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2005 Warmwater Fisheries Survey of Deer Springs Lake (Lincoln County)

Warmwater Fish Enhancement

by Chris P. Moran and Marc J. Divens

Washington Department of
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Science Division

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Acknowledgments

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Abstract

Deer Springs Lake (Lincoln County) was surveyed by Washington Department of Fish and Wildlife biologists on June 8-9, 2005. Fish were sampled by boat electrofishing, gill netting, and fyke netting. Seven fish species were collected. Largemouth bass *Micropterus salmoides* was the most abundant species sampled (51%) and comprised the most biomass (59%). Rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, brown bullhead *Ameiurus nebulosus*, black crappie *Pomoxis nigromaculatus*, pumpkinseed sunfish *Lepomis gibbosus*, and yellow perch *Perca flavescens* were also collected. Largemouth bass are the dominant warmwater species in Deer Springs Lake, and proportional stock density (PSD) revealed a large portion of quality size fish. Largemouth bass over 508 mm (20") were observed and many were sampled within the slot-limit sizes (305-432 mm; 12"-17"). Although, pumpkinseed sunfish exhibited the highest condition of all panfish species, they likely offer limited angling opportunity due to their mostly small size. Rainbow trout showed rapid growth; achieving 254 mm (10") during their first year, although their overall numbers were most likely under represented because of sampling bias. Given its simple species structure, remote location, and morphology, Deer Springs Lake is an example of an excellent mixed-species fishery offering quality angling opportunities in both spring and summer. In order to continue producing quality largemouth bass and sufficient rainbow trout in Deer Springs Lake, future management considerations should include maintaining the slot-limit on largemouth bass, continuing with current rainbow trout stocking rates, and conducting regular creel surveys to determine angler harvest and preferences.

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Introduction

Deer Springs Lake is located approximately 19 km northeast of Odessa, Washington in Lincoln County. It is a moderate sized body of water with a surface area of 25 hectares (ha), mean depth of 12 m, and maximum depth of 20 m (Table 1; Figure 1). Deer Springs Lake is the fifth of eleven lakes located in the Lake Creek drainage, a tributary of Crab Creek, which drains into the Columbia River. Other lakes in the drainage include Wall, Upper Twin, Lower Twin, Coffeepot, Deer Springs, Browns, Tavares, Neves, Wederspahn, Pacific, and Bobs lakes. Lake Creek enters Deer Springs Lake at the northeast end, over an impassible falls, and discharges at the southwest end. Both the inlet and the outlet are perennial.

Lands surrounding Deer Springs Lake are privately owned and used for agricultural purposes. There are no resorts or facilities available at Deer Springs Lake but recreational access via an unimproved boat ramp is available near the north end of the lake. Historically, Deer Springs Lake has offered anglers rainbow trout *Oncorhynchus mykiss* and largemouth bass *Micropterus salmoides*. Eastern brook trout *Salvelinus fontinalis* were stocked once in 1935, and brown trout *Salmo trutta* were stocked in 2004, but rainbow trout have been regularly stocked since 1948 (Table 2).

Deer Springs Lake is managed as a mixed species fishery and is open the last Saturday in April to September 30. Harvest is managed under current Washington Department of Fish and Wildlife (WDFW) statewide general regulations. Largemouth bass are managed under a slot-limit, where largemouth bass less than 305 mm (12”) or greater than 432 mm (17”) may be kept, with a daily limit of 5 and no more than 1 over 432 mm retained. Up to five trout may be kept per day with no minimum size limitation. There is no size or retention limit on other species.

Due to habitat characteristics and history as a warmwater fishery, regional fisheries biologists identified Deer Springs Lake as a water to be surveyed under the Warmwater Fish Enhancement Program. To evaluate warmwater fish populations and to identify ways to maintain and improve the quality of fishing, personnel from the WDFW Warmwater Enhancement Program conducted a fish survey in June 2005. This report is intended to assist regional fisheries biologists with future management decisions. Additionally, this survey may serve as a baseline fisheries evaluation for comparison with future fishery assessment efforts.

Table 1. Physical parameters of Deer Springs Lake, Lincoln County (Dion et al. 1976).

Physical Parameters	Measurement
Surface Area (ha)	25.5
Shoreline Length (km)	2.9
Maximum Depth (m)	20.0
Mean Depth (m)	11.9
Volume (m^3)	3,084,000
Shoreline Development D_L	1.8

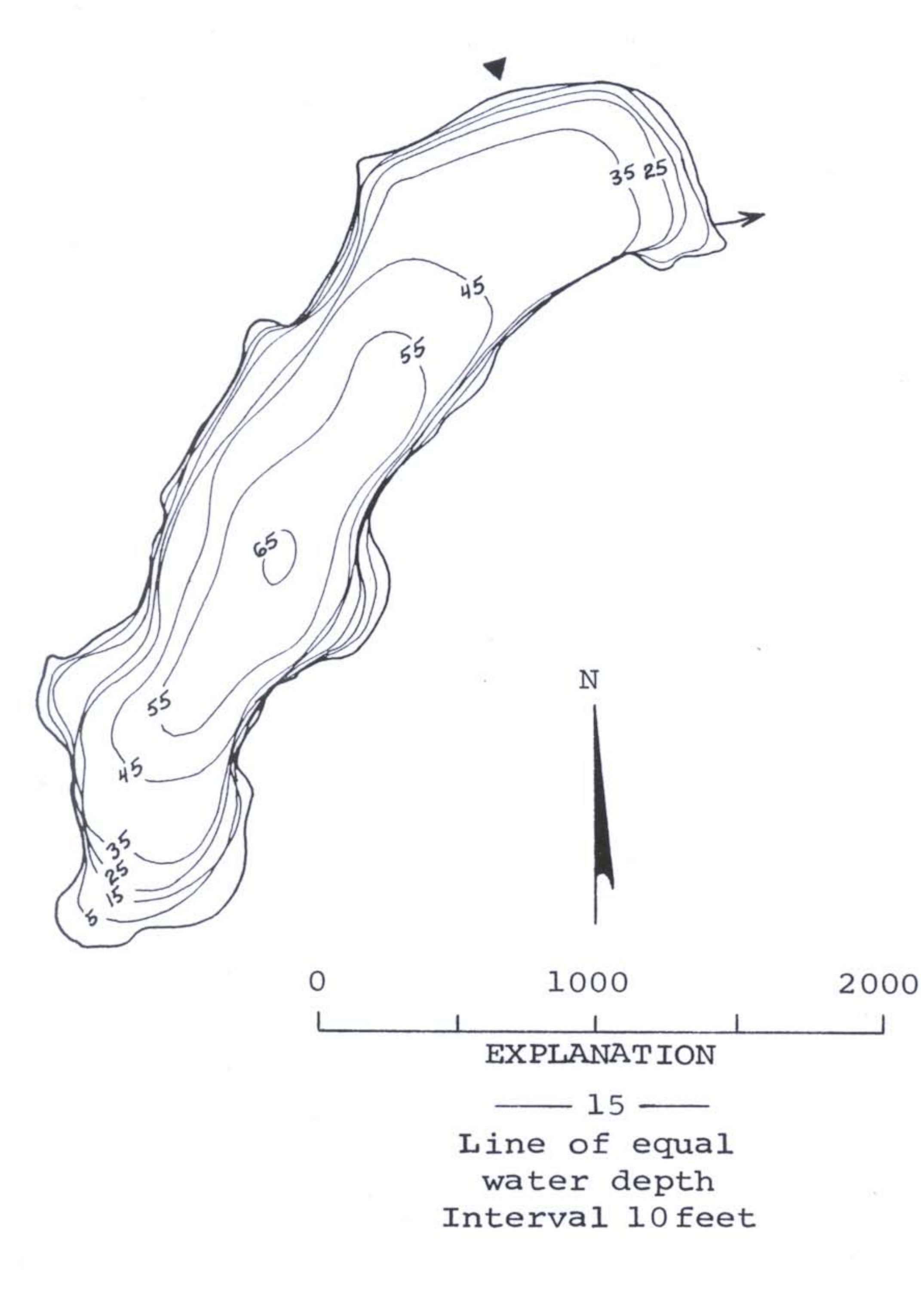

Figure 1. Bathymetric map of Deer Springs Lake (Lincoln County). From Washington Department of Game Archive**.**

