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CUTTHROAT TROUT STUDIES: TURNER/FLORENCE LAKES, ALASKA, DURING 1988[1]

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ABSTRACT

Turner Lake southeast of Juneau was examined in 1988 to estimate the size of the cutthroat trout *Oncorhynchus clarki* population, the condition of the population, the angler effort and harvest and the condition of the cutthroat trout in the angler harvest. During our fishing season (8 June - 31 August), six sampling trips, 10 days each, were conducted to Turner Lake and a total of 575 cutthroat trout were marked and released. The population estimate for cutthroat trout in Turner Lake was 1,753, with approximate 95% confidence interval limits of 871 to 2,635 trout. Fish in Turner Lake were in good condition, in comparison with other Southeast Alaska lakes, with an average condition factor of 1.01 (standard error = 0.01). Harvest studies showed catch per unit effort to be comparable with other studies done in Turner Lake in 1985. We estimated a total of 722 angler-hours (standard error = 560) during our presence at the lake and a harvest of 193 cutthroat trout (standard error = 155), 106 (standard error = 134) Dolly Varden *Salvelinus malma*, and 91 (standard error = 94) kokanee *Oncorhynchus nerka*.

One sampling trip was conducted into Florence Lake to map the lake bottom contours and to sample cutthroat trout lengths, weights, and ages. During the three day Florence Lake trip catch rates were very good compared with Turner Lake and a total of 84 cutthroat trout were caught. The average condition factor of the 84 cutthroat trout was 0.92 (standard error = 0.01).

KEY WORDS: Southeast Alaska, cutthroat trout, *Oncorhynchus clarki*, Dolly Varden char, *Salvelinus malma*, kokanee, *Oncorhynchus nerka*, Turner Lake, Florence Lake, hydroacoustics, condition factor, capture-recapture population estimation, catch per unit effort, Jolly-Seber population estimator, Anderson-Darling *K*-sample goodness-of-fit-test, closure test, CAPTURE computer program, RECAP computer program, bootstrap confidence intervals.

INTRODUCTION

Trophy class cutthroat trout *Oncorhynchus clarki* five pounds and larger are rare in Southeast Alaska. Of the thousands of watersheds in the region very few are known to have significant numbers of large cutthroat trout. Turner Lake near Juneau (Figure 1) is one of those few and was recently selected as the site of a sockeye salmon *Oncorhynchus nerka* enhancement project to supplement the commercial gillnet harvest in the Taku Inlet area (McNair 1987).

Turner Lake is located in upper Taku Inlet 26 km east of Juneau. The lake is 14 km long and has a surface elevation of just over 22 m. Turner Lake is very steep sided except near the inlet streams and totals about 1,270 ha in surface area. The maximum depth is 215 m (Figure 2) with a mean depth of 30 m (Schmidt 1979). The lake outlet flows about 1,700 m from the lake to Taku Inlet and is blocked to upstream fish passage by a barrier falls just below the lake.

The Department of Fish and Game, Fisheries Rehabilitation Enhancement and Development Division (FREDD) has scheduled Turner Lake for stocking between 5 and 10 million juvenile sockeye salmon annually. The eggs for stocking will be taken from the sockeye run to Chilkoot Lake near Haines. The Chilkoot Lake sockeye stock is large enough to support several years of egg takes at the proposed levels and has favorable run timing characteristics for supplementing the Taku gillnet fishery. The sockeye salmon eggs are scheduled to be taken in the fall of 1989, incubated in a special facility at the Snettisham Hatchery and the resulting fry released as soon as Turner Lake is ice free in the spring of 1990 (McNair 1987).

Preliminary research in Turner Lake by Schmidt (1979) and investigations by Joyce (1986) provide no insights on the abundance, recruitment rates, or harvest rates of large cutthroat trout populations. Therefore, the expected impact from the enhancement project on existing cutthroat trout populations cannot be evaluated without additional research.

A primary concern in Turner Lake is the potential for competition between age-0 cutthroat trout and planted sockeye salmon fry (age-0) and fry from existing kokanee *Oncorhynchus nerka* stocks. Sockeye salmon fry (and kokanee) can compete with young cutthroat trout for plankton (Marnell 1988), which can be an important food for juvenile cutthroat trout (Gresswell and Varley 1988; Gerstung 1988). Sockeye salmon fry and kokanee are very efficient open water planktivores (Leathe and Graham 1981). Since cutthroat trout fry emerge in late summer, age-0 cutthroat trout will enter the lake up to two months after the sockeye salmon fry stocking. After feeding for the summer, sockeye salmon fry will be larger and more competitive for existing plankton resources, particularly during the subsequent winter months when other food sources (like terrestrial insects) are limited.

According to Schmidt (1979) cutthroat trout rely heavily on kokanee as a food source once the cutthroat trout reach a size (fork length) of about 240 mm. Other studies on cutthroat trout stocks indicate that cutthroat trout switch to a piscivorous diet between 300 mm (Gerstung 1988) to as large as 386 mm (Nielson and Lentsch 1988). The larger cutthroat trout that have shifted to a piscivorous

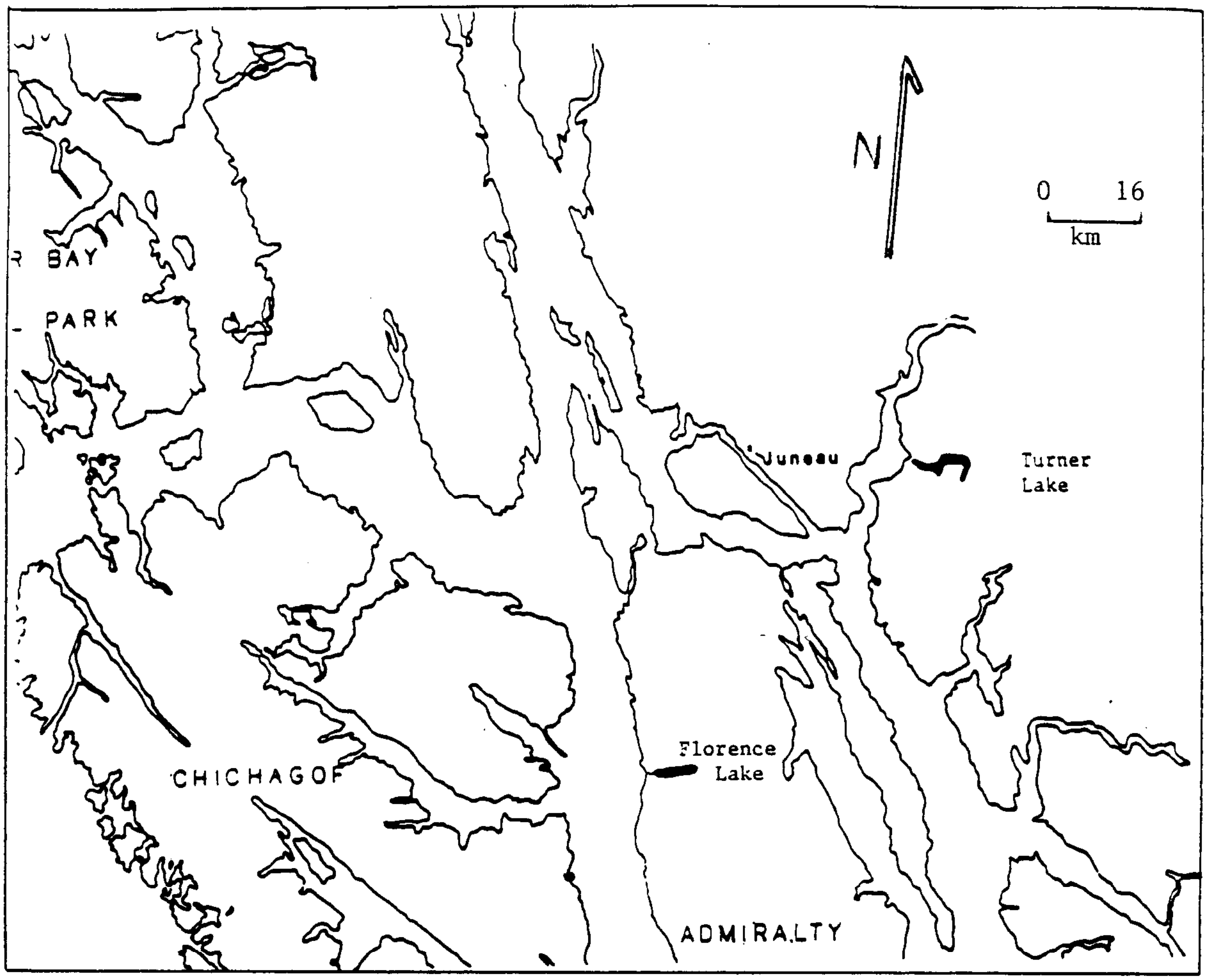

Figure 1. Map of the Juneau area showing the location of Turner and Florence lakes.

