APPLEGATE LAKE

FISHERY ASSESSMENT

2003

Ian S. Reid
Fisheries Biologist
Rogue River-Siskiyou National Forest
Applegate Ranger District
(541) 552-2914
ireid@fs.fed.us

EXECUTIVE SUMMARY

Since 1989, over 40 acres of warmwater fish habitat have been enhanced in Applegate Lake by building structures and planting willows. In 2003, a fishery assessment was conducted in order to describe the Applegate Lake warmwater and coldwater fisheries and their users, and to evaluate the benefits of prior habitat enhancement projects to the warmwater fishery.

Long-term population surveys demonstrated that habitat structures attracted warmwater fishes, and that their growth rates and population structures were acceptable. Sunfish and large bass were more abundant in areas that had been enhanced.

Intensive creel surveys indicated that only 11% of the total angling effort in 2003 targeted warmwater fishes (10% bass and 1% sunfish), while 58% targeted trout, and 31% was not directed at any particular fish species. Bass catch rates and sizes were relatively high, while bass harvest rates were low. Slightly less than half of all anglers surveyed were aware of habitat enhancement projects. Bass anglers had the highest awareness of habitat projects, although they could only identify about 20% of the enhancement area locations.

Mail-in surveys determined that the most important reasons why all anglers fished at Applegate Lake were not related to catch or harvest, but aesthetic factors such as a relaxing atmosphere, few crowds, and clean, well-maintained facilities. Bass anglers believed that habitat enhancement was the best way to improve their fishing experience.

It was estimated that over 11,000 anglers fished Applegate Lake in 2003, spending over $300,000 to catch about 10,000 bass and 40,000 trout. Results suggest that the warmwater fishery has benefited from habitat enhancement, and is a productive but potentially under-utilized fishery resource.

MANAGEMENT RECOMMENDATIONS

- **Expand the seasonal and daily operating schedule of Hart-tish Park to accommodate anglers who fish in the spring and early in the morning.** Surveys found that May is the month of peak angler use and highest catch rates at Applegate Lake. The majority of Applegate Lake anglers surveyed used the facilities at Hart-tish Park including the store, fish-cleaning station, and universal access loading platform. Although Applegate Lake is open to angling year-round, the opening weekend of most Oregon trout fishing (the last weekend in April) is a logical date to open Hart-tish Park because of the full water levels and high angler use that usually occurs on this weekend. The entire month of April had relatively high angler use. Anglers have requested that Hart-tish Park open at dawn so they can launch their boats and start fishing early. Data predicts that expanding Hart-tish Park's operating schedule should result in increased revenue generated through use fees and concession sales.
- **Add a restroom at Copper boat ramp.** Surveys showed that the Copper boat ramp receives almost as much use as the Hart-tish ramp. Many anglers have requested that a restroom be added to Copper, in addition to other improvements. Roving surveys found the presence of human waste at the Copper boat ramp, which can be a potential health hazard.
- **Encourage angling for sunfish and especially bullhead.** The sunfish and bullhead fisheries can experience moderate to heavy pressure and harvest and are currently both under-utilized. A large proportion of Applegate Lake anglers do not target a specific fish species and could benefit from fishing for bullhead and sunfish.
- **Post Special Regulations signs at boat ramps and access points.** Surveys revealed that many anglers, especially those that don't target a particular species, are unaware of bass slot limits and illegal harvest of bass is occurring. Signs describing the bass regulations posted at access points should increase awareness and reduce illegal harvest.

- **Improve access at habitat structures located in the Carberry arm.** Few anglers, especially bank anglers, fished at these enhanced areas in 2003. Removal of non-native blackberry vines should improve access for bank anglers.
- **Estimate the population size of smallmouth and largemouth bass in Applegate Lake.** Having a reliable population estimate is essential when managing fisheries and tracking responses in fish populations relative to changing social, physical, and biological conditions within the reservoir.
- **Evaluate if angling catch rates differ in enhanced and un-enhanced areas.** Conduct a study to compare angler catch rates and size structures in both enhanced and control areas.
- **Expand future creel surveys to include the east side of Applegate Lake.** Pressure surveys found that relatively high bank angler effort occurs on this unimproved side of Applegate Lake. Expanding creel surveys to include this area could yield a more accurate description of catch rates and use trends.
- **Improve outreach related to the Applegate Lake warmwater fishery enhancement project.** Outreach could be achieved through media releases, public field trips, presentations at local angling clubs—especially warmwater clubs, and newspaper articles—especially in the Medford Mail Tribune, Grants Pass Daily Courier, and Applegator. Data suggest that current signage is not heavily used by anglers as a source of information. New signs or brochures placed in different locations may increase awareness about habitat enhancement projects and under-utilized fisheries existing within the reservoir.

TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

Figure Page

LIST OF TABLES

INTRODUCTION

Applegate Reservoir, commonly referred to as Applegate Lake, is a 988-acre multi-purpose reservoir located in the Siskiyou Mountains of southwestern Oregon near the California border (Figure 1). The reservoir was created in 1980 by impounding the Applegate River and several major tributaries including Carberry, Squaw, and Elliott creeks. The reservoir is relatively deep (maximum depth = 233 feet, mean depth = 83 feet, volume = 82,200 acre-feet), has a low proportion of shoal area (5%), and is moderately productive (Johnson et al. 1985). Applegate Lake is managed as a two-story recreational fishery with stocked coldwater species (rainbow and steelhead trout, and chinook and coho salmon) and naturally produced warmwater species (smallmouth and largemouth bass, bluegill, black crappie, and brown bullhead). Trout, salmon, sunfish, and bullhead are managed as a basic yield fishery and smallmouth and largemouth bass are managed as a quality fishery (ODFW 1993).

Since 1989, the USDA Forest Service (USFS) and the Oregon Department of Fish and Wildlife (ODFW) have enhanced over 40 acres of habitat for warmwater fishes by constructing brush rows, building log and boulder structures, and planting willows. While over $325,000 of grants, in-kind contributions, and appropriated monies have been used to enhance warmwater fish habitat in Applegate Lake from 1991-2003, a formal fishery analysis quantifying angler pressure, catch rates, harvest, demographics, and angler knowledge and values had not been conducted. The needs existed to determine current angler pressure in order to monitor use trends, and to assess responses in warmwater fish populations and angler knowledge to habitat enhancement.

PRIMARY STUDY OBJECTIVES

To describe the Applegate Lake fishery and its users, and to evaluate the benefits of prior habitat enhancement projects to the warmwater fishery.

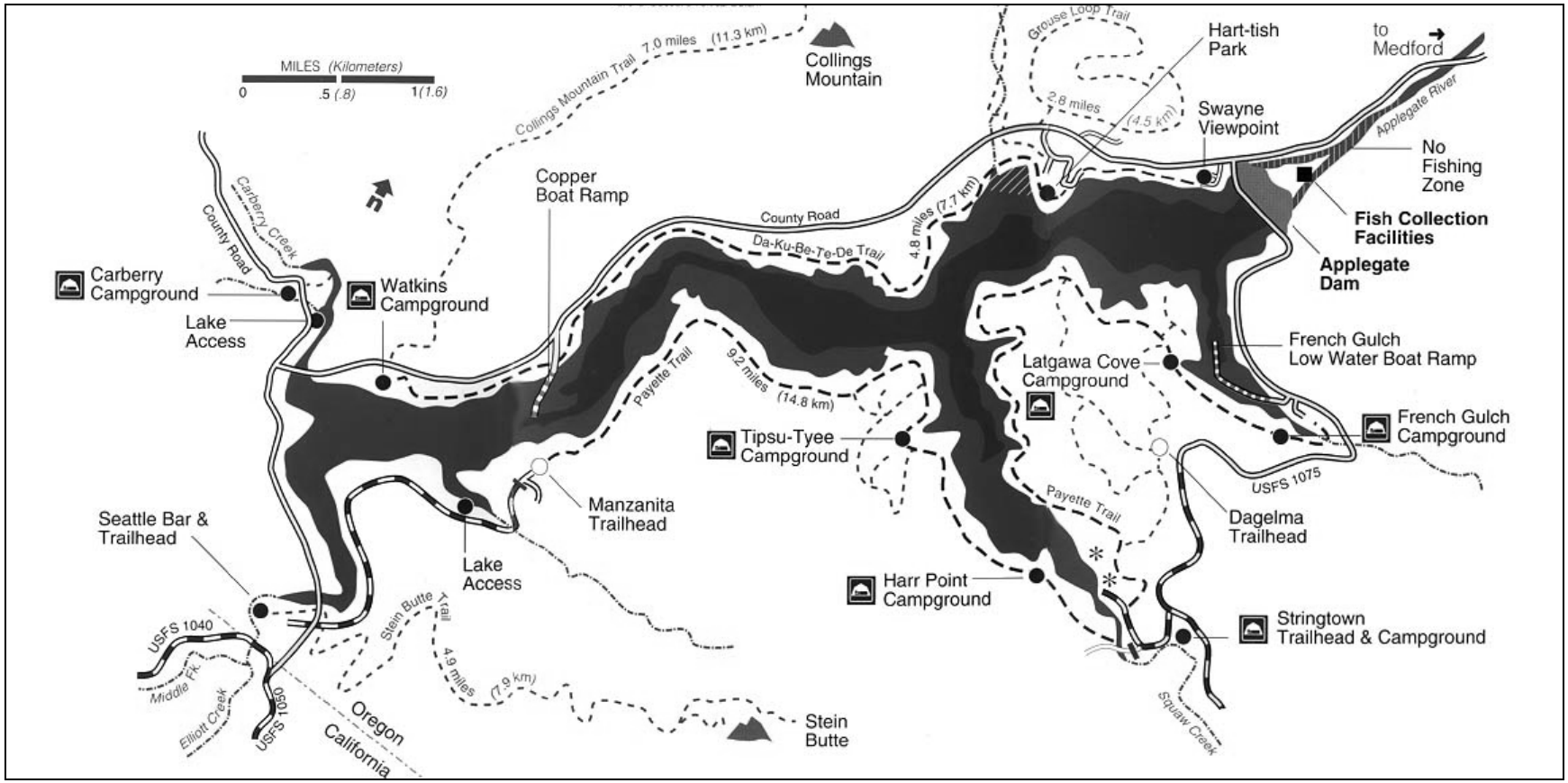

Figure 1. Map of Applegate Lake courtesy of U.S. Army Corps of Engineers.

STUDY GOALS

- To identify the type and relative abundance of game and non-game fishes present in Applegate Lake
- To analyze trends in warmwater fish abundance
- To determine if areas with habitat enhancement contain more and larger warmwater fishes than un-enhanced areas
- To estimate fish population structures and growth rates
- To quantify angler pressure, total catch, and catch rates of boat and bank anglers
- To calculate and compare harvest rates between different fish species
- To assess which species in this fishery are more desirable to anglers
- To evaluate awareness of habitat enhancement projects, and knowledge of the number and location of enhanced areas
- To determine how anglers receive information about habitat enhancement areas
- To estimate economic importance of the Applegate Lake fishery and compare expenditures among angler groups
- To assess which factors are most important in maintaining a quality fishing experience at Applegate Lake
- To quantify angler demographics including place of residence, age, gender, race, and income

METHODS

Fish Populations

Fish populations were sampled from 1982 to 2003 using multi-filament gillnets and boat electrofishing by USFS and/or ODFW crews. Gillnets were used to quantify abundance, relative abundance, and size of all fishes captured, while electrofishing was used to calculate abundance and size structures of warmwater fishes.

