ROSS LAKE RAINBOW TROUT STUDY

1994-95 FINAL REPORT

by

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May, 1995

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Project Funding from
Skagit Environmental Endowment Commission
(SEEC Project No. 94-08)

ACKNOWLEDGMENTS

Numerous people provided invaluable assistance and support during the course of this study. Therefore, I wish to extend my heartfelt thanks to the following individuals and organizations for making this progress report possible:

Members of the Skagit Environmental Endowment Commission (SEEC) for continued funding of the study and their concern for the future of the Ross Lake fishery;

Jim Johnston, WDF&W Area Fisheries Biologist, for project supervision, guidance, manuscript review, and intense committment to conservation of fisheries resources;

Jeff Burrows, independent contractor for the British Columbia Ministry of Environment, for data collection in 1994;

Don Looff, for (opening day) data collection in 1994;

Tom Barnett and *Carol Barnett*, Ross Lake Resort, for use of facilities, boat engine maintenance and repair, lodging, meals, evening satellite television entertainment, and concern for the well-being of the Ross Lake rainbow trout;

Employees of the National Park Service (NPS) for sampling permits and loan of communication equipment;

Brad Howell, Seattle City Light, for providing reservoir levels; and

Kay Bowers, for proofreading.

ABSTRACT

The Washington Department of Fish and Wildlife conducted a rainbow trout study on Ross Reservoir from June 1, 1994 to May 31, 1995. This investigation was the fifth and final year of a study to evaluate the effect of special sport fishing regulations (implemented at the beginning of the 1990 fishing season) on reversing a historic decline in size and numbers of rainbow trout at Ross Lake. Study objectives included estimation of harvest and catch statistics for all species of trout and char, analysis of rainbow trout life history information, and estimation of the total size of the overwintering fish population. A stratified random sampling design was used to develop all effort, catch and harvest estimates.

Ross Lake anglers fished a total of 28,177 hours during the 1994 fishing season, or 7,960 angler days. The total seasonal rainbow trout harvest estimate was 2,196 fish, with a mean seasonal harvest rate of 0.076 fish per hour. Total catch (harvested + released) was estimated at 18,745 rainbow trout, with a mean catch rate of 0.648 fish per hour. Total seasonal dolly varden/bull trout char, brook trout (char), and cutthroat trout harvest estimates were 5, 0, and 0 fish, respectively. Total catch was estimated at 108 dolly varden char, 25 brook trout (char), and 7 cutthroat trout.

The new angling regulations continue to have significant impacts on angler effort, harvest rates, and harvest at Ross Reservoir. Estimated 1990-94 seasonal angler effort, harvest rates, and harvest remain markedly less than during the the early 1970's and mid-1980's. Compared to 1993 estimates, total 1994 seasonal angler effort increased 26 percent, mean seasonal harvest rates (combined species) decreased 21 percent, and total harvest (combined species) did not change.

Four hydroacoustic surveys were conducted on the lower portion of Ross Lake during April of 1995. These surveys are a continuation of annual index counts that are also used to estimate the total size of the reservoir fish population (fish larger than six inches). The total combined reservoir species population was estimated at 72,730 fish, while the rainbow trout portion of the population was estimated at 72,191 fish. Index counts and population estimates continue to increase each year, and probably reflect increasing numbers of immature age classes of fish.

No spawning surveys were conducted in 1995, due to termination of the project study before the start of the rainbow trout spawning season. Previous surveys indicate that peak spawning usually occurs during the first two weeks of June, with Roland Creek normally recording the largest number of spawning fish. Roland Creek and Dry Creek have historically been the most important index tributaries due to fish accessibility, flow, spawner use, availability of spawning habitat, and

visibility and accessibility by survey personnel. Observations of spawning rainbow trout from 1991-94 indicate that numbers continue to increase each year, but still remain below mid-1980's levels.

Data collected from the 1990-91, 1991-92, 1992-93, 1993-94, and 1994-95 rainbow trout studies at Ross Reservoir indicate the fish population is still suffering from the effects of past overharvest. These studies suggest the present rainbow trout population is increasing, but is still below early 1970's levels. Continued evaluation and monitoring of the fish and fishery in response to the new regulations is necessary to promote recovery of rainbow trout stocks in Ross Reservoir.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

Page

LIST OF APPENDICES

LIST OF APPENDICES (continued)

INTRODUCTION

This report summarizes the results of an angler harvest and rainbow trout study conducted on Ross Reservoir from June 1, 1994 to May 31, 1995. This is the final year of a five-year study by the Washington State Department of Fish and Wildlife (WDF&W) to evaluate the effect of special fishery regulations designed to reverse the decline in size and numbers of rainbow trout in Ross Lake (Johnston 1989; Looff 1991, 1992a, 1992b, 1993a, 1993b, 1994a, 1994b, 1995a). These regulations were implemented at the beginning of the 1990 sport fishing season by both the WDF&W and the British Columbia Division of Fish and Wildlife (BCF&W), and are identical for both agencies *(Appendix 1)*.

The new fishery regulations are more restrictive than earlier regulations, and are expected to reduce angler harvest (reduced catch limit) and allow fish to spawn at least once before entering the fishery (increased minimum size limit). A bait restriction was necessary to reduce mortality of released fish, and a later season opener was enacted to permit spawning fish more time to ascend tributary streams before the fishery opened, and also to allow both Canadian and American anglers equal access to the lake on opening day. Johnston (1989) gives a complete list of all Washington State fishing regulations on the reservoir since 1933.

This study was funded by the Skagit Environmental Endowment Commission (SEEC). The SEEC solicits, approves, and funds projects from a special fund using money set aside by Seattle City Light as part of a U.S. Federal Energy Regulatory Commission (FERC) permit requirement.

Previous Studies

The present study is a continuation of fisheries studies conducted on Ross Reservoir by the WDF&W and BCF&W in 1985 and 1986 (Scott and Peterson 1986; Johnston 1989). Earlier in-depth fisheries studies were also conducted on Ross Lake by the University of Washington Fisheries Research Institute (FRI) at the time Seattle City Light (SCL) proposed to proceed with the third and final construction phase of Ross dam (High Ross). A number of studies have also been conducted on the upper Skagit River by BCF&W. A complete list of all major fisheries studies related to Ross Reservoir is given in Resident Fisheries Study for Ross, Diablo and Gorge Lakes (Seattle City Light 1989a).

Study Area

Ross Lake is an oligotrophic reservoir located at 49°N latitude and 121°W longitude in the northeastern portion of Whatcom County, Washington and the southeastern portion of Fraser Cheam Regional District, British Columbia *(Figure 1)*. The reservoir is located within

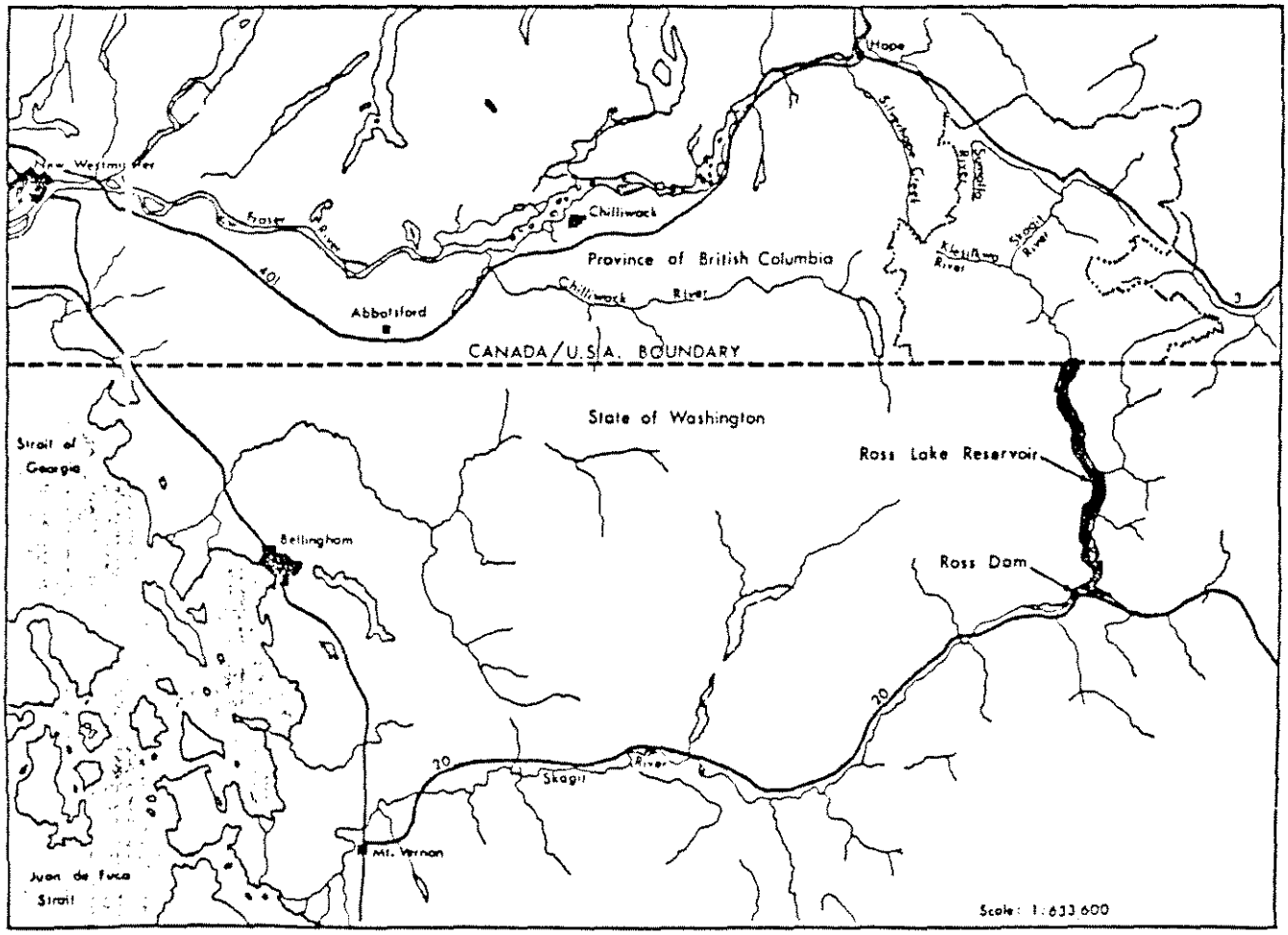

FIGURE 1. Geographic location of Ross Lake in NW Washington and SW British Columbia.

the Skagit River watershed, and was formed by the construction of Ross Dam (1937-49) on the Skagit River. The lake drains approximately 999 square miles of the watershed upstream from the dam. Surface elevation of the lake is 1,602.5 feet mean sea level (msl) at full pool and 1,475 feet msl at maximum drawdown.

Physical characteristics of the reservoir vary seasonally due to winter drawdown by Seattle City Light for power and flood control purposes. Therefore, the following measurements are given for full pool elevation only. The reservoir is approximately 22 miles long, with the northernmost mile extending into Canada. Average width is approximately one mile, and maximum width is two miles. The long axis of the reservoir is oriented in a north-south direction, and is perpendicular to the direction of prevailing winds. Total surface acreage is 11,680 acres, of which 480 acres is located in British Columbia. Total lake volume is estimated at 770,000 acre-ft. The lake basin is predominantly deep and steep-sided, although the northern portion of the lake is relatively shallow. Maximum depth is 400 ft near the base of the dam and mean reservoir depth is 123 ft. A summary of the physical characteristics of Ross Lake is given in *Table 1.*

Ross Reservoir is fed by the upper Skagit River in Canada and several large, perennial streams on the U.S. side of the reservoir *(Figure 2)*. Ruby Creek, Lightning Creek, and Big Beaver Creek are the largest American tributaries, followed by Little Beaver, Devils, Silver, Arctic, No Name, Hozomeen, Dry, Pierce, and Roland Creeks. Physical characteristics and spawning habitat summaries of the major tributaries to Ross Lake are summarized in the Ross Lake Tributary Stream Catalog (Seattle City Light 1989b). Numerous small, intermittent streams also drain into the lake. The Skagit River is the only outflow channel present.

Rainbow trout (Oncorhynchus gairdneri) are the predominate sport fish in Ross Lake. A seasonal sport fishery exists on this species from July through October. Also present in the lake are dolly varden (Salvelinus malma)/bull trout (Salvelinus confluentus) char, cutthroat trout (Oncorhynchus clarkii), and brook trout (Salvelinus fontinalis) char.

Objectives

The specific objectives of the 1994-95 Ross Lake study were as follows:

1. Determine angler effort and distribution on the reservoir.

2. Determine angler catch (kept and released), harvest (kept only), catch per unit effort (CPUE), harvest per unit effort (HPUE), and angler distribution on the reservoir.

3. Determine age distribution, age class strength, age versus length, age versus sexual maturity, and length at sexual maturity of rainbow

TABLE 1. Ross Lake physical data. From The Aquatic Environment, Fishes and Fishery: Ross Lake and the Canadian Skagit River (City of Seattle 1972).

	Reservoir Water Levels		
	Max.	Min.	Mean
Annual Flushing Rate[a]	1.84	---	2.35
Drainage Area (mi^2)[b]	999	---	---
Elevation (feet)	1,602.5	1,475	1,575
Length (miles)	22	---	---
Maximum depth (feet)	400	---	---
Mean depth (feet)	122.5	93.6	---
Shoreline development[c]	4.26	4.01	4.07
Shoreline length (miles)	64.5	37.4	51.0
Surface area (acres)	11,680	4,400	10,300
Volume (acre-feet)	1,435,000	412,000	---

Lake Elevation (feet)	Shoreline length (miles)	Area (acres)	Lake Volume (acre-feet)
1602.5	64.5	11,680	1,435,000
1600	64.3	11,600	1,390,000
1575	58.8	10,280	1,125,000
1550	53.3	9,040	890,000
1525	50.3	7,600	680,000
1500	43.7	5,840	520,000
1475	37.4	4,400	412,000
1450	29.1	3,400	285,000
1425	26.9	2,820	210,000
1400	24.3	2,300	140,000
1375	21.2	1,850	90,000
1350	19.4	1,400	60,000
1325	16.7	900	25,000
1300	13.4	420	10,000

[a]Based on 1953-69 flushing rates.
[b]Skagit River drainage upstream of Ross dam.
[c]Shoreline development (SD) = $S/(2*((P_1*A)\cdot^5))$, where S = shore length and A = lake area.

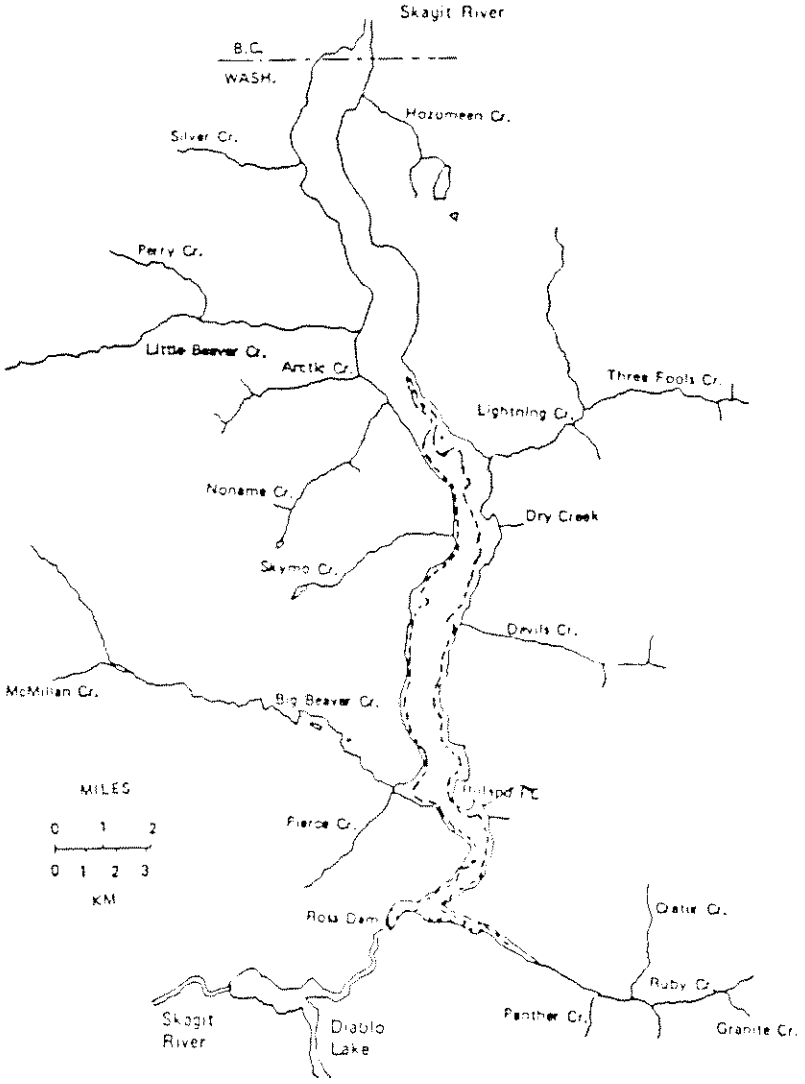

FIGURE 2. Ross Lake and major tributaries. The perimeter of the lake at full pool (1,602.5 feet msl) is shown as a solid line, and the maximum drawdown contour (1,475 feet msl) is depicted as a dotted line.

trout sampled from the angler sport catch.

4. Develop estimates of the reservoir fish population size and conduct index counts from fixed hydroacoustic transects to monitor annual population status.

5. Compare results of the 1994-95 study with previous studies.

6. Identify additional data requirements for future studies.

7. Continue development of a long-term management plan for Ross Reservoir in coordination with federal (National Park Service) and international (British Columbia Ministry of Environment) management agencies.

METHODS

Sampling methods and procedures for the 1994-95 rainbow trout study on Ross Reservoir are nearly identical to studies conducted during 1990-91, 1991-92, 1992-93, and 1993-94. Statistical comparisons of data are primarily limited to the current five-year study, since different fishing regulations and/or sampling designs were in effect for studies conducted in the mid-1980's and early 1970's.

1994-95 Studies

The 1994-95 sampling program consisted of data and information collected from two different studies. A four-month angler creel survey was conducted from July 1 to October 31, 1994 to determine angler harvest and harvest-related information. The second study involved collection of hydroacoustic transect data from four lake surveys performed during April of 1995. The purpose of these surveys was to provide index counts of fish density for use in annual monitoring of population size fluctuations, and to estimate the size of the 1994-95 overwintering reservoir fish population (all species combined). No spawning surveys were conducted in 1995 due to termination of the project before the start of the rainbow trout spawning season.

Personnel consisted of one full-time project biologist hired by WDF&W, and one private contractor hired by BCF&W. The contractor was responsible for collecting angler creel (north end only) and effort (entire reservoir) data, while the project biologist conducted all other project-related work.