Table 2. Fish stocked into Deer Springs Lake (Lincoln County) by WDFW. With few exceptions fish were stocked as fry. Species include brown trout (BT), eastern brook trout (EB), and rainbow trout (RB).

Year	Species	No.	Year	Species	No.	Year	Species	No.
1935	EB	40000	1966	RB	20160	1987	RB	10076
1948	RB	19709	1967	RB	20026	1988	RB	10000
1949	RB	24879	1968	RB	18524	1989	RB	7998
1950	RB	27724	1969	RB	20017	1990	RB	8033
1951	RB	28164	1970	RB	50530	1991	RB	8100
1952	RB	42300	1972	RB	20010	1992	RB	8020
1953	RB	40389	1973	RB	20100	1993	RB	8000
1954	RB	30902	1974	RB	20025	1994	RB	8064
1955	RB	24479	1975	RB	15015	1997	RB	8055
1956	RB	25000	1976	RB	15050	1998	RB	10044
1957	RB	25000	1977	RB	19982	1999	RB	10080
1958	RB	24960	1978	RB	15001	2000	RB	8010
1959	RB	25080	1979	RB	10010	2001	RB	8066
1960	RB	19973	1981	RB	10010	2002	RB	15069
1961	RB	24997	1982	RB	10021	2003	RB	20053
1962	RB	25200	1983	RB	11575	2004	RB	20052
1963	RB	25132	1984	RB	10105		BT	1958
1964	RB	25090	1985	RB	10276	2005	RB	5022
1965	RB	24400	1986	RB	10012			

Methods and Materials

Two 3-person investigation teams surveyed Deer Springs Lake during June 8-9, 2005. Fish were captured using boat electrofishing, gill netting, and fyke netting. The electrofishing unit was a 5.5 meter Smith-Root 5.0 GPP “shock boat” using a DC current of 120 cycles/sec at 3 to 5 amps power. Experimental gill nets (45.7 m long x 2.4 m deep) were constructed of four sinking panels (two each at 7.6 m and 15.2 m long) of variable size monofilament mesh (13, 19, 25, and 51 mm stretched mesh). Fyke nets were constructed of a main trap (4.7 m long x 1.2 m in diameter with five aluminum hoops), a 30.5 m long lead net, and two 7.6 m long wings. All netting material on the fyke nets was constructed of 6.35 mm nylon mesh.

Sampling locations were selected by dividing the shoreline into eight sections of approximately 400 meters each. Due to the relatively small size of the lake we were able to sample seven sections by boat electrofishing. The eighth section near the boat launch was excluded from our sampling because we did not want to resample fish that were released in this area. Four sample sites were randomly chosen for both gill netting and fyke netting. While electrofishing, the boat was maneuvered through the shallows at 0.2 to 2 meters deep, adjacent to the shoreline (Bonar et al. 2000). However, due to the bathymetry of the lake and its small size some sections had areas that were up to 11 m deep. Each electrofishing section was sampled “pedal-down” for approximately 600 seconds. Electrofishing was conducted during evening hours to maximize the size and number of fish captured. Electrofishing is more effective at night because some fish species seek shelter during the day and move freely at night (Reynolds 1996; Dumont and Dennis 1997). Gill nets were set perpendicular to the shoreline with the small mesh end attached onshore and the large mesh end anchored offshore. Fyke nets were set perpendicular to the shoreline with the lead net anchored onshore and the wing nets set at 45-degree angles from the lead net. Fyke nets were set so that the trap was no deeper than three meters where possible (Bonar et al. 2000). Gill nets and fyke nets were set in the evening and retrieved the following morning. Each set was considered 1 net-night of effort.

Each fish captured was identified to species, measured in millimeters (mm) for total length (TL) and weighed to the nearest gram (g). Length data were used to construct length-frequency histograms and to evaluate the size structure of the warmwater gamefish. Up to five scale samples were collected for every 10 mm size group from largemouth bass, black crappie *Pomoxis nigromaculatus*, pumpkinseed sunfish *Lepomis gibbosus*, and yellow perch *Perca flavescens* for age and growth analysis. Scale samples were mounted, pressed, and aged according to Jearld (1983) and Fletcher et al. (1993).

Data Analysis

Water chemistry data were collected from the area of greatest depth at 2 m intervals on June 9, 2005. A Hydrolab® Multi-probe MS-4 meter was used to collect information on dissolved oxygen (milligrams per liter [mg/l]), temperature (degrees Celsius [°C]), pH, conductivity (micro-siemens per centimeter [µS/cm]), and turbidity (nephelometric turbidity units [NTU]).

Species composition by weight (kg) and number were calculated for all fish sampled. Because young-of-the-year fish can give false impressions of year-class strength (Chew 1974), they were excluded from our analyses.

Catch per effort (CPE) of each sampling gear was determined for each warmwater fish species collected. The CPE of electrofishing was determined by dividing the number of fish captured by the total amount of time that was electrofished. Similarly, CPE of gill netting and fyke netting was determined by dividing the number of fish captured by the total time the nets were deployed. Standardized CPE allows for comparisons of catch rates between different lakes or sampling dates on the same water.

The relative weight (W_r) index was used to evaluate the condition of fish sampled in Deer Springs Lake. The index is defined as $W_r = W/W_s \times 100$, where W is the weight of an individual fish and W_s is the standard weight of a fish of the same total length. Standard weight (W_s) was derived from a standard weight-length ($\log_{10}$) relationship that was defined for each species of interest (Anderson and Neumann 1996; Bister et al. 2000). Relative weights are useful for comparing the condition of different size groups within a single population to determine if all sizes are getting adequate nutrition (ODFW 1997). As presented by Anderson and Neumann (1996), a W_r of 100 generally indicates that the fish is in a condition similar to the national 75th percentile for that species and length. Relative weights less than 50 and greater than 150 were excluded from our analyses as we suspected unreliable weight measurements. Fish collected with relative weights below 85 are underweight, and this may be an indication of extensive competition for available food resources (Flickinger and Bulow 1993). Anderson and Neumann (1996) list the parameters for W_r equations of many warmwater fish species, including the minimum length recommendations for their application.

