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Federal Aid to Fish and Wildlife Restoration

Job Performance Report

Project F-73-R-4

Subproject III: Lake and Reservoir Investigations

Study V: Cascade Reservoir Fisheries Investigations

Period Covered: 1 March 1981-28 February 1982

by

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

Page

LIST OF TABLES (Continued)

Page

LIST OF FIGURES

LIST OF FIGURES (Continued)

Page

LIST OF FIGURES (Continued)

Page

LIST OF APPENDIX

LIST OF APPENDIX (Continued)

Page

LIST OF APPENDIX (Continued)

Page

LIST OF APPENDIX (Continued)

JOB PERFORMANCE REPORT

State of: Idaho

Name: LAKE AND RESERVOIR INVESTIGATIONS

Project: F-73-R-4

Title: Cascade Reservoir Fisheries Investigations

Subproject: III

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ABSTRACT

A mathematical model to predict the risk of winterkill at different pool storage levels was developed for Cascade Reservoir to provide a basis for a minimum pool reservation. The work was based on a model where time-to-oxygen depletion is predicted from initial oxygen storage.

Results indicate that the risk of oxygen limitation ranges from 0% at higher pool volumes ($475x10^3$ acre feet) to approximately 58% at lower volumes (84x10 acre feet). The risk increases rapidly with initial reduction in storage, but approaches an upper asymptote at the low volumes. A minimum pool reservation of at least 300x10 acre feet should result in a winterkill risk of less than 10%.

Yellow perch were the most abundant fish species in the reservoir, and comprised 85 and 72% of the total angler catch in 1980 and 1981, respectively.

Spring releases of rainbow trout catchables provided a higher return to the creel than did fall-released catchables. Fingerling releases of rainbow trout were almost nonexistent in the catch.

Coho salmon fingerlings released in the central and southern portions of the reservoir reflected significantly better survival than did those released at the north end of Cascade Reservoir.

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RECOMMENDATIONS

Water Level Management

1. A threat of serious oxygen limitation for fish exists in Cascade Reservoir during the winter period of ice cover and stagnation. The risk is inversely related to pool storage volume. A significant risk (>10%) exists for any reservoir management program that results in a pool volume of less than 300,000 acre feet during the period from mid-December through 31 March. For that reason, we recommend that a reservoir pool management plan be established for Cascade Reservoir. The plan should incorporate a minimum conservation pool of 300,000 acre feet total storage during the period 15 December through 31 March of each winter.

   An 11 year average of monthly pool storage levels indicates the current water management program generally maintains the Cascade Reservoir pool storage above 300,000 acre feet during this period (Fig. 1). The lowest average pool storage calculated for the 15 December-31 March period was about 349, 000 acre feet (Appendix A-3).

   In only two of the last 11 years (1977-73, 1979-80), has the winter storage level (15 December-31 March) been less than the recommended 300,000 acre feet.

   A water management program which calls for maintaining pool storage as close to 300,000 acre feet as possible through the winter period would not only yield an acceptable winterkill risk, but also provide a buffer for high spring inflows, thus reducing the need for releasing water over the spillway during April and May.

2. The yellow perch fishery in Cascade Reservoir is considered one of the best and most popular fisheries in the state. Since the critical spawning period for this species extends from 15 April to 15 May, we recommend no drawdown during this period. A lowering of the water level at this time could result in the exposure and desiccation of eggs deposited along shoreline areas causing greater fluctuations in year-class strength.

3. Releasing water through the radial gates has resulted in losses of coho salmon and other fish species from Cascade Reservoir. To prevent these losses, we suggest that a dead storage buffer be maintained during critical periods capable of absorbing extreme or unusual runoff events to eliminate the need to release water through the radial gates. Since a "no spill" water management policy could be unsuccessful or impractical, we also recommend investigating the feasibility of screening the radial gates.

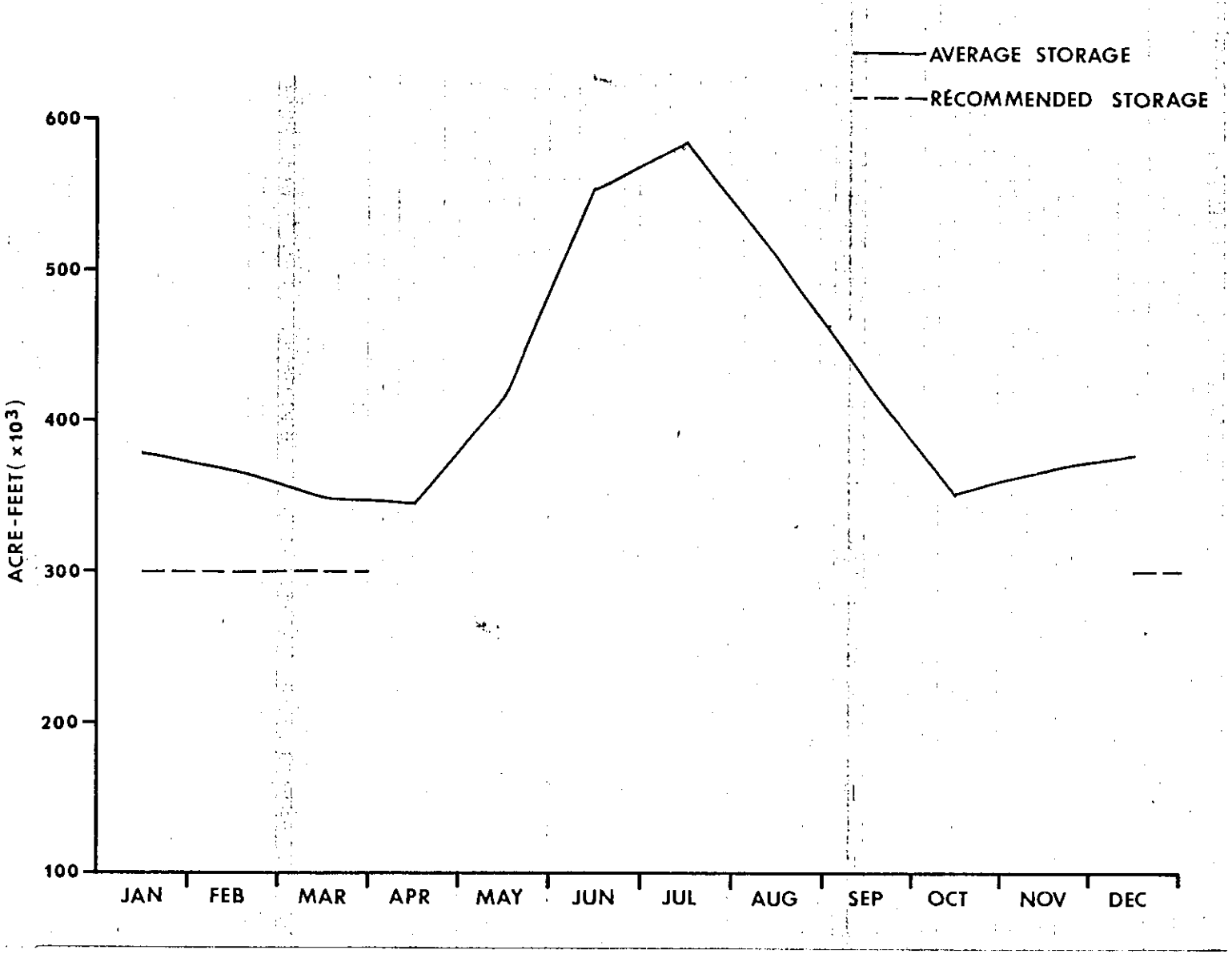

Figure 1. The calculated 11 year average pool storage level and the recommended storage level for Cascade Reservoir, Idaho.

4. Because of the importance of Cascade Reservoir as a recreational area, and since the potential for a summer fish kill exists, we recommend maintaining the reservoir's summer pool level as high as possible. A water management program which would keep all major boat ramps functional would provide for good fishing access and for other water-based recreational activities.

   Management of nutrient sources to the reservoir provide the best means of reducing the threat of a summer fish kill. A high summer pool could reduce problems by diluting high nutrient concentrations responsible for algal blooms, a key factor contributing to summer fish kills.

Fishery Management

1. Rainbow Trout

A. Catchable rainbow trout released in the spring in Cascade Reservoir provided a better return to the creel than did those released in the fall. Because of this and the fact that the south end of the reservoir and the area around Sugarloaf Island receive the greatest fishing pressure, we recommend the following stocking program for catchable rainbow trout:

   1) Approximately 40% of the total annual supply of rain-bow destined for Cascade Reservoir should be released at the Cabarton boat ramp, 40% should be released at the Sugarloaf boat ramp, and the remaining 20% should be released at Tamarack Falls Bridge. All rainbow should be stocked in the spring.

   2) We should utilize a stock of fish that matures at an older age to produce trophy-sized fish.

B. Because rainbow trout released as fingerlings provided essentially no return, we recommend discontinuing fingerling releases of this species except on an experimental basis to test the performance of alternate strains.

C. To enhance the contribution of "wild" rainbow trout to the fishery, we recommend that Cascade Reservoir tributaries be managed to protect spawning stocks of rainbow, but still allow for stream fisheries.

2. Coho Salmon

A. Coho salmon released as fingerlings in the south end of the reservoir and at Sugarloaf boat ramp provided the best return to the creel. Therefore, we recommend that of the total annual supply of coho destined for Cascade Reservoir, 50% be released at the Cabarton boat ramp and 50% be released at Sugarloaf boat ramp.

B. The coho population in Cascade Reservoir exhibits a high percentage of precocial fish which effectively reduces their life span by one year. We recommend investigating ways to reduce this loss of potential fish biomass. Experiments involving the release of different sizes of fingerlings or heat sterilization of green eggs may provide a solution to this problem.

3. Fall Chinook

A. Fall chinook salmon introductions also have the potential for providing a trophy fish for anglers in Cascade Reservoir. We should evaluate fall chinook growth rates, food habits, and catchability to build a data base for this species.

B. We should continue to evaluate the effect (if any) of fall chinook introductions on the other important fisheries in the reservoir.

4. Perch

A. The yellow perch fishery on Cascade Reservoir is one of the most popular in the state. In an effort to maintain this fishery, we should further investigate perch life history and population dynamics in Cascade Reservoir to shed light on potential management techniques and options for this important consumptive fishery.

Tributary Management

1. The potential for increased salmonid production exists in several of Cascade Reservoir's major tributaries. There is currently a direct loss of fish to irrigation canals, and elimination of important spawning and rearing habitat by stream dewatering. Additionally, irrigation waste water is a major source of nutrient input to Cascade Reservoir. These conditions could be improved by implementing the " Best Management Practices" described in the Idaho Agricultural Pollution Abatement Plan, 1980 (available from Idaho Department of Health and Welfare).

2. To allow up-and-downstream passage for migrating fish and prevent losses, the Gold Fork diversion should be laddered and the canal inlet screened. The irrigation diversions and canal inlets on Lake Fork Creek and Boulder Creek should be identified and modified to decrease fish losses.

INTRODUCTION

Background

When Cascade Dam and Reservoir were completed in the late 1940's, the stored water was primarily reserved for irrigation and future power development. Over the years a very popular recreational and fishing resource developed, and these uses continue to expand. A portion of the stored water has not been allocated for any specific use. The Bureau of Reclamation is currently conducting a multi-purpose study of the Payette River Basin. Cascade Reservoir is the major storage facility in the basin.

Cascade Reservoir is considered to be a culturally eutrophied system. Blooms of blue-green algae are common during late summer, and fish kills have been observed during winter and summer. The extent of the fish kills and their relationship to reservoir draw-down is not completely understood, but they are probably associated with oxygen deficiencies.

The primary objective of this study is to investigate the relationship between pool storage and dissolved oxygen (DO) content in the reservoir. These data will provide information on how pool storage affects fishery habitat, particularly overwinter habitat,
and will eventually lead to a "minimum conservation pool" recommendation.

Dissolved oxygen may decline to low levels in Cascade Reservoir during stratification or following periods of high production because of its relatively shallow basin, additional organic load (allocthonous sources), and relatively high productivity. There is some evidence that a "low" winter pool may increase the potential for a winterkill. A reduction in water volume may reduce the ratio of lake volume to bottom area, thereby reducing the quantity of oxygen available for

the decomposition of organic matter in the sediments. Several other factors may also affect the amount of oxygen produced and consumed, including the extent and duration of snow and ice cover, water exchange and dilution, and primary (algal) production.

Other aspects of this study included an evaluation of the salmonid stocking program, fish losses through outlet structures, and the potential for salmonid production in Cascade tributaries.

Description of the Study Area and Its Fishery

Cascade Reservoir, a Bureau of Reclamation water storage project, is located on the North Fork of the Payette River, tributary of the Snake River, in the mountains of west central Idaho near the town of Cascade (Fig. 2). The reservoir is one of the largest bodies of water
in Idaho when full (Table 1). Cascade is fed by three major tributaries: the North Fork of the Payette River, Gold Fork River, Lake Fork Creek, and many minor tributaries. The average monthly total inflow from these tributaries from 1960 through 1981 ranged from 15,390 acre feet in August, to 206,070 acre feet in June (Appendix A-1).

Cascade Reservoir began to fill in 1948, and reached capacity by 1957 (Casey 1962). Fishing was very good for large rainbow trout (Salmo gairdneri) and kokanee salmon (Oncorhynchus nerka) for the first few years. Northern squawfish (Ptychocheilus oregonensis) soon became a dominant and troublesome species (Casey 1962). Spawning runs of squawfish were eradicated in Cascade Reservoir tributaries with rotenone and squoxin between 1958 and 1974 until their numbers were greatly reduced (Welsh 1975). After squawfish were controlled, the fishery was largely supported by releases of hatchery rainbow trout and coho salmon (Oncorhynchus kisutch) (Table 2), and an expanding yellow perch (Perca flavescens population (Welsh 1976).

OBJECTIVES

1. Determine the minimum reservoir level that will be sufficient to sustain fish life in Cascade Reservoir.

2. Evaluate the hatchery-release program for coho and rainbow trout in Cascade Reservoir in relation to release location, release time, and size at release.

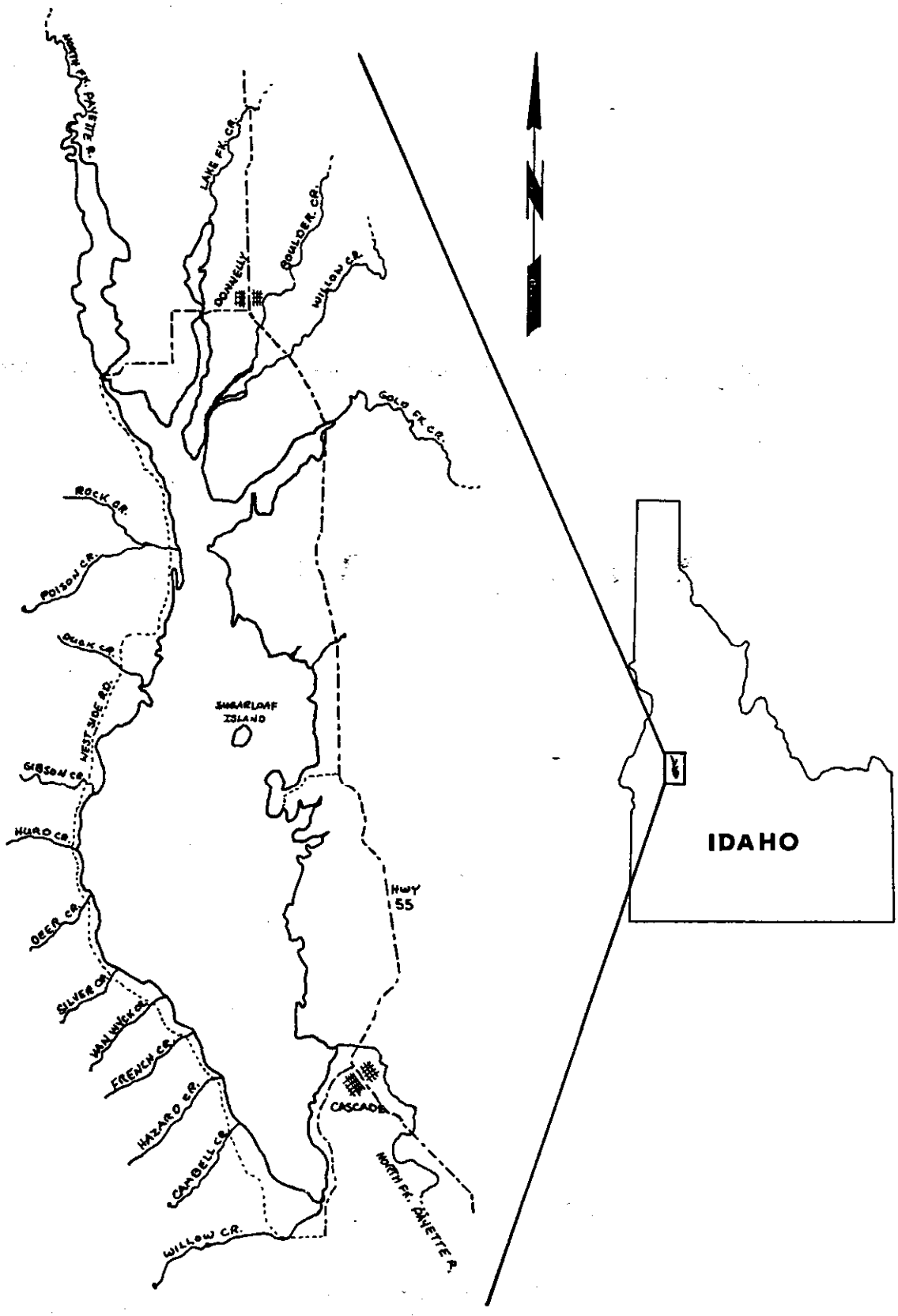

Figure 2. Cascade Reservoir, Idaho.

Table 1. Important physical and morphometric data of Cascade Reservoir and Dam, Cascade, Idaho.

Parameter	Full pool	Dead storage
Reservoir		
Elevation	1,472 m (4,828 ft)	1,459 m (4,787 ft)
Surface area	11,450 ha (28,300 ac)	2,064 ha (5,100 ac)
Volume	875.2 x $10^6 m^3$ (703,200 ac ft)	62.2 x $10^6 m^3$ (50,000 ac ft)
Length	27.4 km (17 mi)	9.4 km (6 mi)
Max. Width	6.4 km (4 mi)	4 km (2.5 mi)
Max. depth	20 m (66 ft)	7 m (23 ft)
Mean depth	7.6 m (25 ft)	3 m (10 ft)
Dam		
Height	32.6 m	(107 ft)
Width top	10.7 m	(35 ft)
base		192.0 m (630 ft)
Crest length	239.3 m	(785 ft)

Table 2 Releases of hatchery rainbow trout, brown trout, coho salmon, and kokanee salmon into Cascade Reservoir, Idaho, from 1968 to 1981.

Year	Rainbow trout			Brown trout	Coho salmon		Kokanee
	Catchables	Fingerlings	Fry	Fingerlings	Fingerlings	Fry	Fry
1968	51,500	279,000	-	-	480,000	-	-
1969	50,000	-	-	-	437,000	-	-
1970	50,000	-	-	-	365,000	-	-
1971	50,000	-	-	-	380,000	-	124,000
1972	59,200	-	-	-	171,400	-	100,800
1973	52,300	35,400	-	-	228,900	-	-
1974	58,000	21,200	-	-	465,200	-	27,000
1975	49,000	63,000	-	-	369,800	-	139,900
1976	49,700	45,600	-	-	634,900	-	-
1977	41,800	14,900	28,800	-	-	57,500	-
1978	48,500	-	262,900	-	-	430,200	-
1979	56,300	-	64,800	-	425,200	104,100	-
1980	80,000	143,000	-	-	500,000	-	-
1981	81,510	45,570	-	114,956	448,900	-	180,944

TECHNIQUES USED

Minimum Conservation Pool Determination

Dissolved Oxygen Measurement

Oxygen-temperature profiles were recorded at one m intervals from the surface to the bottom of the reservoir with a YSI model 57 dissolved oxygen/temperature meter. Calibration of the meter was done by Winkler titration. Secchi transparency was recorded with each profile (except those taken through the ice) using a standard 20 cm disk.

The sampling program was initiated in May 1980 after preliminary data were collected in February and March. Sixteen stations were selected to represent the reservoir (Fig. 3). We sampled all stations on a monthly basis during the spring and fall, and biweekly during the summer. One to nine stations were sampled weekly throughout that period. During winter ice cover, six stations were sampled weekly. Surface elevation of the reservoir was noted to the nearest meter at each sampling, and data were recorded by elevation rather than depth. The mean oxygen concentration of each one m strata was calculated from all samples.

Oxygen Deficits

Morphometric data on Cascade were generated from a U. S. Bureau of Reclamation area-volume table, and contour map of the reservoir (Appendix A-2).

We calculated oxygen content of the hypolimnion on an aerial basis. To do that, the mean oxygen concentration of each strata below an upper hypolimnial limit was weighted by the relative total volume of the strata. Oxygen was expressed on an areal basis by multiplying by the mean thickness of the hypolimnion. The upper limit of the hypolimnion was selected as the elevation which most closely approximated the level of the thermoclinethroughout the period of stagnation. We estimated the areal hypolimnetic oxygen deficit (AHOD) as the rate of decline of hypolimnial oxygen content during stagnation (Hutchinson 1975). The rate of decline was calculated as the slope of a regression of oxygen content against the julian date (Lasenby 1975). The period for the regression analysis was selected as the time during which oxygen content declined continuously (stagnation). The winter oxygen deficit (WOD) was estimated in the same manner as the AHOD, except that the oxygen content was calculated for the entire reservoir rather than just that below the thermocline.

