Dolly Varden and Cutthroat Trout Populations in Auke Lake, Southeast Alaska, during 2000

by

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and

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Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

The Auke Creek weir near Juneau, Alaska, was operated in 2000 to count migrating sea-run Dolly Varden *Salvelinus malma*, cutthroat trout *Oncorhynchus clarki*, and other species of Pacific salmon *Oncorhynchus.* The number of Dolly Varden emigrants 5,254, was the lowest in seven years and less than the 21-year average of 6,383. The number of Dolly Varden immigrants, 3,665, was the lowest observed since accurate immigration counts for this species began in 1997. Average fork length of emigrant Dolly Varden was 259 mm (SD = 70 mm). Emigrant and immigrant wild cutthroat trout counts, 249 and 105, respectively, were the lowest seen since 1993 and since 1997 when fall immigrants were first counted through the weir. Average fork length of emigrant cutthroat trout was 275 mm (SD = 54 mm). The estimated abundance of cutthroat trout ≥180 mm in Auke Lake during May 2000 was 364 (SE = 20), significantly less than estimated in 1999.

Key words: Alaska, Auke Lake, Auke Creek, cutthroat trout, Dolly Varden, sea-run, weir, abundance, length, timing, PIT, VI, tag retention, population estimate, Petersen model, Jolly-Seber model.

INTRODUCTION

The Auke Lake system, north of Juneau, Alaska, has native populations of Dolly Varden *Salvelinus malma;* cutthroat trout *Oncorhynchus clarki;* steelhead *O. mykiss;* and pink *O. gorbuscha*, chum *O. keta*, sockeye *O. nerka,* and coho salmon *O. kisutch*. Chinook salmon *O. tshawytscha* have returned to Auke Creek since 1986 as a result of releases of hatchery smolts in Auke Bay near the mouth of Auke Creek. A weir has been operated on Auke Creek, the outlet stream of Auke Lake, since 1962. A permanent structure was constructed in 1980, and in 1997 the weir was modified to enable it to enumerate, in addition to several other species, all immigrant Dolly Varden and cutthroat trout (Table 1). The Auke Creek database on emigrant and immigrant species is the longest and most complete in Southeast Alaska. The Alaska Department of Fish and Game, Division of Sport Fish (ADF&G), the University of Alaska, Fairbanks (UAF), and the National Marine Fisheries Service (NMFS), fund a seasonal biologist to assist with studies at Auke Creek weir, under an interagency cooperative agreement. Fish data collected at the weir are used as indicators of the health and status of local stocks and help to guide management decisions for the Juneau area. Studies at Auke Creek weir have provided important insights into life history, behavior, age composition, maturity, run timing, and growth of fish present in the Auke Lake system (Neimark 1984a, 1984b; Taylor and Lum 1999, 2000; Lum et al. 1998, 1999, 2000). An annual report for Auke Creek weir summarized the operations and fish counts for 2000 (Taylor and Lum 2001).

DOLLY VARDEN

Dolly Varden have a very complex life history among salmonids (Armstrong and Morrow 1980), and new features are still being learned. Long-term trends in abundance, age structures, growth patterns, and migration timing for Dolly Varden populations in Alaska are largely unknown. Data from the Auke Creek weir help to close this information gap, and the weir provides managers indicators of Dolly Varden population status around Juneau as urban development in this area continues.

Dolly Varden are important in the local Juneau sport fishery and throughout Alaska sport fisheries. Auke Lake provides important over-wintering and rearing habitat for Dolly Varden. Some spawning undoubtedly occurs in the lake system; however, spawner numbers and annual production of smolts remain unknown. Emigrant Dolly Varden at Auke Creek were counted in 1970 and annually since 1980. There were four years in which all, or most, of the emigrant Dolly Varden were fin-marked or tagged when they were captured at Auke Creek weir. Emigrant Dolly Varden were also checked for missing fins and tags, and a subsample (or all) of the emigrants were measured to determine inter- and intra-annual changes in size.

Table 1.–Average number of migrant fish of all species counted at Auke Creek, 1980–2000. Hatchery chinook salmon are not allowed to move above Auke Creek weir.

Annual average	Pink salmon	Coho salmon	Sockeye salmon	Chum salmon	Chinook salmon	Dolly Varden	Cutthroat trout	Steelhead
Emigrating	106,983	6,467	16,647	3,247	0	6,383	249	9[a]
Immigrating	11,632	725	3,450	1,163	218[b]	4,768[a]	285[a]	3[a]

[a] Average of only 1997–2000 weir counts.

[b] Average of 1987–2000 weir counts, fish are sacrificed at the weir.

CUTTHROAT TROUT

Coastal cutthroat trout have a life history that is characterized by a diversity of expressions within individuals and among populations. There can be resident and sea-run cutthroat trout in one population. Resident cutthroat trout spend time in a riverine or lacustrine phase before migrating into inlet streams to spawn, never leaving the freshwater system. Sea-run cutthroat trout typically spend several years in a resident, riverine, or lacustrine phase before migrating to seawater for a period of up to a few months. They return to freshwater to spawn or overwinter, and may repeat this cycle (or a variation) one or more times (Northcote 1997, Trotter 1997). Comprehensive time series of data on the distribution, abundance, age structure, growth, and migration timing are largely absent for this species, as they are for Dolly Varden. Such data are important to understanding the impact that directed fisheries can have on small populations of cutthroat trout (Behnke 1979, Spense 1990, Wright 1992).

Cutthroat trout are caught in Auke Lake through the ice during the winter and from the beach or boats during the remainder of the year (Table 2). Anecdotal information suggests that the cutthroat trout fishery in Auke Lake was more productive than at present. Strategic planning exercises, conducted by ADF&G, in 1989, identified improvement of the cutthroat trout fishery in Auke Lake as a goal to help satisfy the demand for sport fisheries along the Juneau roadside (Schwan 1990). The current research program grew from that planning exercise. The result of this effort is the longest and most complete data set across the range of the species.

The first significant trout tagging program at Auke Creek began in 1994. A mark-recapture program to estimate annual spring or summer abundance in the lake began in 1997. Fish tagged in the lake in the spring of 1997 were recovered by anglers in marine waters over the next few summers, suggesting that Juneau roadside fisheries for anadromous cutthroat trout partly depend on stocks that overwinter or reside in Auke Lake.

Trout research at Auke Creek and Auke Lake, particularly the passive integrated transponder (PIT) tagging program started in 1997, has yielded other valuable information. Growth rates on individual cutthroat trout allow managers to set size-based harvest regulations and describe recruitment into the harvestable size class. Tracking the migration histories of individual fish in and out the lake provides important information on use of the lake as an anadromous rearing area, and ongoing recoveries of tagged fish in local fisheries yield data on saltwater migration patterns and the opportunity to observe the intra- and interannual movements between and within watersheds. As urbanization spreads in the Juneau area, these results will help us to recognize critical habitats and document effects resulting from habitat change.

The purpose of this report is to summarize counts and biological characteristics of Dolly Varden and cutthroat trout at the Auke Creek weir in 2000, as well as results of mark-and-recapture experiments to estimate abundance of cutthroat trout residing in Auke Lake. Our objectives were to:

1. Count emigrant Dolly Varden and cutthroat trout at Auke Creek from March 1 through the end of the emigration (usually June 30);

Table 2–Estimates of sport fishing effort, total catch, and harvest of cutthroat trout and Dolly Varden in the Auke Creek drainage, 1990–-1999. Unpublished mail survey estimates from Research and Technical Services database, ADF&G, Anchorage. All estimates for Auke Creek drainage were derived from low sample sizes and are considered imprecise.

Year	Anglers	Trips	Days	Cutthroat trout		Dolly Varden[a]	
				Catch	Harvest	Catch	Harvest
1990	34	34	34	17	17	0	0
1991	16	33	23	0	0	0	0
1992[b]	75	87	75	18	0	0	0
1993	50	325	271	391	224	49	0
1994	_[c]	_[c]	_[c]	_[c]	_[c]	_[c]	_[c]
1995	29	32	29	26	0	0	0
1996[b]	40	397	375	1,104	0	485	0
1997[b]	45	47	47	16	0	54	0
1998[b]	46	100	113	101	17	177	0
1999	33	12	33	9	0	0	0

[a] Auke Lake is closed to the harvest of Dolly Varden.

[b] Estimates for the years indicated were updated and a change is reflected from previously published materials.

[c] No estimates were made in 1994.

2. Estimate the size composition of Dolly Varden and cutthroat trout emigrants;
3. Count immigrant Dolly Varden and cutthroat trout at Auke Creek from June 30 through the end of the immigration (usually October 30);
4. Measure all tagged cutthroat trout immigrants;
5. Estimate the abundance of cutthroat trout in Auke Lake during late May-early June 2000, using a closed population Petersen model; and
6. Estimate the abundance of cutthroat trout in Auke Lake during spring 1999 using a Jolly-Seber model.

STUDY SITE

The Auke Lake system is a mainland watershed of 1,072 ha located approximately 19 km north of Juneau, Alaska (58°23′, 134°37′), on the Juneau road system. Auke Lake has a surface area of 67 ha and is fed by 5 tributaries. Lake Creek is the largest tributary with a watershed of 648 ha. The greatest depth of Auke Lake is 31 m, and the elevation is approximately 19 m. Auke Creek weir is about 400 m downstream from the lake, at the head of tidewater at Auke Bay (Figure 1). The shoreline of Auke Lake is bordered by forested terrain, which varies from gentle slopes to steep-sided banks. The shoreline zone of water consists of areas dominated by emergent vegetation of *Equisetum* spp. and *Nuphar* spp. and other areas characterized by large numbers of submerged and floating conifers anchored to the lakeshore and bottom by their large root wads.

METHODS

EMIGRANT POPULATIONS

The Auke Creek weir was operated from March 1 through June 29 to intercept all emigrant salmonids. During this time, fish cannot move upstream through the weir. The weir is designed such that water spills through 5 inclined traps and vertical aluminum panels covered with 3-mm perforations that are effective at both high and low flows. Fish and water that exit the inclined traps are diverted through an aluminum trough to a fiberglass holding tank downstream from the weir. A separate water source supplies the holding tank to keep the fish alive. Fish were sorted by species, counted, sampled, tagged and released each day. The fish were not anesthetized.

All Dolly Varden were counted and examined for Floy tags and adipose fin marks. Length compo-
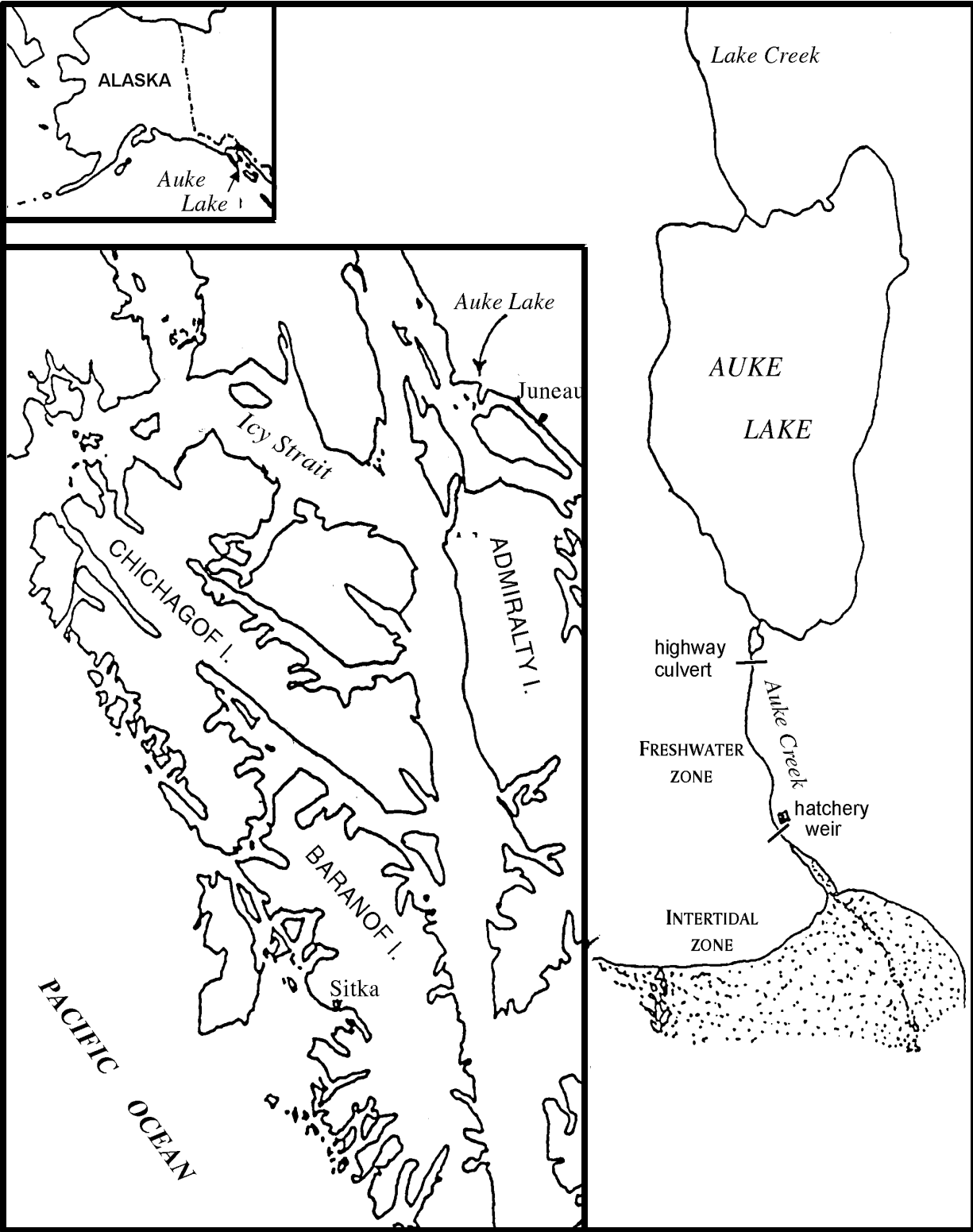
Figure 1.– The Auke Lake system in northern Southeast Alaska and location of the Auke Creek weir.