Age and growth of warmwater gamefish in Deer Springs Lake were evaluated using the direct proportion method described by Fletcher et al. (1993). Using the direct proportion method, total length at annulus formation, L_n, was back–calculated as $L_n = (A \times TL)/S$, where A is the radius of the fish scale at age n, TL is the total length of the fish captured, and S is the total radius of the scale at capture. Mean back-calculated lengths at age n for largemouth bass, pumpkinseed sunfish, and yellow perch were presented in line graph form for easy comparison of growth between the lake average and the known Washington state average for the same species (Fletcher et al. 1993). Fletcher et al. (1993) calculated state averages for most warmwater fish populations throughout the state, and for eastern and western populations for largemouth bass. These growth rates are referred to as the Washington average or the eastern Washington average in the results section. Although not a true average, this is likely representative of fish growth for lakes sampled within the state. Length class frequency distributions, presented in bar graph form, were also included with the line graph comparisons. Fletcher et al. uses the direct proportion method to back calculate age and growth of Washington state fish, however the direct proportion method does not take into account the growth that occurs prior to scale formation. Lee's modification of the direct proportion method factors in this growth (Carlander 1982). Considering this, analysis using Lee's modification has been included in the appendices of this report in tabular form. Using Lee's modification, L_n was back–calculated as $L_n=a+A\times(TL-a)/S$, where a is the species-specific standard intercept from a scale radius-fish length regression.

Proportional stock density (PSD) was determined following procedures outlined in Anderson and Neumann (1996). Proportional stock density uses two measurements, stock length and quality length, to provide useful information about the proportion of various size fish in a population. Stock length is defined as the minimum size of a fish that provides recreational value or the approximate length when fish reach maturity (Table 3). Quality length is defined as the minimum size of a fish that most anglers like to catch or begin keeping. Proportional stock density is calculated by dividing the number of quality size fish by the number of stock size fish, multiplied by 100. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths. Stock length is 20-26% of world record length, whereas quality length is 36-41% of world record length.

Relative stock density (RSD) of each warmwater gamefish 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 length classes to the analysis (Table 3). Preferred length (RSD-P) is defined as the minimum size fish anglers would prefer to catch. Memorable length (RSD-M) 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% of world record length, memorable length is 59-60% of world record length, and trophy length is 74-80% of world record length. Like PSD, RSD can also provide useful information regarding population dynamics and is more sensitive to changes in year-class strength. Eighty-percent confidence intervals for PSDs and RSDs are provided as an estimate of statistical precision and were calculated using normal approximation (Conover 1980; Gustafson 1988).

Table 3. Minimum total length (mm) categories of warmwater fish species used to calculate PSD and RSD values (Anderson and Neumann 1996; Bister et al. 2000). Numbers in parenthesis represent percentages of world record lengths (Gabelhouse 1984).

	Standard Length Categories				
Species	**Stock (20-26%)**	**Quality (36-41%)**	**Preferred (45-55%)**	**Memorable (59-64%)**	**Trophy (74-80%)**
Brown Bullhead	150	230	300	390	460
Black Crappie	130	200	250	300	380
Brown Trout	150	230	300	380	460
Largemouth Bass	200	300	380	510	630
Pumpkinseed Sunfish	80	150	200	250	300
Rainbow Trout	250	400	500	650	800
Yellow Perch	130	200	250	300	380

Results

Water Chemistry

Water chemistry data was collected on June 9, 2005 revealing thermal and dissolved oxygen stratification. Deer Springs Lake water temperature ranged from 8.56 °C at 20 m to 17.59 °C at the surface (Table 4). Below 8 m, temperatures were well under the preferred range for warmwater fish such as largemouth bass (Boyd 1990; Wydoski and Whitney 2003). Values for pH ranged from 7.17 to 8.82, well within the desirable range (6.5-9) for all fish species found (Swingle 1969). Dissolved oxygen levels ranged from 9.96 mg/l at the surface to 0.16 mg/l at 20 m. Due to low dissolved oxygen levels below the thermocline (Wetzel 2001), all fish species are restricted to the upper 6 m of the lake, with the possible exception of brown bullhead which can tolerate dissolved oxygen levels as low as 0.2 mg/l (Wydoski and Whitney 2003).

Table 4. Water chemistry data collected from Deer Springs Lake (Lincoln County) on June 9, 2005.

Depth (m)	Temp (°C)	DO (mg/l)	pH	Conductivity	Turbidity
0	17.59	9.96	8.82	421.5	36.1
2	17.09	10.22	8.92		
4	17.00	10.02	8.95		
6	14.50	3.01	8.34		
8	10.07	0.76	8.14		
10	9.31	0.48	8.05		
12	8.89	0.36	7.97		
14	8.77	0.28	7.89		
16	8.61	0.24	7.83		
18	8.58	0.22	7.78		
20	8.56	0.16	7.17		

Species Composition

A total of 7 fish species were collected during sampling efforts on Deer Springs Lake (Table 5). Warmwater game fish comprised approximately 94% of the total number of fish captured and 78% of the total biomass. Rainbow and brown trout comprised the remaining 6% of the total number of fish captured. Largemouth bass was the most abundant species sampled (51%) and contributed the single highest biomass (56%), followed by pumpkinseed sunfish (23%) and yellow perch (17%). Rainbow trout accounted for approximately 15% of the total biomass sampled and only 5 brown trout were observed (Table 5). However, both rainbow and brown trout may be underrepresented in our survey considering the sampling techniques employed were not effective for sampling pelagic species.

Table 5. Species composition by weight (kg) and number for all fish collected at Deer Springs Lake (Lincoln County) in June 2005.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	**kg**	**%**	**No.**	**%**	**Min**	**Max**
Brown Bullhead	7.1	7.4	13	2.1	224	320
Black Crappie	0.6	0.6	4	0.7	115	281
Brown Trout	3.3	3.5	5	0.8	380	446
Largemouth Bass	56.1	58.6	307	50.5	60	522
Pumpkinseed Sunfish	8.9	9.3	142	23.4	80	180
Rainbow Trout	14.1	14.8	34	5.6	131	509
Yellow Perch	5.7	6.0	103	16.9	87	275

Catch Per Effort (CPE)

Electrofishing captured more fish (n=479) in Deer Springs Lake than gill nets (n=80) or fyke nets (n=49) (Table 6). Electrofishing catch rates were highest for largemouth bass (256 fish/hr) and pumpkinseed sunfish (88 fish/hr). Yellow perch (10 fish/net night) and rainbow trout (6 fish/net night) comprised the highest catch rate for fish sampled by gill netting. Fyke netting CPE was highest for pumpkinseed sunfish at 10 fish/net night.

Table 6. Mean catch-per-effort (CPE) by sampling method, including 80% confidence intervals, for stock length fish collected at Deer Springs Lake (Lincoln County) in June 2005.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	**(# / Hour)**	**Sites**	**# /Net Night**	**Net Nights**	**# /Net Night**	**Net Nights**
Brown Bullhead	1.7 ± 1.4	7	1.8 ± 1.5	4	1.0 ± 0.9	4
Black Crappie	2.6 ± 2.3	7	0.3 ± 0.3	4	0.00	4
Brown Trout	3.4 ± 3.3	7	0.3 ± 0.3	4	0.00	4
Largemouth Bass	256.3 ± 5.0	7	2.0 ± 1.1	4	0.00	4
Pumpkinseed Sunfish	88.3 ± 16.9	7	0.3 ± 0.3	4	9.5 ± 2.0	4
Rainbow Trout	8.6 ± 6.3	7	6.0 ± 4.7	4	0.00	4
Yellow Perch	49.7 ± 17.2	7	9.5 ± 9.7	4	1.8 ± 1.1	4

Stock Density Indices

Sample sizes of largemouth bass and pumpkinseed sunfish caught by boat electrofishing were adequate for evaluating stock density indices (Table 7). Sample sizes of stock length fish for other species were low, and as a result stock density values for those species should be viewed with caution (Bonar et al. 2000). Largemouth bass had a high PSD value (63), with individuals present in all RSD categories except RSD-T (Trophy), indicating a high proportion of large fish in the population.