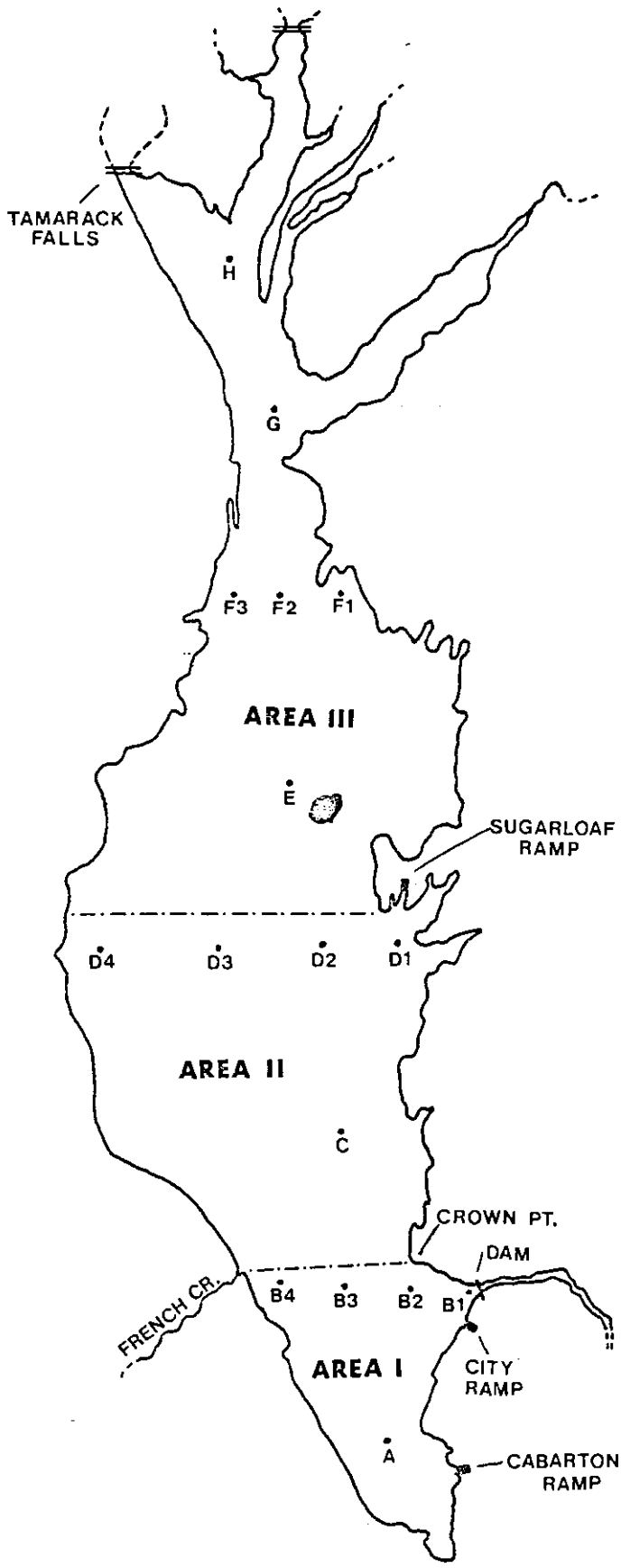

Figure 3. The location of 16 dissolved oxygen and temperature sampling stations (A-H), creel census and gill netting Areas I, II and III in Cascade Reservoir, Idaho.

Development of the Model

We used an oxygen modeling approach similar to that of Barica and Mathias (1979) to predict winterkill potential as a function of pool volume and initial oxygen storage in Cascade Reservoir. Initial oxygen volume, T_j, (g/m^2) was estimated as a direct function of pool volume by:

$$T_j = \frac{\Sigma\ O_i\ S_i}{A_j}$$

Where: O_i = Mean oxygen concentration of strata;

S_i = Volume of strata i;

A_j = Surface area of the reservoir at a given pool volume j.

We partitioned the oxygen deficit into component parts of water column demand and sediment demand, and also included estimates of oxygen input from tributary inflow and output due to outflow through the dam. Because water column consumption, oxygen inflow, and outflow, when calculated on an areal basis, vary as a function of pool volume, it was necessary to estimate these parameters for each possible reservoir elevation. The model of reservoir oxygen consumption was represented as:

$$C_j = S + W_j + OF_j - IF_j - P$$

Where: C_j = Total areal oxygen consumption ($g/m^2/day$) at reservoir elevation j;

S = Areal sediment oxygen consumption;

W_j = Areal water column consumption at reservoir elevations j;

OF_j = Areal oxygen consumption due to reservoir outflow at reservoir elevation j;

IF_j = Areal oxygen input due to tributary inflow at reservoir elevation j;

P = Oxygen input due to primary production.

The time to total oxygen depletion was calculated as:

$$\frac{T_j}{C_j} = \text{days.}$$

Because fish kills would undoubtedly occur at levels of oxygen depletion above complete anoxia, we also calculated the time necessary for oxygen content to drop to a level T_L which we considered limiting for salmonids

$$\frac{T_i - T_L}{C_i} = \text{days.}$$

An oxygen concentration of 5 mg/L is considered as the lower limit of suitable conditions for salmonids. We therefore assumed that oxygen concentrations of 4 mg/L would represent a condition of serious stress with potential for significant damage to the populations. Since salmonids were generally found in the upper strata, we assumed that a normal oxygen stratification with 4 mg/L near the surface, declining to 0.3 mg/L near the bottom, would represent seriously-limiting conditions. The limiting oxygen concentration (T_L) was calculated for each reservoir elevation based on those assumptions.

Significant production of oxygen can occur under the ice due to photosynthesis. With little snow cover, oxygen content in near-surface strata may actually remain at supersaturated levels. With any significant amount of photosynthesis, it is unlikely that seriously-limiting conditions of oxygen limitation would occur. Approximately 10 cm of snow on the ice can eliminate photosynthesis (Barica and Mathias 1979). We, therefore, assumed that severe oxygen limitation at a given pool volume would occur only when winter conditions resulted in a 10 cm or greater snow cover on the reservoir for a period of time equal to or greater than the time necessary for the reservoir oxygen level to drop to anoxia or limiting conditions. Thirty-one years of snow depth records from the BOR weather station located near the dam were used to generate a winter-severity index. The index was calculated as the frequency of occurrence of years when a minimum snow depth (10 cm on the reservoir) persisted for a given period of time. We regressed our 1982 measurements of snow depth on the reservoir on 1982 measurements of snow at the station to determine a threshold value for the station measurement that would represent a 10 cm threshold on the reservoir.

Parameter Estimates

Water Column Consumption

Water column demand was estimated by BOD analysis. We collected triplicate water samples at three representative depths (near surface, mid, and near bottom). Samples were incubated for 20 days in 300 ml BOD bottles at a temperature similar to that at the point of collection. During winter sampling, all samples were incubated at 2 to 4 C. Initial and final oxygen concentration was measured with the YSI meter and a BOD bottle probe. Estimates of oxygen consumption ($g/m^3/day$) were averaged for all three depths to provide a mean of the water column. Areal oxygen consumption for a given pool elevation were estimated as:

$$W_j = \text{Consumption } (g/m^2/day) \cdot \text{Mean depth at reservoir elevation } j.$$

Tributary Oxygen Inflow

Inflow to the reservoir was calculated on a monthly basis during the winter (December-April) from 20 years of data on reservoir pool volume and measured outflow as:

Inflow = outflow - loss in reservoir storage; or

Inflow = outflow + gain in reservoir storage.

Oxygen content of the tributaries was monitored periodically. Average oxygen concentration ($\bar{O}$), inflow, and reservoir surface area were used to calculate oxygen addition on an areal basis ($g/m^2/day$) as:

$$IF_j = \frac{\text{Inflow} \cdot \bar{O}}{\text{Area at reservoir elevation } j}$$

Oxygen Outflow

Oxygen consumption due to the reservoir outflow was calculated as:

$$OF_j = \frac{A \cdot B}{\text{Area at reservoir elevation } j}$$

Where: A = Mean flow through dam.

B = Mean oxygen concentration of the water column in the forebay area.

Sediment Oxygen Demand

In 1980, we attempted to estimate sediment oxygen consumption empirically by incubating sediment cores and measuring the oxygen decline of overlying water. The results were extremely variable and essentially unuseable for the model (Horner and Rimean 1981). As an alternative, we estimated sediment oxygen demand on the basis of the total oxygen deficit, measurements of water column demand, and estimates of tributary input and outflow through the dam during the period of winter stagnation in 1982 as:

$$S = C_j - W_j - OF_j + IF_j$$

Sediment oxygen demand should not vary with pool volume, and was therefore held constant in the model.

Salmonid Stocking Program Evaluation Fish

Marking

Rainbow and coho fingerlings were marked with three different colors of fluorescent grit (Tables 3 and 4) in 1980 and 1981, and released at three locations in Cascade Reservoir (Fig. 2) to evaluate different release locations. The fingerlings were dipped out of a raceway onto a screen, and the grit was applied with a high-pressure spray gun. Mortality was *very* low, and mark retention good. The grit mark was generally detectable with the unaided eye in the fins or eyes of the fish, and was checked with a blacklight whenever practical.

We marked two groups of catchable rainbow with ventral fin clips (Tables 3 and 4) in 1980 and 1981 to evaluate the size at release (catchable versus fingerling) and spring (right ventral clip) versus fall (left ventral clip) release. The abundance and distribution of all marked groups was evaluated by creel census and gill netting.

Fish Recapture

A creel census was conducted from May 1980 through November 1981 (Horner and Rieman 1981). Gill and fyke nets were fished during June, August, and October of 1980, and July and August of 1981 (Horner and Rieman 1981).

Total Harvest Estimate

Creel Census

From December 1981 through April 1982, we conducted a creel census to estimate total angler effort and total harvest of various fish species during a given time interval. The total time period was stratified into nine 2-week intervals. We selected at random one Saturday, one Sunday, two weekdays, and all holidays for angler counts during each two-week interval. Anglers were counted at three randomly-selected time periods during each census day, and interviewed for catch and catch rates in-between counts, and whenever possible during noncount days. We determined the total hours fished by multiplying the average number of anglers per day, times the number of daylight hours, times the number of days in a two-week interval (i.e., ten weekdays and four weekend days). Total harvest was estimated for each species by multiplying catch rates by total hours fished.

Table 3. Marked rainbow trout and coho salmon released into Cascade Reservoir, Idaho, 1980.

Species	Size (cm) Mean	Range	Release Date	Number Released	Mark	Release Location	Comments
Rainbow							
Catchable	27	-	5/5	40,000	Right Vent Clip	Tamarack Falls & Lake Fork Cr. Bridges	2.1/lb
Catchable	23	-	9/22	40,000	Left Vent Clip	Tamarack Falls & Sugarloaf Boatramp	3.2/lb
	7.1	4.5-10					
Fingerling			5/30	83,600	Green Grit	Tamarack Falls	50% mark retention
Fingerling	9.2	7-11	6/11	22,000	Red Grit	Sugarloaf Boatramp	100% mark retention
Fingerling	8.9	6.5-11	6/13	22,000	Yellow Grit	Cabarton Boatramp	99% mark retention
Coho							
Fingerling	7.3	3.5-11.5	5/22	133,100	Green Grit	Tamarack Falls	95% mark retention
Fingerling	8.3	4.5-12	5/22&23	112,600	Red Grit	Sugarloaf Boatramp	93% mark retention
Fingerling	8.7	3.5-11.5	5/28	122,850	Yellow Grit	City Boatramp	95% mark retention

Table 4. Marked rainbow trout and coho salmon released into Cascade Reservoir, Idaho, 1981.

Species	Size Range (cm)	Release Date	Number Released	Mark	Release Location	Comments
Rainbow						
Catchable	15-30	4/23 & 24	41,300	Right Vent Clip	Sugarloaf Boat Ramp	3/5/16
Catchable	15-30	9/21 & 23	29,010	Left Vent Clip	Sugarloaf Boat Ramp	2.5-4.0/16
Fingerling	7.6-15.2	5/7	45,570	Red Grit	Sugarloaf Boat Ramp	2/lb
Coho						
Fingerling	5.5-11.3	5/7	115,600	Green Grit	Tamarack Falls	66/lb 95% mark retention
Fingerling	4.9-11.3	5/7	115,200	Red Grit	Sugarloaf Boat Ramp	64/lb 98% mark retention
Fingerling	5.6-11.7	5/7	118,800	Yellow Grit	Cabarton Boat Ramp	66/lb 94% mark retention

FINDINGS

Limnological Description of the Reservoir

During the period May 1980 through March 1982, reservoir elevation varied from 1,467 m to 1,472 m (full pool). The lowest elevations were generally observed during early spring (March) prior to runoff, and again in the fall (October) at the end of the irrigation season. Full pool was reached in early June 1980, and in early May 1981. The reservoir was ice-free from mid-April until the end of November in 1980, and from the end of March until mid-December 1981. Because of the heavier snow pack and persistence of cold temperatures during the spring of 1982, ice remained on the reservoir until early May.

Maximum mean surface DO (12-14 mg/1) was observed under the ice in February and March of 1980 and 1981 (Fig. 4). Levels were down somewhat (10-11 mg/1) during the winter of 1982. Dissolved oxygen was nearly uniform from surface to bottom during spring mixing (April-May) when the water column was homothermos. Generally by mid-May, DO levels began declining with depth, with mean surface measurements of 8-9 mg/1 and mean bottom measurements of 5-8 mg /i . Vertical DO profiles were strongly clinograde by early July of both years, and persisted through early October 1980, and mid-September 1981. During stagnation, mean DO values near 0 mg/l were recorded near the bottom from July through September, and again in February and March. Dissolved oxygen was again uniform from surface to bottom during October of both years (Fig. 4).

Cascade Reservoir was homothermos in early May 1980 and early April 1981, with surface and bottom temperatures varying from 8-10 C in 1980 and a temperature of 4 C in 1981 (Fig. 5). Surface warming typically began about mid-May, but due to unstable spring weather patterns in the Cascade area, mixing occurred periodically during late May and June. Thermal stratification was evident from late June through early September in 1980, and from early June through mid-September in 1981 (Fig. 5). Maximum mean summer temperatures ranged from 20-23 C at the surface, and 12-14 C near the bottom. During mid-July, the surface of the metalimnion was about 5-6 m below the reservoir surface and dropped to about 8 m below the surface by mid-August. Metalimnion thickness was about 5-6 m in mid-July, and 3-4 m in mid-August. Homothermy was again observed in late September and early October, but the temperature of maximum density (4 C) did not occur until mid-to-late November (Fig. 5).

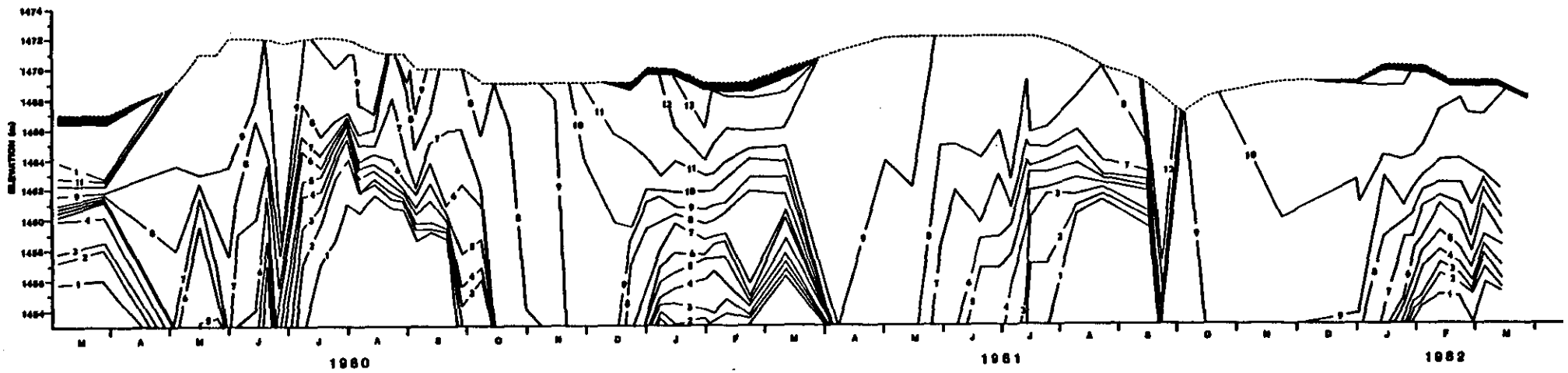

Figure 4. Seasonal cycle of mean dissolved oxygen (mg/l) at Cascade Reservoir, March 1980 through March 1982. Blackened areas indicate period of ice cover.

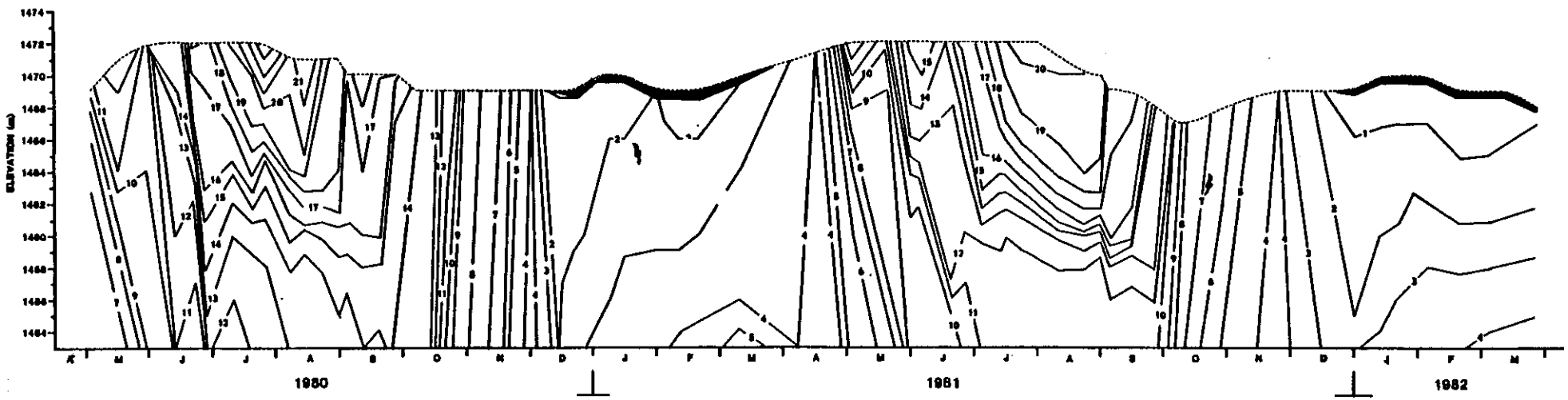

Figure 5. Seasonal cycle of mean water temperatures (^{o} C) at Cascade Reservoir, May 1980 through March 1982. Blackened areas indicate period of ice cover.

Water transparency (as measured by a Secchi disc) was higher in 1981 than 1980. Mean monthly Secchi measurements ranged from 1.6 m to 3.8 m in 1980, and from 1.7 m to 5.9 m in 1981 (Fig. 6). With the exception of June, Secchi readings were consistently higher during the summer and fall in 1981. Lowest water transparency was generally observed in April and May, while higher readings were recorded from June through August. Measurements also indicated that water transparency was usually greater throughout the summer from Sugarloaf boat ramp south.

Oxygen Content of the Reservoir

Oxygen content and stratification varied seasonally. Typically, oxygen content was greatest during periods of mixing in spring and late fall. Stagnation occurred during July, August, and part of September, and again under ice cover (Fig. 4). The hypolimnion was essentially anoxic during August of both years.

Oxygen content of the hypolimnion declined dramatically during summers of both 1980 and 1981 (Fig. 7), though the level of depletion was more pronounced in the earlier year. The hypolimnetic oxygen deficit for the June-July period estimated by linear regression was .66 g/m^2/day (r^2 = .92) in 1980, and .41 g/m^2/day (r^2 = .81) in 1981.

The oxygen content varied considerably under the ice during both years. In 1981, there was not a consistent snow cover on the ice. Primary production maintained near surface oxygen at super-saturated levels throughout the winter. Oxygen content of the pool fluctuated during December, January, and early February, and then declined through early March, following a period of snow cover (Fig. 8). The oxygen deficit estimated by regression was .25 g/m^2/day. During 1982, snow cover on the reservoir exceeded 10 cm from mid-January through mid-February. During that period, oxygen concentrations dropped throughout the water column. Oxygen content of the total pool declined dramatically during the heavy snow cover, but increased following a period of rain, and loss of most of the snow (Fig. 8). The oxygen deficit for that period estimated by regression, was .48 g/m2 /day, with an r^2 of .96.

