Fishery Data Series No. 98-31

Sport Fishing Effort, Catch, and Harvest and Inriver Abundance of Chilkat River Chinook Salmon near Haines, Alaska, in 1997

by

Randolph P. Ericksen

November 1998

Alaska Department of Fish and Game Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

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

General

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

Mathematics, statistics, fisheries

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

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by

Randolph P. Ericksen
Division of Sport Fish, Douglas

Alaska Department of Fish and Game
Division of Sport Fish
333 Raspberry Road
Anchorage, AK 99518-1599

November 1998

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Randolph P. Ericksen
Alaska Department of Fish and Game, Division of Sport Fish
P. O. Box 240020, Douglas, AK 99824-0020, USA

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ABSTRACT

The chinook salmon *Oncorhynchus tshawytscha* sport fishery in Chilkat Inlet, and the escapement into the Chilkat River were studied to add to the understanding of this important sport fishery and the salmon stock which supports it. A mark-recapture experiment was used to estimate spawning abundance of chinook salmon of age 1.3 and older returning to the Chilkat River in 1997. Angler effort and harvest of wild mature chinook salmon in the Haines marine boat fishery were estimated using a stratified two-stage direct expansion survey during the spring of 1997. Harvest of large (>28 inches in total length) chinook salmon and chartered angler effort and harvest were also estimated.

Three hundred twenty-two (322) large (age 1.3 and older) chinook salmon were captured in the lower Chilkat River between June 12 and July 25, 1997 in drift gillnets and two fish wheels; 317 of these fish were tagged with solid-core spaghetti tags. We examined a total of 967 large chinook salmon on spawning tributaries to the Chilkat River, and 37 of these were marked. On the basis of these data, we estimated that 8,100 (SE = 1,193) large chinook salmon immigrated into the Chilkat River during 1997.

An estimated 9,439 angler-hours (SE = 861) of effort (8,758 targeted salmon hours, SE = 697) were expended for a harvest of 381 (SE = 46) large chinook salmon, of which 311 (SE = 41) were wild mature fish. Chartered anglers accounted for 16% of the targeted salmon effort and 21% of the harvest of large chinook salmon.

Key words: Mark-recapture, creel survey, angler effort, harvest, marine boat sport fishery, hatchery, escapement, coded wire tag, age composition, length-at-age, chinook salmon, *Oncorhynchus tshawytscha*, Chilkat River, Kelsall River, Tahini River, Big Boulder Creek, Haines, Southeast Alaska.

INTRODUCTION

The purpose of this study was to monitor the sport harvest and escapement of chinook salmon returning to the Chilkat River during 1997. The long-term goal of this study is to develop maximum harvest guidelines for this stock in accordance with sustained yield management.

The Chilkat River is a large glacial system that originates in British Columbia, Canada, flows through rugged dissected mountainous terrain, and terminates in Chilkat Inlet near Haines, Alaska (Figure 1). The mainstem and major tributaries comprise approximately 350 km of river channel in a watershed covering about 1,600 km² (Bugliosi 1988).

The third or fourth largest population of chinook salmon *Oncorhynchus tshawytscha* in Southeast Alaska occurs in the Chilkat River (Pahlke 1997). Previous studies suggest Chilkat River chinook salmon rear in the inside waters of Southeast Alaska (Pahlke 1991, Johnson et al. 1993, Ericksen 1996). Electrophoretic analysis indicates that this population may be more closely related genetically to southern British Columbia and Washington stocks than to other Southeast Alaskan populations (Gharett et al. 1987).

A spring marine boat sport fishery occurs annually in Chilkat Inlet (Figures 1 and 2) in Southeast Alaska near Haines and targets mature chinook salmon returning to the Chilkat River. A creel survey has been used to monitor harvest in this fishery since 1984. The harvest in this fishery peaked at over 1,600 chinook salmon in 1985 and 1986 (Neimark 1985, Mecum and Suchanek 1986, 1987, Bingham et al. 1988, Suchanek and Bingham 1989, 1990, 1991, Ericksen 1994, 1995, 1996, 1997).

The spring marine boat fishery in Haines has been popular both with local and non-local anglers; an estimated 61% of the anglers that fished in 1985 were not from Haines (Bethers 1986). In 1988, anglers fishing in Haines and Skagway for chinook salmon spent an estimated $1.1 million (Jones and Stokes 1991). The Haines King Salmon Derby, which began in the mid 1950s, is directed primarily at returning Chilkat River chinook salmon.