1994 Creel Survey

The 1994 angler creel census was based on a stratified random design that was identical to that used during the 1990-93 creel surveys (Looff 1992a, Looff 1993a, Looff 1994b, Looff 1995a). Strata were divided into three day-types that reflected intensity of angler use on the reservoir. These day-types included opening day, weekdays, and weekends. Opening day (opening weekend prior to 1990) is treated as a separate strata, since a considerably higher degree of angler effort is generated at this time than at any other time during the fishing season.

Sample days were randomly selected by microcomputer using a Microsoft QuickBASIC program written by the author (Looff 1992a). This program randomly selected four, three-day (continuous) time blocks for each month from July through October, for a total of forty-eight sample days for the 1994 fishing season *(Table 2)*. Logistical and budgetary constraints travelling to and from the lake necessitated the use of continuous three-day time blocks. Two additional constraints on the selection process were that four weekend days and eight weekdays had to be sampled each month, and that opening day (July 1), Independence Day

TABLE 2. Number of days censused per day type strata during the 1994 sport fishing season at Ross Reservoir.

Month	Daytype	Total Days	Days Censused	% Total
Jul	Opener	1	1	100%
	Weekday	19	6	32%
	Weekend	11	5	45%
	Total	31	12	39%
Aug	Weekday	23	8	35%
	Weekend	8	4	50%
	Total	31	12	39%
Sep	Weekday	21	7	33%
	Weekend	9	5	56%
	Total	30	12	40%
Oct	Weekday	21	8	38%
	Weekend	10	4	40%
	Total	31	12	39%
Season	Opener	1	1	100%
	Weekday	84	29	35%
	Weekend	38	18	47%
	Total	123	48	39%

(July 4), and Labor Day (September 5) had to be included as sample days. The latter restriction modified the number of (effective) weekend days and weekdays sampled during the months of July and September *(Table 2)*. Sampling dates for the 1994 sport fishing season are listed in *Appendix 2*.

A continuous eight-hour work day was scheduled for each sample day throughout the creel census. The starting time and subsequent eight-hour work period for each sample day was randomly selected by computer (described above) according to the number of daylight hours available each month *(Table 3)*. This work schedule was based on the same design as that used in 1985 (Scott and Peterson 1986), rather than on the 1986 design, which required sampling over the entire daylight period (Lewynsky 1986). The latter design required continuous sampling of <u>all</u> anglers from dawn to dusk in order to develop effort estimates. The design used in the 1985, and 1990-94 studies required a <u>random</u> sampling of returning anglers (although an attempt was made to survey as many anglers as possible).

Restricted access to the reservoir permitted most anglers to be interviewed during the course of any work day (except for a very few heavy use periods such as opening day and holidays). Scott and Peterson (1986) classified five access areas where anglers were intercepted for interviews and biological sampling of catch. These included Canada, three sites on the American portion of the reservoir at the north end of the lake (Winnebago Flats, government dock, and lower launch), and Ross Lake Resort at the south end of the lake. Only three access areas were designated for the present study. These sites included Canada, Hozomeen campground, and Ross Lake Resort. The three launch sites at Hozomeen campground from 1990 to 1994 were considered to be a single access area, since seasonal angler use was significantly lower than in previous years, and the lower launch site was inundated by water most or all of each fishing season. (When late-season drawdown by Seattle City Light does permit use of the lower launch site, the remaining sites at the north end of the lake are not normally accessible due to receding water levels).

Both ends of the lake were sampled simultaneously during each work day in 1994, with roving interviews conducted between the Canadian and Hozomeen access areas at the north end. This was similar to the first two years of the study (1990 and 1991), but differed from the previous two seasons (1992 and 1993), when only one employee sampled the entire reservoir by equally allocating work days between the north and south ends.

<u>Angler Interviews</u>

Angler interviews at Ross Reservoir were conducted by contacting anglers returning to the three primary access areas. All anglers were asked to volunteer the same information. Anglers were generally interviewed immediately upon returning, but in some cases, especially at the north

TABLE 3. Number of daylight hours assumed available to anglers during the 1994 sport fishing season at Ross Reservoir.

Month	Hours	Start	Finish
July	15	0600	2100
August	13	0700	2000
September	11	0800	1900
October	9	0900	1800

end of the lake where it was impossible for the interviewer to survey the Canadian and Hozomeen access sites at the same time, information was frequently collected later in the day. Information was collected from all anglers contacted, regardless of whether they had finished fishing for the day. Two primary reasons for checking incomplete anglers was that a large proportion of anglers did not continue fishing after indicating they were going to, and information would be lost from anglers that continued fishing but did not return before the work day ended.

Interviews consisted of the collection of angler catch and profile data. The following catch information was recorded for each species of trout and char captured:

- time of interview
- time angler started fishing (to the nearest 15 minutes)
- whether angler had finished fishing for the day
- species
- number of fish harvested
- number of fish released
- size range of fish released
- capture location (discussed below)

As in the early 1970's, 1985-86, and 1990-93 studies, the reservoir was arbitrarily divided into seven zones for purposes of determining distribution of angler effort, CPUE (catch per unit effort), HPUE (harvest per unit effort), and catch and harvest information. The location of each of these zones is shown in *Figure 3*. These zones are numbered the same as shown in the 1989 report (Johnston 1989).

The following angler profile information was collected for each angler interviewed:

- age category (adult, juvenile)
- fishing method (boat, shore, float tube)
- angling gear (lure, fly)

The following biological information was collected from a random sample of the angler harvest for rainbow trout only:

- nose to fork length of harvested fish (mm)
- sex
- scales for aging (discussed below)
- sexual maturity (discussed below)

Approximately 20-30 scales were collected from each rainbow trout sampled. Scales were removed from an area formed by an imaginary line drawn from the rear insertion of the dorsal fin to the front insertion of the anal fin approximately 3-5 scale rows above the lateral line. Scales were then placed in scale envelopes and the date, capture area, species, fork length (mm), sex and sexual maturity (if collected)

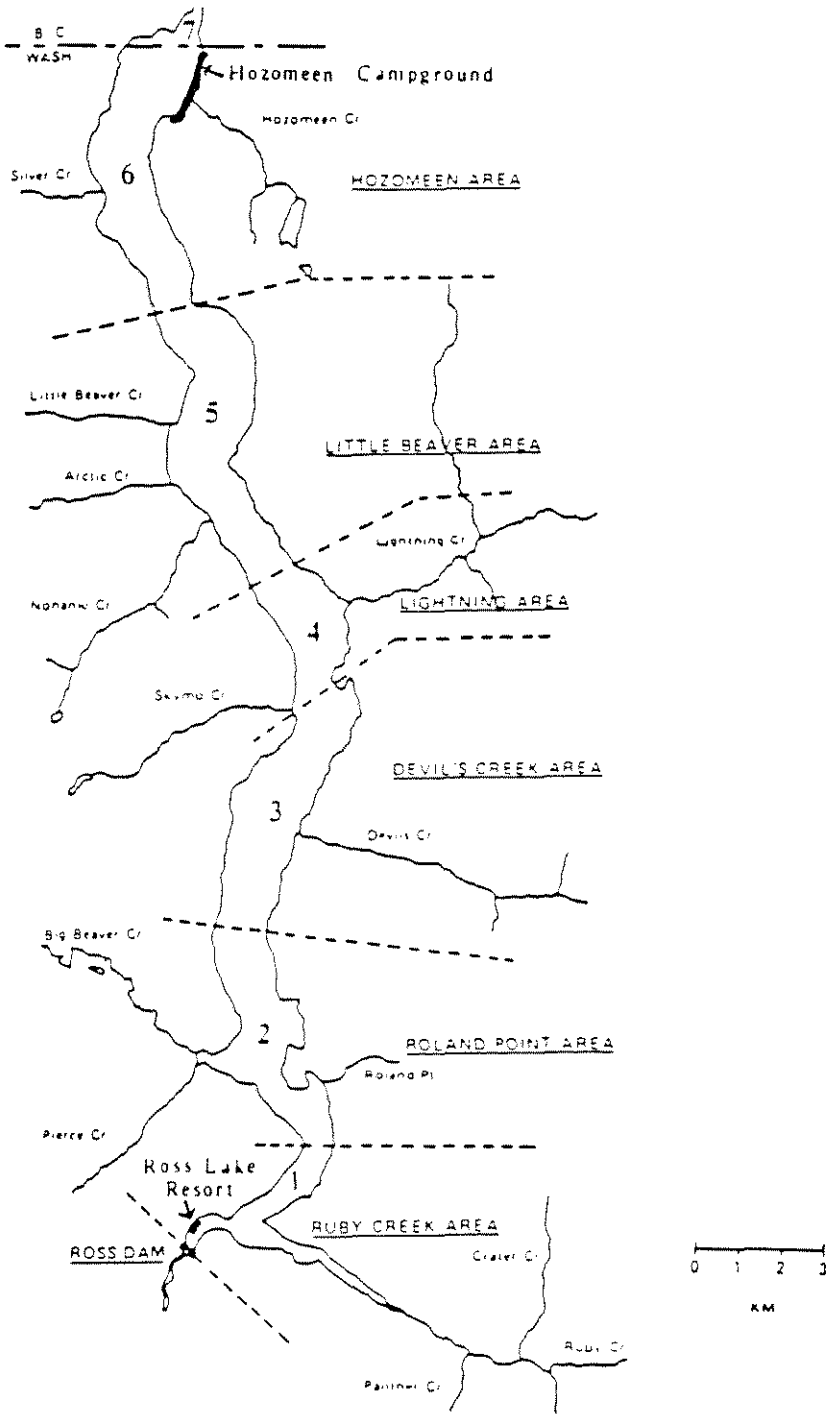

FIGURE 3. Ross Lake survey zones.

recorded on the outside. Five scales from each sample were later cleaned and mounted on a glass slide using a cover slip and transparent tape. A microfiche reader (35X) was then used to age each sample. Only samples containing at least two good scales that did not exhibit regenerated areas were used. After aging all of the samples once to determine growth patterns and other characteristics, the scales were aged a second time. If the two readings did not agree, a third reading was done. The final result of this third reading was considered to be the age of the sample.

A subset of rainbow trout that were sampled for scale analysis were also examined for sexual maturity on the basis of gonadal development. Sexual maturity information was only collected from trout sampled during the month of July, since newly developing egg skeins and sperm sacs of recently spawned fish appear identical (very small size) to those of immature fish after this time. In addition, sexual maturity determinations are further hindered by the rapid disappearance of secondary external sexual characteristics, and resorption of unspawned gametes following spawning.

Fish were classified as mature if testes were enlarged or contained sperm in males, and if eggs were in an advanced stage of development or freely flowing in females. External spawning characteristics, such as dark color, emaciated condition, and enhanced color of the red side stripe, served as secondary aids to classification of mature fish of both sexes. Fish were classified as immature if male testes and female egg skeins were small and poorly developed.

Separate measurements were collected for dolly varden/bull trout char to assist current WDF&W studies aimed at delineating the geographic ranges of these two species, whose external physical characteristics are visually almost identical. A special linear discriminant function developed by Haas (1988) at the University of British Columbia was used to distinguish between the two species. This equation requires the collection of the following four external physical measurements:

- number of branchiostegal rays (slender bones in the gill membranes) on both right and left sides
- maxillary length
- number of principal anal fin rays
- standard length (nose to last vertebra) in millimeters

The function for species identification is as follows (Haas and McPhail 1991):

1) [(0.629 * branchiostegal ray number) + (0.178 * anal fin number) + (37.310 * (maxillary length/standard length))] - 21.8

where,
dolly varden <0, and
bull trout >0.

Char fork length (mm) was also measured to compare with data collected from earlier studies at Ross Reservoir.

Effort

Effort estimates were generated separate from the angler creel survey. This precluded personnel from having to work over the entire daylight period of each sample day, as described earlier. Effort sampling times were randomly selected by computer *(Appendix 2)* to correspond with sample days and work schedules *(Table 2)*.

Instantaneous effort counts were conducted twice daily by running a boat the length of the reservoir and counting the number of anglers actually fishing in each zone of the lake *(Figure 3)*. An angler was not counted unless a line was visually observed in the water. (This sampling method differed from the 1985 effort survey design in that boats, and not anglers, were counted during the 1985 study. These counts were later expanded to angler counts using average number of anglers per boat data collected by National Park Service personnel during the 1985 season). On average, it required from 40-50 minutes to conduct a single count, depending on weather conditions and number of anglers fishing. The second count was made on the return trip back, after waiting approximately 10-20 minutes for the beginning of the next hour. On some days, one or more additional hours was waited before conducting counts on the return trip.

Three separate effort estimates (and associated variances) for 1994 were derived by organizing strata into daytypes, lake zones, and access areas. For reasons outlined below and in later portions of the methods section, daytype estimates for all variables (effort, CPUE, HPUE, catch, and harvest) generate the most accurate estimates based on the sampling design utilized in this study, and will be the actual results reported. Zone and access area estimates, which do not accurately reflect one or more of the above variables, are used for comparative purposes only.

Accurate access area effort estimates were not possible using the effort sampling design of the current study (it was not practical to stop and ask each angler where he launched from while conducting effort counts). However, it was assumed that anglers fishing in zone 7 used the Canadian access, anglers fishing in zones 4-6 utilized the Hozomeen access, and anglers fishing in zones 1-3 came from Ross Lake Resort. The small size and low horsepower engines on the resort boats made it difficult for most anglers using these craft to fish north of Ten-Mile Island (zone 3), which was verified through both visual observations during effort counts, and during angler interviews at the resort. Conversely, very few boats originating from Hozomeen fished farther south on the reservoir than Lightning Creek (zone 4). Lastly, very few anglers from either country purchased a second license to fish on the opposite side of the international boundary (zones 6 and 7).

Effort counts for each of the three estimates were converted to monthly and total estimates using simple expansion techniques. However, due to the random sampling of hourly daylight time periods, not all hours were sampled for a particular strata within any monthly time block. Missing hourly effort within a specific strata was estimated using the following proportion:

2) $e = e_h * (n/h)$

where, in any particular strata,

e = total effort,
e_h = sum of the hourly effort counts in a particular strata,
n = total number of available survey hours, and
h = number of hours actually surveyed

The same technique was applied to variance estimates, using the appropriate equation for multiplication of a variance by a constant (Freese 1962).

Catch Rate and Harvest Rate

Catch rate (and harvest rate) estimates and associated variances were generated by expanding data from the creel surveys. The general formula for the catch rate (CPUE) of any particular strata-type is:

3) $r = c / t$

where, in any particular strata,

r = catch rate (CPUE),
c = catch, and
t = time (hours)

The harvest rate (HPUE) of any particular strata-type is found by substituting harvest (h) for catch (c) in (3).

Three separate rainbow trout catch rate (and harvest rate) estimates for daytype, zone, and access areas were generated using the two formulas. Even though total monthly and seasonal catch (and harvest) rates are identical for the three types of estimates, strata estimates are more accurate for daytype calculations. The primary reason for this is that interviewed anglers were asked to identify which one zone they caught and harvested most fish in. Thus, each fish captured or harvested was not traced to the exact zone of capture. Access area catch (and harvest) rate estimates were calculated by arbitrarily dividing the catch identified by zone using the method outlined earlier in the effort section. Daytype estimates consider only the number of fish caught and/or harvested. Thus, zone and access area estimates imply more accuracy than is acceptable, and are given for comparative purposes only. Dolly varden/bull trout char, cutthroat trout, and brook trout

(char) catch rate (and harvest rate) estimates were produced using daytype information only.

Catch and Harvest

Catch (and harvest) estimates and associated variances were generated by expanding data from the two separate creel and effort surveys. The general formula for total catch of any particular strata-type is:

4) $c = e * Q_1$

where, in any particular strata,

c = total catch,
e = total effort, and
$Q_1 = c/t$

The total harvest of any particular strata-type is found by substituting harvest (h) for catch (c) in (4).

Three separate rainbow trout catch (and harvest) estimates for daytype, zone, and access area were generated using this formula. As discussed previously, daytype estimates produce the most accurate results, while zone and access area estimates are given for comparative purposes only. Dolly varden/bull trout char, cutthroat trout, and brook trout (char) catch (and harvest) estimates were produced using daytype information only.

Variance Estimators

Variance estimators were used to generate standard errors for all effort, CPUE, HPUE, catch, and harvest estimates (Freese 1962). The following estimators were used to compute the variance of a ratio (CPUE and HPUE), and product (catch and harvest) of any particular strata type:

(5) $s_{Q_1}^2 = Q_1^2 * ((s_c^2/c^2) + (s_t^2/t^2) - ((2*s_{ct})/ct))$

where,

c = catch,
t = time (hours),
$Q_1 = c/t$, and
s_{ct} = covariance(c,t)

(6) $s_{Q_2}^2 = Q_2^2 * ((s_e^2/e^2) + (s_r^2/r^2) + ((2*s_{er})/er))$

where,

e = effort,
$r = c/t$, and
$Q_2 = e*r$.

Since effort and catch rate were determined from separate surveys, they were assumed to be independent and the covariance set equal to zero in (6). Thus, the quantity $((2*s_{ct})/ct)$ equaled zero and was dropped from the second equation.

The variance of a harvest rate (HPUE) and total harvest of any particular strata-type is found by substituting harvest (h) for catch (c) in (5) and (6), respectively.

Hydroacoustic Surveys

Hydroacoustic surveys were conducted during April of 1995 to estimate the total number of fish (all species) greater than six inches length in the reservoir. Late winter and early spring is the optimal time to conduct these surveys for several reasons. Both the number and length of hydroacoustic transects is reduced at this time of year due to winter reservoir drawdown by Seattle City Light and subsequent decrease in reservoir size *(Figure 2)*. The reservoir fish population is also at a maximum, since fish have not yet ascended tributary streams to spawn and/or feed. Environmental conditions at this time of the year result in more calm, windless days, which are required to keep the sonic cone perpendicular to the lake surface and also eliminate noise interference from boat waves. Lastly, reservoir and environmental conditions also result in less debris in the water column that can create transducer interference.

A modified Ross 600C Straight Line Recorder with a revolving chart recorder was used to collect population data. Power was supplied to the echosounder using two 12-volt DC deep cycle batteries connected in-line to produce 24 volts. One down-scanning and one side-scanning transducer were mounted on a 14' aluminum boat powered by a 25 horsepower outboard motor *(Figure 4)*. Transducer calibration, equipment operation, and development of estimates and associated variances followed echo counting procedures developed by Johnston (1981). However, sampling design was based on fixed transect counts, instead of random selection of transects for each survey, as explained below.