sition was estimated by using a systematic sampling procedure. Daily, every 10th Dolly Varden captured at the weir was measured to the nearest 5 mm from tip of snout to fork of tail (FL). Average length of Dolly Varden emigrants sampled at the weir was estimated:

$$\bar{y} = \frac{1}{n}(y_1 + y_2 + ... + y_n) = \frac{1}{n}\sum_{i=1}^{n} y_i \qquad (1)$$

where $\bar{y}$ is the sample mean or the average of the y-values in the sample, and n is the number sampled for length. The standard error of $\bar{y}$ was estimated as:

$$se(\bar{y}) = \sqrt{\frac{s^2}{n}} = \sqrt{\left(1 - \frac{n}{N}\right)\frac{1}{n*(n-1)}\sum_{i=1}^{n}(y_i - \bar{y})^2} \qquad (2)$$

where s^2 is the sample variance and N is the weir count. The finite population correction factor (fpc) of $1 - \frac{n}{N}$ is included in s^2 because of the high (and exactly known) sampling rate.

All cutthroat trout were counted, measured to the nearest millimeter, FL, and examined for Floy or visual implanted (VI) tags and missing fins. Possible fin marks on cutthroat trout in 2000 included: (1) adipose-clipped fish carrying a PIT tag placed in 1997–1999; (2) VI tagged and adipose-clipped fish marked during emigrations from the lake in 1994–1996; (3) left ventral-clipped hatchery fish released in 1994; (4) right ventral-clipped hatchery fish released in 1991; and (5) adipose-clipped hatchery fish released in 1986 and 1987. All cutthroat trout missing the adipose fin were checked with an electronic scanner for a PIT tag. Each PIT tag has a unique 10 character alphanumeric code or number. Before 2000, PIT tags were inserted under the skin in the dorsal sinus, next to the basal fin rays of the dorsal fin. In 2000, tags were inserted under the skin immediately posterior and parallel to the midpoint of the cleithrum. The tag was inserted in the new location to prevent fishermen from accidentally biting down on the tag or ingesting the tag. The low rate of PIT tag loss (less than 1%), along with the ability to track individual fish have made the use of PIT tags highly successful in this study.

All unmarked, emigrant cutthroat trout were PIT tagged and adipose finclipped before release. One or two drops of cyanoacrylate, super glue, were used to close the tag wound and prevent tag loss and infection. Photonic dye marks were used to externally mark all cutthroat emigrants given a PIT tag in 2000 and permit a test for tag loss. All emigrant cutthroat trout were given one of two dye marks before release at the weir. Cutthroat trout that were adipose fin marked and PIT tagged (in the dorsal fin sinus) before 2000 were given a red dye mark on the anal fin. Cutthroat trout adipose fin marked and PIT tagged (next to the cleithrum) in 2000 were given a blue dye mark on the right pectoral fin. Newly tagged cutthroat trout were also held for 24 hours to check for short-term tag loss.

All cutthroat trout mortalities were measured and sampled for scales, otoliths, and ovaries, and the PIT tag recovered, if present. Scales from cutthroat trout mortalities were taken from the left side of the caudal peduncle immediately above the lateral line (Brown and Bailey 1949, Laasko and Cope 1956). Each fish was wiped with the blunt side of a knife to remove excess mucus before collecting a sample of scales. A sample of 15 to 20 scales from each fish was spread on a microscope slide so that no scales were over-lapping and sandwiched between another slide (Ericksen 1999). Slides were stored in a labeled coin envelope inscribed with the sample number and date. Scale samples have not yet been aged.

IMMIGRANT POPULATIONS

The weir was converted to count immigrants on June 29 and operated through November 7. Vertical slotted aluminum panels, 90 × 178 cm, were inserted into the weir structure to divert fish into the adult trap without restricting of water flow. The weir captured all small fish, including Dolly Varden, cutthroat trout, and chinook salmon mini-jacks (0-ocean) as well as adult salmon that moved upstream, while blocking any downstream movements. Aluminum plates, 45 × 90 cm, with 1.5 × 10 cm horizontal slots were placed on the bottom half of the lowest weir panels to prevent passage of small fish. Before 1997, small fish passed through the weir panels and were not counted. Small fish were captured in two trout

traps, 1.5 × 2.4 × 0.8 m high, attached to the upstream side of the weir. Pickets on the trap entrance were spaced 2.5 cm apart to prevent larger salmonids from entering the trout traps.

All immigrating Dolly Varden and cutthroat trout were counted and released upstream. Dolly Varden were examined for adipose finclips and Floy tags from other studies, and any marked fish were measured to the nearest 5 mm FL. All cutthroat trout were measured to the nearest 1 mm FL and examined for marks. Early in the immigration, cutthroat trout captured at the weir were placed back downstream to reduce the potential for injury and death caused by low stream flow, high creek temperature, and fish condition. These fish don't have the usual cutthroat trout coloration, exude large amounts of mucous when handled, have fairly deciduous scales, and are generally more lethargic than fish observed during spring or late fall migrations. Trout in this condition were first returned to waters below the weir in fall of 1997. Marked fish placed downstream of the weir in 1997 returned to the weir within 2 to 3 weeks, and had grown an average of 10 mm. Immigrant cutthroat trout were dye marked, but not PIT tagged because upstream tagging in 1996 resulted in high levels of mortality of cutthroat trout (ADF&G unpublished data). All adipose-fin marked cutthroat trout were checked for dye marks on all fins, and scanned for PIT tag code. Unmarked cutthroat trout were marked on the anal fin with a blue photonic dye.

Marine residence of cutthroat trout was defined as the number of days between emigration and immigration at Auke Creek, recognizing, of course, that some fish probably did not spend the whole period in saltwater. Marine growth of individual fish (mm and mm/day) was defined as the increase in fork length during their hiatus from the lake.

Trout mortalities recovered in the creek were sampled for FL (nearest mm), scales, otoliths, and ovaries, and checked for PIT tags. During the immigration period, examination of mortalities bearing PIT tags showed no scarring or encysting, good tag placement, and no migration of the tag into the body cavity or out through the skin.

LAKE POPULATION ESTIMATE

A two-event Petersen mark-recapture model for a closed population was used to estimate abundance of cutthroat trout ≥180 mm FL in Auke Lake in 2000. In addition, capture histories from 1998, 1999, and 2000 were tabulated to estimate annual recruitment and mortality rates and abundance of cutthroat trout ≥180 mm FL in 1999 using the Jolly-Seber (JS) model for an open population (Seber 1982). Two 9-day sampling events were conducted to capture fish in Auke Lake in 2000; the marking event was May 2 to May 11, and the recapture event was May 16 to May 25. Trout were captured with traps baited with chinook salmon eggs and by casting small spoons, spinners, and other lures with spinning gear. Trap soak-times were typically 22 to 24 hr. Traps were plastic-mesh cylindrical devices 1 m long × 0.5 m diameter, with a funnel entrance at each end (Rosenkranz et al. 1999).

Auke Lake was divided into 8 areas to facilitate sampling and accurate recording of locations where cutthroat trout were captured (Figure 2). Data from these areas were then pooled into 3 strata (A, B, C) for testing experimental assumptions. Fishing occurred only in areas ≤15 m deep (Figure 2) since cutthroat trout were not captured at greater depths in Auke Lake during the summer (NMFS unpublished data, Juneau, Alaska). Fifteen traps were fished each day using a fathometer to determine depth. Fishing effort (number of traps set and hours of hook and line effort) in each area was proportional to the lake surface area ≤15 m (Table 3). Lake areas were fished in similar order during each trip so that the hiatus between events was constant by area.

All captured cutthroat trout were inspected for tags or marks and measured for fork length. Fish missing the adipose fin were scanned to determine PIT tag number. Unmarked cutthroat trout were tagged with a uniquely numbered PIT tag and had their adipose fin excised. Trout handled during the marking event were also given a photonic dye mark on the left ventral fin. Fish caught during the recapture event were treated similarly except "recapture" was also noted in comments and a small ventral portion of the caudal fin was excised to prevent resampling should the PIT tag be lost. Area of capture, mortality status, capture gear, trap

Figure 2.–Bathymetric map of Auke Lake in northern Southeast Alaska, showing location of sampling areas in 2000. The lake area inside the inner bold line was excluded from sampling, as depths were >15 m. The two intersecting straight lines indicate the separation between the three strata (A, B, and C) used in analysis.

number and depth, and the daily total catch and gear units fished (trap-hours or rod-hours) were recorded such that depth of capture was available for fish caught in traps. Trout were handled without using anesthesia and released in the area where they were captured.

Assumptions of the two-event mark recapture experiment (Seber 1982) include:

1. that recruitment (or immigration) and death (or emigration) do not both occur between sampling events;

2. all fish ≥180 mm FL have an equal probability of being marked during the first event, *or* that every fish has an equal probability of being captured during the second event;

3. marking does not affect the catchability of a fish;

4. fish do not lose their marks between events, and marks are recognized and reported.

Growth recruitment was limited in this experiment because of the short duration

Table 3.–Distribution of sampling effort in Auke Lake by area in 2001. Sampling effort was uniformly distributed across each of the eight areas (see Figure 2) of the lake in direct proportion to the amount of lake surface (<15m depth) present, given a total effort of 135 traps and 20 rod-hours during each 9 day sampling trip.

Area no.	Analysis stratum	Area[a] (km^2)	Prop.[a]	Hook and line effort (hrs)	Trap effort (sets)
1	A	0.5463	0.0459	1:00	6
2	A	2.6098	0.2195	4:23	30
3	A	1.0583	0.0890	1:47	12
4	B	0.8275	0.0696	1:23	9
5	B	1.4691	0.1236	2:28	17
6	B	1.4562	0.1225	2:27	17
7	C	3.1297	0.2632	5:16	36
8	C	0.7932	0.0667	1:20	8
Totals		11.8901	1.0000	20:04	135

[a] Tabulated area and proportions are estimates for 0- to 15-m depths.

between the mark and recapture events. Significant undetected migration into Lake Creek and other smaller streams feeding Auke Lake was also unlikely since sampling should have largely preceded the spawning season presumed to be in June (Harding 1995, Lum et al. 1999, Rosenkranz et al. 1999), and anadromous emigrants would be captured at the weir. Significant deaths are also unlikely prior to spawning during the relatively short experiment. A spawning migration within the Auke Lake drainage may be possible in late May (around the second sampling event), but this would not impact this abundance estimate as long as every fish had an equal chance of being marked in the first sampling event. Emigration from the Auke Lake system during the study was detected at the weir, and PIT tagged fish caught during the mark and recapture events were removed from the lake abundance estimate data. Assumption 4 was assured because of the double marking (secondary finclip and dye marks) and thorough examination of all cutthroat trout captured.

