7	128.2	262.9	339.9				
		141.4	268.9	341.8				
1997	0							
1996	1	77.4	236.9	369.0	408.4	435.8		
		94.0	246.4	372.7	410.5	436.6		
1995	1	67.6	202.7	319.9	375.4	408.5	437.0	
		84.6	213.8	325.7	378.8	410.4	437.6	
1994	2	84.4	202.3	314.4	383.0	418.5	438.0	453.3
		100.7	213.5	320.7	386.3	420.2	438.9	453.5
Direct Proportion mean		81.8	213.3	335.8	389	420.9	437.5	453.3
Fraser Lee mean		87.8	193.4	339.3	390.5	421.9	438.5	453.5
Eastern WA Average (DP)		68.8	135.6	189.2	248.9	300.0	351.5	421.6

**Table 12.** Age and growth of largemouth bass captured at Shiner Lake during October 2001. 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).

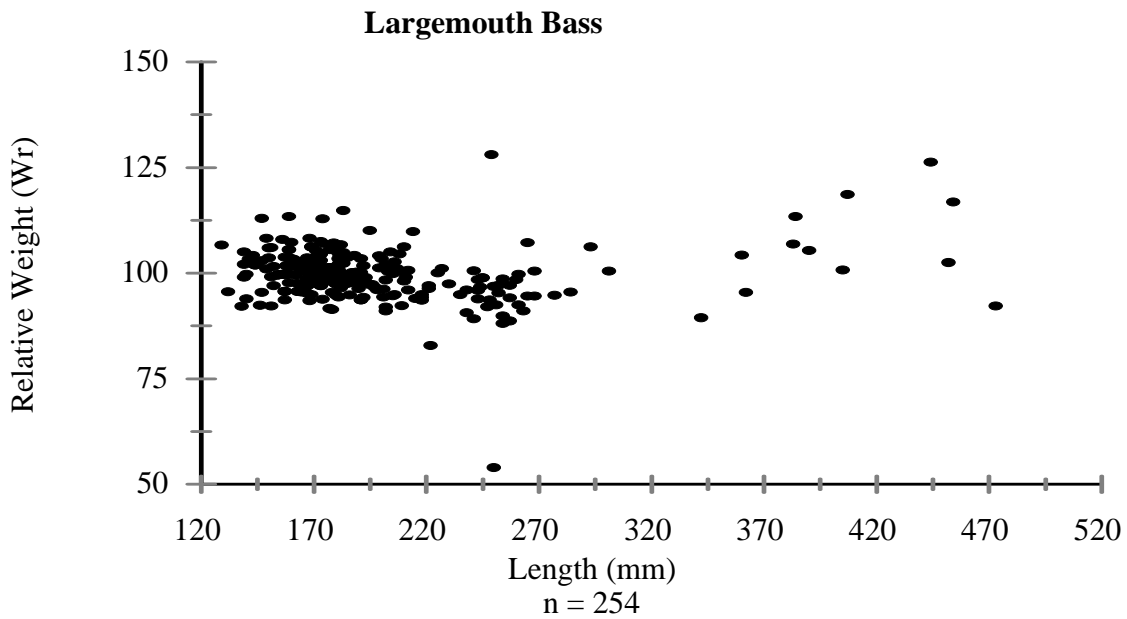
Year Class	# Fish	Mean length (mm) at age			
		1	2	3	4
2000	38	70.1			
		81.4			
1999	32	53.6	156.3		
		69.3	163.6		
1998	7	117.0	231.4	305.5	
		130.5	238.5	308.4	
1997	2	98.3	212.4	287.7	342.7
		112.8	220.7	291.9	343.9
Direct Proportion mean		84.7	200.1	296.6	342.7
Fraser Lee mean		81.6	179.1	304.7	343.9
Eastern WA Average (DP)		68.8	135.6	189.2	248.9



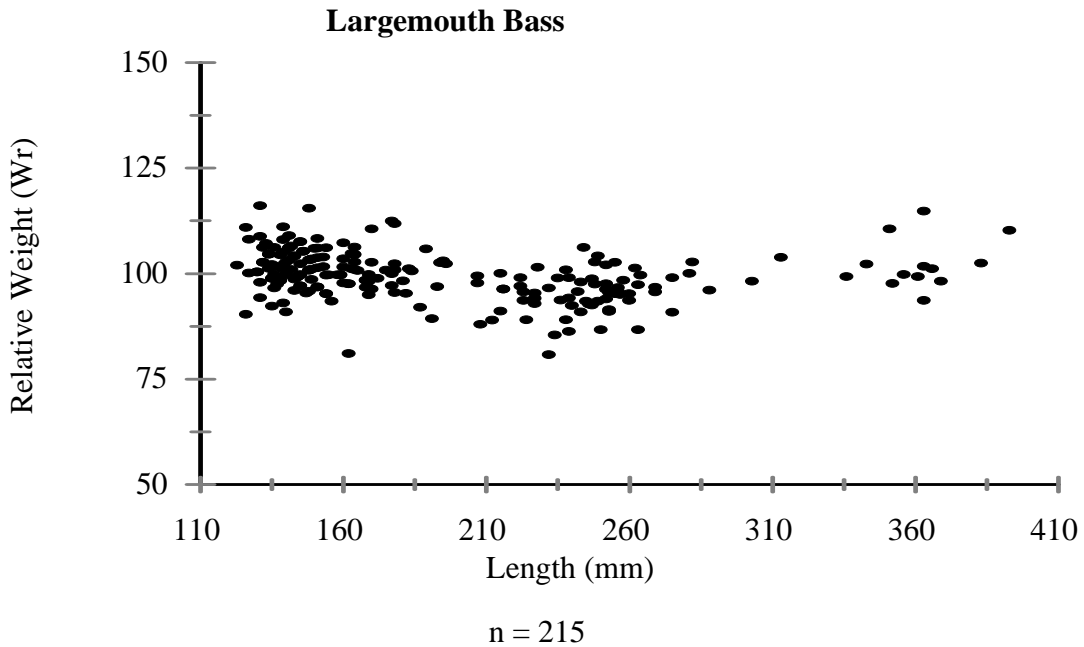
**Figure 2.** Length frequencies of largemouth bass sampled using a boat electrofisher (EB), and gill nets (GN) on Hutchinson Lake during October 2001.



**Figure 3.** Length frequencies of largemouth bass sampled using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.



**Figure 4.** Relative weights for largemouth bass sampled at Hutchinson Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).



**Figure 5.** Relative weights for largemouth bass sampled at Shiner Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).