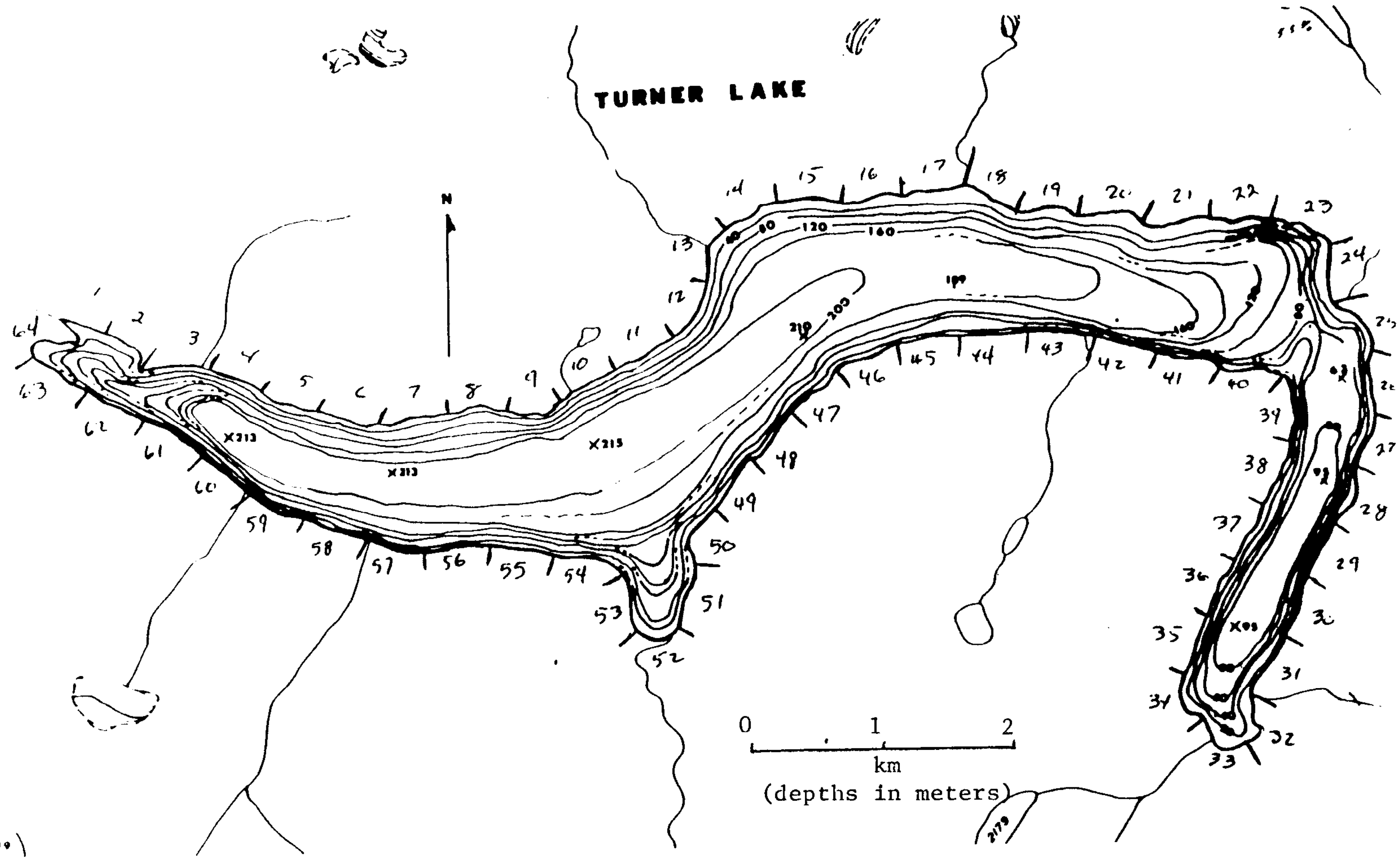

Figure 2. Turner Lake Bathymetric Map with the 1988 study area locations.

diet in Turner Lake may benefit from increased food availability as a result of the introduction of large numbers of sockeye salmon fry.

In Florence Lake, the proposed clear cut logging is expected to strip the watershed around the lake of all marketable timber. The potential impacts of the logging and associated road building on the lake and its fishery resources are unknown. There might be an increase in angler use due to increased accessibility. An increase in siltation in the lake may also occur. Studies by Jones (1982) in Florence Lake included habitat mapping, but work on the cutthroat trout population was limited to lengths and ages for 30 fish. No estimate was obtained for the abundance of the cutthroat trout population.

Florence Lake is located on the west side of Admiralty Island about 50 kilometers southwest of Juneau. Florence Lake is a narrow lake approximately 7.2 kilometers long with a maximum depth of just over 27 meters (Figure 3). The lake outlet flows about 1 kilometer into Chatham Straits directly across from Tenakee Inlet. There is a barrier falls about 400 meters upstream of Chatham Straits.

Florence Lake is one of the most popular fly-in lakes in Southeast Alaska. It now supports over 4,000 visitor days (United States Forest Service, personal communication) of use annually and provides some of the best cutthroat trout fishing in the region. The Florence Lake watershed is scheduled for extensive clear cut logging in the next two to four years (Shee Atika Corporation, P.O.Box 1949, Sitka, Ak. 99835, personal communication with James Senna).

The only harvest information available prior to this study for Turner or Florence lakes comes from the Statewide Harvest Survey program (Mike Mills, ADF&G, 333 Raspberry Road, Anchorage, AK 99518, personal communication). The surveys indicate harvests ranging from a low of 42 cutthroat trout in 1983 (Mills 1984), to a high of 882 in 1979 (Mills 1981) in Turner Lake. In Florence Lake, the surveys show harvests ranging from 112 cutthroat in 1986 (Mike Mills, ADF&G, Anchorage, personal communication) to 1,727 in 1979 (Mills 1981).

Another concern in both lake systems, is that the number of reported visitor days at both Turner and Florence lakes have nearly doubled in the past 15 years. Increased recreational use and increasing expertise of anglers in catching cutthroat trout could deplete these valued populations and reduce recruitment rates.

Since Turner and Florence lakes are designated as "High Quality or Important Watersheds" by both the Department of Fish and Game and the U.S. Forest Service (TLMP 1979), they should be managed for their unique biological and recreational characteristics. This project was designed to provide base-line information needed to conserve and manage the high-value cutthroat trout fisheries in these important fly-in lake systems.

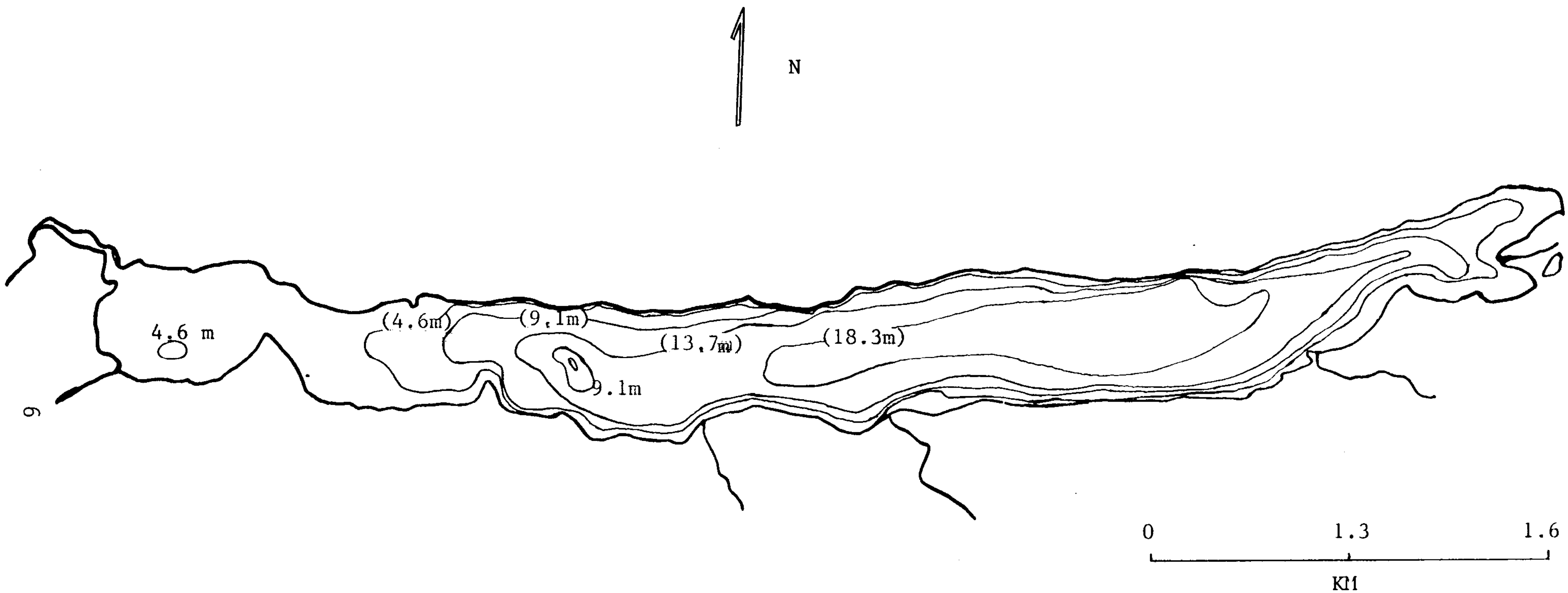

Figure 3. Florence Lake Bathymetric Map.

OBJECTIVES

1. Develop and implement methods and techniques for estimating the abundance of littoral and pelagic cutthroat trout in Turner and Florence Lakes during the 1988 field season.

2. Estimate the age and size composition of littoral and pelagic cutthroat trout in Turner and Florence Lakes during the 1988 field season.

3. Estimate the size composition of cutthroat trout observed in the angler catch at Turner Lake during July, August, and September 1988.