Size-selective sampling (a violation of the second assumption) was investigated ($P < 0.1$) with two Kolmogorov-Smirnov (KS) tests, and procedures were adopted to reduce bias if selective sampling was detected (Appendix A1). The second assumption was also investigated using two chi-square tests (Seber 1982:438-39, Arnason et al. 1996). Sampling data were tabulated by stratum (A-C) and probabilities that (1) fish marked in the different strata were recaptured at equal rates in the second sample, and that (2) marked fractions were similar in each recovery stratum were estimated using SPAS software (Arnason et al. 1996). Since one of these tests yielded a non-significant result, strata were pooled and the Petersen model was used to estimate abundance.

Sampling data for the JS analysis were pooled by year; fish captured several times in a summer were treated as being caught only once. Three sampling trips were made in 1998 between July 8 and August 14 (Lum et al. 1999), and two sampling trips were made in 1999 between May 25 and June 16 (Lum et al. 2000).

Assumptions of the general JS model (Seber 1982) include:

1. every fish in the population has the same probability of capture in the ith sample;
2. every marked fish has the same probability of surviving from the ith to the $(i+1)$th sample and being in the population at the time of the $(i+1)$th sample;
3. every fish caught in the ith sample has the same probability of being returned to the population;
4. marked fish do not lose their marks between sampling events and all marks are reported on recovery; and

8

5. all samples are instantaneous (sampling time is negligible).

A goodness of fit (GOF) test (of marked fish seen before versus not seen before against seen again versus not seen again) as discussed in Pollock et al. (1990) was used to test the assumptions of homogeneous capture and survival probabilities in 1999. The GOF test is equivalent to the Robson (1969) test for short-term mortality.

The condition that the probability of capture is the same for all fish within a sampling event can be waived in an experiment based on the JS model if marked and unmarked fish mix completely between sampling events (Seber 1982:211). Such a test was made by comparing the R/C (where R = the number of recaptures and C = the number of captures) fractions of fish caught in strata A, B, and C, using only fish marked in the previous year. If $(R/C)_A = (R/C)_B = (R/C)_C$ complete mixing was indicated; otherwise, incomplete mixing was indicated. A chi-square statistic (from a 3×3 contingency table, a = 0.10) was used for the test. Because few fish were captured using hook-and-line each year, comparisons based on gear type were not attempted.

The equal probability of capture assumption is also violated by size-selective sampling. Abundance for large (>220 mm FL) and small (180–220 mm FL) fish was therefore estimated separately, in addition to an analysis for all fish =180 mm FL. If size-selective sampling is not significant, the sum of the stratified estimates should not be significantly different from the estimate for all fish. Adequacy of the stratified data set for large fish was tested using the GOF test. Size-selective sampling was also investigated within each sampling year, as described above.

The assumption that all fish have the same chance of surviving from the i_{th} to the $(i+1)_{th}$ sampling implies the absence of significant age dependent mortality rates for cutthroat trout =180 mm FL. Little evidence of age-dependent mortality was found for cutthroat trout ≥180 mm FL in Florence Lake (Rosenkranz et al. 1999). An indication of size (or age) dependent mortality in this experiment can be obtained by comparing survival estimates from the larger size class of

the length-stratified analysis (described above) to the survival estimates from the unstratified analysis. If the two estimates were similar, the absence of a strong age dependent mortality schedule at Auke Lake would be indicated. Also, it is probable that some sea-run cutthroat trout spawn in Auke Lake. Thus, immature, anadromous fish may reside (rear) in the lake, and emigrate in subsequent years as they smolt and/or mature. This was investigated by tallying the incidence of fish marked in the lake in 1998 and 1999 that exited the lake through the weir in subsequent years (through 2000).

Assumption 3 was evaluated by direct examination of the capture histories (mortality status by year) from each event. The number of fish killed or released alive without tags was usually <1% per sampling occasion. Assumption 4 was addressed by double marking trout with different combinations of finclips and photonic dye marks each year and estimating the annual rate of tag loss. Assumption 5 was accommodated as possible; in this experiment, sampling was confined to about 24 days. This is a relatively short time span in the context of the experiment, so that additions to and losses from the population (as indicated by the JS recruitment and death rate estimates) should be negligible.

Data for the analysis were collated using SAS (SAS 1990) then input to POPAN (Arnason and Schwarz 1995) to obtain capture histories and estimate population parameters. GOF statistics for the analysis were obtained using the program JOLLY (Brownie et al. 1986).

LAKE POPULATION LENGTH COMPOSITION

The length composition of cutthroat trout in the lake was estimated in 20-mm size increments. Since size-selective sampling was undetected, the fraction p_a of fish in length group a was calculated:

$$\hat{p}_a = \frac{n_a}{n} \qquad (3)$$

$$var[\,\hat{p}_a\,] = (1 - \frac{n}{\hat{N}})\frac{\hat{p}_a(1 - \hat{p}_a)}{n - 1} \qquad (4)$$

where n is the number of large or small fish measured for length, n_a is the subset of n that belong to length group a, and a fpc is again included because of the high sampling rate and availability of a precise abundance estimate from the mark-recapture experiment. The estimated abundance of length group a in the population is

$$\hat{N}_a = \hat{p}_a \hat{N} \qquad (5)$$

$$\mathrm{var}\left[\hat{N}_a\right] = \mathrm{var}(\hat{p}_a)\hat{N}^2 + \mathrm{var}(\hat{N})\hat{p}_a^2 \\ + \mathrm{var}(\hat{p}_a)\mathrm{var}(\hat{N}) \qquad (6)$$

where the variance equation for two independent variables is from Goodman (1960).

RESULTS AND DISCUSSION

MIGRANT DOLLY VARDEN

A total of 5,254 Dolly Varden emigrated in 2000. The emigration has been declining since 1995, and in 2000 it was slightly below the 20-year average of 6,383 (Table 4, Figure 3). The first Dolly Varden was captured March 20 and the last June 27 (Appendix A2, Figure 4). The midpoint of the emigration was May 6, and the average mid-point date of the emigration, 1980–2000, was May 8, range April 30 to May 24. Average fork length of emigrant Dolly Varden in 2000 was 259 mm (SD = 70), range 60 to 460 mm (n = 538). The weekly average length of Dolly Varden declined during the migration; i.e. larger fish emigrated earlier (Figure 5). Six adipose-clipped fish emigrated from Auke Lake in 2000. These fish were most likely marked in 1997 at Windfall Lake, about 15 km north of Auke Lake (Jones and Harding 1998).

The Dolly Varden immigration of 3,665 fish began on June 29 when the upstream trap was installed, and the last fish was captured November 7 when the weir was removed (Figure 4, Appendix A3). This was the bwest count since upstream migration of Dolly Varden was first monitored in 1997. Immigration counts for 1997–1999 were 5,705, 4,993 and 4,709 Dolly Varden. Major peaks in immigration occurred intermittently in August and September. The count of 80 Dolly Varden on June 29 when the upstream trap was first installed suggests that at least a few fish

Table 4.–Annual counts of downstream migrant, wild Dolly Varden and cutthroat trout at Auke Creek, 1980–2000 (hatchery-produced or lake-stocked cutthroat trout not included in this table).

Year	Dolly Varden	Midpoint of emigration	Cutthroat trout	Midpoint of emigration
1980	3,110	13-May	85	18-May
1981	6,461	5-May	157	14-May
1982	4,136	24-May	157	31-May
1983	3,718	7-May	149	15-May
1984	4,512	8-May	198	14-May
1985	3,052	14-May	112	21-May
1986	4,358	13-May	99	24-May
1987	6,443	6-May	250	17-May
1988	6,770	30-Apr	294	9-May
1989	7,230	8-May	259	18-May
1990	6,425	5-May	417	11-May
1991	5,579	17-May	237	20-May
1992	6,839	4-May	219	16-May
1993	5,074	8-May	174	14-May
1994	7,600	4-May	422	13-May
1995	11,732	9-May	412	13-May
1996	11,323	4-May	462	7-May
1997	10,506	7-May	418	12-May
1998	7,532	1-May	336	11-May
1999	6,393	14-May	341	16-May
2000	5,254	6-May	249	13-May
Mean	6,383	8-May	259	16-May

would have immigrated earlier, except that the weir blocked upstream migration.

MIGRANT CUTTHROAT TROUT

A total of 250 cutthroat trout, including 249 wild and 1 lake-stocked fish (identified by a missing ventral fin), emigrated in 2000. The emigration count for wild fish has been declining since a high value of 462 in 1996. The 2000 count of 249 was substantially less than the 1994–1999 average of 398, but only slightly below the 20-year average of 259 wild fish (Table 4, Figure 6). The first emigrant was captured March 20, and the last June 29, after which the weir was converted to an upstream migrant trap and no additional emigration was allowed (Figure 7, Appendix A2). The midpoint of emigration was May 13, and the average median date of emigration is May 16
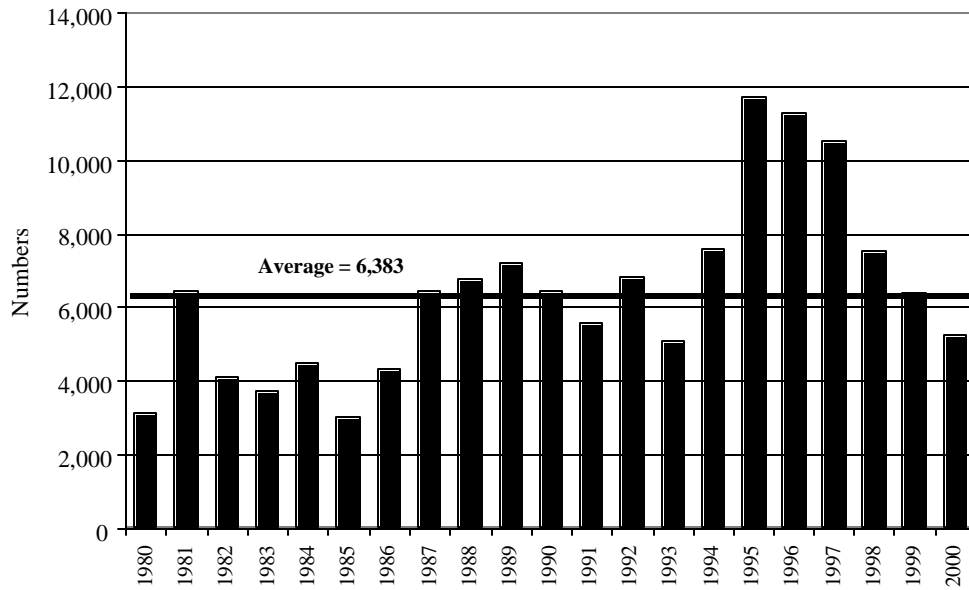
Figure 3.–Annual emigration of Dolly Varden at Auke Creek, 1980–2000.
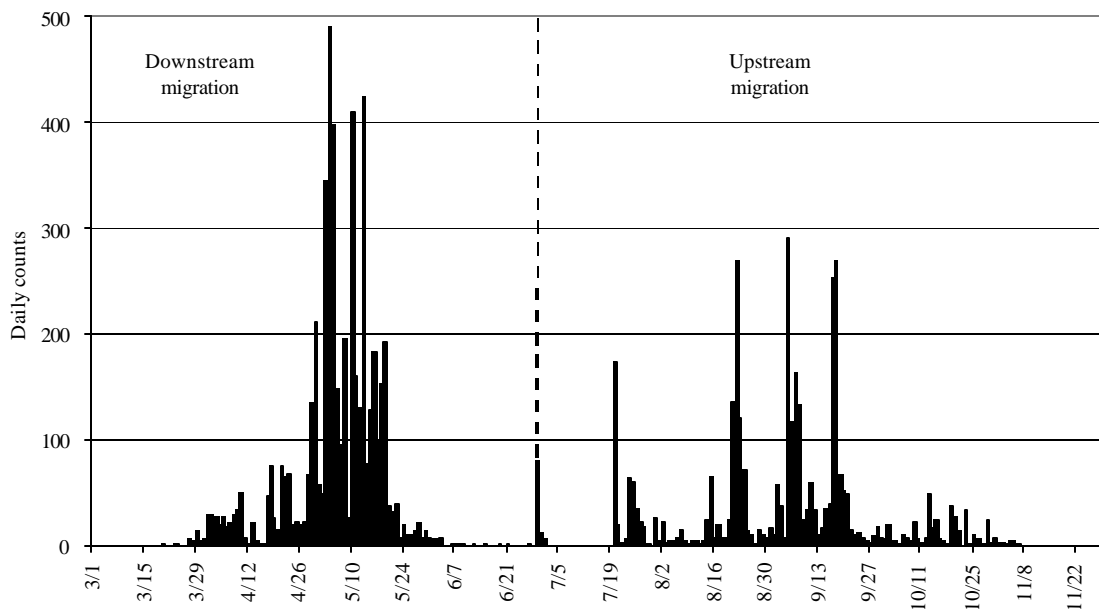
Figure 4.– The 2000 migration for Dolly Varden at Auke Creek. Spring downstream migration started March 20 and ended June 27. Fall upstream migration started June 29 and ended November 7, at which time the upstream weir was removed. Vertical dashed line delineates time when the weir was converted to count upstream migrants.