Parameter Estimates for the Model Initial

Oxygen Content

During the two years of study, the reservoir froze over in early December 1980, and late December 1981. Mean oxygen concentration was 10.7 and 10.3 mg/l at the first sample following ice cover in 1980 and 1981, respectively. We therefore assumed a mean oxygen concentration

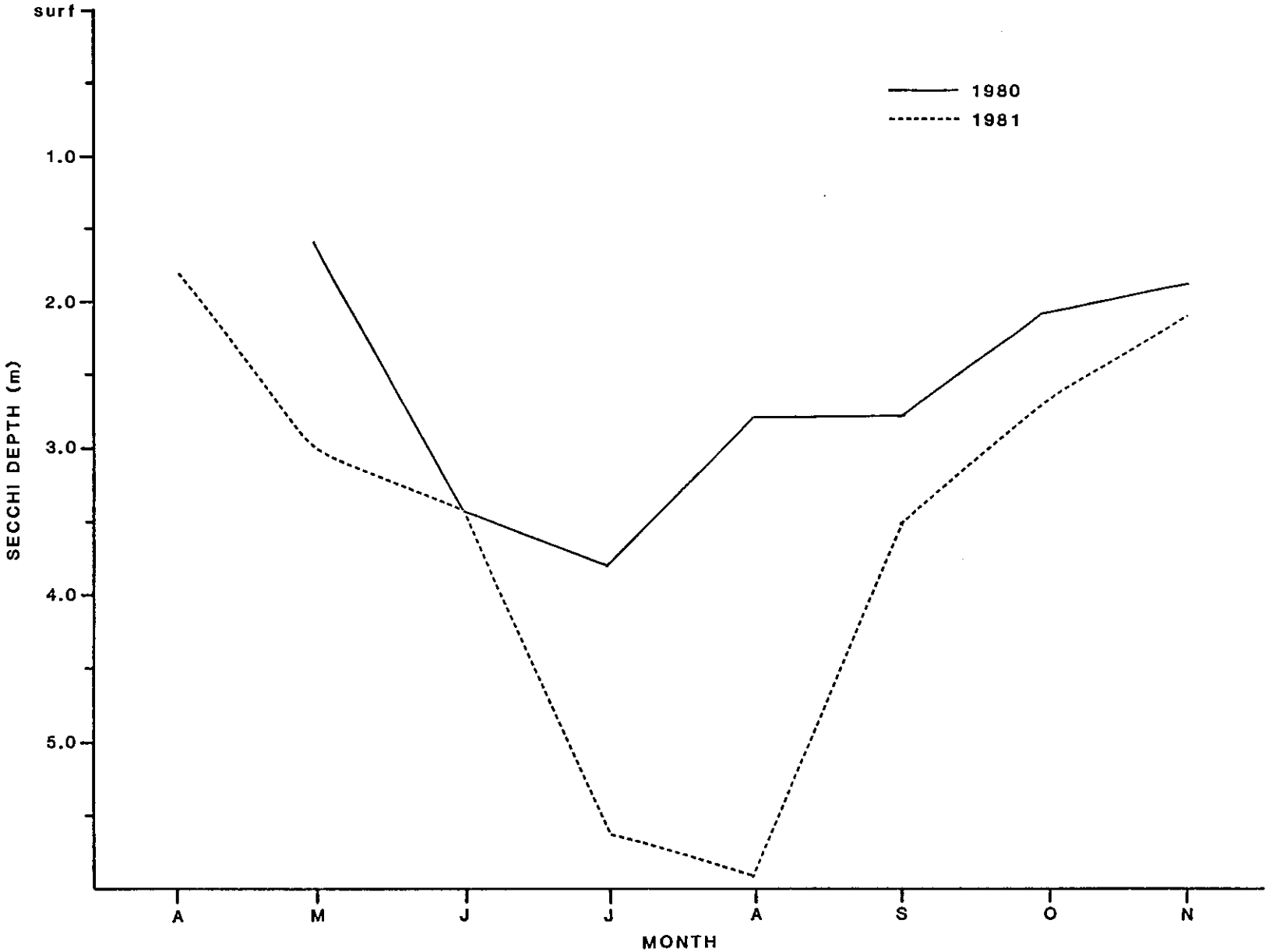

Figure 6. Mean monthly Secchi disc measurements from Cascade Reservoir, May through November 1980 and April through November 1981.

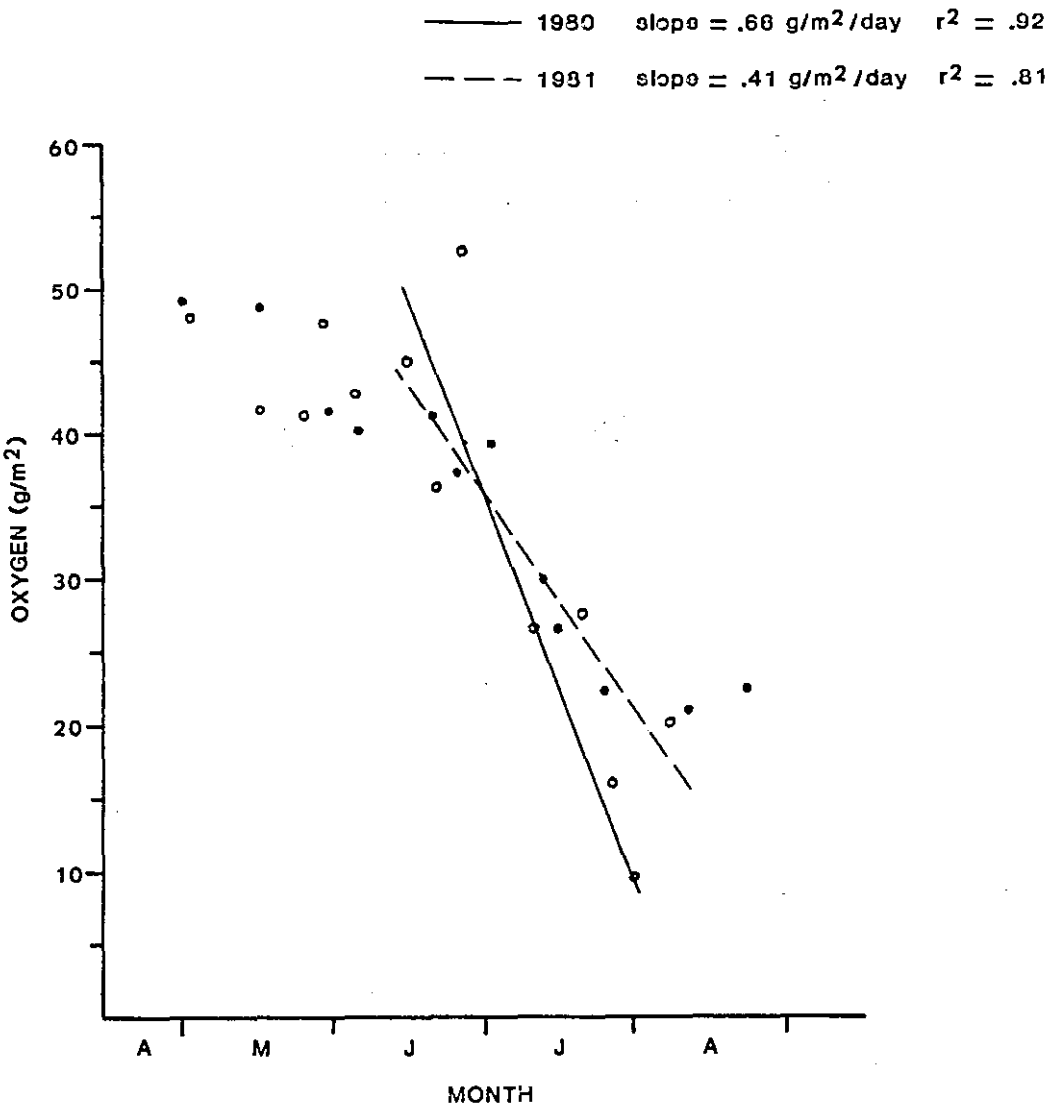

Figure 7. Oxygen content of the hypolimnion during 1980 and 1981 in Cascade Reservoir. The length of each line indicates those points included in the regression.

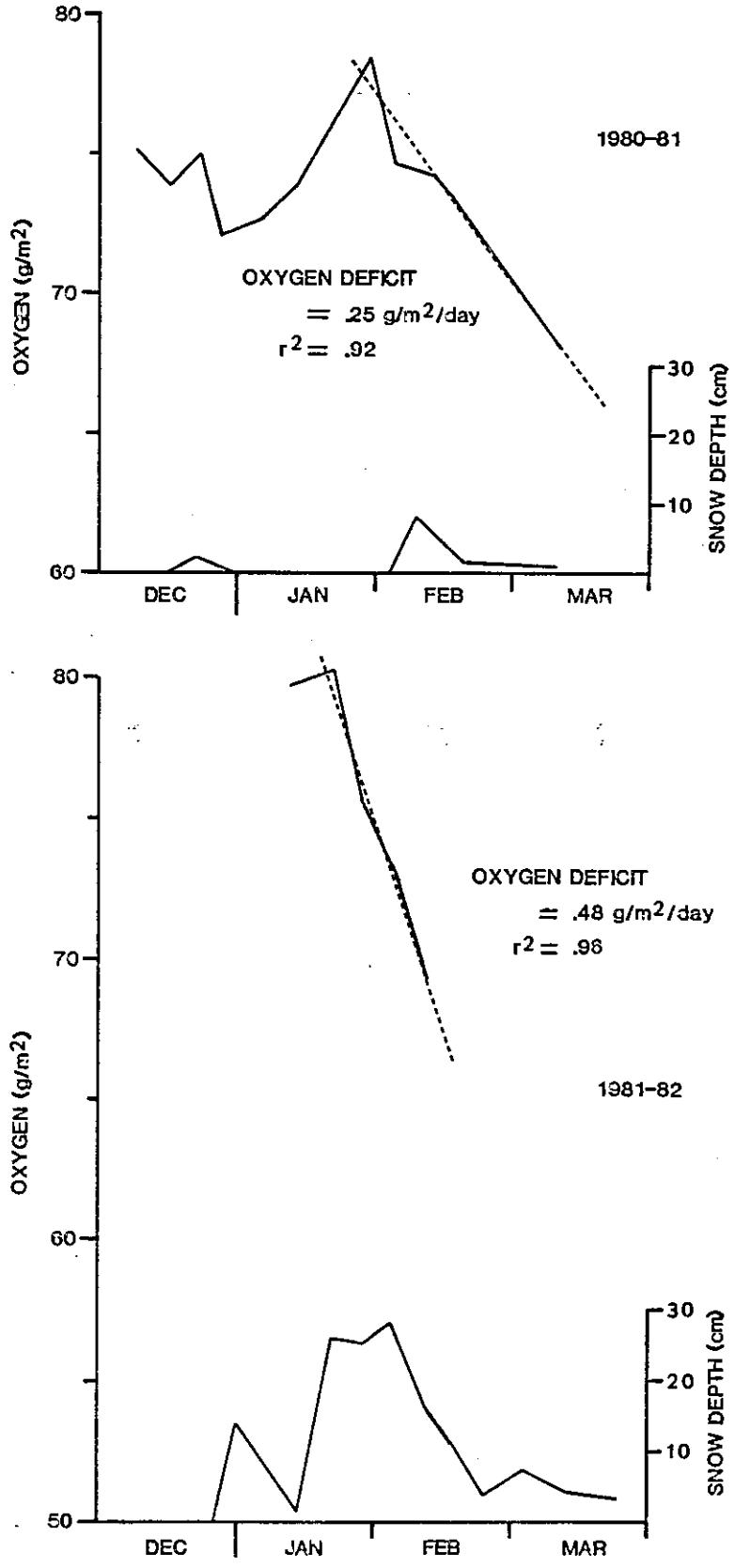

Figure 8. Oxygen content of Cascade Reservoir during winter ice cover (g/m^2) and snow depth (cm) in 1981 and 1982. The length of the regression line indicates those points included in the regression.

of the water column for the model of 10.5 mg/l. Initial areal oxygen content was calculated for reservoir elevations of 1,469 to 1,461 m above sea level (Table 5).

Water Column Demand

Consumption of oxygen within the water column, as estimated by the BOD method, was high through the summer, but declined during late fall, and was low during the winter (Fig. 9). The greatest seasonal variation in oxygen demand was observed from samples taken midway in the water column and near the bottom. Mean oxygen demand for the entire water column ranged from .01 to .06 mg/l/day (Table 6). For three samples taken during ice cover (April 1981, January-February 1982), mean water column demand ranged from .01 to .02 mg/l/day. For the model, we assumed a value of .016 mg/l/day (observed during heavy snow cover in February 1982) to be representative and used that for calculation of available water column demand for each reservoir elevation (Table 7).

Inflow

Oxygen concentrations measured in the tributaries during the winter in 1982 ranged from 9.7 to 10.1 mg/l, with an average of 9.8 mg/l. Average inflow in water volume ranged from 1.4×10^6 m^3/day (1,165 acre feet/day) in December, to 1.82×10^6 m^3/day (1,476 acre feet/day) in February. During the winter of 1982, the estimated oxygen input to the reservoir was 0.18 g O^2/m^2/day. The estimated average winter inflow for a 20 year period was 1.59×10^6 m^3/day (1,289 acre feet/day). Using that value, the mean oxygen input for each reservoir elevation ranged from 0.44 g/m^2/day at an elevation of 1,461 m, to 0.18 g/m^2/day at an elevation of 1,469 m (Table 8).

Outflow

Oxygen outflow for the winter period of stagnation in 1982 was estimated as 0.15 g/m^2/day.

Because oxygen outflow is dependent upon oxygen content in the water column, it will decline during stagnation. For the model, we calculated a mean outflow rate for the first 30 days and the remaining period of stagnation. Estimated oxygen outflow for the first 30 days of winter stagnation ranged from 0.16 g/m^2/day at a reservoir of 1,469 m to 0.37 g/m^2/day at 1,461 m (Table 9).

Table 5. Estimated initial oxygen content (g/m^2) following ice cover for Cascade Reservoir, Idaho.

Reservoir Elevation (m)	Oxygen Content (g/m^2)
1469	72.0
1468	67.5
1467	61.0
1466	56.4
1465	51.0
1464	45.5
1463	40.8
1462	36.4
1461	32.2

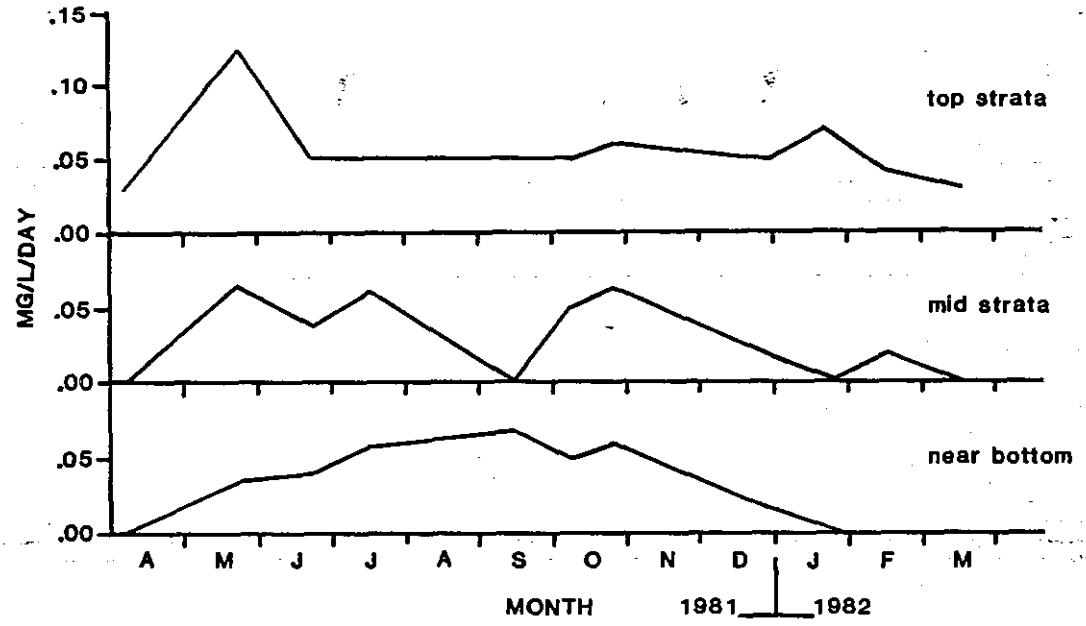

Figure 9. Estimated water column demand (mg/l) in the top strata, mid-strata, and near bottom in Cascade Reservoir, April 1981 to April 1982.

Table 6. Oxygen demand of three points in the water column (mg/1/day) estimated by BOD samples for Cascade Reservoir in 1981 and 1982.

Date	4/2/81	5/17/81	6/20/81	7/15/81	9/11/81	10/5/81	10/27/81	12/31/81	1/19/82	2/15/82
Near Surface (mean of 3)	0.03	0.12	0.05	0.05	0.05	0.05	0.06	0.05	0.07	0.0
Mid-Depth (mean of 3)	0.00	0.07	0.04	0.06	0.00	0.05	0.07	0.02	0.00	0.0
Near Bottom (mean of 3)	0.00	0.03	0.04	0.06	0.07	0.05	0.06	0.02	0.00	0.0
X	0.01	0.07	0.04	0.06	0.04	0.05	0.06	0.03	0.02	0.0

Table 7. Estimated water column oxygen demand during ice cover on Cascade Reservoir, Idaho.

Reservoir Elevation (m)	Oxygen Demand ($g/m^2/day$)
1469	0.11
1468	0.10
1467	0.09
1466	0.08
1465	0.08
1464	0.07
1463	0.06
1462	0.06
1461	0.05

Table 8. Estimated mean [a] oxygen input due to tributary inflow on Cascade Reservoir, Idaho.

Reservoir Elevation (m)	Oxygen Input ($g/m^2/day$)
1469	0.18
1468	0.17
1467	0.21
1466	0.23
1465	0.25
1464	0.28
1463	0.32
1462	0.37
1461	0.44

a Calculated using a mean inflow of 159 x 10^6 m 3/day from December-March, and a mean oxygen concentration of 9.8 mg/L.

Table 9. Estimated mean [a] oxygen outflow for the first 30 days and after 30 days of winter stagnation on Cascade Reservoir, Idaho.

Reservoir Elevation	Outflow First 30 Days $g/m^2/day$	Outflow After 30 Days $g/m^2/day$
1469	0.16	0.13
1468	0.17	0.14
1467	0.17	0.14
1466	0.19	0.16
1465	0.21	0.17
1464	0.24	0.20
1463	0.28	0.23
1462	0.30	0.25
1461	0.37	0.30

a Calculated as a mean oxygen concentration of the entire water column in the forebay area.

Sediment Oxygen Demand

Sediment oxygen demand estimated from total oxygen demand, water column demand, and inflow and outflow estimates for the period of winter stagnation in 1982 was 0.40 g/m^2/day. Sediment demand should not vary with pool volume and was, therefore, assumed to be stable for all reservoir elevations in the model.

Model Output

Using the preceeding parameter estimates, the model was used to estimate the number of days of winter stagnation (adequate ice and snow to eliminate primary production) necessary for the reservoir to approach a completely anoxic condition. The estimated times ranged from 154 days at a reservoir elevation of 1,469 m to 92 days at an elevation of 1,461 m (Table 10). We also used the model to calculate the time necessary under stagnation to reach conditions that would be considered seriously limiting for salmonids. Calculated oxygen content under these conditions ranged from 158 g/m2 at an elevation of 1,469 m, to 80 g/m^2 at an elevation of 1,461 m (Table 11). The estimated time to reach these conditions under stagnation ranged from 119 days at a reservoir elevation of 1,469 m, to 68 days at an elevation of 1,461 m (Table 10).

Winter Severity

Snow depth on the reservoir was recorded 11 times during the 1982 period of ice cover. If a single point is eliminated, a strong correlation exists (r = .81) between reservoir snow depths and BOR snow gauge depths (Fig.10). A linear regression fit to the data had a slope of 0.4, indicating that snow depth at the BOR gauge was generally 2.5 times that on the reservoir. When the regression line was forced through the origin, a slope of 0.33 was obtained (gauge depth = three times reservoir depth). To calculate the severity index, we assumed the three-fold difference. We, therefore, assumed a threshold snow depth of 30 cm at the BOR gauge to be indicative of stagnation conditions (10 cm snow, and no primary production) on the reservoir. From 31 years of snow records at the BOR gauge (NOAA 1950-1981), the frequency of stagnation conditions ranged from 80% for a period of 20 days, to 0% for a period of 120 days (Fig. 11). In other words, 80% of the years of record had 30 cm or more snow on the ground for at least 20 days, o% of the years of record for 120 days.

Table 10. Estimated time (days) to reach anoxia and oxygen limiting conditions for salmonids during winter stagnation in Cascade Reservoir, Idaho.

Reservoir elevation (m)	Days to anoxia	Days to limiting conditions
1469	154	119
1468	151	117
1467	139	105
1466	134	100
1465	125	93
1464	113	81
1463	109	78
1462	100	71
1461	92	68

Table 11. Estimated oxygen content (g/m^2) resulting in limiting conditions for salmonids in Cascade Reservoir, Idaho.[a]

Reservoir elevation (m)	Oxygen content (g/m^2)
1469	15.8
1468	15.4
1467	15.0
1466	14.5
1465	13.8
1464	12.6
1463	11.0
1462	10.0
1461	8.0

a Assumes normal stratification with maximum oxygen concentration of 4 mg/L near the surface.

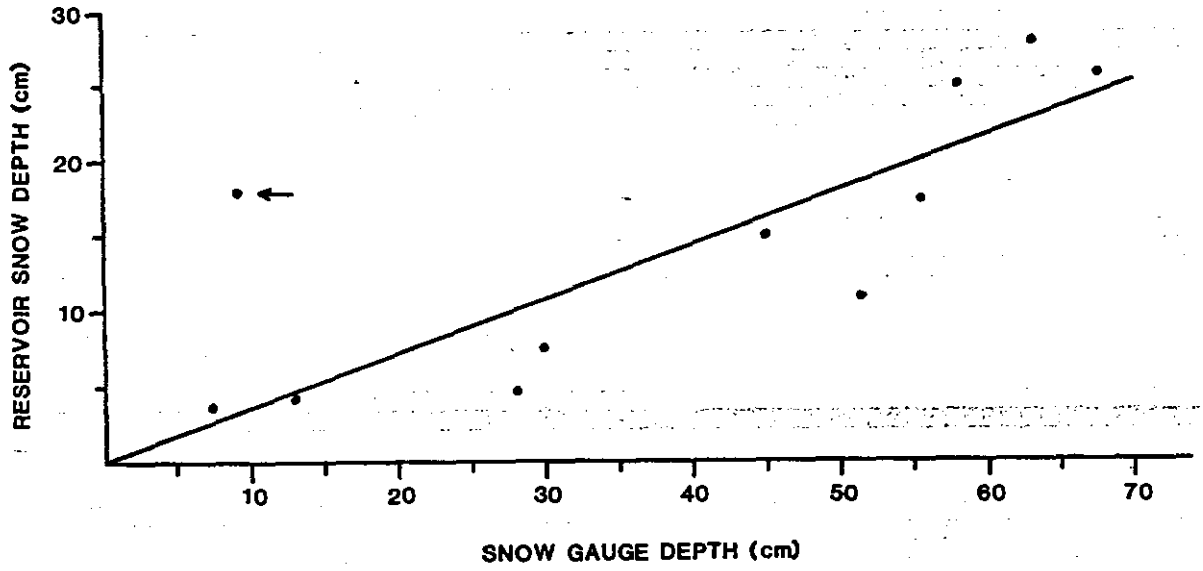

Figure 10. Reservoir snow depth (cm) versus the BOR snow guage readings (cm) during 1982. Arrow indicates outlying point eliminated from regression.