## Bluegill

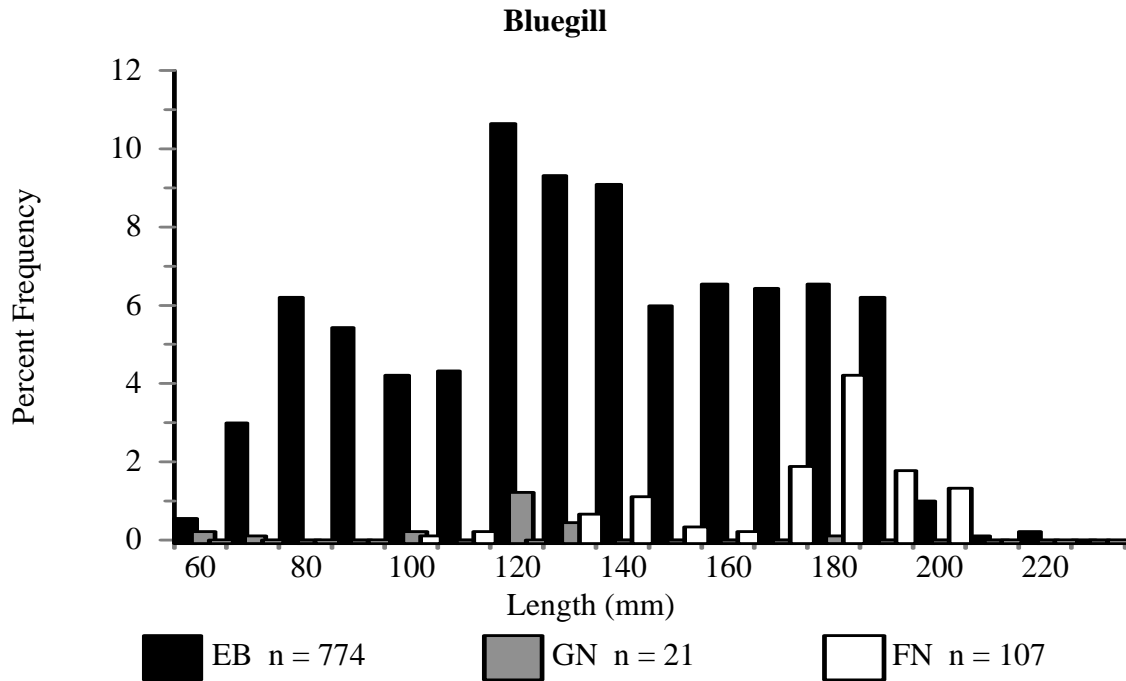
A total of 902 and 907 bluegill were collected at Hutchinson and Shiner lakes, respectively, in 2001. Bluegill ranged from 1 to 4 years of age in Hutchinson Lake and from 1 to 5 years of age in Shiner Lake (Tables 13,14). Growth of age 1 and 2 bluegill in both Hutchinson and Shiner lakes was below the state average, whereas growth of age 3 and 4 bluegill was above the state average. The majority (>85%) of bluegill collected in both lakes were captured with our boat electrofisher (Figures 6,7). Relative weights for bluegill captured in both lakes were above the national average (Figures 8,9). Bluegill populations in Hutchinson and Shiner lakes appear to be in excellent condition; PSD's were high and multiple age classes are represented well (Tables 7,8,13,14).

**Table 13.** Age and growth of bluegill captured at Hutchinson Lake during October 2001. 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).

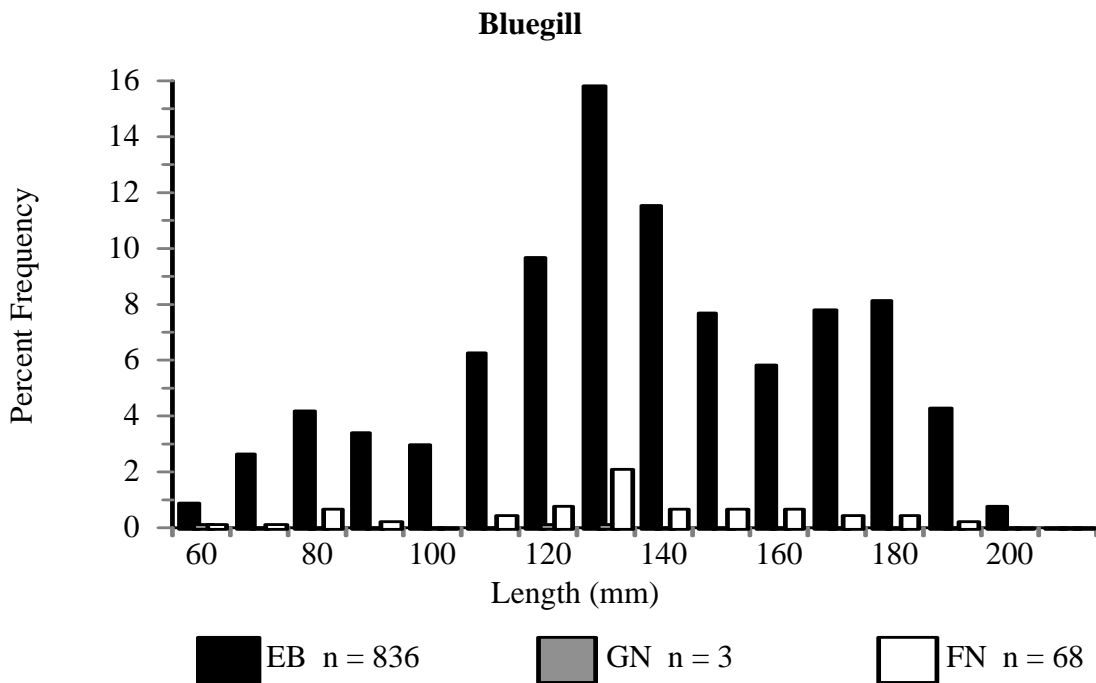
Year Class	# Fish	Mean length (mm) at age			
		1	2	3	4
2000	22	29.8			
		42.7			
1999	30	17.5	70.3		
		34.9	79.9		
1998	22	31.5	96.5	162.9	
		48.3	106.4	165.7	
1997	3	39.8	103.7	149	172.6
		55.5	112.5	152.8	173.9
Direct Proportion mean		29.6	90.2	156.0	172.6
Fraser Lee mean		41.8	92.3	164.2	173.9
WA State Average (DP)		37.3	96.8	132.1	148.3

**Table 14.** Age and growth of bluegill captured at Shiner Lake during October 2001. 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).