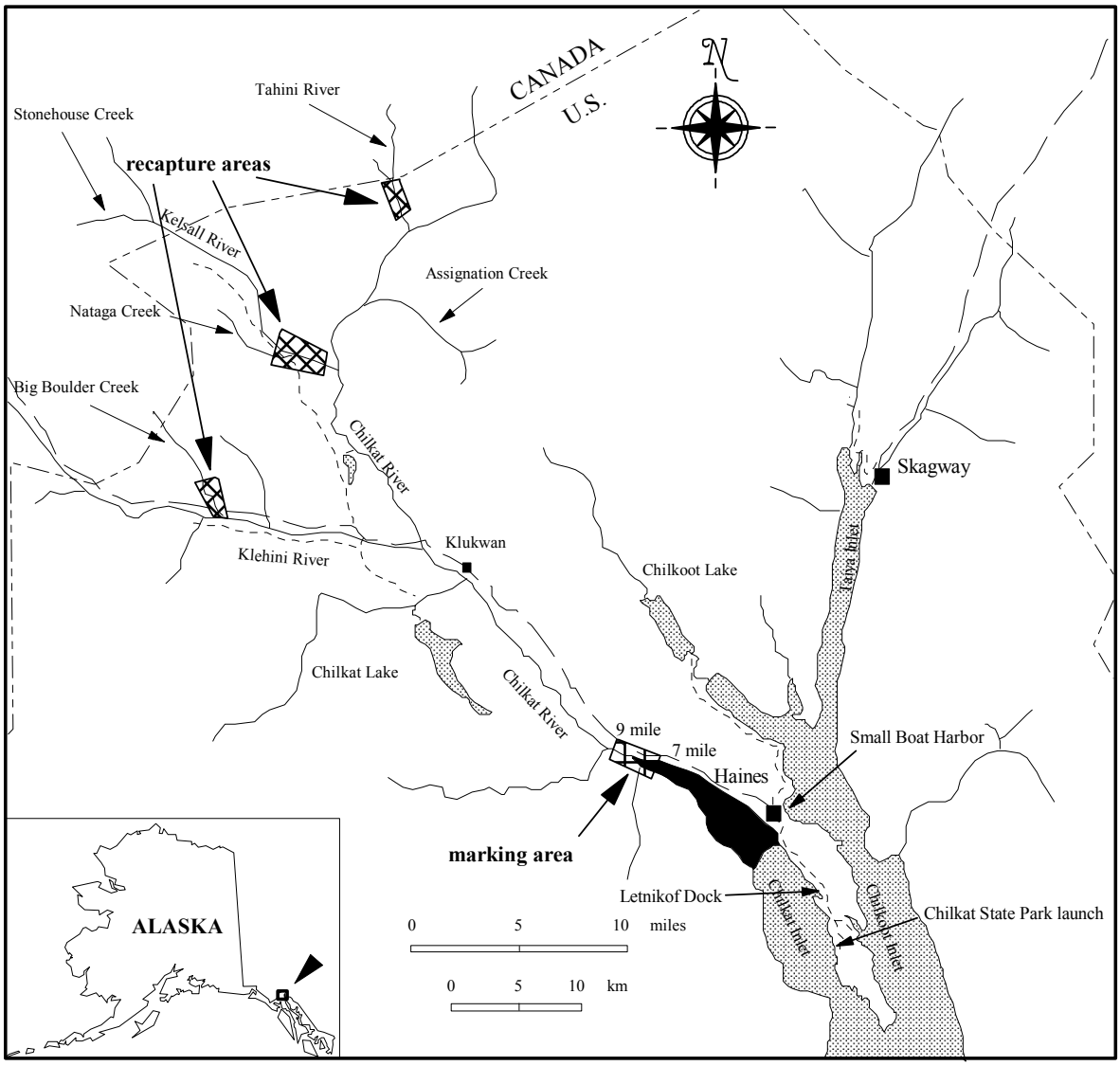


Figure 1.–Location of sampling sites and release sites of coded wire tagged chinook salmon near Haines and Skagway, Southeast Alaska, 1997.

Beginning in 1981, the Alaska Department of Fish and Game (ADF&G), Division of Sport Fish began a program to index chinook salmon abundance in the Chilkat River (Kissner 1982) using aerial survey counts in Stonehouse and Big Boulder creeks (Figure 1). These areas were selected because they were the only clearwater spawning areas that could be effectively surveyed. The indices were used in a regionwide program to monitor chinook salmon escapements in Southeast Alaska (Pahlke 1992).

Concern about Chilkat River chinook salmon developed when the indices of adult abundance declined in 1985 and 1986. This decline coincided with high harvests of chinook in the commercial troll, commercial drift gillnet, and marine sport fisheries in the area. In 1987, the Department began to restrict sport, subsistence and commercial fisheries in upper Lynn Canal, and recreational fisheries were closed entirely in 1991 and 1992. The Haines King Salmon Derby was closed beginning in 1988.