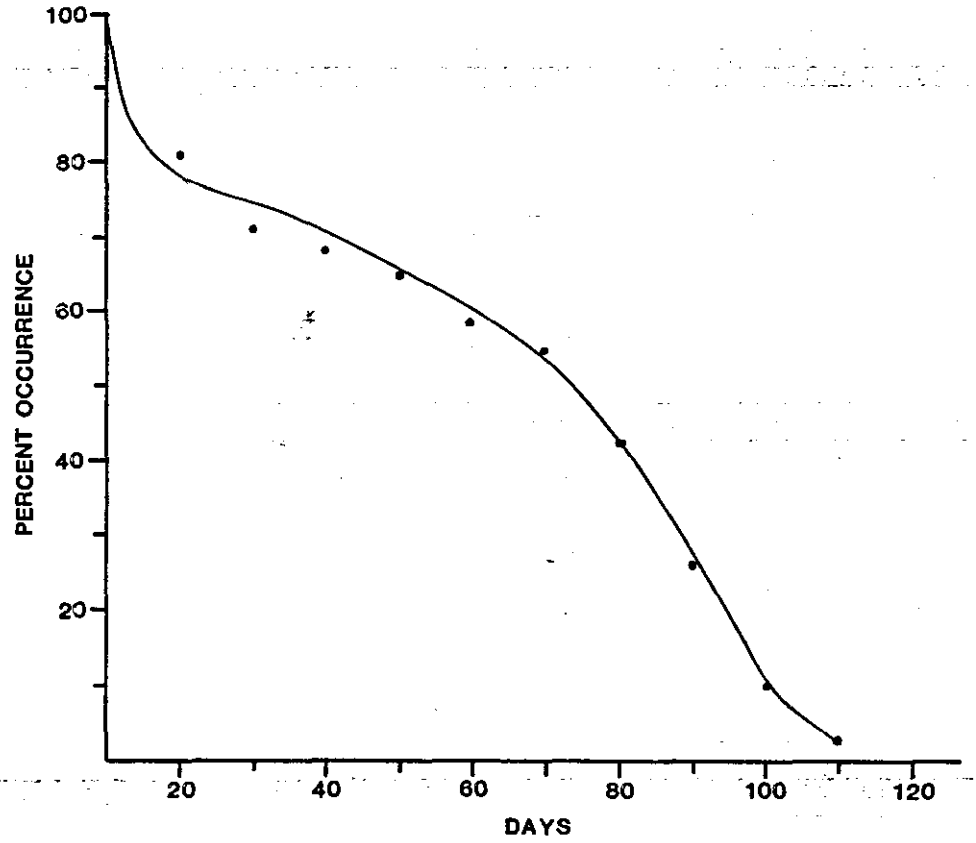

Figure 11. Winter severity index (frequency of 30 cm or more of snow for a continuous period of time) for Cascade Reservoir (line fitted by inspection). (Data from Climatological Data-Idaho, NationalOceanic and Atmospheric Administration, National Climatic Center, Ashville, N. C.).

Winterkill Risk and Pool Elevation

By combining the winter severity data and output from the oxygen model, it is possible to estimate the frequency or risk of reaching anoxic or oxygen "limiting" conditions on the reservoir for a given pool elevation. By interpolating from Figure 12, we estimate that winter stagnation conditions should occur (did occur in the last 31 years) long enough for the reservoir to become totally anoxic at a pool elevation of 1,461 m 30% of the time (Fig. 12). Anoxia should not occur at elevations of 1,465 m and higher. Oxygen-limiting conditions should occur 57% of the time at an elevation of 1,461 m, but only 1% of the time at 1,468 m.

Salmonid Stocking Program

Creel Census and Netting

Numbers and species of fish caught and catch rates are expressed in Appendix C-1 through C-21. Generally, yellow perch were harvested in greater abundance than any other fish specie
in the reservoir. Perch comprised 85 and 72% of the total angler catch during 1980 and 1981, respectively, and 53% of the total net catch (Tables 12 and 13). Coho and rainbow were harvested in respectively fewer numbers.

Release Location

Coho released at the Cabarton and Cascade City boat ramps had the best apparent survival of the six groups of coho fingerlings released during 1980 and 1981 (Tables 14 and 15). Of 894 recaptured grit-marked coho released in 1980, 36.8% were fish released at the Cabarton and Cascade City boat ramps, while the remaining 34.1% and 29.1% were fish released at Sugarloaf boat ramp and Tamarack Falls Bridge, respectively. Similarly, coho released at the Cabarton boat ramp in 1981 comprised 46.3% of grit-marked fish returned to the creel (Table 16). Fish released at Sugarloaf boat ramp and Tamarack Falls Bridge comprised 32.6% and 21.1%, respectively, of the angler catch. So few grit-marked rainbow fingerlings were observed that an evaluation of stocking location is not practical (Table 16).

Size at Release

Rainbow trout released as catchables in 1980 and 1981 provided the largest percentage of the total rainbow harvest ' (53.0%), whereas rainbows released as fingerlings were almost nonexistent in both the angler harvest and net catches (1.3%) (Table 16). An additional 36.9% of the rainbow harvest from

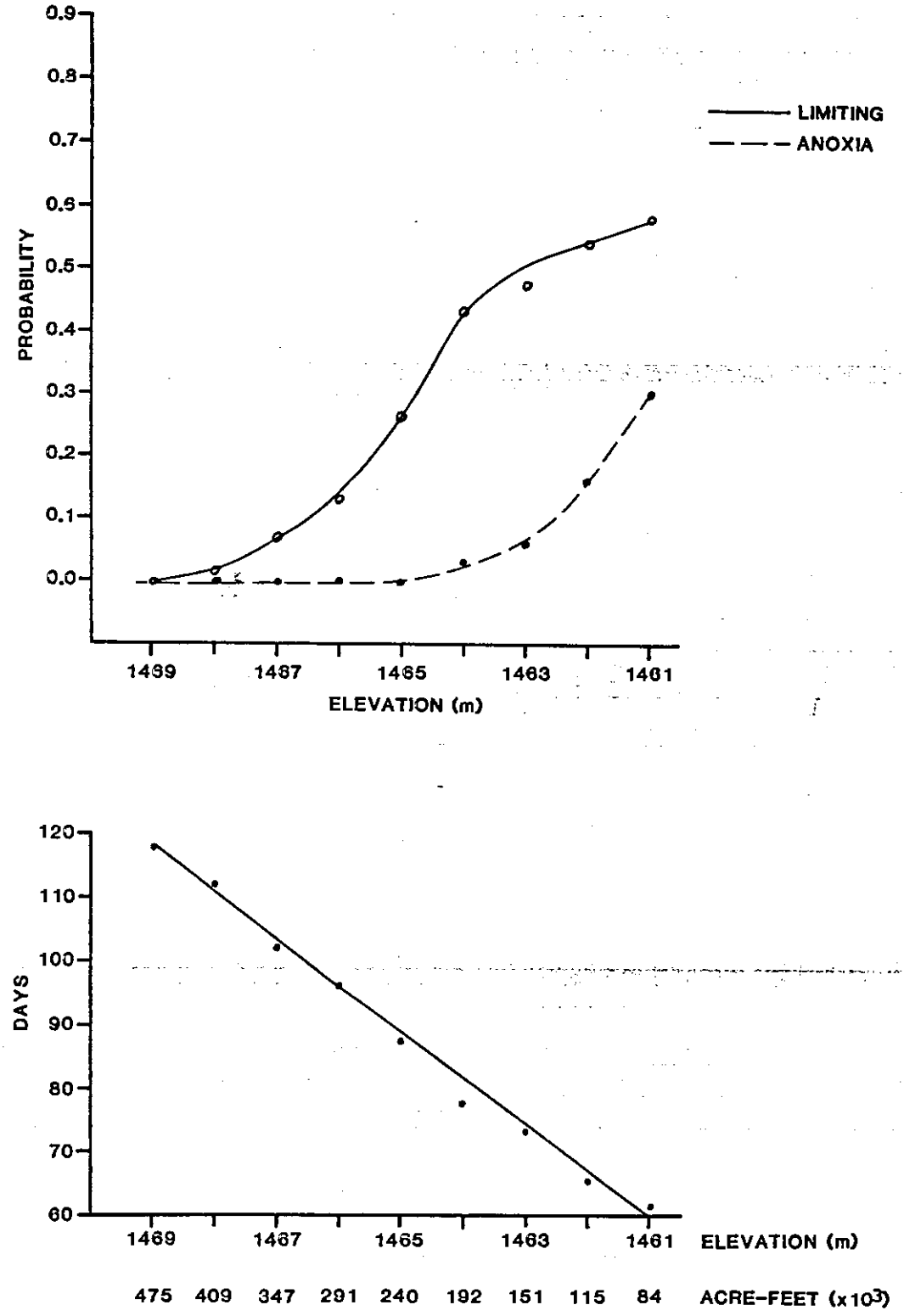

Figure 12. The probability of reaching limiting and anoxic conditions (upper figure) and the time required to reach oxygen limitation (lower figure) for a given pool elevation on Cascade Reservoir.

Table 12. The percentage of various fish species caught by anglers in Cascade Reservoir, Idaho, May 1980 to November 1981.

Month (1980)	Percentage of species caught by anglers					
	Rainbow	Coho	Perch	Bullhead	Squawfish	Sucker
May	18.6	23.2	39.2	2.7	15.2	1.1
June	12.6	1.9	76.5	3.0	5.0	1.0
July	4.0	1.1	90.9	1.4	2.4	0.2
August	1.5	1.0	95.4	1.0	1.0	0.1
September	15.7	4.0	74.3	1.5	2.9	1.6
October	29.8	13.1	53.9	2.1	0.9	0.2
November	95.7	3.1	1.2	-	-	-
December	4.8	65.9	29.3	-	-	-
Mean a	7.2	4.1	84.6	1.4	2.3	0.4

Month (1981)	Rainbow	Coho	Perch	Bullhead	Squawfish	Sucker
January	5.0	43.6	51.2	-	0.2	-
February	9.6	27.5	61.2	-	1.7	-
March	4.4	7.0	86.9	0.3	1.4	-
April	47.7	3.4	29.2	5.7 -	10.6	3.4
May	12.1	38.2	37.5	3.6	7.8	0.8
June	6.3	17.6	73.1	0.3	2.3	0.4
July	3.2	14.8	78.5	0.6	2.7	0.2
August	2.4	8.3	84.1	1.4	2.7	1.1
September	6.3	9.9	81.7	0.2	1.4	0.5 .
October	48.0	31.0	2.0	16.0	3.0	-
'November	76.5	14.4	7.6	-	-	1.5
Mean	6.6	17.0	72.2	0.9	2.8	0.5

a Means calculated from overall catch, not monthly percentages.

Table 13. The percentage of various fish species caught in gill and fyke nets in Cascade Reservoir, Idaho, in June, August, and October 1980, and January and August 1981.

Month	Rainbow	Coho	Kokanee	Perch	Bullhead	Squawfish	Sucker
June	0.7	4.3	-	68.0	7.8	11.4	7.8
August	1.2	3.7	1.0	48.8	10.3	24.2	10.8
October	7.3	13.3	4.0	21.2	24.5	17.4	12.3
January	6.8	24.3	14.9	27.0	-	27.0	-
August	0.2	3.4	0.5	60.8	10.0	15.3	9.8
Mean [a]	1.6	5.2	1.2	53.0	11.3	17.8	9.9

a Means calculated from overall catch, not monthly percentages.

Table 14. The number of fluorescent grit marked coho salmon (released in 1980) observed in angler creels and gill nets from Cascade Reservoir, June 1980 to April 1982.

	Tamarack Falls	Sugarloaf Boat Ramp	City/Cabarton Boat Ramp
Color	Green	Red	Yellow
Number released	133,100	112,600	122,850
Weighting factor	1.18	1.00	1.09
Angler catch	248	244	288
Net catch	35	37	42
Grand total	283	281	330
Weighted value	240	281	303
Percentage	29.1	34.1	36.8
X^2 value		7.470 (significant at p= 0.05)	

Table 15. The number of fluorescent grit marked coho salmon (released in 1981) observed in angler creels and gill nets from Cascade Reservoir, Idaho, June 1981 to April 1982.

	Tamarack Falls	Sugarloaf Boat ramp	Cabarton Boat
Color	Green	Red	Yellow
Number released	115,600	115,200	118,800
Weighting factor	1.00	1.00	1.03
Angler catch	23	33	62
Net catch	8	15	8
Grand total	31	48	70
Weighted value	31	48	68
Percentage	21.1	32.6	46.3
x^2 value		14.008 (significant at p = 0.05)	

Table 16 The number of various types of rainbow trout (released in 1980 and 1981) observed in angler creels and gill nets from Cascade Reservoir, Idaho, May 1980 to April 1982. (RV-spring release; LV-fall release; no dorsal-catchables released in prior years; bent ray-catchables or fingerlings released in prior years; good dorsal-native or fingerling release origin.)

	Marked Catchables				Marked Fingerlings				Unmarked Rainbow		
						Red					
	81 LV	80 LV	81 RV	80 RV	Green	80	81	Yellow	No Dorsal	Bent Ray	Good Dorsal
Angler Catch	98	275	437	688	3	4	12	9	314	710	247
Percentage	3.5	9.8	15.6	24.6	0.1	0.1	0.4	0.3	11.2	25.4	8.8
Net Catch	0	10	0	10	2	2	2	3	13	19	4
Percentage	0	15.4	0	15.4	3.1	3.1	3.1	4.6	20.0	29.2	6.1
Grand Total	98	285	437	698	5	6	14	12	327	729	251
Percentage	3.4	10.0	15.3	24.4	0.2	0.2	0.5	0.4	11.4	25.5	8.8

May 1980 to April 1982 was comprised of unmarked fish which were probably released as catchables in prior years (Table 16), as most appeared to have hatchery-deformed dorsal fins (Fig. 13). Unmarked rainbow with "good" dorsal fins which were either native or of fingerling release origin comprised approximately 9% of the rainbow harvest.

Spring Versus Fall Release

Catchable rainbow released in the spring provided better catches and catch rates than fall-released catchables (Table 17). After 20 months residence in Cascade Reservoir, 672 spring-released catchables (1980) were returned to the creel, whereas only 275 fall-released fish were taken in the same amount of time. Similarly, after eight months in the reservoir, 203 rainbow from spring 1981 releases were harvested, compared to only 98 fall-released fish (Table 17).

Total Harvest Estimate

During the winter ice fishery, 26 December 1981 through 23 April 1982, anglers fished an estimated 29,223 hours in Area I and 10,604 hours in Area III (Appendix B-1 and B-2). Angler use was higher in the southern end of the reservoir at 8,590 fishermen compared to 3,182 anglers in the northern end. Very few anglers fish in Area II during the ice fishery.

Yellow perch were harvested in greater numbers than any other fish species in the reservoir (Table 18). From December through January, most perch were harvested in the northern end of the reservoir. After January, however, greater numbers of perch were taken in the southern end of the reservoir. Angler effort was consistently higher in Area I (Appendix B-1 and B-2), and catch rates for perch ranged from 0.03-0.91 fish/hr in Area I, and 0.62-1.89 fish/hr in Area III. An estimated 29,186 perch were harvested from the reservoir during this period, 59% of which were from Area I.

Rainbow trout were caught in consistently greater numbers from Area I of Cascade Reservoir. Rainbow caught from mid-March through April (Intervals 7-9) constituted 68% of the fish caught in Area I, and 58% of the total estimated number of rainbow harvested from the entire reservoir during this period (Table 18). Catch rates in Area I ranged from 0.06-0.31 fish/hr, and from 0.02-0.16 fish/hr in Area III (Appendix B-1 and B-2). A total of 4,662 rainbow were harvested during the census period, 85% of which came from Area I (Table 8).

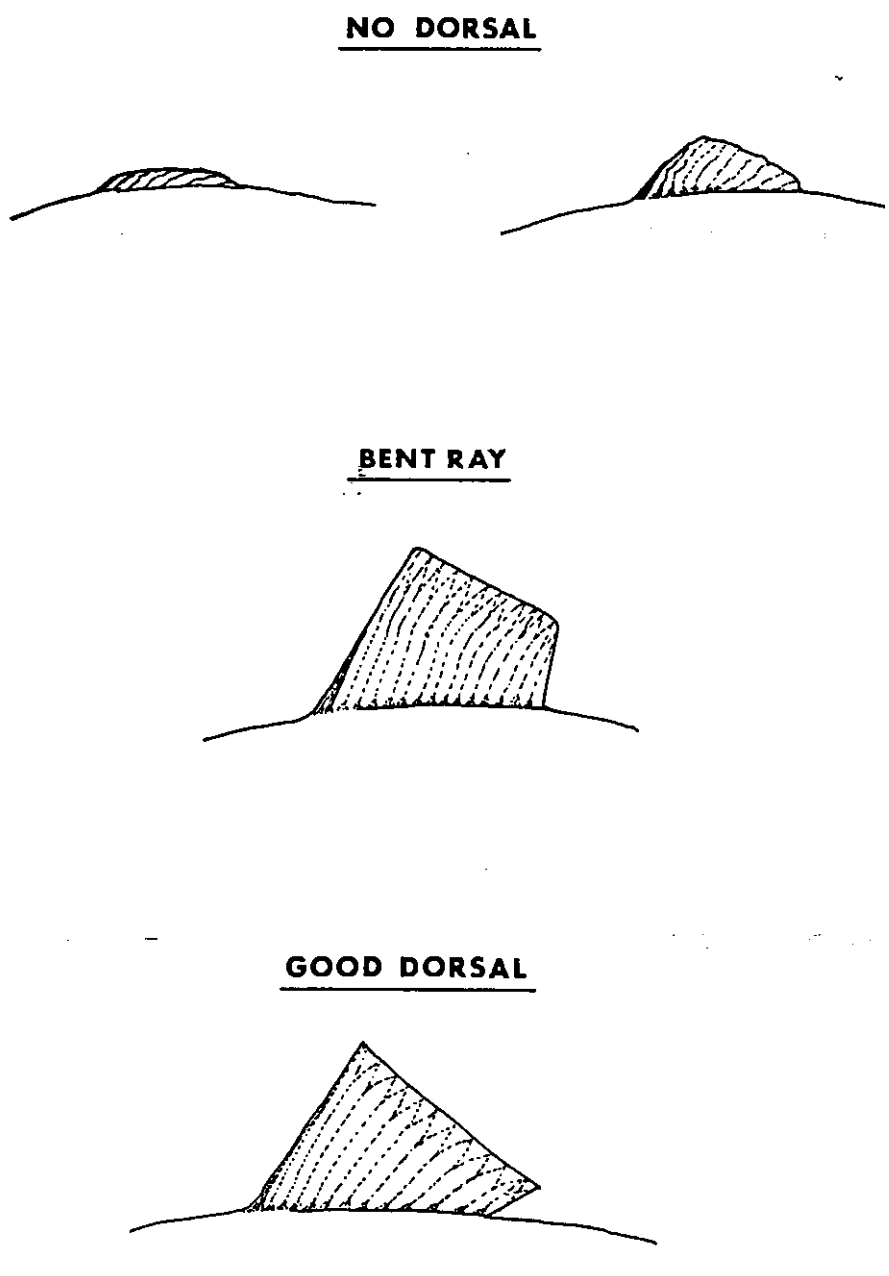

Figure 13. The appearance of dorsal fins on rainbow trout classified as "no dorsal", "bent ray", or "good dorsal."

Table 17. Catch and catch rate (fish/hour) of fin clipped catchable rainbow trout released in April and May and September during 1980 and 1981 in Cascade Reservoir.

	Spring Release				Fall Release			
	1980		1981		1980		1981	
Month/Year	Catch	Catch Rate	Catch	Catch Rate	Catch	Catch Rate	Catch	Catch Rate
5/80	42	.063	-	-	-	-	-	-
6/80	67	.024	-	-	-	-	-	-
7/80	139	.021	-	-	-	-	-	-
8/80	40	.012	-	-	-	-	-	-
9/80	60	.021	-	-	67	.023	-	-
10/80	69	.031	-	-	66	.028	-	-
11/80	42	.070	-	-	37	061	-	-
12/80	8	.015	-	-	7	.013	-	-
1/81	11	.022	-	-	4	.008	-	-
2/81	9	.068	-	-	3	.022	-	-
3/81	4	.046	-	-	4	.046	-	-
4/81	92	.075	3	.002	3	.002	-	-
5/81	20	.014	11	.008	14	.010	-	-
6/81	41	.010	57	.014	21	.005	-	-
7/81	15	.003	62	.010	15	.002	-	-
8/81	0	-	21	.015	2	.001	-	-
9/81	2	- .004	16	.035	0	-	0	-
10/81	3	.007	10	.025	1	.007	1	.009
11/81	4	.007	23	.042	12	.022	12	.022
12/81	4	.022	9	.050	4	.022	1	.006
1/82	4	.003	57	.038	6	.004	21	.014
2/82	0	-	36	.037	2	.002	8	.008
3/82	4	.003	68	.048	2	.001	30	.021
4/82	8	.008	64	.069	5	.005	25	.027
Total	688	-	437	-	275	-	98	-
Mean	28.7	.023	33.6	.030	13.8	.014	12.2	.013

Table 18. Total estimated catch and percentage of rainbow trout, coho salmon, and yellow perch caught by anglers in Cascade Reservoir, December through April 1982.