Gill net sampling was conducted 10 times between 1982 and 2003, usually in late fall. One 125-foot long research gill net with graduated mesh size was set perpendicular to the shore line using a 16-foot motorboat at each of three to four stations (Figure 2). Gill nets were set from 18 to 25 hours (mean = 22) and recovered the next day. Fish were removed from nets, identified, enumerated, measured, weighed, and sexed the same day they were collected at the ODFW District Office located in Central Point, Oregon. Fork lengths of collected fishes were measured to the nearest 0.1-inch on measuring boards, and a calibrated digital scale was used to weigh fishes to the nearest gram.

Electrofishing surveys were conducted nine times between 1990 and 2001 using a johnboat with a GPP-5 electroshocker adjusted to 50% of available voltage, 6 amps, and a pulse rate of 120. Electrofishing was conducted at night in late April or May. Five stations were established along the shoreline (Figure 2), although not every station was sampled every year. For comparisons, stations 1 and 3 were used to represent un-enhanced and enhanced areas respectively, because they were the most consistently sampled. The station 1 transect was located near the forebay of Applegate Dam and consisted largely of boulder and large cobble substrate including riprap. The station 3 transect was located in the Squaw Creek arm, which contained habitat enhancement such as brush rows and log structures, and had primarily sandy substrate. Sampling effort at stations 1 and 3 averaged 714 seconds.

Stunned fishes were collected with dip nets, identified, enumerated, measured (fork length) to the nearest inch, and released. Catch per unit effort (CPUE) for each transect was calculated by ODFW fisheries biologists as the number of fish caught per 1,000 seconds. ODFW and USFS biologists also calculated proportional stock density (PSD) for smallmouth bass by dividing the number of fish caught > 11 inches (quality) by the number of fish caught > 7 inches (stock size), and PSD for largemouth bass by dividing the number of fish caught > 12 inches (quality) by the number of fish caught > 8 inches (stock size). PSD is an index used to estimate if fish populations are balanced with quality and stock size fish. Anderson and Weithman (1978) suggested that an optimum PSD

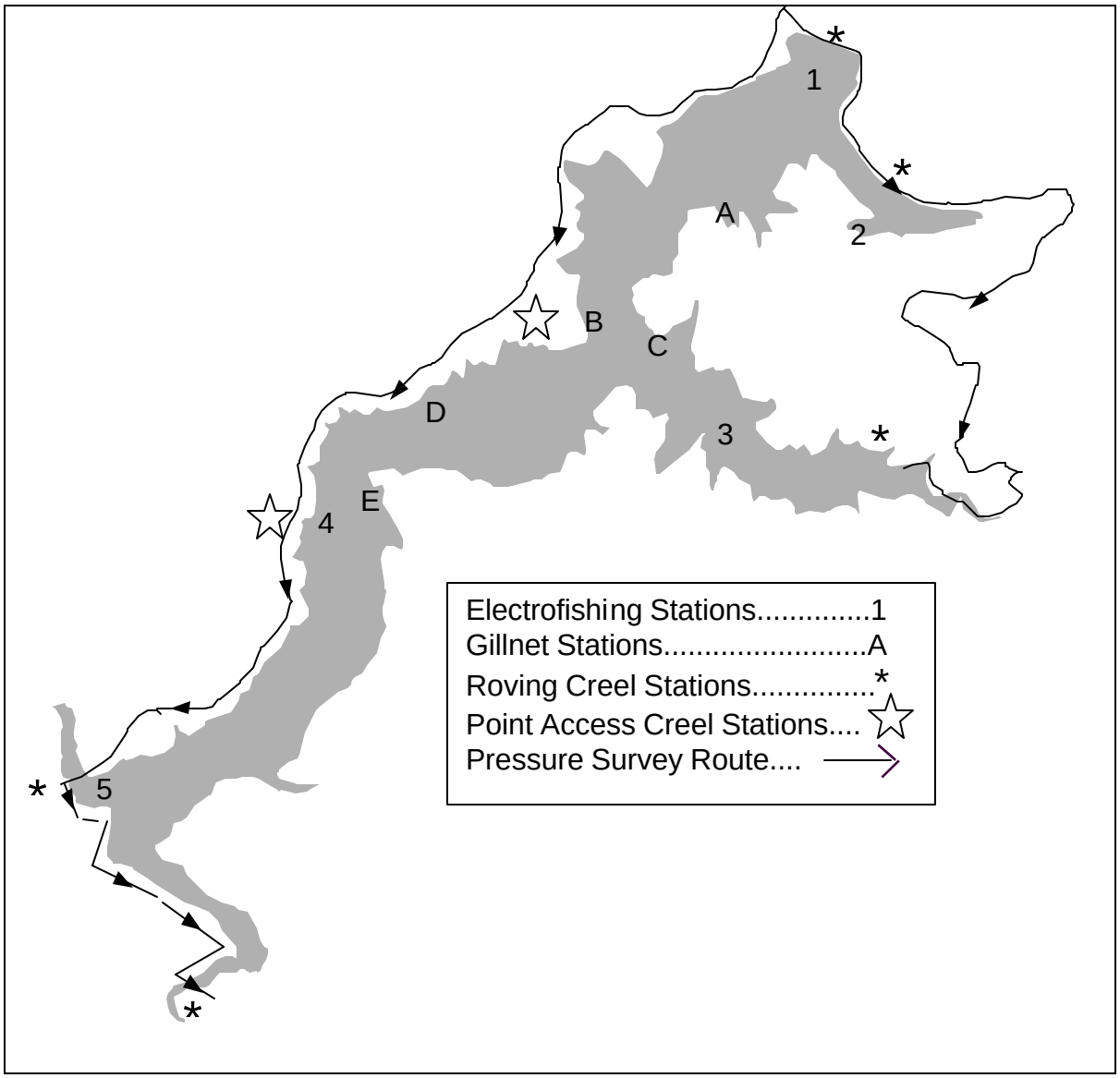

Figure 2. Map of survey stations at Applegate Lake.

for smallmouth bass populations should contain between 30 and 60 percent quality fish relative to stock size fish.

Condition factors for rainbow trout and chinook salmon were calculated using Fulton's index (*K*) described by the equation:

$$K = W \bullet 10^{5} \bullet L^{-3}$$

where *K* = condition, *W* = weight in grams, and *L* = length in millimeters. Condition indices were not calculated for warmwater fishes because they may not accurately estimate growth rates and detect size-related growth patterns such as stunting associated with overcrowding of juvenile fish (Gutreuter and Childress 1990).

As an alternative to condition factors, scale reading was used to determine growth and age relations of smallmouth bass and black crappie in Applegate Lake. Although scale reading can produce biases within age estimates of certain warmwater fishes (Long and Fisher 2001; Buckmeier 2002), it is a relatively cost-effective and reliable method used to age warmwater fishes and calculate growth rates (DeVries and Frie 1996). Smallmouth bass scales were collected by USFS employees and volunteers during 2003 from fish harvested by anglers using standard procedures (Schneider et al. 2000). Scales were mounted on glass slides and projected at 40x under a dissecting microscope. Mounted scales were read by two readers and differences in age determination between readers were resolved by re-reading scales (Orth et al. 1983). Length at age was back-calculated by projecting the scale at 32x using a microfiche reader, measuring the distance from the scale focus to the scale annulus of a given year, and using the equation described by Schneider et al. (2000):

$$L_n = (S_n \div S) \bullet (L - a) + a$$

where L_n = Length at a given annulus, S_n = distance from the focus to that annulus, *S* = scale radius, *L* = Fish Length, and *a* = a correction factor. For this study a standardized value of 35 mm was used for an *"a"* value for smallmouth bass (Carlander 1982). Black crappie scales were collected and read by ODFW employees in 1994. No largemouth bass scales were available for analysis.

On-Site Fishery Surveys

A complemented creel survey (Malvestuto 1983) was conducted by USFS employees and volunteers (creel clerks) from 12 April to 18 October 2003. Eight randomly generated days (four weekend or holiday and four weekday) were surveyed every complete month of sampling for a total of 47 sampling days. On each sampling date, fishery surveys consisted of a 4-hour point-access sampling period and 2 hours of pressure and roving creel surveys (one before and one after the point access survey), which accounted for 282 total hours of sampling effort (376 hours including travel time). Surveys were divided into late or early times (Thiesfeld et al. 1995) and equal numbers of early and late surveys were conducted each month (Appendix A). The maximum number of anglers counted during either the first or second pressure survey was doubled to estimate total daily pressure.

Monthly pressure was expanded by calculating mean daily survey pressure during a given month, doubling to account for early and late use periods, and then multiplying by the number of days in the respective month. Pressure was expressed in terms of angler-days (1 angler-day = 8 hours of angling use) and recreational visitor days or RVDs (1 RVD = 12 hours of use).

Only point-access surveys were used to calculate catch rates because of inherent catch rate biases in roving surveys (Hayne 1991). However, roving survey data were used in calculating harvest rates and target species, assessing angler knowledge regarding location of habitat enhancement areas, and for receiving input from primarily bank anglers. Total catch was expanded by multiplying known angler CPUE for a given species and size class (determined by onsite creel surveys) by the total number of angler-hours estimated during the study period. Target species were classified into four categories: trout (rainbow, cutthroat, winter steelhead, chinook and coho salmon), bass (smallmouth and largemouth), sunfish (black crappie and bluegill), and any (no particular fish species was being targeted). If anglers had already been surveyed at Applegate Lake during 2003, they were not asked questions related to values, attitudes, and demographics; only those related to catch and effort.

Harvested fishes were identified and measured by creel clerks to the nearest 2-inch size class (total length), except warmwater fishes which were measured to the nearest millimeter.

Mail-in Fishery Surveys

In order to determine angler values, attitudes, and socioeconomics (Hudgins and Malvestuto 1996), a fishery survey was designed using standard protocols (Pollock et al. 1994) and mailed to 173 Applegate Lake anglers who gave their addresses to creel clerks during on-site interviews (Appendix B). The survey was mailed out on 31 October along with a technical brochure describing fishing opportunities at Applegate Lake (Appendix C), a cover letter from the Applegate District Ranger, and an addressed, metered, return envelope.

RESULTS AND DISCUSSION

Fish Populations

While there can be limitations in using gillnets to describe fish assemblages related to varying catch susceptibility among different species, gillnet survey data showed the Applegate Lake fish assemblage contained nine species and was dominated by Klamath smallscale sucker, a native non-game species (Figure 3). Stocked juvenile salmonids (rainbow trout and chinook salmon) were approximately five times more abundant in gillnet catches than were naturally-produced warmwater fishes. Coho salmon have been occasionally stocked at Applegate Lake, but were not observed in gillnet surveys. Naturally-produced cutthroat trout were also absent from gillnet surveys, and bluegill were not observed in gillnet surveys until 1998.

Although the most abundant fish sampled in Applegate Lake gillnet surveys was a non-game species that does not contribute directly to the fishery, juvenile suckers may provide quality forage for warmwater fishes, especially smallmouth and largemouth bass. It is unknown if warmwater fishes in Applegate Lake affect sucker population dynamics and recruitment. However, 98% of all

suckers sampled in gillnets were greater than 8 inches long (mean = 12.6 inches), suggesting a population comprised of older individuals with poor recruitment.

