FISHERY DATA SERIES NO. 90-50

MIGRATORY PATTERNS AND FISHERY CONTRIBUTIONS OF CHILKAT RIVER CHINOOK SALMON[1]

By

Keith A. Pahlke,
Robert D. Mecum,
and
Robert P. Marshall

Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

September 1990

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-5, Job Number S-1-6.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

A total of 35,398 wild juvenile chinook salmon *Oncorhynchus tshawytscha* were coded-wire tagged at three locations in the Chilkat River drainage during 1989. Subtracting estimates for tag loss, 5,293 fish with tag code 4-28-37 were tagged and released on the Tahini River between August 5 and September 24; 20,098 fish with tag codes 4-27-04, 4-27-15, or 4-28-43 were tagged and released on the Kelsall River between September 24 and October 16; and, 9,778 fish with tag code 4-27-10 were tagged and released on the mainstem Chilkat River between October 20 and November 8, 1989. Recovery of the tags will occur in commercial and recreational fisheries sampling programs, and on spawning grounds.

In 1985 and 1986, the Alaska Department of Fish and Game released hatchery reared fry near spawning grounds on the Tahini River, a tributary to the Chilkat River. Tagged chinook salmon from these releases were recovered in commercial and recreational fisheries sampling programs, and on the Tahini River in 1989. Preliminary tag recovery data show that some Chilkat River chinook salmon rear in the inside waters of northern Southeast Alaska and are harvested as both mature and immature fish. Estimates of harvest rates and migratory patterns for a brood year will be available in 1992.

An estimated 25 chinook salmon of Tahini River origin which were 5 years of age (1984 brood stock aged 1.3) were harvested in sport fisheries sampled in 1989. Also, an estimated 57 chinook salmon of Tahini River origin which were 4 years of age (1985 brood stock aged 1.2) were harvested in sport fisheries sampled in 1989. An estimated 147 chinook salmon of Tahini River origin which were 5 years of age (1984 brood stock aged 1.3) were delivered for sale in commercial fisheries sampled in 1989. Also, an estimated 185 chinook salmon of Tahini River origin which were 4 years of age (1985 brood stock aged 1.2) were delivered for sale in commercial fisheries sampled in 1989.

KEY WORDS: Chinook salmon, *Oncorhynchus tshawytscha*, Chilkat River, coded-wire tagging, Monte Carlo, bootstrap, harvest, escapement, juvenile salmon, migration, Southeast Alaska.

INTRODUCTION

The Chilkat River originates in the Yukon Territories, Canada and flows into northern Lynn Canal near Haines, Alaska (Figures 1 and 2). This large, glacial river flows through a broad flood plain, forming numerous, braided stream channels, gravel bars and islands covered with dense stands of willow and cottonwood (Mills et al. 1983). The river supports large populations of sockeye *Oncorhynchus nerka*, chum *O. keta*, and coho salmon *O. kisutch*, and a small population of chinook salmon *O. tshawytscha* that are very important to local recreational, subsistence and commercial drift gill net fisheries.

Chinook salmon returning to the Chilkat River are targeted by a marine recreational fishery and a salmon derby in Haines, Alaska. Because escapements have been small, fishing time, area restrictions, and bag limits have been imposed on the Haines marine recreational fishery since 1987 (Table 1). In 1989, the Haines Chinook Salmon Derby was voluntarily canceled to conserve Chilkat chinook salmon. From 1984 to 1988 an average of 23% of the total Haines area recreational harvest of chinook salmon was caught during the derby (Suchanek and Bingham 1989).

Progress in rebuilding Chilkat River chinook salmon stock(s) has been below expectations (Mecum *In press*). It is possible that these stocks are harvested at immature life stages, in mixed-stock fisheries. In 1988 the Alaska Department of Fish and Game (ADF&G), divisions of Sport and Commercial Fisheries began a coded-wire tagging (CWT) study to document harvest areas and estimate harvests of Chilkat River chinook salmon to commercial and recreational fisheries. Results from the second year of tagging juvenile chinook salmon in the Chilkat River drainage are reported in this document.

Field studies were also conducted in 1989 to estimate an escapement to an important tributary of the Chilkat River (the Tahini River), and estimate the harvest of age 1.2 and 1.3 chinook salmon from the Tahini River to commercial and recreational fisheries sampled in 1989.[1] Contribution estimates are the product of sampling for tagged, hatchery reared, chinook salmon from 1984 and 1985 brood years, which were released into the Tahini River in 1985 and 1986. These tagged fish were sampled in commercial and recreational fisheries in 1989 and in Tahini River escapements to estimate the proportion of tagged fish returning to the river at ages 1.2 and 1.3. An escapement to the Tahini River was estimated with a Petersen marked-recapture study. In this study, fish were captured in a gill net, marked, released, and later counted during surveys to recover CWTed fish on spawning grounds of the Tahini River.

The objectives of the project in 1989 were to:

1. estimate the harvest of Chilkat River chinook salmon in ocean commercial and recreational fisheries;

2. estimate the mean size of juvenile chinook salmon in the Chilkat River;

---

[1] Ages are reported in European notation. The first numeral refers to the number of years of freshwater residence after emergence. The second numeral refers to the number of years of marine residence. The total age is the sum of the two years plus one.

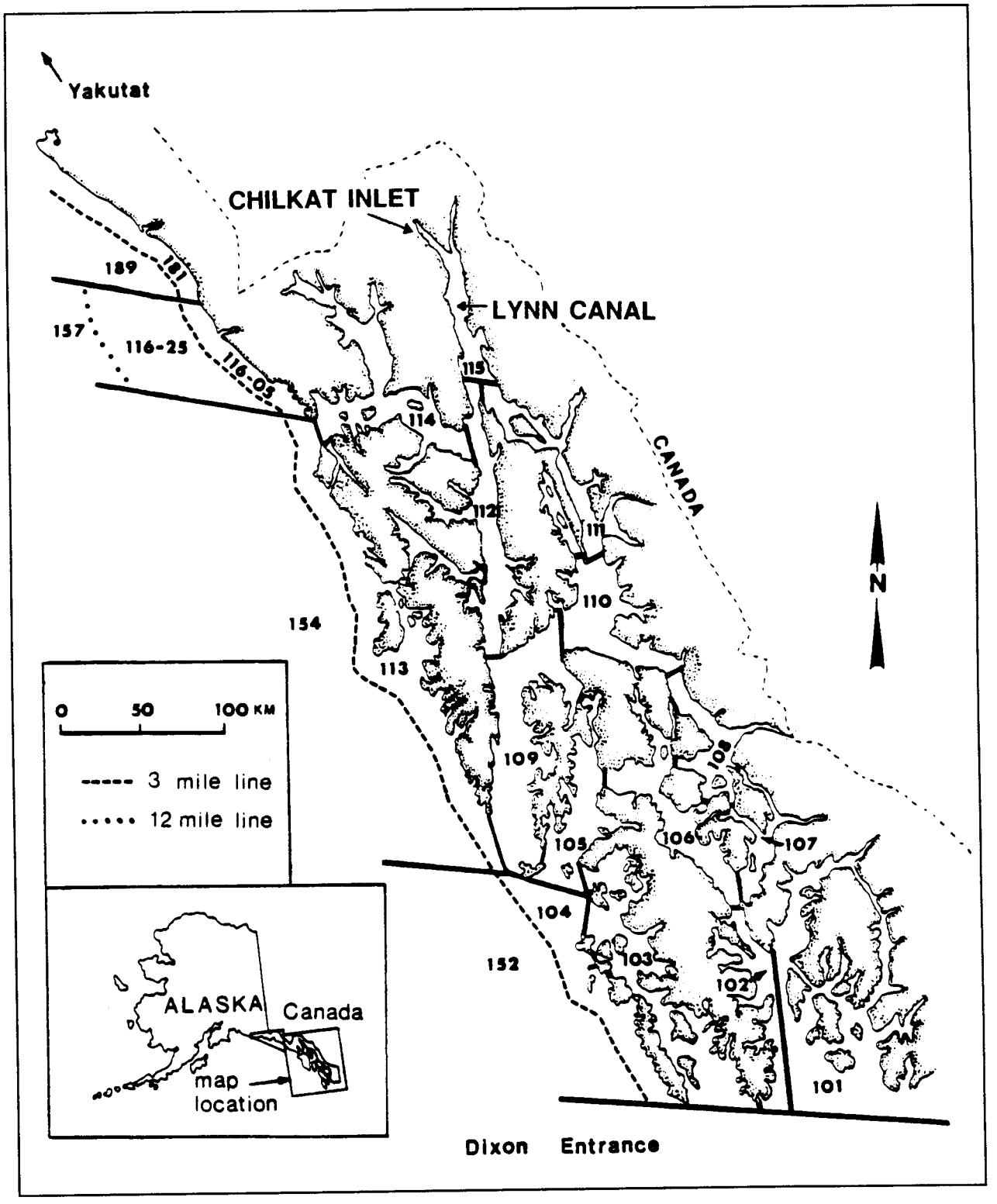

Figure 1. Southeast Alaska commercial fishing districts and statistical areas, including Lynn Canal and Chilkat Inlet.