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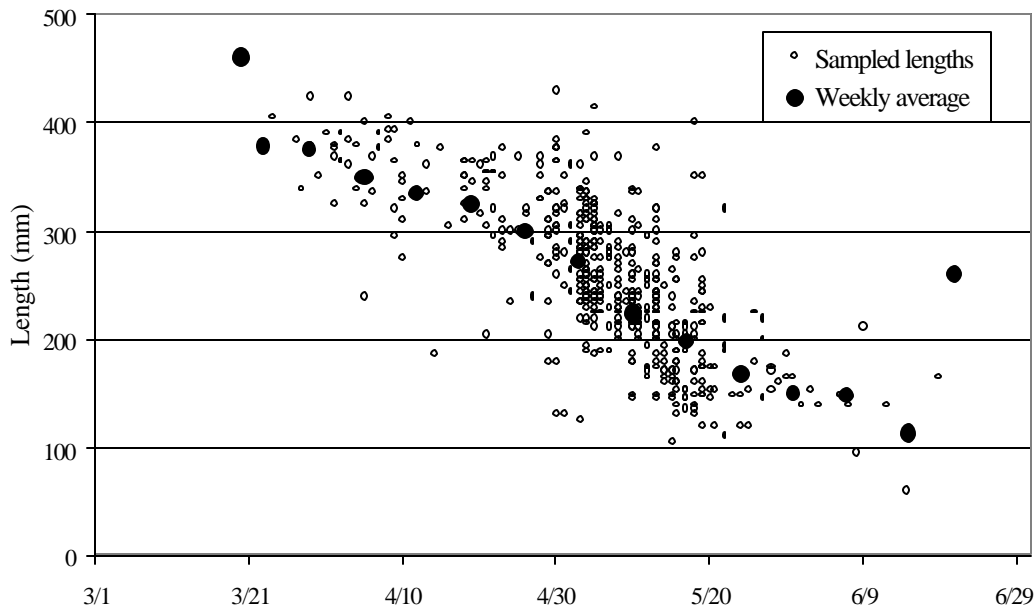
Figure 5.–Dolly Varden lengths (mm) over time during the downstream migration at Auke Creek, 2000. Average lengths for each migration week are overlaid upon sampled length data.
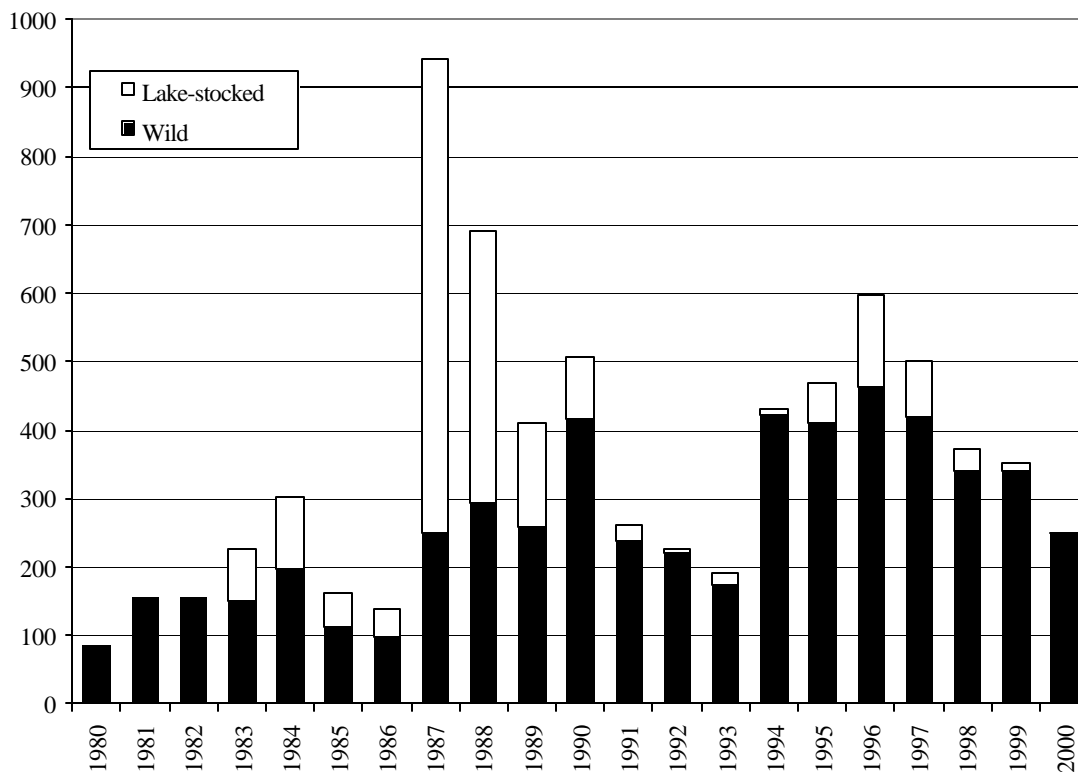
Figure 6.– Annual downstream cutthroat trout migration for Auke Creek, 1980–2000. Hatchery cutthroat trout were stocked in Auke Lake in 1983 (1,286 right ventral marked and 4,078 left ventral marked fish); 1986 (3,489 adipose marked fish); 1987 (1,1719 adipose marked fish); 1991 (2,465 right ventral marked fish); and 1994 (3,098 left and right ventral marked fish).
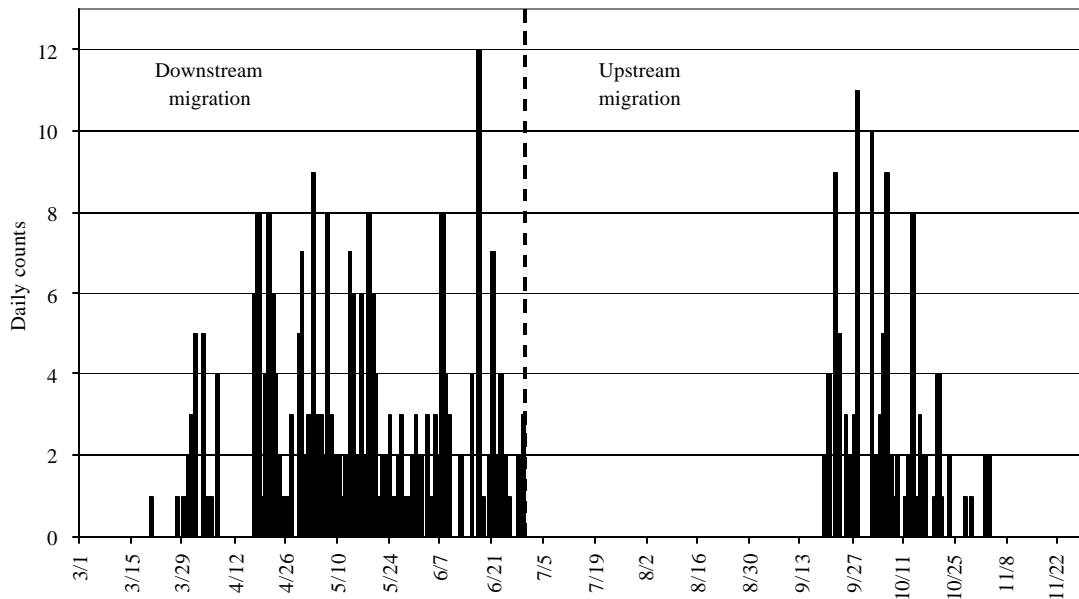
Figure 7.–The cutthroat trout migration for Auke Creek, 2000. Spring downstream migration started March 20 and ended June 29. Fall upstream migration started September 19 and ended November 7. Vertical dashed line delineates time when weir was converted to count upstream migrants.

(1980–2000); range May 7 to May 31 (Table 4). Water temperatures during the emigration in 2000 ranged between 3.4° and 17.7°C.

Of the 250 emigrant cutthroat trout in 2000, 147 were missing their adipose fin, and 103 were not marked or tagged. All fish missing an adipose fin in 2000 had a PIT tag (tag retention was 100%). The marked fish included 111 wild and 1 lake-stocked fish tagged before 2000, and 35 fish tagged in Auke Lake during the lake abundance project in spring 2000. Of the 103 unmarked fish, 100 were marked by excision of the adipose fin and tagged with a PIT tag; 2 unmarked cutthroat trout escaped during handling, and one in poor condition died the next day. Average fork length for emigrant wild sea-run cutthroat trout was 275 mm (SD = 54 mm) and ranged from 166 to 444 mm. The weekly average length of all emigrants declined over time (Figure 8).

A total of 105 cutthroat trout immigrated and were examined for marks and PIT tags in 2000. This was the lowest number of immigrant cutthroat trout since recording began in 1997, with prior counts being 467, 361, and 205, respectively. No cutthroat trout migrated upstream in August, 39

did in September, 61 in October, and 5 in November. As noted in the methods, some cutthroat trout were not ready to remain in freshwater when captured at the weir early in the immigration, and they were placed back downstream. Run timing data collected may thus be biased.

PIT tag retention on immigrant cutthroat trout in 2000 was 100%. A total of 33 of the immigrant cutthroat trout had been dye marked during the 2000 emigration, as proven by the PIT tag number. These numbers revealed that 17 cutthroat trout should have had a red dye mark on the anal fin, and 16 should have had a blue dye mark on the right pectoral fin. Only 12 of 17 (71%) cutthroat trout retained the red anal-fin mark, and only 6 of 16 (38%) retained the blue pectoral-fin mark.