Preliminary hydroacoustic surveys conducted on March 29-30, 1991, indicated that the upper portion of the reservoir north of Rainbow Point was unsuitable for echosounding due to the presence of large numbers of trees just below the lake surface. The reservoir was only partially logged prior to inundation in the late 1940's and early 1950's, with most of the logging having occurred north of Lightning Creek (Pitzer 1978). Both fish and tree parts trace identically on the chart recorder, making it impossible to conduct population estimates in this portion of the lake. Furthermore, other areas south of Rainbow Point, including areas adjacent to May Creek, Big Beaver Creek, and Roland Point, also have large numbers of standing trees close to the surface. Based on the above information, eleven fixed transects south of Rainbow Point were selected for annual index counts and subsequent calculation

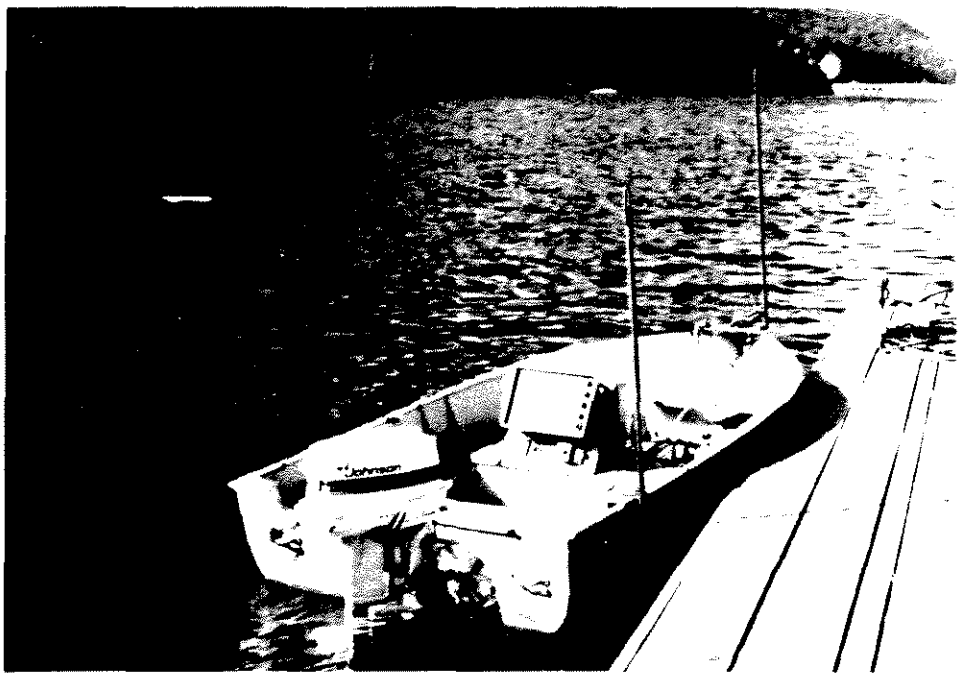

FIGURE 4. Hydroacoustic equipment used in reservoir trout population estimates and index counts.

of reservoir population density. Transects were almost or entirely devoid of standing trees, and were selected to encompass as many geographic features of the lake as possible. Each transect was surveyed with the down-scanning transducer using a 0-100 foot setting. It was not necessary to scan deeper than 100 feet, since very few fish were present below 60 feet. Additionally, three of the eleven transects were randomly selected for sampling with the side-scanning transducer (transects 1, 6, and 8). Approximately four hours were required to survey all eleven transects.

Four estimates were conducted on April 22 and 23. On each sample day, one estimate was conducted in the morning between 0800 and 1200 hours, and a second estimate was performed in the afternoon between 1200 and 1600 hours.

Population estimates were calculated from index count data, and are based on the assumption that fish are randomly distributed in the reservoir during early spring. Visual inspection of transect data did not indicate clumping of fish in any of the areas surveyed. Relatively rapid water level fluctuations probably inhibit establishment of territories along shallow littoral areas of the lake, possibly enhancing random dispersion into pelagic zones. Also, the absence of terrestrial and aquatic invertebrates due to seasonal timing and/or reservoir fluctuations, probably entice fish to disperse and feed on zooplankton throughout the upper water column of the lake.

The development of reservoir population estimates required the calculation of lake strata volumes. Lake volumes were estimated at (even) 25-foot contour intervals from 1600 feet down to 1375 feet using a set of 1933 topographic maps supplied by Seattle City Light. Johnston (1981) lists the methods and procedures for determining lake strata volumes from topographic maps. It was necessary to first locate the appropriate 25-foot contour intervals used in the lake volume estimates on the down-scan transect echograms before making any initial fish counts. This was necessary since the reservoir was at a different elevation on each survey date. Fish counts were then made between these intervals. Volume adjustments (linear interpolation) were necessary for the upper and lower portion of each echogram, since the echogram did not precisely match the 25-foot volume contour intervals.

Population estimates and variances for each complete survey were calculated using statistical procedures developed by Johnston (1981). These procedures utilize simple expansion techniques to estimate density within each 25-foot depth strata.

RESULTS

1994-95 Lake Levels

The opening day lake elevation was 1,595.41 feet msl on July 1, 1994. The reservoir reached a maximum elevation of 1,600.41 feet msl on July 26, 1994, and a minimum elevation of 1,507.96 feet msl on April 30, 1995.

1994 Opening Day Creel Survey - (post-1990 regulation change)

A total of 83 anglers were checked at Ross Lake on opening day, July 1, 1994 *(Table 4)*. These anglers fished a total of 341.25 hours and caught 389 rainbow trout (harvest and release) for a catch per unit effort (CPUE) of 1.140 fish per hour. Catch per unit effort was higher for anglers originating from Hozomeen (1.717 fish per hour), than for anglers fishing out of the resort (0.928 fish per hour) and in Canada (0.791 fish per hour). The fish per angler average was 4.7 for a combination of complete and incomplete anglers, while completed trip anglers caught an average of 3.6 fish per person. One dolly varden/bull trout char was the only other species reported in the catch on opening day. This fish was subsequently released by an angler fishing at the south end of the lake, as the new 1994 protective regulations for this species require (see *Appendix 1*).

1994 Opening Day - Harvest

Opening day harvest totalled 40 rainbow trout for interviewed anglers *(Table 4)*. A total of 349 fish (90%) were released. Harvest per unit effort (HPUE) was 0.117 fish per hour, and was markedly higher at the north end of the lake (0.188 and 0.140 for Hozomeen and Canadian anglers, respectively) than at the south end (0.085 fish per hour). The fish per angler average was 0.5 for a combination of complete and incomplete anglers, while completed trip anglers harvested an average of 0.7 fish per person.

1994 Opening Day - Methods and Gear

All anglers checked at Ross Lake used boats on opening day. The most popular angling method (n=68) was trolling with flashers and lures, while the remaining anglers (n=6) utilized flies.

1994 Opening Day - Age

Out of thirty-seven rainbow trout randomly sampled from the opening day harvest in 1994, the majority were age 4 (57%). Thirty percent were age 5, eight percent were age 6, three percent were age 3, and the remaining three percent were age 7. A greater percentage of age 4 fish occurred in the south end sample (75%) than the north end (43%), while a

TABLE 4. Comparison of 1994 opening day rainbow trout catch statistics between different access areas at Ross Reservoir.

			Rainbow Trout					
						Fork Length (mm)		
Access	Anglers	Hours	Catch	CPUE[a]	F/A[b]	Min	Max	Avg
COMBINED TRIPS[c] - Harvest Only								
Canada	9	22	3	0.140	0.3	334	375	350
Hozomeen	29	96	18	0.188	0.6	269	417	343
Resort	45	224	19	0.085	0.4	297	360	319
Total	83	341	40	0.117	0.5	269	417	333
COMBINED TRIPS[c] - Harvest + Released								
Canada	9	22	17	0.791	1.9			
Hozomeen	29	96	164	1.717	5.7			
Resort	45	224	208	0.928	4.6			
Total	83	341	389	1.140	4.7			
COMPLETE TRIPS - Harvest Only								
Canada	---	---	---	---	---	---	---	---
Hozomeen	2	1	0	0.000	0.0	---	---	---
Resort	9	41	8	0.198	0.9	307	360	323
Total	11	42	8	0.193	0.7	307	360	323
COMPLETE TRIPS - Harvest + Released								
Canada	---	---	---	---	---			
Hozomeen	2	1	0	0.000	0.0			
Resort	9	41	40	0.988	4.4			
Total	11	42	40	0.964	3.6			

[a]Catch per unit effort (fish/hour).

[b]Fish per angler.

[c]Includes data from fishermen that were not finished fishing for the day (complete + incomplete trips).

larger percentage of age 5 fish occurred in the north end sample (38%) than the south end (19%). The remainder of the north end sample comprised age 6 (14%) and age 7 (5%) fish, while the balance of the south end sample comprised age 3 (6%) fish.

1994 Opening Day - Length

The average fork length of rainbow trout kept by anglers on opening day was 333 mm *(Table 4)*. These trout ranged in length from 269 mm (illegal) to 417 mm. *Figure 5* depicts length-frequency histograms of the opening day harvest of rainbow trout sampled from the north, south, and combined ends of Ross Lake. The most numerous number of fish occurred in the 330-340 mm size group (combined sample), which is slightly larger than the approximate minimum legal fork length size limit of 317 mm (12.5 inches). The 330-340 mm size group comprised the most numerous number of fish from the north end sample, while the 310-320 mm size group contained the most numerous number of fish from the south end.

1994 Opening Day - Sex

On July 1, 1994, a sub-sample of twenty-six rainbow trout were examined internally for sex determination. Nine fish (35%) were males and seventeen fish (65%) were females. The north end sample (n=10) comprised 20 percent males and 80 percent females, while the south end sample (n=16) was composed of 44 percent males and 56 percent females.

1994 Opening Day - Sexual Maturity

Twenty-two fish from the sub-sample that was examined for sex determination were also checked for sexual maturity *(Table 5)*. Mature and immature fish each comprised 50 percent of the sample. The average lengths of mature fish were 345 mm for males, and 335 mm for females. Immature males averaged 316 mm, while immature females averaged 327 mm.

Age and length information from the opening day sexual maturity sub-sample, grouped by access, sex, and maturity, is given in *Table 6*. All mature fish (both sexes) were from four to six years old. Immature males were age 4, while immature females were age 4 and age 5.

A complete list of the 1994 opening day creel data for Ross Lake is given in *Appendix 1* of the Ross Lake Rainbow Trout Study: 1994-95 Data Appendix (Looff 1995b).

1994 Season Creel Survey

A total of 1,802 anglers were interviewed during the July 1 to October 31, 1994 creel census at Ross Reservoir. During the interviews 355 rainbow trout were sampled for life history information.

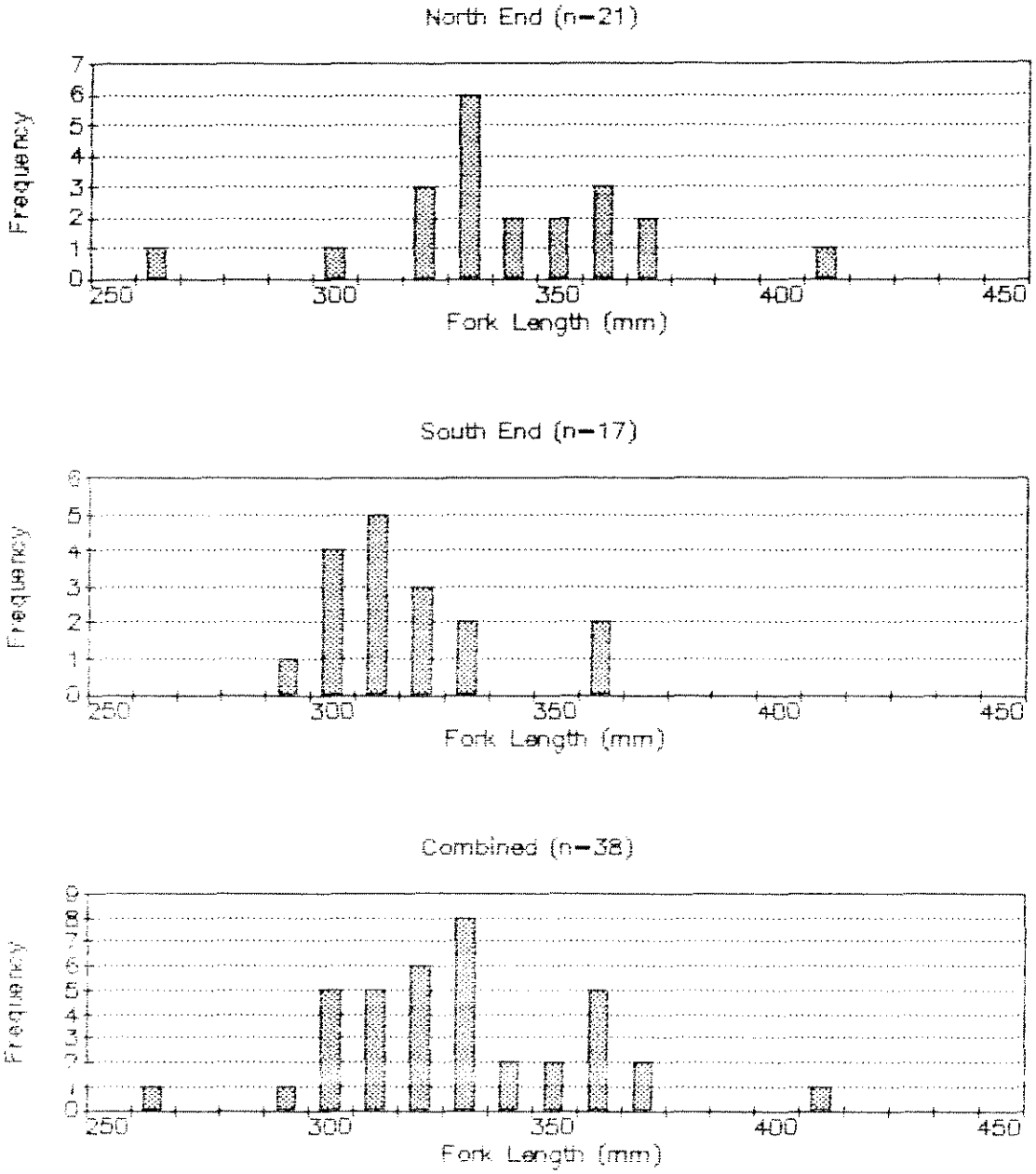

FIGURE 5. Length-frequency distributions of rainbow trout sampled from the Ross Lake sport harvest on opening day, 1994. Minimum legal size limit is approximately 317 mm fork length. Abscissa values indicate lower limit of length interval.

TABLE 5. Rainbow trout length information, grouped by sex and maturity, from the opening day, 1994 sport harvest at Ross Reservoir.

			Fork Length (mm)		
Sex	Maturity	N	Avg	Min	Max
Male	Mature	5	345	312	375
	Immature	3	316	307	334
Female	Mature	6	335	320	375
	Immature	8	327	297	359

TABLE 6. Rainbow trout age and length information, grouped by access area, sex and maturity, from the opening day, 1994 sport harvest at Ross Reservoir.

					Fork Length (mm)		
Access	Sex	Maturity	Age	N	Avg	Min	Max
Hozomeen	Male	Mature	6	1	375	375	375
		Immature	4	1	334	334	334
	Female	Mature	6	1	375	375	375
		Immature	4	3	326	305	339
			5	3	347	340	359
Resort	Male	Mature	4	2	315	312	318
			5	2	360	360	360
		Immature	4	2	307	307	307
	Female	Mature	4	4	327	320	333
			5	1	325	325	325
		Immature	4	2	299	297	300

1994 Season - Angler Effort

From July 1, 1994 to October 31, 1994 anglers fished an estimated 28,177 ± 71 hours, or 7,960 angler days *(Table 7*, daytype estimate*)*. Angling decreased steadily as the season progressed *(Figure 6* and *Appendix 3)*, with 45 percent of the seasonal effort total occurring in July, 25 percent in August, 20 percent in September, and 10 percent in October.

A total seasonal estimate of 30,496 ± 6 hours was calculated for effort data that was partitioned into zones *(Table 7* and *Appendix 4)*. From *Figure 7*, it can be seen that most effort was expended in zones 6-Hozomeen (23%), 2-Big Beaver (21%), and 7-Canada (21%). Zones 1-Ruby (11%), 3-Devils (9%), 5-Little Beaver (8%), and 4-Lightning (7%) comprised the remaining effort.

Effort data that was partitioned into access areas resulted in a total seasonal estimate of 30,496 ± 55 hours *(Table 7* and *Appendix 5)*. An estimated total of 14,735 hours (48%) was calculated for anglers utilizing the resort, 9,497 hours (31%) for anglers at Hozomeen, and 6,264 hours (21%) for anglers in Canada.

1994 Season - Angler Catch and Harvest Rates

The mean seasonal catch rate (combination of harvested and released) for rainbow trout was 0.648 ± <0.001 fish per hour *(Table 8*, daytype estimate*)*. Rainbow trout catch rates declined steadily from July to September, then stabilized in October *(Figure 8* and *Appendix 6)*. Catch rates were highest in July (0.862 CPUE) and lowest in October (0.431 CPUE), with intermediate rates occurring in August (0.641 CPUE) and September (0.434 CPUE).

The mean seasonal harvest rate for rainbow trout was 0.076 ± <0.001 fish per hour *(Table 8*, daytype estimate*)*. As shown in *Figure 8*, harvest rates were identical in July and August (0.089 HPUE, respectively), then declined in September (0.056 HPUE) to a seasonal low in October (0.052 HPUE).

Mean seasonal capture rates for zone and access area estimates are identical to daytype estimates *(Table 8)*, since all three estimates were calculated from the same creel data. As shown in *Table 8* and *Figure 9*, the highest seasonal catch rates for rainbow trout (zone estimate) occurred in zones 7-Canada (1.092 CPUE) and 6-Hozomeen (0.881 CPUE). Intermediate catch rates occurred in zones 5-Little Beaver (0.464 CPUE), 2-Big Beaver (0.450 CPUE), and 1-Ruby (0.430 CPUE), while zones 3-Devils (0.373 CPUE), and 4-Lightning (0.372 CPUE) exhibited the lowest catch rates. Rainbow trout harvest rates followed a similar pattern as catch rates for the different zones, being highest at the north end of the lake, and lowest at the south end. Monthly and seasonal capture rate estimates for the different zone strata can be found in *Appendix 7*.

TABLE 7. Estimated total seasonal angler effort in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Type[a]	Strata	Angler Hours[b]		Mean Hours Fished per Day[c]	Total Angler Days[d]
Daytype	Opener	1073	(0)	4.11	261
	Weekday	14102	(91)	3.61	3905
	Weekend	13003	(121)	3.43	3794
	Total	28177	(71)	3.54	7960
Zone[e]	1 Rby	3252	(8)	3.48	933
	2 Bbv	6442	(10)	4.05	1592
	3 Dev	2861	(9)	5.17	553
	4 Lit	2180	(8)	4.59	475
	5 Lbv	2588	(9)	3.44	753
	6 Hoz	6908	(13)	3.16	2186
	7 Can	6264	(12)	2.70	2318
	Total	30496	(6)	3.46	8810
Access	Resort	14735	(97)	4.12	3581
	Hozomeen	9497	(115)	3.18	2983
	Canada	6264	(67)	2.70	2318
	Total	30496	(55)	3.43	8882

[a]Type of estimate. Daytype estimates are the most accurate based on sample design, and are the values reported for this study (see text).