METHODS

Population Estimates

Fish were captured for this study using baited funnel traps, gill nets (both baited and unbaited), surface long lines and sport gear. The baited traps were of two sizes, the large traps were 1.5 m in length, 0.6 m in diameter, with a 9 cm opening the funnels at each end of the trap and a mesh size of 1 cm. The small funnel traps were 44 cm long and 23 cm wide, with 4 cm openings and a mesh size of 0.6 cm. The gill nets were 38.1 m long, 1.8 m deep and consisted of five 7.6 m panels of stretched mesh sizes 12.7 mm, 19.1 mm, 25.4 mm, 38.1 mm, and 50.8 mm. Surface long lines consisted of a synthetic floating line about 30 m long with baited hooks on monofilament leaders clipped onto the surface line at 1.8 m intervals. Sport gear was rod and reel with a small lure or spinner attached as bait.

Each captured cutthroat trout over 200 mm was tagged with a uniquely numbered floy-type anchor tag, adipose fin clipped, measured from the tip of snout to fork of tail (fork length) to the nearest millimeter, weighed (nearest two grams), a smear of scales were removed from each cutthroat trout (from just forward of a line from the posterior portion of the dorsal fin to the anterior portion of the anal fin just over the lateral line), and then the fish were released back into the capture area. Cutthroat trout under 200 mm were too small to conveniently tag so each was fin clipped with a clip unique to each sampling trip. Stomach samples were taken from a subsample of the cutthroat trout and kokanee catch only in Turner Lake. The stomach contents were preserved in 10% buffered formalin for later identification and enumeration. Dolly Varden *Salvelinus malma* and kokanee were all weighed, measured for fork length to the nearest millimeter. Scale smears (from the same preferred area as in the cutthroat trout above) were taken from the kokanee only, because Dolly Varden scales are very difficult to read. The scales were selected to cover the full size range of fish sampled over the season.

During each sample period, all captured fish under about 180 mm were anesthetized with tricaine methanesulfonate (MS222). Each fish over that size range was anesthetized using an electroshock basket (Gunstrom and Bethers 1985) prior to processing to prevent the possibility of any fish being caught for consumption in the recreational fishery with residual amounts of MS222 in their systems.

The bait used in the funnel traps and on the baited gillnets was Borax treated salmon eggs. The bait was secured inside the traps in perforated plastic sample jars which allowed water to permeate the bait but protected it from being eaten by the fish. The gillnets had salmon eggs hung loose through the mesh at several places along the net to attract fish. We found that by baiting the gillnets and keeping sets to one-half hour or less the variable mesh gillnets were more effective and mortality was reduced.

Six sampling trips were conducted into Turner Lake from early June through August. Florence Lake was visited for one four day period in early August to evaluate catch rates, sizes of fish, and the possibility of conducting more extensive population work there in 1989.

Temperature profiles were run during each sampling occasion in the center of the lake, midway in the lake directly out from the large waterfall on the north shore. Temperatures were taken at the surface and at each one meter interval to 12 meters depth.

The shoreline of Turner Lake was divided into 64 sections (Figure 2) to allow us to track the movements of tagged fish. As each fish was caught, the area of capture was recorded. Information on the degree of movement and population mixing was needed to evaluate and select the appropriate population estimation method. Distance traveled was estimated by measuring the shortest distance (from point to point) from the tagging location to the recovery location.

Hydroacoustic surveys were conducted in Turner Lake from 21-24 July and from 4-5 August, using dual beam hydroacoustic methods similar to those described by Burczynski and Johnson (1986). Transects were established at approximately 0.8 km intervals along the lake. The transects were run once during the night and twice during daylight hours to see if there were diurnal differences in fish abundance and depth.

The assumption that all size classes of Turner Lake cutthroat trout had equal probability of capture was tested. We compared the cumulative empirical distribution function (cedf) of lengths of fish from the first four sampling trips (group 1) with the cedf of recaptured trout during the last two occasions (group 2). An empirical quantile-quantile plot was used to evaluate the degree of similarity between these two cedf's (Chambers, et al. 1983). Then we tested the hypothesis of no difference between the cedf's using the K-sample Anderson-Darling test (Scholz and Stephens 1987). The nature of discrepancy between the two cedf's as indicated by the empirical quantile-quantile plots as then used to establish size classes for stratified mark-recapture estimates, if necessary. If these analyses indicated that size-selectivity occurred then we stratified the population into size classes for further abundance estimation.

In addition, the closed population capture-recapture computer program CAPTURE (White et al. 1982) was used to evaluate the capture histories of cutthroat trout caught in Turner Lake. The CAPTURE program was also used to test the closure hypothesis (whether the population is subject to birth, recruitment, emigration, immigration, or death). Details on testing procedures and appropriate formulae are contained in White et al. (1982) and Otis et al. (1978). CAPTURE indicated an open population so we used the Jolly-Seber type estimator as provided in the computer program RECAP. RECAP uses a modified Jolly-Seber estimator and the bootstrap resampling procedure (Efron and Gong 1983) to obtain non-parametric confidence intervals (Buckland 1980, 1982).

<u>Population Status</u>

Paired length and weight samples were taken from each captured fish (see <u>Population Estimates</u> section above). Relative condition of the population at the time of sampling was measured by condition factor (K) using the following formula:

$$K = \text{Weight(g)} \times 10^5 \; / \; \text{Fork Length (mm)}^3 \qquad [1]$$

We also calculated an estimate of the mean, standard deviation, and 95% confidence interval using the bootstrap resampling procedure (Efron and Gong 1983; Efron and Tibshirani 1985). One thousand replicate samples of size n were randomly selected from the data, where n was equal to the number of data points in the original sample. The data points were sampled with replacement so any one point could theoretically be selected several times or not at all. These bootstrap estimates were used to evaluate the bias of the standard (normal approximation) estimation procedures. If the bias was insignificant then the normal approximation procedure was used for confidence interval construction.

Age composition was estimated by adjusting the observed proportions in each age class from our samples by the estimated population abundance in our length-defined strata (noted above). The adjustment procedure is initiated by estimating the conditional fractions from our samples:

$$p_{ij} = n_{ij}/n_i \qquad [2]$$

where

n_i = the number sampled from i^{th} stratum in the mark-recapture experiment;

n_{ij} = the number sampled from i^{th} stratum that belong to j^{th} group; and

p_{ij} = the estimated fraction of the fish in j^{th} group in i^{th} stratum.

Note that $\sum_j p_{ij} = 1$. The variance for p_{ij} is:

$$V[p_{ij}] = \frac{p_{ij}(1 - p_{ij})}{n_i - 1} \qquad [3]$$

The estimated abundance of j^{th} group in the population (N_j) is:

$$N_j = \sum_i p_{ij} N_i \qquad [4]$$

where N_i = the estimated abundance in i^{th} stratum of the mark-recapture experiment. The variance for N_j is a sum of the exact variance of a product from Goodman (1960):

$$V[N_j] = \sum_i (V[p_{ij}]N_i^2 + V[N_i]p_{ij}^2 - V[p_{ij}]V[N_i]) \qquad [5]$$

The estimated fraction of the population that belongs to j^{th} group (p_j) is:

$$p_j = N_j/N \qquad [6]$$

where $N = \Sigma N_i$. The variance of the estimated fraction can be approximated with the delta method (see Seber 1982):

$$V[p_j] \approx \sum_i V[p_{ij}] \left\{ \frac{N_i}{N} \right\}^2 + \frac{\Sigma V[N_i] \; (p_{ij} - p_j)^2}{N^2} \qquad [7]$$

Angler Effort and Harvest

Information explaining this study was placed in each of the U.S. Forest Service recreational cabins at Turner Lake with voluntary data forms requesting harvest information. The forms requested information on the date, number of anglers, hours spent fishing, numbers of fish caught, numbers of fish released, and fork length of fish harvested.

We also conducted periodic angler interviews and recorded the number of anglers, the number of hours fished by each angler, and the number of fish taken. Harvested cutthroat trout were checked for the presence of a floy tag or missing adipose fin, and lengths (fork length in mm) were taken on each fish, scales removed from the preferred area, and otoliths removed when possible.

Since we only conducted one three day trip into Florence Lake, little creel census work was conducted there. One contact was made with anglers from the east cabin.

Due to the sparsity (e.g., some days had estimates of angler effort but no CPUE estimates, or vice versa) of the creel data we were not able to estimate the variance components associated with either the between angler or the between day portions of the effort, harvest, or CPUE estimates. Accordingly we were only able to estimate variance components for the between biweekly period portions. As such in the following equations only the between biweekly period variance components are defined.

The first step in obtaining harvest estimates for the 1988 Turner Lake cutthroat trout creel census involves estimating the "angler-residency rate", as follows:

$\hat{r}$ = angler-residency rate;

$$= \sum_{h=1}^{q}\left(\sum_{i=1}^{n_h}(a_{hi})\right) \div \sum_{h=1}^{q}\left(\sum_{i=1}^{n_h}(p_{hi})\right) \quad [8]$$

h = subscript denoting biweekly period;

q = number of biweekly sample periods;

i = subscript denoting day sampled within the biweekly period;

n_h = number of days sampled within the h^{th} biweekly period;

a_{hi} = number of different people actually observed fishing on the i^{th} day within the h^{th} biweekly period; and

p_{hi} = number of people for all cabin-parties in the US Forest Service (USFS) reservation list for the i^{th} day sampled (note this only includes data for the days in which we sampled the fishery).