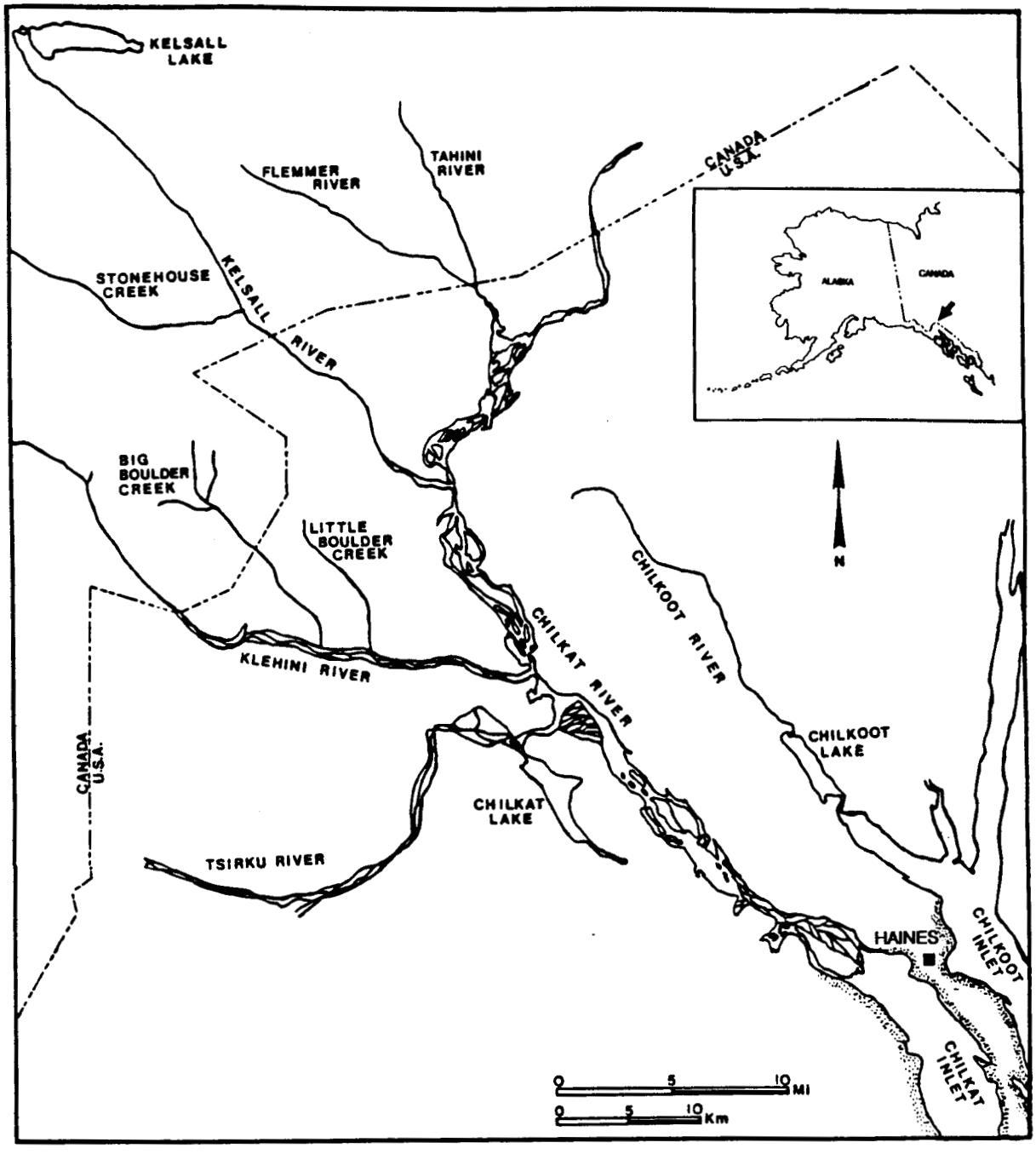

Figure 2. The Chilkat River drainage.

Table 1. Peak escapement counts of chinook salmon in the Chilkat River index areas, angler effort (angler-hours) and harvest of chinook salmon in the Chilkat Inlet marine recreational and District 115 drift gill net fisheries, 1960 to 1989.[a]

	Escapement					Harvest	
Year	Big Boulder[b]	Stonehouse Creek[b]	Total	Drainage Expansion	Angler Effort	Sport	115 Gill net
1960	316 (F)	–	316		–	–	1,453
1961	88 (F)	–	88		–	–	683
1962	–	–	–		–	–	806
1963	–	–	–		–	–	276
1964	–	–	–		–	–	771
1965	–	–	–		–	–	1,735
1966	330 (F)	–	330		–	–	868
1967	150 (F)	–	150		–	–	1,171
1968	259 (F)	–	259		–	–	1,489
1969	–	–	–		–	–	1,618
1970	176 (F)	–	176		–	–	1,771
1971	56 (F)	–	56		–	–	2,929
1972	–	–	–		–	–	986
1973	–	–	–		–	–	2,479
1974	0 (F)	–	0		–	–	1,672
1975	21 (F)	–	21	187	–	–	816
1976	25 (F)	–	25	223	–	–	2,142
1977	25 (F)	–	25	223	–	–	1,214
1978	–	–	–	214	–	–	536
1979	–	–	–	214	–	–	3,572
1980	–	–	–	214	–	–	440
1981	187 (H/F)	69 (H)	256	1,143	–	–	1,300
1982	56 (H/F)	123 (H)	179	799	–	–	5,945
1983	121 (H/F)	126 (H)	247	1,103	–	–	2,119
1984	229 (H/F)	104 (H)	333	1,487	10,250	1,070	6,207
1985	70 (H/F)	50 (H)	120	536	21,600	1,615	3,260
1986	20 (F)	9 (H)	29	129	31,540	1,620	2,772
1987	98 (F)	190 (H)	288	1,286	26,590	1,094	3,223
1988	86 (F)	89 (H)	175	781	36,222	481	1,257
1989	74	231 (H)	305	1,362	10,526	252	1,995

[a] Escapement counts before 1975 may not be comparable because of differences in survey dates and counting methods

[b] (F) = Escapement survey conducted by walking
(H) = Escapement survey conducted by helicopter
(H/F) = Escapement survey conducted by helicopter and by walking
– = No survey conducted or data not comparable

3. estimate the tagged to untagged ratio of the 1989 escapement to the Chilkat River; and,

4. estimate the age composition of the total 1989 return (escapement plus harvest) of chinook salmon to the Chilkat River.

Tagging ratios were only estimated for age 1.2 and age 1.3 fish escaping to the Tahini River during 1989. These estimates provide information required to estimate the harvest of age 1.2 and age 1.3 Tahini River fish to commercial and recreational fisheries sampled in 1989. In future years, tagged to untagged ratios in several streams will be used to estimate fishery contributions from Chilkat River drainage chinook salmon.

METHODS

Coded-Wire Tagging of Juvenile Chinook Salmon

Trapping areas on the lower Tahini River, the Kelsall River, and the mainstem Chilkat River below the Klehini River (Figure 2) were selected on the basis of our accessibility to preferred juvenile chinook salmon habitat (Mecum and Kissner *In press*). Trapping was concentrated on the lower Tahini River first, and then moved downstream as catch rates dropped, to the Kelsall River, and then to mainstem areas. This progression was employed to maximize the number of juveniles tagged.

Juvenile chinook were captured with standard minnow traps (Gee brand) during the summer and fall of 1989. Between 50 and 80 minnow traps baited with clusters of salmon roe were available to fish each day. Salmon roe was disinfected before use, by immersion in a dilute solution of betadyne at a ratio of 1 part betadyne per 90 parts water, for 15 minutes. Traps were checked and re-baited daily.

Juvenile fish were transported from capture sites to a field camp and held in live pens near until tagged in a semipermanent shed. Young-of-the-year (YOY) chinook salmon were anesthetized with tricaine methanesulfonate (MS 222), marked by removal of the adipose fin, and injected with a CWT using a Northwest Marine Technology (NMT) tag injector. The 120 fish/pound head mold was used to tag YOY salmon. A different tag code was used for each area trapped.

The CWT's used in this study were 1.0 mm in length, 0.25 mm in diameter, and made of Type 302 stainless steel. The tags were implanted in the cartilaginous wedge of the fish snout. Tag placement was observed on several chinook salmon each day by making a vertical incision through the dorsal median plane to the oral cavity. Head mold depth was adjusted if improper placement of tags was observed. Bisection and adjustment continued until tags were properly placed. Implanted CWT's were magnetized by dropping tagged fish, head first, through a ring magnet into a bucket of water, and then passing the fish through a NMT field sampling detector to check for the presence of a magnetized tag. Tagged juvenile chinook salmon were released in mainstem areas above or below the areas being trapped at the time of their release to minimize recaptures.