[b]Ninety-five percent confidence interval of estimated total angler-hours given in parentheses.

[c]Mean hours calculated using data from all anglers, including those that indicated they had not finished fishing for the day (see text).

[d]Total angler days = angler hours/mean hours fished per day.

[e]See *Figure 3* for location of lake survey zones.

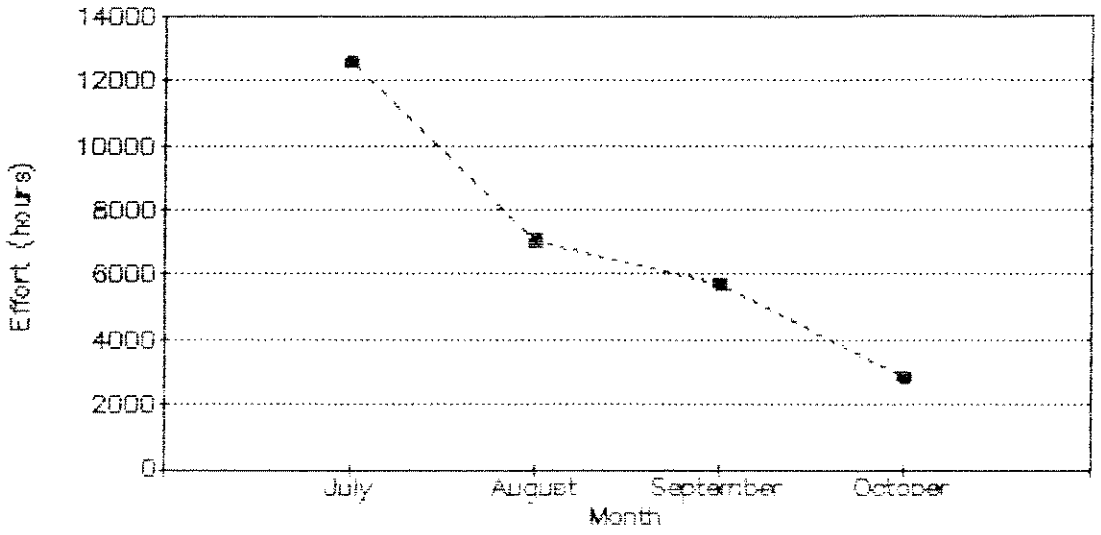

FIGURE 6. Monthly distribution of seasonal angler effort (daytype estimate) during the 1994 Ross Reservoir sport fishery. Range intervals denote 95% confidence limit of each estimate.

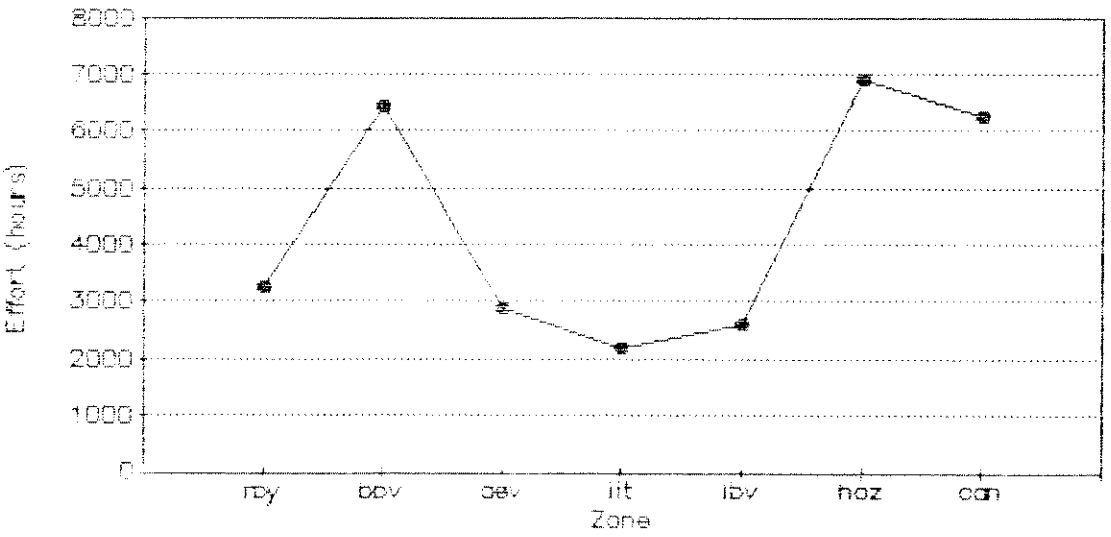

FIGURE 7. Distribution of seasonal angler effort (zone estimate) among lake zones during the 1994 Ross Reservoir sport fishery. Zone abbreviations are as follows: rby = ruby (zone 1), bbv = big beaver (zone 2); dev = devils (zone 3); lit = lightning (zone 4); lbv = little beaver (zone 5); hoz = hozomeen (zone 6); and can = canada (zone 7). Range intervals denote 95% confidence limit of each estimate.

TABLE 8. Estimated mean seasonal catch and harvest rates for rainbow trout in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

			Rainbow Trout Captures per Hour[a]					
Type[b]	Strata	N[c]	Harvested		Released		Total	
Daytype	Opener	83	.117	(.001)	1.023	(.002)	1.140	(.003)
	Weekday	802	.069	(.000)	.516	(.000)	.585	(.000)
	Weekend	917	.079	(.000)	.575	(.000)	.654	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)
Zone[d]	1 Rby	270	.046	(.000)	.384	(.000)	.430	(.000)
	2 Bbv	396	.044	(.000)	.406	(.000)	.450	(.000)
	3 Dev	150	.044	(.000)	.329	(.000)	.373	(.000)
	4 Lit	65	.030	(.000)	.342	(.002)	.372	(.002)
	5 Lbv	59	.037	(.000)	.428	(.002)	.464	(.003)
	6 Hoz	407	.094	(.000)	.788	(.000)	.881	(.000)
	7 Can	455	.160	(.000)	.932	(.000)	1.092	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)
Access	Resort	871	.043	(.000)	.373	(.000)	.416	(.000)
	Hozomeen	476	.087	(.000)	.752	(.000)	.839	(.000)
	Canada	455	.160	(.000)	.932	(.000)	1.092	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Type of estimate. Daytype estimates are the most accurate based on sample design, and are the values reported for this study (see text).

[c]Number of anglers surveyed.

[d]See *Figure 3* for location of lake survey zones.

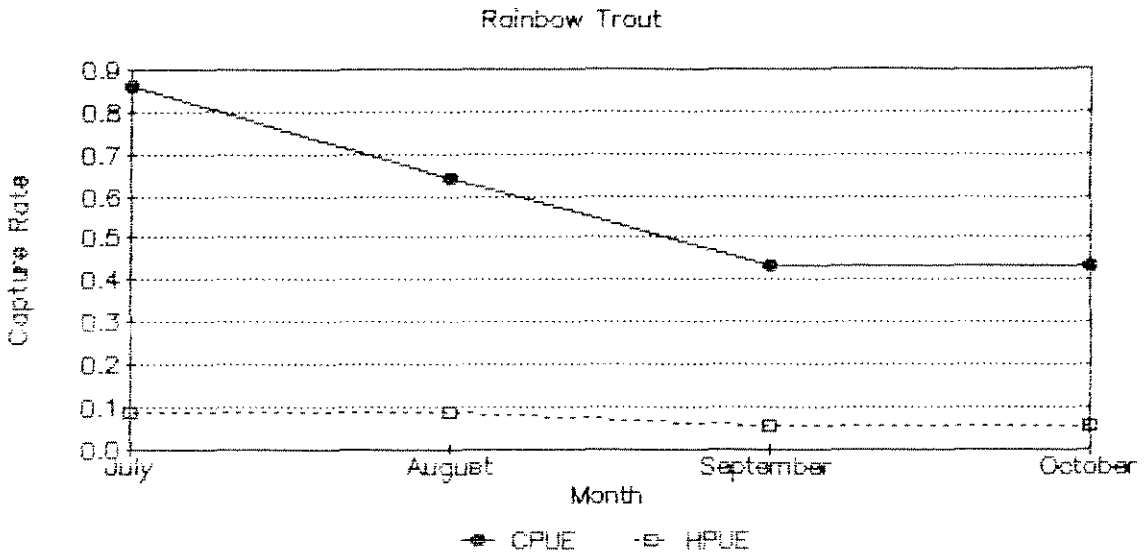

FIGURE 8. Monthly distribution of seasonal rainbow trout catch and harvest rates (daytype estimate) during the 1994 Ross Reservoir sport fishery.

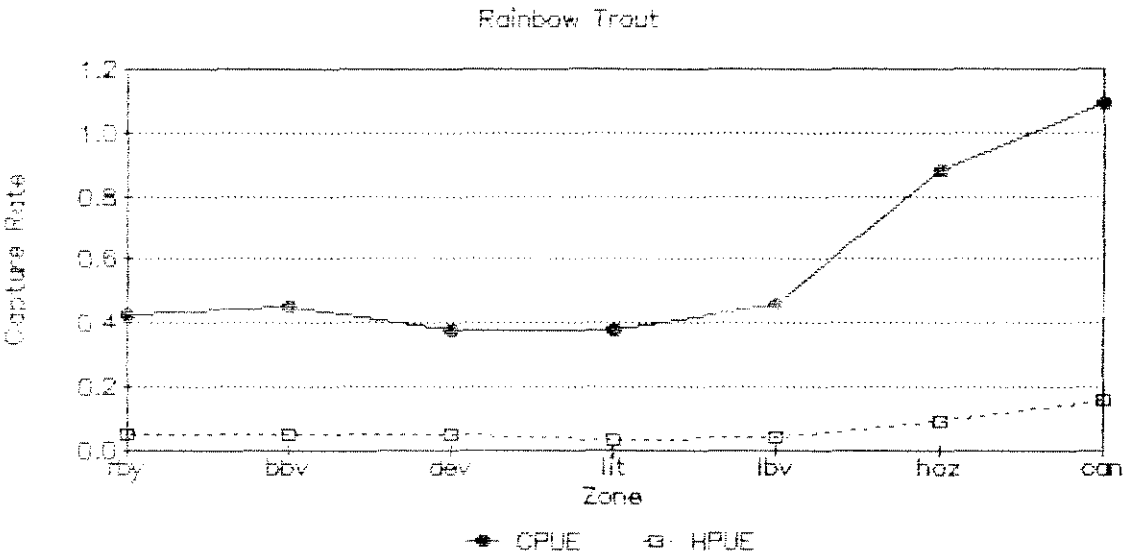

FIGURE 9. Distribution of seasonal rainbow trout catch and harvest rates (zone estimate) among lake zones during the 1994 Ross Reservoir sport fishery. Zone abbreviations are as follows: rby = ruby (zone 1), bbv = big beaver (zone 2); dev = devils (zone 3); lit = lightning (zone 4); lbv = little beaver (zone 5); hoz = hozomeen (zone 6); and can = canada (zone 7).

As shown in *Table 8*, anglers fishing in Canada had the highest seasonal catch rate (access area estimate) for rainbow trout (1.092 CPUE). An intermediate catch rate was returned by anglers utilizing the Hozomeen access (0.839 CPUE), while resort anglers experienced the lowest catch rate (0.416 CPUE). Rainbow trout harvest rates followed the same pattern as catch rates, being highest at the north end of the lake, and lowest at the south end. Monthly and seasonal capture rate estimates for the different access area strata can be found in *Appendix 8.*

Angler catch and harvest rate estimates for dolly varden/bull trout char, cutthroat trout, and eastern brook trout (char) were low during the 1994 sport fishing season at Ross Lake *(Table 9* and *Appendix 9-11)*. Mean seasonal catch rates were 0.004, <0.001, and 0.001 for dolly varden/bull trout, cutthroat trout, and brook trout, respectively (daytype estimates). Mean seasonal harvest rates were less than 0.001 fish per hour for all three species.

Mean seasonal catch and harvest rate estimates for all species of trout and char combined are given in *Table 9* and *Appendix 12)*. The mean seasonal catch rate of all species combined was 0.653 fish per hour, while the seasonal harvest rate was 0.076 fish per hour (daytype estimate).

1994 Season - Angler Catch and Harvest

The total seasonal catch (combination of harvested and released) of rainbow trout was 18,745 ± 38 fish *(Table 10*, daytype estimate*)*. Total catch dropped sharply from a seasonal high of 10,656 fish in July to 4,329 in August, then declined more slowly to 2,491 fish in September, and 1,270 in October *(Figure 10* and *Appendix 13)*.

The total seasonal harvest of rainbow trout was 2,196 ± 4 fish *(Table 10*, daytype estimate*)*. As shown in *Figure 10*, harvest of rainbow trout followed the same pattern as catch. Total harvest decreased markedly as the season progressed, with 51 percent of the seasonal harvest occurring in July, 28 percent in August, 15 percent in September, and 7 percent in October.

A total seasonal catch estimate of 21,345 ± 46 rainbow trout were calculated for data separated into zones *(Table 10* and *Appendix 14)*. As shown in *Figure 11*, the greatest catch of rainbow trout occurred near the north end of the lake in zones 7-Canada (34%) and 6-Hozomeen (30%). An intermediate catch total occurred in zone 2-Big Beaver (13%), while zones 5-Little Beaver (7%), 1-Ruby (7%), 3-Devils (5%), and 4-Lightning (4%) recorded the lowest totals. A total seasonal harvest estimate of 2,403 ± 5 rainbow trout was distributed similar to catch for the different zones. The greatest numbers were harvested at the north end of the lake in zones 7-Canada (42%) and 6-Hozomeen (27%), while lower numbers were harvested at the south end in zones 2-Big Beaver (11%), 1-Ruby (6%), 3-Devils (5%), 5-Little Beaver (5%), and 4-Lightning (3%).

TABLE 9. Estimated mean seasonal catch and harvest rates for all trout and char species in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Species	Strata*	Harvest	Release	Total
Rainbow	Opener	0.117	1.023	1.140
	Weekday	0.069	0.516	0.585
	Weekend	0.079	0.575	0.654
	Mean	0.076	0.572	0.648
Dolly Varden	Opener	0	0.003	0.003
	Weekday	0.000	0.004	0.005
	Weekend	0	0.003	0.003
	Mean	0.000	0.004	0.004
Cuttroat Trout	Opener	0	0	0
	Weekday	0	0.001	0.001
	Weekend	0	0	0
	Mean	0	0.000	0.000
Brook Trout	Opener	0	0	0
	Weekday	0	0	0
	Weekend	0	0.002	0.002
	Mean	0	0.001	0.001
All Species	Opener	0.117	1.026	1.143
	Weekday	0.069	0.522	0.590
	Weekend	0.079	0.580	0.659
	Mean	0.076	0.577	0.653

*Daytype estimate.

TABLE 10. Estimated total seasonal catch and harvest of rainbow trout in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Type[b]	Strata	Rainbow Trout Captures[a] Harvested		Released		Total	
Daytype	Opener	126	(1)	1097	(3)	1223	(4)
	Weekday	991	(4)	7296	(34)	8287	(38)
	Weekend	1079	(4)	8156	(31)	9235	(35)
	Total	2196	(4)	16549	(33)	18745	(38)
Zone[c]	1 Rby	153	(2)	1313	(16)	1466	(18)
	2 Bbv	270	(3)	2481	(24)	2752	(27)
	3 Dev	127	(3)	932	(23)	1059	(26)
	4 Lit	79	(2)	852	(23)	932	(25)
	5 Lbv	123	(3)	1422	(35)	1545	(38)
	6 Hoz	637	(9)	5787	(76)	6423	(85)
	7 Can	1014	(11)	6155	(66)	7169	(77)
	Total	2403	(5)	18942	(41)	21345	(46)
Access	Resort	667	(3)	5739	(28)	6406	(31)
	Hozomeen	806	(10)	7429	(89)	8235	(99)
	Canada	1014	(11)	6155	(66)	7169	(77)
	Total	2486	(7)	19323	(50)	21809	(57)

[a]Ninety-five percent confidence interval of estimated captures given in parentheses.

[b]Type of estimate. Daytype estimates are the most accurate based on sample design, and are the values reported for this study (see text).

[c]See *Figure 3* for location of lake survey zones.

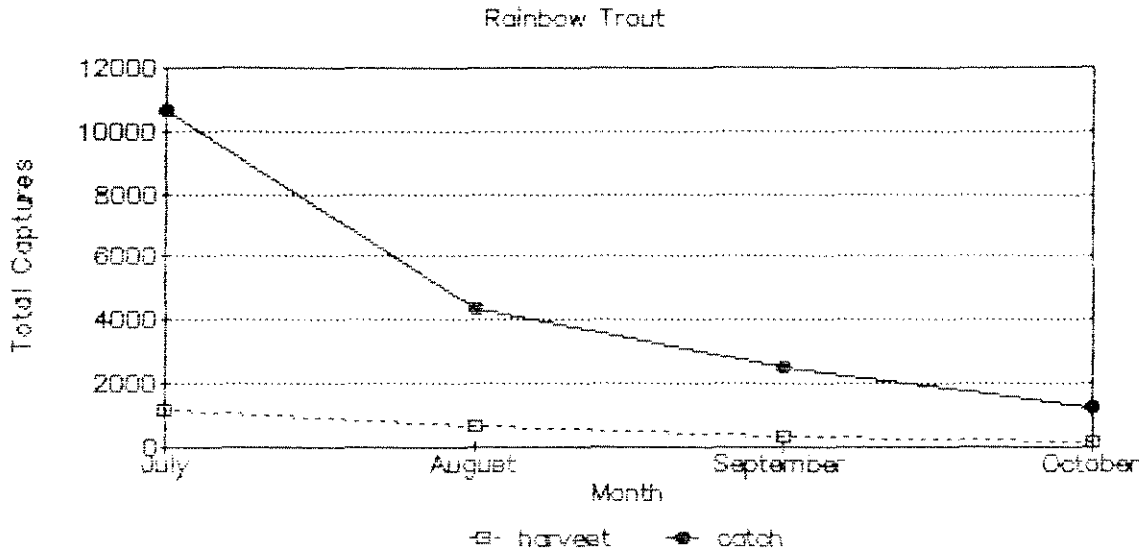

FIGURE 10. Monthly distribution of seasonal rainbow trout catch and harvest (daytype estimate) during the 1994 Ross Reservoir sport fishery.