Census Period	Total Estimated Catch					
	Rainbow		Coho		Perch	
	Area I	Area III	Area I	Area III	Area I	Area III
(1) Dec. 26-Jan. 1	105	101	584	14	26	1011
(2) Jan. 2-Jan.15	223	8	790	0	258	414
(3) Jan.16-Jan.29	356	307	518	27	2461	4585
(4) Jan.30-Feb.12	280	75	235	15	1398	910
(5) Feb.13-Feb.26	118	13	213	2	765	261
(6) Feb.27-Mar.12	172	23	193	0	1630	1221
(7) Mar.13-Mar.26	855	116	656	7	3657	1793
(8) Mar.27-Apr.9	503	- 3	107	0	1216	-
(9) Apr.10-Apr.23	1364	40	778	0	5798	1782
Total	3976	686	4074	65	17209	11977
Percentage	10.5	1.8	10.7	0.2	45.3	31.5

Coho salmon were harvested in lowest numbers compared to perch and rainbow (Table 18). Of the estimated 4,139 coho harvested, 98% were taken from Area I in the southern end of the reservoir. Catch rates for coho ranged from 0.06-0.61 fish/hr in Area I and 0.004-0.02 fish/hr in Area III. Catch rates were highest from December through January (Intervals 1-3) and during March and April (Intervals 7 and 9, respectively). The majority of coho taken were Age 0+ fish.

DISCUSSION

Oxygen Content of the Reservoir -

There is a large volume of literature examining oxygen deficits and their measurement. A considerable effort has gone into developing the ability to predict oxygen consumption for different lakes and reservoirs (Hutchinson 1957, Mathias and Barica 1980, Charlton 1930, Hargrave 1972, Cornett and Rigler 1979, Lasenby 1975, Welch et al 1976, Welch 1974, Cornett and Rigler 1980). The oxygen deficit has generally been estimated on an areal basis and has been shown to be related to many factors, including temperature, phosphorous retention, hypolimnetic thickness, mean depth, and basin morphometry. The oxygen deficit does not vary consistently as a function of these factors, though it is generally much higher in productive lakes than unproductive ones. It does appear that within a single body of water, the winter oxygen deficit may be fairly consistent from one year to the next (Barica and Mathias 1979). It is reasonable to assume then, that once the deficit has been estimated, it can be used for accurately estimating future oxygen conditions with a water body.

Cascade Reservoir exhibited a pronounced oxygen deficit during both summer and winter periods of stagnation. Estimates of the summer oxygen deficit (AHOD) of .66 g/m^2 /day and .41 g/m^2/day are well within the range of those reported for eutrophic waters (Hutchinson 1957, Mathias and Barica 1980), but the true oxygen demand may be even higher. The summer estimates based on regression of hypolimnetic oxygen content over time may acutally underestimate the actual oxygen demand in the reservoir. Cascade did not stratify strongly and unstable periods of mixing were common throughout the summer. It is likely that entrainment of oxygen into the hypolimnion occurred throughout the summer, masking actual oxygen consumption. Estimates of oxygen deficits over short periods of stratification were often much greater and the actual summer demand might more closely approximate 1. 0 g/m^2/day (Horner and Rieman 1982).

The estimates of winter oxygen demand differed dramatically in 1981 (0.25 g/m^2 /day) and 1982 (0.48 g/m^2 /day). During 1981, there was little snow cover on the reservoir, and significant oxygen production probably occurred under the ice throughout the winter. We consistently observed supersaturation of oxygen just under the ice during winter sampling in 1981. During 1982, there was a much greater snow cover on the reservoir. Measured snow depths exceeded the 10 cm threshold that should eliminate any oxygen production due to photosynthesis (Barica and Mathias 1979) for approximately one month. A consistent oxygen deficit of .48 g/m^2/day was observed throughout that period, and is probably an accurate estimate of the actual winter oxygen demand in Cascade Reservoir.

Development of the Model

Barica and Mathias (1979) used winter oxygen deficits to predict winterkill risk in lakes. Their model used oxygen content at freeze-up (g 0_2/m2), and the estimated oxygen deficit
(9 02/m^2/day) to predict the number of days to completely anoxic conditions:

$$\frac{g\ O_2/m^2}{g\ O_2/m^2/day} = days$$

Initially, our model was similar, incorporating only reservoir volume and the oxygen deficit to predict the time to anoxic conditions (Horner and Rieman 1982). We originally assumed that sediment oxygen demand was the only significant component of the winter oxygen deficit. However, our data indicates that water column oxygen consumption may contribute up to 22% of the total oxygen demand and that net oxygen input due to tributary inflow may reduce the deficit by as much as 10%. Because of the significant contribution of both tributary inflow and water column demand, it was necessary to incorporate both into the model. Recent work (Charlton 1980, Cornett and Rigler 1979, Mathias and Barica 1980, Welch et al 1976) has shown that oxygen deficits calculated on an areal basis (as ours) may vary with mean depth of the water body. The inclusion of water column demand (which normally was considered insignificant) may explain that phenonmenon. Since the water column demand calculated on an areal basis declines with mean depth of the reservoir, and since we are considering a fluctuating rather than a stable body of water, it must be included.

Barica and Mathias (1979) also did not incorporate winter conditions in their model, using it only as a tool for prediction of relative winterkill potential. In the Cascade area, winter severity can vary considerably. As an example, snow and ice conditions in 1981 were not adequate to result in elimination of primary production and measurement of the oxygen deficit to quantify the actual risk of a winterkill. On Cascade, it was necessary to incorporate a winter severity index to predict the frequency of winterkill conditions. Barica and Mathias (1979) indicated that 10 cm of snow was adequate to eliminate oxygen production and result in stagnation. Our 1982 data (Fig. 7) show that the maximum oxygen deficit occurred only during the period when snow depth on the reservoir exceeded 10 cm, confirming their observations. Snow conditions at the BOR weather station did not coincide with our measurements of snow on the reservoir, but the two did show a stong positive correlation. The data from the weather station can be used to estimate past snow conditions on the reservoir. Assuming that climatic conditions during the last 31 years can be used to estimate the frequency of given winter conditions at the station, the data should also provide a useful indication of the frequency of stagnation conditions on Cascade Reservoir.

Initially, we assumed that total anoxia was necessary for winterkill. Obviously, some oxygen limitation may occur at higher concentrations. Percids and ictalurids have been reported to survive oxygen concentrations as low as 0.7 mg/1 (Moss and Scott 1961). Other authors (Burdick et al 1957, Moore 1942) report DO levels in the range of 0.7 to 1.5 mg/1 to be lethal for yellow perch. Minimum oxygen requirements for salmonids are generally considered to be 5 mg/1, and anything below saturation may cause some adverse effects on growth, reproductive activity, or other physiological functions (Wedemeyer et al 1976). It is likely, then, that significant damage may occur to the Cascade fish community at DO levels well above anoxia. It is difficult to predict the actual level where severe limitation may occur, particularly since vulnerability may vary by species. Since oxygen depletion tends to develop from the bottom of the reservoir, the ability of fish to move to oxygenated waters and their actual oxygen requirements will dictate the critical level of oxygen depeltion. During our summer sampling, we saw an obvious avoidance of anoxic waters by perch, the fish moving inshore as oxygen in deep water was depleted. Salmonids were generally found higher in the water column where the greatest oxygen concentrations exist. During winter stagnation, it is likely that all species would be found in the upper strata of the water column where maximum oxygen concentrations would be found. For that reason, we estimated the final minimum oxygen content of the reservoir to be that level where near-surface oxygen concentrations would definitely be considered limiting. For salmonids we assumed that to be 4 mg/l. Since other species are more tolerant, the prediction of "oxygen limiting" conditions by the model should be considered in reference to the salmonid populations.

Winterkill Risk

The final product of the modeling is the development of an estimated risk for oxygen limitation at different winter storage levels, with the objective of recommending a minimum conservation pool. Our analysis indicates that a significant risk (> 12% chance) may occur when the reservoir is held below a pool level of 1,466 m (290,000 acre feet) during the period of winter stagnation. The analysist assumes that the reservoir elevation is stable and remains at that level for an extended period of time. For example, at an elevation of 1,466 m, it would require between 90 and 100 days for the reservoir to reach limiting conditions. The BOR does not have a standard operation procedure for maintenance of the winter pool level, and pool elevation has rarely been held stable during the period of winter stagnation. In light of fairly erratic changes in reservoir volume during this period, a minimum pool reservation alone is not too meaningful since the reservoir might be drawn below an elevation of 1,466, but not for a period of time approaching that necessary for oxygen limitation. Any recommendation of a minimum conservation pool should also incorporate a time restriction. Figure 12 incorporates the estimates of risk and the time necessary to reach oxygen limitation at given pool elevations (and volumes). For example, there is a 40% risk of oxygen limitations at an elevation of 1,464 m (192,000 acre feet). The lower graph shows that it would require approximately 80 days to reach those conditions. An appropriate recommendation is that during winter stagnation (December-March), the reservoir not be allowed to drop below 1,464 m for a period of time approaching 80 days. Similarly, to reduce the risk below 12%, the reservoir should not be allowed to drop below an elevation of 1,466 m (290,000 acre feet) for a period approaching 90-100 days.

Summerkill Risk

The development of a summer oxygen deficit during the period of thermal stratification did not appear to pose a serious potential for summerkill on Cascade in 1980 or 1981. A substantial amount of habitat was eliminated from use by anoxic and low oxygen conditions, but it appeared that all species were able to respond to declinging oxygen by moving to areas of higher concentration. Salmonid habitat was further restricted by warm surface temperatures. Although surface temperatures did occasionally reach 24-25 C (often considered lethal to salmonids [Scott and Crossman 1973]), the extent and duration of these conditions was not enough to cause a kill of salmonids during the summer of 1980 or 1981. The potential for summerkill due to normal stagnation could be accentuated by a low summer pool and/or a long, hot summer.

The serious potential for summerkill in Cascade Reservoir lies in the apparent high productivity and potential for massive algal blooms. The collapse of algal blooms can result in a massive oxygen demand and complete oxygen depletion in a very short period of time (Barica 1975, Papst et al 1980). It appears that a period of thermal instability (mixing) coincidental with a bloom collapse is necessary to create a summerkill situation (Papst et al 1980). We did not observe conditions of this nature in Cascade during 1980 or 1981, but it is obvious that each of the prerequisites necessary to develop those conditions exists within the reservoir. Reported nutrient levels, particularly phosphorous, are high in Cascade (Clark and Wroten 1976, U. S. Bureau of Reclamation 1975), and large algal blooms have occurred in some years. Our observations of thermal stratification also show the reservoir to be relatively unstable. Occasionally, the conditions for a massive algae bloom and its collapse and mixing will occur simultaneously. Summer fish kills have been observed. The potential for more frequent and massive summer fish kills is also present. Increased nutrient loading will increase the frequency of algal blooms. A high summer pool could reduce problems by diluting nutrient concentrations and providing a high initial oxygen volume, but the real problem lies in excessive nutrient loading. Management of nutrient sources to the reservoir provide the best means of reducing the threat of summer losses.

Cascade Reservoir Fishery

Cascade's fishery at present is mostly supported by a self-sustaining yellow perch population and hatchery releases of rain-bow trout and coho salmon. Limnological conditions of the reservoir favor the continuation of yellow perch and nongame species and make salmonid survival marginal at times.

Coho released at Cabarton and the Cascade City boat ramps showed the best apparent survival of the six groups of coho fingerlings released during 1980 and 1981. Reasons for the better survival are likely food and/or predator related. The southern end of the reservoir is typically 1-2 C warmer than the north end, and may support a greater zooplankton population. Also, the squawfish population in the south end (based upon catch rates) is lowest of any other area of the reservoir during May and June when coho fingerlings are released.

The rainbow trout fishery appears to be almost totally supported by releases of catchable-size fish. Virtually no rainbow released as fingerlings are recovered. The poor survival of fingerling rainbow compared to similar-sized coho fingerlings released at similar times and places suggests some behavioral difference between rainbow and coho fingerlings. Catchable rainbows released in the spring provided better catches and catch rates than fall-released catchables. Spring-released fish have the advantage of adjusting from a hatchery environment to the lacustrine environment during a period of mild water temperatures and an abundant food supply prior to the onset of harsh winter conditions.

An estimated 12,000 anglers fished 40,000 hours on Cascade Reservoir during the 1981-82 winter ice fishery. Yellow perch were harvested in greater numbers than any other fish species. A seasonal horizontal displacement was observed with yellow perch, rainbow trout, and coho salmon. Generally, all three species were harvested in greater numbers in the south end of Cascade Reservoir.

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APPENDIX

Appendix A-1. Total inflow into Cascade Reservoir (acre feet) for water years 1960 through 1981. Underlined values indicate monthly minimum and maximum levels for the 21-year period.

Year (Oct.1-Sept.30)	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Total
80-81	16,730	34,620	72,900	44,940	52,150	48,960	81,050	161,950	151,290	21,010	12,690	21,610	719,690
79-80	19,830	20,320	21,580	43,680	33,830	36,960	109,860	257,670	152,300	45,740	13,600	43,400	798,770
78-79	27,570	26,100	21,890	18,770	19,420	36,080	60,370	155,950	76,380	18,700	23,500	10,800	495,530
77-78	19,140	26,020	60,660	37,310	31,930	59,600	138,860	187,900	230,800	87,650	27,800	31,290	938,960
76-77	23,710	13,860	12,430	14,000	10,650	14,260	29,570	34,340	26,820	13,840	20,890	14,580	228,950
75-76	52,470	45,940	61,000	44,070	31,520	30,200	106,930	246,260	159,230	49,270	37,000	28,700	892,590
74-75	18,730	17,930	21,530	24,200	23,920	32,690	45,330	137,890	258,660	106,240	34,400	28,200	749,770
73-74	24,410	96,630	61,430	111,630	203,500	91,000	130,600	187,820	411,600	115,400	14,900	31,390	1,480,310
72-73	16,890	23,020	37,960	34,640	18,920	30,950	41,040	130,110	79,320	8,130	900	16,100	437,980
71-72	14,920	20,790	28,260	35,410	35,540	87,100	76,450	188,250	304,980	28,940	15,700	17,290	853,630
70-71	28,020	48,570	51,390	51,780	37,100	40,000	126,200	286,410	343,000	75,270	12,250	21,530	1,121,520
69-70	20,850	15,410	28,180	61,760	33,000	37,870	56,020	192,190	324,500	44,520	15,300	25,060	854,660
68-69	26,600	42,320	35,230	50,240	23,840	20,000	142,230	265,400	162,480	22,650	6,200	19,700	816,890
67-68	37,950	27,540	26,280	24,440	40,340	52,270	52,250	130,790	146,470	4,790	13,470	21,800	578,390
66-67	16,900	26,140	22,130	29,470	24,270	36,550	62,590	164,440	298,950	54,480	9,900	15,000	751,910
65-66	26,810	26,050	20,420	30,180	15,490	31,310	88,770	146,940	81,950	7,100	2,500	4,700	482,220
64-65	24,470	24,790	97,430	59,570	32,200	28,600	117,100	233,370	292,800	47,430	31,190	22,600	1,011,550
63-64	25,740	53,600	20,650	24,960	18,290	25,610	64,200	146,600	289,400	43,390	7,600	23,900	723,940
62-63	89,640	72,470	55,760	30,080	76,740	45,900	64,610	190,500	176,700	15,650	3,000	13,400	834,450
61-62	12,700	19,390	20,220	16,410	22,920	24,980	122,340	177,380	182,960	14,160	9,700	8,460	631,620
60-61	15,140	30,070	18,070	11,800	43,560	45,080	55,730	167,420	176,960	0	10,800	16,200	590,830
Mean	26,630	32,930	37,880	38,060	38,200	40,750	84,390	180,460	206,070	39,250	15,390	20,750	761,630
SD	16,940	19,880	22,590	22,100	40,260	19,300	35,260	56,460	101,850	33,250	10,270	8,880	264,990
Range	12,700 to 89,600	13,860 to 96,630	12,430 to 97,430	11,800 to 111,630	10,650 to 203,500	14,260 to 91,000	29,570 to 142,230	34,340 to 286,410	26,820 to 411,600	0 to 115,400	900 to 37,000	4,700 to 43,400	228,950 to 1,480,310

Appendix A-2. Morphometric characteristic of Cascade Reservoir, Idaho.

Reservoir Elevation		Area		Volume		Strata volume		Area		Volume (Z)
ft	m	Acres	Hectares	Acre ft	$m^3 x 10^6$	$m^3 x 10^6$	Relative Volumes/Strata	Δ Between Strata	Relative Bottom Area/strata	Area
4,831.4	1,473	28,280	11,445	801,142	988.29					8.63
4,828.2	1,472	26,650	10,785	711,040	877.14	111.15	158.8	660	4.29	8.13
4,824.9	1,471	25,000	10,118	626,321	772.63	104.51	149.3	667	4.33	7.63
4,821.6	1,470	23,090	9,308	547,584	675.50	97.13	138.8	810	5.26	7.26
4,818.3	1,469	21,180	8,572	475,113	586.10	89.40	127.7	736	4.78	6.84
4,815.0	1,468	19,370	7,839	408,596	504.05	82.06	117.2	733	4.76	6.43
4,811.8	1,467	18,000	7,285	347,296	428.43	75.62	108.0	554	3.60	5.88
4,808.5	1,466	16,500	6,678	290,702	358.61	69.82	99.7	607	3.94	5.37
4,805.2	1,465	15,000	6,071	239,028	294.87	63.75	91.1	607	3.94	4.86
4,801.9	1,464	13,500	5,464	192,275	237.19	57.68	82.4	607	3.94	4.34
4,798.6	1,463	11,800	4,776	150,770	185.99	51.20	73.1	688	4.47	3.89
4,795.4	1,462	10,100	4,088	114,843	141.67	44.32	63.3	688	4.47	3.47
4,792.1	1,461	8,400	3,400	84,492	104.23	37.44	53.5	688	4.47	3.07
4,788.8	1,460	6,600	2,671	59,885	73.88	30.36	43.4	729	4.73	2.77
4,785.5	1,459	5,100	2,064	40,693	50.20	23.68	33.8	607	3.94	2.43
4,782.2	1,458	3,850	1,558	26,013	32.09	18.11	25.9	506	3.29	2.06
4,779.0	1,457	2,800	1,133	14,984	18.49	13.61	19.4	425	2.76	1.63
4,775.7	1,456	1,800	729	7,437	9.18	9.31	13.3	404	2.62	1.26
4,772.4	1,455	1,000	406	2,837	3.50	5.68	8.1	323	2.10	0.86
4,769	1,454	380	154	567	0.70	2.80	4.0	252	1.64	0.45
4,766	1,453	0	0	0	0	0.70	1.0	154	1.00	0.00

Appendix A-3. The average, maximum, and minimum monthly water storage levels (acre feet) in Cascade Reservoir, Idaho, for water years 1972 through 1982.

Water year (1 Oct-30 Sep)		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
81-82	Ave	348,256	370,190	418,911	458,864	432,184	401,606	324,869	373,239	549,815	642,589	617,878	546,471
	Max	354,959	393,487	443,801	469,635	459,144	442,487	352,039	461,970	659,965	664,448	630,064	592,464
	Min	342,473	355,350	394,301	444,679	415,811	355,150	312,681	322,316	466,998	630,332	595,026	504,894
80-81	Ave	250,705	397,917	413,138	465,662	493,644	534,610	576,816	647,272	650,044	620,830	532,741	394,028
	Max	401,067	400,451	450,873	476,539	518,059	554,942	624,334	662,068	662,594	639,799	588,367	460,232
	Min	100,343	395,725	114,523	452,430	477,219	518,996	559,042	639,738	641,653	590,924	463,928	342,851
79-80	Ave	205,526	195,211	213,655	233,693	256,482	295,382	340,619	540,767	627,401	642,229	481,775	479,505
	Max	250,900	203,000	218,650	247,880	278,410	311,800	405,000	633,460	647,900	652,660	625,920	520,340
	Min	185,720	192,010	204,850	218,650	247,880	280,510	311,800	412,460	600,480	627,740	524,840	452,120
78-79	Ave	489,182	471,867	437,589	397,723	372,533	355,321	363,714	441,422	564,988	520,123	416,346	308,464
	Max	520,340	479,730	454,100	415,820	383,450	362,360	388,290	528,880	578,500	562,870	468,700	359,210
	Min	477,920	454,980	418,140	384,450	362,360	350,010	349,040	389,910	533,910	472,060	361,570	254,960
77-78	Ave	172,573	185,074	224,216	264,355	279,798	293,416	372,416	482,363	605,548	648,739	603,420	541,261
	Max	177,740	197,620	248,040	274,040	283,320	312,530	419,620	546,230	643,940	655,570	635,290	564,350
	Min	167,130	177,450	197,170	249,560	273,690	283,320	316,210	422,800	548,180	637,110	567,310	523,410
76-77	Ave	443,968	435,773	419,142	382,873	357,582	360,784	367,217	340,577	347,290	294,513	226,581	173,587
	Max	471,400	436,700	431,800	400,300	365,100	364,100	375,200	352,400	353,300	329,500	260,400	193,400
	Min	433,900	432,600	401,500	366,300	354,900	357,600	354,500	333,500	332,500	261,800	195,200	162,400
75-76	Ave	440,935	476,243	506,106	480,555	423,717	353,842	325,780	444,871	617,220	642,029	592,548	507,697
	Max	457,000	488,400	513,100	497,500	455,400	391,100	355,300	556,700	650,500	650,800	623,900	551,400
	Min	430,000	458,300	491,600	457,800	392,800	318,100	309,600	360,400	563,600	624,600	554,800	472,500
74-75	Ave	457,116	447,530	415,955	378,894	356,632	328,603	274,933	271,687	438,083	609,123	567,865	496,150
	Max	485,900	453,200	432,000	396,600	362,600	346,500	306,900	311,800	547,500	630,300	603,500	534,600
	Min	448,200	433,700	396,800	363,500	348,100	307,600	254,600	251,400	317,100	551,600	537,000	458,300
73-74	Ave	215,142	257,693	323,192	376,855	397,089	290,316	247,087	316,177	560,360	653,442	613,668	525,050
	Max	234,000	298,600	342,500	422,400	423,600	344,200	263,800	390,900	671,100	663,600	645,800	566,100
	Min	208,400	214,980	301,500	341,700	347,100	259,200	238,900	251,200	398,500	646,800	569,100	488,400
72-73	Ave	371,245	366,117	366,419	372,842	360,686	361,145	383,030	440,968	549,583	527,597	427,268	288,690
	Max	402,700	370,900	377,000	378,000	370,900	371,900	395,400	513,100	564,600	561,600	480,400	361,000
	Min	360,000	361,000	359,800	365,900	351,000	352,400	372,300	395,600	517,500	483,800	367,500	236,300

Appendix A-3 (Continued).