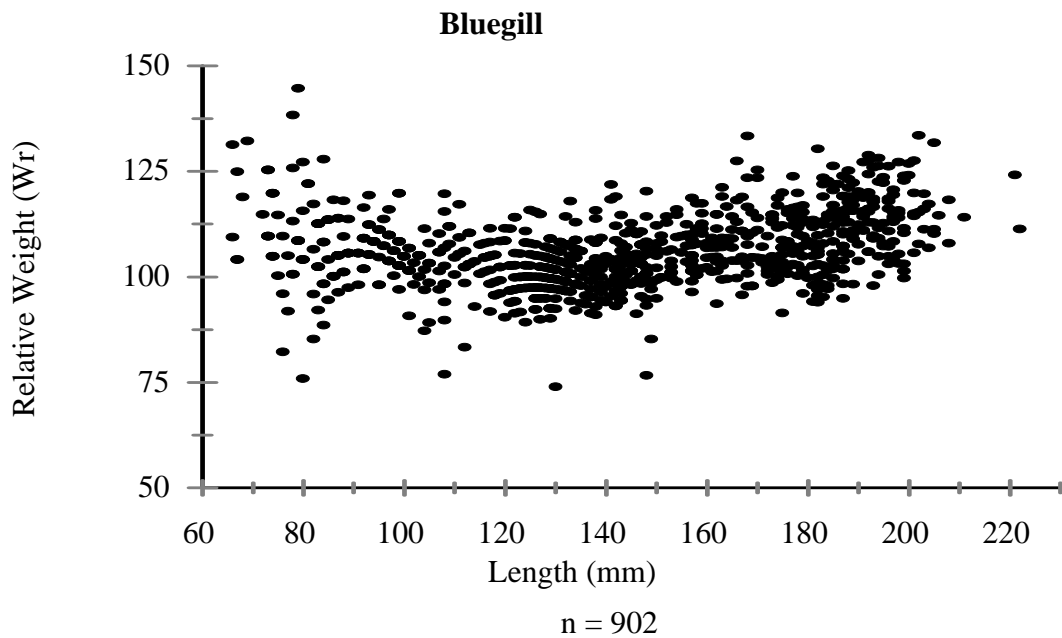
Year Class	# Fish	Mean length (mm) at age				
		1	2	3	4	5
2000	21	31.6				
		43.7				
1999	35	20.9	70.6			
		37.8	79.4			
1998	13	19.7	72.1	147.1		
		37.6	84.3	151.3		
1997	3	49.4	129.6	154.8	182.1	
		64.3	136.4	159.1	183.6	
1996	1	10.5	35.3	67.7	103.9	161.1
		29.4	51.4	80.3	112.6	163.6
Direct Proportion mean		24.8	73.7	161.3	162.6	161.1
Fraser Lee mean		40.5	83.4	164.2	165.8	163.6
WA State Average (DP)		37.3	96.8	132.1	148.3	169.9



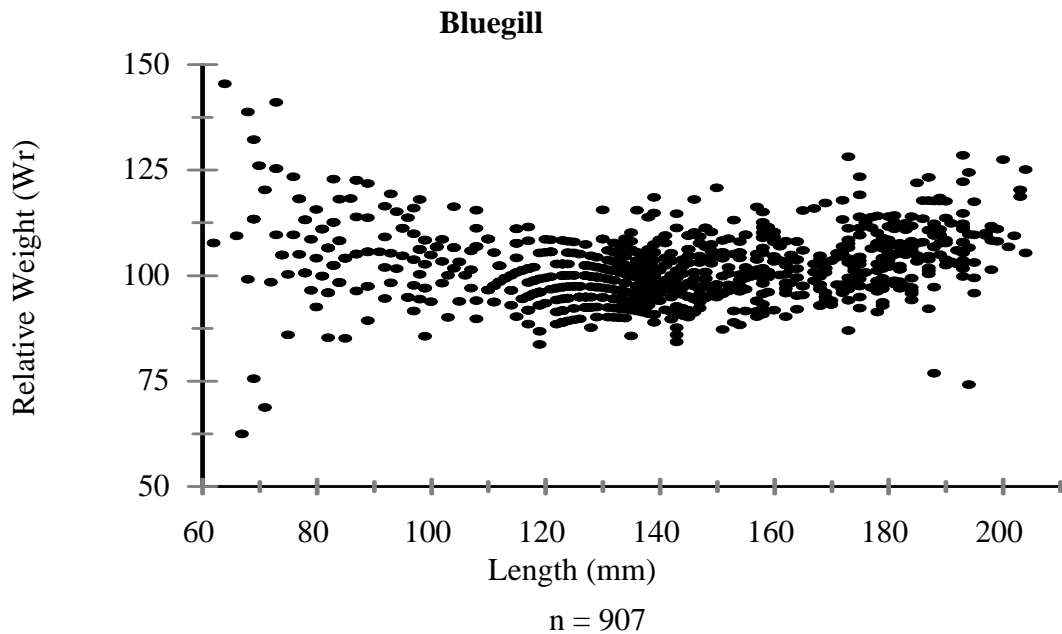
**Figure 6.** Length frequency of bluegill captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Hutchinson Lake during October 2001.