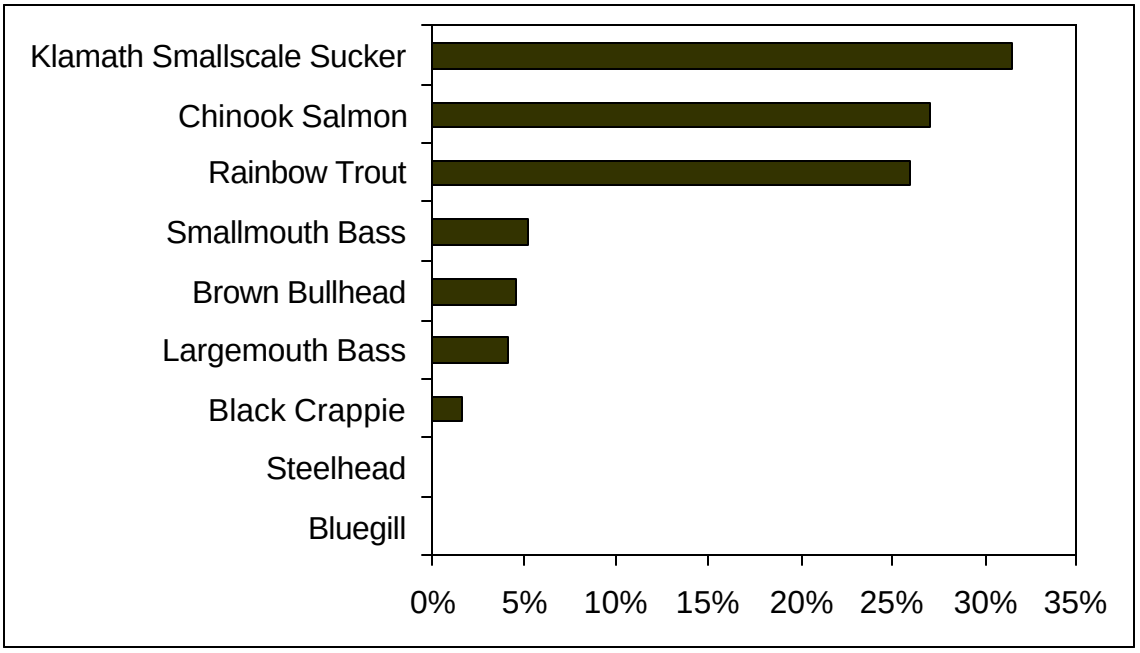

Figure 3. Relative abundance of 790 fish sampled during 1982-2003 Applegate Lake gillnet surveys.

Size-class distributions of stocked rainbow trout and chinook salmon showed that most rainbow sampled were 8-10 and most chinook were 6-8 inches long (Figure 4). Few rainbow larger than 14 and few chinook larger than 12 inches were caught in gillnets. This implies slowed growth at larger size classes or high mortality related to fishing or environmental factors. Comparing condition factor (*K*) of rainbow trout and chinook salmon showed a similar pattern in body condition between species, with a mean condition factor always above 1.0 (Figure 5). This suggests that stocked salmonids are experiencing satisfactory growth, and that the lack of larger size classes of salmonids in Applegate Lake is likely related to high mortality or genetics. USFS scale analysis showed juvenile chinook in Applegate Lake became sexually mature at the end of their second year of life. Consequently, it is unlikely that any chinook live past two years, but are able to grow 12-14 inches in less than three years in Applegate Lake.

Electrofishing CPUE varied for warmwater fishes between enhanced and un-enhanced areas (Figure 6). Smallmouth bass CPUE was always higher, by as much as 20 times, in un-enhanced areas. Largemouth bass CPUE was generally higher in enhanced areas, especially after the mid-1990s when more area had been enhanced in the Squaw Creek arm. These results were similar to Bryant (1992) who found that largemouth and smallmouth bass densities in a northern California reservoir were not necessarily higher in areas enhanced with habitat structures than un-enhanced rocky points such as those located in station 1 at Applegate Lake.

Black crappie and bluegill catch rates were almost always higher in enhanced areas. Bluegill have shown strong attractions to areas containing structures (Johnson et al. 1988). Bluegill were first observed in electrofishing surveys in 1995, and it is unknown if they are affecting the black crappie population through competition or juvenile predation as previously documented (Kim and DeVries 2001). Black crappie were not observed during electrofishing in either enhanced or un-enhanced areas in 1999 and 2001, but bluegill also showed a decreasing trend in abundance (Figure 6).

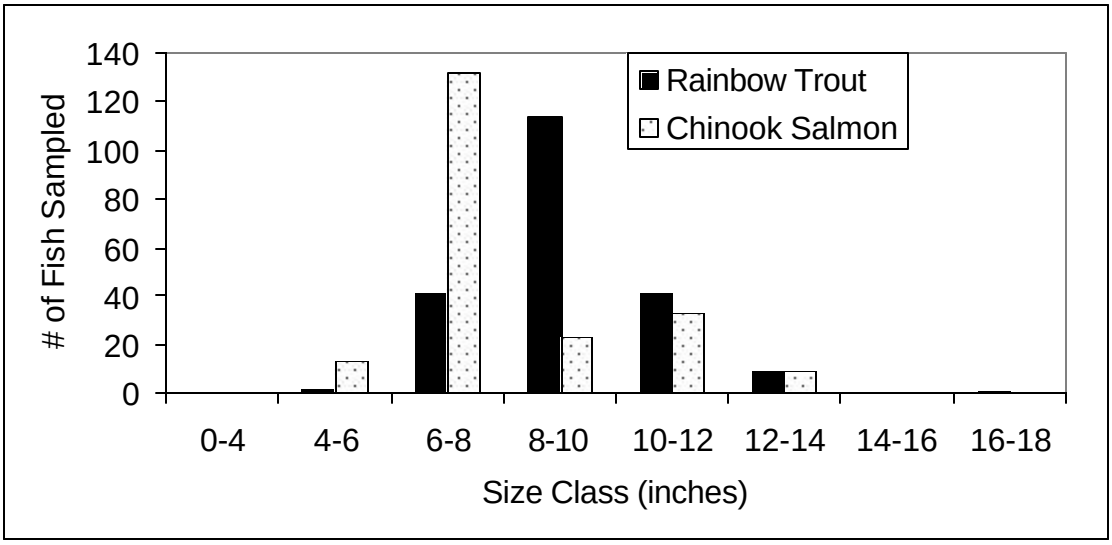

Figure 4. Size-class distribution of stocked salmonids in Applegate Lake sampled during gillnet surveys from 1982-2003.

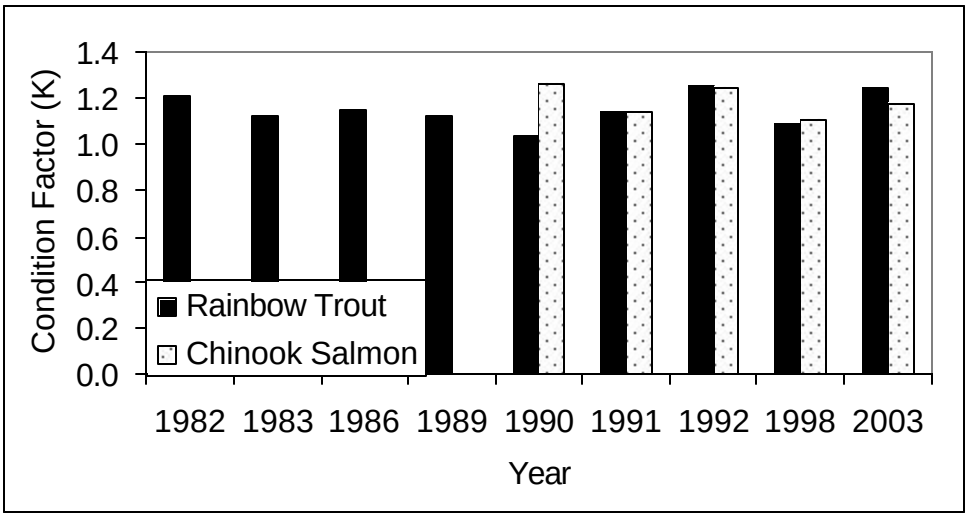

Figure 5. Mean annual condition factor (*K*) for stocked salmonids at Applegate Lake sampled from gillnet surveys.

Comparing proportional stock densities between un-enhanced and enhanced areas showed that quality smallmouth (> 11 inches) and largemouth (> 12 inches) bass were more likely to be found in enhanced areas than un-enhanced areas (Figure 7). High PSDs of 1.0 showed that areas in Applegate Lake enhanced with structures were dominated by large fishes. These results agree with Bennett (2002) who found that wood structures located in bare substrates attracted the largest and oldest warmwater fishes in shoal areas of seven Willamette Basin reservoirs. No largemouth bass were found in un-enhanced areas in Applegate Lake after 1992. This observation, combined with decreasing electrofishing catch rates of largemouth bass between 1990 and 2001 (Figure 6), suggests that enhanced areas may provide refugia for largemouth bass from competition from smallmouth bass. Current research has found that while largemouth and smallmouth bass use different habitat types within lakes (Olson et al. 2003), they have enough overlap in their diets during similar life stages to be considered strong competitors (Olson and Young 2003).

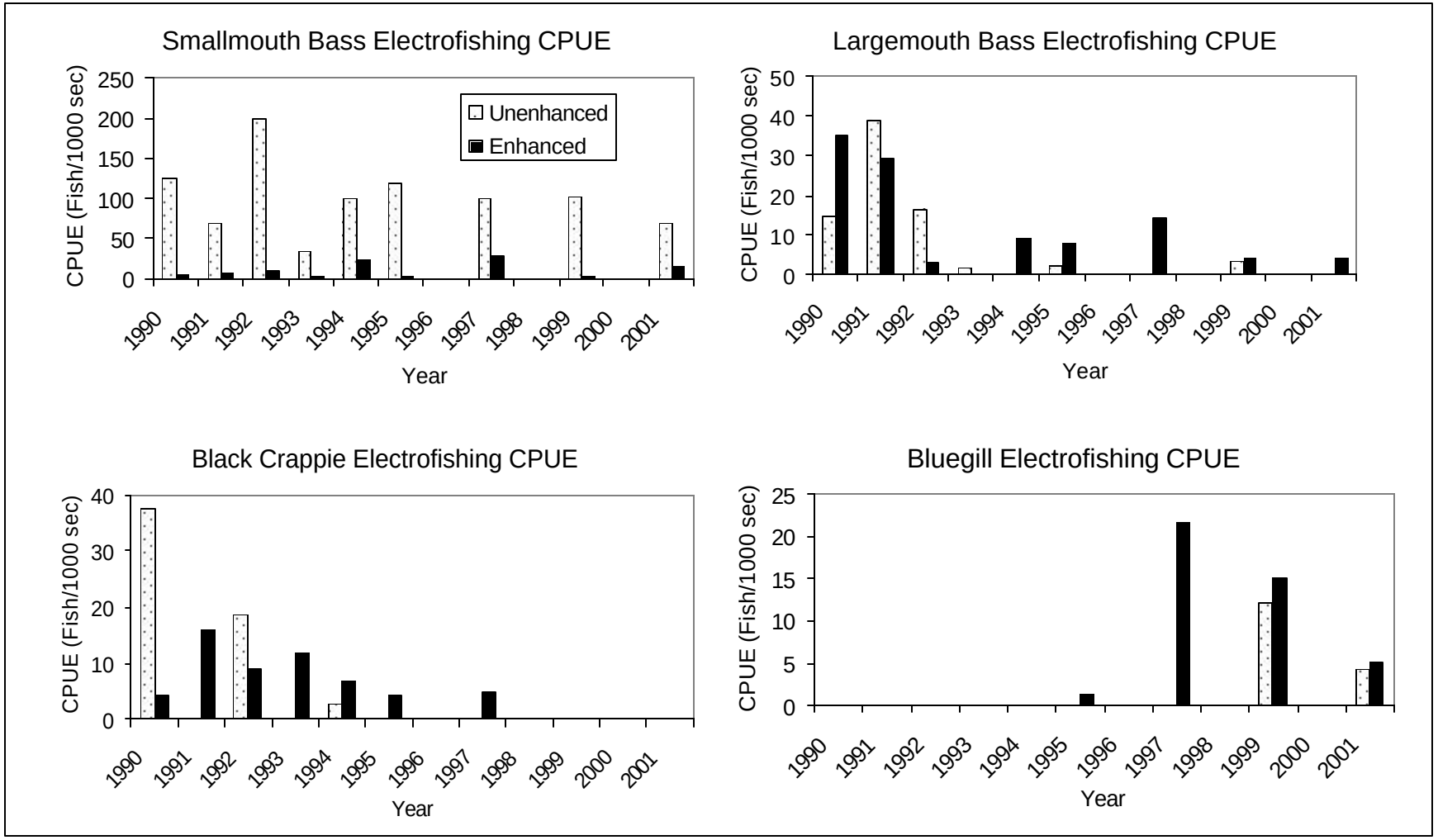

Figure 6. Electrofishing CPUE (fish caught per 1,000 seconds) of black bass and sunfish in enhanced (station 3) and un-enhanced areas (station 1) in Applegate Lake. *Note different y-axis scales used.