All juvenile chinook salmon with missing adipose fins that were recaptured during the tagging operation were checked with a NMT magnetic tag detector for the presence of a CWT to estimate the percentage of fish that had lost their tags.

The total number of fish released with tags was then estimated from this in-river tag loss percentage.

Once every week during the tagging process about 40 tagged YOY chinook salmon were selected by random grab of a dip net through the catch for the day and measured for length (tip of the snout to the fork of tail to the nearest millimeter). Mean lengths and associated standard errors are calculated with normal procedures (Zar 1974).

Tagging of Juveniles in 1985 and 1986

In 1984 and 1985 chinook salmon eggs were taken from Tahini River fish, incubated and reared in a hatchery, coded-wire tagged, and released back into the Tahini River. Approximately 42,360 fry from brood year 1984 were returned to the Tahini River in May 1985, and 44,120 fry from brood year 1985 were returned in May 1986 (Table 2). Adult chinook salmon from the 1984 brood which are 5 years of age (age 1.3) and fish from the 1985 brood which are 4 years of age (age 1.2) may return to the Tahini River or be harvested in 1989. Sampling for fish with these tags was conducted in 1989.

Estimation of θ, the Fraction of Juvenile Chinook Salmon Tagged

The total number of juveniles in the brood or population of juveniles at the time of tagging (or enhancement with tagged fish) was unknown at the time tags were placed in the population. However, estimation of the harvest of a tagged stock or release to a mixed-stock fishery requires that the proportion of the population of interest which is tagged is known or estimable. In this study, the tagging ratio for a brood year was estimated from sampling adults that have returned to spawn, for age and CWTs. Since fish of several ages and brood years will be present in a typical sample of spawning adults, tagging ratios for a given brood are estimated as:

$$\theta_{b,i} = \frac{y_{b,i}}{t_{b,i}} \qquad (1)$$

where:

$\theta_{b,i}$ = estimate from year i of the proportion of juveniles from brood year b that were tagged with a coded wire tag;

$y_{b,i}$ = number of fish in the sample from year i that are successfully aged, determined to be from brood year b, and are missing their adipose fin; and,

$t_{b,i}$ = number of fish in the sample from year i that are successfully aged and determined to be from brood year b.

The standard errors of the estimates were calculated with normal procedures (Cochran 1972).

The estimate $\theta_{b,i}$ is an unbiased estimate of the true tagging ratio θ_b, assuming that tagging does not affect survival and recapture rates. Under these assumptions θ_b can also be updated from year to year as additional age classes

Table 2. Summary of coded-wire tag releases in the Tahini River, 1985 and 1986.[a]

Tag Code	Number of tagged chinook released	Number of untagged chinook released	Estimated tag loss
B41114[b]	42,360	601	1.4%
Total (1985)	42,360		
B30610[c,d]	10,419	556	3.2%
B30611[c,d]	10,539	563	3.2%
B30612[c,d]	11,383	608	3.2%
B30613[c,d]	11,779	631	3.2%
Total (1986)	44,120		

[a] Johnson 1987.
[b] 1984 Tahini River brood stock released in 1985.
[c] 1985 Tahini River brood stock released in 1986.
[d] replicate tag codes.

from the brood year are sampled on the spawning grounds, i.e., updating $y_{b,i} = \Sigma y_{b,j}$ and $t_{b,i} = \Sigma t_{b,j}$. Also, data from several sampling events in the same year may be combined to increase sample size ($t_{b,i}$) as long as the tagging ratio in the population being sampled is unaltered by previous sampling. Fish age was estimated from scale pattern analyses (see Age Determination and Age Composition, below) which we assumed is an unbiased estimator.

In the current study, sampling to estimate θ_{1984} and θ_{1985} was conducted with a gill net set in the lower Tahini River (see Estimation of Spawning Escapement, below), and by surveys of carcass on the spawning grounds. All chinook salmon caught in the gill net were sampled for scales (age) and a missing adipose fin. Some sampled fish were retained for brood stock, and all remaining fish were returned to the river with a marked dorsal fin. Later, carcasses on the spawning grounds were sampled for missing adipose fins and marks on dorsal fins. Scales and adipose fin clip data from all carcasses without dorsal marks were added to the pool of samples (from the gill net) to be aged and used to estimate tagging ratios, and all CWTs were collected.

In 1991 when the first returns of (age 1.2) jacks from the multiple tagging conducted in this study occur, carcass surveys in many spawning areas of the Chilkat River drainage will be conducted to estimate tagging ratios. The ratios most surely will vary by spawning area. Definitions of $y_{b,i}$ and $t_{b,i}$ may then be redefined to be specific for a tag code (instead of a missing adipose fin).

Sampling Tahini River Escapement for Age, Length, and Abundance

The escapement of chinook salmon measuring ≥660 mm from mid-eye to fork of tail (MEF) (age 1.3 and older) to the Tahini River in 1989 was estimated using the Chapman modification of the Petersen estimator (Seber 1982):

$$\hat{N} = \frac{(n_1+1)(n_2+1)}{(m_2+1)} - 1 \qquad (2)$$

$$V[\hat{N}] = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \qquad (3)$$

where:

- $\hat{N}$ = abundance;
- n_1 = number of marked chinook salmon ≥660 MEF released in the lower river;
- n_2 = number of carcasses ≥660 MEF examined on the spawning grounds; and,
- m_2 = number of carcasses ≥660 MEF examined that had a dorsal fin mark.

A normal approximation was used to estimate 95% confidence intervals for $\hat{N}$.

A set gill net was used to catch chinook salmon as they moved up the Tahini River to spawn. The net was operated by the ADF&G Fisheries Rehabilitation, Enhancement, and Development (FRED) Division who were collecting chinook salmon

for brood stock. Netted fish were either retained for brood stock, or returned to the river with a caudal fin clip. The number of fish returned to the river was tallied by releases longer than 660 mm MEF, and by releases shorter than 660 mm MEF.

Dead or nearly dead chinook salmon in post-spawning condition were enumerated in carcass surveys (the recapture event). Gaffs and gill nets were used to collect fish for examination. All fish were checked for a missing adipose fin, measured (MEF in mm), sexed using external characteristics, and tallied separately if ≥660 mm MEF. Also, fish marked with a caudal fin clip were counted for the Petersen estimator. Once sampled (or counted), carcasses were slashed to prevent repeated sampling. The heads of all carcasses with missing adipose fins were removed, tagged with a numbered strap inserted through the mouth, and sent to the ADF&G FRED Division Tag Lab in Juneau for dissection and decoding of CWT's. These samples were used with the gill net data to estimate age and length compositions of the escapement, but not to estimate tagging ratios.

Spawning grounds were sampled every day between August 8 and August 15, the period of peak spawning activity (Mecum *In press*). Spawning grounds on the Tahini River were defined as the area between the set gill net site and the junction with the Flemmer River.

The Petersen estimates were compared to an index of escapement of large fish obtained from a helicopter survey (Mecum and Kissner *In press*). We assumed: a) population is closed (there is no recruitment or emigration between sampling events); b) all fish had the same probability of capture during the second sample; c) that marking did not affect the probability of recapture; d) that fish did not lose marks between sampling events; and e) that all marks were recognizable during the second sampling event.

These assumptions were not strictly tested. The gill net was fished over the major period of upstream migration, and no new fish were captured after August 8. The carcass sampling should have included the total population (assumption a). The gill net was fished only during daylight and was closely monitored; whenever a fish is caught it was quickly removed to minimize injury (assumption c). Dorsal fin clips applied less than 3 weeks earlier were very easy to recognize during carcass sampling (assumption e).

Harvest Sampling

A port sampling program conducted by the Alaska Department of Fish and Game (ADF&G) Division of Commercial Fisheries existed to recover CWTed chinook salmon from the commercial fisheries in Southeast Alaska (Van Alen 1988). Port sampling was stratified by statistical area (Figure 1) and statistical weeks (1-52). Approximately 244,508 commercially caught (Larson 1990) king salmon were harvested in Southeast Alaska in 1988. Excluding private, hatchery, and miscellaneous harvests, 90.4% of this harvest occurred in trap and troll fisheries, 5.2% occurred in seine fisheries, and 4.4% occurred in gill net fisheries (Larson 1990). In 1988 (the most recent data summarized) ≈100% of the troll harvest of chinook salmon landed in Southeast Alaska, 99% of the Lynn Canal (district 15) gill net harvest of chinook salmon, and 91% of district 109, 112, and 114 seine harvests of chinook salmon occurred in strata sampled for CWT fish (John E. Clark, ADF&G Commercial Fisheries Division, Douglas, personal communication). With similar sampling rates in 1989, minimal bias was expected

in estimates of total commercial harvests of Chilkat River chinook salmon to commercial fisheries due to incomplete sampling of strata. About 46% of the total commercial catch of chinook salmon was actually inspected for CWT's in 1988; in the northern inside districts about 64% of the catch was inspected (Oliver 1989). Thus, sampling fractions were also expected to be high in 1989.