**Figure 7.** Length frequency of bluegill captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.



**Figure 8.** Relative weights for bluegill sampled at Hutchinson Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).



**Figure 9.** Relative weights for bluegill sampled at Shiner Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).

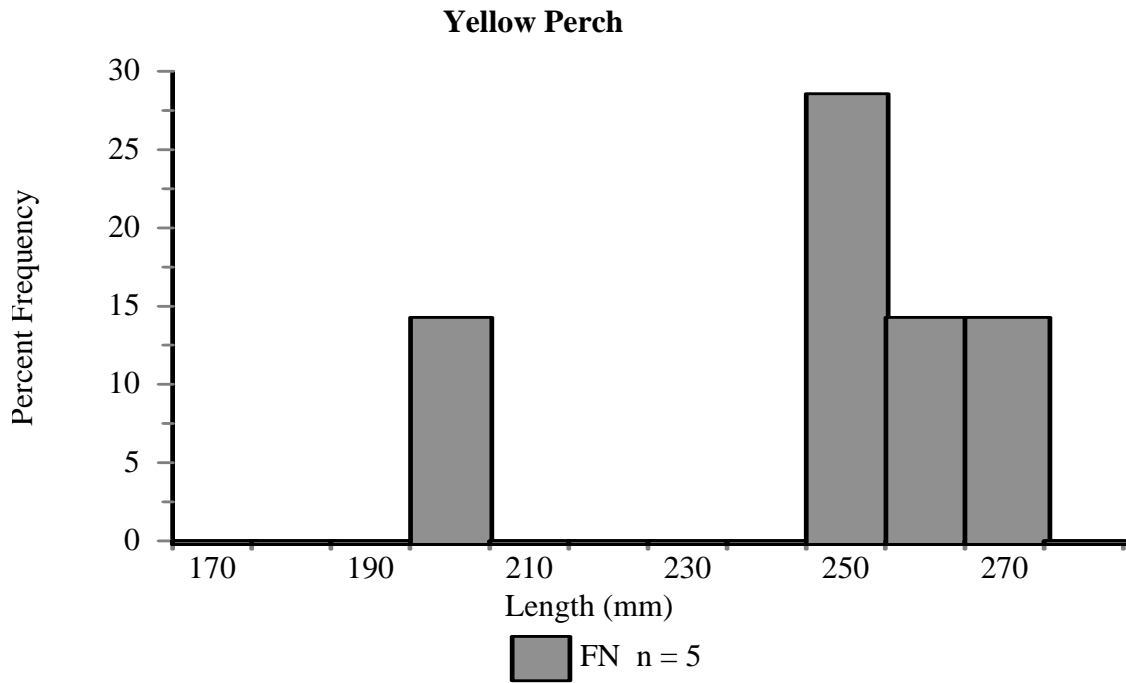


## Yellow Perch

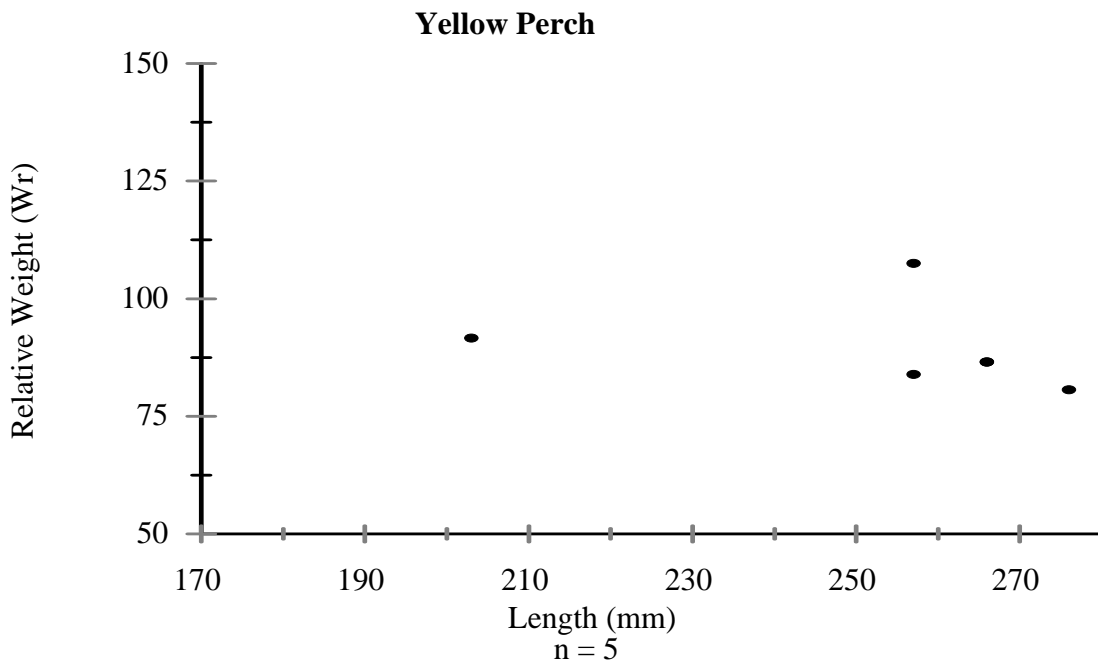
Seven yellow perch were sampled in during this survey, all of which were collected in Hutchinson Lake in fyke nets (Figure 10). Five of these were age 2, and two were YOY (Table 15). The relative weights of 4 yellow perch were below the national average, while the relative weight of the largest yellow perch in our sample was above the national average (Figure 11). Growth of yellow perch was below the WA state average at age 1, but above average at age 2 (Table 15). Yellow perch are not stocked in Hutchinson or Shiner lakes. These lakes were rehabilitated, in part, to remove yellow perch. Yellow perch collected during this survey likely entered via Hayes Creek, or were the offspring of fish that survived the rehabilitation.

**Table 15.** Age and growth of yellow perch captured at Hutchinson Lake during October 2001. 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).

Year Class	# Fish	Mean length (mm) at age	
		1	2
2000	0		
1999	5	40.8	176.8
		65.9	185.8
Direct Proportion mean		40.8	176.8
Fraser Lee mean		65.9	185.8
WA State Average (DP)		59.7	119.9



**Figure 10.** Length frequency of yellow perch captured while using fyke nets (FN) on Hutchinson Lake during October 2001.



**Figure 11.** Relative weights for yellow perch sampled at Hutchinson Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).

## Black Crappie

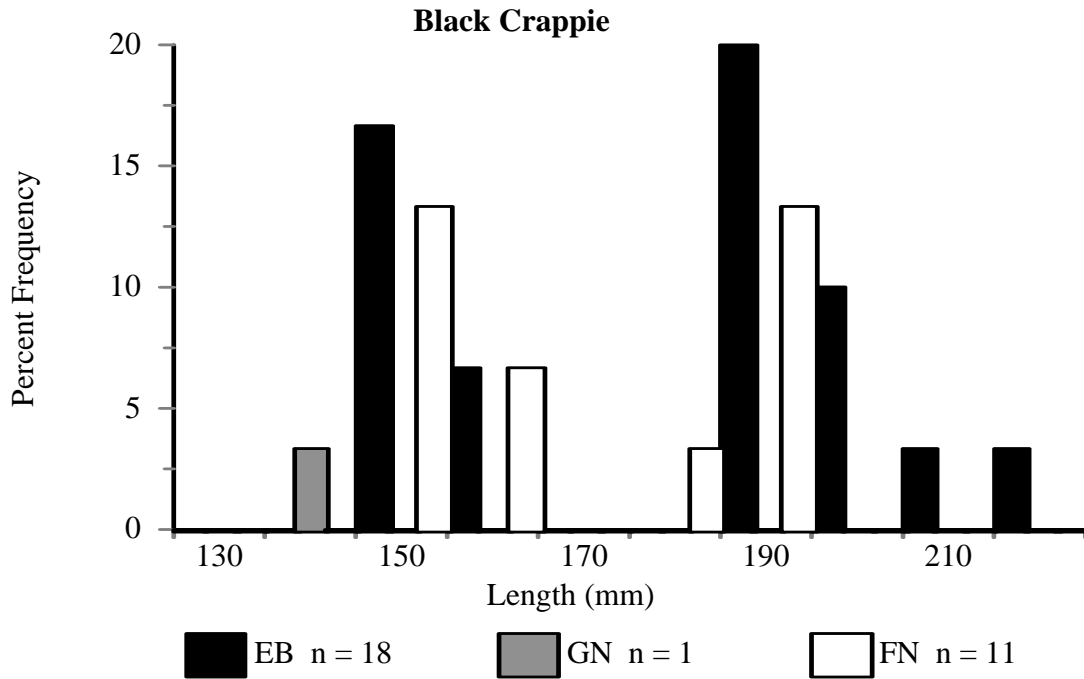
Black crappie were found in low abundance in both Hutchinson (n = 30) and Shiner (n = 7) lakes during this survey (Tables 3,4). Growth of black crappie in both lakes was above average (Tables 16,17). Relative weights of black crappie in Hutchinson Lake were above the national average for age 1 fish, while relative weights for age 2 fish were below the national average (Figure 14). Relative weights for black crappie in Shiner Lake were near, or above the national average (Figure 15). Approximately 13,800 black crappie were planted in Hutchinson and Shiner lakes between 1997 and 1999 (Table 1). The majority of black crappie stocked were fry and may have suffered high predation by largemouth bass that were stocked as juveniles and adults during the same time period.