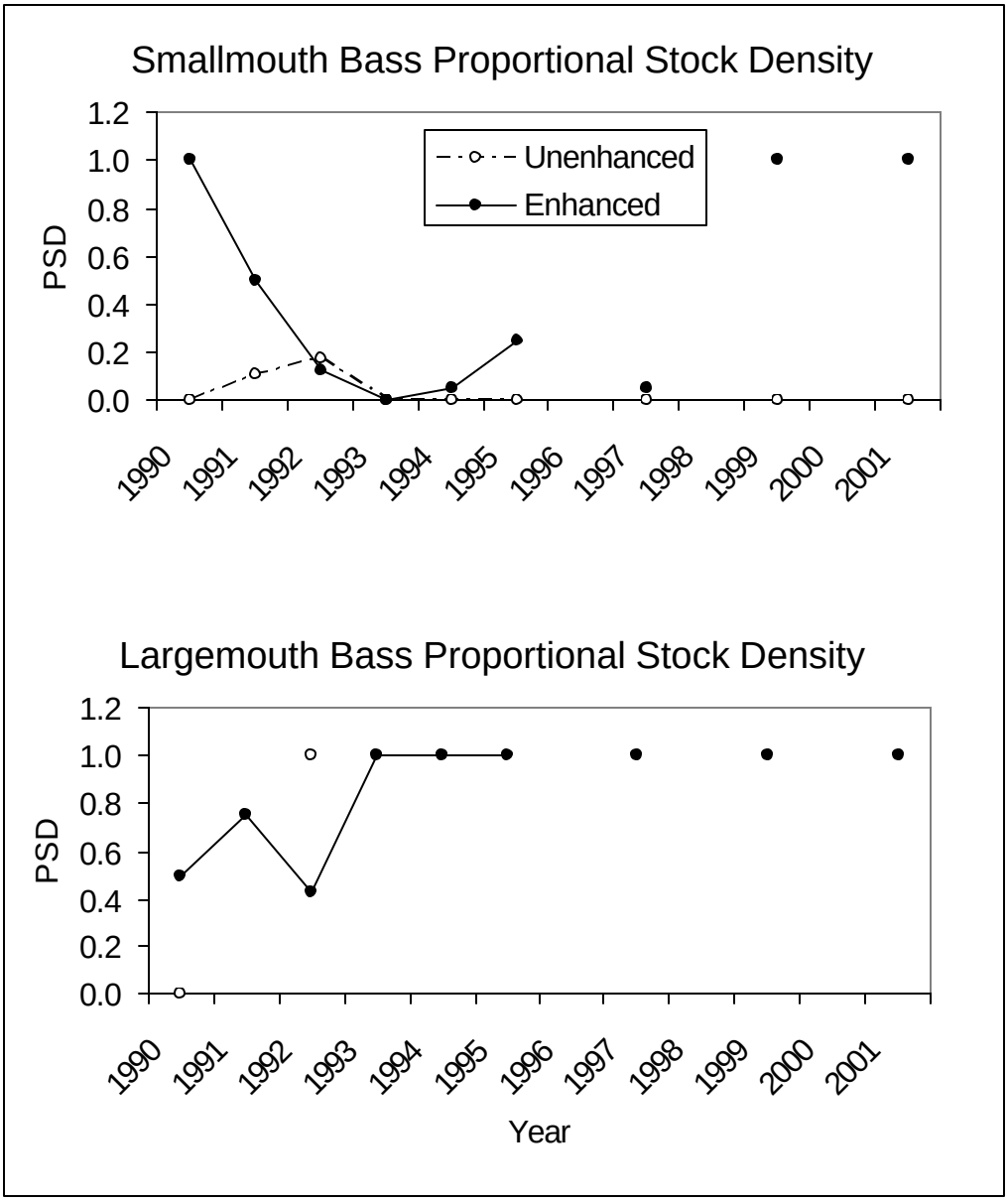

Figure 7. Smallmouth and largemouth bass proportional stock density (PSD) in enhanced and un-enhanced areas in Applegate Lake.

Length-weight regressions from basses collected during gillnet surveys show that smallmouth bass grew slightly heavier in relation to length than largemouth bass (Figure 8). These data also suggest that smallmouth bass in Applegate Lake have a competitive advantage over largemouth bass.

Subsequently, in order to maintain a largemouth bass population in Applegate Lake, it may be necessary to create their preferred habitats such as log and brush structures and aquatic vegetation through enhancement projects. While others have found it difficult to detect a response in warmwater fish populations relative to large scale reservoir enhancement (Allen et al. 2003), it appears that a positive association exists between enhanced areas, smallmouth bass size, and largemouth bass presence in Applegate Lake.

Scales were collected and read from 16 Applegate Lake smallmouth bass in 2003 (Table 1). Average lengths at age of smallmouth bass in Applegate Lake were similar to, or slightly longer than, those calculated from Lost Creek Reservoir in 1994; except for age-1 fish, which were substantially longer in Applegate Lake (Figure 9). This difference in length at age indicates that young-of-the-year smallmouth bass grew faster in Applegate Lake than Lost Creek Reservoir for reasons that may be related to habitat enhancement in Applegate Lake. Lengths of older fish (age 5 and 6) were calculated from only one fish in each reservoir and may not represent the entire population.

Scales read by ODFW in 1993 and 1994 also showed that black crappie growth rates were higher in Applegate Lake than other southern Oregon reservoirs, with the exception of Lake Selmac (Figure 10). While warmwater fish growth rates can be affected by both density-independent factors such as water temperature and primary production and density-dependent factors such as competition and limited habitat availability, it is likely that enhancement projects can also increase juvenile warmwater fish growth rates by creating additional habitat and subsequently decreasing competition.

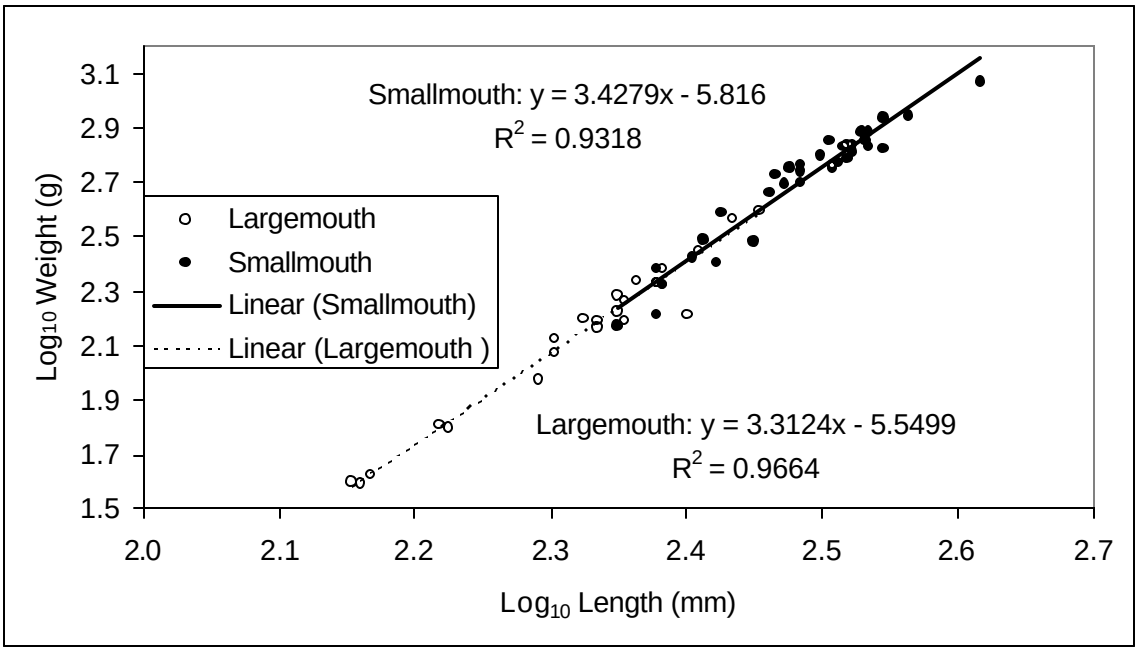

Figure 8. Log weight-length regression for smallmouth and largemouth bass sampled during gillnet surveys at Applegate Lake 1982-2003.

Table 1. Length at age of smallmouth bass collected from Applegate Lake.

Number of Fish	Age	Average Total Length (mm)	Calculated Length at Age (mm)				
0	1		1	2	3	4	5
4	2	220	126	220			
3	3	259	116	177	259		
8	4	305	114	158	202	305	
1	5	335	107	154	202	236	335
16		Mean (mm)	117	177	217	297	335
		Mean (inches)	4.6	7.0	8.6	11.7	13.2
		Growth (inches)	4.6	2.3	1.6	3.1	1.5

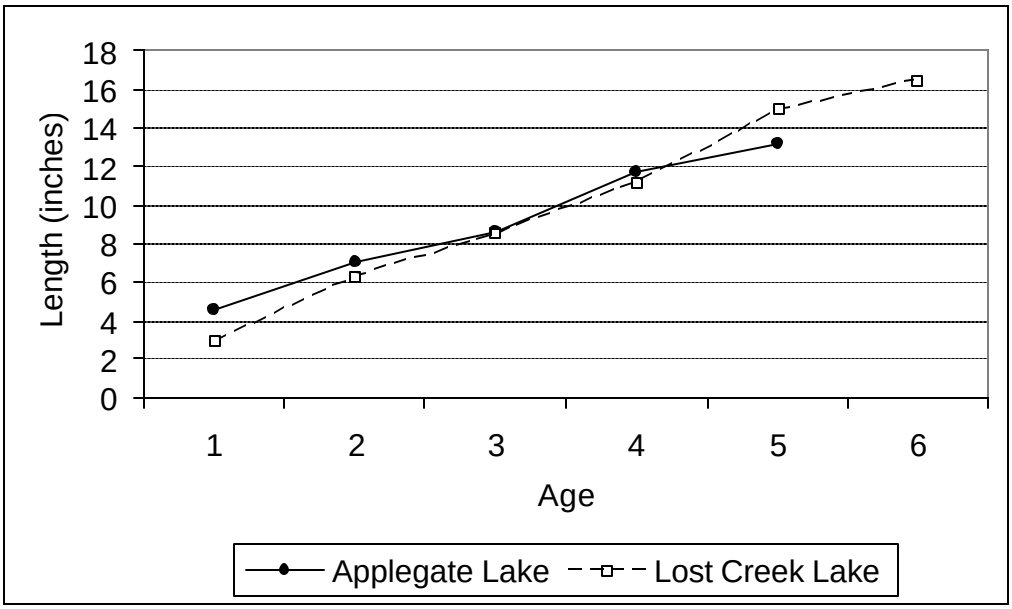

Figure 9. Mean length at age of smallmouth bass from Applegate and Lost Creek lakes. Lost Creek scales collected and read in 1994 by ODFW. Applegate scales collected and read in 2003 by USFS. Length of 5 and 6 year old bass were calculated or back-calculated from only one specimen from each lake.