The variance for the angler-residency rate was obtained by using the approximate formula for the variance of a ratio of random variates (Jessen 1978, equation 5.8, page 128, omitting the finite population correction factor):

$\hat{V}(\hat{r})$ = variance estimate for the angler-residency rate estimate;

$$\approx \{(\bar{a} \div \bar{p})^2\}\ \{(s_a^2 \div \bar{a}^2) + (s_p^2 \div \bar{p}^2) - [(2\mathrm{cov}(p,a)) \div (\bar{a}\ \bar{p})]\} \quad [9]$$

$\bar{a}$ = mean number of anglers observed fishing over all biweekly periods;

$$= \left(\sum_{h=1}^{q}\left(\sum_{i=1}^{n_h} a_{hi}\right)\right) \div q \quad [10]$$

$\bar{p}$ = mean number of people for all cabin-parties in the reservation list over all biweekly periods;

$$= \left(\sum_{h=1}^{q}\left(\sum_{i=1}^{n_h} p_{hi}\right)\right) \div q \quad [11]$$

s_a^2 = between period variance component for the number of anglers observed fishing;

$$= \left(\sum_{h=1}^{q} \left[\left(\sum_{i=1}^{n_h} a_{hi} \right) - \bar{a} \right]^2 \right) \div (q - 1) \qquad [12]$$

s_p^2 = between period variance component for the number of people with reservations; and

$$= \left(\sum_{h=1}^{q} \left[\left(\sum_{i=1}^{n_h} p_{hi} \right) - \bar{p} \right]^2 \right) \div (q - 1) \qquad [13]$$

cov(a,p) = the covariance between the number of anglers fishing and the number of people with reservations.

$$= \left(\sum_{h=1}^{q} \left\{ \left[\left(\sum_{i=1}^{n_h} a_{hi} \right) - \bar{a} \right] \left[\left(\sum_{i=1}^{n_h} p_{hi} \right) - \bar{p} \right] \right\} \right) \div (q - 1) \qquad [14]$$

The next step involves estimating the angler effort in angler-days:

$\hat{P}$ = estimated number of angler-days expended in the fishery;

$$= p\hat{r} \qquad [15]$$

p = the total number of people-days reserved (from the USFS reservation list);

$$= \sum_{h=1}^{q} \left(\sum_{x=1}^{14} (p_{hx}) \right) \qquad [16]$$

x = subscript denoting day in the biweekly period; and

p_{hx} = number of people with reservations for all cabins combined for the x^{th} day of the h^{th} biweekly period.

The variance of this estimate is obtained by the standard formula for the product of a constant and a variance (Lehmann 1975, equation A.19, page 330):

$\hat{V}(\hat{P})$ = variance estimate of the estimated number of angler-days expended in the fishery.

$$= p^2\hat{r} \qquad [17]$$

The next step involves evaluating the relationship between angler effort in angler-days (as obtained above) and angler effort in terms of angler-hours, as follows:

$\bar{e}$ = mean effort in angler-hours per angler expended by anglers who reported an entire angler-day's effort information (i.e, angler-hours per angler-day);

$$= \sum_{h=1}^{q}\left(\sum_{i=1}^{n_h}(e_{hi})\right) \div \sum_{h=1}^{q}\left(\sum_{i=1}^{n_h}(o_i)\right) \quad [18]$$

e_{hi} = sum of hours fished by all anglers interviewed on the i^{th} day, who reported their entire angler-days effort;

$$= \sum_{j=1}^{o_i}(e_{hij}) \quad [19]$$

j = subscript denoting the angler interviewed;

o_i = number of anglers interviewed, who reported their entire angler-days effort; and

e_{hij} = angler-hours expended by the j^{th} angler interviewed.

The variance for the angler-hours per angler-day estimate was obtained by using the approximate formula for the variance of a ratio of random variates:

$\hat{V}(\bar{e})$ = variance estimate for the angler-hours per angler-day estimate;

$$\approx \{(\bar{e}_{.}\div\bar{o}_{.})^2\}\{(s_e^2\div\bar{e}_{.}^2)+(s_o^2\div\bar{o}_{.}^2)-[(2\mathrm{cov}(e,o))\div(\bar{e}_{.}\bar{o}_{.})]\} \quad [20]$$

$\bar{e}_{.}$ = mean number of angler-hours over all biweekly periods;

$$= \left(\sum_{h=1}^{q}\left(\sum_{i=1}^{n_h} e_{hi}\right)\right) \div q \quad [21]$$

$\bar{o}_{.}$ = mean number of angler-days all biweekly periods;

$$= \left(\sum_{h=1}^{q}\left(\sum_{i=1}^{n_h} o_i\right)\right) \div q \quad [22]$$

s_e^2 = between period variance component for angler-hours;

$$= \left(\sum_{h=1}^{q} \left[\left(\sum_{i=1}^{n_h} e_{hi}\right) - \bar{e}. \right]^2 \right) \div (q - 1) \qquad [23]$$

s_o^2 = between period variance component for angler-days; and

$$= \left(\sum_{h=1}^{q} \left[\left(\sum_{i=1}^{n_h} o_i\right) - \bar{o}. \right]^2 \right) \div (q - 1) \qquad [24]$$

$cov(e,o)$ = the covariance between the angler-hours and angler-day components.

$$= \left(\sum_{h=1}^{q} \left\{ \left[\left(\sum_{i=1}^{n_h} e_{hi}\right) - \bar{e}. \right] \left[\left(\sum_{i=1}^{n_h} o_i\right) - \bar{o}. \right] \right\} \right) \div (q - 1) \qquad [25]$$

The next step involves estimating the catch (or harvest) per angler-hour:

$\hat{t}$ = catch per angler-hour estimate;

$$= \sum_{h=1}^{q} \left(\sum_{i=1}^{n_h} (c_{hi}) \right) \div \sum_{h=1}^{q} \left(\sum_{i=1}^{n_h} (e_{hi}) \right) \qquad [26]$$

c_{hi} = sum of fish caught by all anglers interviewed within the i^{th} day during the h^{th} biweekly period; and

$$= \sum_{j=1}^{o_i} (c_{hij}) \qquad [27]$$

c_{hij} = catch (or harvest) of the j^{th} angler interviewed.

The variance of the catch or harvest rate estimate was estimated using the approximate formula for the ratio of random variates:

$\hat{V}(\hat{r})$ = variance estimate for the catch or harvest rate estimate;

$$\approx \{(\bar{c}. \div \bar{e}.)^2\}\{(s_c^2 \div \bar{c}.^2) + (s_e^2 \div \bar{e}.^2) - [(2cov(c,e)) \div (\bar{c}.\bar{e}.)]\} \qquad [28]$$

$\bar{c}.$ = mean catch or harvest over all biweekly periods;

$$= \left(\sum_{h=1}^{q} \left(\sum_{i=1}^{n_h} c_{hi} \right) \right) \div q \qquad [29]$$

s_c^2 = between period variance component for catch or harvest; and

$$= \left(\sum_{h=1}^{q} \left[\left(\sum_{i=1}^{n_h} c_{hi} \right) - \bar{c}. \right]^2 \right) \div (q - 1) \quad [30]$$

cov(c,e) = the covariance between the catch or harvest and effort (angler-hours).

$$= \left(\sum_{h=1}^{q} \{ [(\sum_{i=1}^{n_h} c_{hi}) - \bar{c}.][(\sum_{i=1}^{n_h} e_i) - \bar{e}.] \} \right) \div (q - 1) \quad [31]$$

The next step involves estimating the angler effort in angler-hours by combining the estimates obtained above:

$\hat{E}$ = estimated angler-hours expended by all anglers.

$$= \hat{P}\bar{e} \quad [32]$$

The variance of this estimate is obtained using the equation proposed by Goodman (1960) for the estimation of the variance of a product of two random independent variates:

$\hat{V}(\hat{E})$ = estimated variance of the angler-hour estimate.

$$= \hat{P}^2\hat{V}(\bar{e}) + \bar{e}^2\hat{V}(\hat{P}) - \hat{V}(\bar{e})\hat{V}(\hat{P}) \quad [33]$$

The final step involves estimating the catch or harvest by combining the above estimates:

$\hat{C}$ = estimated catch (and/or harvest).

$$= \hat{E}\hat{t} \quad [34]$$

The variance of this estimate is obtained using the equation for the estimation of the variance of a product of two random independent variates:

$\hat{V}(\hat{C})$ = estimated variance of the catch or harvest estimate.

$$= \hat{E}^2\hat{V}(\hat{t}) + \hat{t}^2\hat{V}(\hat{E}) - \hat{V}(\hat{t})\hat{V}(\hat{E}) \quad [35]$$

RESULTS

Population Estimates

A total of 728 cutthroat trout, 457 Dolly Varden, and 205 kokanee were captured during the six sampling trips into Turner Lake (Table 1). The total number of cutthroat trout marked and released this season in Turner Lake was 575. The computer program CAPTURE (White et al. 1982) indicated that the closure hypothesis was rejected ($z = -2.349$, $p=0.0094$), indicating an open population. The program indicated that the best model for the data was M_t[2] which is one of the models with which the closure test works properly so the closure test is probably valid. As a result, we used the RECAP computer program to estimate a Jolly-Seber population estimate.