**Table 16.** Age and growth of black crappie captured at Hutchinson Lake during October 2001. 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).

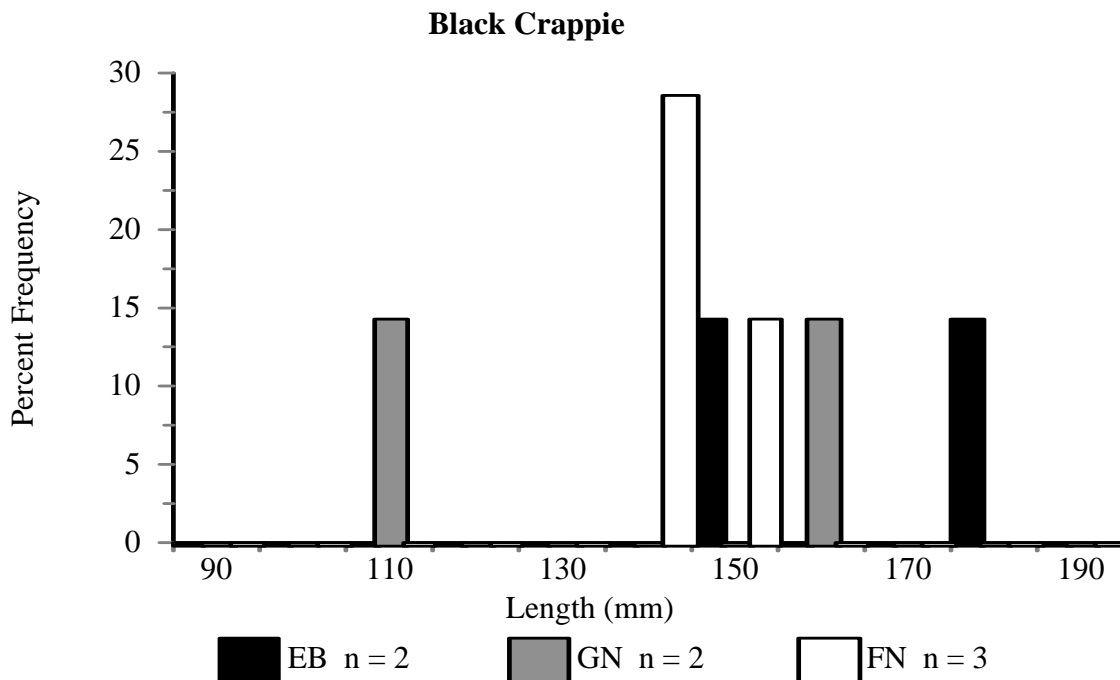
Year Class	# Fish	Mean length (mm) at age	
		1	2
2000	9	69.4	
			88.7
1999	11	48.9	145.3
			155.0
Direct Proportion mean		59.2	145.3
Fraser Lee mean		81.4	155.0
WA State Average (DP)		46.0	111.2

**Table 17.** Age and growth of black crappie captured at Shiner Lake during October 2001. 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).

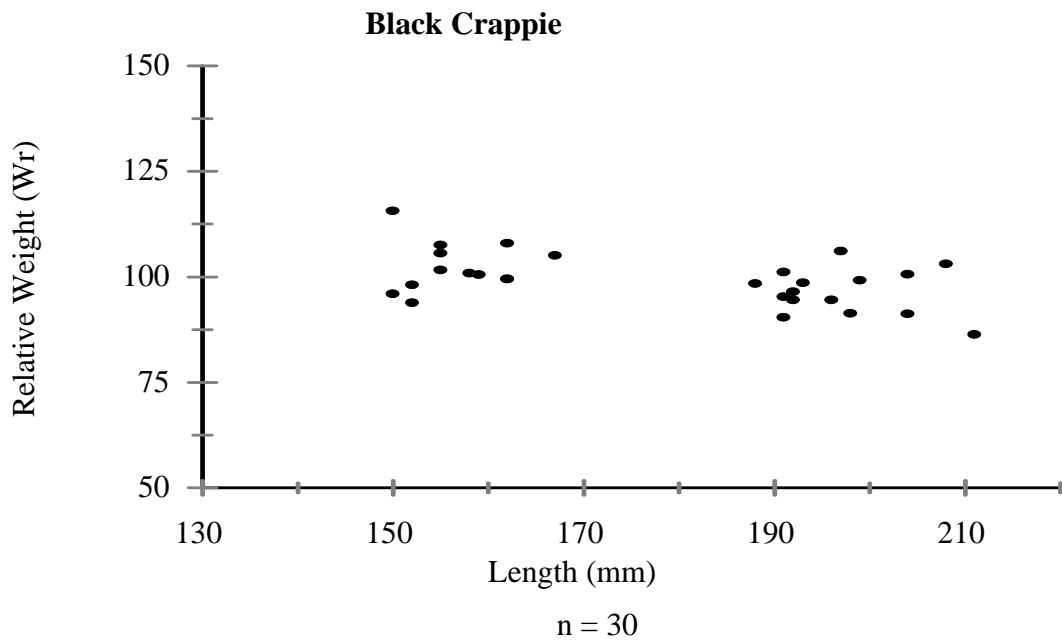
Year Class	# Fish	Mean length (mm) at age	
		1	2
2000	6	63.1	
		82.9	
1999	1	29.5	130.7
		58.9	140.7
Direct Proportion mean		46.4	130.7
Fraser Lee mean		79.5	140.7
WA State Average (DP)		46.0	111.2