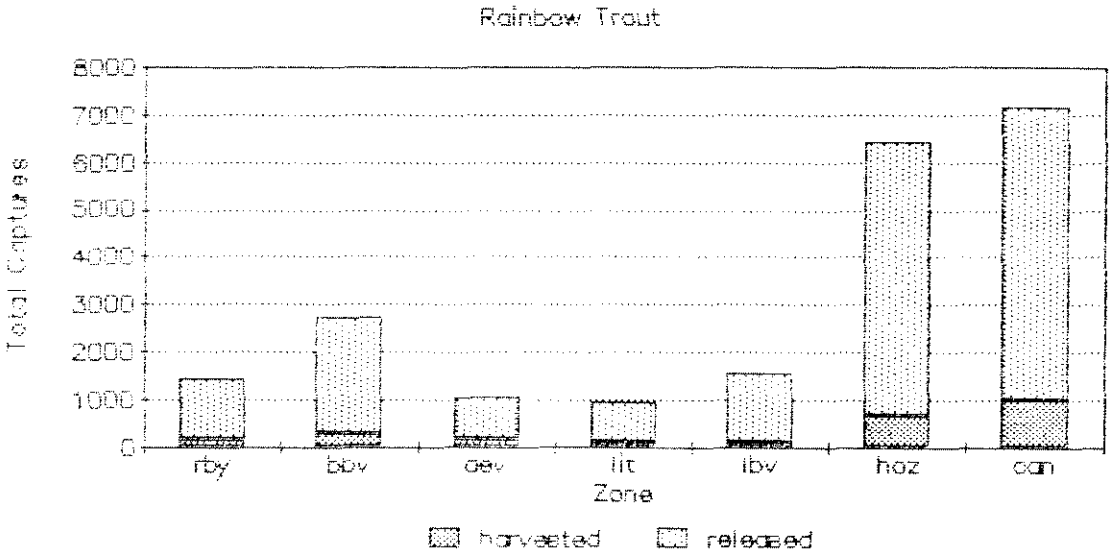

FIGURE 11. Distribution of seasonal rainbow trout catch and harvest (zone estimate) among lake zones during the 1994 Ross Reservoir sport fishery. Zone abbreviations are as follows: rby = ruby (zone 1), bbv = big beaver (zone 2); dev = devils (zone 3); lit = lightning (zone 4); lbv = little beaver (zone 5); hoz = hozomeen (zone 6); and can = canada (zone 7).

A total seasonal catch estimate of 21,809 ± 57 rainbow trout were calculated for data separated into access areas *(Table 10* and *Appendix 15)*. Anglers utilizing the Hozomeen access caught the largest numbers of rainbow trout (38%). Anglers fishing in Canada also caught a large proportion of the catch (33%), while anglers originating from Ross Lake Resort caught the fewest fish (29%). A total seasonal harvest estimate of 2,486 ± 7 rainbow trout did not follow the same distribution pattern as catch. More fish were harvested by anglers fishing in Canada (41%), than by anglers originating from Hozomeen (32%) and the resort (27%).

Catch and harvest estimates for dolly varden/bull trout char, cutthroat trout, and eastern brook trout (char) were low during the 1994 sport fishing season at Ross Lake *(Table 11* and *Appendix 16-18)*. Total seasonal catch was estimated at 108 dolly varden/bull trout, 7 cutthroat trout, and 25 brook trout (daytype estimates). Total seasonal harvest of dolly varden/bull trout char was estimated at 5 fish (illegal), while cutthroat trout and brook trout estimates were both zero.

Total seasonal catch and harvest estimates for all species of trout and char combined are given in *Table 11* and *Appendix 19*. The total seasonal catch of all species combined was 18,885 ± 38 fish, while the seasonal harvest was 2,201 ± 4 fish (daytype estimate).

1994 Season - Angling Methods and Gear

The majority of anglers (95%) interviewed at Ross Lake fished from boats during 1994 *(Table 12)*. Only eighty-six shore anglers (5%) were interviewed the entire season. The most popular angling method was trolling with flashers and lures (74%), followed by casting or trolling flies from a boat (21%). The remaining anglers were either casting flies (3%), lures (2%), or bait (<1%) from shore. Bait fishing is no longer permitted under the new regulations (implemented at the beginning of the 1995 sport fishing season).

Anglers trolling lures caught sixty-one percent of the total harvest, and experienced a HPUE of 0.058 fish per hour *(Table 12)*. Anglers trolling flies harvested an additonal thirty-six percent of the seasonal total, and returned a HPUE of 0.151 fish per hour. The remaining harvest was caught by shore anglers utilizing flies (3%) and lures (1%), and having respective HPUE rates of 0.099 and 0.111 fish per hour. The three anglers (illegally) fishing with bait did not harvest any fish.

1994 Season - Age

A total of 234 rainbow trout scale samples from the 1994 angler sport harvest were analyzed for age determination. Age 4 fish were the most abundant age class throughout the entire season, comprising fifty-one percent of the total sample *(Table 13)*. Age 5 fish also comprised a large proportion of the harvest (35%), while the remaining harvest consisted of age 6 (7%), age 7 (3%), and age 3 (3%) fish.

TABLE 11. Estimated total seasonal catch and harvest of all species of trout and char in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Species	Strata*	Harvest	Release	Total
Rainbow	Opener	126	1097	1223
	Weekday	991	7296	8287
	Weekend	1079	8156	9235
	Total	2196	16549	18745
Dolly Varden	Opener	0	3	3
	Weekday	5	65	70
	Weekend	0	35	35
	Total	5	103	108
Cutthroat	Opener	0	0	0
	Weekday	0	7	7
	Weekend	0	0	0
	Total	0	7	7
Brook Trout	Opener	0	0	0
	Weekday	0	0	0
	Weekend	0	25	25
	Total	0	25	25
All Species	Opener	126	1100	1226
	Weekday	996	7368	8364
	Weekend	1079	8216	9295
	Total	2201	16684	18885

*Daytype estimate.

TABLE 12. Harvest, harvest rates, and number of anglers fishing for rainbow trout using different types of gear and methods during the 1994 sport fishing season*.

Geartype[b]	Resort	Hozomeen	Canada	Total	Percent
ANGLERS					
bl	777	417	136	1330	74
bf	82	52	252	386	21
sl	10	1	20	31	2
sf	2	6	44	52	3
sb			3	3	<1
Total	871	476	455	1802	100
HARVEST					
bl	140	110	46	296	61
bf	16	23	135	174	36
sl	0	0	5	5	1
sf	0	2	11	13	3
sb			0	0	0
Total	156	135	197	488	100
HPUE					
bl	0.042	0.080	0.122	0.058	
bf	0.056	0.141	0.190	0.151	
sl	0.000	0.000	0.192	0.111	
sf	0.000	0.235	0.096	0.099	
sb			0.000	0.000	
Mean	0.043	0.087	0.160	0.076	

*Data compiled from combined (complete + incomplete) trip anglers.

[b]bl = boat, trolling lure
bf = boat, trolling fly
sl = shore, casting lure
sf = shore, casting fly
sb = shore, casting bait (illegal)

TABLE 13. Percent age composition of rainbow trout sampled from the 1994 sport harvest at Ross Reservoir.

	MONTH									
	Jul		Aug		Sep		Oct		Total	
AGE	n	%	n	%	n	%	n	%	n	%
THREE:	4	3	2	3	1	3	1	5	8	3
FOUR:	67	58	20	31	18	56	14	67	119	51
FIVE:	37	32	31	48	9	28	5	24	82	35
SIX:	5	4	8	12	4	13			17	7
SEVEN:	3	3	4	6			1	5	8	3
TOTAL:	116	100	65	100	32	100	21	100	234	100

Occurrence of most age classes fluctuated throughout the season, although occurrence of age 3 (n=8) and age 7 (n=8) fish remained relatively constant. Age 4 (n=119) fish showed a sharp decline from July to August (seasonal low), and a subsequent large increase in September and October (seasonal high). Conversely, age 5 (n=82) fish increased to a seasonal high in August, then declined to a seasonal low in October. Age 6 (n=17) fish showed a marked increase from July to August, then increased only slightly more in September.

1994 Season - Length

A total of 355 rainbow trout were measured during the 1994 fishing season *(Table 14)*. The minimum size regulations restrict angler harvest to fish longer than 13 inches (330 mm) total length. A fork length of 317 mm is an approximate equivalent to the 330 mm (total length) minimum size restriction. The average fork length of angler harvested rainbow trout during the 1994 season was 334 mm. Sizes ranged from a low of 226 mm (illegally harvested) to a high of 449 mm. Average size increased from July to August, then declined in September and October. Life history characteristics that may be responsible for the apparent temporal decrease in average size of specific age classes will be presented in a later section of this report.

Length at age information for the rainbow trout harvest is shown in *Table 15*. As expected, average fork length increases with each successive age class. Age 3 fish averaged 285 mm, age 4 fish averaged 321 mm, age 5 fish averaged 349 mm, age 6 fish averaged 384 mm, and age 7 fish averaged 417 mm.

Table 16 and *Figure 12* show the summer growth of rainbow trout in Ross Lake, as reflected by the size of fish in the angler sport harvest. Several age classes appeared to exhibit little variation in growth throughout the summer, while small sample sizes may have caused fluctuations in other age groups. Average monthly size of age 4 (n=119) and age 5 (n=82) fish fluctuated a maximum of 3 mm and 4 mm, respectively, throughout the summer. Age 6 (n=17) fish increased 22 mm from July to August, then decreased 12 mm in September. Sample sizes of age 3 (n=8) and age 7 (n=8) fish are too small to draw any definitive conclusions. As mentioned earlier in this section, factors that may be responsible for static and/or negative temporal growth of specific age classes of fish will be presented in a later section of this report.

Monthly and seasonal length-frequency histograms of angler harvested rainbow trout at Ross Reservoir are shown in *Figure 13*. The abscissa scale values are standardized to facilitate comparison. All five histograms (monthly and seasonal) closely resemble the standard normal curve, and are not centered around any predominant fork length interval. The 320-330 mm size group predominates in July, the 330-340 mm group in August, the 310-320 mm group in September, and the 310-320 mm and 330-340 mm size groups in October. The legal size limit is 330 mm total length or approximately 317 mm fork length.

TABLE 14. Trout and char length information, by month, from the 1994 sport fishing season at Ross Reservoir.

Month	Number	Percent	Fork Length (mm) Average	Minimum	Maximum
RAINBOW					
July	183	52	330	269	417
August	102	29	346	280	449
September	40	11	333	226	403
October	30	8	322	257	361
Season	355	100	334	226	449

TABLE 15. Rainbow trout length information, by age, from the 1994 sport harvest at Ross Reservoir.

Age	Number	Percent	Fork Length (mm) Average	Minimum	Maximum
3	8	3	285	226	314
4	119	51	321	280	356
5	82	35	349	269	381
6	17	7	384	364	449
7	8	3	417	381	458

TABLE 16. Average fork length (mm) of rainbow trout, grouped by month and age class, from the 1994 sport harvest at Ross Reservoir.

AGE		JUL	AUG	SEP	OCT	SEASON
THREE:	n	4	2	1	1	8
	avg	299	300	226	257	285
FOUR:	n	67	20	18	14	119
	avg	321	323	323	320	321
FIVE:	n	37	31	9	5	82
	avg	348	351	349	347	349
SIX:	n	5	8	4	---	17
	avg	372	394	382	---	384
SEVEN:	n	3	4	---	1	8
	avg	401	418	---	458	417

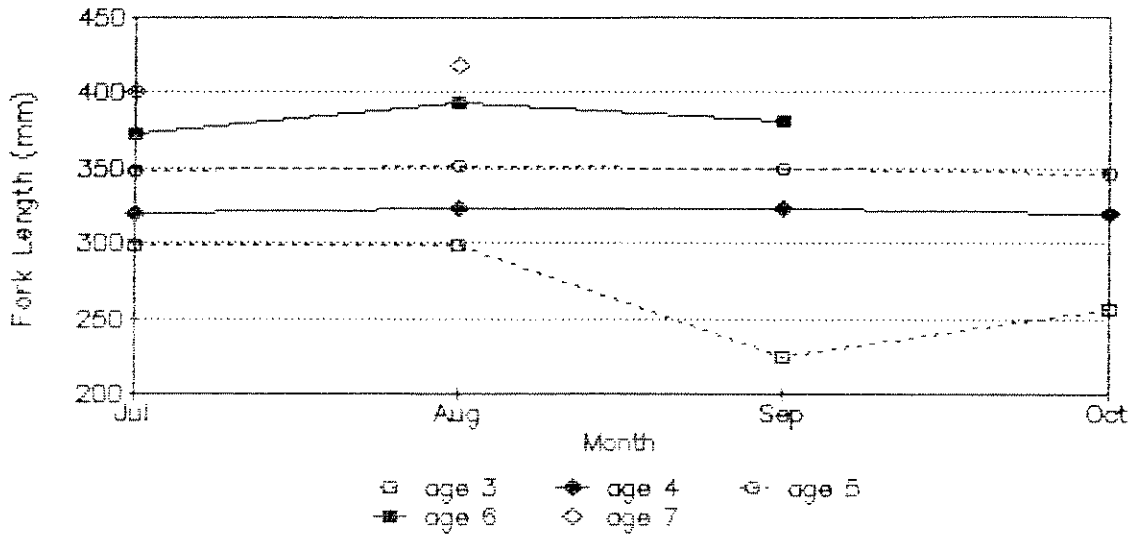

FIGURE 12. Average lengths of age 3 - age 7 rainbow trout, by month, from the 1994 Ross Lake sport harvest.

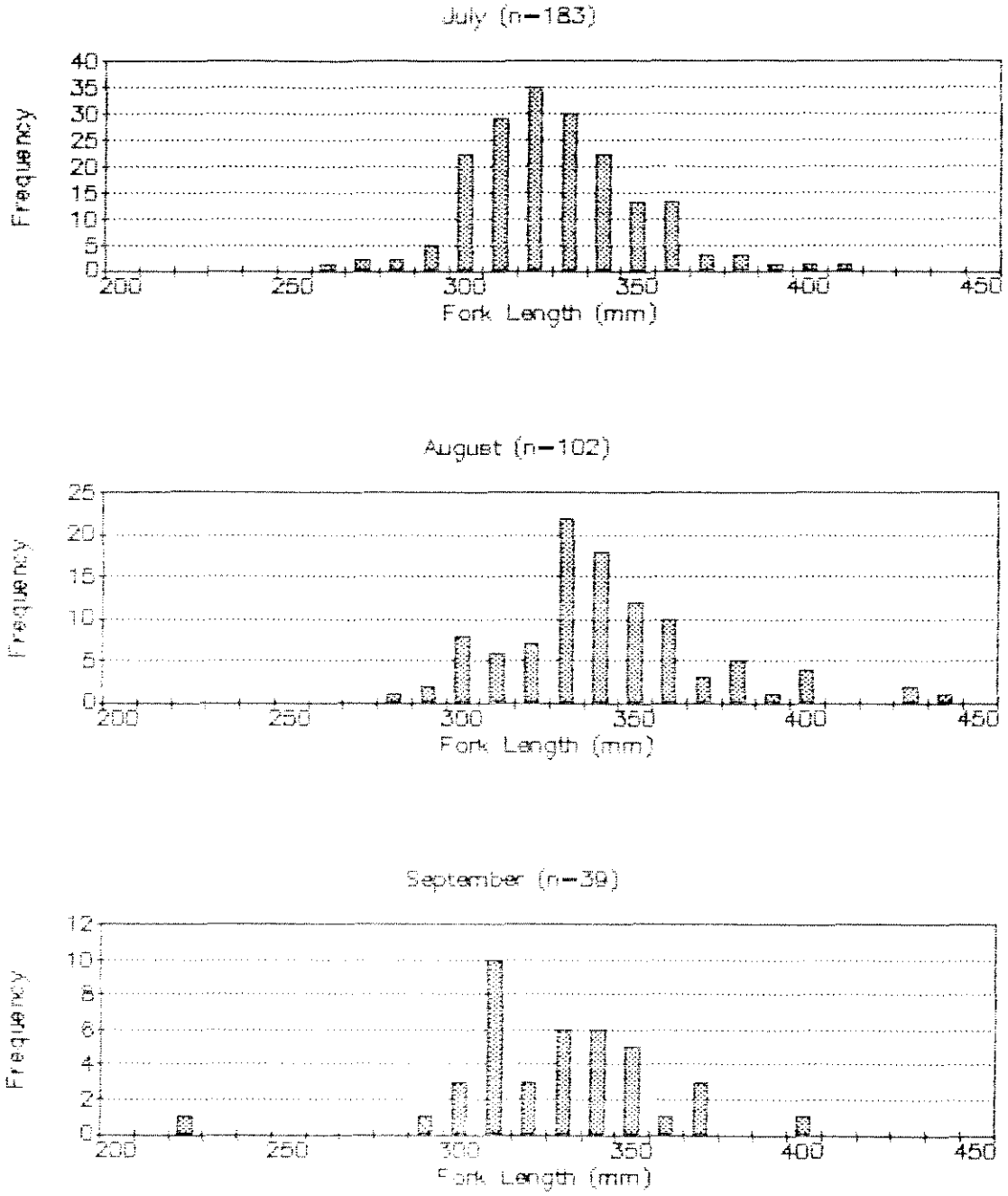

FIGURE 13. Length-frequency distribution of rainbow trout sampled from the 1994 Ross Lake sport harvest. Minimum legal size limit is approximately 317 mm fork length. Abscissa values indicate lower limit of length interval.

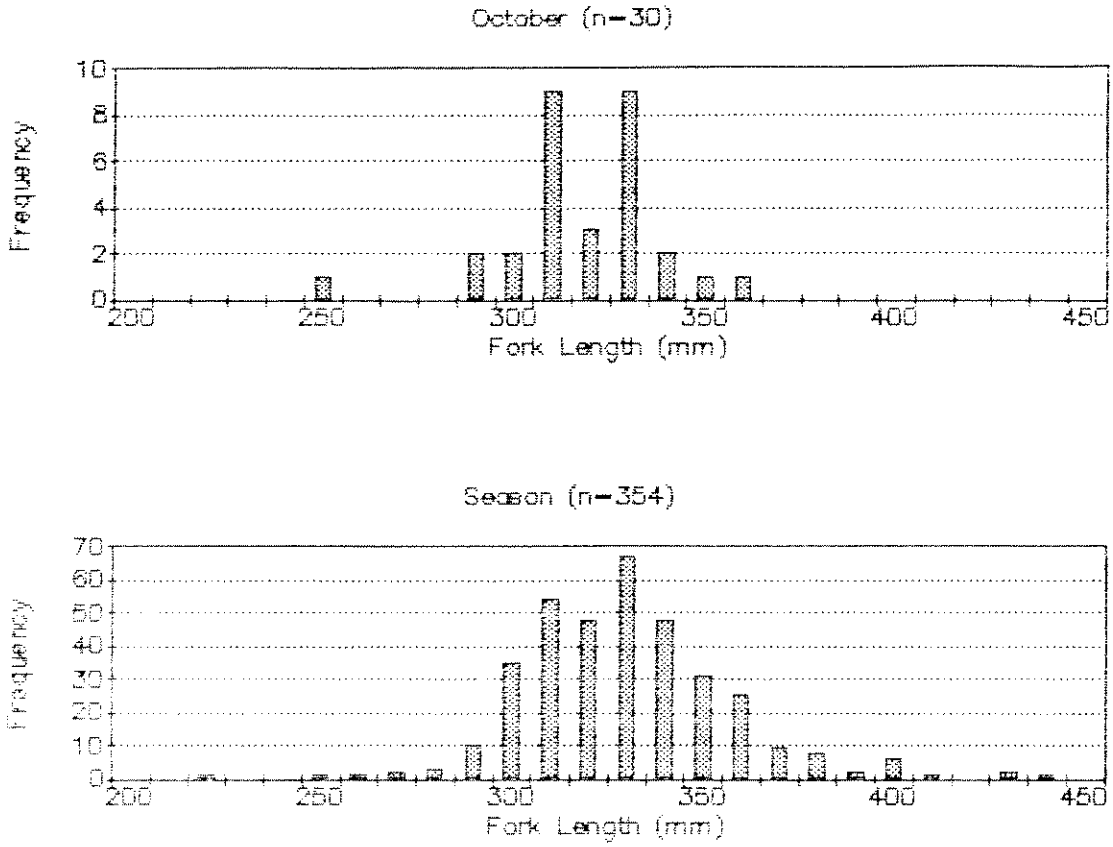

FIGURE 13. (Continued).