The K-sample Anderson-Darling test comparing the cedf of newly captured trout from periods 1 through 4 (group 1) with the cedf of those trout from group 1 recaptured during subsequent occasions (group 2) indicated that we did have size selectivity (with $A^2_{akn}= 3.3319$, $\sigma^2_N = 0.5758$, and $T_{aKN} = 3.073$, with the critical value for T_{aKN} of 1.96). The empirical quantile-quantile plot indicated that we were size selective, such that we captured fish from three size categories at different rates (Figure 4). Fish under approximately 200 mm at one rate, a different recapture rate for fish between 200 mm and 300 mm, and another for fish over 300 mm. As a result, we partitioned the population mark and recapture information by these three categories and estimated the cutthroat trout population for each size category separately.

The first sample period was eliminated (due to "nonsense" parameter estimates with this occasion included and because of the small sample of fish) in the small and middle size categories (the ≤200 mm category and the >200 mm and ≤300 mm category) and RECAP was run on the remaining five sample periods (periods 2-6). The first sample period was one with very low catches, probably due to a combination of at least two factors. The average water temperature (from the surface to 12 meters depth) during the first period was 7.7 °C (Table 2) which was between 2.5°C and 4.4°C, lower than during any other occasion; and we were still learning how and where to catch cutthroat trout in Turner Lake.

Samples for the largest size category in Turner Lake (>300 mm) were merged into three sample groups by combining periods 1 and 2, 3 and 4, and 5 and 6. The sample periods were combined due to the low numbers of large fish in any one sample period.

Combining the estimates from all three size categories (Tables 3-5) for the average numbers of fish alive results in a population average of 1,753 cutthroat trout alive in Turner Lake during this study (95% confidence interval (C.I.) limits: 871 - 2,635 trout). The estimated number of live cutthroat trout in the ≤200 mm size category alive between occasions 2 and 4 was 605 (95% C.I. limits: 273 - 1,394, Table 3). In the category >200 mm and ≤ 300 mm, the estimated average number of trout alive between occasions 2 and 4 was 968 (95%

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[2] M_t is a model that allows for time specific changes in capture probabilities.

Table 1. Effort (hours), catch, and catch per unit effort (CPUE, fish per hour) by period, gear, and species for 1988 Turner Lake sampling.

			Cutthroat Trout		Dolly Varden		Kokanee	
Period	Gear	Effort	Catch	CPUE	Catch	CPUE	Catch	CPUE
1	Gillnet	5.7	5	0.87	2	0.35	19	3.32
	Hook and Line	26.7	9	0.34	-	-	3	0.11
(June 8	Large Trap	1,677.4	22	0.01	223	0.13	19	0.01
to	Small Trap	1,674.9	9	0.01	40	0.02	-	-
June 17)	Trot Line	-	-	-	-	-	-	-
	Total	3,384.7	45	0.01	265	0.08	41	0.01
2	Gillnet	8.4	7	0.83	1	0.12	18	2.14
	Hook and Line	14.0	6	0.43	-	-	-	-
(June 28	Large Trap	1,682.6	49	0.03	85	0.05	12	0.01
to	Small Trap	1,665.2	8	0.00	22	0.01	-	-
July 7)	Trot Line	17.6	30	1.71	1	0.06	-	-
	Total	3,387.8	100	0.03	109	0.03	30	0.01
3	Gillnet	22.1	39	1.76	2	0.09	38	1.72
	Hook and Line	9.4	15	1.60	-	-	-	-
(July 13	Large Trap	1,651.6	20	0.01	26	0.02	4	0.00
to	Small Trap	1,623.1	-	-	2	0.00	-	-
July 21)	Trot Line	14.6	25	1.72	-	-	-	-
	Total	3,320.8	99	0.03	30	0.01	42	0.01
4	Gillnet	37.7	98	2.60	1	0.03	45	1.19
	Hook and Line	18.7	42	2.24	-	-	3	0.16
(July 26	Large Trap	327.7	30	0.09	5	0.02	-	-
to	Small Trap	-	-	-	-	-	-	-
Aug 3)	Trot Line	-	-	-	-	-	-	-
	Total	384.1	170	0.44	6	0.02	48	0.12

- Continued -

Table 1. Effort (hours), catch, and catch per unit effort (CPUE, fish per hour) by period, gear, and species for 1988 Turner Lake sampling (Continued).

			Cutthroat Trout		Dolly Varden		Kokanee	
Period	Gear	Effort	Catch	CPUE	Catch	CPUE	Catch	CPUE
5	Gillnet	16.6	54	3.25	2	0.12	19	1.14
	Hook and Line	13.2	15	1.13	-	-	1	0.08
(Aug 9	Large Trap	728.3	46	0.06	11	0.02	-	-
to	Small Trap	109.9	1	0.01	12	0.11	-	-
Aug 15)	Trot Line	-	-	-	-	-	-	-
	Total	868.0	116	0.13	25	0.03	20	0.02
6	Gillnet	15.8	88	5.56	3	0.19	23	1.45
	Hook and Line	35.6	68	1.91	1	0.03	1	0.03
(Aug 23	Large Trap	1,249.2	42	0.03	15	0.01	47	0.04
to	Small Trap	153.0	-	-	6	0.04	-	-
Aug 31)	Trot Line	-	-	-	-	-	-	-
	Total	1,453.6	198	0.14	25	0.02	71	0.05
Total	Gillnet	106.4	291	2.73	11	0.10	162	1.52
	Hook and Line	117.6	155	1.32	1	0.01	8	0.07
	Large Trap	7,316.8	209	0.03	365	0.05	82	0.01
	Small Trap	5,226.0	18	0.00	82	0.02	-	-
	Trot Line	32.1	55	1.71	1	0.03	-	-
	Total	12,799.0	728	0.06	460	0.04	252	0.02

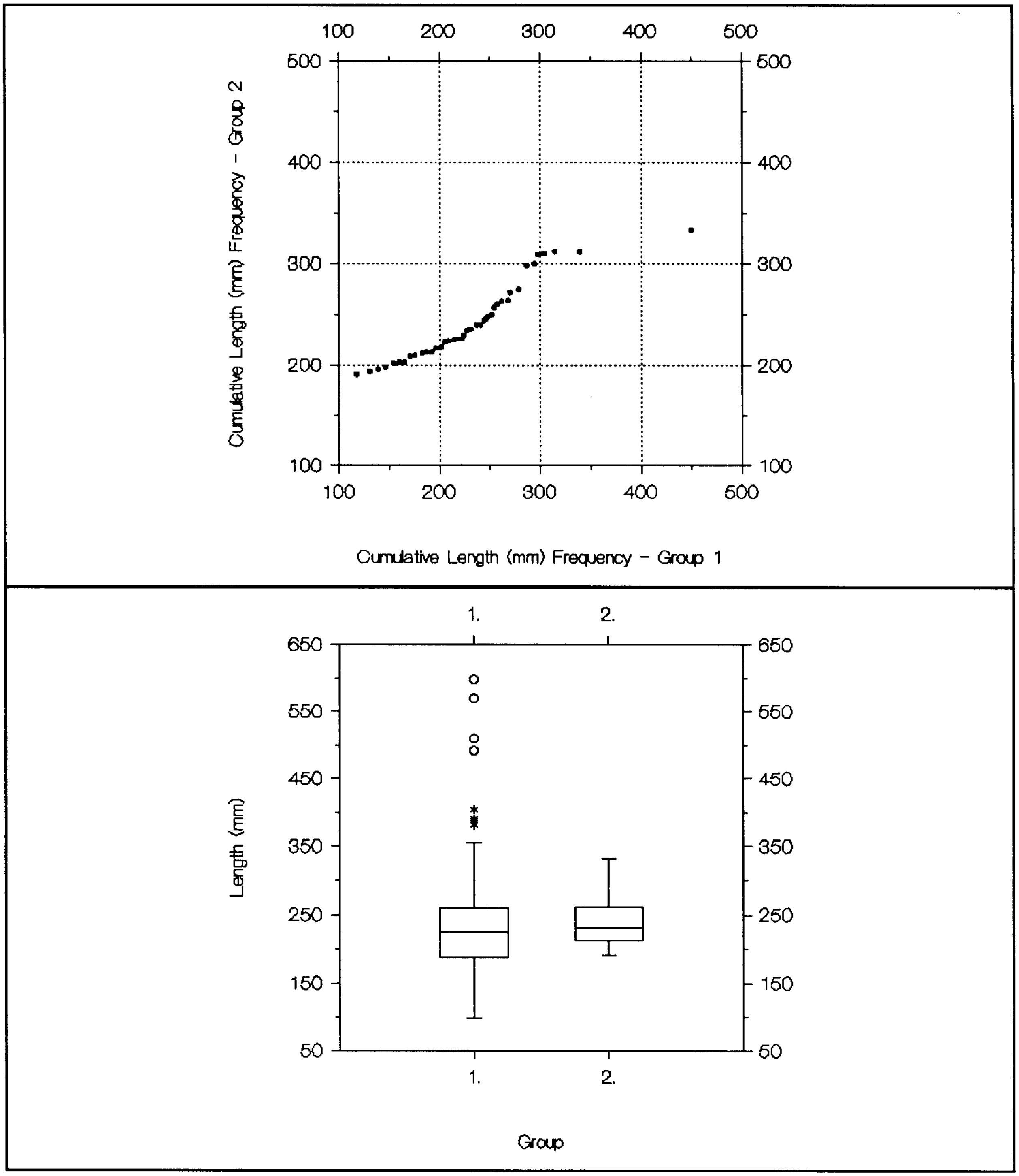

Figure 4. Q-Q and box plot of lengths of Turner Lake cutthroat trout by group. Group 1 includes trout newly captured during occasions 1-4, whereas group 2 includes trout recaptured from group 1 during occasions 5-6. The upper frame presents the Q-Q plot, which is a plot of the interpolated lengths of group 1 fish at the length associated with the cumulative frequency percentiles of the group 2 fish. The curvature on both ends of the plotted points in the upper frame indicates size selectivity: relatively fewer of both the "smaller" and "larger" trout were recaptured than expected. The lower plot presents a Tukey-type box plot of the observed lengths of each group, further supporting the size selectivity conclusion: few very small or large trout recaptured. Refer to Chambers, et al. (1983) for details on the graphical procedures used.