Creel surveys of major marine boat and selected roadside recreational fisheries conducted by the ADF&G Division of Sport Fisheries existed to recover CWTed chinook salmon from the sport fisheries in Southeast Alaska (Suchanek and Bingham 1989). The marine surveys were conducted in Haines, Sitka, Juneau, Petersburg, Wrangell, and Ketchikan at times of peak sport fishing activity. Approximately 26,160 sport caught (Mills 1989) chinook salmon were harvested in Southeast Alaska in 1988. Approximately 18,064 chinook salmon or 73% of this estimated total harvest occurred in marine sport fisheries strata sampled during 1988 (Suchanek and Bingham 1989). Similarly, about 72% of sport harvests in the Haines/Skagway and Juneau areas occurred in strata that were sampled (Suchanek and Bingham 1989). Since sport harvests were a small (probably ≤10%) component of total (sport plus commercial) Southeast Alaska or northern Southeast Alaska chinook harvests, minimal bias in estimates of total harvests of Chilkat River chinook salmon to all sampled fisheries were likely to result from incomplete sampling in 1989.

Fishery Contributions

Harvests in 1989 of two ages (1.2 and 1.3) of chinook salmon from the Tahini River were estimated from random recoveries of CWT's obtained during port and creel sampling programs (see Harvest Sampling, above). The ADF&G FRED Division Tag Lab totaled the numbers of tags successfully decoded and reported the data by tag code. Tagging ratios were estimated, by fish age, from samples collected in spawning escapements see Estimation of θ, the Fraction of Juvenile Chinook Salmon Tagged, above).

Omitting notation for age, the harvest of Tahini River chinook salmon (by age) to a sport or commercial fishery strata was estimated as :

$$\hat{n}_1 = \left(\frac{m_1}{m_2}\right)\left(\frac{a_1}{a_2}\right)\left(\frac{N_h}{n_2}\right)\frac{\hat{m}_c}{\theta} \qquad (4)$$

where:

n_1 = number of chinook salmon from the Tahini River harvested (by age) in sampled strata h and associated with a unique tag code;

n_2 = number of chinook salmon in sampled strata h examined for a missing adipose fin;

N_h = total number of chinook salmon harvested in sampled strata h;

m_c = number of tags dissected out of fish heads and decoded as a unique tag code;

θ = proportion of a release which contains a CWT of a unique tag code;

a_1 = number of fish missing an adipose fin which are counted and marked with a head strap;

a_2 = number of heads with a head strap which arrive at the tag lab;
m_1 = number of CWT's which are detected in fish heads at the tag lab; and
m_2 = number of CWT's which are removed from fish heads and decoded.

An unbiased estimate of the variance of n_1 (Clark and Bernard 1987) is:

$$V(\hat{n}_1) = \left[\frac{m_2 (m_1-1)\, a_2 (a_1-1)\, n_2 (N_h-1)}{(m_2-1)\, m_1 (a_2-1)\, a_1 (n_2-1)\, N_h}\right] S^2(\hat{n}_1) \tag{5}$$

where

$$S^2(\hat{n}_1) = \left[\hat{m}_c\left(\frac{N_h m_1 a_1}{m_2 a_2 n_2 \theta}\right)^2\right]\left[1 - \hat{m}_c + \left(\frac{(m_2-1)\,(a_2-1)\,(n_2-1)}{(m_1-1)\,(a_1-1)\,(N_h-1)}\right)\left(\frac{m_1 a_1 N_h \hat{m}_c}{m_2 a_2 n_2} - \theta\right)\right] \tag{6}$$

Equation 5 is appropriate for estimating contributions of a stock tagged at a known rate to a fishery where catch N_h is known. In fisheries where catch is estimated, say in a creel survey, the variance of n_1 may be estimated using a different equation (Carlon and Lang 1989):

$$\hat{V}[\hat{n}_1] = \left[\frac{m_1 a_1}{m_2 a_2 n_2 \theta}\right]^2 \left[\hat{N}_h^2 V(\hat{m}_c) + \hat{m}_c^2 V(\hat{N}_h) - V(\hat{m}_c)\, V(\hat{N}_h)\right] \tag{7}$$

where:

$$V(\hat{m}_c) = \left[\frac{m_2 (m_2-1)\, a_2 (a_2-1)\, n_2 (n_2-1)\, \hat{n}_1 (\hat{n}_1-1)\, \theta^2}{m_1 (m_1-1)\, a_1 (a_1-1)\, N_h (N_h-1)}\right] + \left[\frac{m_2 a_2 n_2 \hat{n}_1 \theta}{m_1 a_1 N_h}\right] - \left[\frac{m_2 a_2 n_2 \hat{n}_1 \theta}{m_1 a_1 N_h}\right]^2 \tag{8}$$

is from Clark and Bernard (1987) for N_h being known. When the tagging ratio (θ) is estimated with less than comforting precision a bootstrap estimate of confidence intervals is indicated (Geiger *In press*) since a closed form estimator for variance is not available. To implement the bootstrap, a computer is used to estimate the harvest (equation 4) in every strata h, many (say 500) times. During each iteration (i=1,2,..,500), stochastic values for inputs needed to estimate a contribution (equation 4) are generated from the parameters of the actual sampling events using the distributions assumed by equation 4. After each iteration, the estimated harvests are summed over the q strata, and stored:

$$C_{n_1,i} = \sum_{h=1}^{q} \hat{n}_{1,h} \tag{9}$$

Then, confidence intervals for an estimates of overall harvest (by age), or harvest (by age) in each strata, are taken from percentiles of the stored (simulated) distribution of estimates.

Clark and Bernard (1987) and Geiger (*In press*) employ binomial and hypergeometric distributions to model an Alaskan commercial fishery. Parameters from the

fisheries (a_1, a_2, m_1, m_2, N_h, n_2, M_c) will be supplied from actual sampling data for 1989. During the bootstrap, we assume that catch in commercial fisheries is a constant, but in sport fisheries follows a normal distribution with parameters (mean and variance) estimated in another study (Suchanek and Bingham *In press*).

A value for θ in each bootstrap sample can be generated was follows. The number of fish examined for marks (those fish known to be of the "proper" age) in each bootstrap sample ($t_{b,i}$) follows a Poisson distribution with parameter $\hat{t}_{b,i}$ unless several surveys are used to obtain the sample (probably the actual case)– then a negative binomial distribution for $t_{b,i}$ is more appropriate. A binomial distribution with parameters $\hat{t}_{b,i}$ and $\hat{\theta}$ is then used to generate a bootstrap sample of $y_{b,i}$, the number of tagged fish found (Geiger 1989). Each bootstrap sample value θ is then computed as in equation 1. The simulated value of the number of marked fish in a sample of the catch is then used to estimate the catch of fish from the stock. This process is repeated thousands of times and the replicates are then used to construct the variances.

Age Measurement and Age Compositions

Age of sampled chinook salmon was estimated from scale pattern analyses. Four scales were removed from the left side of each sampled fish (right side if scales were regenerated) at the posterior edge of the dorsal fin, two scale rows above the lateral line. Scales were mounted on gummed cards, and impressions were made in cellulose acetate (Clutter and Whitesel 1956). Age was estimated during visual examination of scale impressions magnified approximately 70x on a microfiche reader.

Age composition, average lengths, and standard errors of these estimates for sampled harvests and escapements (see above) were estimated using standard normal estimators (Van Alen et al. 1987).

RESULTS

Coded-Wire Tagging of Juvenile Chinook Salmon

Exploratory trapping was conducted between April 11 and April 13 to determine if many pre-smolt chinook salmon could be captured at this time. Catches in April were very low; 9 traps set on the Kelsall caught 15 fish, 13 traps on the mainstem Chilkat caught 0 chinook salmon, and 18 traps set in side sloughs of the mainstem caught only 4 pre-smolt chinook salmon. Snow and heavy ice conditions made it very difficult to set traps in good habitat. Approximately 20 minnow traps were also fished in an exploratory manner in early August (Table 3); 110 fish were tagged but catch rates were low and further trapping was delayed. Tagging began in earnest on September 12 and continued through November 8.

Trapping occurred on the Tahini River from the confluence of the Flemmer River downstream to the confluence of the Tahini and mainstem of the Chilkat River, between August 5 and September 24. Catch rates fluctuated from less than 1 fish/trap-day in August to over 11/trap-day in mid September (Table 3). An estimate of the average length of juveniles trapped is 64.2 mm (SE = 0.45), and sizes ranged from 47 to 80 mm. A total 5,293 YOY chinook salmon were tagged with an estimated tag retention (derived from the tagged to untagged ratio of

Table 3. Summary of trapping and coded-wire tagging of YOY chinook salmon on the Tahini River from August 5 to September 24, 1989.