1994 Season - Sex

A total of 111 rainbow trout were sampled from the seasonal sport harvest for sex determination. Males constituted 25 percent of the total sample (n=28), while females accounted for 75 percent (n=83). Both the south end (n=75) and north end (n=36) samples consisted of 25 percent males and 75 percent females.

1994 Season - Sexual Maturity

A random sample of 74 rainbow trout from the seasonal sport harvest were checked for gonadal development *(Table 17)*. Mature fish comprised 55 percent of the sample, while the remaining 45 percent were immature. Males consisted of 48 percent mature and 52 percent immature fish, while the female sample was comprised of 58 percent mature and 42 percent immature fish.

Table 18 shows the average fork length and size range of a random sample of 72 rainbow trout from the seasonal sport harvest, separated by access, sex, sexual maturity, and age. The north end sample (n=29) was comprised of 17 percent mature, and 83 percent immature fish. The male sample was composed of 22 percent mature (average length = 378 mm), and 78 percent immature fish (average length = 350 mm). Fifteen percent of the female sample were mature (average length = 368 mm), while 85 percent were immature (average length = 335 mm).

A much larger percentage of mature fish occurred at the south end of the lake than at the north end. The south end sample (n=43) comprised 81 percent mature, and 19 percent immature fish *(Table 18)*. The male sample included 67 percent mature (average length = 342 mm), and 33 percent immature (average length = 304 mm) fish. Eighty-seven percent of the female sample were mature fish (average length = 330 mm), while 13 percent were immature (average length = 302 mm).

1994 Season - Additional Data

Forty-one percent of the interviewed anglers that were fishing for rainbow trout during the 1994 sport fishing season at Ross Reservoir were unsuccessful at catching a fish *(Figure 14)*. The remaining anglers (59%) were successful at catching from one to thirty-one fish. Eighty-two percent of the anglers were unsuccessful in harvesting a legal rainbow trout, while the remaining anglers harvested one (12%), two (5%), and three (2%) fish. Two anglers (illegally) harvested four (<1%) and five (<1%) fish, respectively, during the 1994 season.

Very few of the three remaining species of trout and char were caught and/or harvested by interviewed anglers during the season *(Figure 15)*. Nineteen anglers caught one (1%), and three anglers caught two (<1%) dolly varden/bull trout char, one of which was (illegally) harvested. Two anglers each caught one cutthroat trout, none of which were harvested. Three anglers caught one (<1%), and one angler caught

TABLE 17. Rainbow trout length information, grouped by sex and maturity, from the 1994 sport harvest at Ross Reservoir.

				Fork Length (mm)		
Sex	Maturity	N	%	Avg	Min	Max
Male	Mature	10	48	349	312	381
	Immature	11	52	333	273	374
Female	Mature	31	58	333	309	406
	Immature	22	42	328	297	364

TABLE 18. Rainbow trout age and length information, grouped by access area, sex and maturity, from the 1994 sport harvest at Ross Reservoir.

					Fork Length (mm)		
Access	Sex	Maturity	Age	N	Avg	Min	Max
Hozomeen	Male	Mature	6	1	375	375	375
			7	1	381	381	381
		Immature	4	2	336	334	338
			5	5	356	340	374
	Female	Mature	4	1	323	323	323
			6	1	375	375	375
			7	1	406	406	406
		Immature	4	10	325	305	339
			5	6	347	334	359
			6	1	364	364	364
Resort	Male	Mature	4	3	319	312	327
			5	5	355	347	360
		Immature	3	1	273	273	273
			4	3	314	307	327
	Female	Mature	4	19	323	309	334
			5	8	347	325	360
		Immature	3	1	300	300	300
			4	3	302	297	309

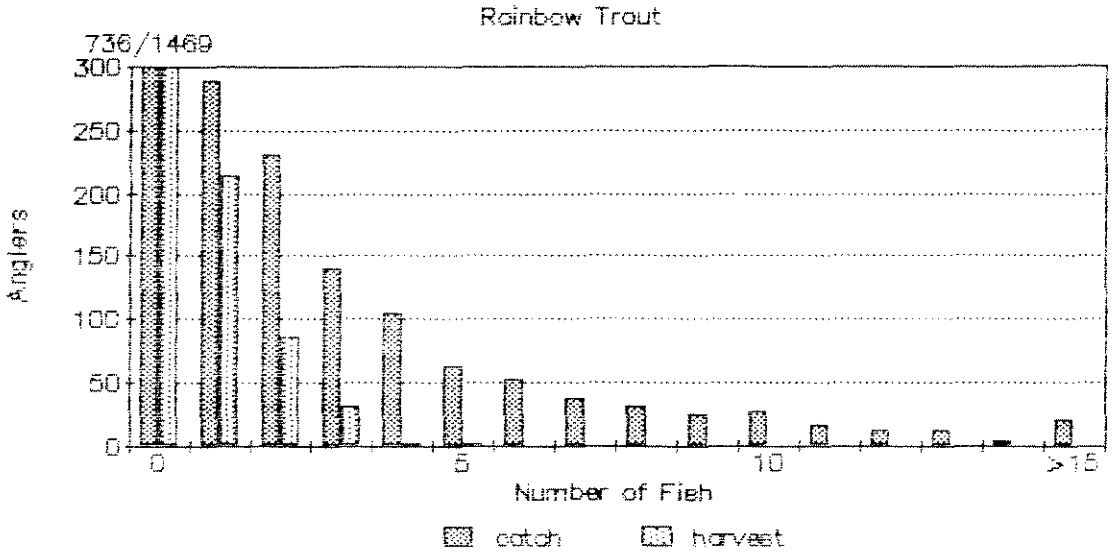

FIGURE 14. Reported angler success at catching rainbow trout during the 1994 sport fishing season at Ross Reservoir.

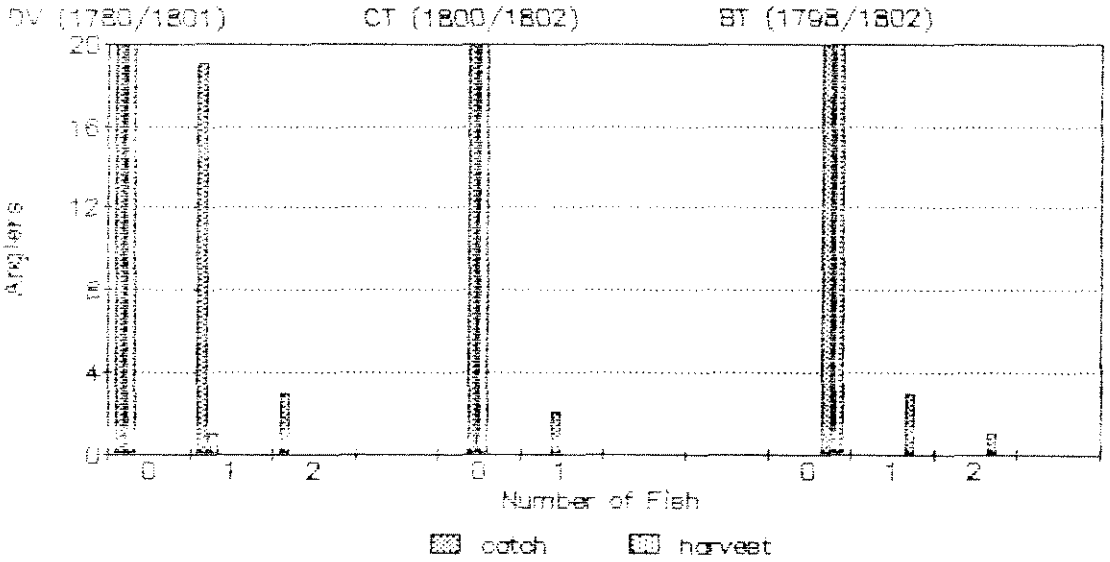

FIGURE 15. Reported angler success at catching dolly varden/bull trout char, cutthroat trout, and brook trout (char) during the 1994 sport fishing season at Ross Reservoir.

two (<1%) eastern brook trout (char), none of which were harvested.

1994 Season - Dolly Varden/Bull Trout Char

No dolly varden/bull trout char were measured for (possible future) species classification during the 1994-95 study at Ross Lake. Harvest of dolly varden/bull trout char is prohibited under a statewide restriction implemented at the beginning of the 1994 season *(Appendix 1)*.

Hydroacoustic Surveys

Four hydroacoustic surveys were conducted on Ross Lake on April 22 and April 23, 1995. A total of 222 fish were recorded for the four surveys, resulting in an average of 56 fish per survey *(Table 19)*. Index counts varied as much as 229 percent between surveys, ranging from 38 to 87 fish per survey. A large difference occurred between the average number of fish recorded between morning and afternoon surveys (AM average = 73, PM average = 39).

Population estimates for the four hydroacoustic surveys are given in *Table 20*. Based on the assumption that percent species occurrence in the sport catch reflects species occurrence in the reservoir, rainbow trout population estimates for the four surveys ranged from a high of 115,429 fish to a low of 42,395. The total reservoir rainbow trout population was estimated at 72,191 ± 13,487, while the total combined species (trout and char) population was estimated at 72,730 ± 13,587. Confidence limits are within ± 20 percent of both estimates, indicating moderate precision. Estimates should also be viewed with caution for reasons outlined earlier in the methods section of this report.

greater percentage of older rainbow trout in the 1990-94 harvests than in previous studies *(Table 25)*. The 1990 harvest consisted primarily of age 3 (47 percent) and age 4 (32 percent) fish, while the 1991, 1992, and 1994 harvests comprised mostly age 4 (48, 61, and 51 percent, respectively) and age 5 (43, 29, and 35 percent, respectively) fish. The 1993 harvest consisted mostly of age 5 (48 percent) and age 4 (33 percent) fish. This is in contrast to earlier years, when small numbers of age 1 and large numbers of age 2 fish were present in the harvest. Except for 1986, when age 3 fish comprised the majority of the harvest, age 2 fish were the age class harvested in greatest numbers by anglers prior to 1990. Johnston (1989) attributes the increase in percentage of older age classes (age 3 and age 4) in the harvest from the early 1970's to the mid-1980's to anglers targeting older Canadian Skagit River rainbow trout (that enter the reservoir fishery in June and again in September and October) at the north end of the lake, and to selectively "high-grading" their catch to retain the largest and brightest rainbow trout (predominantly age 3, immature females).

The ratio of age 4 to age 3 rainbow trout also increased from previous years *(Table 25)*. The 1990-94 age 4:age 3 harvest ratios were 68, 960, 1,525, (no age 3 fish were sampled in 1993), and 1700 percent, respectively, compared to 27 percent in 1971, 21 percent in 1972, 21 percent in 1973, 45 percent in 1985, and 48 percent in 1986. The 13-inch minimum size restriction is designed to increase the percentage of age 4 and older age classes of rainbow trout harvested. This appears to have occurred from 1990-94, with 43, 95, 96, 100, and 97 percent of the harvest comprising age 4 and older fish, respectively. Sexual maturity and spawning or post-spawning of Ross Lake rainbow trout occurs primarily at age 4 for females (age 3 for males), generally before opening day of the fishing season (July 1). Theoretically, fish should then be able to spawn at least once before becoming available to the fishery.

Length

The average size of most rainbow trout age classes declined annually during the study, although the mean size of a few older age classes did increase in 1994 (*Table 26* and *Figure 20)*. From 1990-94, the average size of age 3 to age 5 fish declined 41 mm (1990-92 and 1994 only), 18 mm, and 3 mm, respectively, while age 6 fish increased 6 mm. The increase in size of most age classes from 1993 to 1994 could indicate increased food resources and/or decreased population density.

Sexual Maturity

A fairly large proportion of the rainbow trout harvest was composed of immature fish during most years of the 1990-94 study *(Table 27)*. The only exceptions occurred during 1992 and 1993, when only 23 and 3 percent of the fish harvested were immature. (It should be noted that

TABLE 25. Percent age class contribution* of rainbow trout to the 1971-73, 1985-86, and 1990-94 seasonal sport harvest at Ross Reservoir.

	Percent of Season Harvest									
Age	1971	1972	1973	1985	1986	1990	1991	1992	1993	1994
2	55	49	62	36	28	10	0	0	0	0
3	26	39	29	29	40	47	5	4	0	3
4	7	8	6	13	19	32	48	61	33	51
5	1	2	1	4	4	10	43	29	48	35
6	0	0	0	1	1	1	4	5	15	7
7	0	0	0	0	0	<1	0	<1	5	3

*Fishing regulations differed between 1971-73, 1985-86, and 1990-94. See Johnston (1989) and *Appendix 1*.

TABLE 26. Seasonal rainbow trout age and length data* from the 1985-86 and 1990-94 sport harvests at Ross Reservoir.

			Fork Length (mm)		
Year	Age	N	Avg	Min	Max
1985	2	216	260	183	337
	3	169	302	207	369
	4	76	334	275	378
	5	23	347	307	384
	6	5	394	374	424
	7	0	---	---	---
1986	2	207	257	157	328
	3	251	302	218	380
	4	146	333	286	403
	5	32	349	295	395
	6	3	380	365	409
	7	0	---	---	---
1990	2	36	313	270	330
	3	172	326	271	370
	4	115	339	300	460
	5	36	352	300	400
	6	5	368	350	395
	7	1	380	380	380
1991	2	0	---	---	---
	3	15	310	292	332
	4	145	325	301	371
	5	128	350	315	385
	6	13	378	325	411
	7	0	---	---	---
1992	2	0	---	---	---
	3	12	308	290	318
	4	167	324	295	370
	5	78	343	306	373
	6	14	366	340	402
	7	1	365	365	365

TABLE 26. (Continued)

Year	Age	N	Fork Length (mm) Avg	Min	Max
1993	2	0	---	---	---
	3	0	---	---	---
	4	13	323	312	333
	5	19	331	318	346
	6	6	352	340	361
	7	2	395	394	395
1994	2	0	---	---	---
	3	8	285	226	314
	4	119	321	280	356
	5	82	349	269	381
	6	17	384	364	449
	7	8	417	381	458

*Fishing regulations differed between 1985-86 and 1990-94. See Johnston (1989) and *Appendix 1*.

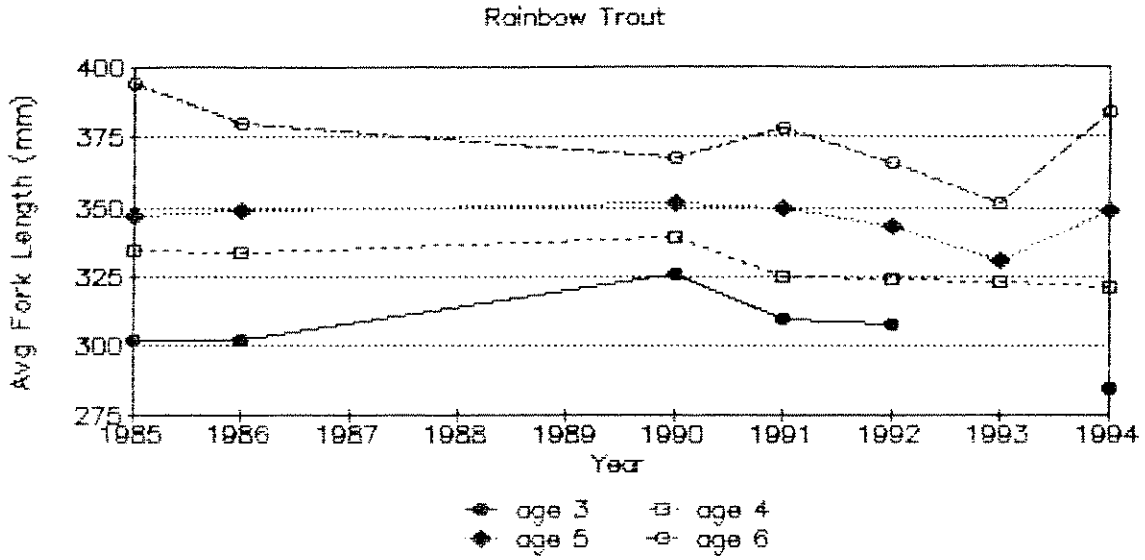

FIGURE 20. Average lengths of age 3 - age 6 rainbow trout from the 1985-86 and 1990-94 Ross Lake sport harvests.

TABLE 27. Percent immature rainbow trout sampled, by age, from the 1990–94 sport harvests at Ross Reservoir.

	Percent Immature*						
Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Total
1990	86	83	62	38	0	-----	70
	(7)	(53)	(37)	(13)	(1)	-----	(111)
1991	-----	80	62	38	0	-----	52
	-----	(10)	(34)	(39)	(1)	-----	(84)
1992	-----	50	26	19	0	0	23
	-----	(2)	(58)	(36)	(3)	(1)	(100)
1993	-----	-----	0	6	0	0	3
	-----	-----	(8)	(16)	(6)	(2)	(32)
1994	-----	100	44	46	33	0	44
	-----	(2)	(41)	(24)	(3)	(2)	(72)

*Sample size of each age class given in parentheses.

the 1993 sample size was approximately one-third smaller than in previous years). Thus, the 13-inch minimum size restriction did not appear to completely protect immature fish during the study. However, the total percentage of immature fish harvested (all age classes combined) declined markedly from 1990-93, then increased substantially in 1994. Population density and/or environmental factors are probably influencing age at maturity, which in turn directly influences the percentage of immature fish occurring in the harvest.