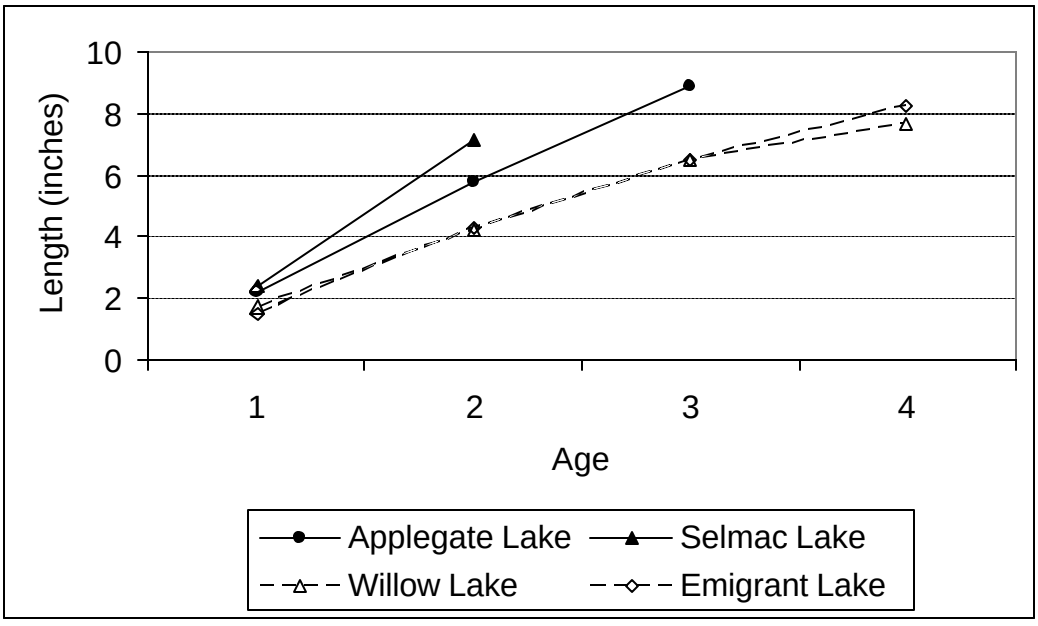

Figure 10. Mean black crappie length at age from Applegate Lake and other southern Oregon reservoirs. Scales collected and read in 1993 or 1994 by ODFW.

Fishery

During the 2003 study period (April through October), 271 angler interviews representing 575 anglers were conducted. Ten percent of these interviews (27) were anglers that had been previously surveyed this season. During the study period, it was estimated that 10,075 anglers spent 39,649 hrs fishing at Applegate Lake (Table 2). Total angling effort during this period accounted for 4,956 angler-days or 3,304 Recreational Visitor Days (RVDs). Because of a depressed local and regional economy, it is probable that angler effort estimated for Applegate Lake in 2003 was lower than would have been generated in a typical year. A creel survey of Lost Creek Reservoir during April through October 1993, estimated three to four times the number of anglers (34,922) and effort (152,074 angler-hours) than the current study estimated for Applegate Lake (Daily 1996). A 1997 creel survey of Emigrant Reservoir estimated less use (8,965 anglers) and effort (33,490 angler-hours), but only sampled four months (Daily 1999). Some of this variation in angler effort between Applegate Lake and other local reservoir fisheries is likely related to changes in socioeconomic conditions.

In Applegate Lake, both bank and boat angler pressure peaked in May, with bank pressure decreasing rapidly throughout the summer months (Figure 11). This decrease in bank anglers might have been related to the increased use of popular bank fishing spots by swimmers and other recreationists. When recreationist pressure increased at day-use areas sampled during roving surveys, bank angler pressure appeared to shift to undeveloped areas on the east side of the lake adjacent to Road 1041. Bank anglers using these areas were counted in pressure surveys, but not interviewed. Total angling effort during the survey period was relatively similar between boat and bank anglers, which differed from other local mixed-stock recreational fisheries where either bank (Daily 1999) or boat angler (Daily 1996) effort greatly exceeded the other.

Table 2. 2003 Estimated Applegate Lake angler effort by month and type.

Month	Angler-days						
	Bank[1]	Boat[1]	Trout	Bass	Sunfish	Any	Total[1]
April	527	373	528	62	0	310	900
May	544	609	750	38	0	365	1,154
June	444	497	534	76	0	331	941
July	308	601	534	158	0	217	909
August	237	368	259	138	0	207	604
September	69	145	127	17	0	0	215
October	114	118	93	0	47	93	233
Total	2,244	2,712	2,824	490	47	1,524	4,956

[1]Bank and Boat effort is for all species combined. Total = Bank + Boat, or the sum of all four fish classes.

About 58% of the total angling effort during the study period targeted trout, 31% any fish species, 10% bass, and 1% sunfish. The proportion of anglers targeting bass never exceeded 20% for any month, and was highest in August when the proportion of anglers targeting trout was lowest (Figure 12). Sunfish were rarely targeted (one interview out of 271) and the proportion of anglers who targeted any species remained nearly constant throughout the study period at about 33%. Brown bullhead and cutthroat trout were absent from angler catch records.

An extrapolation of angler pressure for 2003 outside the study period (January through March and November through December) was calculated by forecasting a best-fit line to the observed pressure data (Figure 13). The function that best represented the data set was a fifth-degree polynomial with a correlation coefficient of 0.67 and the equation: $y = -2E\text{-}7x^4 + 0.0254x^3 - 1442x^2 + 4E+7x - 3E+11$. This best-fit line estimated that angler pressure in January through March was slight and pressure in November and December was similar to levels observed in September and October (Table 2), and resulted in a total estimate of 11,335 anglers who spent 41,936 hours fishing (5,242 angler-days or

3,495 RVDs) in 2003. This extrapolation corresponded fairly well to anecdotal observations made during these off-seasons when the lake is drawn down and the weather is often inclement, except that slight pressure occurred in late February and March and it is likely that less occurred than estimated in late fall. Estimated pressure during the study period accounted for almost 89% of the total angler effort estimate for 2003.

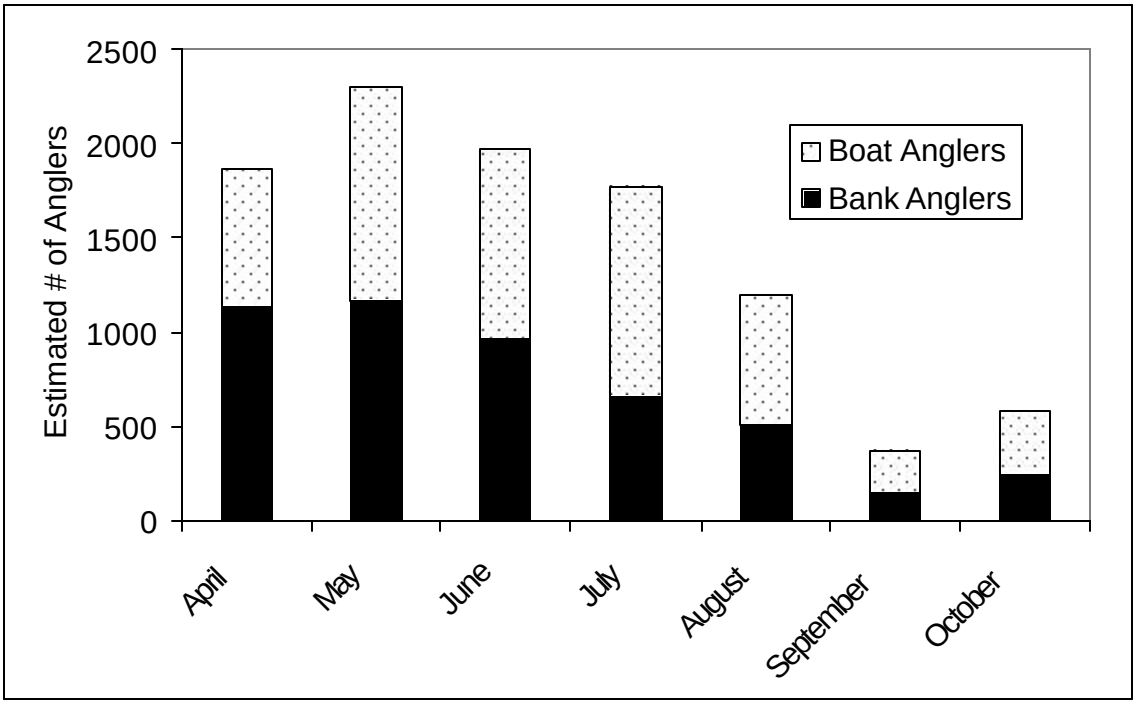

Figure 11. Estimated monthly angler pressure at Applegate Lake during the study period, total = 10,075 anglers.

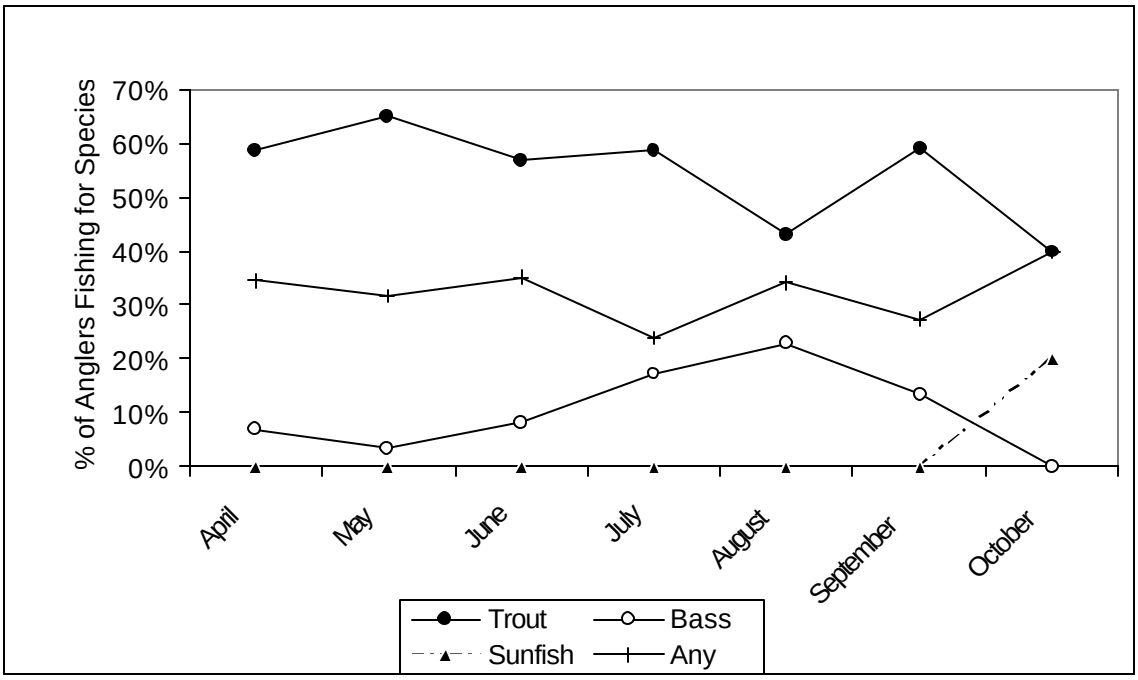

Figure 12. Mean monthly proportion of Applegate Lake anglers that targeted a particular fish species from April through October 2003.