Date	Traps Checked	Estimated Catch			Chinook Tagged	Number Recap.	Tags Retain	Tag Code	Mean Length (mm)	Samp Size
		Chin	Coho	DV						
05-Aug	20	18	24	28					58.5	18
06-Aug										
07-Aug										
08-Aug										
09-Aug	8	30							62.5	36
10-Aug	4	24		15						
11-Aug	19	17	5	20						
12-Aug	17	17	2	42						
13-Aug	17	24	2	17	110			4-28-37		
14-Aug	16	22								
15-Aug	19	48	1	40						
16-Aug	19	55	2	20					61.3	35
12-Sep										
13-Sep	41	501	120	115						
14-Sep	74	496	159	250						
15-Sep	76	865	339	316						
16-Sep	76	1,139	345	190						
17-Sep					2,515	10	10	4-28-37	69.2	24
18-Sep	54	919	55	63						
19-Sep	53	586	164	250						
20-Sep	61	792	395	455						
21-Sep	40	592	255	288						
22-Sep	23	?	?		1,879	56	56	4-28-37		
23-Sep					721	15	15	4-28-37	66.4	67
24-Sep	13	68	29	47	68	11	11	4-28-37		
	650	6,213	1,897	2,156	5,293	92	92		64.2	180

Overall Statistics

Valid Tags Released: Code (4-28-37) = 5,293
Catch/trap = 9.6
Tag Retention = 100.0
Mean Length = 64.2
Standard Deviation = 6.0
Standard Error = 0.45
95% CI = 63.3 to 65.1
Range = 47mm to 80mm

recaptured, adipose-clipped fish) of 100%. Catches were still high when we moved trapping downstream to the Kelsall River.

Tagging on the Kelsall River took place in the 5 km section above the confluence of the Kelsall and mainstem Chilkat River, from September 24 to October 16. Catch rates were high, ranging from over 33 fish/trap-day on September 28 to approximately 15/trap-day on October 16 (Table 4). Average length was 65.0 mm (S.E. 0.52) ranging from 52 to 87 mm. A total of 20,199 YOY chinook salmon were tagged with an estimated tag retention rate of 99.5% yielding an estimated 20,098 valid tags released.

The mainstem of the Chilkat River between the Wells Bridge and about mile 17 on the Haines Highway was conducted between October 20 and November 8. Catch rates were again high, averaging 15.4 fish/trap-day over a 15 day period (Table 5). Average length was 62.7 mm (SE = 0.46) ranging from 47 to 82 mm. A total of 9,897 YOY chinook salmon were captured, adipose-clipped, coded-wire tagged, and released. Adjusting for an estimated tag retention rate of 98.8%, a total of 9,778 valid tags were released.

Estimation of Tagging Fractions for 1985 and 1986

Sampling to estimate the fractions of pre-smolt (fresh water age 1) chinook salmon in the Tahini River that had a CWT (after enhancements in 1985 and 1986) was conducted between July 19 and August 16, 1989. Gill net catches peaked in late July (Table 6). One hundred and sixty-three (163) adult chinook salmon were captured in the nets, and scales were collected from 159 of these fish. Scales from 134 of these fish were successfully aged; 45 of these fish were aged 1.2, and 58 fish were aged 1.3 (Table 7). The remainder of the aged fish represented other age classes. Eleven (11) of the 45 fish aged 1.2 were missing an adipose fin, and 15 of the 58 fish aged 1.3 were missing an adipose fin.

Eight surveys of spawning areas on the Tahini River occurred between August 8 and August 16 (Table 7). Fifty-two adult chinook salmon without dorsal marks were examined in the surveys. Scales from 43 of these fish were successfully aged. Ten (10) of these fish were age-1.2, and 12 of these fish were age-1.3. None (0) of the 10 fish aged 1.2 was missing an adipose fin and 1 of the 12 fish aged 1.3 was missing an adipose fin.

A preliminary estimate of the fraction of 1984 brood year pre-smolt Tahini River chinook salmon tagged, based on the tagged proportion of age-1.3 fish captured in 1989, was 22.9% (SE = 0.12). A preliminary estimate of the fraction of 1985 brood year pre-smolt Tahini River chinook salmon tagged, based on the tagged proportion of age-1.2 fish captured in 1989, was 20.0% (SE = 0.10).

In total, eleven tagged fish were recovered during the gill net sampling and 5 were recovered on the spawning grounds. All of the tags were placed on hatchery reared fish placed in the Tahini River in 1985 and 1986 (Table 8).

Age, Length, and Abundance

Age composition of the Tahini River escapement of chinook salmon was estimated from 177 ageable scales that were collected (Table 9). The percentages of age-1.1 and -1.2 males (jacks) were high, indicating good survival of the poor

Table 4. Summary of trapping and coded-wire tagging of YOY chinook salmon on the Kelsall River from September 24 to October 16, 1989.

Date	Traps Checked	Estimated Catch Chin	Coho	DV	Chinook Tagged	Number Recap.	Tags Retain	Tag Code	Mean Length (mm)	Samp Size
24-Sep	13	580	40	60	43	0	0	4-28-43	63.3	43
25-Sep										
26-Sep										
27-Sep										
28-Sep	54	1,865	260	530	610	1	1			
29-Sep	54	1,637	195	260						
30-Sep	71	1,923	195	260	2,970	34	33			
01-Oct	64	1,177	275	350	2,621	118	118	4-27-04	64.4	50
02-Oct	63	801	368	577	746	94	94			
03-Oct	71	1,476	115	190	1,365	104	104			
04-Oct	71	1,304	40	65	1,284	82	82			
05-Oct	60	965	106	141	908	44	44			
06-Oct	71	1,544	125	245	1,511	75	75			
06-Oct	69	500								
07-Oct	0	0			547	41	41		64.6	39
08-Oct	0	0								
09-Oct	40	631	13	22	572	44	44			
10-Oct	71	1,330	53	125	1,133	48	48			
11-Oct	69	1,811	43	120	1,305	71	69			
12-Oct	70	1,228	28	307	1,490	31	30	4-27-15		
13-Oct	70	890	39	270	565	17	17			
14-Oct	69	914	13	412	1,287	24	24			
15-Oct	54	564	8	88	755	7	7		67.8	44
16-Oct	33	511	1	20	487	1	1			
	1,137	21,651	1,917	4,042	20,199	836	832		65.0	176

Overall Statistics

Valid Tags Released:
Code (4-28-43) = 5,467
Code (4-27-04) = 10,447
Code (4-27-15) = 4,184
Total 20,098

Catch/trap = 19.0
Tag Retention = 99.5
Mean Length = 65.0
Standard Deviation = 6.9
Standard Error = 0.52
95% CI = 64.0 to 66.0
Range = 52mm to 87mm

Table 5. Summary of trapping and coded-wire tagging of YOY chinook salmon on the Chilkat and Klehini Rivers from October 20 to November 8, 1989.

Date	Traps Checked	Estimated Catch Chinook	Chinook Tagged	Number Recap.	Tags Retain	Tag Code	Mean Length (mm)	Samp Size
20-Oct	40	159						
21-Oct	22	59	[a]				66.9	50
22-Oct								
23-Oct								
24-Oct	17	158						
25-Oct	27	380						
26-Oct	44	548						
27-Oct								
28-Oct	55	988						
29-Oct	49	958						
30-Oct								
31-Oct	57	1,629	1,320	8	7	4-27-10		
01-Nov	56	1,041	2,972	12	12		59.9	100
02-Nov	58	675	2,096	43	43			
03-Nov	38	395						
04-Nov	50	989	783	19	19			
05-Nov	48	825	1,456	35	35			
06-Nov	44	601	594	17	17			
07-Nov	54	713						
08-Nov			676	29	28		63.4	100
	659	10,118	9,897	163	161		62.7	250

Overall Statistics

Valid Tags Released: Code (4-27-10) = 9,778
Catch/trap = 15.4
Tag Retention = 98.8
Mean Length = 62.7
Standard Deviation = 7.2
Standard Error = 0.46
95% CI = 61.8 to 63.6
Range = 47mm to 82mm

[a] Catches from Klehini River, released without tags.

Table 6. Daily gill net catch of chinook salmon and CPUE, Tahini River, 1989.