Table 2. Temperature (°C) profiles from Turner Lake, 1988.

Depth (meters)	Date: 11 Jun	02 Jul	17 Jul	01 Aug	13 Aug	28 Aug
0	11.2	13.1	13.9	14.8	13.5	14.0
1	10.0	13.0	13.9	14.2	13.6	14.0
2	9.8	13.0	13.8	14.1	13.5	13.9
3	9.0	13.0	13.0	13.8	13.4	13.8
4	8.1	11.1	12.0	13.0	13.0	13.7
5	7.9	10.9	11.0	12.4	12.0	12.4
6	7.3	10.0	10.2	11.8	11.0	12.0
7	7.0	9.1	10.0	10.9	10.5	11.4
8	6.5	8.9	9.8	10.1	10.1	11.0
9	6.0	8.2	9.1	9.5	10.0	10.9
10	6.0	8.0	9.0	9.3	9.9	10.4
11	5.8	7.2	8.1	9.0	9.9	10.0
12	5.8	7.0	7.9	8.6	9.1	9.9
Mean	7.7	10.2	10.9	11.7	11.5	12.1
S.E.[1]	0.5	0.6	0.6	0.6	0.5	0.4

[1] Standard error.

Table 3. Summary of marks, recaptures, and population estimates with 95% confidence intervals by sample period for cutthroat trout ≤200 mm in Turner Lake, 1988.

	Capture Occasion[1]					
	1	2	3	4	5	6
Captured, marked, and released						
Newly marked fish	9	34	15	52	43	66
Recaptures from						
period 1	0	0	0	0	0	0
period 2	---	3	0	0	1	0
period 3	---	---	0	1	3	1
period 4	---	---	---	1	3	10
period 5	---	---	---	---	1	2
period 6	---	---	---	---	---	3
periods 3 & 5	---	---	---	---	0	1
periods 4 & 5	---	---	---	---	0	2
periods 4 & 6	---	---	---	---	---	1
Captured and died						
Newly marked fish	1	3	1	4	1	5
Recaptures from						
period 2	---	---	1	0	0	1
Total Catch	10	40	17	58	52	92
Removed by anglers						
Recaptures from						
period 4	---	---	---	---	---	1
Jolly-Seber Population Estimate (using only occasions 2-6)						
95% CI lower limit	---	---	17	200	340	---
Point	---	---	157	830	826	---
95% CI upper limit	---	---	417	1,860	1957	---
Estimated average number of animals alive between occasion 2 & 4				605		
95% CI lower limit				273		
95% CI upper limit				1,394		

[1] Occasion #1 8 June - 17 June; #2 28 June - 7 July; #3 13 July - 21 July; #4 26 July - 3 August; #5 9 August - 15 August; #6 23 August - 31 August

Table 4. Summary of marks, recaptures, and population estimates with 95% confidence intervals by sample period for cutthroat trout >200mm and ≤300mm in Turner Lake, 1988.

	Capture Occasion[1]					
	1	2	3	4	5	6
Captured, marked, and released						
Newly marked fish	24	37	58	76	43	67
Recaptures from						
period 1	1	0	5	2	2	0
period 2	---	1	1	2	5	2
period 3	---	---	1	5	2	3
period 4	---	---	---	4	2	9
period 5	---	---	---	---	0	7
period 6	---	---	---	---	---	3
periods 1 & 3	---	---	0	1	0	0
periods 2 & 3	---	---	0	1	1	0
periods 1 & 4	---	---	---	0	1	0
Captured and died						
Newly marked fish	0	12	7	8	4	1
Recaptures from						
period 3	---	---	0	1	1	0
period 4	---	---	---	1	1	1
Total Catch	25	50	72	101	59	93
Removed by anglers						
Recaptures from						
period 1	---	---	---	1	---	---
period 2	---	---	---	2	---	---
period 3	---	---	---	4	---	2
period 4	---	---	---	2	---	0
period 5	---	---	---	---	---	1
Jolly-Seber Population Estimate (using only occasions 2-6)						
95% CI lower limit	---	---	341	530	282	-
Point	---	---	1,071	1,064	770	-
95% CI upper limit	---	---	1,751	1,717	1691	-
Estimated average number of animals alive between occasion 2 & 4				968		
95% CI lower limit				547		
95% CI upper limit				1,652		

[1] Occasion #1 8 June - 17 June; #2 28 June - 7 July; #3 13 July - 21 July; #4 26 July - 3 August; #5 9 August - 15 August; #6 23 August - 31 August

Table 5. Summary of marks, recaptures, and the population estimate with 95% confidence interval by combined sample period for cutthroat trout >300mm in Turner Lake, 1988.

	Capture Occasion		
	1	2	3[1]
Captured, marked, and released			
Newly marked fish	15	18	15
Recaptures from			
period 1	1	0	0
period 2	---	2	3
period 3	---	---	1
period 2 & 2	---	1	---
Captured and died			
Newly marked fish	1	1	1
Total Catch	17	22	20
Removed by anglers			
Recaptures from			
period 1	---	2	---
period 2	---	1	---
period 3	---	---	2
Jolly-Seber Population Estimate (using only occasions 1-3)			
Point		180	
95% CI lower limit		21	
95% CI upper limit		380	

[1] Occasion #1 8 June - 7 July
#2 13 July - 3 August
#3 9 August - 31 August

C.I. limits: 547 - 1,652, Table 4) and the estimate for > 300 mm cutthroat trout was 180 (95% C.I. limits: 21 - 380, Table 5).

A total of 102 floy tagged fish were recovered during the season and most had moved, some significantly, during the period from tagging to recapture. One fish was at large for 60 days and moved from one end of the lake to the other and several moved from one shoreline to the other. Of the 102 recoveries, 54 or 52.9% had moved 2.0 km or more from tagging to recapture. The hydroacoustic work showed fish out in the middle of the lake on several transects which would also indicate that they are very mobile. No indication of shoreline orientation was seen during the hydroacoustic surveys, fish were observed at substantial depths (up to 80 meters deep, 260 feet) in the middle of some of the longest transects. This information indicates that we have one large, well mixed population of cutthroat trout, rather than small sub-populations.

We evaluated the hypothesis of equal capture probability for cutthroat trout in different areas of the lake. A contingency table analysis comparing the ratio of recaptures by lake section in periods 4, 5, and 6 from fish tagged in the first three periods (1, 2, and 3) with the total number of fish captured during periods 4, 5, and 6 was used to test this hypothesis (Table 6). This analysis indicated that all three areas of the lake had similar rates of recapture (i.e., we failed to reject the null hypothesis of equal probablility of capture, $G = 0.328$, $p = 0.849$).

Only one trip was conducted into Florence Lake (8 August through 11 August) and since only two fish were recaptured, no population estimate was made. A total of 84 cutthroat trout were caught, marked, and released during the three day period. Two kokanee were observed in angler harvest (both were caught on bobbers and worms) but none were collected in our sampling.

Cutthroat trout catch rates in Florence Lake were excellent for the three day period we were there. A total of 88 cutthroat were caught in Florence Lake, and most of that total was caught on hook and line gear.

<u>Population Status</u>

A total of 728 pairs of length and weight were collected from cutthroat trout in Turner Lake in 1988. The lengths for all fish ranged from 31 mm (1.2 inches) to 598 mm (23.5 inches) (Table 7). Weights ranged from 7 g (0.02 lbs) to 2100 g (4.6 lbs.). The mean condition factor for Turner Lake cutthroat trout was 1.01 (standard error = 0.01), with a range from 0.68 to 1.35 (Table 8).

Based on our sampling this past season and trophy fish that have been voluntarily turned over to us, we estimate that it takes a cutthroat trout over nine years to reach trophy size (1,360 gm, 3 pounds) in Turner Lake. The length-weight regression from the 1988 sampling indicates that a 1,360 gm (3 pound) cutthroat trout is just over 500 mm (20.3 inches) which is between a nine and ten year old fish (Figure 5).

Table 6. Turner Lake cutthroat trout recaptures in periods 4, 5, and 6 from periods 1, 2, and 3 and the numbers of new fish marked in periods 4, 5, and 6.

	Recaptures from Periods 1,2,& 3	Newly Marked Fish released
North Shore Main Lake	11	147
South Shore Main Lake	12	140
Basin at East end of lake	9	92

Table 7. Length frequencies of cutthroat trout by gear type for Turner Lake, 1988.