Table 7. Traditional stock density indices, including 80% confidence intervals, of fish collected from Deer Springs Lake (Lincoln County) in June 2005, by sampling method.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
Electrofishing					
Largemouth Bass	81	63 ± 7	10 ± 4	1 ± 2	0
Pumpkinseed Sunfish	103	28 ± 6	0	0	0
Yellow Perch	35	6 ± 5	3 ± 4	0	0
Gill Netting					
Rainbow Trout	24	25 ± 11	8 ± 7	0	0
Yellow Perch	36	14 ± 7	3 ± 4	0	0
Fyke Netting					
Pumpkinseed Sunfish	38	37 ± 10	0	0	0

Largemouth Bass

Largemouth bass sampled in Deer Springs Lake ranged in length from 60 to 522 mm TL (Table 5; Figure 3). The age of largemouth bass ranged from 1 to 11 years (Appendix 1). Growth rates of largemouth bass closely resembled average growth rates for eastern Washington (Fletcher et al. 1993)(Figure 2), while length frequency distribution indicates stable year-class strength (Figure 3). Largemouth bass condition was generally at or above the national 75th percentile and increased with length (Figure 4).

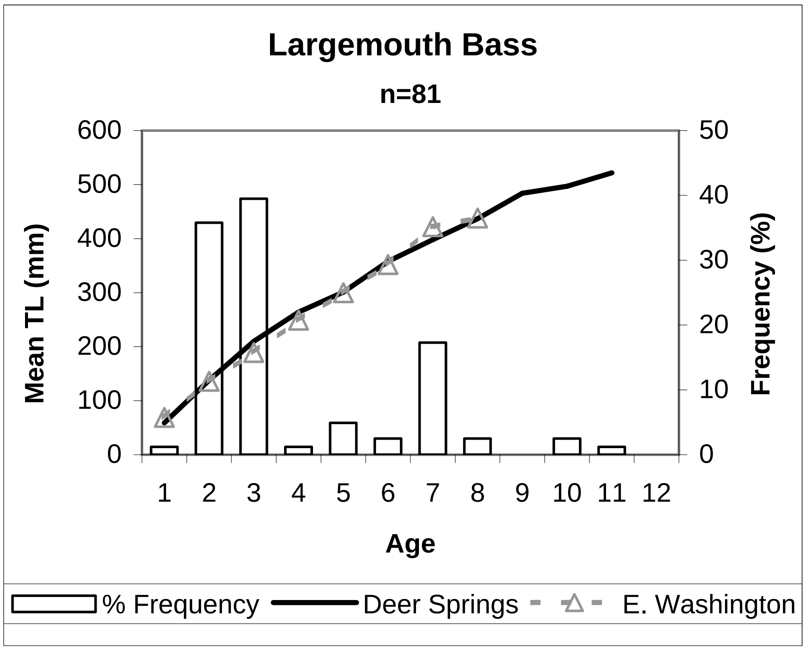

Figure 2. Back-calculated mean length (TL) at age compared to the eastern Washington average and age class frequency for largemouth bass sampled from Deer Springs Lake (Lincoln County) in June 2005.

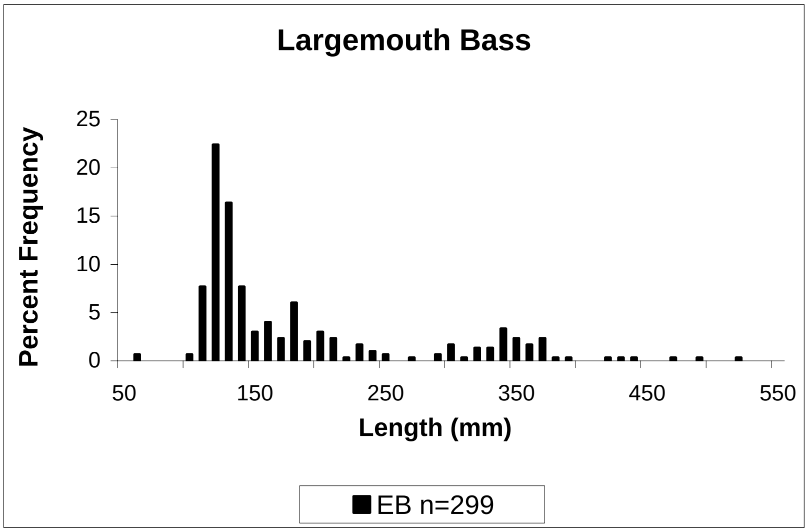

Figure 3. Length frequency distribution of largemouth bass sampled by boat electrofishing (EB) from Deer Springs Lake (Lincoln County) in June 2005.

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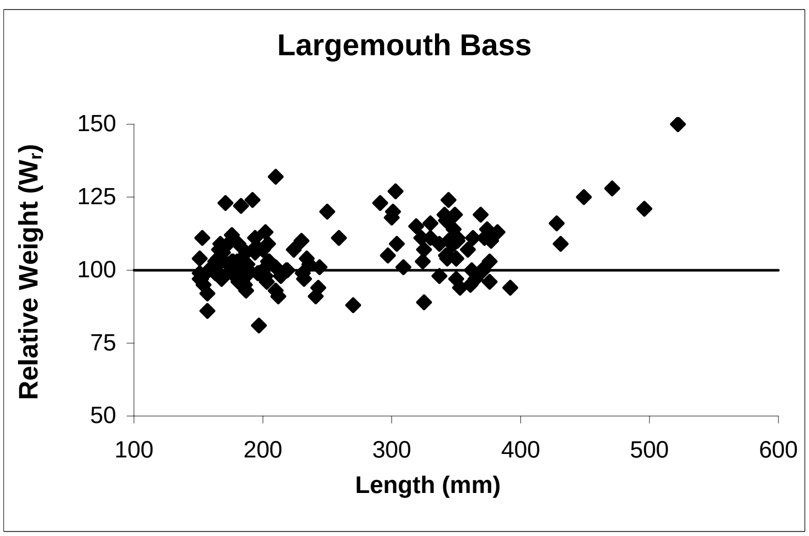

Figure 4. Relative weights of largemouth bass (n=138), sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, W_r=100.

Pumpkinseed Sunfish

Deer Springs Lake pumpkinseed sunfish ranged in length from 80 mm to 180 mm TL (Table 5; Figure 6). The age of pumpkinseed sunfish ranged from two to seven years old with ages 3 and 4 providing the most numerous samples. Except for ages 2 and 3, growth rates of pumpkinseed sunfish were at or above the Washington average (Figure 5; Appendix 2). Pumpkinseed sunfish condition was above the national 75th percentile for the majority of fish sampled (Figure 7).