Date	Hours Fished	Catch: Unmarked Males	Catch: Unmarked Females	Catch: Adipose Clipped Males	Catch: Adipose Clipped Females	Catch: Total	Catch/ Hour	Cum. Catch
19-Jul	2.0	0	0	0	0	0	0.00	0
20-Jul	15.0	9	0	1	0	10	0.67	10
21-Jul	14.0	5	0	2	0	7	0.50	17
22-Jul	14.5	5	1	4	0	10	0.69	27
23-Jul	14.0	13	1	5	1	20	1.43	47
24-Jul	15.5	9	3	1	3	16	1.03	63
25-Jul	14.0	16	5	6	1	28	2.00	91
26-Jul	9.5	6	1	0	1	8	0.84	99
27-Jul	9.0	1	0	3	0	4	0.44	103
28-Jul	9.0	8	1	1	0	10	1.11	113
29-Jul	10.7	8	0	2	0	10	0.93	123
30-Jul	10.5	7	2	0	2	11	1.05	134
31-Jul	0.0	0	0	0	0	0	0.00	134
01-Aug	10.0	2	3	0	0	5	0.50	139
02-Aug	4.0	3	1	0	1	5	1.25	144
03-Aug	7.8	1	2	1	0	4	0.51	148
04-Aug	5.5	1	1	0	0	2	0.00	150[a]
05-Aug	4.0	1	2	0	0	3	0.75	153
06-Aug	4.0	2	1	2	1	6	1.50	159
07-Aug	7.0	2	0	0	0	2	0.29	161
08-Aug	4.0	1	0	0	1	2	0.50	163
09-Aug	0.0	0	0	0	0	0	0.00	163
10-Aug	0.0	0	0	0	0	0	0.00	163
11-Aug	4.5	0	0	0	0	0	0.00	163
12-Aug	0.0	0	0	0	0	0	0.00	163
13-Aug	0.0	0	0	0	0	0	0.00	163
14-Aug	5.0	0	0	0	0	0	0.00	163
Total	193.5	100	24	28	11	163	0.83	
Thru Aug 1[b]	147.7	89	17	25	8	139	0.94	

[a] Two fish were caught and released without dorsal fin marking.

[b] Gill net was fished intermittently thru August 14. For comparison with previous years, totals thru August 1 are also shown.

Table 7. Summary of chinook salmon sampled for CWTs on the Tahini River by age and gear type, 1989.[a]

Date	Number Sampled	Number Aged	Age-1.3 Total	Age-1.3 Adipose Clipped	Age-1.2 Total	Age-1.2 Adipose Clipped
Set gill net	159	134	58	15	45	11
Carcass samples	52	43	12	1	10	0
Totals	211	177	70	16	55	11

[a] Does not include recaptures of fish sampled by gill net.

Table 8. Spawning ground recoveries of CWT tagged chinook salmon on the Tahini River, 1989.

Brood Year	Tag Code	Stat Week	Sample Source	Head Number	Sample Type	Length	District	Number Observed
85	B30610	31	ESC SURVEY	37959	RANDOM	715	115-32	1
85	B30612	31	ESC SURVEY	37960	RANDOM	655	115-32	1
85	B30612	31	ESC SURVEY	37957	RANDOM	675	115-32	1
85	B30612	33	ESC SURVEY	37968	RANDOM	605	115-32	1
85	B30613	31	ESC SURVEY	37956	RANDOM	635	115-32	1
85	B30613	31	ESC SURVEY	37961	RANDOM	740	115-32	1
						Age-1.2	Subtotal	6
84	B41114	31	ESC SURVEY	37962	RANDOM	750	115-32	1
84	B41114	31	ESC SURVEY	37955	RANDOM	795	115-32	1
84	B41114	32	ESC SURVEY	37965	RANDOM	780	115-32	1
84	B41114	31	ESC SURVEY	37954	RANDOM	820	115-32	1
84	B41114	32	ESC SURVEY	37963	RANDOM	830	115-32	1
84	B41114	31	ESC SURVEY	37958	RANDOM	795	115-32	1
84	B41114	33	ESC SURVEY	37967	RANDOM	850	115-32	1
84	B41114	31	ESC SURVEY	37953	RANDOM	820	115-32	1
84	B41114	31	ESC SURVEY	37951	RANDOM	805	115-32	1
84	B41114	32	ESC SURVEY	37966	RANDOM	765	115-32	1
						Age-1.3	subtotal	10
Total								16

Table 9. Age composition of chinook salmon in the Tahini River escapement by sex, 1989.[a]

	Brood Year and Age Class								
	1986	1985	1984		1983		1982		
	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Male									
Percent	6.2	29.9	33.9	1.1	4.5	1.1	1.7		78.5
Standard Error	1.8	3.4	3.5	0.8	1.6	1.0	1.0		3.1
Sample Size	11	53	60	2	8	2	3		139
Female									
Percent		0.6	6.8		13.0		0.6	0.6	21.5
Standard Error		0.6	1.9		2.5		0.6	0.6	3.1
Sample Size		1	12		23		1	1	38
All Fish									
Percent	6.2	30.5	40.7	1.1	17.5	1.1	2.3	0.6	100.0
Standard Error	1.8	3.5	3.7	0.8	2.9	1.0	1.1	0.6	
Sample Size	11	54	72	2	31	2	4	1	177

[a] Statistical Weeks 29 - 32 (July 16 - August 12)

escapements in 1985 and 1986. Approximately 78% of the escapement examined were male chinook salmon. Age classes 1.2 and 1.3 comprised over 70% of the total return, but over half of the female chinook salmon were age-1.4. Average lengths by age of the escapement are shown in Table 10.

No scales were collected in 1989 from commercial catches of chinook salmon in District 115. Also, scales were not collected from sport harvested chinook salmon from the Tahini River. Therefore, age and length composition of harvests of Tahini River chinook salmon is unknown.

A total of 79 fish $\geq$ 660 mm MEF length were captured by set gill net on the Tahini River, marked and released. Thirteen (13) of 49 fish examined on the spawning grounds were marked, giving a Petersen estimate of chinook salmon escapement of 285 age 1.3 and older fish (SE = 57, 95% C.I. 173 - 396). An additional 20 age-1.3 and 1.4 fish were killed to provide eggs for the Pullen Creek Hatchery, so the total return to the river was 305 chinook salmon.

Fishery Contributions

Commercial and recreational fisheries in Southeast Alaska were sampled according to standard procedures (Van Alen et al. 1987, Suchanek and Bingham *In press*). Ten tags from the 1985 release (1984 brood) and 18 tags from the 1986 release (1985 brood) were recovered (Table 11). Select and voluntary tag recoveries provided an additional 7 tags, all from the 1985 brood year. Select and voluntary tags are shown in Table 12, but did not contribute to total harvest estimates because expansions for sampling rates and variances cannot be estimated for these types of recoveries. A total of 10 tags were recovered from sport fishermen; all but one was from the 1985 brood year and 5 (50%) were random recoveries from ADF&G sampling. Twenty five tags were recovered from commercial fisheries and all but 2 of these were from ADF&G sampling. Commercial catch recoveries occurred in several areas, primarily Lynn Canal gill net, Taku gill net and Northern Inside troll fisheries (Figure 1).

Parameters from the fisheries that are required to estimate the contributions, and update them as estimates of the tagging fraction (θ_b) improve are shown in Table 12. Due to time limitations, variances for contributions to commercial fisheries were not estimated. Preliminary estimates of variance for sport fisheries were estimated by assuming θ is a constant.

The unexpanded contribution estimate of age-1.3 tagged fish (from 1984 brood) to commercial and sport fisheries in 1989 was 10 fish. Expanded for the fishery sampling rate and by the tagging fraction of 22.9%, the overall contribution was approximately 172 fish. An escapement of 297 fish, plus 20 fish killed for the hatchery, plus 172 catch yielded a minimum of 489 age-1.3 fish in catch plus escapement in 1989.

The unexpanded contribution estimate of age-1.2 tagged fish (from 1985 brood) to commercial and sport fisheries in 1989 was 18 fish. Expanded for the fishery sampling rate and by the tagging fraction of 19.8%, the overall contribution was approximately 242 fish. An escapement of approximately 195 age-1.2 fish, plus 5 fish killed for the hatchery, plus 242 catch yielded a minimum of 442 age-1.2 fish in catch plus escapement in 1989.

Table 10. Length composition of chinook salmon in the Tahini River escapement by sex and age class, 1989.[a]

	Brood Year and Age Class								
	1986	1985	1984		1983		1982		
	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Male									
Avg. Length	386	628	764	670	870	720	972		690
Standard Error	6.6	8.4	9.9	10.0	26.4	35.1	37.7		11.7
Sample Size	11	53	59	2	8	3	3		139
Female									
Avg. Length		670	813		887		985	905	862
Standard Error			13.2		10.7				11.8
Sample Size		1	10		21		1	1	34
All Fish									
Avg. Length	386	628	771	670	883	720	975	905	724
Standard Error	6.6	8.3	8.9	10.0	10.5	35.1	26.8		11.0
Sample Size	11	54	69	2	29	3	4	1	173

[a] Statistical Weeks 29 - 32 (July 16 - August 12)

Table 11. Summary of expanded tag recoveries from 1989 sport and commercial harvests of 1984 and 1985 brood Tahini River chinook salmon, excluding select and voluntary recoveries.

	Observed	Fishery[a] Expansion	Total[b] Expansion
1984 BROOD			
Sport			
District 115	1	5.7	25.0
Commercial			
District 109 Troll	3	5.1	22.8
District 114 Troll	5	26.5	115.9
District 115 Gill net	1	1.8	8.0
Subtotal Commercial	9	33.4	146.7
Total Sport and Commercial	10	39.1	171.7
1985 BROOD			
Sport			
District 111	3	9.0	45.0
District 115	1	2.3	11.5
Subtotal Sport	4	11.3	56.5
Commercial			
District 109 Troll	1	1.6	7.9
District 110 Troll	1	1.2	5.9
District 114 Troll	7	11.9	61.9
District 115 Gill net	5	21.9	109.3
Subtotal Commercial	14	36.6	185.0
Total Sport and Commercial	18	47.9	241.5

[a] Expanded by sampling rate
[b] Expanded by tagging fraction

Table 12. Summary of parameters obtained from commercial and sport fisheries sampling programs for 1989 recoveries of Tahini River chinook salmon reared at Crystal Lake Hatchery and released in the Tahini River.