Immigrant cutthroat trout averaged 250 mm (SD = 6 mm), ranging from 165 to 405 mm. Average lengths of immigrating cutthroat trout did not vary greatly over time (Figure 9). The length of the single lake-stocked immigrant returning in the fall was 390 mm. The length frequency distribution for fall immigrants is skewed toward
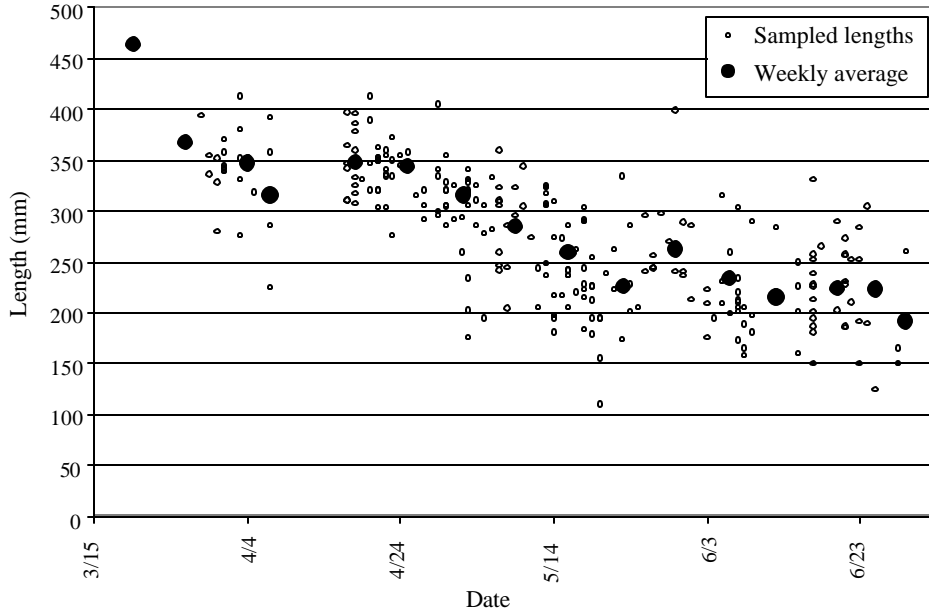
Figure 8.–Cutthroat trout lengths (mm) over time during the downstream migration at Auke Creek, 2000. Average lengths for each migration week are overlaid upon sampled length data.
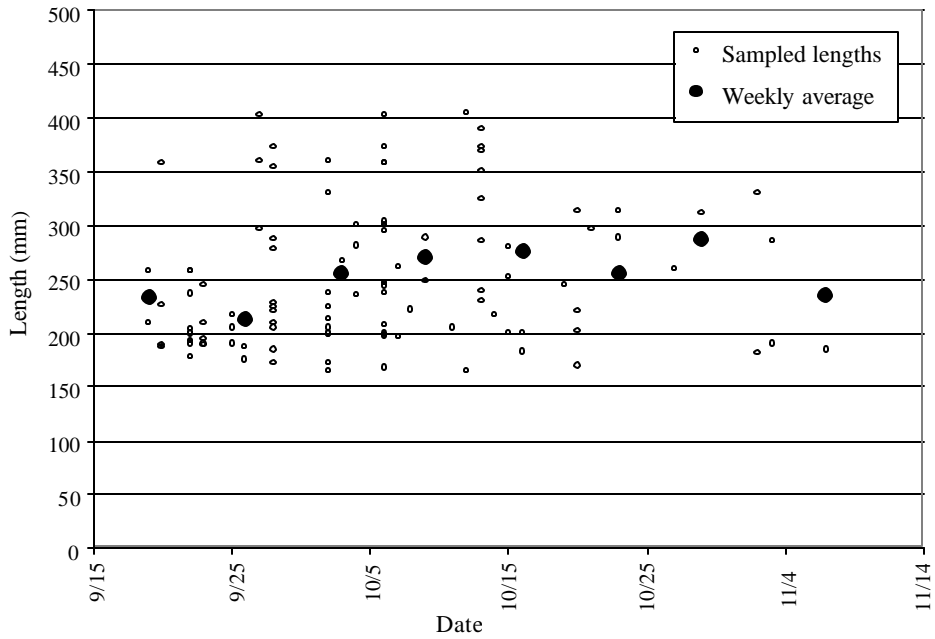
Figure 9.– Cutthroat trout lengths (mm) over time during the upstream migration at Auke Creek, 2000. Average lengths for each migration week are overlaid upon sampled length data.

much shorter lengths than that for spring emigrants (Figure 10).

Marine residence and growth of cutthroat trout was determined for fish with PIT tags that emigrated and immigrated at Auke Creek in 2000. PIT-tagged cutthroat trout that returned to Auke Creek in the summer and fall 2000 had an average hiatus of 149 days (SE = 4, range 97–193 days) from Auke Lake, compared to 126 days in 1998 and 133 days in 1999. The data did not show a relationship between migration time and return time for cutthroat trout leaving Auke Creek, and there was not a strong relationship between size at emigration and duration of marine residence. Average growth during the hiatus was 43 mm (SE = 3 mm) and ranged from 11 to 90 mm (Figure 11). The average growth rate during the hiatus was 0.30 mm/day (SE = 0.03), less than the 0.48, 0.49, and 0.45 mm/day observed in 1997–1999, respectively (Lum et al. 2000). Growth rate tends to decrease as the size of the fish gets larger.

CUTTHROAT TROUT IN AUKE LAKE

We captured a total of 686 cutthroat trout in Auke Lake during 2000, 477 of which were ≥180 mm FL (Table 5). Ninety-nine percent (682) of the fish were caught in large traps; the remaining 4 were caught by hook-and-line gear. The largest numbers of fish caught were in the 181–200 mm FL size class, but a wide variety of size classes were captured (Figure 12).

In the first sampling trip in 2000, 103 unmarked cutthroat trout between 180 mm and 336 mm FL and 62 fish tagged in the lake during the prior two years were captured and released (Table 6). No (sea-run) fish previously tagged at the weir were caught.

During the second sampling trip, 104 cutthroat trout between 181 mm FL and 347 mm FL not seen in the first trip and 86 fish seen during the first sampling trip were captured and released (Table 6). One of the 104 fish above had been tagged at the weir in the spring of 1999.
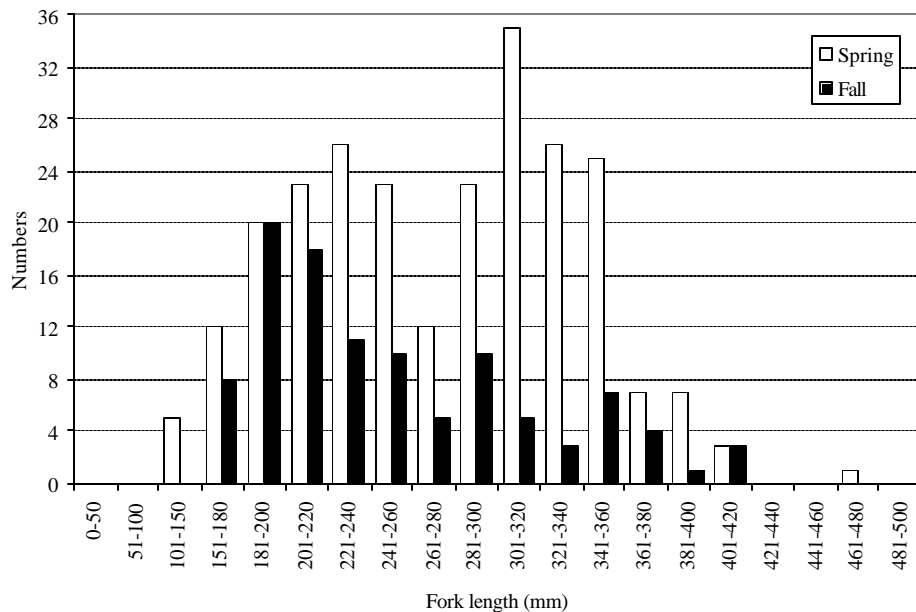
Figure 10.–Length frequency distributions of cutthroat trout captured at Auke Creek weir, spring emigration and fall immigration, 2000.
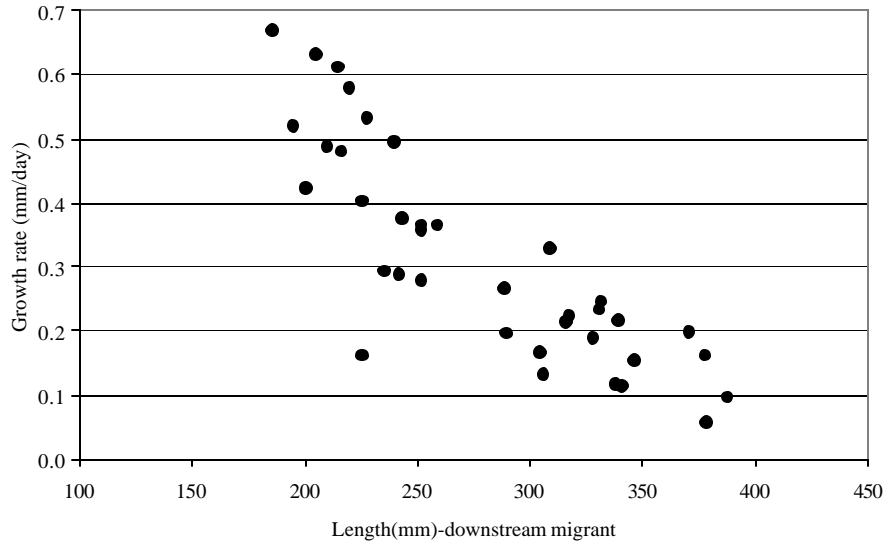
Figure 11.–Cutthroat trout growth (mm/day) during time between downstream and upstream migration plotted against their size at the time of downstream migration and tagging, Auke Creek, 2000.

Seventeen (17) uniquely tagged cutthroat trout captured in the first trip and 14 cutthroat trout captured in the second trip subsequently emigrated past the weir in May and June. These sea-run cutthroat trout were not used in the calculations to estimate abundance of lake-resident fish.

There was no indication of size-selectivity during the second sampling trip. Lengths of cutthroat trout released during the first trip were not significantly different (at the $\alpha = 0.05$ level) when the fish were recaptured ($d_{max} = 0.155$, P = 0.113; Figure 13). Thus, data were pooled to estimate length composition, and stratification based on size was not needed to accurately estimate abundance (Appendix A1).

Considerable movement and mixing of cutthroat trout among sampling strata occurred in 2000 (Table 7). Although the marked fraction varied significantly (P = 0.03, $\chi^2 = 7.34$, Table 7) by recovery stratum during trip 2 (the marked fractions were 0.42, 0.40, 0.66 for strata A-C), fish marked in the 3 strata during trip 1 were recaptured at similar rates during trip 2 (P = 0.48, $\chi^2 = 1.48$). Thus, the Petersen estimate of 364 (SE = 20) cutthroat trout ≥180 mm FL in Auke

Lake for 2000 is unbiased. Relative precision for the estimate is ±11% for a 95% confidence interval.

The JS model used to estimate an annual recruitment and mortality rate and abundance in 1999 employs the following data reported by Lum et al. (1999, 2000). Eighty-nine (89) cutthroat trout between 180 and 339 mm FL were captured, tagged and released at Auke Lake in 1998, and 279 fish between 180 and 432 mm FL were sampled and returned to the population in 1999. We captured a total of 212 unique cutthroat trout between 180 and 347 mm FL in 2000. Eighteen (18) fish sampled in 1999 and 74 sampled in 2000 had been marked in prior years. We estimate tag loss was insignificant (0 fish). Summary statistics and capture histories used in the JS analysis are given in Appendices A4 and A5.

Contingency table tests for mixing by mark status indicate complete mixing of marked fish between capture strata from 1998 to 2000 ($?^2 = 3.29$, P = 0.19). We found no indication (P = 0.146) of different capture/survival probabilities by mark status in 1999 (Table 8), although the estimate for fish newly captured in 1999 was over twice that of fish first captured in 1998 (27% vs. 11%,

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Table 5.–Sampling effort (hours) and cutthroat trout catch, and catch per unit effort (CPUE, fish per hour) by sampling event, gear, and size class, Auke Lake, 2000.

Sampling event[a]	Gear type	Effort (hours)	≥180 mm		<180 mm		Combined	
			Catch	CPUE	Catch	CPUE	Catch	CPUE
Marking	Hook and line	20	3	0.150	1	0.050	4	0.2
	Large traps	3,240	201	0.062	100	0.031	301	0.093
Recovery	Hook and line	20	0	0.000	0	0.000	0	0
	Large traps	3,240	273	0.084	108	0.033	381	0.118
Subtotal	Hook and line	40	3	0.075	1	0.025	4	0.1
	Large traps	6,480	474	0.073	208	0.032	682	0.105
TOTAL:	both events, all gear		477		209		686	

[a] Marking = May 2–May 11; recovery = May 16–May 25.
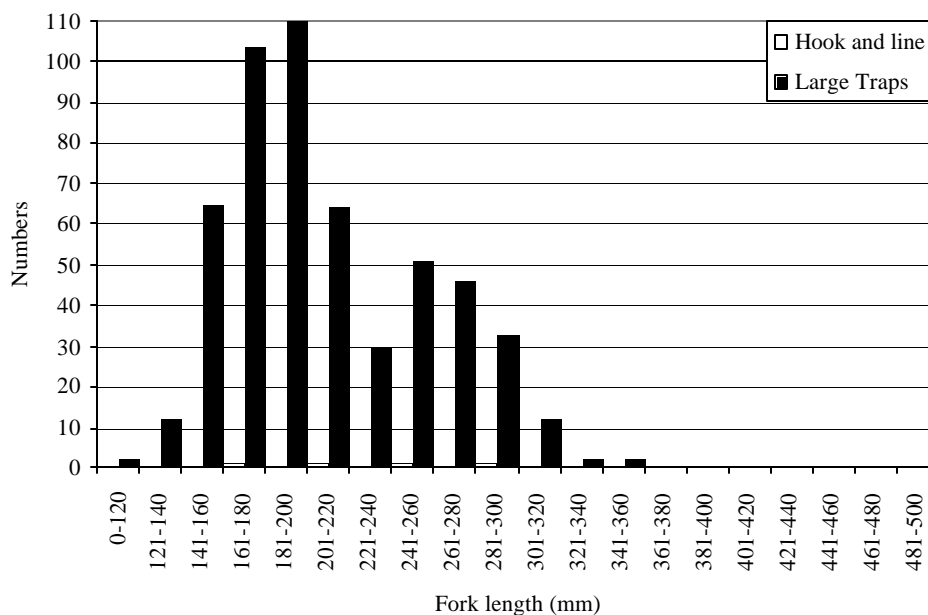
Figure 12.–Length frequency of cutthroat trout captured at Auke Lake by gear type, 2000.