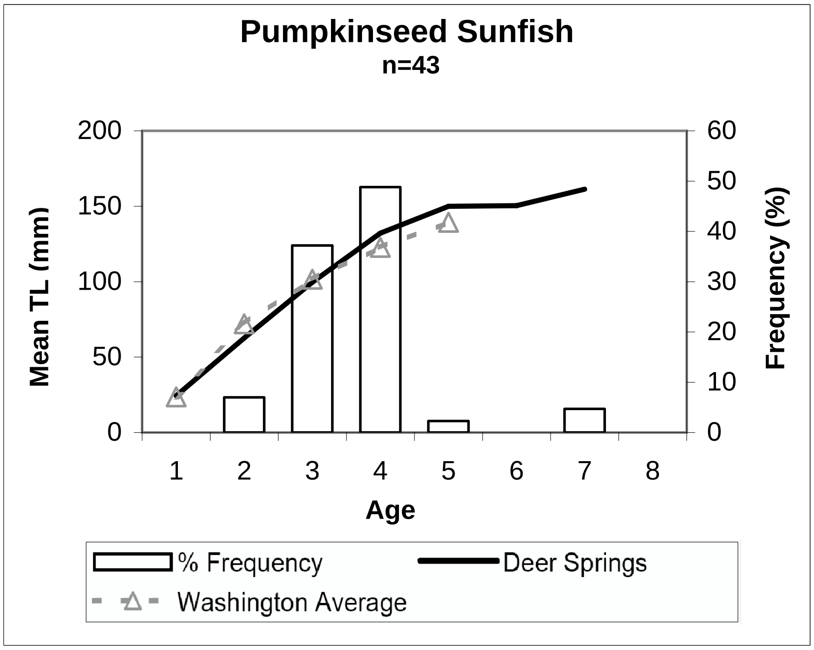

Figure 5. Back-calculated mean length (TL) at age compared to the Washington average and age class frequency for pumpkinseed sunfish sampled from Deer Springs Lake (Lincoln County) in June 2005.

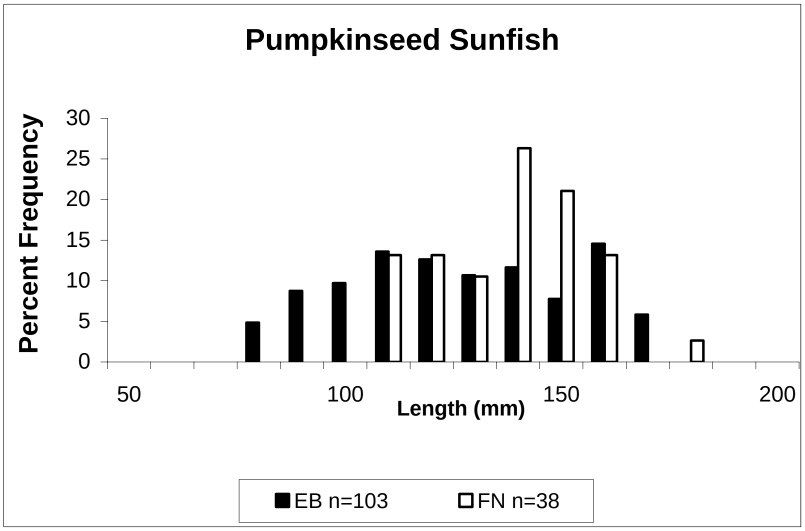

Figure 6. Length frequency distribution of pumpkinseed sunfish, sampled by electrofishing (EB) and fyke netting (FN) at Deer Springs Lake (Lincoln County), in June 2005.

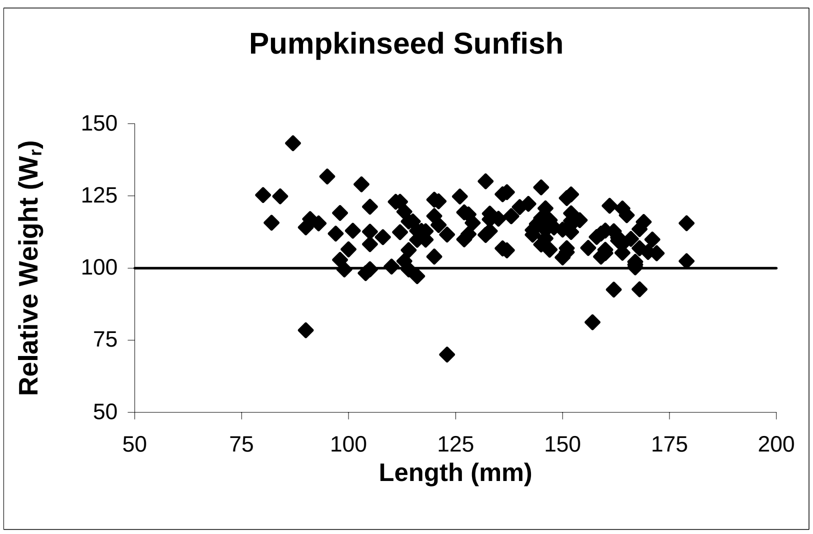

Figure 7. Relative weights of pumpkinseed sunfish (n=125), sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, W_r=100.

Yellow Perch

Yellow perch sampled in Deer Springs Lake ranged in length from 87 mm to 275 mm TL (Table 5; Figure 9). The age of yellow perch ranged from two to five years with ages 2 and 3 being the most numerous (Figure 8; Appendix 3). Yellow perch growth rates varied from below the known Washington average at ages 1 and 2, to above the state average thereafter. The condition of yellow perch varied with most falling below the national 75th percentile (Figure 10).

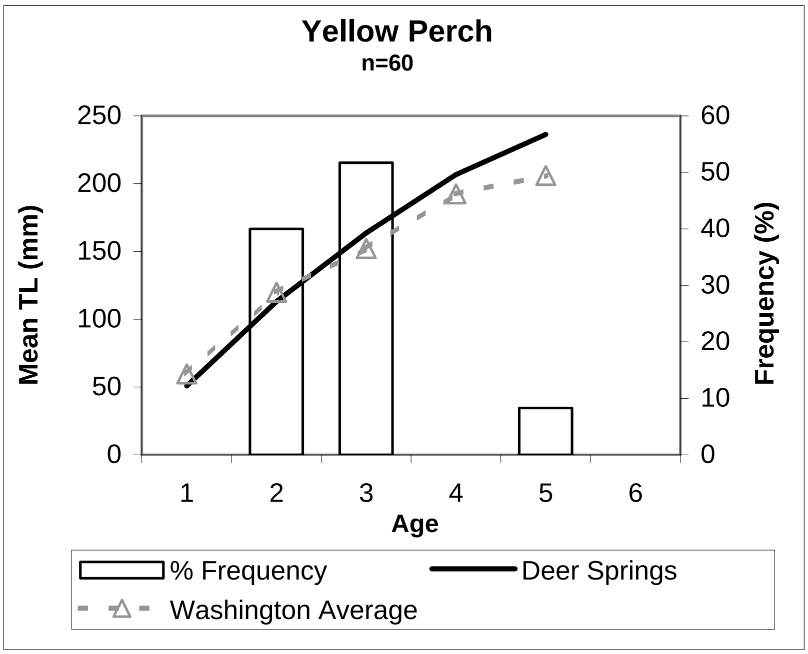

Figure 8, Back-calculated mean length (TL) at age compared to the Washington average and age class frequency for yellow perch sampled from Deer Springs Lake (Lincoln County) in June 2005.