Length Increments(mm)	Gear				
	Gillnet	Hook & Line	Large Trap	Small Trap	Trot Line
40	0	0	0	1	0
60	0	0	0	0	0
80	0	0	0	0	0
100	0	0	2	0	0
120	4	2	10	4	0
140	8	6	17	5	3
160	10	14	36	7	1
180	27	17	21	0	1
200	36	24	30	0	3
220	56	27	28	1	8
240	41	12	25	0	17
260	49	19	15	0	7
280	20	12	9	0	5
300	17	15	7	0	6
320	11	2	6	0	1
340	2	2	3	0	2
360	1	1	0	0	0
380	2	3	0	0	0
400	0	3	0	0	1
420	1	0	0	0	0
440	0	0	0	0	0
460	0	0	0	0	0
480	0	0	0	0	0
500	1	0	0	0	0
520	0	1	0	0	0
540	1	0	0	0	0
560	0	0	0	0	0
580	0	1	0	0	0
600	1	0	0	0	0
Total	298	160	209	18	55

Table 8. Comparison of condition factors (K^1) of cutthroat trout, Dolly Varden, and kokanee from Ella, Manzanita, Wilson, Lower Wolf, Turner, and Florence Lakes.

Cutthroat Trout

Lake	Year	N	$\bar{K}$	Minimum - Maximum	Standard Error
Ella[2]	1977	24	0.84	0.45 - 1.19	0.03
Manzanita[2]	1977	27	0.88	0.64 - 1.28	0.03
Wilson[2]	1977	50	1.05	0.81 - 2.09	0.03
Lower Wolf[3]	1987	223	1.02	0.41 - 3.01	0.01
Turner[2]	1977	25	1.02	0.74 - 1.32	0.02
Turner[4]	1985	151	1.03	0.50 - 2.88	0.02
Turner	1988	736	1.01	0.68 - 1.35	0.00
Florence	1988	88	0.92	0.54 - 1.20	0.01

Dolly Varden

Lake	Year	N	$\bar{K}$	Minimum - Maximum	Standard Error
Ella[2]	1977	3	1.35	0.87 - 2.31	0.48
Manzanita[2]	1977	21	0.95	0.73 - 1.71	0.04
Wilson[2]	1977	3	0.85	0.74 - 1.03	0.09
Turner[2]	1977	27	0.94	0.82 - 1.06	0.01
Turner[4]	1985	199	0.90	0.52 - 1.96	0.01
Turner	1988	457	0.95	0.73 - 1.42	0.04

- Continued -

Table 8. Comparison of condition factors (K^1) of cutthroat trout, Dolly Varden, and kokanee from Ella, Manzanita, Wilson, Lower Wolf, Turner and Florence Lakes (Continued).

Kokanee

Lake	Year	N	$\bar{K}$	Minimum - Maximum	Standard Error
Ella[2]	1977	11	1.00	0.87 - 1.35	0.05
Wilson[2]	1977	1	1.03	-	-
Turner[2]	1977	18	1.03	0.89 - 1.15	0.02
Turner[4]	1985	166	1.10	0.94 - 1.24	0.00
Turner	1988	205	1.07	0.77 - 1.34	0.01

1 $$K = \frac{\text{Weight(gm)} \times 10^5}{\text{Length(mm)}^3}$$

2 Schmidt 1979.
3 Hubartt and Bingham 1988.
3 Joyce 1986.

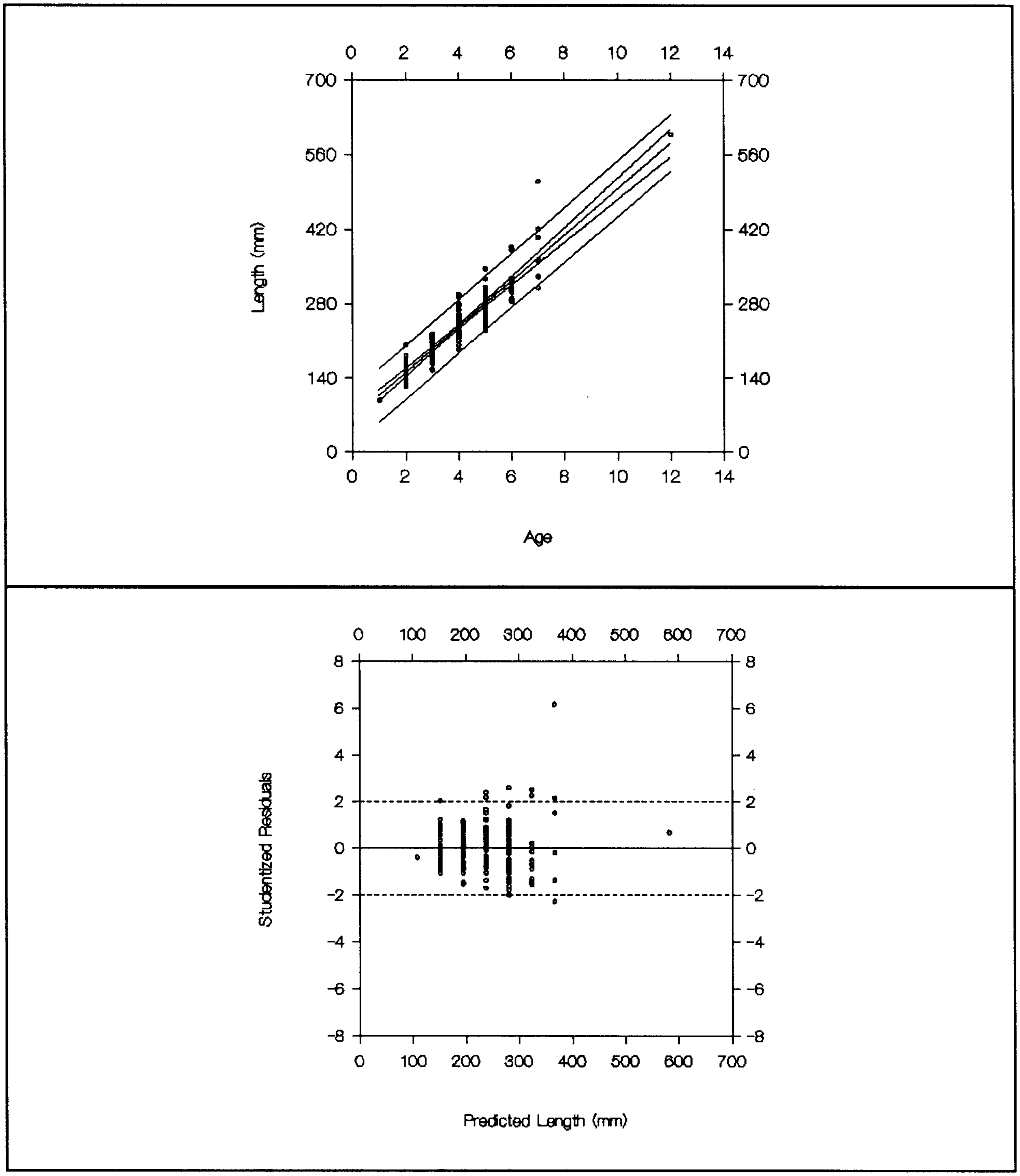

Figure 5. Turner Lake cutthroat trout length at age relationship and residual scatterplots. The upper frame presents the observed data points as well as the predicted relationship with error bands. The regression equation is: length = 64.77 + 43.13(age); with the following associated statistics: R^2 = 0.85; F = 1,085 with 1 and 192 degrees of freedom; $p < 0.001$. The inner error bands in the upper frame represent the 95% confidence interval about the mean predicted values, whereas the outer error bands represent the 95% confidence interval about an individual predicted value. The lower frame presents the studentized residuals against the predicted values, indicating that one of the data points is a probable outlier. This point was included in the analysis.

A total of 194 cutthroat trout have been aged with the youngest being age 1 and the oldest 12 years of age. The only fry we encountered in our sampling were caught in mid to late August and they were caught near one of the two primary inlet streams. The majority of the fish we caught in our sampling were two to five years of age (Table 9). The adjusted proportions indicated that ages 3-5 predominated.

In Florence Lake, 88 cutthroat trout length and weight pairs were collected using hook and line. Average cutthroat trout lengths from the Florence Lake sampling (194.8 mm, 7.7 inches) were 40.2 mm smaller than the average trout lengths observed at Turner Lake in similar hook and line sampling. Trout lengths in our catches at Florence Lake ranged from 57 mm (2.2 inches) to 343 mm (13.5 inches). Weights from the 88 cutthroat averaged 83.1 g (0.18 lbs.) with a range from 1 g (0.002 lbs.) to 300 g (0.66 lbs.). The mean condition factor was 0.92 (standard error = 0.01), which is below the average condition factor seen this past season at Turner Lake (Table 8).

The average length of the 457 Dolly Varden in Turner Lake was 196.3 mm (7.7 inches), with a range from 81 mm (3.2 inches) to 380 mm (15.0 inches). In weight, the Dolly Varden averaged 82.9 g (0.2 lbs.) and ranged from 4 g (0.01 lbs) up to a maximum of 450 g (0.99 lbs.). The mean condition factor for Dolly Varden was 0.95 with a range from 0.73 to 1.42 (Table 8).

The 205 kokanee caught in Turner Lake averaged 190.3 mm in length (7.5 inches), ranging from 118 mm (4.6 inches) to 225 mm (8.9 inches). Kokanee weights averaged 75.5 g (0.17 lbs.) and ranged from 17 g (0.04 lbs.) to 128 g (0.28 lbs). Condition factors for kokanee averaged 1.07 with a range from 0.77 to 1.34 (Table 8).