Table 8). GOF statistics for JS models having fewer survival and capture parameters than the usual JS model were also estimated. However, each of the three possible reduced models were discounted since the GOF statistics did not significantly differ from that for the full model.

The JS abundance estimate for cutthroat trout =180 mm FL in Auke Lake in May 1999 was 525 (SE = 131; Table 9). The estimated survival rates for all fish (0.376, SE = 0.093) and large fish (0.435, SE = 0.190) were not significantly different, suggesting stratification of the inter-

annual sampling data based on fish size was not critical. Reported annual harvests at Auke Lake are <20 fish from 1998 through 1999, so the estimated survival rates for all (>180 mm FL) and large (>220 mm FL) fish essentially estimate natural rates for these size groups (Table 9).

The lengths of cutthroat trout caught in the lake averaged 207 mm (SD = 48 mm) and ranged from 102 to 347 mm. The length frequency distributions of cutthroat trout captured during the first and second sampling events were not significantly different (d_{max} = 0.108, P = 0.217;

Table 6.–Summary of tagging and recovery data for all cutthroat data for all cutthroat trout ³180 mm used in the abundance experiment, Auke Lake, 2000.

	Marking event	Recapture event
	Period 1 (5/2–5/11)	Period 2 (5/16–5/25)
Newly tagged fish released, ≥180 mm	165	103[a]
Recaptured newly tagged fish, ≥180 mm	0	86
Sea-run fish observed (remained in lake)[b]		1[b]
Recaptured sea-run fish	0	0
Total "marked" or inspected	165	190

[a] Total includes 9 fish <180 mm that were marked in the first event, but grew into the population ≥180 mm by the second event.

[b] This sea-run fish was PIT tagged at the weir in spring 1999. It is included in the second event as a new capture.
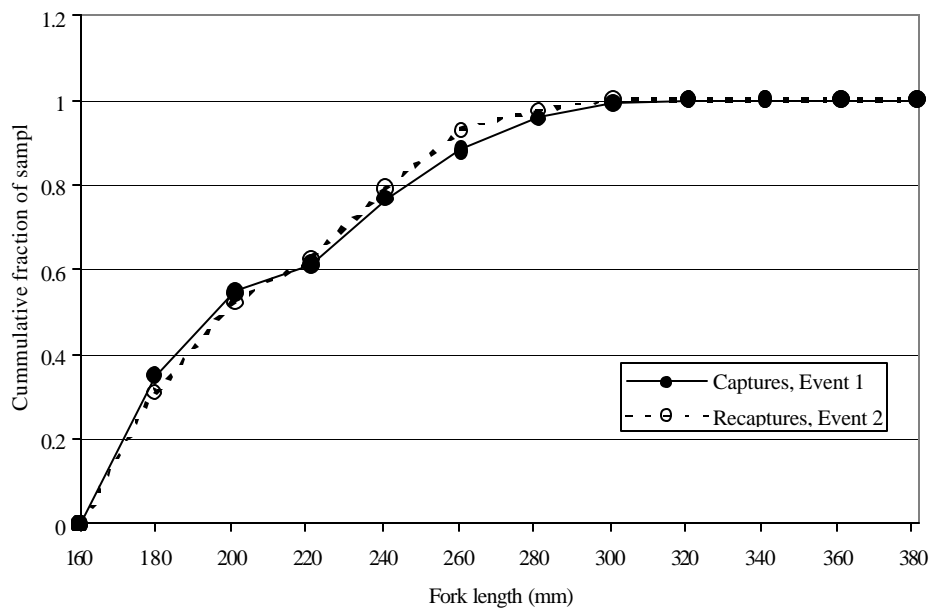
Figure 13.-Cumulative histogram of lengths of cutthroat trout marked versus lengths of cutthroat trout recaptured, Auke Lake, 2000.

Table 7.–Number of cutthroat trout marked by stratum (a$_i$)**, number of marked fish recaptured by stratum of recapture** (m$_{ij}$)**, and number of unmarked fish caught by stratum** (u$_j$) **during the second sampling event at Auke Lake, 2000.**

Stratum where fish was marked	Total fish marked (a$_i$)	Number of marked fish recaptured, by stratum of recapture (m$_j$)			Total all strata	Proportion recaptured
		Stratum A (study areas 1,2,3)	Stratum B (study areas 4,5,6)	Stratum C (study areas 7,8)		
A	44	16	8	0	24	0.55
B	41	4	12	2	18	0.44
C	80	9	14	21	44	0.55
Total	165	29	34	23	86	0.52
Unmarked fish caught (u$_j$)		40	52 [a]	12	104	
Total caught in recapture event		69	86	35	190	
Marked fraction		0.42	0.40	0.66	0.45	

[a] Includes one sea-run fish, tagged at the weir May 1999.

Figure 14); therefore, length data collected during both events were used to estimate the length composition of cutthroat trout =180 mm FL. Fifty percent (50%) of the population was ≤220 mm FL (Table 10, Figure 12). By regulation, harvest of cutthroat trout in Auke Lake is restricted to fish ≥356 mm FL (14 inches TL). Our data indicate that none of the cutthroat trout in Auke Lake during May exceeded the 14-inch minimum size limit.

Table 8.– Goodness-of-fit test for homogeneous capture/survival probabilities by tag group (p = probability of capture for each group)**.**

TEST FOR 1999	First captured in 1998	First captured in 1999
Captured in 1999 and recaptured in 2000	2.00	74.00
Expected value	4.61	71.39
Captured in 1999 and not recaptured in 2000	16.00	205.00
Expected value	13.39	207.61
c^2 = 2.11, 1 df, P = 0.146		
p ->	0.11	0.27

A total of 123 PIT tagged cutthroat trout immigrated into Auke Lake in fall of 1999 (Lum et al. 1999). Seventy-one (71) of those fish emigrated from the lake in 2000, leaving 52 that either chose to remain in Auke Lake for the summer or died over the winter. Two of these 52 fish were caught while sampling the lake in 2000. Thus, an estimated 3 (2 tagged/269 inspected * total population of 364) PIT tagged fish remained alive in the lake in 2000. We estimate that overwinter survival of these fish was 60% (71 + 3/123). This compares closely to the estimated overwinter survival rates for PIT tagged fall immigrants of 67% in 1997–1998 (Lum et al. 1999) and 58% in 1998–1999 (Lum et al. 2000).

CONCLUSION AND RECOMMENDATIONS

The completion of the 2000 field season brings to a close a three-year study to estimate abundance of resident cutthroat trout in Auke Lake. Some insight about the life histories of cutthroat trout using Auke Lake is apparent from capture histories tabulated since PIT tagging began at the weir in 1997 and in the lake in 1998. In general, the summertime population of cutthroat trout in Auke Lake consists of fish that are truly resident (potamodromous), and fish that are actually

Table 9.–Jolly Seber estimates of abundance (N)**, survival** (F)**, and capture probability** (p) **for all cutthroat trout = 180 mm FL** (panel A)**, and for only small- and large-sized fish** (panels B and C)**.**

Trout size class	Year	N	SE(N)	F	SE(F)	p	SE(p)
PANEL A: ³180 mm FL	1998			0.376	0.093		
	1999	525	131			0.333	0.193
	2000						
PANEL B: 180-220 mm FL	1998			0.411[a]	0.098[a]		
	1999	97	n/a [b]			0.333	0.93
	2000						
PANEL C: >220 mm FL	1998			0.435	0.190		
	1999	558	282			0.5	0.354
	2000						

[a] Survival estimate for the small size class includes loss to the larger group as well as mortality.

[b] Too small a sample size to calculate standard error.
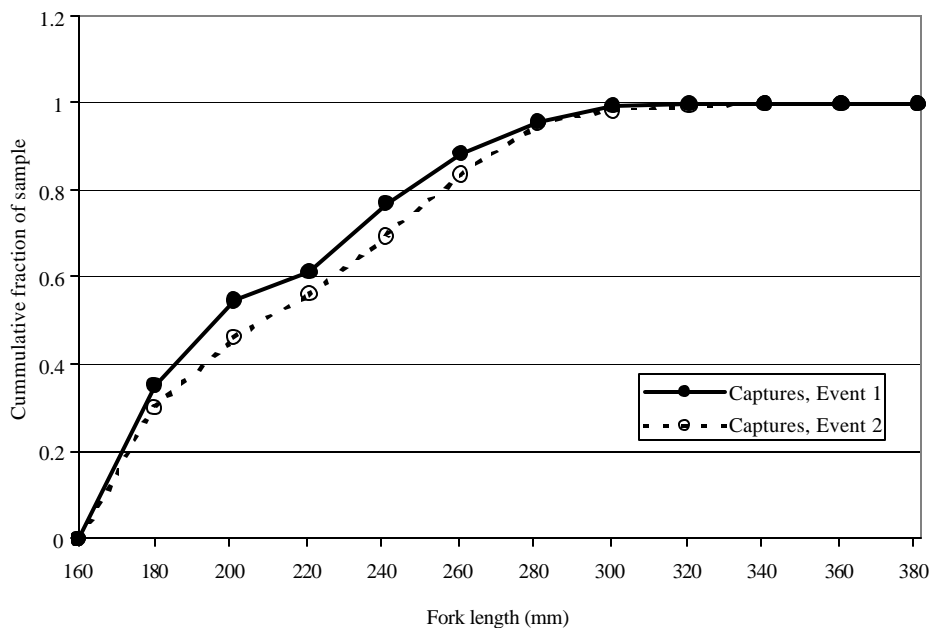
Figure 14.–Cumulative distribution of lengths of cutthroat trout marked versus lengths of cutthroat trout examined for marks, Auke Lake, 2000.

migratory (diadromous and anadromous) at some point in their life. Prevalence of fish in the latter group was especially interesting to us. Eighteen (18) of 121 (15%) PIT tagged fish handled during lake sampling in 1998 (and which did not pass the weir at any time in 1998) eventually emigrated from the lake; 15 (83%) of the 18 fish left in 1999, and 3 (17%) left in 2000. In 1999, 16 of 364 (4%) of the PIT tagged fish handled in the lake emigrated during spring 2000 (11 fish, 69%) and 2001 (5 fish, 31%, unpublished data). Thus, a 2-year average of 9% of the summer

Table 10.–Length composition and estimated abundance at length for cutthroat trout ³180 mm FL, Auke Lake, 2000. Number sampled (n_k), proportion (p_k), abundance (N_k), and standard error (SE) are shown for each 20-mm length class.

Length k, mm FL	n_k	P_k	$SE(p_k)$	N_k	$SE(N_k)$
180-200	115	0.324	0.0039	118	1.42
201-220	63	0.178	0.0032	65	1.16
221-240	30	0.085	0.0023	31	0.85
241-260	51	0.144	0.0029	52	1.07
261-280	46	0.130	0.0028	47	1.02
281-300	34	0.096	0.0025	35	0.90
301-320	12	0.034	0.0015	12	0.55
321-340	3	0.009	0.0008	3	0.28
341-360	1	0.003	0.0004	1	0.16
Total	355			364	

"residents" survived to exhibit sea-run behavior. Of the 18 eventual emigrants from the 1998 lake sampling, 5 (28%) returned to the lake during the fall immigration within the same year that they left. Similarly, 5 of the 16 (31%) eventual emigrants from the 1999 lake sampling returned to the lake during the following fall immigration. That these emigrants are largely progeny of anadromous fish, rather than strays, thus seems reasonable.