Water year (1 Oct-30 Sep)		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
71-72	Ave	466,026	451,287	421,810	360,252	308,652	263,794	220,007	283,306	569,427	625,619	527,468	444,323
	Max	488,600	454,300	444,500	389,900	333,100	291,300	224,200	392,300	639,000	642,900	580,300	480,400
	Min	448,200	445,800	391,900	335,200	290,200	227,300	216,100	218,200	405,000	583,300	483,400	506,800
Grand Average		350,970	368,627	378,194	379,324	367,182	348,984	345,135	416,604	552,705	584,258	509,778	427,748
Average Maximum		385,873	379,672	396,033	397,147	384,826	372,111	373,644	486,346	601,714	604,913	558,422	471,227
Average Minimum		327,480	356,536	333,889	364,834	351,005	328,199	326,798	363,411	484,129	555,460	474,516	391,085

Appendix B-1 . Catch rates (fish/hour), estimated angler use (numbers of fishermen), estimated angler hours, and total estimated catch of rainbow trout and coho salmon taken by anglers from Area I and Area III of Cascade Reservoir, Idaho, from December 1981 to April 1982.

	Area I		Area III		Rainbow trout Area I		Area III	Coho Salmon Area I		Area III	
Census Period	Angler Use	Angler Hours	Angler Use	Angler Hours	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest
(1) Dec.26-Jan.1	-	958.5	-	628.2	0.110	105	0.160	101	0.609	584	0.023	14
(2) Jan.2-Jan.15	963	1926.0	73	219.0	0.160	223	0.037	8	0.410	790	-	0
(3) Jan.16-Jan.29	1408	6476.0	688	2977.0	0.055	356	0.103	307	0.080	518	0.009	27
(4) Jan.30-Feb.12	1626	3789.8	612	1468.8	0.074	280	0.051	75	0.062	235	0.010	15
(5) Feb.13-Feb.26	382	1234.0	32	186.0	0.096	118	0.071	13	0.173	213	0.009	2
(6) Feb.27-Mar.12	395	1791.0	256	1196.0	0.096	172	0.019	23	0.108	193	-	0
(7) Mar.13-Mar.26	729	4623.8	613	1839.0	0.185	855	0.063	116	0.142	656	0.004	7
(8) Mar.27-Apr.9	1571	1602.6	73	87.2	0.314	503	0.032	3	0.067	107	-	0
(9) Apr.10-Apr.23	1516	6821.6	835	2002.8	0.20	1364	0.020	40	0.114	778	-	0
Total	8590	29223.3	3182	10604.0	-	3976	-	686	-	4074	-	65
Mean	1074	3247.0	393	1178.2	0.143	442	0.062	76	0.196	453	0.006	7

Appendix B-2. Catch rates (fish/hour), estimated angler use (numbers of fishermen), estimated angler hours, and total estimated catch of yellow perch, squawfish, and sucker taken by anglers from Area I and Area III of Cascade Reservoir, Idaho, from December 1981 to April 1982.

	Area I		Area III		Yellow Perch				Squawfish				Sucker			
					Area I		Area III		Area I		Area III		Area I		Area III	
Census Period	Angler Use	Angler Hours	Angler Use	Angler Hours	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest	Catch Rate	Total Harvest
(1) Dec.26-Jan.1	-	958.5	-	628.2	0.027	26	1.610	1011	-	-	0.020	12	-	-	-	-
(2) Jan.2-Jan.15	963	1926.0	73	219.0	0.134	258	1.889	414	0.003	6	0.037	8	0.003	6	-	-
(3) Jan.16-Jan.29	1408	6476.0	688	2977.0	0.380	2461	1.54	4585	-	-	-	-	-	-	-	-
(4) Jan.30-Feb.12	1626	3789.8	612	1468.8	0.369	1398	0.619	910	-	-	-	-	-	-	-	-
(5) Feb.13-Feb.26	382	1234.0	32	186.0	0.620	765	1.404	261	0.011	14	-	-	-	-	-	-
(6) Feb.27-Mar.12	395	1791.0	256	1196.0	0.910	1630	1.021	1221	0.004	7	0.009	11	-	-	-	-
(7) Mar.13-Mar.26	729	4623.8	613	1839.0	0.791	3657	0.975	1793	0.019	38	0.008	15	-	-	0.001	2
(8) Mar.27-Apr.9	1571	1602.6	73	87.2	0.759	1216	-	-	0.007	11	-	-	-	-	-	-
(9) Apr.10-Apr.23	1516	6821.6	835	2002.8	0.850	5798	0.890	1782	0.010	68	0.050	100	-	-	0.090	180
Total	8590	29223.3	3182	10604.0	-	17209	-	11977	-	194	-	146	-	6	-	182
Mean	1074	3247.0	398	1178.2	0.538	1912	1.105	1331	0.006	22	0.014	16	0.0003	1	0.010	20

Appendix C-1. Location descriptions for creel census Areas I, II and III on Cascade Reservoir, Idaho, and the description of various marked and unmarked groups of rainbow trout and coho salmon released into Cascade Reservoir during 1980 and 1981. These descriptions apply to all tables in Appendix C.

Area I - From the south end of the reservoir north to a transect running due west from Crown Point to French Creek,

Area II - From the Crown Point/French Creek transect north to a transect running due west from the Sugarloaf Boatramp.

Area III - From the Sugarloaf Boatramp transect north.

LV - Left ventral fin clipped catchable rainbow released at Tamarack Falls and Sugarloaf Boatramp in September.

RV - Right ventral fin clipped catchable rainbow released at Tamarack Falls and Lake Fork Creek Bridges in May.

No dorsal - Catchable rainbow released in prior years.

Bent ray - Rainbow released as fingerlings or catchables in prior years. Good dorsal -

Rainbow of either native or fingerling release origin.

Green - Fluorescent grit marked rainbow and coho fingerlings released at Tamarack Falls.

Red - Fluorescent grit marked rainbow and coho fingerlings released at Sugarloaf Boa tramp.

Yellow - Fluorescent grit marked rainbow and coho fingerlings released at City and Cabarton Boatramps.

Unknown mark - Fingerling coho released in 1980 and 1981 with no visible mark. No mark - Coho released as fingerlings in prior years.

Appendix C-2. The catch, catch rate (fish/hr) and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, May 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout								Coho salmon				
			Catchable		Fingerling			Other							
			LV	RV	Green	Red	Yellow	No dorsal	Bent ray	Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Area I															
Boat	22	41	-	-	-	-	-	-	1	-	-	-	-	-	3
Bank	165	323	-	-	-	-	-	-	2	-	-	-	-	-	35
Total	187	364	-	-	-	-	-	-	3	-	-	-	-	-	38
Fish/hr									.008						.10
Percentage									1.8						22.9
Area II															
Boat	19	54	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	6	31	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	25	85	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr															
Percentage															
Area III															
Boat	4	6	-	-	-	-	-	-	-	-	-	-	-	-	2
Bank	99	243	-	42	-	-	-	-	3	1	-	-	-	-	21
Total	103	249	-	42	-	-	-	-	3	1	-	-	-	-	23
Fish/hr				.17					.012	.004					.092
Percentage				54.5					3.9	1.3					29.9
Grand Total															
Boat	45	101	-	-	-	-	-	-	1	-	-	-	-	-	5
Bank	270	597	-	42	-	-	-	-	5	1	-	-	-	-	56
Total	315	698	-	42	-	-	-	-	6	1	-	-	-	-	61
Fish/hr				.060					.009	.001					.087
Percentage				16.0					2.3	0.4					23.2
Spillway															
Bank	89	116	-	-	-	-	-	-	1	-	-	-	-	-	1
Fish/hr									.009						.009
Percentage									.5						.5

Appendix C-2 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	-	-	6	-	-
Bank	95	6	16	2	-
Total	95	6	22	2	-
Fish/hr	.26	.016	.06	.005	
Percentage	57.3	3.6	13.2	1.2	
Area II					
Boat	-	-	12	-	-
Bank	7	1	-	-	-
Total	7	1	12	-	-
Fish/hr	.082	.012	.14		
Percentage	35.0	5.0	60.0		
Area III					
Boat	-	-	-	-	-
Bank	1	6	1	-	-
Total	1	6	1	-	-
Fish/hr	.004	.024	.004	-	-
Percentage	1.3	7.8	1.3		
Grand Total					
Boat	-	-	18	-	-
Bank	103	13	17	2	-
Total	103	13	35	2	-
Fish/hr	.15	.019	.050	.003	
Percentage	39.1	4.9	13.3	0.8	
Spillway					
Bank	164	-	13	-	19 WF
Fish/hr	1.41		.11		.16
Percentage	82.8		6.6		9.6

[a/] WF = Whitefish

Appendix C-3. The catch, catch rate (fish/hr) and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, June 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout: Catchable LV	Catchable RV	Fingerling Green	Fingerling Red	Fingerling Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I															
Boat	105	345	-	2	-	-	-	3	8	-	-	-	-	-	-
Bank	564	1262	-	-	-	-	-	9	38	7	-	-	-	-	16
Total	669	1607	-	2	-	-	-	12	46	7	-	-	-	-	16
Fish/hr				.001				.007	.029	.004					.010
Percentage				0.2				1.0	3.9	0.6					1.4
Area II															
Boat	111	609	-	9	-	-	-	29	47	7	-	-	-	-	14
Bank	38	101	-	-	-	-	-	-	1	-	-	-	-	-	-
Total	149	710	-	9	-	-	-	29	48	7	-	-	-	-	14
Fish/hr				.013				.041	.068	.010					.020
Percentage				1.8				5.7	9.4	1.4					2.7
Area III															
Boat	13	32	-	1	-	-	-	-	-	-	-	-	-	-	1
Bank	321	427	-	55	-	-	-	12	9	1	-	-	-	-	4
Total	334	459	-	56	-	-	-	12	9	1	-	-	-	-	5
Fish/hr				.12				.026	.020	.002					.011
Percentage				25.8				5.5	4.1	0.5					2.3
Grand Total															
Boat	229	986	-	12	-	-	-	32	55	7	-	-	-	-	15
Bank	923	1790	-	55	-	-	-	21	48	8	-	-	-	-	20
Total	1152	2776	-	67	-	-	-	53	103	15	-	-	-	-	35
Fish/hr				.024				.019	.037	.005					.013
Percentage				3.8				3.0	5.8	0.8					2.0
Spillway															
Bank	637	990	-	21	-	-	-	21	37	14	-	-	-	-	59
Fish/hr				.021				.021	.037	.014					.060
Percentage				1.4				1.4	2.4	0.9					3.8

Appendix C-3 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	867	18	1	-	-
Bank	133	22	25	7	-
Total	1000	40	26	7	-
Fish/hr	.62	.025	.016	.004	
Percentage	86.6	3.5	2.2	0.6	
Area II					
Boat	377	6	7	-	-
Bank	4	6	2	2	-
Total	381	12	9	2	-
Fish/hr	.54	.017	.013	.003	
Percentage	74.5	2.3	1.8	0.4	
Area III					
Boat	-	-	3	-	-
Bank	61	4	57	9	-
Total	61	4	60	9	-
Fish/hr	.13	.009	.13	.020	
Percentage	28.2	1.8	27.7	4.1	
Grand Total					
Boat	1124	24	11	-	-
Bank	198	32	84	18	-
Total	1322	56	95	18	-
Fish/hr	.48	.020	.034	.006	
Percentage	75.0	3.2	5.4	1.0	
Spillway	-				
Bank	1281	2	17	26	2CT, 61WF
Fish/hr	1.29	.002	.017	.026	.002, .061
Percentage	83.2	0.1	1.1	1.7	0.1, 3.9

[a/] WF = Whitefish, CT = Cutthroat trout

Appendix C-4. The catch, catch rate (fish/hr) and percentage of various species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, July 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout: Catchable LV	Catchable RV	Fingerling Green	Fingerling Red	Fingerling Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I															
Boat	443	1330	-	20	-	-	-	4	33	-	-	2	4	-	12
Bank	741	1483	-	12	-	-	-	2	11	-	-	-	-	-	14
Total	1184	2813	-	32	-	-	-	6	44	-	-	2	4	-	26
Fish/hr				.011				.002	.016				.002		.009
Percentage				1.0				0.2	1.3				0.2		0.8
Area II															
Boat	542	1946	-	44	-	-	-	8	61	4	2	4	2	-	32
Bank	81	100	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	623	2046	-	44	-	-	-	8	61	4	2	4	2	-	32
Fish/hr				.022				.004	.030	.002			.004		.016
Percentage				1.7				0.3	2.4	0.2			0.3		1.3
Area III															
Boat	133	400	-	21	-	-	-	-	5	1	-	-	-	-	2
Bank	805	1267	-	42	-	-	-	1	3	3	1	-	-	-	4
Total	938	1667	-	63	-	-	-	1	8	4	1	-	-	-	6
Fish/hr				.050				.001	.006	.003			.001		.005
Percentage				5.7				0.1	0.7	0.4			0.1		0.5
Grand Total															
Boat	1118	3676	-	85	-	-	-	12	99	5	2	6	6	-	46
Bank	1627	2850	-	54	-	-	-	3	14	3	1	-	-	-	18
Total	2745	6526	-	139	-	-	-	15	113	8	3	6	6	-	64
Fish/hr				.021				.002	.017	.001			.002		.010
Percentage				2.0				0.2	1.6	0.1			0.2		0.9
Spillway															
Bank	682	954	-	11	-	-	-	3	13	1	-	-	-	-	3
Fish/hr				.012				.003	.014	.001					.003
Percentage				0.7				0.2	0.9	0.1					0.2

Appendix C-4 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	2868	13	9	-	-
Bank	199	22	42	4	-
Total	3067	35	51	4	-
Fish/hr	1.09	.012	.018	.001	
Percentage	93.7	1.1	1.6	0.1	
Area II					
Boat	2264	11	21	-	-
Bank	44	24	10	-	-
Total	2308	35	31	-	-
Fish/hr	1.13	.017	.015		
Percentage	91.2	1.4	1.2		
Area III					
Boat	399	-	4	2	-
Bank	512	30	77	5	1BK
Total	911	30	81	7	1BK
Fish/hr	.72	.024	.064	.006	.001
Percentage	81.8	2.7	7.3	0.6	0.1
Grand Total					
Boat	5531	24	34	2	-
Bank	755	76	129	9	1BK
Total	6286	100	163	11	1
Fish/hr	.96	.015	.025	.002	-
Percentage	91.0	1.4	2.4	0.2	-
Spillway					
Bank	1428	1	18	7	12WF, 2PKS
Fish/hr	1.50	.001	.019	.007	.013 , .002
Percentage	95.2	0.1	1.2	0.5	0.8 , 0.1

[a/] BK = Brooktrout, WF = Whitefish, PKS = Pumpkinseed Sunfish

Appendix C-5. The catch, catch rate (fish/hr) and percentage of various species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, August 1980.

Area Fished	No. of Anglers	Hours Fished	Rainbow trout								Coho salmon				
			Catchable		Fingerling			Other							
			LV	RV	Green	Red	Yellow	No dorsal	Bent ray	Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Area I															
Boat	235	572	-	2	-	-	-	-	2	1	-	-	-	-	3
Bank	306	438	-	2	-	-	1	-	-	-	-	-	-	-	4
Total	541	1010	-	4	-	-	1	-	2	1	-	-	-	-	7
Fish/hr				.004			.001		.002	.001					.007
Percentage				0.3			0.1		0.1	0.1					0.5
Area II															
Boat	444	1337	-	13	-	-	-	-	11	1	-	-	1	-	4
Bank	27	68	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	471	1405	-	13	-	-	-	-	11	1	-	-	1	-	4
Fish/hr				.009					.008	.001			.001		.003
Percentage				0.5					0.4	-			-		0.2
Area III															
Boat	207	497	-	17	-	-	-	1	4	3	1	-	-	-	29
Bank	255	412	-	6	-	-	-	-	4	1	-	-	-	-	1
Total	462	909	-	23	-	-	-	1	8	4	1	-	-	-	30
Fish/hr				.025				.001	.009	.004			.001		.033
Percentage				5.0				0.2	1.7	0.9			0.2		6.5
Grand Total															
Boat	886	2406	-	32	-	-	-	1	17	5	1	-	1	-	36
Bank	588	918	-	8	-	-	1	-	4	1	-	-	-	-	5
Total	1474	3324	-	40	-	-	1	1	21	6	1	-	1	-	41
Fish/hr				.012			-	-	.006	.002			.001		.012
Percentage				0.9			-	-	0.5	0.1			-		0.9
Spillway															
Bank	162	211	-	-	-	-	-	-	1	1	-	-	-	-	-
Fish/hr									.005	.005					
Percentage									0.3	0.3					

Appendix C-5 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	1127	5	2	-	-
Bank	138	20	16	1	-
Total	1265	25	18	1	-
Fish/hr	1.25	.025	.018	.001	
Percentage	95.5	1.9	1.4	0.1	
Area II					
Boat	2611	7	15	1	1PKS
Bank	17	1	4	-	-
Total	2628	8	19	1	1
Fish/hr	1.87	.006	.014	.001	.001
Percentage	97.9	0.3	0.7	-	-
Area III					
Boat	233	-	3	-	-
Bank	141	10	6	-	-
Total	374	10	9	-	-
Fish/hr	.41	.011	.010		
Percentage	81.3	2.2	2.0		
Grand Total					
Boat	3971	12	20	1	1PKS
Bank	296	31	26	1	-
Total	4267	43	46	2	1
Fish/hr	1.28	.013	.014	.001	-
Percentage	95.6	1.0	1.0	-	-
Spillway	-				1RSS
Bank	361	-	2	1	1WF, 1PKS
Fish/hr	1.71		.009	.005	.005
Percentage	97.8		0.6	0.3	0.3

[a/] PKS = Pumpkinseed sunfish, WF = Whitefish, RSS = Redside shiner

Appendix C-6. The catch, catch rate (fish/hr) and percentage of various species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, September 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout: Catchable LV	Catchable RV	Fingerling Green	Fingerling Red	Fingerling Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I															
Boat	113	342	3	13	-	-	-	3	6	1	8	-	9	6	-
Bank	293	960	1	6	-	-	-	9	25	3	-	-	-	-	-
Total	406	1302	4	19	-	-	-	12	31	4	8	-	9	6	-
Fish/hr			.003	.014				.009	.024	.003			.018		
Percentage			1.0	4.6				2.9	7.5	1.0			5.6		
Area II															
Boat	213	604	-	17	-	-	-	2	9	1	3	2	3	2	5
Bank	45	73	12	-	-	-	-	1	4	-	-	-	-	-	-
Total	258	677	12	17	-	-	-	3	13	1	3	2	3	2	5
Fish/hr			.018	.025				.004	.019	.001			.015		.007
Percentage			1.6	2.2				0.4	1.7	0.1			1.3		0.6
Area III															
Boat	68	178	-	7	-	-	-	-	9	4	-	-	-	1	8
Bank	260	768	51	17	2	-	-	4	25	9	-	-	-	-	8
Total	328	946	51	24	2	-	-	4	34	13	-	-	-	1	16
Fish/hr			.054	.025	.002			.004	.036	.014			.001		.017
Percentage			14.1	6.6	0.6			1.1	9.4	3.6			0.3		4.4
Grand Total															
Boat	394	1124	3	37	-	-	-	5	24	6	11	2	12	9	13
Bank	598	1801	67	23	2	-	-	14	54	12	-	-	-	-	8
Total	992	2925	70	60	2	-	-	19	78	18	11	2	12	9	21
Fish/hr			.024	.020	.001			.006	.027	.006			.012		.007
Percentage			4.5	3.9	0.1			1.2	5.0	1.2			2.2		1.4
Spillway															
Bank	28	24	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr															
Percentage															

Appendix G-6 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	229	1	9	2	1KOK
Bank	48	6	3	22	-
Total	277	7	12	24	1KOK
Fish/hr	.21	.005	.009	.018	.001
Percentage	66.9	1.7	2.9	5.8	0.1
Area II					
Boat	669	6	13	1	-
Bank	16	2	3	-	-
Total	685	8	16	1	-
Fish/hr	1.01	.012	.024	.001	
Percentage	88.9	1.0	2.1	0.1	
Area III					
Boat	16	1	7	-	-
Bank	173	9	10	-	-
Total	189	10	17	-	-
Fish/hr	.20	.011	.018		
Percentage	52.4	2.8	4.7		
Grand Total					
Boat	914	8	29	3	1KOK
Bank	237	17	16	22	-
Total	1151	25	45	25	1KOK
Fish/hr	.39	.009	.015	.009	-
Percentage	74.4	1.6	2.9	1.6	-
Spillway					
Bank	22	-	4	-	-
Fish/hr	.92		.17		
Percentage	84.6		15.4		

[a/] KOK = Kokanee salmon

Appendix C-7. The catch, catch rate (fish/hr) and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, October 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout: Catchable LV	Catchable RV	Fingerlings: Green	Fingerlings: Red	Fingerlings: Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I															
Boat	72	272	-	3	-	-	-	4	2	-	24	16	14	37	1
Bank	282	846	13	12	-	-	5	25	17	6	1	-	-	1	1
Total	354	1118	13	15	-	-	5	29	19	6	25	16	14	38	2
Fish/hr			.012	.013			.004	.026	.017	.005			.083		.002
Percentage			4.9	5.7			1.9	11.0	7.2	2.3			35.1		0.8
Area II															
Boat	90	307	6	11	-	-	-	6	10	1	2	2	4	6	1
Bank	31	141	2	14	-	-	-	9	9	4	-	-	-	-	-
Total	121	448	8	25	-	-	-	15	19	5	2	2	4	6	1
Fish/hr			.018	.056				.033	.042	.011			.031		.002
Percentage			1.9	5.8				3.5	4.4	1.2			3.3		0.2
Area III															
Boat	19	65	2	10	-	-	-	1	4	-	-	1	1	-	1
Bank	226	583	40	19	-	-	-	4	5	11	-	-	-	-	2
Total	245	648	42	29	-	-	-	5	9	11	-	1	1	-	3
Fish/hr			.065	.045				.008	.014	.017			.003		.005
Percentage			25.6	17.7				3.0	5.5	6.7			1.2		1.8
Grand Total															
Boat	181	644	8	24	-	-	-	11	16	1	26	19	19	43	3
Bank	539	1570	55	45	-	-	5	38	31	21	1	-	-	1	3
Total	720	2214	63	69	-	-	5	49	47	22	27	19	19	44	6
Fish/hr			.028	.031			.002	.022	.021	.010			.049		.003
Percentage			7.3	8.0			0.6	5.7	5.5	2.6			12.7		0.7
Spillway															
Bank	56	96	3	-	-	-	-	1	6	3	-	-	1	2	-
Fish/hr			.031					.010	.062	.031			.031		
Percentage			2.4					0.8	4.8	2.4			2.4		

Appendix C-7 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other
Area I					
Boat	19	-	-	-	-
Bank	49	12	-	2	-
Total	68	12	-	2	-
Fish/hr	.061	.011		.002	
Percentage	25.8	4.5		0.8	
Area II					
Boat	340	1	1	-	-
Bank	-	1	-	-	-
Total	340	2	1	-	-
Fish/hr	.76	.004	.002		
Percentage	79.0	0.5	0.2		
Area III					
Boat	3	4	4	-	-
Bank	50	-	2	-	-
Total	53	4	6	-	-
Fish/hr	.082	.006	.009		
Percentage	32.4	2.4	3.7		
Grand Total					
Boat	362	5	5	-	-
Bank	99	13	2	2	-
Total	461	18	7	2	-
Fish/hr	.21	.008	.003	.001	
Percentage	53.8	2.1	0.8	0.2	
Spillway					
Bank	108	-	2	-	-
Fish/hr	1.12		.021		
Percentage	85.6		1.6		

Appendix C-8. The catch, catch rate (fish/hr) and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, November 1980.