Angler Effort and Harvest

We documented a total of 539.5 angler hours for 86 anglers from both voluntary returns and interviews (Table 10). Anglers caught a total of 295 cutthroat trout, 124 Dolly Varden, and 247 kokanee. Of the total catch, 151 (51.2%) of the cutthroat trout, 45 (36.3%) of the Dolly Varden, and 179 (72.5%) kokanee were released. Expanding the observed catches yields an estimated catch of 395 cutthroat trout, 166 Dolly Varden, and 331 kokanee caught from 6 June to 28 August, 1988, in Turner Lake (Table 11).

Population Status in the Angler Harvest

A total of 93 cutthroat trout, 32 Dolly Varden, and 28 kokanee lengths were collected during the season from the angler harvests. The majority of the lengths for all three species were reported on the voluntary creel census forms by anglers, we sampled nine cutthroat and two kokanee for length and weight during interviews. We supplied a meter/yard stick for each cabin to allow anglers to measure their own fish for the voluntary creel census forms.

Cutthroat trout in the angler harvest averaged 326 mm (12.8 inches) (standard error = 11.4 mm), which is 91 mm (3.6 inches) larger than the sizes we observed in our hook and line sampling in Turner Lake. This is a significant difference

Table 9. Turner Lake cutthroat trout age composition estimates during 1988. Proportions adjusted for gear selectivity bias.

Age	Number Sampled	Proportion	Adjusted Proportion	Adjusted SE
1	1	0.005	0.002	0.028
2	29	0.149	0.053	0.758
3	42	0.216	0.094	0.348
4	54	0.278	0.152	1.404
5	48	0.247	0.118	1.092
6	13	0.067	0.016	0.149
7	6	0.031	0.003	0.088
12	1	0.005	0.001	0.015

Table 10. Summary of the Turner Lake sampled creel data from 6 June to 28 August, 1988.

Biweekly Sample Period	# of Anglers	Total # of Angler Hours	Cutthroat trout		Kokanee		Dolly Varden	
			Caught	Released	Caught	Released	Caught	Released
12	24	60.5	40	11	2	2	12	7
13	0	0.0	0	0	0	0	0	0
14	8	62.0	52	40	49	37	4	4
15	23	185.0	65	26	41	30	86	19
16	21	184.0	108	62	151	106	21	15
17	10	48.0	30	12	4	4	1	0
Total	86	539.5	295	151	247	179	124	45

Table 11. Estimated angler effort, catch (kept and released), and harvest by species for the Turner Lake fishery from 6 June to 28 August, 1988.

Season Totals and estimates	
Effort (angler-days)	
Point estimate	149.89
Variance estimate	12,180.63
Standard error	110.37
Mean angler-hours/angler-day	
Point estimate	4.82
Variance estimate	2.98
Standard error	1.73
Total angler-hours	
Point estimate	722.03
Variance estimate	313,330.70
Standard error	559.76
Cutthroat trout kept-rate (per angler-hour)	
Point estimate	0.2669
Variance estimate	0.008167
Cutthroat trout released-rate (per angler-hour)	
Point estimate	0.2799
Variance estimate	0.032776
Dolly Varden kept-rate (per angler-hour)	
Point estimate	0.1464
Variance estimate	0.053558
Dolly Varden released-rate (per angler-hour)	
Point estimate	0.0834
Variance estimate	0.000842
Kokanee kept-rate (per angler-hour)	
Point estimate	0.1260
Variance estimate	0.018295
Kokanee released-rate (per angler-hour)	
Point estimate	0.3318
Variance estimate	0.092618

Season Totals and estimates	
Cutthroat trout kept (harvest)	
Point estimate	193
Variance estimate	24,022
Standard error	155
Cutthroat trout released	
Point estimate	202
Variance estimate	31,363
Standard error	177
Dolly Varden kept (harvest)	
Point estimate	106
Variance estimate	17,859
Standard error	134
Dolly Varden released	
Point estimate	60
Variance estimate	2,355
Standard error	49
Kokanee kept (harvest)	
Point estimate	91
Variance estimate	8,783
Standard error	94
Kokanee released	
Point estimate	240
Variance estimate	53,757
Standard error	232

(Students *t*-test, $t = -7.23$, $df = 133$, $p = 0.0001$) and it was expected because the anglers tend to target on larger fish and tend not keep most of the smaller fish they catch. The size range of the cutthroat trout in the angler harvest was 127 mm (5 inches) to 648 mm (25.5 inches).

The 32 Dolly Varden observed in the Turner Lake angler harvest averaged 244 mm (9.6 inches) (standard error = 10.3 mm) with a range of 127 mm (5.0 inches) to 381 mm (15 inches). This compares with an average size of 196 mm (7.7 inches) observed in our sampling program with all gear types combined. We caught only one Dolly Varden with hook and line gear so no comparisons can be done between our hook and line sampling and the anglers.

The average length of the 28 kokanee in the angler harvest was 208 mm (8.2 inches) (standard error = 6.3 mm) with a range of 152 mm (6.0 inches) to 254 mm (10 inches). Like the cutthroat and Dolly Varden, the kokanee in our samples averaged smaller than the kokanee we observed in the angler harvest. The kokanee in our sampling (all gears combined, we only caught 7 kokanee with hook and line) averaged 190 mm (7.5 inches) which is 17.3 mm (0.7 inches) smaller.

We were able to compute condition factors only on the nine cutthroat trout and two kokanee that we measured and weighed, the anglers voluntary returns included only length. The cutthroat trout condition factor in the angler harvest averaged 1.01 which very close to the condition factor from cutthroat caught in our sampling program. The condition factor of the two kokanee sampled in the angler harvest were 1.00 and 1.05.

DISCUSSION

The cutthroat trout population in Turner Lake was smaller than we had anticipated considering the size of the lake and its popularity as a trophy class cutthroat system. Other studies on cutthroat trout populations in lakes around Southeast Alaska (Table 12) by Jones (1981, 1982) also indicated that cutthroat trout populations were relatively small. One factor that may be influencing the size of the Turner Lake cutthroat trout population is the relatively small amount of rearing area for the fry. The lake is very steep and deep and a large part of the shoreline is sheer rock which provides little cover for the smaller fish. Since no other population estimates have been done in Turner Lake in the past, the only comparison we can make at this time is with the catch per unit effort (CPUE) information collected by Joyce (1986) in 1985. CPUE from our angler surveys show an average catch rate of 0.55 fish per hour in 1988 which is comparable to the rate found by Joyce of 0.44 cutthroat trout per hour. The comparable catch rates indicate that the population may not have changed dramatically during that three year period.

In our sampling, which started in early June, a marked increase in our hook and line catch rates was noted between the first sampling occasion and the subsequent occasions. One short trip was conducted back into the lake in early October to sample kokanee for FRED Division. With three of us hook and line fishing one morning during that trip (9.75 angler hours), we only caught one cutthroat trout

Table 12. Estimated population size of resident cutthroat trout in five lakes in Southeast Alaska.

Lake	Area (ha)	Year	Population Estimate	95% Confidence Limits Lower	Upper
Turner Lake	1,270	1988	1,753	871	2,635
Jims Lake[1]	112	1980	2,816	1,908	5,373
Harvey Lake[2]	160	1979	669	NA	NA
Virginia Lake[2]	258	1979	5,631	4,710	6,998

[1] Jones 1982.
[1] Jones 1981.

(0.10 fish/hour) and no cutthroat trout were caught in some of the areas that had been most productive during the summer. Surface water temperatures had cooled back to the nearly the levels we recorded in early June and apparently the fish either move away from the nearshore shallow areas or are less available to hook and line gear.

In addition to our routine sampling during the season, we returned to Turner Lake on 6 October to look for spawning kokanee for Infectious Hematopietic Necrosis Virus (IHNV) samples for FRED Division. We started at the head of the east arm of Turner Lake and found no evidence of spawning kokanee in either of the small inlet streams. After a series of empty surface gillnet sets we tried sinking the gillnet to the lake bottom in about 12 m of water approximately 100 m off a small inlet stream. We caught a total of 67 female and 13 male spawning and post spawning kokanee in four sets at that location. Samples from the 80 fish were tested at the ADF&G Pathology Laboratory and all tested negative for IHNV and Bacterial Kidney Disease (BKD).

On our first sinking gillnet set (looking for kokanee) we also caught a 10 year old cutthroat trout (541 mm and 1900 gm), one of the largest of the season. The trout had a whole adult kokanee in its stomach and the tail was protruding out of the cutthroat's mouth.

We only saw two fish in spawning condition this field season and both of these were females. Prior to the start of our sampling season we took a one day trip (May 27) into Turner Lake looking for a campsite and caught a very ripe female at the outlet. The second was a large female (570 mm and 1900 gm) also caught on hook and line June 10 off the cliffs on the southeast shoreline. Surveys of the inlets during our sampling trip (June 8 through June 17) revealed no evidence of spawning activity.

Due to the overall low numbers of fish sampled and the gear selectivity problems our estimates of age-at-length and age composition should be used with extreme caution. Collection of additional years of data should be undertaken to obtain a more complete picture of the age and length composition of these populations.

Next season (1989) we will again be conducting field work on Turner Lake and plan to continue the population work and harvest studies. Additional emphasis will be placed on improving the harvest estimates for the period the crew will be present at Turner Lake. We are planning to be in Turner Lake through late July and then will move to Florence Lake to initiate the same type of sampling program there as we conducted at Turner Lake.

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