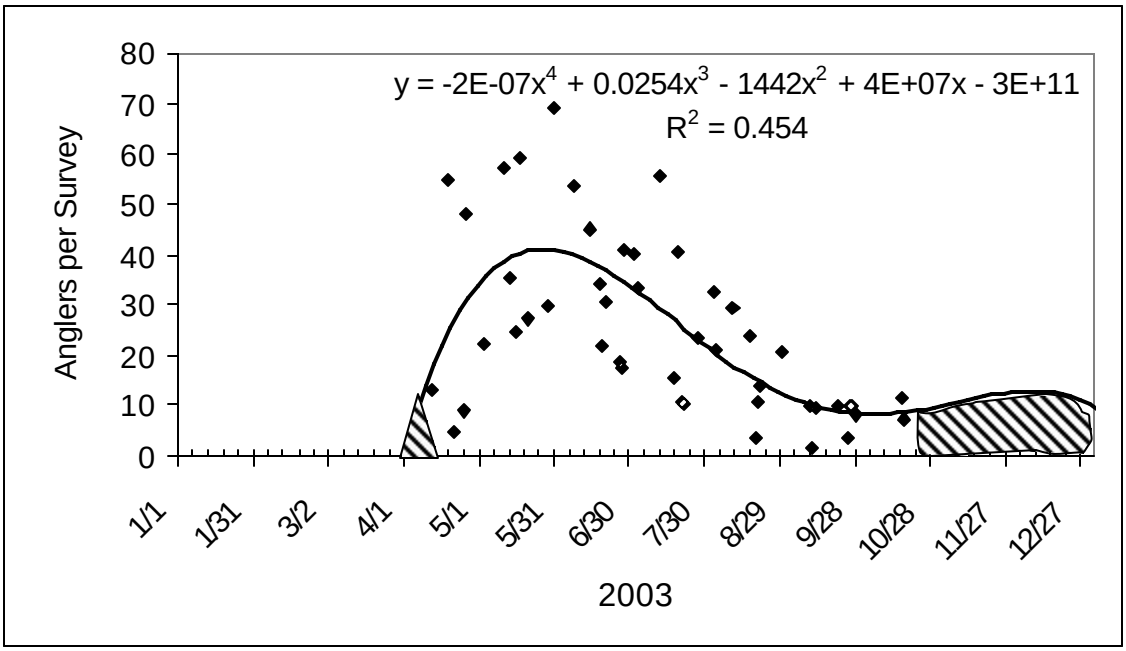

Figure 13. Extrapolated angler pressure at Applegate Lake outside the study period (area under the curve in the shaded areas), Total estimate = 11,335 boat and bank anglers.

During the study period, anglers caught an estimated 40,728 trout (30,933 rainbow, 9,635 chinook, 156 brook, and 156 steelhead); 9,791 bass (9,518 smallmouth and 273 largemouth); and 3,199 sunfish (2,067 black crappie and 1,131 bluegill). Angler catch data supported electrofishing data and incidental observations that suggest the largemouth bass population is substantially smaller than the smallmouth bass population at Applegate Lake.

During the study period, average monthly catch rates for trout ranged from 0.2 to 1.1 fish per angler-hour, while bass average monthly catch rates ranged from 0.2 to 1.6 fish per angler-hour. Peak angler CPUE for both bass and trout occurred in May, with trout catch rates decreasing and bass catch rates increasing throughout the summer months (June through August) (Figure 14). These results were similar to those observed in Lost Creek Reservoir where trout catch rates peaked in May and bass catch rates peaked in June (Daily 1996). During October, no bass anglers were interviewed and sunfish CPUE was highest (1.6 per angler-hour) in October, the only month any anglers reported targeting sunfish. Average catch rates for trout and bass were similar to, or higher than, those observed previously in Lost Creek and Emigrant reservoirs (Daily 1996, 1999).

Harvest rates for all combined size classes were highest in chinook salmon (64%) and rainbow trout (59%) and lowest in largemouth (0%) and smallmouth (11%) bass (Figure 15). Harvest rates calculated using only legal (> 8-inch) chinook and rainbow were slightly higher at 67% and 62% respectively. These findings were similar to those observed in Lost Creek Reservoir where 80% of trout and 8% of bass caught were harvested (Daily 1996). About 35% of both sunfish species caught in Applegate Lake were harvested. This finding was similar to the average black crappie harvest rate (33%) observed in Emigrant Reservoir from 1995-1997 (Daily 1999). While harvest rates of bass at Applegate Lake were relatively low due to catch-and-release methods common with bass anglers, an estimated 1,326 smallmouth bass were harvested during the study period. This total included an estimated 234 bass between the size of 12 and 16 inches. It is likely that many of these 234 fish were outside of the current slot

limits (zero bass harvested between 12 and 15 inches and only one over 20 inches) and would have been harvested illegally. No harvested trout or salmon were observed that were less than the 8-inch minimum size. Brook trout were only reported to be caught once during the current study and were all released. Brook trout are not stocked in Applegate Lake and might have dispersed downstream from high-elevation lakes in the headwaters of the Applegate River, or the caught trout might have been misidentified by an angler.

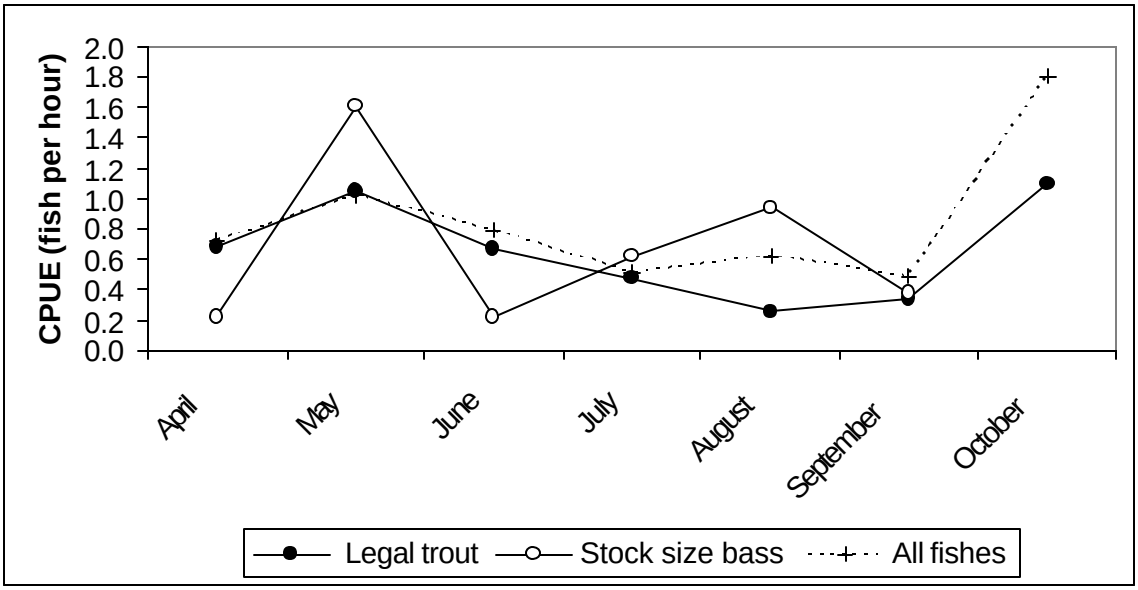

Figure 14. Applegate Lake CPUE (fish per angler-hour) during the study period based on target species from point-access creel interviews only. For this analysis, stock-size bass and legal trout includes all fishes 8 inches and longer.

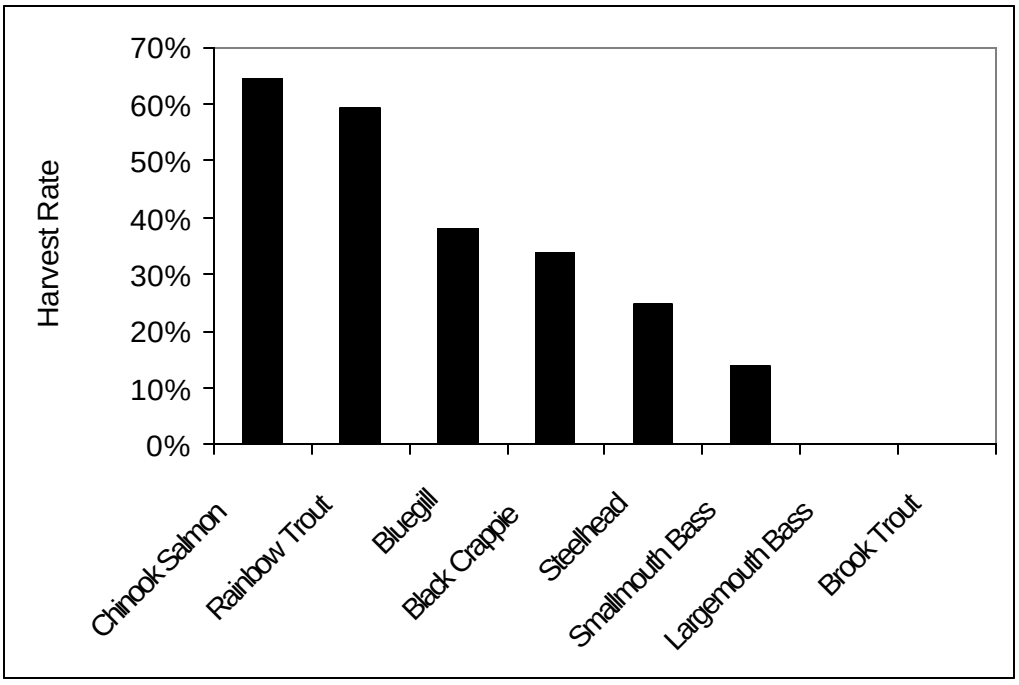

Figure 15. Harvest rates of all fish species caught at Applegate Lake in 2003 calculated from roving and point-access creel interview data.

Most rainbow trout caught and harvested were in the 10-12 inch size class, while most chinook salmon caught and harvested were in the 12-14 inch size class (Figure 16). Also, most smallmouth bass caught and harvested were in the 10-12 inch size class, while all trophy smallmouth bass (16-20 inches) were released after catching (Figure 17). The large proportion of smallmouth bass caught greater than 10 inches long indicates that current slot limit regulations set by ODFW are effective in helping to achieve the management goals of a quality smallmouth bass fishery.