COMMERCIAL CATCH

Tag Code	Length (mm)	Sample Source	District	Port	Stat. Week	Tags Decoded (m_2)	Tags Detected (m_1)	Heads Received (a_2)	Heads Marked (a_1)	Number Examined (n_2)	Total Catch (N_h)	Expansions: Sampling Rate	Head Loss	Tag Loss	Tagging Rate	Total
1984 Brood																
B41114	765	Troll	109	Port Alexander	25	209	210	226	228	2,435	5,306	2.2	1.0	1.0	4.4	9.7
B41114	698	Troll	109	Petersburg	27	169	171	191	196	2,718	5,273	1.9	1.0	1.0	4.4	8.8
B41114	865	Troll	109	Juneau	41	101	101	106	106	837	828	1.0	1.0	1.0	4.4	4.3
B41114	885	Troll	114	Juneau	41	39	39	42	42	763	1,176	1.5	1.0	1.0	4.4	6.7
B41114	710	Troll	114	Hoonah	23	103	103	116	118	1,352	2,162	1.6	1.0	1.0	4.4	7.1
B41114	680	Troll	114	Hoonah	23	103	103	116	118	1,352	2,162	1.6	1.0	1.0	4.4	7.1
B41114	750	Troll	114	Hoonah	27	17	17	18	18	193	2,097	10.9	1.0	1.0	4.4	47.5
B41114		Troll	114	Excursion Inlet	27	17	17	18	18	193	2,097	10.9	1.0	1.0	4.4	47.5
B41114	851	Gill net	115	Petersburg	27	14	14	14	14	131	240	1.8	1.0	1.0	4.4	8.0
1985 Brood																
B30610	710	Troll	109	Sitka	44	13	13	16	16	114	180	1.6	1.0	1.0	5	7.9
B30613	895	Troll	110	Juneau	43	54	54	56	56	565	670	1.2	1.0	1.0	5	5.9
B30612	695	Troll	114	Hoonah	40	34	34	37	39	741	1,651	2.2	1.1	1.0	5	11.7
B30610	700	Troll	114	Hoonah	40	34	34	37	39	741	1,651	2.2	1.1	1.0	5	11.7
B30610	720	Troll	114	Hoonah	41	39	39	42	42	763	1,176	1.5	1.0	1.0	5	7.7
B30611	695	Troll	114	Hoonah	41	39	39	42	42	763	1,176	1.5	1.0	1.0	5	7.7
B30612	680	Troll	114	Juneau	41	39	39	42	42	763	1,176	1.5	1.0	1.0	5	7.7
B30610	755	Troll	114	Juneau	41	39	39	42	42	763	1,176	1.5	1.0	1.0	5	7.7
B30613	675	Troll	114	Juneau	41	39	39	42	42	763	1,176	1.5	1.0	1.0	5	7.7
B30612	630	Gill net	115	Pelican	30	6	6	6	6	20	97	4.9	1.0	1.0	5	24.3
B30612	762	Gill net	115	Pelican	31	2	2	2	2	19	235	12.4	1.0	1.0	5	61.8
B30610	781	Gill net	115	Petersburg	33	7	7	9	9	80	227	2.8	1.0	1.0	5	14.2
B30613	750	Gill net	115	Pelican	35	8	8	8	8	37	34	0.9	1.0	1.0	5	4.6
B30613	710	Gill net	115	Pelican	38	1	1	1	1	9	8	0.9	1.0	1.0	5	4.4
B30613	620	Gill net	115	Haines	27	Select Sample										
B30612	585	Gill net	115	Excursion Inlet	36	Select Sample										

-(Continued)-

Table 12. (page 2 of 2)

Tag Code	Length (mm)	Sample Source	District	Port	Stat. Week	Tags Decoded (m_2)	Tags Detected (m_1)	Heads Received (a_2)	Heads Marked (a_1)	Number Examined (n_2)	Total Catch (N_h)	SPORT CATCH Expansions: Sampling Rate[a]	Head Loss	Tag Loss	Tagging Rate	Total
1984 Brood																
B41114	890	Sport	115	Haines	23	1	1	1	1	7	40	5.7(32)	1.0	1.0	4.4	25.0
1985 Brood																
B30612	680	Sport	111	Juneau	31	46	46	51	52	388	412	1.1(0)	1.02	1.0	5	5.5
B30612	790	Sport	111	Juneau	32	46	46	51	52	388	412	1.1(0)	1.02	1.0	5	5.5
B30612	740	Sport	111	Juneau	36	3	3	3	3	33	224	6.8(44)	1.0	1.0	5	34.0
B30611	705	Sport	115	Haines	24	1	1	1	1	8	18	2.3(4)	1.0	1.0	5	11.5
B30612	787	Sport	111	Juneau	31	Select Sample										
B30610		Sport	111	Juneau	33	Select Sample										
B30612	737	Sport	115	Pullen Creek	35	Voluntary Sample										
B30610	813	Sport	115	Pullen Creek	36	Voluntary Sample										
B30612	864	Sport	115	Pullen Creek	37	Voluntary Sample										

[a] Numbers in parentheses are an estimate of variance

Note that harvests estimated in this study do not include harvests in some unsampled and unreported fisheries, such as sport fishery in the Skagway area.

DISCUSSION

The harvest estimates presented in this report are based on several assumptions. First, we assume that survival and behavior of Tahini River fry reared in a hatchery and released in the river is similar to that of Tahini River wild fish. At this time we have no reason to believe otherwise. Second, we assume that the tagging proportion estimated from the carcass and set gill net samples on the Tahini is accurate. Depending on water conditions and predation levels, these samples may be biased towards either large or small fish. The conditions during the spawning surveys of 1989 were average, so we think that the samples are representative.

Note that the current estimate for harvests of Tahini River chinook salmon from 1984 and 1985 brood years is **not** an estimate of the total contribution of Tahini River chinook salmon from the 1984 and 1985 brood years to the fisheries. This is because only one age class from each brood is reported at this time, and because some unsampled and unreported strata exist. Although the latter problem may be small, the contribution of unreported age classes is not small.

Mature chinook salmon harvested in early June in the northern inside waters of southeast Alaska are assumed to be returning to Alaskan or transboundary Rivers, primarily the Chilkat, Taku and Stikine (Kissner 1986). Chinook salmon harvested after late June are either immature Alaskan or non-Alaskan fish. Of 18 Tahini River or Pullen Creek CWT tagged fish recovered in 1989, 14 were harvested after July 1 (week 26) indicating that most of the harvest of Tahini River chinook salmon in district 115 is of immature fish.

It is difficult to estimate the harvest contribution of age-1.2 chinook salmon. Age-1.2 chinook salmon are not fully recruited to the troll fishery, but are vulnerable to the drift gill net fishery. Many age-1.2 fish are not of legal size (28 inches in total length, approx. 615 mm MEF) for the commercial troll or recreational fisheries but there are no similar size restrictions on gill net catches. An unknown number of chinook salmon, mostly immature fish, are harvested in drift gill net fisheries but are not sold or reported in catch records. The price paid for immature salmon is often poor, and some gill net fishermen choose not to sell those chinook salmon.

We had originally assumed that most chinook salmon harvested in the Lynn Canal gill net fishery were of Chilkat or Taku river origin. Although the highest recovery rate of Chilkat chinook salmon CWT recoveries in 1989 occurred in the District 115 Lynn Canal drift gill net fishery, they comprised only 18 of 88 (20%) of the total CWT recoveries from the fishery (Sam Bertoni, ADF&G FRED Division, personal communication). Recoveries were primarily from other southeast Alaska hatcheries, with a few tags from British Columbia and Washington State.

The 1989 average catch per trap-day of juvenile chinook salmon in the Tahini and mainstem Chilkat Rivers were much higher than those observed in 1988 (Mecum and Kissner *In press*). The 1989 trap catches on the Kelsall River were also high but were similar to 1988, averaging nearly 20 fish per trap-day. Overall escapement

to the Chilkat drainage in 1988 was only 781 spawners, making the high juvenile abundance in 1989 unexpected. Stonehouse Creek, one of the aerial survey index areas, flows into the Kelsall. The 1987 surveyed escapement of 190 chinook salmon to Stonehouse Creek was the highest since surveys began in 1981. The high juvenile catch rates in 1988 in the Kelsall resulted from that escapement, while the high 1989 catches were from a more average escapement of 89 fish.