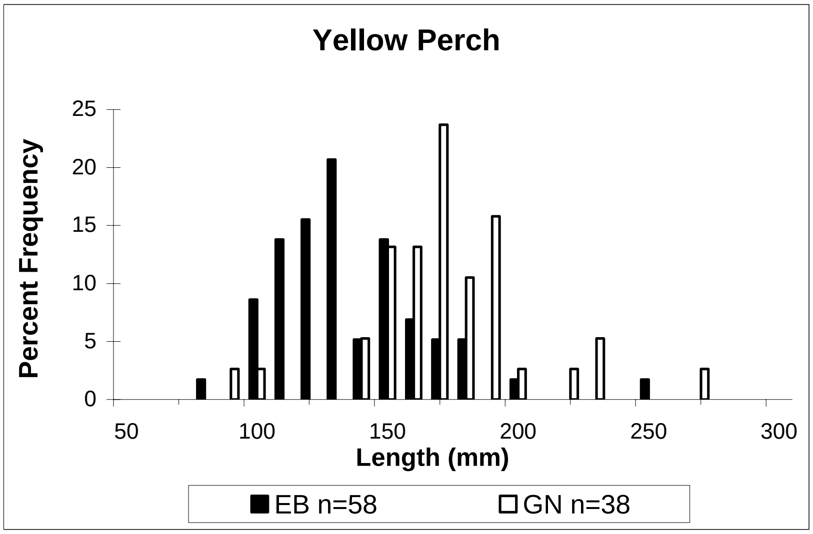

Figure 9. Length frequency distribution of yellow perch, sampled by electrofishing (EB) and gill netting (GN) at Deer Springs Lake (Lincoln County) in June 2005.

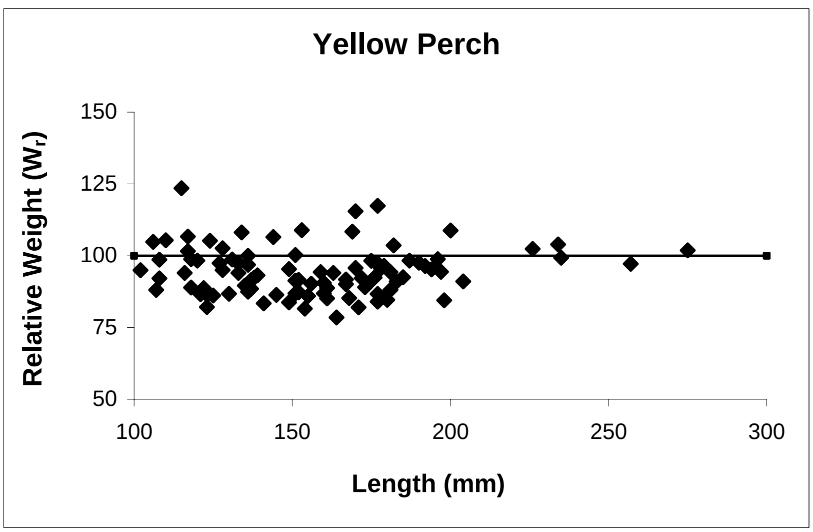

Figure 10. Relative weights of yellow perch (n=100), sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, W_r=100.

Black Crappie

The length of black crappie sampled in Deer Springs Lake ranged from 115 mm to 281 mm TL (Table 5) and varied in age from two to four years (Appendix 4). Of the 4 black crappie sampled, growth rates varied from below the Washington average (Fletcher at al. 1993) prior to age three, to above average after age three (Appendix 4). The condition of 3 of the black crappie sampled was above the national 75th percentile, while the fourth and oldest fish was below (Figure 12).

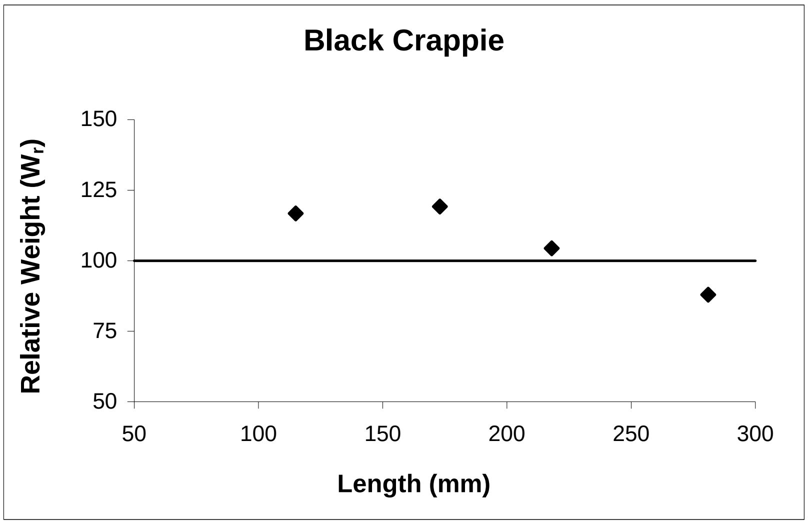

Figure 11. Relative weights of black crappie (n=4) sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, Wr=100.

Brown Bullhead

Deer Springs lake brown bullhead ranged in length from 224 mm to 320 mm TL (Table 5). The condition of all brown bullhead was above the national 75th percentile (Figure 14). No age analysis was conducted for brown bullhead.

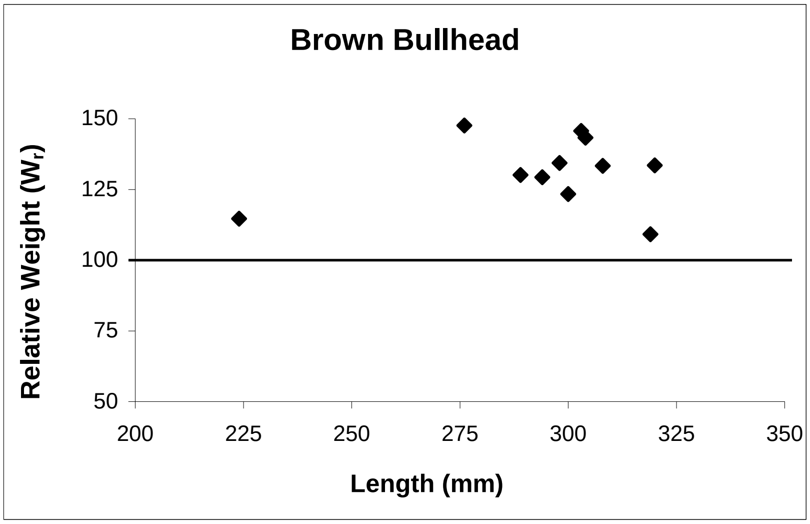

Figure 12. Relative weights of brown bullhead (n=13) sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, Wr=100.

Rainbow Trout

Rainbow trout sampled in Deer Springs Lake ranged in length from 131 mm to 509 mm TL with the majority in the 250 mm to 300 mm size class (Table 5, Figure 15). The condition of rainbow trout varied with most below the national 75th percentile (Figure 16). Age and growth were not analyzed for rainbow trout.