It is very difficult to distinguish sea-run from resident cutthroat trout in a lake that is accessible to upstream migrants. For example, some sea-run fish appear to become temporary lake residents and some apparent "residents" mature and emigrate. A small number of (presumably sea-run) fall immigrants elect to not participate in the next spring emigration, and remain in Auke Lake. Over three years, we estimate an average of 8% (annual estimates were 6%, 13%, and 4%, Lum et al. 1999, 2000) of the PIT tagged immigrants that lived through the spring emigration and lake sampling events, remained in the lake. From 1998 through 2000, 11 such PIT tagged fish have been captured in Auke Lake. The majority (10 of 11, or 91%) of these fish were not seen leaving the lake again, and most (9 of the 11) were not captured in the lake in a subsequent year,

suggesting they died in the lake. Two of these 10 fish were captured in the lake in 2 successive years, while the other 8 were never seen again. These anadromous recruits to the summer population in the lake could be spawning in the lake, or electing to forgo their annual emigration (and perhaps spawning). The one (of the 11) tagged fish that did leave the lake again first passed the weir in both directions in 1997, remained in the lake during 1998 and 1999, and then passed the weir in both directions in 2000.

Inference about life history from this sample of 11 fish requires some qualification. First, the Auke Creek weir is not operated during winter. Also, some of the 8 PIT tagged fish that were never seen again were captured in the lake in May of 1999 or 2000, prior to the conclusion of the spring emigration. It is possible that some of these fish did not "elect" to stay in the lake, but died en route to the sea (or weir) after capture in the lake—possibly due to handling mortality. Handling mortality should be very low, because lake temperatures during this period are low, and little stress is typically placed on previously captured and tagged fish. It is also possible that a few fish tried to emigrate after the weir was converted to an upstream trap about June 30 (see Figure 7) but could not do so because the weir blocked downstream migration and they subsequently reentered and lake and died. We have not yet devised a viable method to allow upstream migration while the weir is operated to count emigrants and vice versa.

Overwinter survival of PIT tagged sea-run migrants averaged 62% (annual estimates were 68%, 59%, and 60%). These survival rates are significantly greater than the JS annual survival rate for Auke Lake "residents" in this study (38%, SE 9%) or similar lake-bound populations in Neck Lake (51%, SE 6%, Harding et al. 1999) or Florence Lake (40–52%, SE 2–3%, Rosenkranz et al. 1999). This difference is in part due to presence of immature anadromous fish that leave the lake at some point (deflating the annual survival statistic). In fact, a JS analysis of the capture history data for 1998–2000 (described above), which excludes all fish ever observed at the weir, yields an annual survival estimate of 0.51 (SE 0.065), similar to that found in other studies in Southeast Alaska.

Overwinter survival rates also do not include the spawning and spawning migration period when mortality is probably substantial.

The Petersen abundance estimate of 364 (SE = 20) cutthroat trout ≥180 mm FL in Auke Lake in 2000 is significantly higher than the estimate of 247 (SE = 59) for mid-July 1998, but lower than the estimate of 464 (SE = 23) for early-June 1999 (Lum et al. 1999, 2000). Fish <180 mm (too small to tag) were also caught in the traps in larger numbers in 2000 than in 1998 and 1999. Sampling in 1998 occurred during July and August when water temperature was high (18° to 20°C to a depth of 2 to 3 m) and catch rates were low. Perhaps the relatively late sampling date and high water temperature in 1998 resulted in low catch rates because some groups of fish systematically avoided sampling. Sources of food during this time included aquatic insects and the eggs from other spawning salmonids that entered the weir in July and August. Fish were also generally observed to be less active.

Our JS model estimate for lake abundance in 1999 (525, SE = 131) is similar to the Petersen estimate of 464 (SE = 23) for the same time. This provides reassuring evidence of representative sampling in 1999 (Rosenkranz et al. 1999). As noted above, the JS annual survival rate estimate of 38% (SE = 9%) between 1998 and 1999 was lower than we might have expected. In addition to the factors noted above, some cutthroat trout are captured during September and October when Auke Lake is open to bait fishing for coho salmon. These hook-and-released fish may experience hooking mortality as high as 50%, because of the baited gear allowed during this period (Mongillo 1984, Taylor and White 1992).

One assumption of the JS experiment is that sampling is essentially instantaneous. We evaluated this assumption by rerunning the analysis without pooling sampling trips within years. Results from that analysis do not suggest significant short-term mortality (maximum between trips within years was 0.28), which would violate the instantaneous sampling assumption. However, a recruitment of 236 individuals was indicated between the first and second trip in 1998. This could be a result from rapid growth of small recruits during summer, a small immigration of fish from a tributary such as Lake Creek, or simply as a random artifact of the sampling process. As noted above, some fish may have avoided sampling in 1998 due to the timing and water temperatures on the first trip, and then became available to our gear on subsequent sampling trips.

During our 2000 lake and weir studies, we examined 97 cutthroat trout PIT tagged in Auke Lake in 1999 and found that 77% (75) of these fish retained their photonic dye secondary marks. We also examined 11 fish tagged and marked in 1998 and 7 of these had retained their mark for a retention of 64% for the second year. In 1999 we estimated an 87% retention rate for marks placed in 1998 (Lum et al. 1999). This shows that our dye marks are not dependable for long-term (more than several month) experiments.

The Dolly Varden and cutthroat trout assessments in Auke Lake/Creek provide a rare time series of abundance, survival, growth, migration timing, and other life history information for these species. The data for cutthroat trout may be the longest and most complete series of its kind in existence and should be continued. The continuity of the dataset will become increasingly important as urban development continues in the Juneau area. PIT tagging of emigrating cutthroat trout at Auke Creek provides particularly valuable information and should be continued. Tagging trout and char migrants at Auke Creek also meshes well with other local trout/salmon projects where the tagged fish may be sampled. Information on salt- and freshwater migrations and habitat preferences are important because these species utilize other watersheds for spawning and juvenile rearing. While anecdotal in nature, the pre-1960 population of cutthroat trout in Auke Lake may have been substantially larger than it is now, and the recent pattern of declining numbers of emigrants and immigrants at Auke Creek may be of concern if it continues.

Sampling the lake population in late May and early June, before spawning occurs, rather than in July or August appears to work well. The increased catches improve the accuracy and precision of our population estimates, and we recommend that spring sampling in the lake be continued. A continued evaluation of photonic dye marks, with a focus on extending their visibility over time is also recommended.

ACKNOWLEDGMENTS

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APPENDIX A

Appendix A1.–Detection of size-selective sampling (Bernard and Hansen 1992).

Result of Hypothesis Test on lengths of fish CAPTURED during the First Event and RECAPTURED during the Second Event.	**Result** of Hypothesis Test on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event.

Case I: **Accept H_0**   **Accept H_0**
      There is no size-selectivity during either sampling event.

Case II: **Accept H_0**   **Reject H_0**
      There is no size-selectivity during the second sampling event but there is during the first.

Case III: **Reject H_0**   **Accept H_0**
      There is size-selectivity during both sampling events.

Case IV: **Reject H_0**   **Reject H_0**
      There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data.

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

Whenever the results of the hypothesis tests indicate that there has been size-selective sampling (Case III or IV), there is still a chance that the bias in estimates of abundance from this phenomenon is negligible. Produce a second estimate of abundance by not stratifying the data as recommended above. If the two estimates (stratified and unbiased vs. biased and unstratified) are dissimilar, the bias is meaningful, the stratified estimate should be used, and data on compositions should be analyzed as described above for Cases III or IV. However, if the two estimates of abundance are similar, the bias is negligible in the UNSTRATIFIED estimate, and analysis can proceed as if there were no size-selective sampling during the second event (Cases I or II).

Appendix A2.–Daily counts of downstream migrant salmonids at Auke Creek, 2000.

		Daily counts						
	Water temp	Pink salmon fry	Coho salmon smolts	Sockeye salmon smolts	Chum salmon fry	Dolly Varden	Cut-throat trout	Steel-head
March 1	2.6	0	0	0	0	0	0	0
2	2.6	6	0	0	0	0	0	0
3	2.5	8	0	0	0	0	0	0
4	2.6	40	0	0	0	0	0	0
5	2.7	22	0	0	0	0	0	0
6	2.7	34	0	0	5	0	0	0
7	2.6	59	0	0	1	0	0	0
8	2.8	46	0	0	2	0	0	0
9	3.0	71	0	0	1	0	0	0
10	3.0	70	0	0	6	0	0	0
11	3.1	34	0	0	0	0	0	0
12	3.3	14	0	0	1	0	0	0
13	3.2	106	0	0	1	0	0	0
14	3.2	123	0	0	6	0	0	0
15	3.1	381	0	0	13	0	0	0
16	3.2	145	0	0	6	0	0	0
17	3.2	222	0	0	6	0	0	0
18	3.7	285	0	0	17	0	0	0
19	3.8	400	0	0	17	0	0	0
20	3.8	408	0	0	11	1	1	0
21	3.5	366	0	0	14	0	0	0
22	3.5	675	0	0	10	0	0	0
23	3.4	947	0	0	22	1	0	0
24	3.4	935	0	0	13	2	0	0
25	3.6	1,098	0	0	27	0	0	0
26	3.5	1,076	0	0	22	0	0	0
27	3.4	2,062	0	0	21	6	1	0
28	3.6	1,468	0	0	76	5	0	0
29	3.8	1,236	0	0	32	13	1	0
30	4.0	1,346	0	0	31	5	2	0
31	3.9	1,569	0	0	52	6	3	0
April 1	4.0	3,482	0	0	144	29	5	0
2	4.0	5,759	0	0	102	29	0	0
3	4.0	3,402	0	0	37	28	5	0
4	4.0	2,429	0	0	51	20	1	0
5	4.0	2,536	0	0	42	28	1	0
6	4.0	3,111	0	0	82	18	0	0
7	4.0	3,092	0	0	92	21	4	0
8	4.0	4,026	0	0	72	29	0	0
9	4.0	6,263	0	0	41	34	0	0
10	4.0	2,711	0	0	18	50	0	0
11	4.1	2,184	0	0	27	8	0	0
12	4.2	2,730	0	0	11	2	0	0
13	4.2	3,609	0	0	49	21	0	0
14	4.2	2,722	0	0	14	5	0	0
15	4.3	3,592	0	0	23	2	0	0
16	4.9	4,127	0	0	9	1	0	0
17	5.0	3,719	0	0	14	47	6	0
18	5.2	2,984	0	0	8	76	8	0
19	5.2	4,675	0	0	17	26	1	0
20	5.5	3,653	0	0	14	15	4	0
21	5.1	5,500	0	0	8	76	8	0
22	5.5	7,098	0	0	5	65	6	0
23	5.5	4,857	0	0	12	68	4	0
24	5.6	3,768	0	0	6	19	2	0

-continued-

		Daily counts						
	Water temp	Pink salmon fry	Coho salmon smolts	Sockeye salmon smolts	Chum salmon fry	Dolly Varden	Cut-throat trout	Steel-head
April 25	5.6	4,251	0	0	6	22	1	0
26	6.3	3,188	0	0	3	19	1	0
27	6.4	3,046	0	0	3	22	3	0
28	6.9	4,401	0	0	3	67	0	0
29	7.2	3,358	0	0	5	135	5	0
30	6.1	1,439	0	0	0	212	7	0
May 1	7.2	1,333	1	1	2	57	2	0
2	7.2	939	2	0	2	48	3	0
3	7.9	745	2	1	2	345	9	0
4	8.0	539	10	1	0	491	3	0
5	8.5	545	1	0	0	398	3	0
6	9.0	327	3	0	0	149	2	0
7	9.8	187	8	2	0	96	8	0
8	9.8	153	12	1	0	195	3	0
9	10.7	115	17	3	0	26	2	0
10	11.2	110	30	11	0	410	2	1
11	11.7	51	71	22	0	161	1	0
12	12.2	37	146	39	0	131	2	0
13	12.2	18	291	48	0	425	7	0
14	11.7	8	409	89	0	77	6	0
15	11.5	3	308	23	0	129	2	0
16	11.4	1	528	253	0	184	6	0
17	11.4	0	307	422	0	100	2	0
18	11.4	0	154	274	0	153	8	0
19	10.3	0	498	1341	0	193	6	1
20	10.3	0	226	1002	0	38	4	1
21	10.0	0	248	640	0	32	1	0
22	9.5	0	267	808	0	39	2	1
23	9.0	0	143	996	0	7	2	0
24	9.1	0	133	686	0	20	3	0
25	9.5	0	124	611	0	10	1	0
26	9.5	0	66	375	0	11	2	0
27	10.7	0	105	777	0	14	3	0
28	11.5	0	61	632	0	21	1	0
29	11.2	0	91	404	0	8	1	0
30	11.0	0	86	698	0	14	2	0
31	12.0	0	139	535	0	8	3	0
June 1	13.2	0	61	400	0	6	2	0
2	14.0	0	59	467	0	6	0	0
3	14.8	0	63	468	0	8	3	0
4	15.7	0	50	463	0	0	1	0
5	15.7	0	39	372	0	0	3	0
6	15.5	0	29	167	0	1	2	0
7	15.4	0	16	186	0	1	8	0
8	14.9	0	21	31	0	1	4	1
9	15.1	0	17	51	0	1	3	0
10	15.1	0	9	49	0	0	0	0
11	16.0	0	13	59	0	0	0	0
12	15.5	0	3	55	0	2	2	0
13	16.6	0	4	17	0	0	0	0
14	15.9	0	3	4	0	0	0	0
15	15.4	0	0	9	0	1	4	0
16	15.0	0	1	5	0	0	0	0
17	13.7	0	1	11	0	0	12	1
18	13.7	0	3	33	0	0	1	0