Population Size

Ross Lake rainbow trout mark-recapture population estimates from the early 1970's are substantially higher than hydroacoustic estimates conducted during the present study *(Table 28)*. Mark-recapture studies estimated reservoir rainbow trout population sizes of 153,580, 206,185, and 191,480 fish in 1971, 1972, and 1973, respectively. These estimates are much larger than the 1991-95 hydroacoustic estimates of 19,733, 37,080, 59,320, 68,812, and 72,191 fish, respectively. A possible explanation for this large discrepancy is that mark-recapture efforts in the early 1970's may have focused at stream mouths, where fish concentrations are typically high. In contrast, hydroacoustic surveys conducted on the reservoir between December 1970 and June 1973 ranged in size from 26,000-90,000 fish with a mean of 49,000 (Thorne 1976). These estimates range and average lower than 1995 hydroacoustic estimates *(Table 20)*. (The 1973 estimate of 31,000 rainbow trout listed in *Table 28* is the only year that a specific hydroacoustic date and estimate were reported).

The 1991-95 hydroacoustic estimates suggest that the reservoir trout population has increased approximately 88 percent, 60 percent, 16 percent, and 5 percent annually over the past five years *(Table 28* and *Figure 21)*. In addition, the 1995 estimate is approximately forty-seven percent larger than the 1973 hydroacoustic average. (It should be noted that the fairly large confidence intervals associated with the 1991-95 hydroacoustic estimates should be treated with caution, while any future measurements should incorporate a larger number of sample transects to reduce variance associated with the estimate). Catch rate information also tends to support an increase in the reservoir trout population. Overall HPUE shows a slight decrease from 1990-94 of 0.12, 0.10, 0.11, 0.10, and 0.08, respectively *(Table 22)*, while CPUE indicates a corresponding increase of 0.39 (Looff 1992a), 0.37 (Looff 1993a), 0.43 (Looff 1994b), 0.55 (Looff 1995a), and 0.65 *(Appendix 12)*. Overall 1993 and 1994 CPUE are also larger than the 1971-72 and 1985-86 HPUE of 0.48, 0.52, 0.33, and 0.41, respectively. (The 1993 and 1994 overall CPUE estimates are used for comparison with the overall 1971-72 and 1985-86 HPUE estimates, since 1993 <u>catch</u> would be roughly equivalent to 1971-72 and 1985-86 <u>harvest</u>). This suggests that expanding numbers of younger (non-harvestable) age classes (age 2 and age 3) may be occurring in the reservoir.

TABLE 28. Population estimates of Ross-Skagit system rainbow trout in 1971-73, and 1991-95.

Year	Estimate	95% CI	Method	Source
1971	153,580	± 33,317	Mark-Recapture	Johnston (1989)
1972	206,185	± 31,685	Mark-Recapture	Johnston (1989)
1973	191,480	± 20,729	Mark-Recapture	Johnston (1989)
1973	31,000*	------	Hydroacoustic	Thorne (1976)
1991	19,733	± 6,509	Hydroacoustic	Looff (1992a)
1992	37,080	± 10,636	Hydroacoustic	Looff (1993a)
1993	59,320	± 12,095	Hydroacoustic	Looff (1994b)
1994	68,812	± 17,529	Hydroacoustic	Looff (1995a)
1995	72,191	± 13,487	Hydroacoustic	

*One estimate. See text for explanation.

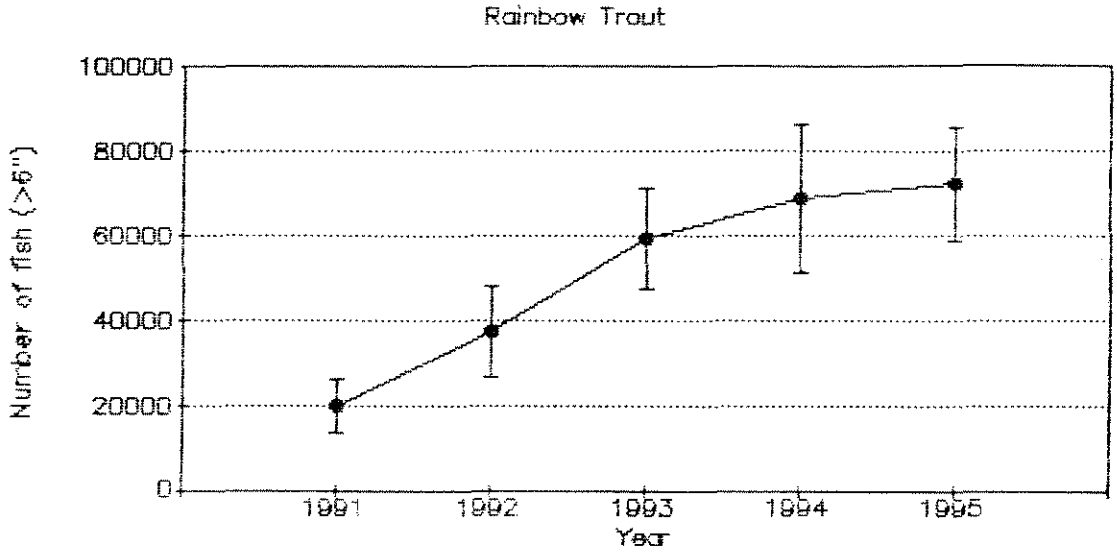

FIGURE 21. Hydroacoustic population estimates of rainbow trout (greater than six inches length) in Ross Reservoir from 1991-95. Range intervals denote 95% confidence limit of each estimate.

Spawning Surveys

Spawning survey data conducted on selected tributary streams of Ross Reservoir from 1991 to 1994 show an increase in the number of spawning rainbow trout *(Table 29)*. Spawning numbers increased from a total of 120 fish in 1991 (n=8 surveys), to 660, 1,294, and 1,369 fish in 1992 (n=7 surveys), 1993 (n=7 surveys), and 1994 (n=6 surveys), respectively (instream counts only). However, this is still well below a single estimate of 2,500 to 3,000 fish that were observed spawning in Roland Creek by a National Park Service employee on June 13, 1986 (National Park Service letter from Gary Mason to Washington Department of Wildlife area fisheries biologist Jim Johnston). Excessive and prolonged spring and early summer runoff during 1991 may have prevented most fish from ascending tributary streams to spawn that year, as well as reducing survival of any eggs that may have been deposited. However, very few fish were observed milling off stream mouths during the 1991 surveys, suggesting a depressed rainbow trout spawning population.

All five tributaries recorded increases in numbers of spawning rainbow trout from 1991 to 1994 *(Table 29)*. Roland Creek recorded the largest number of (instream) spawners during all four annual surveys, and is the best index stream based on spawner use, flow, available spawning habitat, and accessibility. Dry Creek is another excellent index stream that should continue to be included in future surveys. As well as recording the second highest spawner totals, Dry Creek registered the greatest percentage increase (4,750 percent) over the four year survey period. Pierce and Thursday Creeks also recorded marked spawning increases, even though total numbers remain low due to migration barriers located near the mouth of each tributary. Total (instream) numbers on Lightning Creek are difficult to determine due to stream size and flow. In addition, a substantial number of fish probably spawn in the lake immediately adjacent to the stream mouth.

Analysis of data collected from the 1990-91, 1991-92, 1992-93, 1993-94, and 1994-95 reservoir studies at Ross Lake indicate that the rainbow trout population is beginning to recover from the effects of past overharvest. A final management report outlining steps to protect and enhance the reservoir fishery will follow this report, pending consultation with appropriate administrators within the North Cascades National Park Service, British Columbia Ministry of Environment, and Washington Department of Fish and Wildlife.

TABLE 29. Number of spawning rainbow trout observed in selected tributaries of Ross Reservoir from 1991 to 1994.

Tributary	Number of Rainbow Trout*							
	1991[b]		1992[c]		1993[d]		1994[e]	
Dry	8	(8)	155	(126)	345	(305)	436	(380)
Lightning	51	(0)	1554	(29)	963	(15)	604	(4)
Pierce	5	(2)	30	(30)	95	(42)	137	(37)
Roland	107	(107)	597	(447)	1012	(897)	1067	(926)
Thursday	3	(3)	64	(28)	49	(35)	35	(22)
Total	174	(120)	2400	(660)	2464	(1294)	2279	(1369)

*Counts include fish observed milling in the immediate vicinity of mouth to upstream migration barrier. Counts from drawdown elevation to upstream migration barrier (instream counts only) given in parentheses.

[b]1991 = eight surveys.

[c]1992 = seven surveys

[d]1993 = seven surveys

[e]1994 = six surveys

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APPENDIX 1. Summary of 1989-1994 Ross Lake fishing regulations.

1990-1994

	Washington State	British Columbia
Season:	07/01 - 10/31	
Catch limit:	three	
Size limit[a]:	thirteen inch minimum size for all species[b]	same as Washington State
Possession limit:	six	
Gear restriction:	no bait single barbless hook[c]	

1989

	Washington State	British Columbia
Season:	06/17 - 10/31	07/01 - 10/31
Catch limit:	eight	four
Size limit[d]:	no more than three over 14 inches	
Possession limit:	eight	four
Gear restriction:	none	none

[a]Size limits measured using total length in both Washington State and British Columbia.

[b]Dolly varden/bull trout char protected in 1994, twenty-inch minimum size restriction in 1992 and 1993.

[c]1994 season only.

[d]Size limits were measured using total length in Washington State, and fork length in British Columbia.

APPENDIX 2. Creel and effort sampling schedule for the 1994 sport fishing season at Ross Reservoir.

Month	Day[a]	Daytype[b]	Work Period Start	Work Period Finish	Effort Count 1	Effort Count 2
July	1	OD	1000	1800	1400	1700
	3	WE	1200	2000	1500	1700
	4	WE	0600	1400	1200	1400
	14	WD	1200	2000	1500	1600
	15	WD	1300	2100	1800	1900
	16	WE	0900	1700	1100	1300
	22	WD	1300	2100	1500	1600
	23	WE	0700	1500	1000	1200
	24	WE	0600	1400	1200	1300
	27	WD	1000	1800	1400	1600
	28	WD	1300	2100	1600	1700
	29	WD	0600	1400	0800	1000
August	4	WD	1100	1900	1200	1300
	5	WD	1100	1900	1400	1600
	6	WE	0800	1600	0900	1000
	9	WD	1200	2000	1600	1800
	10	WD	0700	1500	1000	1100
	11	WD	0700	1500	1100	1300
	14	WE	0900	1700	1400	1600
	15	WD	1000	1800	1300	1500
	16	WD	0700	1500	1000	1100
	20	WE	1000	1800	1400	1500
	21	WE	1100	1900	1100	1300
	22	WD	1000	1800	1300	1400
September	3	WE	1000	1800	1600	1800
	4	WE	0900	1700	1300	1500
	5	WE	0800	1600	0800	1100
	16	WD	1000	1800	1300	1500
	17	WE	1000	1800	1300	1500
	18	WE	0900	1700	1300	1500
	21	WD	1100	1900	1600	1700
	22	WD	1000	1800	1600	1700
	23	WD	0900	1700	0900	1100
	27	WD	1100	1900	1400	1500
	28	WD	1100	1900	1700	1800
	29	WD	0900	1700	1300	1500

APPENDIX 2. (Continued)

Month	Day[a]	Daytype[b]	Work Period Start	Work Period Finish	Effort Count 1	Effort Count 2
October	2	WE	0900	1700	1400	1600
	3	WD	1000	1800	1100	1300
	4	WD	0900	1700	1500	1600
	10	WD	1000	1800	1600	1700
	11	WD	0900	1700	1000	1300
	12	WD	0900	1700	1000	1100
	15	WE	0900	1700	0900	1100
	16	WE	1000	1800	1100	1200
	17	WD	0900	1700	0900	1100
	23	WE	1000	1800	1600	1700
	24	WD	1000	1800	1400	1500
	25	WD	0900	1700	1100	1300

[a]Two holidays, July 4 (Independence Day) and September 5 (Labor Day), were treated as weekend days, even though they were observed during midweek in 1994 (see text).

[b]OD=opening day, WD=weekday, WE=weekend day.

APPENDIX 3. Estimated monthly and seasonal angler effort by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	Angler Hours[a]		Mean Hours Fished per Day[b]	Total Angler Days[c]
Jul	Opener	1073	(0)	4.11	261
	Weekday	4320	(103)	3.70	1166
	Weekend	7158	(344)	3.47	2061
	Total	12550	(127)	3.60	3488
Aug	Weekday	4965	(270)	3.08	1615
	Weekend	2065	(131)	3.30	626
	Total	7030	(198)	3.14	2241
Sep	Weekday	2743	(145)	4.20	654
	Weekend	2992	(187)	3.49	858
	Total	5735	(111)	3.79	1512
Oct	Weekday	2075	(168)	4.42	470
	Weekend	788	(72)	3.16	249
	Total	2863	(113)	3.98	719
Ssn	Opener	1073	(0)	4.11	261
	Weekday	14102	(91)	3.61	3905
	Weekend	13003	(121)	3.43	3794
	Total	28177	(71)	3.54	7960

[a]Ninety-five percent confidence interval of estimated total angler-hours given in parentheses.

[b]Mean hours calculated using data from all anglers, including those that indicated they had not finished fishing for the day (see text).

[c]Total angler days = angler hours/mean hours fished per day.

APPENDIX 4. Estimated monthly and seasonal angler effort by lake zone[a] in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	Angler Hours[b]		Mean Hours Fished per Day[c]	Total Angler Days[d]
Jul	1 Rby	1656	(12)	3.84	432
	2 Bbv	2388	(16)	4.59	520
	3 Dev	1184	(15)	5.38	220
	4 Lit	1282	(14)	4.57	281
	5 Lbv	1332	(16)	3.17	420
	6 Hoz	3724	(23)	2.88	1294
	7 Can	2501	(18)	2.61	957
	Total	14066	(10)	3.41	4124
Aug	1 Rby	590	(9)	3.05	194
	2 Bbv	1927	(14)	3.75	513
	3 Dev	427	(8)	3.62	118
	4 Lit	313	(8)	4.00	78
	5 Lbv	640	(11)	3.35	191
	6 Hoz	1135	(12)	3.00	379
	7 Can	2488	(18)	2.77	899
	Total	7521	(8)	3.17	2371
Sep	1 Rby	414	(12)	3.33	124
	2 Bbv	1266	(14)	3.59	353
	3 Dev	902	(15)	5.91	153
	4 Lit	373	(8)	4.58	81
	5 Lbv	516	(11)	4.02	128
	6 Hoz	1298	(18)	4.18	310
	7 Can	1208	(14)	2.89	418
	Total	5977	(8)	3.81	1568
Oct	1 Rby	592	(10)	3.21	184
	2 Bbv	860	(12)	4.20	205
	3 Dev	349	(8)	5.55	63
	4 Lit	212	(11)	6.14	34
	5 Lbv	101	(8)	7.50	13
	6 Hoz	752	(12)	3.71	203
	7 Can	67	(4)	1.50	45
	Total	2932	(6)	3.92	747
Ssn	1 Rby	3252	(8)	3.48	933
	2 Bbv	6442	(10)	4.05	1592
	3 Dev	2861	(9)	5.17	553
	4 Lit	2180	(8)	4.59	475
	5 Lbv	2588	(9)	3.44	753
	6 Hoz	6908	(13)	3.16	2186
	7 Can	6264	(12)	2.70	2318
	Total	30496	(6)	3.46	8810

[a]See *Figure 3* for location of lake survey zones.
[b]Ninety-five percent confidence interval of estimated total angler-hours given in parentheses.
[c]Mean hours calculated using data from all anglers, including those that indicated they had not finished fishing for the day (see text).
[d]Total angler days = angler hours/mean hours fished per day.

APPENDIX 5. Estimated monthly and seasonal angler effort by access area[a] in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	Angler Hours[b]		Mean Hours Fished per Day[c]	Total Angler Days[d]
Jul	Resort	6510	(293)	4.48	1452
	Hozomeen	5055	(338)	2.90	1741
	Canada	2501	(160)	2.61	957
	Total	14066	(153)	3.39	4150
Aug	Resort	3258	(117)	3.52	925
	Hozomeen	1775	(97)	3.06	581
	Canada	2488	(163)	2.77	899
	Total	7521	(71)	3.13	2404
Sep	Resort	2955	(67)	4.14	715
	Hozomeen	1814	(205)	4.14	438
	Canada	1208	(89)	2.89	418
	Total	5977	(75)	3.81	1570
Oct	Resort	2012	(124)	4.11	489
	Hozomeen	853	(87)	3.81	224
	Canada	67	(9)	1.50	45
	Total	2932	(49)	3.87	758
Ssn	Resort	14735	(97)	4.12	3581
	Hozomeen	9497	(115)	3.18	2983
	Canada	6264	(67)	2.70	2318
	Total	30496	(55)	3.43	8882

[a]See *Figure 3* for location of access areas.

[b]Ninety-five percent confidence interval of estimated total angler-hours given in parentheses.

[c]Mean hours calculated using data from all anglers, including those that indicated they had not finished fishing for the day (see text).

[d]Total angler days = angler hours/mean hours fished per day.

APPENDIX 6. Estimated monthly and seasonal mean captures per hour for rainbow trout by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	N[b]	Rainbow Trout Captures per Hour[a] Harvested		Released		Total	
Jul	Opener	83	.117	(.001)	1.023	(.002)	1.140	(.003)
	Weekday	247	.072	(.000)	.694	(.000)	.766	(.000)
	Weekend	343	.095	(.000)	.761	(.000)	.855	(.000)
	Mean		.089	(.000)	.772	(.000)	.862	(.000)
Aug	Weekday	292	.082	(.000)	.480	(.000)	.562	(.000)
	Weekend	207	.097	(.000)	.647	(.001)	.744	(.001)
	Mean		.089	(.000)	.552	(.000)	.641	(.000)
Sep	Weekday	132	.063	(.000)	.374	(.001)	.437	(.001)
	Weekend	253	.051	(.000)	.381	(.000)	.432	(.000)
	Mean		.056	(.000)	.378	(.000)	.434	(.000)
Oct	Weekday	131	.047	(.000)	.429	(.001)	.475	(.001)
	Weekend	114	.061	(.000)	.300	(.001)	.361	(.001)
	Mean		.052	(.000)	.379	(.000)	.431	(.000)
Ssn	Opener	83	.117	(.001)	1.023	(.002)	1.140	(.003)
	Weekday	802	.069	(.000)	.516	(.000)	.585	(.000)
	Weekend	917	.079	(.000)	.575	(.000)	.654	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Number of anglers surveyed.