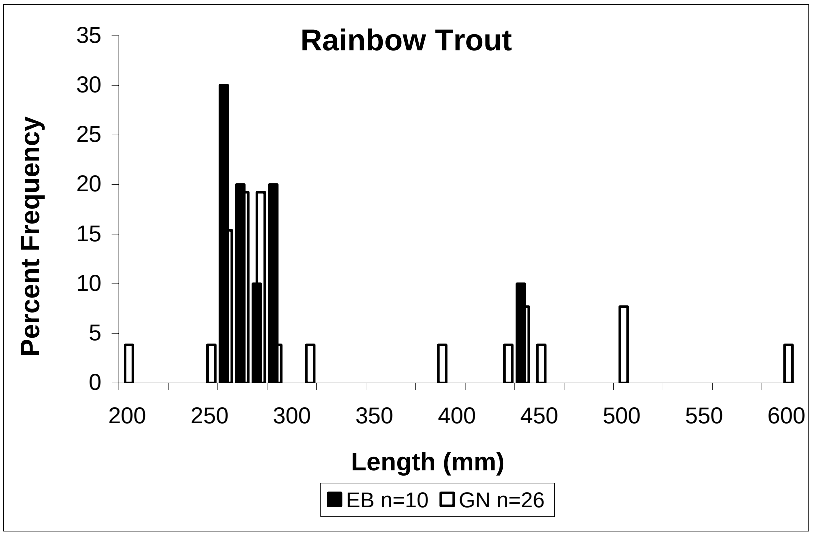

Figure 13. Length frequency distribution of rainbow trout sampled by electrofishing (EB) and gill netting (GN) at Deer Springs Lake (Lincoln County) in June 2005.

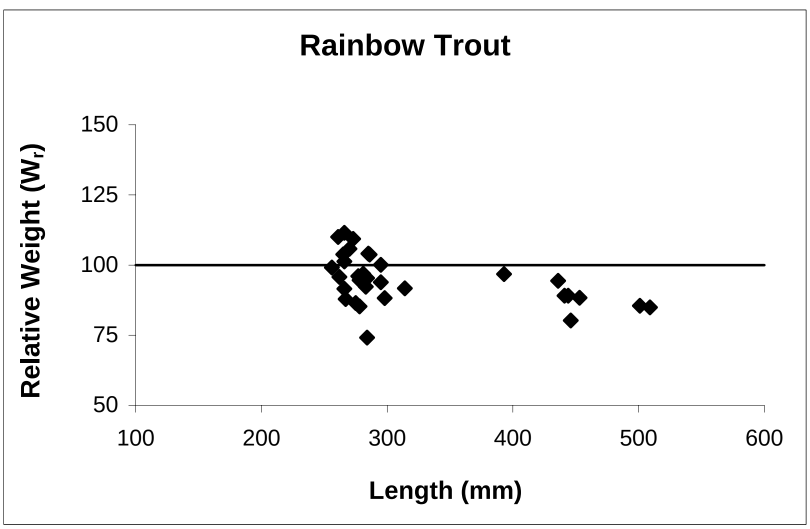

Figure 14. Relative weights of rainbow trout (n=32) sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, Wr=100.

Brown Trout

The 5 brown trout sampled in Deer Springs Lake ranged in length from 380 mm to 446 mm TL (Table 5). The condition of most brown trout was below the national 75th percentile (Figure 17). Age and growth were not analyzed for brown trout.

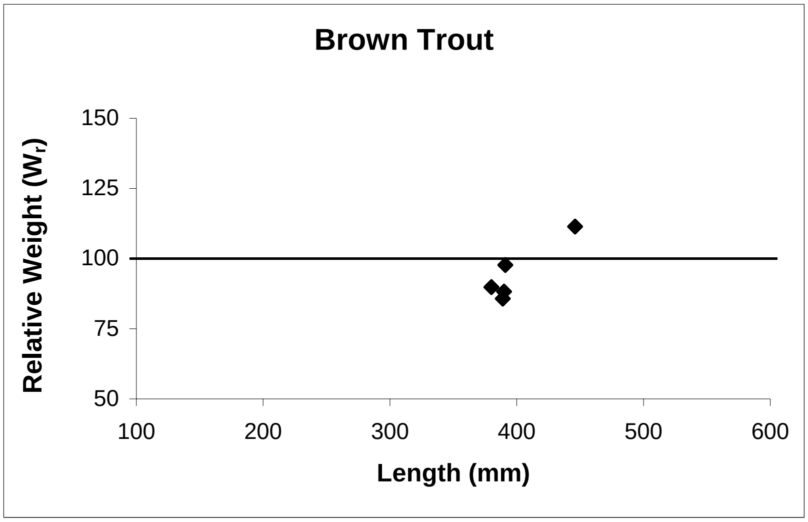

Figure 15. Relative weights of brown trout (n=5) sampled at Deer Springs Lake (Lincoln County) in June 2005, as compared to the national 75th percentile, Wr=100.

Discussion

Seven species of fish were observed in Deer Springs Lake in June 2005. Largemouth bass, pumpkinseed sunfish, and yellow perch were the most abundant species present. Catch per effort (CPE) suggests that the largemouth bass population is of relatively high density compared to other species found in the lake (Table 6). Stock density indices for largemouth bass revealed an uncommonly high PSD, with several individuals in the RSD preferred (RSD-P) and memorable (RSD-M) size classes (Table 7). Largemouth bass condition (W_r) appeared to be at or above the national 75th percentile, indicating plentiful forage available for bass at all ages, and especially for adult fish. The combination of high CPE and PSD indicates that largemouth bass in Deer Springs Lake are of quality size and condition, and are likely experiencing low exploitation.

Findings for largemouth bass were similar to other nearby lakes (WDFW, unpublished data). Largemouth bass in Coffeepot and Upper Twin lakes, located in the same drainage system (Lake Creek) as Deer Springs Lake, had the highest CPE of all species in each lake (WDFW, unpublished data). Upper Twin and Deer Springs Lake had virtually the same unusually high CPE values. As with CPE, RSD for bass in Deer Springs Lake was similar to the other lakes in that all but trophy size fish were present. The PSD in Deer Springs Lake (63) was higher than those of Upper Twin (14) and Coffeepot (14) lakes, indicating that Deer Springs Lake had a higher density of quality largemouth bass.

Pumpkinseed sunfish appear to be an important component in the Deer Springs Lake fish community. Although pumpkinseed sunfish typically have little angling value (Wydoski and Whitney 2003), they are likely important here as a forage species for largemouth bass. Pumpkinseed sunfish were present in relatively high numbers as indicated by CPE. However, they were not so abundant as to exhibit common signs of high intraspecific competition (i.e., slow growth and stunting). Lake morphology likely influences this population in that the limited littoral area within the lake provides minimal cover for fish to escape predation by largemouth bass. Overall, the lake's pumpkinseed sunfish population appeared stable with recruitment adequate to sustain the population.

Yellow perch in Deer Springs Lake exhibited low condition and size and likely offer little angling value. More than half of the perch sampled were under the national 75th percentile for condition (Figure 10), and no perch greater than 275 mm was sampled (Table 5, Figure 9). Results for yellow perch may indicate that resources available to perch are limited due to inter- or intraspecific competition. However, large yellow perch are primarily pelagic during warmer months and our sampling methods were not designed to adequately test open waters. Thus these results are not necessarily conclusive. The greatest value of yellow perch in Deer Springs Lake is as forage for largemouth bass.