-continued-

		Pink salmon fry	Coho salmon smolts	Sockeye salmon smolts	Chum salmon fry	Dolly Varden	Cut-throat trout	Steel-head
	Water temp							
June 19	13.5	0	1	31	0	1	0	0
20	14.0	0	3	18	0	0	2	0
21	13.0	0	4	15	0	1	7	0
22	12.8	0	0	25	0	0	2	0
23	13.9	0	1	15	0	0	4	0
24	14.9	0	1	20	0	0	2	0
25	16.0	0	0	11	0	0	1	0
26	17.0	0	0	8	0	0	0	0
27	17.7	0	1	5	0	2	0	0
28	17.2	0	1	3	0	0	2	0
29	16.3	0	0	6	0	0	3	0
Totals		132,075	4,891	13,699	1,337	5,254	250	6

Daily counts

Appendix A3.–Daily counts of upstream migrant salmonids at Auke Creek weir, 2000.
Counts do not include sockeye or coho jacks (0-ocean; < 400 mm MEF), or chinook mini-jacks
(0-ocean).

				Daily counts					
	Water temp	Sockeye salmon adults	Pink salmon adults	Chum salmon adults	Coho salmon adults	Chinook salmon adults	Dolly Varden	Cut-throat trout	Steel-head
June 29	16.3	173	0	0	0	0	80	0	0
30	16.2	89	0	0	0	0	12	0	0
July 1	15.8	9	0	0	0	0	0	0	0
2	15.6	21	0	0	0	0	0	0	0
3	15.6	0	0	0	0	0	0	0	0
4	15.9	67	0	0	0	0	0	0	0
5	17.0	0	0	0	0	0	0	0	0
6	17.0	101	0	0	0	0	0	0	0
7	16.9	0	0	0	0	0	0	0	0
8	17.1	0	0	0	0	0	0	0	0
9	17.8	0	0	0	0	0	0	0	0
10	18.1	0	0	0	0	0	0	0	0
11	17.3	0	0	0	0	0	0	0	0
12	17.2	0	0	0	0	0	0	0	0
13	17.2	0	0	0	0	0	0	0	0
14	17.5	0	0	0	0	0	0	0	0
15	17.4	0	0	0	0	0	0	0	0
16	17.0	0	0	0	0	0	0	0	0
17	17.0	0	0	0	0	0	0	0	0
18	16.6	0	0	0	0	0	0	0	0
19	16.1	0	0	0	0	0	0	0	0
20	15.2	1,011	0	16	0	0	174	0	0
21	15.2	307	1	29	0	3	19	0	0
22	15.2	75	0	28	0	0	3	0	0
23	14.9	95	1	43	0	1	6	0	0
24	14.0	102	4	169	0	16	63	0	0
25	14.0	41	7	297	0	18	61	0	0
26	14.2	17	9	398	0	14	35	0	0
27	14.4	9	13	336	0	28	23	0	0
28	14.0	4	4	329	0	0	18	0	0
29	14.1	3	3	205	0	3	2	0	0
30	14.1	3	5	220	0	16	0	0	0
31	14.0	6	13	516	0	6	26	0	0
Aug. 1	13.7	2	7	289	0	14	5	0	0
2	15.1	17	8	155	0	20	23	0	0
3	16.8	7	3	161	0	5	3	0	0
4	16.4	4	0	181	0	11	4	0	0
5	16.3	3	2	77	0	5	4	0	0
6	16.2	0	1	88	0	3	7	0	0
7	16.0	3	3	95	0	0	15	0	0
8	16.0	0	2	115	0	0	5	0	0
9	15.1	1	2	147	0	3	2	0	0
10	16.0	0	3	76	0	2	4	0	0
11	17.0	0	1	24	0	0	4	0	0
12	17.0	1	4	50	0	0	2	0	0

-continued-

	Daily counts							
	Water temp	Sockeye salmon adults	Pink salmon adults	Chum salmon adults	Coho salmon adults	Chinook salmon adults	Dolly Varden	Cut-throat trout	Steel-head
Aug. 13	17.0	0	5	46	0	1	4	0	0
14	16.4	3	8	46	0	0	25	0	0
15	15.0	3	8	46	0	0	25	0	0
16	15.0	26	47	30	0	10	7	0	0
17	14.8	9	37	20	0	0	19	0	0
18	15.0	0	26	11	0	5	8	0	0
19	15.8	2	50	7	0	4	8	0	0
20	14.5	5	76	6	0	6	25	0	0
21	14.0	94	322	31	0	50	136	0	0
22	13.0	82	496	16	0	17	269	0	0
23	13.0	31	275	21	0	29	121	0	0
24	13.5	7	102	14	0	12	71	0	0
25	13.5	0	56	9	0	3	14	0	0
26	13.5	0	50	4	0	7	10	0	0
27	14.0	0	41	1	0	10	2	0	0
28	13.6	3	47	0	0	1	15	0	0
29	13.7	0	27	3	0	0	10	0	0
30	14.4	2	46	1	0	0	7	0	0
31	14.0	1	93	0	0	3	17	0	0
Sept. 1	14.2	5	68	0	0	1	10	0	0
2	13.5	1	45	0	0	13	57	0	0
3	13.4	1	33	0	0	6	38	0	0
4	13.4	1	74	0	0	2	8	0	0
5	12.8	8	200	0	0	4	291	0	0
6	12.8	7	44	0	0	3	116	0	0
7	12.0	2	41	0	1	0	163	0	0
8	12.0	0	10	0	0	2	133	0	0
9	12.0	0	10	0	0	1	25	0	0
10	12.0	1	3	0	0	0	33	0	0
11	11.6	0	4	0	2	0	59	0	0
12	11.8	0	3	0	2	0	33	0	0
13	11.6	0	3	0	44	0	10	0	0
14	10.8	0	2	0	78	0	17	0	0
15	11.0	0	2	0	71	0	35	0	0
16	10.7	0	0	0	50	0	39	0	0
17	10.5	2	1	0	91	0	253	0	0
18	10.6	0	1	0	120	0	269	0	0
19	10.8	0	0	0	68	0	66	2	0
20	10.4	0	1	0	20	0	52	4	0
21	10.2	0	0	0	10	0	49	0	0
22	10.5	0	0	0	11	0	15	9	0
23	10.4	0	0	0	11	0	11	5	0
24	11.0	0	0	0	13	0	12	0	0
25	11.3	0	0	0	11	0	7	3	0
26	11.8	0	0	0	4	0	5	2	0
27	11.1	0	0	0	5	0	3	3	0
28	11.0	0	0	0	6	0	9	11	0

-continued-

		Daily counts							
	Water temp	Sockeye salmon adults	Pink salmon adults	Chum salmon adults	Coho salmon adults	Chinook salmon adults	Dolly Varden	Cut-throat trout	Steel-head
Sept. 29	10.7	0	0	0	18	0	18	0	0
30	10.1	0	0	0	11	0	8	0	0
Oct. 1	9.6	0	0	0	4	0	6	0	0
2	9.3	0	0	0	3	0	20	10	1
3	9.0	0	0	0	0	0	4	2	0
4	8.7	0	0	0	2	0	4	3	1
5	9.0	0	0	0	1	0	1	0	0
6	9.0	0	0	0	5	0	10	14	2
7	8.8	0	0	0	7	0	7	2	0
8	8.8	0	0	0	6	0	4	1	0
9	8.5	0	0	0	5	0	22	2	0
10	8.5	0	0	0	0	0	6	0	0
11	8.5	0	0	0	0	0	3	1	0
12	8.7	0	0	0	1	0	7	2	0
13	8.5	0	0	0	1	0	48	8	0
14	8.6	0	0	0	0	0	16	1	0
15	8.4	0	0	0	1	0	24	3	0
16	8.1	0	0	0	0	0	6	2	0
17	8.1	0	0	0	0	0	5	0	0
18	8.0	0	0	0	0	0	2	0	0
19	7.8	0	0	0	0	0	38	1	0
20	7.8	0	0	0	0	0	27	4	0
21	7.7	0	0	0	0	0	14	1	0
22	7.6	0	0	0	0	0	0	0	0
23	7.5	0	0	0	0	0	34	2	0
24	7.6	0	0	0	0	0	2	0	0
25	7.4	0	0	0	0	0	10	0	0
26	7.2	0	0	0	0	0	6	0	0
27	7.1	0	0	0	0	0	6	1	0
28	6.8	0	0	0	0	0	1	0	0
29	6.7	0	0	0	0	0	25	1	0
30	6.6	0	0	0	0	0	3	0	0
31	6.6	0	0	0	0	0	8	0	0
Nov. 1	6.2	0	0	0	0	0	3	0	0
2	6.1	0	0	0	0	0	3	2	0
3	6.2	0	0	0	0	0	2	2	0
4	6	0	0	0	0	0	5	0	0
5	5.9	0	0	0	0	0	4	0	0
6	5.8	0	0	0	0	0	1	0	0
7	5.8	0	0	0	0	0	1	1	0
Total		2,480	2,491	4,444	683	377	3,665	105	4

Appendix A4.–Summary statistics for the Jolly-Seber model, Auke Lake.

Year	n_i	m_i	R_i	r_i	z_i
All fish ≥180 mm FL					
1998	89	0	89	22	0
1999	279	18	279	76	4
2000	212	80	212	0	0
Fish 180-220 mm FL					
1998	75	0	75	21	0
1999	244	17	244	75	4
2000	198	79	198	0	0
Fish >220 mm FL					
1998	16	0	16	3	0
1999	35	2	35	2	1
2000	14	3	14	0	0

n_i = number of fish caught in sample i.

m_i = number of marked fish caught in sample i.

R_i = number returned to the population alive with marks from sample i.

r_i = number caught in sample i which are recaptured later.

z_i = number not caught in sample i which were previously captured and are recaptured later.

Appendix A5.–Capture histories for the Jolly-Seber model, Auke Lake, 1998–2000.

Capture history[a]	Frequency		
	Fish 180-220 mm FL	Fish >220 mm FL	All fish ≥180 mm FL
0,0,1	198	14	212
0,1,0	171	34	205
0,1,1	73	1	74
1,0,0	54	13	67
1,0,1	4	0	4
1,1,0	15	1	16
1,1,1	2	0	2

[a] A "0" signifies not captured during that particular sampling event while a "1" signifies a capture; i.e., a capture history of 1,1,0 represents a group of fish that were captured during the 1st and 2nd sampling events and not captured during the 3rd event.

Appendix A6.–List of computer data files for studies at Auke Creek weir in 2000.

Data file	Description
Cut00.xls	Excel file of length information for downstream and upstream cutthroat trout, Auke Creek weir, 2000.
Down2000.xls	Excel file of the counts of downstream migrant salmonids at Auke Creek weir, 2000.
DV2000.xls	Excel file of the lengths of marked and unmarked Dolly Varden moving downstream at Auke Creek weir, 2000.
Grwct00.xls	Excel file of recovered tagged cutthroat trout with lengths and growth information for the 2000 field season.
Lake00-1.xls	Excel file of cutthroat trout PIT tagging information for Trip 1 for the abundance study in Auke Lake, 2000.
Lake00-2.xls	Excel file of cutthroat trout PIT tagging information for Trip 2 for the abundance study in Auke Lake, 2000.
Pit00.xls	Excel file of PIT tagging information from spring tagging and fall recoveries of cutthroat trout at Auke Creek weir, 2000.
Up2000.xls	Excel file of the counts of upstream migrant salmonids at Auke Creek weir, 2000.