APPENDIX 7. Estimated monthly and seasonal mean captures per hour for rainbow trout by lake zone[a] in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Zone	N[c]	Rainbow Trout Captures per Hour[b] Harvested		Released		Total	
Jul	1 Rby	109	.067	(.000)	.555	(.001)	.622	(.001)
	2 Bbv	145	.087	(.000)	.724	(.001)	.811	(.001)
	3 Dev	58	.061	(.000)	.509	(.002)	.570	(.002)
	4 Lit	26	.034	(.001)	.531	(.009)	.564	(.010)
	5 Lbv	18	.070	(.005)	.737	(.021)	.807	(.023)
	6 Hoz	177	.104	(.000)	1.047	(.001)	1.151	(.001)
	7 Can	140	.145	(.000)	1.036	(.002)	1.181	(.002)
	Mean		.089	(.000)	.772	(.000)	.862	(.000)
Aug	1 Rby	70	.056	(.001)	.267	(.002)	.323	(.002)
	2 Bbv	113	.021	(.000)	.203	(.001)	.224	(.001)
	3 Dev	34	.024	(.001)	.179	(.003)	.203	(.003)
	4 Lit	8	.094	(.018)	.094	(.018)	.188	(.026)
	5 Lbv	17	.018	(.002)	.456	(.011)	.474	(.012)
	6 Hoz	85	.082	(.000)	.581	(.002)	.663	(.002)
	7 Can	172	.191	(.000)	1.115	(.001)	1.306	(.002)
	Mean		.089	(.000)	.552	(.000)	.641	(.000)
Sep	1 Rby	30	.000		.310	(.009)	.310	(.009)
	2 Bbv	82	.017	(.000)	.190	(.001)	.207	(.001)
	3 Dev	33	.036	(.001)	.174	(.003)	.210	(.003)
	4 Lit	24	.018	(.001)	.264	(.006)	.282	(.005)
	5 Lbv	22	.023	(.001)	.249	(.010)	.271	(.010)
	6 Hoz	68	.039	(.000)	.467	(.002)	.506	(.002)
	7 Can	126	.146	(.000)	.653	(.001)	.799	(.002)
	Mean		.056	(.000)	.378	(.000)	.434	(.000)
Oct	1 Rby	61	.015	(.000)	.184	(.001)	.199	(.001)
	2 Bbv	56	.000		.140	(.001)	.140	(.001)
	3 Dev	25	.036	(.002)	.274	(.004)	.310	(.005)
	4 Lit	7	.000		.209	(.051)	.209	(.051)
	5 Lbv	2	.067	(.424)	.200	(.424)	.267	(.847)
	6 Hoz	77	.140	(.001)	.829	(.003)	.969	(.003)
	7 Can	17	.000		.000		.000	
	Mean		.052	(.000)	.379	(.000)	.431	(.000)
Ssn	1 Rby	270	.046	(.000)	.384	(.000)	.430	(.000)
	2 Bbv	396	.044	(.000)	.406	(.000)	.450	(.000)
	3 Dev	150	.044	(.000)	.329	(.000)	.373	(.000)
	4 Lit	65	.030	(.000)	.342	(.002)	.372	(.002)
	5 Lbv	59	.037	(.000)	.428	(.002)	.464	(.003)
	6 Hoz	407	.094	(.000)	.788	(.000)	.881	(.000)
	7 Can	455	.160	(.000)	.932	(.000)	1.092	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)

[a]See *Figure 3* for location of lake survey zones.
[b]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.
[c]Number of anglers surveyed.

APPENDIX 8. Estimated monthly and seasonal mean captures per hour for rainbow trout by access area* in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Zone	N[c]	Rainbow Trout Captures per Hour[b] Harvested		Released		Total	
Jul	Resort	330	.072	(.000)	.626	(.000)	.699	(.000)
	Hozomeen	203	.097	(.000)	.963	(.001)	1.060	(.001)
	Canada	140	.145	(.000)	1.036	(.002)	1.181	(.002)
	Mean		.089	(.000)	.772	(.000)	.862	(.000)
Aug	Resort	217	.032	(.000)	.215	(.000)	.248	(.000)
	Hozomeen	110	.073	(.000)	.532	(.001)	.605	(.001)
	Canada	172	.191	(.000)	1.115	(.001)	1.306	(.002)
	Mean		.089	(.000)	.552	(.000)	.641	(.000)
Sep	Resort	173	.021	(.000)	.193	(.000)	.214	(.000)
	Hozomeen	86	.035	(.000)	.502	(.001)	.537	(.002)
	Canada	126	.146	(.000)	.653	(.001)	.799	(.002)
	Mean		.056	(.000)	.378	(.000)	.434	(.000)
Oct	Resort	151	.014	(.000)	.194	(.000)	.208	(.000)
	Hozomeen	77	.141	(.001)	.826	(.003)	.967	(.003)
	Canada	17	.000		.000		.000	
	Mean		.052	(.000)	.379	(.000)	.431	(.000)
Ssn	Resort	871	.043	(.000)	.373	(.000)	.416	(.000)
	Hozomeen	476	.087	(.000)	.752	(.000)	.839	(.000)
	Canada	455	.160	(.000)	.932	(.000)	1.092	(.000)
	Mean		.076	(.000)	.572	(.000)	.648	(.000)

*See *Figure 3* for location of access areas.

[b]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[c]Number of anglers surveyed.

APPENDIX 9. Estimated monthly and seasonal mean captures per hour for dolly varden char by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

			Dolly Varden Char Captures per Hour[a]					
Month	Daytype	N[b]	Harvested		Released		Total	
Jul	Opener	83	0		.003	(.000)	.003	(.000)
	Weekday	247	0		.003	(.000)	.003	(.000)
	Weekend	343	0		.002	(.000)	.002	(.000)
	Mean		0		.002	(.000)	.002	(.000)
Aug	Weekday	292	0		.004	(.000)	.004	(.000)
	Weekend	207	0		.007	(.000)	.007	(.000)
	Mean		0		.006	(.000)	.006	(.000)
Sep	Weekday	132	.002	(.000)	.009	(.000)	.011	(.000)
	Weekend	253	0		.001	(.000)	.001	(.000)
	Mean		.001	(.000)	.004	(.000)	.005	(.000)
Oct	Weekday	131	0		.002	(.000)	.002	(.000)
	Weekend	114	0		.006	(.000)	.006	(.000)
	Mean		0		.003	(.000)	.003	(.000)
Ssn	Opener	83	0		.003	(.000)	.003	(.000)
	Weekday	802	.000	(.000)	.004	(.000)	.005	(.000)
	Weekend	917	0		.003	(.000)	.003	(.000)
	Mean		.000	(.000)	.004	(.000)	.004	(.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Number of anglers surveyed.

APPENDIX 10. Estimated monthly and seasonal mean captures per hour for cutthroat trout by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	N[b]	Cutthroat Trout Captures per Hour[a] Harvested	Released	Total
Jul	Opener	83	0	0	0
	Weekday	247	0	0	0
	Weekend	343	0	0	0
	Mean		0	0	0
Aug	Weekday	292	0	0	0
	Weekend	207	0	0	0
	Mean		0	0	0
Sep	Weekday	132	0	0	0
	Weekend	253	0	0	0
	Mean		0	0	0
Oct	Weekday	131	0	.003 (.000)	.003 (.000)
	Weekend	114	0	0	0
	Mean		0	.002 (.000)	.002 (.000)
Ssn	Opener	83	0	0	0
	Weekday	802	0	.001 (.000)	.001 (.000)
	Weekend	917	0	0	0
	Mean		0	.000 (.000)	.000 (.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Number of anglers surveyed.

APPENDIX 11. Estimated monthly and seasonal mean captures per hour for eastern brook trout by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	N[b]	Eastern Brook Trout Captures per Hour[a] Harvested	Released	Total
Jul	Opener	83	0	0	0
	Weekday	247	0	0	0
	Weekend	343	0	.003 (.000)	.003 (.000)
	Mean		0	.001 (.000)	.001 (.000)
Aug	Weekday	292	0	0	0
	Weekend	207	0	0	0
	Mean		0	0	0
Sep	Weekday	132	0	0	0
	Weekend	253	0	.002 (.000)	.002 (.000)
	Mean		0	.001 (.000)	.001 (.000)
Oct	Weekday	131	0	0	0
	Weekend	114	0	0	0
	Mean		0	0	0
Ssn	Opener	83	0	0	0
	Weekday	802	0	0	0
	Weekend	917	0	.002 (.000)	.002 (.000)
	Mean		0	.001 (.000)	.001 (.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Number of anglers surveyed.

APPENDIX 12. Estimated monthly and seasonal mean captures per hour for all trout and char species by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Daytype	N[b]	Trout and Char Captures per Hour[a] Harvested		Released		Total	
Jul	Opener	83	.117	(.001)	1.026	(.002)	1.143	(.003)
	Weekday	247	.072	(.000)	.697	(.000)	.770	(.000)
	Weekend	343	.095	(.000)	.765	(.000)	.860	(.000)
	Mean		.089	(.000)	.776	(.000)	.865	(.000)
Aug	Weekday	292	.082	(.000)	.484	(.000)	.567	(.000)
	Weekend	207	.097	(.000)	.655	(.001)	.751	(.001)
	Mean		.089	(.000)	.558	(.000)	.647	(.000)
Sep	Weekday	132	.065	(.000)	.383	(.001)	.448	(.001)
	Weekend	253	.051	(.000)	.384	(.000)	.435	(.000)
	Mean		.056	(.000)	.384	(.000)	.440	(.000)
Oct	Weekday	131	.047	(.000)	.434	(.001)	.481	(.001)
	Weekend	114	.061	(.000)	.305	(.001)	.366	(.001)
	Mean		.052	(.000)	.384	(.000)	.437	(.000)
Ssn	Opener	83	.117	(.001)	1.026	(.002)	1.143	(.003)
	Weekday	802	.069	(.000)	.522	(.000)	.590	(.000)
	Weekend	917	.079	(.000)	.580	(.000)	.659	(.000)
	Mean		.076	(.000)	.577	(.000)	.653	(.000)

[a]Ninety-five percent confidence interval of estimated mean captures per hour given in parentheses.

[b]Number of anglers surveyed.

APPENDIX 13. Monthly and seasonal estimates of rainbow trout captured by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Rainbow Trout Captured*					
Month	Daytype	Harvested		Released		Total	
Jul	Opener	126	(1)	1097	(3)	1223	(4)
	Weekday	312	(2)	2999	(20)	3310	(22)
	Weekend	679	(7)	5444	(56)	6123	(63)
	Total	1116	(5)	9539	(43)	10656	(47)
Aug	Weekday	409	(7)	2383	(40)	2792	(47)
	Weekend	200	(3)	1337	(20)	1537	(23)
	Total	609	(6)	3720	(37)	4328	(43)
Sep	Weekday	173	(4)	1025	(23)	1199	(27)
	Weekend	153	(2)	1139	(18)	1292	(21)
	Total	326	(3)	2165	(20)	2491	(23)
Oct	Weekday	97	(4)	890	(33)	986	(36)
	Weekend	48	(1)	236	(7)	284	(8)
	Total	145	(3)	1125	(22)	1270	(25)
Ssn	Opener	126	(1)	1097	(3)	1223	(4)
	Weekday	991	(4)	7296	(34)	8287	(38)
	Weekend	1079	(4)	8156	(31)	9235	(35)
	Total	2196	(4)	16549	(33)	18745	(38)

*Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 14. Monthly and seasonal estimates of rainbow trout captured by lake zone[a] in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Rainbow Trout Captured[b]					
Month	Zone	Harvested		Released		Total	
Jul	1 Rby	111	(3)	918	(23)	1029	(26)
	2 Bbv	208	(5)	1729	(44)	1937	(50)
	3 Dev	72	(5)	603	(41)	675	(46)
	4 Lit	43	(4)	680	(53)	723	(57)
	5 Lbv	93	(11)	981	(100)	1075	(109)
	6 Hoz	388	(13)	3897	(127)	4285	(140)
	7 Can	362	(12)	2592	(89)	2954	(101)
	Total	1277	(8)	11400	(68)	12677	(76)
Aug	1 Rby	33	(2)	158	(7)	191	(9)
	2 Bbv	41	(1)	391	(11)	431	(12)
	3 Dev	10	(1)	76	(6)	87	(6)
	4 Lit	29	(5)	29	(5)	59	(10)
	5 Lbv	11	(2)	292	(30)	303	(31)
	6 Hoz	94	(4)	659	(28)	753	(32)
	7 Can	475	(15)	2774	(89)	3250	(104)
	Total	694	(5)	4380	(32)	5074	(37)
Sep	1 Rby	0		128	(22)	128	(22)
	2 Bbv	22	(1)	241	(12)	263	(13)
	3 Dev	32	(4)	157	(18)	190	(22)
	4 Lit	7	(1)	98	(9)	105	(9)
	5 Lbv	12	(2)	128	(17)	140	(18)
	6 Hoz	50	(5)	607	(55)	657	(59)
	7 Can	176	(7)	789	(33)	965	(40)
	Total	298	(4)	2149	(28)	2447	(32)
Oct	1 Rby	9	(1)	109	(7)	118	(7)
	2 Bbv	0		121	(8)	121	(8)
	3 Dev	13	(1)	96	(10)	108	(11)
	4 Lit	0		44	(17)	44	(17)
	5 Lbv	7	(4)	20	(9)	27	(12)
	6 Hoz	105	(7)	623	(43)	729	(50)
	7 Can	0		0		0	
	Total	134	(2)	1013	(18)	1147	(20)
Ssn	1 Rby	153	(2)	1313	(16)	1466	(18)
	2 Bbv	270	(3)	2481	(24)	2752	(27)
	3 Dev	127	(3)	932	(23)	1059	(26)
	4 Lit	79	(2)	852	(23)	932	(25)
	5 Lbv	123	(3)	1422	(35)	1545	(38)
	6 Hoz	637	(9)	5787	(76)	6423	(85)
	7 Can	1014	(11)	6155	(66)	7169	(77)
	Total	2403	(5)	18942	(41)	21345	(46)

[a]See *Figure 1* for location of lake survey zones.

[b]Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 15. Monthly and seasonal estimates of rainbow trout captured by access area[a] in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

Month	Access	Rainbow Trout Captured[b] Harvested		Released		Total	
Jul	Resort	471	(8)	4077	(66)	4548	(74)
	Hozomeen	493	(15)	4868	(147)	5361	(162)
	Canada	362	(12)	2592	(89)	2954	(101)
	Total	1326	(11)	11537	(91)	12863	(101)
Aug	Resort	105	(2)	701	(11)	806	(13)
	Hozomeen	130	(4)	945	(31)	1075	(35)
	Canada	475	(15)	2774	(89)	3250	(104)
	Total	710	(6)	4421	(35)	5131	(41)
Sep	Resort	63	(1)	571	(6)	634	(7)
	Hozomeen	63	(5)	911	(69)	974	(73)
	Canada	176	(7)	789	(33)	965	(40)
	Total	301	(4)	2271	(28)	2573	(32)
Oct	Resort	29	(1)	390	(13)	418	(14)
	Hozomeen	120	(9)	704	(50)	825	(59)
	Canada	0		0		0	
	Total	149	(3)	1094	(22)	1243	(25)
Ssn	Resort	667	(3)	5739	(28)	6406	(31)
	Hozomeen	806	(10)	7429	(89)	8235	(99)
	Canada	1014	(11)	6155	(66)	7169	(77)
	Total	2486	(7)	19323	(50)	21809	(57)

[a]See *Figure 1* for location of access areas.

[b]Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 16. Monthly and seasonal estimates of dolly varden/bull trout char captured by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Dolly Varden Char Captured*					
Month	Daytype	Harvested		Released		Total	
Jul	Opener	0		3	(0)	3	(0)
	Weekday	0		14	(0)	14	(0)
	Weekend	0		12	(0)	12	(0)
	Total	0		29	(0)	29	(0)
Aug	Weekday	0		22	(0)	22	(0)
	Weekend	0		15	(0)	15	(0)
	Total	0		37	(0)	37	(0)
Sep	Weekday	5	(0)	25	(1)	30	(1)
	Weekend	0		3	(0)	3	(0)
	Total	5	(0)	28	(0)	33	(0)
Oct	Weekday	0		4	(0)	4	(0)
	Weekend	0		4	(0)	4	(0)
	Total	0		8	(0)	8	(0)
Ssn	Opener	0		3	(0)	3	(0)
	Weekday	5	(0)	65	(0)	70	(0)
	Weekend	0		35	(0)	35	(0)
	Total	5	(0)	103	(0)	108	(0)

*Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 17. Monthly and seasonal estimates of cutthroat trout captured by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Cutthroat Trout Captured*					
Month	Daytype	Harvested	Released		Total		
Jul	Opener	0	0		0		
	Weekday	0	0		0		
	Weekend	0	0		0		
	Total	0	0		0		
Aug	Weekday	0	0		0		
	Weekend	0	0		0		
	Total	0	0		0		
Sep	Weekday	0	0		0		
	Weekend	0	0		0		
	Total	0	0		0		
Oct	Weekday	0	7	(0)	7		(0)
	Weekend	0	0		0		
	Total	0	7	(0)	7		(0)
Ssn	Opener	0	0		0		
	Weekday	0	7	(0)	7		(0)
	Weekend	0	0		0		
	Total	0	7	(0)	7		(0)

*Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 18. Monthly and seasonal estimates of eastern brook trout captured by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Eastern Brook Trout Captured*					
Month	Daytype	Harvested		Released		Total	
Jul	Opener	0		0		0	
	Weekday	0		0		0	
	Weekend	0		18	(0)	18	(0)
	Total	0		18	(0)	18	(0)
Aug	Weekday	0		0		0	
	Weekend	0		0		0	
	Total	0		0		0	
Sep	Weekday	0		0		0	
	Weekend	0		7	(0)	7	(0)
	Total	0		7	(0)	7	(0)
Oct	Weekday	0		0		0	
	Weekend	0		0		0	
	Total	0		0		0	
Ssn	Opener	0		0		0	
	Weekday	0		0		0	
	Weekend	0		25	(0)	25	(0)
	Total	0		25	(0)	25	(0)

*Ninety-five percent confidence interval of estimated captures given in parentheses.

APPENDIX 19. Monthly and seasonal estimates of trout and char captured by daytype in the Ross Reservoir sport fishery, July 1 to October 31, 1994.

		Trout and Char Captured*					
Month	Daytype	Harvested		Released		Total	
Jul	Opener	126	(1)	1100	(3)	1226	(4)
	Weekday	312	(2)	3013	(20)	3324	(22)
	Weekend	679	(7)	5474	(56)	6153	(63)
	Total	1116	(5)	9587	(43)	10703	(48)
Aug	Weekday	409	(7)	2405	(40)	2814	(47)
	Weekend	200	(3)	1352	(21)	1552	(24)
	Total	609	(6)	3757	(37)	4366	(43)
Sep	Weekday	178	(4)	1050	(23)	1229	(27)
	Weekend	153	(2)	1149	(18)	1302	(21)
	Total	331	(3)	2200	(20)	2530	(23)
Oct	Weekday	97	(4)	900	(33)	997	(37)
	Weekend	48	(1)	240	(7)	288	(9)
	Total	145	(3)	1141	(22)	1286	(25)
Ssn	Opener	126	(1)	1100	(3)	1226	(4)
	Weekday	996	(5)	7368	(34)	8364	(39)
	Weekend	1079	(4)	8216	(31)	9295	(35)
	Total	2201	(4)	16684	(34)	18885	(38)

*Ninety-five percent confidence interval of estimated captures given in parentheses.