Area fished	No. of Anglers	Hours fished	Rainbow trout: Catchable LV	Rainbow trout: Catchable RV	Rainbow trout: Fingerling Green	Rainbow trout: Fingerling Red	Rainbow trout: Fingerling Yellow	Rainbow trout: Other No dorsal	Rainbow trout: Other Bent ray	Rainbow trout: Other Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I															
Boat	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	142	403	24	27	-	1	-	20	35	1	-	-	-	1	-
Total	142	403	24	27	-	1	-	20	35	1	-	-	-	1	-
Fish/hr			.060	.067		.002		.050	.087	.002				.002	
Percentage			22.0	24.8		0.9		18.3	32.2	0.9				0.9	
Area II															
Boat	1	8	-	-	-	-	-	2	-	-	-	-	-	-	-
Bank	9	17	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	10	25	-	-	-	-	-	2	-	-	-	-	-	-	-
Fish/hr								.08							
Percentage								100							
Area III															
Boat	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	82	173	13	15	-	-	-	3	10	2	-	-	-	-	4
Total	83	175	13	15	-	-	-	3	10	2	-	-	-	-	4
Fish/hr			.074	.086				.017	.057	.011					.023
Percentage			26.5	30.6				6.1	20.4	4.1					8.2
Grand Total															
Boat	2	10	-	-	-	-	-	2	-	-	-	-	-	-	-
Bank	233	593	37	42	-	1	-	23	45	3	-	-	-	1	4
Total	235	603	37	42	-	1	-	25	45	3	-	-	-	1	4
Fish/hr			.061	.070		.002		.041	.075	.005			.002		.007
Percentage			23.1	26.3		0.6		15.6	28.1	1.9			0.6		2.5
Spillway															
Bank	8	14	-	-	-	-	-	2	-	-	-	-	-	-	-
Fish/hr								.14							
Percentage								8							

Appendix C-8 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other
Area I					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentate					
Area II					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentage					
Area III					
Boat	-	-	-	-	-
Bank	2	-	-	-	-
Total	2	-	-	-	-
Fish/hr	.011				
Percentage	4.1				
Grand Total					
Boat	-	-	-	-	-
Bank	2	-	-	-	-
Total	2	-	-	-	-
Fish/hr	.003				
Percentage	1.3				
Spillway					
Bank	23	-	-	-	-
Fish/hr	1.64				
Percentage	92				

Appendix C-9. The catch, catch rate (fish/hr) and percentage of various fish species caught by ice and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, December 1980.

Area fished	No. of Anglers	No. of poles	Hours fished	Rainbow trout: Catchable LV	Catchable RV	Fingerling Green	Fingerling Red	Fingerling Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Red	Yellow	Unknown mark	No mark
Area I																
Ice	204	695	473	6	7	-	1	-	1	6	2	42	52	34	215	2
Fish/hr				.013	.015		.002	-	.002	.013	.004			.725		.004
Percentage				1.4	1.7		0.2	-	0.2	1.4	0.5			83.0		0.5
Area II																
Ice	10	20	12	-	-	-	-	-	-	-	-	-	.083	-	-	-
Fish/hr													.029			
Percentage													8.3			
Area III																
Ice	19	38	47	.021	.021	-	-	-	-	-	.021	-	-	-	-	-
Fish/hr				.009	.009						.009					
Percentage				0.9	0.9						0.9					
Grand Total																
Ice	233	753	532	7	8	-	1	-	1	6	3	42	53	34	215	2
Fish/hr				.013	.015		.002		.002	.011	.016			.641		.004
Percentage				1.6	1.9		0.2		0.2	1.4	0.7			80.2		0.5
Spillway																
Bank	26	-	44	2	-	-	-	-	-	2	4	1	1	1	5	-
Fish/hr				.045						.045	.091			.18		
Percentage				2.7						2.7	5.5			11.0		

Appendix C-9 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Ice	44	-	-	-	2KOK
Fish/hr	.093				.004
Percentage	10.6				0.5
Area II					
Ice	11	-	-	-	-
Fish/hr	.917				
Percentage	91.7				
Area III					
Ice	103	-	-	-	-
Fish/hr	2.19				
Percentage	97.2				
Grand Total					
Ice	55	-	-	-	2KOK
Fish/hr	.103				.004
Percentage	12.8				0.5
Spillway					
Bank	56	-	-	-	1BK
Fish/hr	1.27				.023
Percentage	76.7				1.4

[a/] KOK = Kokanee salmon, BK = Brooktrout

Appendix C-10. The catch, catch rate (fish/hr) and percentage of various fish species caught by ice and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, January 1981.

Area fished	No. of anglers	No. of poles	Hours fished	Rainbow trout: Catchable LV	Rainbow trout: Catchable RV	Rainbow trout: Fingerling Green	Rainbow trout: Fingerling Red	Rainbow trout: Fingerling Yellow	Rainbow trout: Other No dorsal	Rainbow trout: Other Bent ray	Rainbow trout: Other Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I																
Ice	110	488	427	3	8	-	-	-	3	1	-	11	13	17	152	-
Fish/hr				.007	.019				.007	.001			.452			
Percentage				0.9	2.5				0.9	0.3			61.2			
Area II																
Ice	8	32	26	-	3	-	-	-	3	-	-	-	2	-	5	-
Fish/hr					.115				.115				.269			
Percentage					3.7				3.7				8.6			
Area III																
Ice	16	56	53	1	-	-	-	-	-	1	-	-	-	-	-	-
Fish/hr				.019						.019						
Percentage				1.6						1.6						
Grand Total																
Ice	134	576	506	4	11	-	-	-	6	2	-	11	15	17	157	-
Fish/hr				.008	.022				.012	.004			.391			
Percentage				0.9	2.4				1.3	0.4			43.7			
Spillway																
Bank	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																
Percentage																

Appendix C-10 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Ice	107	-	-	1	-
Fish/hr	.250			.002	
Percentage	33.9			0.3	
Area II					
Ice	68	-	-	-	-
Fish/hr	2.615				
Percentage	84.0				
Area III					
Ice	60	-	-	-	-
Fish/hr	1.132				
Percentage	96.8				
Grand Total					
Ice	235	-	-	1	-
Fish/hr	.464			.002	
Percentage	51.3			0.2	
Spillway					
Bank	1	-	-	2	1WF
Fish/hr	1.0			2.0	1.0
Percentage	25			50	25

[a/] WF = Whitefish

Appendix C-11. The catch, catch rate (fish/hr) and percentage of various fish species caught by ice and bank anglers in Cascade Reservoir and spillway, Cascade, Idaho, February 1981.

Area fished	No. of anglers	No. of poles	Hours fished	Rainbow trout: Catchable LV	Rainbow trout: Catchable RV	Rainbow trout: Fingerling Green	Rainbow trout: Fingerling Red	Rainbow trout: Fingerling Yellow	Other: No dorsal	Other: Bent ray	Other: Good dorsal	Coho salmon: Green	Coho salmon: Red	Coho salmon: Yellow	Coho salmon: Unknown mark	Coho salmon: No mark
Area I																
Ice	120	465	112	3	9	1	-	-	1	8	-	7	11	9	38	1
Fish/hr				.027	.080	.009			.009	.071				.580		.009
Percentage				2.7	8.1	0.9			0.9	7.2				58.6		0.9
Area II																
Ice	3	14	9	-	-	-	-	-	-	1	-	-	-	-	-	-
Fish/hr										.011						
Percentage										5.6						
Area III																
Ice	14	50	12	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																
Percentage																
Grand Total																
Ice	137	529	133	3	9	1	-	-	1	9	-	7	11	9	38	1
Fish/hr				.022	.068	.008			.008	.068				.489		.008
Percentage				1.2	3.8	0.4			0.4	3.8				27.1		0.4
Spillway																
Bank	14	-	20	-	-	-	-	-	-	-	5	-	-	-	-	-
Fish/hr											.25					
Percentage											13.5					

Appendix C-11 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Ice	20	-	3	-	-
Fish/hr	.178		.027		
Percentage	18 0		2.7		
Area II					
Ice	17	-	-	-	-
Fish/hr	1.889				
Percentage	94.4				
Area III					
Ice	110	-	1	-	-
Fish/hr	9.167		.083		
Percentage	99.1		0.9		
Grand Total					
Ice	147	-	4	-	-
Fish/hr	1.105		.030		
Percentage	61.1		1.8		
Spillway					
Bank	30	-	-	-	2CT
Fish/hr	1.5				.10
Percentage	81.1				5.4

[a/] CT = Cutthroat trout

Appendix C- 12. The catch, catch rate (fish/hr), and percentage of various fish species caught by ice anglers in Cascade Reservoir, Idaho, March 1981.

Area fished	No. of anglers	No. of poles	Hours fished	Rainbow Trout					Other			Coho salmon				
				Catchable		Fingerling										
				LV	RV	Green	Red	Yellow	No dorsal	Bent ray	Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Area I																
Ice	33	-	107	-	-	-	-	-	-	-	-	4	2	1	2	-
Fish/hr												.037	.019	.009	.019	-
Percentage												1.8	0.9	0.4	0.9	-
Area II																
Ice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																
Percentage																
Area III																
Ice	11	-	43	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																
Percentage																
Grand Total																
Ice	44	-	150	-	-	-	-	-	-	-	-	4	2	1	2	-
Fish/hr												.026	.013	.007	.013	-
Percentage												1.3	0.6	0.3	0.6	-

Appendix C-12 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Ice	213	1	-	-	-
Fish/hr	1.990	.009	-	-	-
Percentage	95.5	0.4	-	-	-
Area II					
Ice	-	-	-	-	-
Fish/hr					
Percentage					
Area III					
Ice	83	-	3	-	-
Fish/hr	1.930	-	0.70	-	-
Percentage	96.5	-	3.5	-	-
Grand Total					
Ice	296	1	3	-	-
Fish/hr	1.973	.007	.020	-	-
Percentage	95.8	0.3	1.0	-	-

Appendix C-13. The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir March 1981.

Area Fished	No.of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green	Red	Yellow	Unknown mark	No Mark
Area I																		
Boat	6	30	-	-	-	-	2	-	-	-	-	-	-	-	-	-	9	-
Bank	26	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1
Total	32	90	-	-	-	-	2	-	-	-	-	-	-	-	-	-	14	1
Fish/hr							.022										.156	.011
Percentage							11.8										82.3	5.9
Area II																		
Boat	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																		
Percentage																		
Area III																		
Boat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	48	88	-	4	-	4	1	-	-	-	-	1	3	-	-	-	-	-
Total	48	88	-	4	-	4	1	-	-	-	-	1	3	-	-	-	-	-
Fish/hr				.046		.046	.011					.011	.034					
Percentage				22.2		22.2	5.6					5.6	16.7					

Appendix C-13 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentage					
Area II					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentage					
Area III					
Boat	-	-	-	-	-
Bank	3	-	2	-	-
Total	3	-	2	-	-
Fish/hr	.034		.023		
Percentage	16.7		11.0		

Appendix C-13 (Cont'd).

Area Fished	No.of anglers	Hours fished	Rainbow trout: Catchable: LV: 81	LV: 80	RV: 81	RV: 80	No dorsal	Fingerling: Green	Red: 81	Red: 80	Yellow	Other: Bent rays	Other: Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Grand Total																		
Boat	9	33	-	-	-	-	2	-	-	-	-	-	-	-	-	-	9	-
Bank	74	148	-	4	-	4	1	-	-	-	-	1	3	-	-	-	5	1
Total	83	181	-	4	-	4	3	-	-	-	-	1	3	-	-	-	14	1
Fish/hr				.022		.022	0.16					.006	0.16				.077	.006
Percentage				11.4		11.4	8.6					2.8	8.6				40.0	2.8
Spillway																		
Bank	45	64	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr						.016												
Percentage						0.4												

Appendix C-13 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	-	-	-	-	-
Bank	3	-	2	-	-
Total	3	-	2	-	-
Fish/hr	.016		.011		
Percentage	8.6		5.7		
Spillway	291	-	-	-	16WF;1 KOK
Fish/hr	4.58				0.250 .016
Percentage	99.6				

a/ WF-Whitefish
KOK-Kokanee

Appendix C-14. The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir April 1981.

Area Fished	No.of anglers	Hours fished	Rainbow trout																Brook trout				Kokanee salmon
			Catchable					Fingerling				Other											
			LV		RV		No		Red			Bent	Good										
			81	80	81	80	dorsal	Green	81	80	Yellow	rays	dorsal	Green	Red	Yellow	Unknown mark	No mark	Green	Red	Yellow	Unknown mark	No mark
Area I																							
Boat	12	27	-	1	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Bank	150	570	-	3	-	24	8	-	-	1	1	3	2	-	2	1	1	1	-	-	-	-	-
Total	162	597	-	3	-	25	8	-	-	1	1	3	2	-	2	2	2	1	-	-	-	-	-
Fish/hr				.005	-	.042	.013	-	-	.002	.002	.005	.003	-	.003	.003	.003	.002					
Percentage				3.3		27.8	8.9			1.1	1.1	3.3	2.2		2.2	2.2	2.2	1.1					
Area II																							
Boat	13	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Bank	35	90	-	-	3	5	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Total	48	146	-	-	3	5	1	-	-	-	-	1	1	-	-	-	2	-	-	-	-	-	-
Fish/hr					.020	.034	.007					.007	.007				.014						
Percentage					5.8	9.6	1.9					1.9	1.9				3.8						

Appendix C-14 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	1	-	-	-	-
Bank	21	-	12	6	-
Total	22	-	12	6	-
Fish/hr	.037		.020	.010	
Percentage	24.4		13.3	6.7	
Area II					
Boat	17	15	1	-	-
Bank	1	-	3	2	-
Total	18	15	4	2	-
Fish/hr	.123	.102	.027	.014	-
Percentage	34.6	28.8	7.7	3.8	

Appendix C-14 (Continued). The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, April 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Area III																		
Boat	20	76	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Bank	146	408	-	-	-	58	6	-	-	-	-	2	2	-	-	-	-	-
Total	166	484	-	-	-	62	6	-	-	-	-	2	2	-	-	-	-	-
Fish/hr						.128	.012					.004	.004					
Percentage						50.8	4.9					1.6	30.3					
Grand Total																		
Boat	45	159	-	-	-	5	-	-	-	-	-	-	-	-	-	1	3	-
Bank	331	1,068	-	3	3	87	15	-	-	1	1	6	5	-	2	1	1	1
Total	376	1,227	-	3	3	92	15	-	-	1	1	6	5	-	2	2	4	1
Fish/hr				.002	.002	.075	.012			.001	.001	.005	.004		.002	.002	.003	.001
Percentage				1.1	1.1	34.8	5.7			0.4	0.4	2.3	1.9		0.7	0.7	1.5	0.7
Spillway																		
Bank	34	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																		
Percentage																		

Appendix C-14 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area III					
Boat	4	-	2	-	-
Bank	33	-	10	1	-
Total	37	-	12	1	-
Fish/hr	.076		.025	.002	
Percentage	9.8		9.8	0.8	
Grand Total					
Boat	22	15	3	-	-
Bank	55	-	25	9	-
Total	77	15	28	9	-
Fish/hr	.063	.012	.023	.007	-
Percentage	29.2	5.7	10.6	3.4	
Spillway					
Bank	69	-	-	1	5 WF
Fish/hr	1.47		-	.021	.106
Percentage	92.0			1.3	6.7

a/ WF-whitefish

Appendix C-15. The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir, May 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green	Red	Yellow	Unknown mark	No mark
Area I																		
Boat	140	319	-	3	1	2	3	-	-	1	-	10	2	12	16	27	43	1
Bank	149	389	-	1	2	1	2	-	-	-	-	5	1	23	32	8	58	-
Total	289	708	-	4	3	3	5	-	-	1	-	15	3	35	48	35	101	1
Fish/hr				.006	.004	.004	.007			.001		.021	.004	.049	.068	.049	.143	.001
Percentage				1.1	0.9	0.9	1.4			0.3		4.3	0.9	10.0	13.8	10.0	29.0	0.3
Area II																		
Boat	52	150	0	2	1	2	2	-	-	-	1	2	2	3	9	5	8	-
Bank	14	25	-	-	2	1	-	-	-	-	-	-	-	2	-	1	16	-
Total	66	175	-	2	3	3	2	-	-	-	1	2	2	5	9	6	24	-
Fish/hr				.011	.017	.017	.011				.006	.011	.011	.028	.051	.034	.137	
Percentage				2.5	3.8	3.8	2.5				1.2	2.5	2.5	6.2	11.2	7.5	30.0	

Appendix C-15 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	6	18	17	-	-
Bank	43	-	9	1	-
Total	49	18	26	1	-
Fish/hr	.069	.025	.037	.001	
Percentage	14.1	5.2	7.5	0.3	
Area II					
Boat	7	-	6	1	-
Bank	3	-	3	1	-
Total	10	-	9	2	-
Fish/hr	.057		.051	.011	
Percentage	12.5		11.2	2.5	

Appendix C-15 (Continued). The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, May 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable LV 81	Catchable LV 80	Catchable RV 81	Catchable RV 80	Catchable dorsal	Fingerling Green	Fingerling Red 81	Fingerling Red 80	Fingerling Yellow	Other Bent rays	Other Good dorsal	Other Green	[illegible]ed	Yellow	Unknown mark	No mark
Area III																		
Boat	80	228	-	7	5	5	7	-	-	-	-	10	6	7	8	6	13	-
Bank	67	328	-	1	-	9	-	-	-	-	-	-	2	1	-	-	-	-
Total	147	556	-	8	5	14	7	-	-	-	-	10	8	8	8	6	13	-
Fish/hr				.014	.009	.025	.012					.018	.014	.014	.0[illegible]4	.011	.023	
Percentage				2.2	1.4	3.9	1.9					2.8	2.2	2.2	[illegible]2	1.6	3.6	
Grand Total																		
Boat	272	697	-	12	7	9	12	-	-	1	1	22	10	22	[illegible]3	38	64	1
Bank	230	742	-	2	4	11	2	-	-	-	-	5	3	26	[illegible]2	9	74	-
Total	502	1,439	-	14	11	20	14	-	-	1	1	27	13	48	[illegible]5	47	138	1
Fish/hr				.010	.008	.014	.010			.001	.001	.019	.009	.033	.0[illegible]5	.033	.096	.001
Percentage				1.8	1.4	2.5	1.8			0.1	0.1	3.4	1.6	6.1	[illegible].2	5.9	17.5	0.1
Spillway																		
Bank	46	48	-	-	-	-	-	-	-	-	-	-	1	-	2	-	18	-
Fish/hr													.021		.042		.375	
Percentage													2.4		4.8		42.8	

Appendix C-15 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area III					
Boat	150	-	9	1	1 KOK
Bank	84	10	17	2	1 BK
Total	234	10	26	3	1KOK; 1 BK
Fish/hr	.421	.018	.047	.005	.002 .002
Percentage	64.6	2.8	7.2	0.8	0.3 0.3
Grand Total					
Boat	163	18	32	2	1 KOK
Bank	130	10	29	4	1 BK
Total	293	28	61	6	1 KOK; 1 BK
Fish/hr	.204	.019	.042	.004	.001 .001
Percentage	37.1	3.5	7.7	0.8	0.1 0.1
Spillway					
Bank	12	-	7	-	1 BK; 1 WF
Fish/hr	.250		.146		.021 .021
Percentage	28.6		16.7		2.4 2.4

a/ KOK-Kokanee; BK-Brook trout; WF-Whitefish.