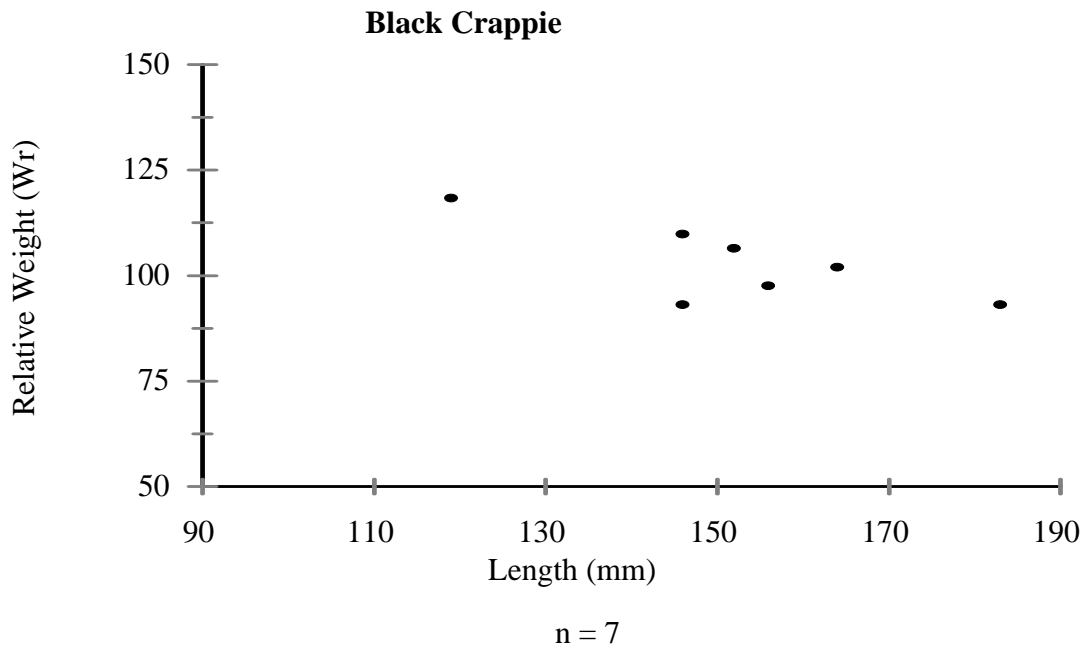
**Figure 12.** Length frequency of black crappie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Hutchinson Lake during October 2001.



**Figure 13.** Length frequency of black crappie captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.



**Figure 14.** Relative weights for black crappie sampled at Hutchinson Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).



**Figure 15.** Relative weights for black crappie sampled at Shiner Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).

## Pumpkinseed Sunfish

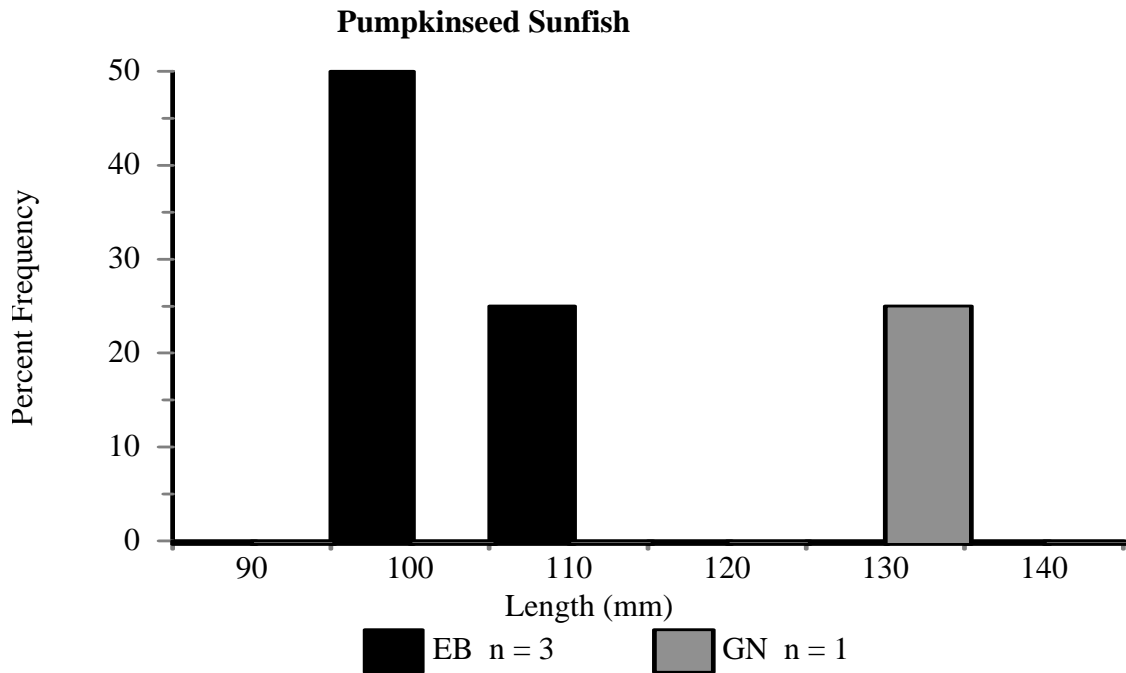
Four pumpkinseed sunfish were collected from Hutchinson Lake, and twenty from Shiner Lake during this survey. All fish were age 1 and growth was above the state average (Tables 18, 19). Lengths ranged from 83 mm to 136 mm (Figures 16,17) and relative weights were above the national average for most fish (Figures 18,19). Pumpkinseed sunfish were not stocked in Hutchinson or Shiner Lake after the rehabilitation in 1998. These fish were either the offspring of fish that survived the rehabilitation, or entered the lake via Hays Creek.

**Table 18.** Age and growth of pumpkinseed sunfish captured at Hutchinson Lake during October 2001. 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).