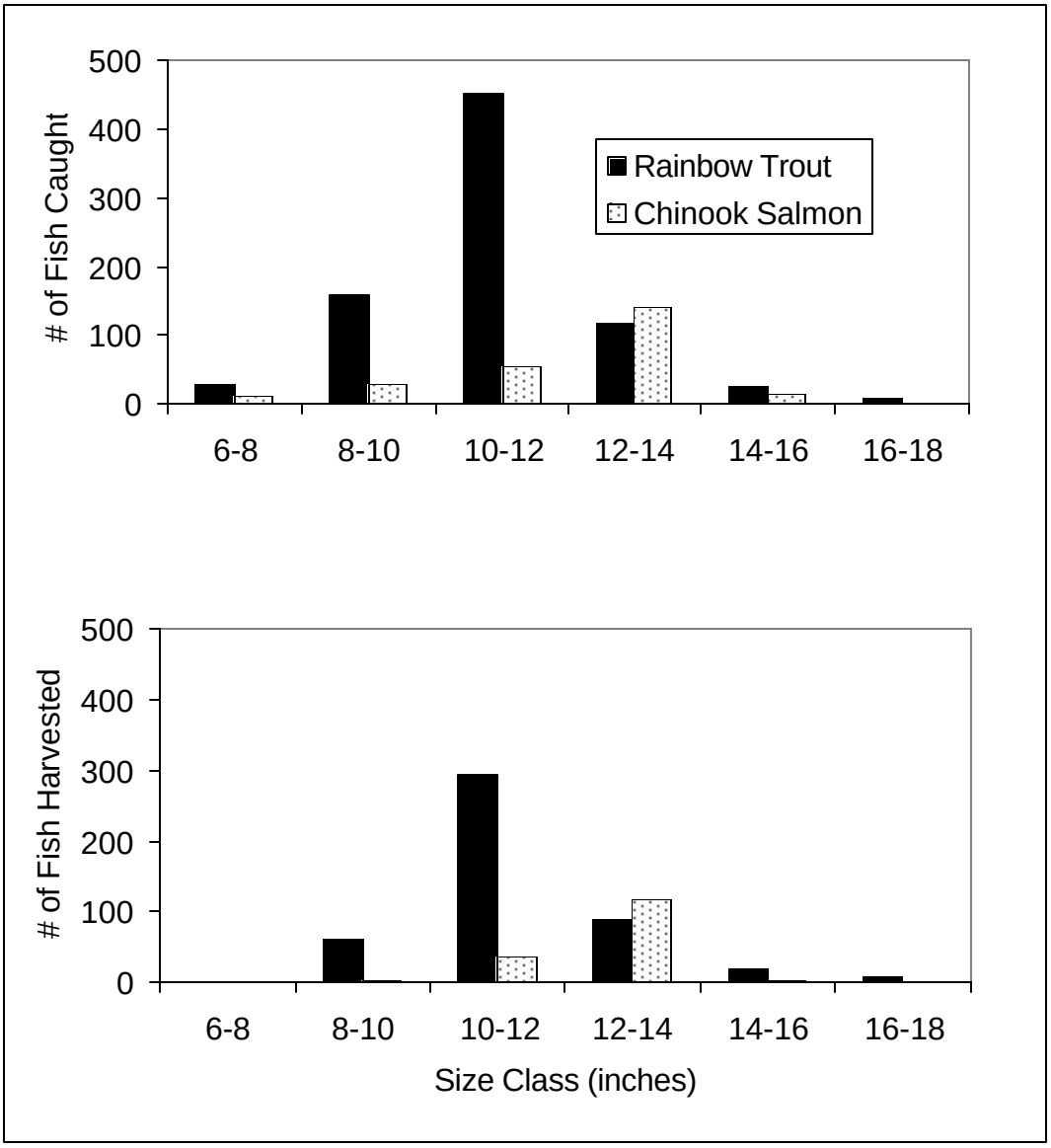

Figure 16. Observed catch and harvest size-class distributions of stocked juvenile salmonids at Applegate Lake.

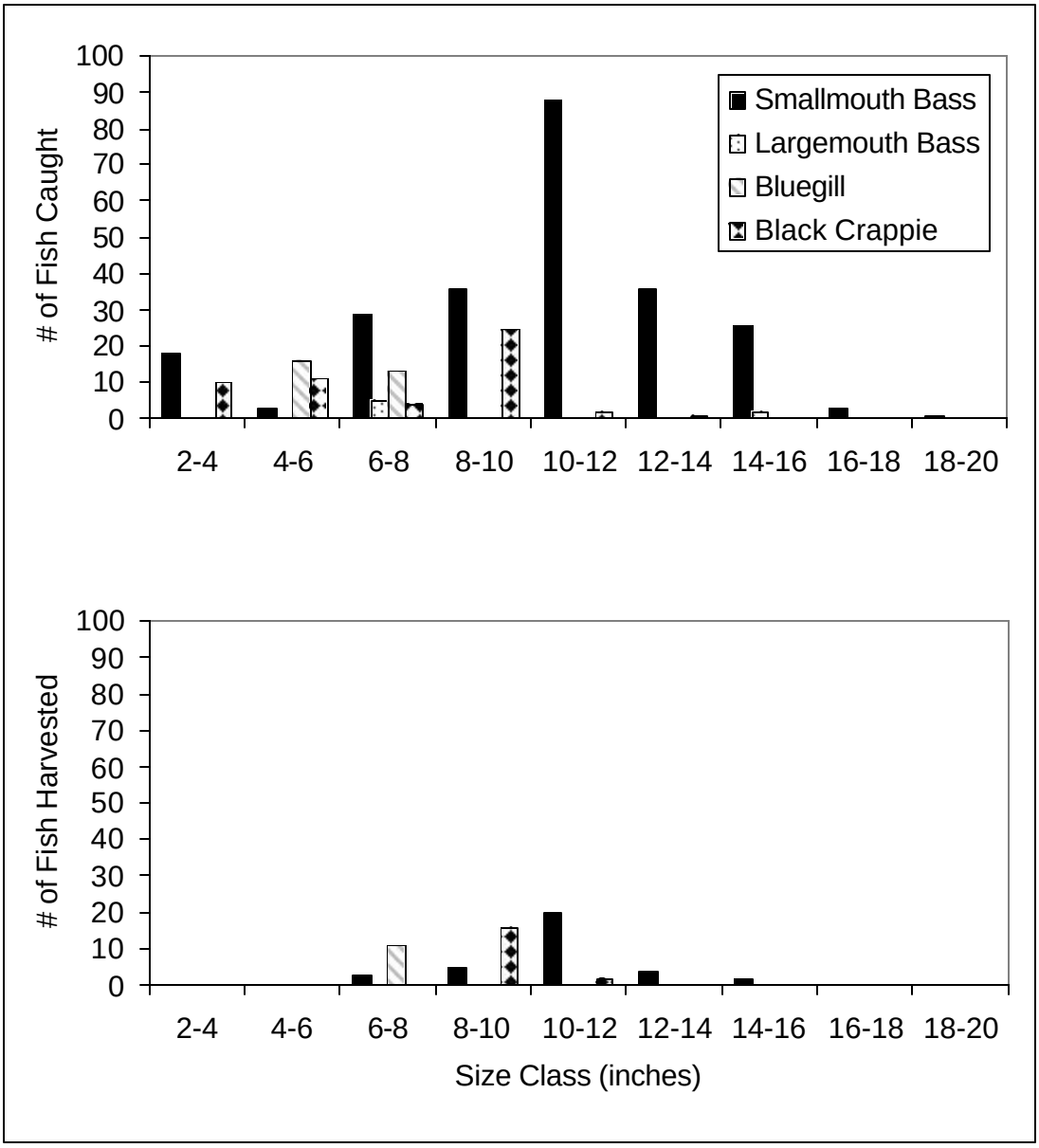

Figure 17. Observed catch and harvest size-class distributions of warmwater fishes at Applegate Lake.

Angler Knowledge, Values, and Demographics

On-site Interviews

About 48% of 517 anglers interviewed (58% of boat anglers and 22% of bank anglers) were aware that warmwater fish habitat enhancement projects had been conducted at Applegate Lake. Bass anglers had the highest awareness of

habitat projects (79%), while anglers who targeted any species had the lowest (39%) (Figure 18). The lowest awareness of habitat enhancement (19%) was observed in bank anglers who fished for any species. Among the anglers that were aware that habitat enhancement projects had occurred, 77% could identify at least one location containing structures in the lake. However, on average, anglers could only identify two (median) to three (mean) locations where habitat structures had been installed. At least 10 general areas have been enhanced in Applegate Lake through a combination of brush rows, log structures, and willow planting.

About 76% of the anglers who were aware of the habitat enhancement projects found out by direct observation—usually when the lake was drawn down—while 13% learned by word of mouth, 8% by newspapers (Medford Mail Tribune and Applegate River Watershed Council's Applegator), and 3% by television news programs. No anglers reported finding out about habitat enhancement projects or their locations from signs—such as those located in an interpretive kiosk at Hart-tish Park—or the internet. Lack of knowledge related to signage could have been related to the late installation of the signs at Hart-tish Park in 2003 (mid-June) or other reasons including the use of other access points. In over 90 pressure surveys, observed angler use of the structures was very low, especially by bank anglers, even when pressure in the rest of the lake was relatively high (Figure 19).

From 175 anglers who gave their address of residence, the overwhelming majority (98%) were people that resided locally within the Rogue basin. The other 2% of the anglers surveyed also lived in Oregon (one respondent each from Eugene, Prineville, Brookings, and John Day). In contrast, a 1993 creel survey of Lost Creek Reservoir found that anglers from outside the local area comprised 15-30% of angler effort during peak months (Daily 1996). This difference in angler demographics may help explain some of the variation in angler effort between Applegate and Lost Creek reservoirs. When comparing Applegate Lake angler residence within the Rogue basin, 55% came from the major cities of

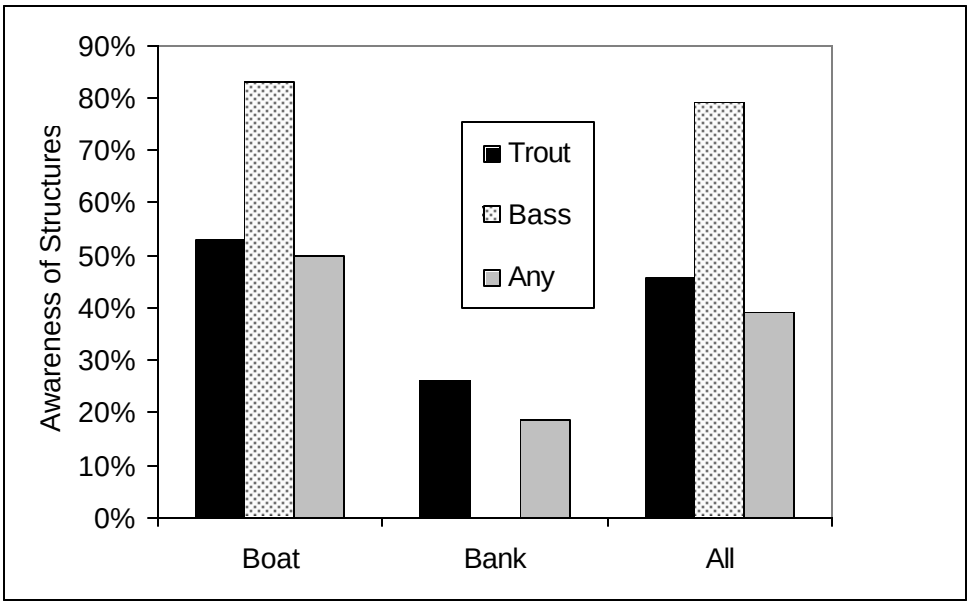

Figure 18. Proportions of 575 anglers that were aware that habitat enhancement project had been implemented in Applegate Lake. Only one bass bank angler was interviewed during the study period.