The rainbow and brown trout in Deer Springs Lake appear to provide ample trout fishing opportunity for anglers. Rainbow trout fry planted in spring 2005 were observed as catchable fish in our study, indicating growth of approximately 254 mm (10”) before their first year. The majority of the rainbow trout sampled were in the 254 mm and 432 mm (17”) size class. The rapid growth exhibited by rainbow trout signifies that there is sufficient forage available in the lake. Only 1,958 brown trout were stocked in 2004, and the 5 that we sampled were of roughly average condition. As with yellow perch, rainbow and brown trout are pelagic species and our sampling may have inaccurately represented their numbers.

Deer Springs Lake’s combination of remoteness, high productivity, and fish populations make it a good candidate for mixed species angling during spring and summer. The relatively simple species composition found in Deer Springs Lake provides for low levels of interspecific competition. Deer Springs Lake is a prime example of the quality of largemouth bass fishery that can be produced in a simple system. Since this survey was the first to be conducted on Deer Springs Lake, these data should be considered baseline for future comparisons to extrapolate meaningful trends. Under current management practices, the lake is producing sizeable catches and is possibly among the best largemouth bass lakes in the state.

The following are suggestions to maintain and enhance the Deer Springs Lake fishery: 1) maintain the slot-limit for largemouth bass to retain the existing size structure; 2) maintain current rainbow trout stocking levels; 3) evaluate exploitation by conducting consistent creel surveys; 4) monitor fish population trends with regular surveys to establish reliable trend data; and 5) include sampling techniques to adequately evaluate pelagic fish populations.

Appendix

Appendix 1. Back-calculated mean length at age (mm) of largemouth bass collected at Deer Springs Lake (Lincoln County) during June 2005. Unshaded values represent length at age calculated using the direct proportion method (Fletcher at al. 1993). Shaded values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age										
Year class	**# Fish**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2004	1	56										
		60										
2003	29	65	129									
		76	130									
2002	32	63	147	198								
		77	153	199								
2001	1	43	149	230	267							
		60	158	233	267							
2000	4	50	124	214	279	229						
		66	137	221	282	229						
1999	2	59	119	186	245	286	324					
		76	131	194	250	288	324					
1998	14	48	97	158	203	262	315	350				
		65	112	169	212	268	318	350				
1997	2	68	139	183	225	288	328	366	391			
		85	152	194	234	294	331	367	391			
1996	0	--	--	--	--	--	--	--	--	--		
		--	--	--	--	--	--	--	--	--		
1995	2	72	160	240	298	351	402	436	453	473	484	
		89	174	250	305	356	406	438	455	473	484	
1994	1	68	173	274	331	392	419	442	468	495	511	522
		86	186	283	338	397	423	445	470	496	511	522
Overall Mean		59	138	210	264	301	358	398	437	484	497	522
Weighted Mean		74	138	197	241	277	333	366	432	481	493	522
E. WA. Average		69	136	189	249	300	352	422	438			

Appendix 2. Back-calculated mean length at age (mm) of pumpkinseed sunfish collected at Deer Springs Lake (Lincoln County) during June 2005. Unshaded values represent length at age calculated using the direct proportion method (Fletcher et al. 1993). Shaded values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age						
Year class	**# Fish**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2004	0	0						
		0						
2003	3	25	69					
		42	73					
2002	16	21	58	96				
		41	69	98				
2001	21	22	60	99	129			
		43	74	106	130			
2000	1	30	69	113	149	161		
		50	83	121	151	161		
1999	0	0	0	0	0	0	0	
		0	0	0	0	0	0	
1998	2	25	56	90	118	139	150	161
		46	73	101	125	143	152	162
Overall Mean		24	63	100	132	150	150	161
Weighted Mean		42	72	103	131	149	152	162
State Average		24	72	102	123	139		

Appendix 3. Back-calculated mean length at age (mm) of yellow perch collected at Deer Springs Lake (Lincoln County) during June 2005. Unshaded values represent length at age calculated using the direct proportion method (Fletcher at al. 1993). Shaded Values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age				
Year class	**# Fish**	**1**	**2**	**3**	**4**	**5**
2004	0	0				
		0				
2003	24	48	117			
		67	120			
2002	31	54	111	163		
		75	121	165		
2001	0	0	0	0	0	
		0	0	0	0	
2000	5	50	112	164	207	236
		74	128	174	211	237
Overall Mean		51	113	164	207	236
Weighted Mean		72	121	166	211	237
State Average		60	120	152	193	206

Appendix 4. Back-calculated mean length at age (mm) of black crappie collected at Deer Springs Lake (Lincoln County) during June 2005. Unshaded values represent length at age calculated using the direct proportion method (Fletcher et al. 1993). Shaded values represent length at age calculated using Lee's modification of the direct proportion method (Carlander 1982).

		Mean total length (mm) at age			
Year class	**# Fish**	**1**	**2**	**3**	**4**
2004	0	--			
		--			
2003	1	32	96		
		57	102		
2002	1	29	88	166	
		58	105	167	
2001	1	28	76	158	211
		58	99	168	213
Overall Mean		30	87	162	212
Weighted Mean		58	102	168	213
State Average		46	111	157	183

Literature Cited

Anderson, R. O. and S. J. Guetreuter. 1983. Length, weight, and associated structural indices. Pages 283-300 *in* L. A. Nielsen and D. L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

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, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Bister, T. J., D. W. Willis, and M. L. Brown. 2000. Proposed standard weight (Ws) equations and standard length categories for 18 warmwater nongame and riverine fish species. North American Journal of Fisheries Management.

Bonar, S. A., B. Bolding, and M. Divens. 1996. Management of aquatic plants in Washington state using grass carp: effects on aquatic plants, water quality, and public satisfaction 1990-1995. Washington Department of Fish and Wildlife, Research Report #IF96-05.

Boyd, E. C. 1990. Water quality in ponds for aquiculture. Birmingham Publishing Company, Birmingham, Alabama.

Carlander, K. D. 1982. Standard intercepts for calculation lengths from scale measurements for some centrarchid and percid fishes. Transaction of the American Fisheries Society111:332-336.

Chew, R. L. 1974. Early life history of the Florida largemouth bass. Florida Game and Freshwater Fish Commission, Fishery Bulletin No. 7, 76p.

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

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

Dion, N. P., G. C. Bortleson, J. B. McConnell, and L. M. Nelson. 1976. Reconnaissance data of lakes in Washington; Water-Supply Bulletin 43, Volume 6. Washington State Department of Ecology.

Dumont, S. C. and J. A. Dennis. 1997. Comparison of day and night electrofishing in Texas reservoirs. North American Journal of Fisheries Management 17:939-946.

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

Flickinger, S. A. and F. J. Bulow. 1993. Small impoundments. Pages 485-486 in C. C. Kohler and W. A. Hubert, editors. Inland Fisheries Management in North America. American Fisheries Society, Bethesda, Maryland.

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.

Jearld, A. 1983. Pages 301-324 *in* Nielson, L. A., and D. L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

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

Reynolds, J. B. 1996. Electrofishing. Pages 221-253 *in* B. R. Murphy and D. W. Willis, editors. Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, Maryland.

Swingle, H. S. 1969. Methods for the analysis of waters, organic matter, and pond bottom soils used in fisheries research. Auburn University, Auburn, Alabama.

Wetzel, R. G. 2001. Limnology-Lake and River Ecosystems, Third Edition. Academic Press, San Diego, California.

Wydoski, R. S. and R. R. Whitney. 2003. Inland Fishes of Washington, Second Edition. American Fisheries Society, Bethesda, Maryland, in association with the University of Washington Press, Seattle, Washington.