Appendix C-16. The catch, catch rate (fish/hr) and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, June 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable LV 81	Catchable LV 80	Catchable RV 81	Catchable RV 80	Catchable No dorsal	Fingerling Green	Fingerling Red 81	Fingerling Red 80	Fingerling Yellow	Other Recent clays	Other Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark	No mark
Area I																					
Boat	258	694	-	3	5	6	2	-	-	-	-	14	2	-	3	-	3	-	5	34	-
Bank	521	1,115	-	1	5	3	1	-	2	-	-	15	-	-	18	-	33	-	37	154	-
Total	779	1,809	-	4	10	9	3	-	2	-	-	29	2	-	21	-	36	-	42	183	-
Fish/hr				.002	.006	.005	.002		.001			.016	.001		.012		.020		.023	.104	
Percentage				0.2	0.4	0.4	0.1		0.1			1.3	0.1		0.9		1.6		1.8	8.2	
Area II																					
Boat	219	772	-	7	28	13	9	-	1	-	-	29	5	-	37	-	32	-	34	107	-
Bank	97	221	-	-	-	1	4	-	-	-	-	5	1	-	3	-	4	-	-	3	-
Total	316	993	-	7	28	14	13	-	1	-	-	34	6	-	40	-	36	-	34	110	-
Fish/hr				.007	.028	.014	.013		.001			.034	.006		.040		.036		.034	.111	
Percentage				0.7	2.9	1.4	1.4		0.1			3.5	0.6		4.2		3.8		3.5	11.4	
Area III																					
Boat	275	895	-	10	18	18	6	-	-	-	-	26	4	1	35	-	22	1	30	91	2
Bank	245	443	-	-	1	-	1	-	-	-	-	1	3	-	2	-	1	-	3	4	-
Total	520	1,338	-	10	19	18	7	-	-	-	-	27	7	1	37	-	23	1	33	95	2
Fish/hr				.007	.014	.013	.005					.020	.005	.001	.028		.017	.001	.025	.071	.001
Percentage				1.4	2.6	2.5	1.0					3.7	1.0	0.1	5.1		3.2	0.1	4.5	13.0	0.3

Appendix C-16 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	1,653	1	3	8	3KOK;2?RB
Bank	271	-	7	5	-
Total	1,924	1	10	13	3KOK;2?RB
Fish/hr	1.06	.001	.006	.007	.002;.001
Percentage	83.7	0.0	0.4	0.6	0.1; 0.1
Area II					
Boat	490	1	8	-	5 KOK
Bank	130	-	2	1	-
Total	620	1	10	1	5 KOK
Fish/hr	.624	.001	.010	.001	.005
Percentage	64.6	0.1	1.0	0.1	0.5
Area III					
Boat	161	1	26	-	4KOK;5?RB
Bank	194	9	46	3	-
Total	355	10	72	3	4KOK;5?RB
Fish/hr	.265	.007	.054	.002	.003;.004
Percentage	48.7	1.4	9.9	0.4	0.5; 0.7

Appendix C-16 (Continued). The catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, June 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark	No mark
Grand Total																					
Boat	752	2,361	-	20	51	37	17	-	1	-	-	69	11	1	75	-	57	1	69	232	2
Bank	863	1,779	-	1	6	4	6	-	2	-	-	21	4	-	23	-	38	-	40	161	-
Total	1,615	4,140	-	21	57	41	23	-	3	-	-	90	15	1	98	-	95	1	109	393	2
Fish/hr				.005	.014	.010	.006		.001			.022	.004	.000	.024	.023		.000	.026	.095	.000
Percentages				0.5	1.4	1.0	0.6		0.1			2.2	0.4	0.0	2.4	2.4		0.0	2.7	9.8	0.0
Spillway																					
Bank	319	478	-	1	15	-	1	-	2	-	-	9	4	-	20	-	43	1	46	214	-
Fish/hr				.002	.031		.002		.004			.019	.008		.058	.090		.002	.096	.448	
Percentage				0.1	2.1		0.1		0.3			1.2	0.6		3.9	6.0		0.1	6.4	29.7	

Appendix C-16 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	2,304	3	37	8	12KOK;7?RB
Bank	595	9	55	9	-
Total	2,899	12	92	17	12KOK;7?RB
Fish/hr	.700	.003	.022	.004	.003 ;.002
Percentage	72.7	0.3	2.3	0.4	0.3 0.2
Spillway					
Bank	326	1	17	1	10WF;2RSS
Fish/hr	.682	.002	.036	.002	.021;.004
Percentage	45.2	0.1	2.4	0.1	1.4 ; 0.3

a/ KOK-Kokanee; ?RB-Rainbow trout with unknown mark; WF-Whitefish; RSS-Redside shiner.

Appendix C-17. Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, July 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Area I																						
Boat	353	986	-	2	9	4	-	-	-	-	-	13	1	-	6	1	8	1	11	4	31	-
Bank	266	670	-	-	1	-	2	-	-	-	-	4	-	-	-	-	-	-	-	1	3	-
Total	619	1,656	-	2	10	4	2	-	-	-	-	17	1	-	6	1	8	1	11	5	34	-
Fish/hr				.001	.006	.002	.001					.010	.001		.004		.001	.005	.001	.007	.003	.020	
Percentage				0.1	0.5	0.2	0.1					0.8	0.0		0.3		0.0	0.4	0.0	0.5	0.2	1.6	
Area II																						
Boat	411	1,235	-	8	31	5	10	-	2	-	-	13	9	1	21	2	17	2	31	10	130	-
Bank	127	339	-	-	-	1	2	-	-	-	-	9	1	-	-	-	-	-	1	-	7	-
Total	538	1,574	-	8	31	6	12	-	2	-	-	22	10	1	21	2	17	2	32	10	137	-
Fish/hr				.005	.020	.004	.008		.001			.014	.006	.001	.013	.001	.013	.001	.020	.006	.087	
Percentage				0.5	2.1	0.4	0.8		0.1			1.5	0.7	0.1	1.4	0.1	1.1	0.1	2.1	0.7	9.2	

Appendix C-17 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	1,473	3	17	3	1 KOK
Bank	437	7	20	2	-
Total	1,910	10	37	5	1 KOK
Fish/hr	1.15	.006	.022	.003	.001
Percentage	92.5	0.5	1.8	0.2	0.0
Area II					
Boat	966	-	35	3	3KOK
Bank	171	2	4	-	-
Total	1,137	2	39	3	3KOK
Fish/hr	.722	.001	.025	.002	.002
Percentage	76.0	0.1	2.6	0.2	0.2

Appendix C-17 (Continued). Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, July 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling Green	Fingerling Red 81	Red 80	Yellow	Other: Bent rays	Other: Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Boat	701	2,159	-	5	21	5	7	-	1	-	-	11	6	-	48	2	31	2	62	12	400	-
Bank	230	375	-	-	-	-	-	-	-	-	-	-	-	1	2	-	4	-	-	4	3	-
Total	931	2,534	-	5	21	5	7	-	1	-	-	11	6	1	50	2	35	2	62	16	403	-
Fish/hr				.002	.008	.002	.003		.000			.004	.002	.000	.020	.001	.014	.001	.024	.006	.159	
Percentage				0.2	0.9	0.2	0.3		0.0			0.5	0.3	0.0	2.2	0.1	1.6	0.1	2.8	0.7	18.0	
Grand Total																						
Boat	1,465	4,380	-	15	61	14	17	-	3	-	-	37	16	1	75	5	56	5	104	26	561	-
Bank	623	1,384	-	-	1	1	4	-	-	-	-	13	1	1	2	-	4	-	1	5	13	-
Total	2,088	5,764	-	15	62	15	21	-	3	-	-	50	17	2	77	5	60	5	105	31	574	-
Fish/hr				.003	.011	.003	.004		.000			.009	.003	.000	.013	.001	.010	.001	.018	.005	.100	-
Percentage				0.2	1.1	0.2	0.4		0.0			0.9	0.3	0.0	1.3	0.1	1.0	0.1	1.8	0.5	9.9	-
Spillway																						
Bank	78	95	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-
Fish/hr												.010	.021									
Percentage												0.7	1.4									

Appendix C-17 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Boat	1,275	-	53	7	1 KOK
Bank	227	23	27	-	-
Total	1,502	23	80	7	1 KOK
Fish/hr	.593	.009	.032	.003	.000
Percentage	67.0	1.0	3.6	0.3	0.0
Grand Total					
Boat	3,714	3	105	13	5 KOK
Bank	835	32	51	2	-
Total	4,549	35	156	15	5 KOK
Fish/hr	.789	.006	.027	.003	.001
Percentage	78.4	0.6	2.7	0.3	0.1
Spillway					
Bank	125	-	12	-	1 WF; 1 RSS
Fish/hr	1.32		.126		.010; .010
Percentage	88.0		8.4		0.7 0.7

a/ KOK-Kokanee; WF-Whitefish; RSS-Redside shiner.

Appendix C-18. Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, August 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Other: Cool dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Area I																						
Boat	113	268	-	1	1	-	-	-	-	-	-	-	2	1	11	2	7	5	4	15	19	-
Bank	57	101	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	-
Total	170	369	-	1	1	-	-	-	-	-	-	1	2	1	11	2	7	5	4	15	22	-
Fish/hr				.003	.003							.003	.005	.003	.030	.005	.019	.014	.011	.041	.060	
Percentage				0.3	0.3							0.3	0.6	0.3	3.2	0.6	2.0	1.4	1.2	4.4	6.4	
Area II																						
Boat	92	286	-	-	5	-	-	-	1	-	-	-	1	2	-	4	4	2	1	7	7	-
Bank	11	24	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	2	-
Total	103	310	-	-	5	-	-	-	2	-	-	-	1	2	-	4	5	2	2	7	9	-
Fish/hr					.016				.006				.003	.006		.013	.016	.006	.006	.022	.029	
Percentage					0.8				0.3				0.2	0.3		0.6	0.8	0.3	0.3	1.1	1.4	
Area III																						
Boat	166	512	-	1	15	-	1	-	-	-	-	1	3	1	1	2	1	-	-	1	11	-
Bank	114	218	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	3	4	-
Total	280	730	-	1	15	-	1	-	-	-	-	3	3	1	1	2	1	-	2	4	15	-
Fish/hr				.001	.020		.001					.004	.004	.001	.001	.003	.001	.003	.005	.020		
Percentages				0.2	2.9		0.2					0.6	0.6	0.2	0.2	0.4	0.2	0.4	0.8	2.9		

Appendix C-18 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	200	-	1	-	1KOK;1 BC
Bank	64	4	-	1	-
Total	264	4	1	1	1KOK;1 BC
Fish/hr	.715	.011	.003	.003	.003;.003
Percentage	76.7	1.2	0.3	0.3	0.3 0.3
Area II					
Boat	577	1	4	-	2 KOK
Bank	3	-	-	-	-
Total	580	1	4	-	2 KOK
Fish/hr	1.87	.003	.013		.006
Percentage	92.6	0.2	0.6		0.3
Area III					
Boat	360	14	35	3	-
Bank	46	2	-	12	-
Total	406	16	35	15	-
Fish/hr	.556	.022	.048	.020	
Percentage	77.9	3.1	6.7	2.9	

Appendix C-18 (Continued). Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, August 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable LV 81	Catchable LV 80	Catchable RV 81	Catchable RV 80	Catchable No dorsal	Fingerling Green	Fingerling Red 81	Fingerling Red 80	Fingerling Yellow	Other Bent rays	Other Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Grand Total																						
Boat	371	1,066	-	1	21	-	1	-	1	-	-	1	6	4	12	8	12	7	5	23	37	-
Bank	182	343	-	1	-	-	-	-	1	-	-	3	-	-	-	-	1	-	-	3	9	-
Total	553	1,409	-	2	21	-	1	-	2	-	-	4	6	4	12	8	13	7	5	26	46	-
Fish/hr				.001	.015		.001		.001			.003	.004	.003	.008	.006	.009	.005	.004	.013	.033	
Percentage				0.1	1.4		0.1		0.1			0.3	0.4	0.3	0.8	0.5	0.9	0.5	0.3	1.7	3.1	
Spillway																						
Bank	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																						
Percentage																						

a/ KOK-Kokanee; BC-Black Crappie

Appendix C-18 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	1,137	15	40	3	3KOK;1 BC
Bank	113	6	-	13	-
Total	1,250	21	40	16	3KOK;1 BC
Fish/hr	.887	.015	.028	.011	.002;.001
Percentage	84.1	1.4	2.7	1.1	0.2 0.1
Spillway					
Bank	28	-	-	-	-
Fish/hr	3.5				
Percentage	100.0				

a/ KOK-Kokanee; BC-Black crappie

Appendix C-19. Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, September 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Unknown mark: Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	No mark 81	No mark 80	No mark
Area I																						
Boat	21	62	-	-	2	-	-	-	1	-	-	-	-	-	2	1	-	2	-	-	3	-
Bank	42	152	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	5	-	17	-
Total	63	214	-	-	2	-	1	-	1	-	-	-	-	-	2	1	-	2	5	-	20	-
Fish/hr					.009		.005		.005					.009	.005			.009	.023		.093	
Percentage					2.2		1.1		1.1					2.2	1.1			2.2	5.4		21.7	
Area II																						
Boat	22	69	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	3	-
Bank	18	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	40	113	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	3	-
Fish/hr															.009		.009				.026	
Percentage															0.4		0.4				1.3	
Area III																						
Boat	34	84	-	-	14	2	1	-	-	-	-	2	3	-	-	-	-	-	-	-	1	-
Bank	27	48	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	3	-
Total	61	132	-	-	14	2	1	-	-	-	-	2	3	-	1	-	-	-	1	-	4	-
Fish/hr					.106	.015	.008					.015	.023		.008				.008		.030	
Percentage					15.6	2.2	1.1					2.2	3.3		1.1				1.1		4.4	

Appendix C-19 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	16	-	1	-	-
Bank	39	-	1	1	-
Total	55	-	2	1	-
Fish/hr	.257		.009	.005	
Percentage	59.8		2.2	1.1	
Area II					
Boat	145	-	4	1	-
Bank	77	1	-	-	-
Total	222	1	4	1	-
Fish/hr	1.96	.009	.035	.009	
Percentage	95.7	0.4	1.7	0.4	
Area III					
Boat	23	-	-	-	-
Bank	39	-	-	-	-
Total	62	-	-	-	-
Fish/hr	.470				
Percentage	68.9				

Appendix C-19 (Continued). Catch, catch rate (fish/hr), and percentage of various fish species caught by boat and bank anglers in Cascade Reservoir and spillway, September 1981.

Area Fished	No.of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Other: Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Grand Total																						
Boat	77	215	-	-	16	2	1	-	1	-	-	2	3	-	2	2	-	3	-	-	7	-
Bank	87	244	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	6	-	20	-
Total	164	459	-	-	16	2	2	-	1	-	-	2	3	-	3	2	-	3	6	-	27	-
Fish/hr					.035	.004	.004		.002			.004	.006		.006	.004		.006	.013		.059	
Percentage					3.8	0.5	0.5		0.2			0.5	0.7		0.7	0.5		0.7	1.4		6.5	
Spillway																						
Bank	12	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																						
Percentage																						

Appendix C-19 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	184	-	5	1	-
Bank	155	1	1	1	-
Total	339	1	6	2	-
Fish/hr	.738	.002	.013	.004	
Percentage	81.7	0.2	1.4	0.5	
Spillway					
Bank	42	-	1	1	-
Fish/hr	3.00		.071	.071	
Percentage	95.4		2.3	2.3	

Appendix C-20. Catch, catch rate (fish/hr), and percentage of various fish species caught by anglers in Cascade Reservoir and spillway, October 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Area I																						
Boat	12	43	1	1	4	-	2	-	-	-	1	-	-	3	-	-	-	4	2	2	1	-
Bank	53	118	1	1	-	-	11	-	-	-	-	2	2	-	-	1	2	1	1	-	2	-
Total	65	161	2	2	4	-	13	-	-	-	1	2	2	3	-	1	2	5	3	2	3	-
Fish/hr			.012	.012	.025		.081				.006	.012	.012	.019		.006	.012	.031	.019	.012	.019	
Percentage			4.3	4.3	8.7		28.3				2.2	4.3	4.3	6.5		2.2	4.3	10.9	6.5	4.3	6.5	
Area II																						
Boat	2	2	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Bank	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4	5	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Fish/hr							.200						.200									
Percentage							50.0						50.0									
Area III																						
Boat	7	26	-	-	6	-	-	-	-	-	-	1	1	-	-	1	-	-	-	2	-	-
Bank	64	252	2	1	1	3	1	-	-	1	-	1	2	1	2	-	1	-	-	-	5	-
Total	71	278	2	1	7	3	1	-	-	1	-	2	3	1	2	1	1	-	-	2	5	-
Fish/hr			.007	.004	.025	.011	.004			.004		.007	.011	.004	.007	.004	.004			.007	.018	
Percentage			3.8	1.9	13.5	5.8	1.9			1.9		3.8	5.8	1.9	3.8	1.9	1.9			3.8	9.6	

Appendix C-20 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	-	-	-	-	-
Bank	-	-	1	-	-
Total	-	-	1	-	-
Fish/hr			.006		
Percentage			2.2		
Area II					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentage					
Area III					
Boat	1	-	1	-	-
Bank	1	16	1	-	-
Total	2	16	2	-	-
Fish/hr	.007	.058	.007		
Percentage	3.8	30.8	3.8		

Appendix C-20 (Continued). Catch, catch rate (fish/hr), and percentage of various fish species caught by anglers in Cascade Reservoir and spillway, October 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Grand Total																						
Boat	21	71	1	1	10	-	3	-	-	-	1	1	2	3	-	1	-	4	2	4	1	-
Bank	119	373	3	2	1	3	12	-	-	1	-	3	4	1	2	1	3	1	1	-	7	-
Total	140	444	4	3	11	3	15	-	-	1	1	4	6	4	2	2	3	5	3	4	8	-
Fish/hr			.009	.007	.025	.007	.034			.002	.002	.009	.014	.009	.004	.004	.007	.011	.007	.009	.018	
Percentage			4.0	3.0	11.0	3.0	15.0			1.0	1.0	4.0	6.0	4.0	2.0	2.0	3.0	5.0	3.0	4.0	8.0	
Spillway																						
Bank	16	16	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Fish/hr							.062						.062									
Percentage							1.1						1.1									

Appendix C-20 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	1	-	1	-	-
Bank	1	16	2	-	-
Total	2	16	3	-	-
Fish/hr	.004	.036	.007		
Percentage	2.0	16.0	3.0		
Spillway					
Bank	83	-	2	-	1 BK
Fish/hr	5.19		.125		.062
Percentage	94.3		2.3		1.1

a/ BK-Brook trout

Appendix C-21. Catch, catch rate (fish/hr), and percentage of various fish species caught by anglers in Cascade Reservoir and spillway, November 1981.

Area fished	No. of anglers	Hours fished	Rainbow trout: Catchable: LV 81	LV 80	RV 81	RV 80	No dorsal	Fingerling: Green	Red 81	Red 80	Yellow	Other: Bent rays	Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown Mark 81	Unknown Mark 80	No mark
Area I																						
Boat	8	22	1	-	4	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-
Bank	82	340	8	7	12	3	24	-	2	-	-	4	6	-	-	-	1	-	1	3	6	-
Total	90	362	9	7	16	3	24	-	2	-	-	5	6	-	-	1	1	-	1	5	6	-
Fish/hr			.025	.019	.044	.008	.066		.006			.014	.016			.003	.003		.003	.014	.016	
Percentage			10.1	7.9	18.0	3.4	27.0		2.2			5.6	6.7			1.1	1.1		1.1	5.6	6.7	
Area II																						
Boat	2	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	3	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	5	10	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr			.100		.100																	
Percentage			50.0		50.0																	
Area III																						
Boat	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank	53	166	2	5	6	1	3	-	-	-	-	5	5	-	-	-	-	-	-	-	5	-
Total	55	172	2	5	6	1	3	-	-	-	-	5	5	-	-	-	-	-	-	-	5	-
Fish/hr			.012	.029	.035	.006	.017					.029	.029								.029	
Percentage			4.8	11.9	14.3	2.4	7.1					11.9	11.9								11.9	

Appendix C-21 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Area I					
Boat	1	-	-	-	-
Bank	2	-	-	-	-
Total	3	-	-	-	-
Fish/hr	.008				
Percentage	3.4				
Area II					
Boat	-	-	-	-	-
Bank	-	-	-	-	-
Total	-	-	-	-	-
Fish/hr					
Percentage					
Area III					
Boat	-	-	-	-	-
Bank	7	-	-	2	1 MAC
Total	7	-	-	2	1 MAC
Fish/hr	.070			.012	.006
Percentage	16.7			4.8	2.4

Appendix C-21 (Continued). Catch, catch rate (fish/hr), and percentage of various fish species caught by anglers in Cascade Reservoir and spillway, November, 1981.

Area Fished	No. of anglers	Hours fished	Rainbow trout: Catchable LV 81	Catchable LV 80	Catchable RV 81	Catchable RV 80	Catchable No dorsal	Fingerling Green	Fingerling Red 81	Fingerling Red 80	Fingerling Yellow	Other Bent rays	Other Good dorsal	Green 81	Green 80	Red 81	Red 80	Yellow 81	Yellow 80	Unknown mark 81	Unknown mark 80	No mark
Grand Total																						
Boat	12	30	2	-	5	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-
Bank	138	514	10	12	18	4	27	-	2	-	-	9	11	-	-	-	1	-	1	3	11	-
Total	150	544	12	12	23	4	27	-	2	-	-	10	11	-	-	1	1	-	1	5	11	-
Fish/hr			.022	.022	.042	.007	.050		.004			.018	.020			.002	.002		.002	.009	.020	
Percentage			9.0	9.0	17.3	3.0	20.3		1.5			7.5	8.3			0.8	0.8		0.8	3.8	8.3	
Spillway																						
Bank	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish/hr																						
Percentage																						

Appendix C-21 (Cont'd).

Area fished	Perch	Bullhead	Squawfish	Sucker	Other[a/]
Grand Total					
Boat	1	-	-	-	-
Bank	9	-	-	2	1 MAC
Total	10	-	-	2	1 MAC
Fish/hr	.018			.004	.002
Percentage	7.5			1.5	0.8
Spillway					
Bank	-	-	-	-	-
Fish/hr					
Percentage					

a/ MAC-Mackinaw

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