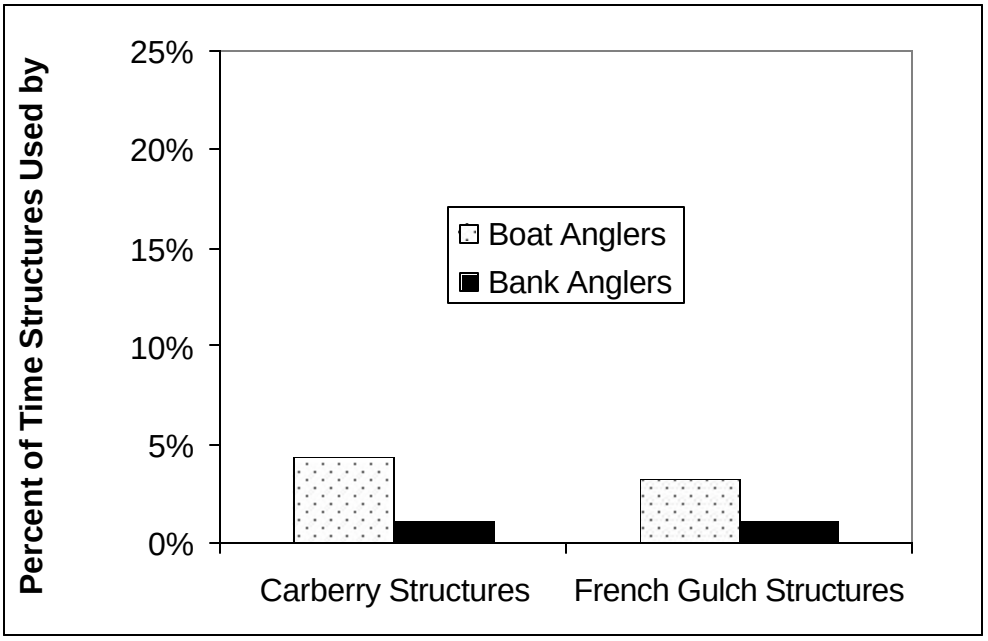

Figure 19. Proportion of anglers observed fishing at the habitat structures located in French Gulch and Carberry Creek arms during 93 pressure surveys.

Medford and Grants Pass, while 36% lived in rural or outlying communities (Figure 20). Fourteen rural communities were represented with the outlying towns of Jacksonville, Williams, and Applegate accounting for almost 55% of the rural Applegate Lake anglers (Table 3).

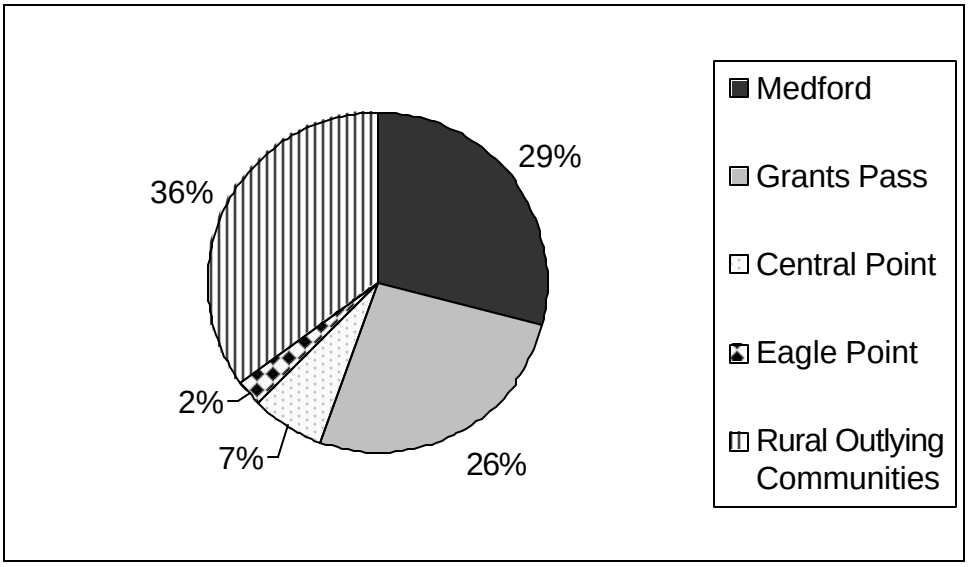

Figure 20. Residence location of 171 Applegate Lake anglers who lived within the Rogue basin.

Table 3. Percentage of 60 Applegate Lake angler residences located in rural or outlying communities within the Rogue basin.

Town of Residence	Proportion
Jacksonville	33%
Williams	18%
Applegate	12%
Rogue River	7%
Murphy	7%
Cave Junction	5%
Merlin	3%
Talent	3%
White City	3%
Phoenix	2%
Wilderville	2%
Ruch	2%
Shady Cove	2%
Gold Hill	2%

Mail-in Surveys

Sixty-five mail-in surveys were returned by 31 December for a 38% response rate. On average, survey respondents fished Applegate Lake 14 days per year and spent 5.8 hours fishing per trip. This high average annual use suggests that the mail-in survey data may have experienced a non-respondent bias (Pollock et al. 1994) where serious anglers were more likely to respond to mail-in surveys than the occasional recreational anglers.

It was estimated that in 2003, the average angler spent almost $27.00 per trip, and all anglers spent almost $303,000 fishing at Applegate Lake (Table 4). The average amount spent on a fishing trip at Applegate Lake was considerably less than trout angler expenditures estimated during 1989 and 1990 ($39.00 - $71.00) in the southern Sierra Nevada Mountains (Lechner and Pustejovsky 1993). Bass anglers spent more money per trip than any other type of angler using Applegate Lake, but trout anglers contributed the most to the yearly total. It is likely that this expenditure estimate, like the effort estimate, is lower than what would have been observed in a typical year due to socioeconomic factors experienced in 2003 (i.e. depressed economy). Survey respondents spent more money on gas than any other item, including food and beverages, bait and tackle, and use fees (Table 5). However, the majority of expenditures were items that could have been purchased at the Hart-tish store.

Table 4. Estimated angler expenditures at Applegate Lake during 2003.

Mean	Angler Type				
	Trout	Bass	Sunfish[1]	Any	All
$ Spent/Trip	$24.59	$31.44	$29.57	$29.57	$26.78
Trip Length (Hours)	5.5	6.6	6.6	6.6	5.8
Angler Trips/Year	6,878[2]	1,061	101	3,295	11,335
$ Spent/Year	$169,162	$33,363	$2,987	$97,438	$302,949

[1]Assumes that sunfish anglers spent the same amount of time and money per trip as anglers who pursued any species.

[2] Includes all angler pressure extrapolated outside the April-October study period.

Table 5. Mean expenditures by item per angler-trip at Applegate Lake during 2003.

Item	Mean Expenditure
Gas	$12.22
Food and Beverages	$7.30
Bait and Tackle	$5.51
Use Fees	$3.16
Lodging	$0.17
Other	$0.29
Total	$26.78

According to answers from 63 survey respondents, the most important factors determining why all angler types fished at Applegate Lake were aesthetically-related such as a relaxing atmosphere, few crowds, and clean, well-maintained facilities (Table 6). Catch or harvest related factors were generally less important than aesthetic factors among all angler groups. Most factors had similar rankings between trout and bass anglers, except the type and size of fish caught were more important to bass anglers than trout anglers. These results agree with Ross and Loomis (2001) who found that trout and bass anglers shared many motives for going fishing, and that bass anglers prefer quality (fewer large fish) over quantity (many small fish caught).

About 92% of survey respondents used boat ramps at Applegate Lake, 59% used both the store and the fish-cleaning station located at Hart-tish Park, and 51% used the universal access boat-loading platform at Hart-tish during a previous fishing trip. In addition, 56% of survey respondents participated in at least one other activity during a prior fishing trip to Applegate Lake. About 50% of survey respondents engaged in swimming, 33% hiking, 25% camping, 8% mountain biking, and 15% other activities including picnicking, photography, and prospecting.

Table 6. Relative importance of factors determining why anglers fished at Applegate Lake during 2003. Listed values are means for angler types; 3 = neutral, 4 = relatively important, 5 = very important.

Factor	Angler Type			
	Trout	Bass	Any	All
Relaxing Atmosphere	4.4	4.2	4.4	4.3
Few Crowds	4.2	4.1	4.6	4.3
Clean, Well-maintained Facilities	4.3	3.8	4.5	4.2
Close to Home	3.7	4.2	4.0	4.0
Type of Fish Caught	3.3	4.2	4.3	3.9
Spend Time with Friends and/or Family	3.9	3.4	4.3	3.9
Size of Fish Caught	3.4	3.9	4.2	3.9
Number of Fish Caught	3.5	3.6	3.9	3.6
Number of Respondents	38	9	16	63

The boat ramp at Hart-tish was used most frequently by survey respondents (43%), followed closely by the Copper boat ramp (36%). The ramp at French Gulch was used less (21%) than the other two, but is closed during much of the peak use season. Forty-two percent of survey respondents replied that the boat ramps were crowded or in need of maintenance. However, some of the improvements suggested by respondents at the French Gulch ramp (e.g. paving or grading) have already been corrected since the survey. The most common suggestions for improving the launch sites were to install restrooms at Copper and to keep the ramps clear of floating debris.

About 16% of all survey respondents and 22% of trout anglers felt the fishing experience at Applegate Lake was satisfactory, and no improvements were necessary (Table 7). The highest priority for all anglers to improve their fishing experience at Applegate Lake involved modifying the current stocking program, with more anglers requesting to stock larger fish than more fish (Appendix D). Observed and estimated angler catch rates, size class distributions, and motives for fishing at Applegate Lake (Table 6) all suggest that

the trout and salmon stocking program is working well, and needs little modification. However, estimated catch of rainbow trout in Applegate Lake in 2003 was above the number stocked in 2003, implying that if future trout harvest rates increase, catch rates may fall steeply. Conversely, estimated chinook catch was a small fraction of the number stocked annually, suggesting that even if trout become over-fished, there may be enough chinook present to sustain a successful recreational coldwater fishery.

When comparing anglers' top three areas to improve, enhancing habitat was most important to bass anglers, modifying the stocking program was most important to trout anglers, and improving existing or adding new facilities was most important to anglers who did not target any particular species (Table 8). Other suggestions for improvements were related to increasing boat speed limits and the amount of security or agency presence at the lake (Appendix D).

The average survey respondent was a 58 year-old white (96%) male (97%) with a median household income of $42,900. Two percent of survey respondents were Hispanic and 2% were Native American.

ACKNOWLEDGEMENTS

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Table 7. Survey respondents' highest priority for improving the fishing experience at Applegate Lake.

Improvement Area	Angler Type			
	Trout	Bass	Any	All
Modify stocking program by stocking more, larger, or different species	44%	33%	31%	39%
Nothing is needed; the fishing experience at Applegate Lake is satisfactory	22%	11%	8%	16%
Improve existing or add new facilities (boat ramps, restrooms, parking, etc.)	7%	0%	38%	14%
Enhance habitat for warmwater fishes by creating structure and cover	4%	33%	8%	10%
Other	11%	0%	8%	8%
Change fishing regulations	0%	22%	8%	6%
Limit large fluctuations in water levels throughout the season	11%	0%	0%	6%
Provide better public information on fishing opportunities at Applegate Lake	0%	0%	0%	0%

Table 8. Survey respondents' top three areas that need improvement at Applegate Lake.

Improvement Area	Angler Type			
	Trout	Bass	Any	All
Modify stocking program by stocking more, larger, or different species	24%	15%	21%	21%
Improve existing or add new facilities (boat ramps, restrooms, parking, etc.)	17%	7%	29%	17%
Limit large fluctuations in water levels throughout the season	19%	19%	8%	17%
Enhance habitat for warmwater fishes by creating structure and cover	6%	26%	21%	13%
Other	13%	7%	8%	11%
Provide better public information on fishing opportunities at Applegate Lake	7%	15%	4%	8%
Nothing is needed; the fishing experience at Applegate Lake is satisfactory	10%	4%	4%	7%
Change fishing regulations	4%	7%	4%	5%

thanks go to the anglers who took the time to answer questions during on-site interviews and mail-in surveys.

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