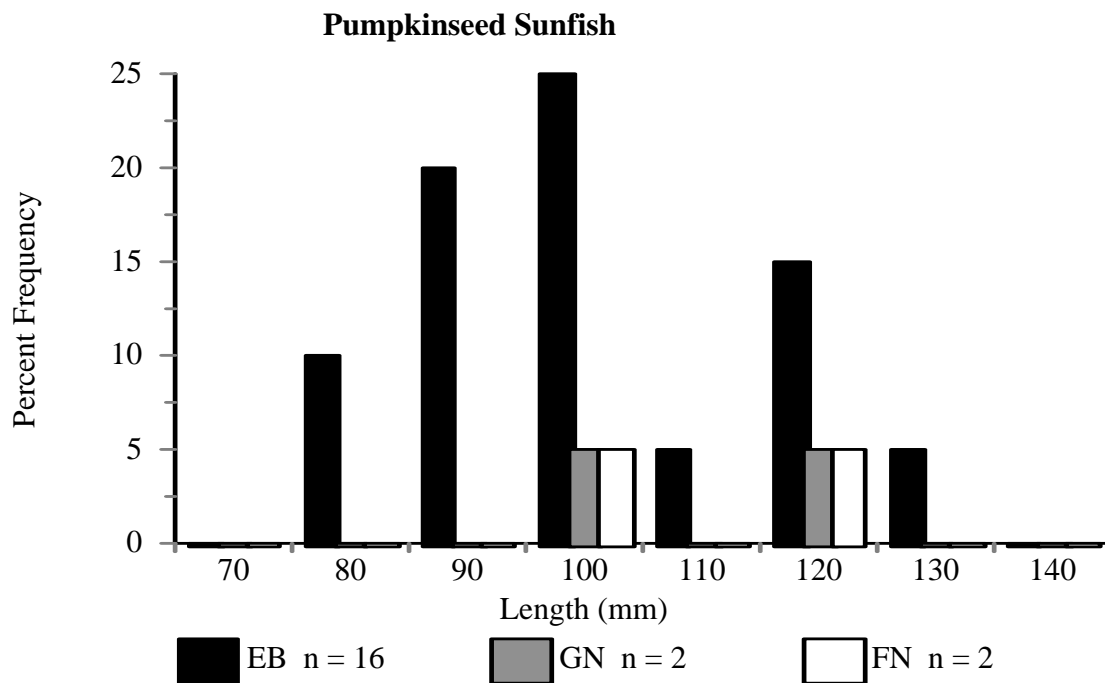
Year Class	# Fish	Mean length (mm) at age 1
2000	3	28.4 47.3
Direct Proportion mean		28.4
Fraser Lee mean		47.3
WA State Average (DP)		23.6

**Table 19.** Age and growth of pumpkinseed sunfish captured at Shiner Lake during October 2001. 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).

Year Class	# Fish	Mean length (mm) at age 1
2000	19	28.2 46.8
Direct Proportion mean		28.2
Fraser Lee mean		46.8
WA State Average (DP)		23.6

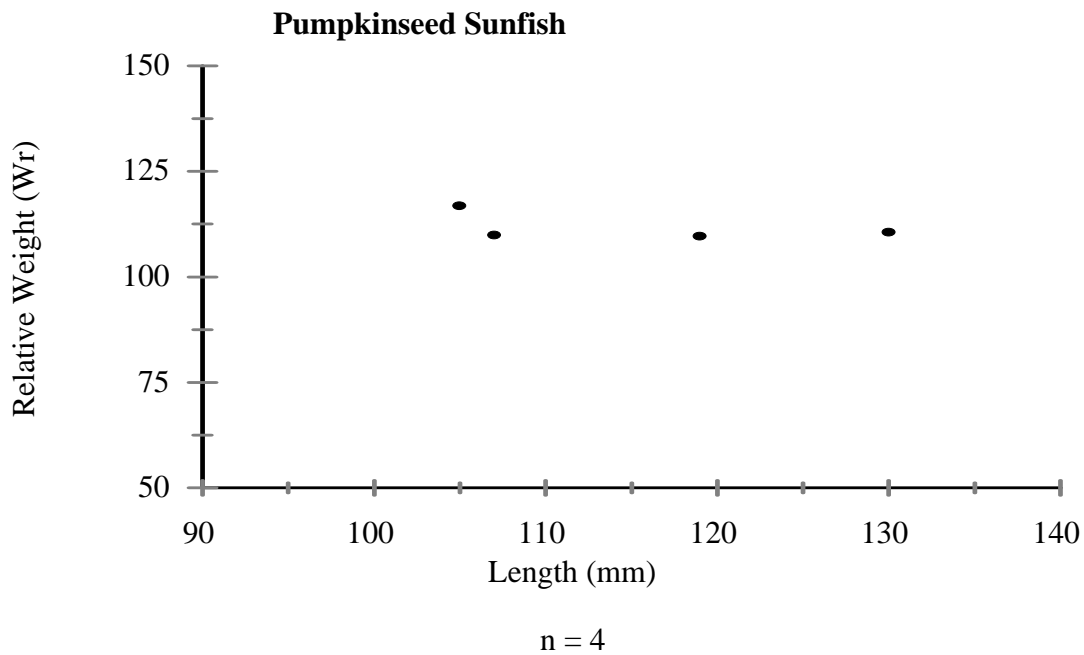


**Figure 16.** Length frequency of pumpkinseed sunfish captured while using a boat electrofisher (EB), and gill nets (GN) on Hutchinson Lake during October 2001.

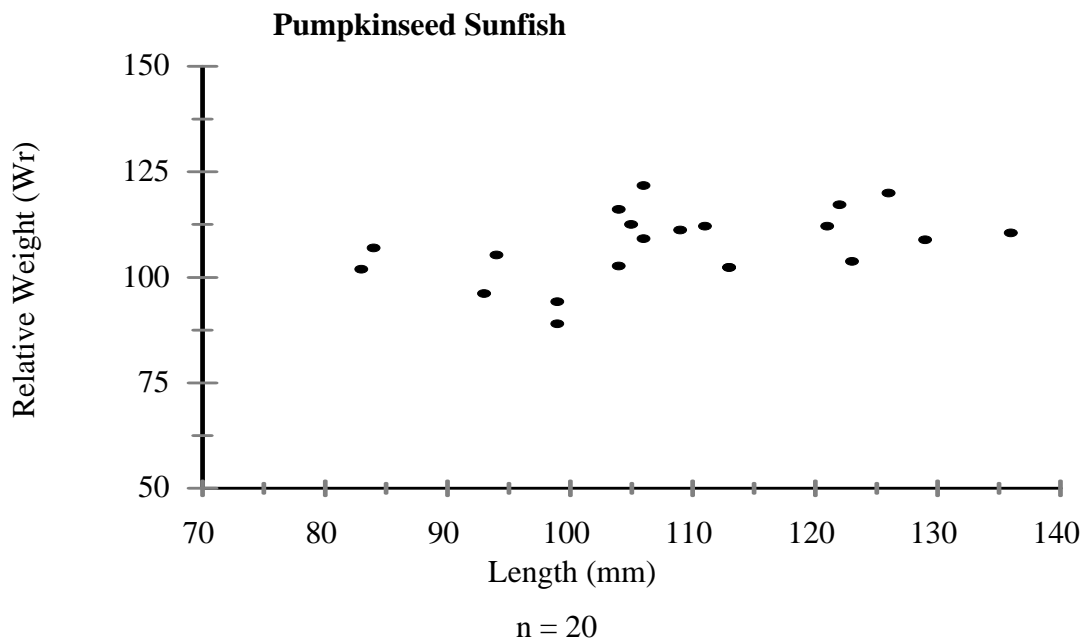


**Figure 17.** Length frequency of pumpkinseed sunfish captured while using a boat electrofisher (EB), gill nets (GN), and fyke nets (FN) on Shiner Lake during October 2001.