A comparison of the Tahini River set gill net catch/hour through August 1 and the escapement determined from the index areas (Table 13) may indicate the significance of the Tahini stock to the Chilkat River chinook salmon production. There is a good correlation between these variables in all years except 1987, when the catch/hour indicated a poor escapement but the overall surveyed escapement was much higher. One explanation may be that the unsurveyed Tahini River may contribute significant numbers of chinook salmon to the Chilkat drainage some years. Poor juvenile catch rates were observed on the Tahini River in 1988, and these juveniles would have been produced by the low escapement of 1987. Juvenile catch rates have not correlated well with adult abundance, but coded-wire tag recoveries from this project will increase our understanding of the contributions of the three main tributaries of the Chilkat drainage and refine the index area expansion formula.

The average length of juvenile chinook salmon from the Kelsall River captured during late October 1989 was 63.8 mm compared to 72.9 mm over the same period in 1988. The difference could be the result of competition in 1989, as juvenile abundance on the Tahini and mainstem Chilkat Rivers was much higher in 1989 than in 1988. Other factors could be winter conditions, stream flow, and competition with coho salmon and Dolly Varden *Salvelinus malma*. The average lengths of juvenile Chilkat chinook salmon in 1989 was similar to averages that have been found in studies of other systems in southeast Alaska. Pre-smolt chinook salmon captured on the Unuk and Chickamin Rivers from 1983 to 1987 ranged from 64 to 78 mm in length; on the Alsek River, YOY chinook salmon averaged 64.7 mm in length (Mecum and Kissner *In press*).

Conclusions and Recommendations

Estimates of variance for contributions to sport and commercial fisheries are required to evaluate the precision of the harvest estimates and the efficacy of the tagging program. Although time limitations prevented their inclusion in this report, the bootstrap estimates of these variances for 1989 are in progress and will be included in future reports.

Preliminary recovery data from coded-wire tagged Tahini River chinook salmon indicate that immature chinook salmon are harvested in the District 115 commercial drift gill net fishery. With a combination of time and area closures and the cancellation of the Haines Derby, angler effort in 1989 was reduced to 1984 levels and the estimated sport harvest was the lowest since surveying began in 1984. Chinook salmon escapement to the Chilkat River in 1989 was the third highest since 1966, but still only 68% of the escapement goal. Additional reductions in sport angler effort are not likely to increase escapements significantly, and any further increases will need to come from the commercial harvest.

Table 13. Tahini River set gill net catch/hour of chinook salmon compared to chinook salmon escapement to index systems.

Year	Dates	Gill Net Catch/hour	Chinook Escapement
1983	July 23 - July 26	0.87	247
1984	July 22 - July 25	1.13	333
1985	July 24 - July 27	0.59	120
1986	July 23 - July 25	0.51	29
1987	July 28 - August 1	0.39	288
1988	No Fishing		
1989	July 19 - August 1	0.94	305

Regression Output: All years

Constant	39.393
Standard Error of Y Estimate	108.847
R^2	0.340
Observations	6
Degrees of Freedom	4
X Coefficient	245.066
Standard Error of Coefficient	170.641

Regression: 1987 excluded

Constant	-189.029
Standard Error of Y Estimate	34.776
R^2	0.945
Observations	5
Degrees of Freedom	3
X Coefficient	489.888
Standard Error of Coefficient	68.034

Information on migratory timing, areas of harvest, and exploitation rates of Chilkat River chinook salmon should be obtained from continued coded-wire tagging of juveniles and recovery of adults in commercial and recreational fisheries and on the spawning grounds. Escapement goals and indices can be refined with more information and if necessary, new fishery regulations could be developed in cooperation with local advisory committees, the Alaska Board of Fisheries, and ADF&G to insure rebuilding of this stock.

The Haines Highway follows the north bank of the Chilkat River from Haines to the confluence of the Klehini River where the Wells Bridge crosses the Chilkat and the highway follows the north bank of the Klehini River to the Canadian border. Built during WWII and improved in the 1960's the road crosses Big Boulder Creek near its confluence with the Klehini River. It appears that bridge and road construction activities resulted in the loss of spawning and rearing areas and changes in stream flow. Logging and road construction on the Kelsall River may also contribute to the decline of this stock. Enhancement strategies should be implemented that will offer continued protection of the natural stock while allowing recreational fishing opportunity. Damaged or lost spawning and rearing habitat in the Chilkat River drainage should be improved or restored.

ACKNOWLEDGEMENTS

The authors wish acknowledge the assistance of ADF&G employees Larry Derby, Paul Kissner and Becky Wilson for field data collection on the Chilkat River. Ron Josephson (FRED Division) and Lon Garrison (NSRAA) supervised the egg take on the Tahini River. Randy Ericksen (Sport Fish) and Ray Staska (Commercial Fisheries) provided logistic support from the Haines office. Mark Olsen (CF) aged the chinook scales and provided preliminary data analysis and Iris Frank (CF) drew the map. Sam Bertoni and the FRED Division Tag Lab decoded the CWTs and provided the expansion factors.

LITERATURE CITED

Carlon, J. A., and D. Vincent-Lang. 1989. Sport efforts for and harvests of coho and chinook salmon, halibut, and lingcod in Resurrection Bay sport fisheries, Alaska, during 1988. Alaska Department of Fish and Game, Fishery Data Series No. 83. 62 pp.

Clark, J. E., and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded micro-wire tag recovery from commercial salmon catches in Southeastern Alaska. Alaska Department of Fish Game, Informational Leaflet No. 261. 113 pp.

Clark, J. E., B. W. Van Alen, and R. P. Marshall. Estimated contributions of coded-wire tagged releases of chinook salmon (*Oncorhynchus tshawytscha*) to the commercial fisheries of Southeast Alaska in 1982. Alaska Department of Fish Game, Informational Leaflet No. 161. 44 pp.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bull. Int. Pac. Salmon Fish. Comm., No. 9. 15 pp.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley and Sons, Incorporated, New York, New York, USA. 427 pp.

Geiger, H. J. *In press*. Parametric bootstrap confidence intervals for estimates of fisheries contribution in salmon marking studies. *in* R.L. Kendall, editor. Proceedings of the International Marking Symposium. American Fisheries Society, Bethesda, Maryland, USA.

Johnson, K. J. 1987. Pacific salmon coded-wire tag releases through 1986. Pacific Marine Fisheries Commission. Portland, Oregon, USA.

Koerner, J. F. 1977. The use of the coded-wire tag injector under remote field conditions. Alaska Department of Fish and Game, Informational Leaflet No. 172. 24 pp.

Kissner, P. D. Jr. 1986. A study of chinook salmon in southeast Alaska: status of important native chinook salmon stocks in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-9-17, Vol. 26 (AFS-41-12A). 57 pp.

Larson, P. R. 1990. Introduction to 1989 Finfish Fisheries. Report to the Board of Fisheries. Alaska Department Fish Game, Division of Commercial Fisheries. Juneau, Alaska, USA.

Mecum, R. D. *In press*. Escapements of chinook salmon in southeast Alaska and transboundary rivers. Alaska Department of Fish and Game, Fishery Data Series.

Mecum, R. D., and P. D. Kissner, Jr. *In press*. Migratory patterns and exploitation rates of chinook salmon (*Oncorhynchus tshawytscha*) originating in transboundary rivers in southeast Alaska and northern British Columbia. Alaska Department Fish Game, Division of Commercial Fisheries, Technical Data Report.

Mecum, R. D., and M. C. Seibel. 1989. Preliminary, post-season information on chinook salmon catches and escapements in southeast Alaska. Alaska Department of Fish and Game, Report to the U.S./Canada Pacific Salmon Commission. 25 pp.

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report (1988). Alaska Department of Fish and Game, Fishery Data Series No. 122. 142 pp.

Mills, D., G. George, V. Sumida, and M. Kookesh. 1983. Salmon use by the residents of the Chilkat and Chilkoot River drainages. Alaska Department of Fish and Game, Technical Paper Series Number 95. 83 pp.

Oliver, G. T. 1989. Southeast Alaska port sampling project. Alaska Department of Fish and Game, Regional Information Report 1J89-26. 26 pp.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Bd. Can. Bull. 191.

Seber, G. A. 1982. The estimation of animal abundance and related parameters. Charles Griffen and Co. London.

Suchanek, P. M. and A. E. Bingham. 1989. Harvest estimates of selected sport fisheries in southeast Alaska in 1988. Alaska Department of Fish and Game, Fishery Data Series No. 114. 120 pp.

Suchanek, P. M. and A. E. Bingham. *In press*. Harvest estimates of selected sport fisheries in southeast Alaska in 1989. Alaska Department of Fish and Game, Fishery Data Series.

Van Alen, B. W. 1988. Southeast Alaska port sampling project. Alaska Department of Fish and Game, Regional Information Report 1J88-45.

Van Alen, B. W., K. A. Pahlke, and M. A. Olsen. Abundance, age, sex, and size of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) catches and escapements in Southeastern Alaska in 1985. Alaska Department of Fish and Game. Technical Data Report No. 215. Juneau, Alaska, USA.

Zar, J. H. 1974. Biostatistical Analysis. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 620 pp.