**Figure 18.** Relative weights for pumpkinseed sunfish sampled at Hutchinson Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).



**Figure 19.** Relative weights for pumpkinseed sunfish sampled at Shiner Lake, October 2001, compared to the national average  $W_r = 100$  (Anderson and Neumann 1996).

## Conclusions and Management Options

---

A total of five fish species were sampled in both Hutchinson and Shiner Lake (Tables 3, 4). Each lake had similar species present with the exception of yellow perch (Hutchinson only) and rainbow trout, which were found in Shiner Lake only. Bluegill was the most abundant species present in both lakes (Tables 3, 4). Growth of age 1 and 2 bluegill was below the Washington average, yet relative weights for all age classes were at, or above the national average (Figures 8,9). The remainder of the panfish (black crappie, pumpkinseed, and yellow perch) sampled in both lakes represented a very small percentage of the total sample, and probably have little impact on the bluegill and bass populations. Largemouth bass were second in abundance in both lakes (Tables 3,4), growth rates were well above eastern Washington averages (Tables 11,12), and relative weights were at, or above the national average for all age classes except age 2 (Figures 4,5).

Hutchinson and Shiner lakes are managed as bluegill/ bass lakes. Our sampling indicates that bluegill and bass populations are in proper balance. Quality fishing for both of these species should continue for several years, provided these lakes don't become overpopulated by undesirable species such as pumpkinseed sunfish, yellow perch and carp.

The WDFW's management goal for Hutchinson and Shiner lakes was to reduce undesirable fish species through rehabilitation and prevent immigration of fish by installing a fish barrier. Despite the fact that a fish barrier is in place on Hayes Creek (an outlet of Hutchinson Lake), undesirable fish such as carp, yellow perch, and pumpkinseed sunfish are still able to enter these lakes via the inlet to Shiner Lake, which has no fish migration barrier. Both Hutchinson and Shiner lakes were rehabilitated in March 1998, and subsequently stocked with largemouth bass, bluegill, black crappie, rainbow trout and Lahontan cutthroat trout. At the time of this survey, rehabilitation efforts, combined with the fish barrier installed on Hayes Creek, appear to have been effective since low numbers of undesirable fish were collected (pumpkinseed sunfish  $n = 24$ , yellow perch  $n = 5$ ) on either lake. Warmwater surveys should be conducted at regular intervals in order to monitor the fish community, and allow managers to make timely regulation and management changes.

## Literature Cited

---

- Anderson, R.O. and R.M. Neumann. 1996. Length, weight and associated structural indices. Pages 447-482 *in* Murphy, B.R. and D.W. Willis, editors. Fisheries Techniques, 2<sup>nd</sup> edition. American Fisheries Society, Bethesda, Maryland.
- Anderson, R.O. and A.S. Weithman. 1978. The concept of balance for coolwater fish populations. American Fisheries Society Special Publication 11:371-381.
- Bonar, S.A., B.D. Bolding, and M.J. Divens. 2000. Standard fish sampling guidelines for Washington State pond and lake surveys. Report No. FTP 00-28, Washington Department of Fish and Wildlife, Olympia, Washington. 24 pp.
- Carlander, K.D. 1982. Standard intercepts for calculation lengths from scale measurements for centrarchid and percid fishes. Transactions of the American Fisheries Society 111:332-336.
- Fletcher, D., S.A. Bonar, B.D. Bolding, A. Bradbury, and S. Zeylmaier. 1993. Analyzing warmwater fish populations in Washington State. Warmwater Fish Survey Manual. Washington Department of Fish and Wildlife, Olympia, Washington. 164 pp.
- Gabelhouse, D.W., Jr., R.L. Hager, and H.E. Klaassen. 1982. Producing fish and wildlife from Kansas ponds. Kansas Fish and Game Commission, Pratt.
- Gabelhouse, D.W., Jr. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.
- Gustafson, K.A. 1988. Approximating confidence intervals for indices of fish population size structure. North American Journal of Fisheries Management 8:139-141.
- Hubert, W.A. 1996. Passive capture techniques. Pages 157-192 *in* B.R. Murphy and D. W. Willis, eds. Fisheries Techniques, 2<sup>nd</sup> edition. AFS, Bethesda, MD.
- Pope, K.L. and D.W. Willis. 1996. Seasonal influences on freshwater fisheries sampling data. Reviews in Fisheries Science 4:57-73.
- Swingle, H.S. 1950. Relationships and dynamics of balanced and unbalanced fish populations. Alabama Poly. Inst.. Ag. Expt. Stn. Bull. 274, Auburn.

- Swingle, H.S. 1969. Methods for the analysis of waters, organic matter, and pond bottom soils used in fisheries research. Auburn University, Auburn, Alabama.
- Willis, D.W., M.D. Beem, and R.L. Hanten. 1990. Managing South Dakota Ponds for Fish and Wildlife. South Dakota Department of Game, Fish and Parks.
- Willis, D.W., B.R. Murphy, and C.S. Guy. 1993. Stock density indices: development, use, and limitations. *Reviews in Fisheries Science* 1:203-222.
- Zar, J. H. 1996. *Biostatistical Analysis*. Prentice Hall. Upper Saddle River, New Jersey.

## 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% 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% 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% 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% 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 also identified as 74-80% of world record length. Trophy length varies by species.



This program receives Federal financial assistance from the U.S. Fish and Wildlife Service Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972. The U.S. Department of the Interior and its bureaus prohibit discrimination on the bases of race, color, national origin, age, disability and sex (in educational programs). If you believe that you have been discriminated against in any program, activity or facility, please write to:

U.S. Fish and Wildlife Service  
Office of External Programs  
4040 N. Fairfax Drive, Suite 130  
Arlington, VA 22203