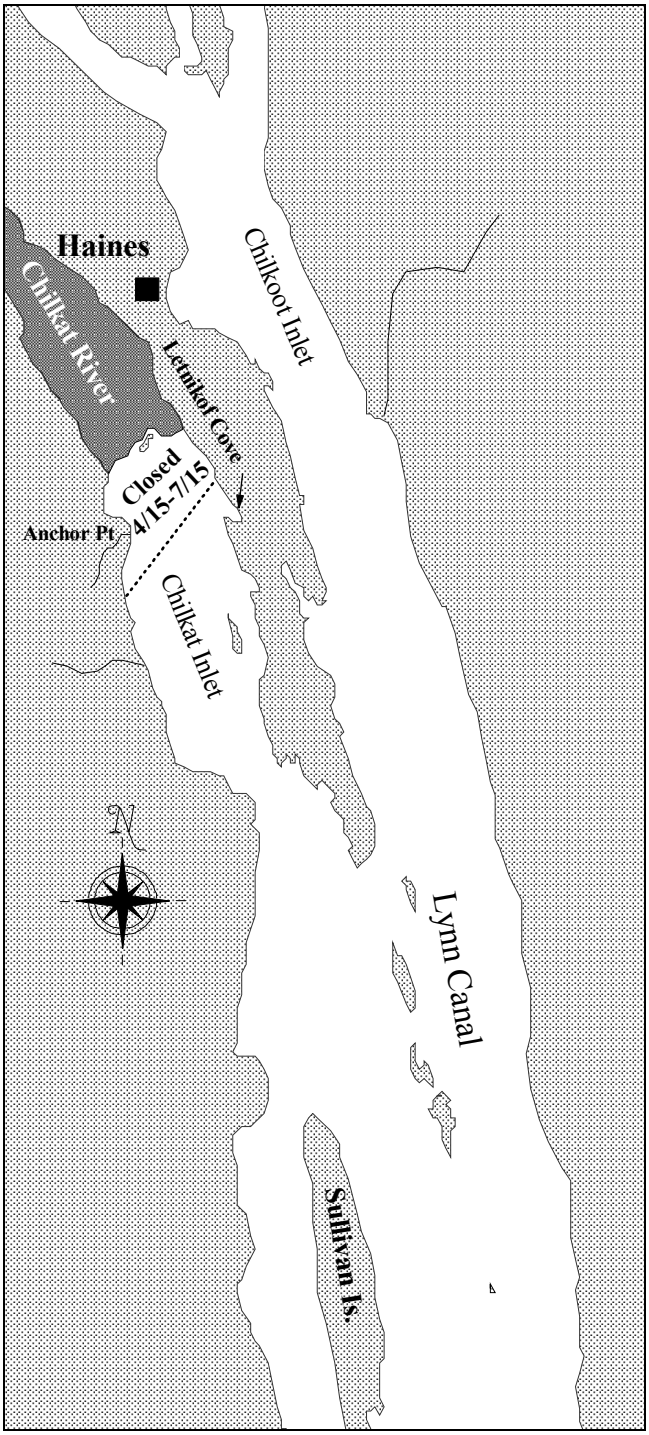


Figure 2.–Location of 1997 Haines marine chinook salmon ADF&G sport fishing regulatory area.

As a result of these concerns, the Division of Sport Fish initiated a program to tag wild juvenile chinook salmon in 1988 with coded wire tags (CWTs) to identify migratory patterns and to estimate contributions to sport and commercial fisheries. The Division of Sport Fish also conducted radio telemetry and mark-recapture experiments in 1991 and 1992, to estimate spawning distribution and abundance of large (age 1.3 years and older) chinook salmon in the river. Results of this research indicated that most of the chinook spawn in two major tributaries of the Chilkat River, the Kelsall and Tahini rivers, and immature fish are harvested as they rear in the inside waters of Southeast Alaska (Johnson et al. 1992, 1993; Ericksen 1996).

Mark-recapture experiments were maintained as a means to estimate the escapement of large chinook salmon after 1992. Estimates have ranged between 4,472 (SE = 851) and 6,795 (SE = 1,005) fish (Johnson et al. 1992, 1993; Johnson 1994; Ericksen 1995, 1996, 1997). Because abundance has appeared relatively high and stable, a King Salmon Derby was held in Haines during 1995, for the first time in eight years, and continues to the present.

The current Chilkat River escapement goal of 2,000 chinook salmon was established in the late 1970s and is currently under review. Regulations in effect during 1997 prevented sport fishing for chinook salmon near the mouth of the Chilkat River (Figure 2). At its spring 1997 meeting, the Alaska Board of Fisheries (BOF) repealed the seasonal limit of two chinook salmon. At the same meeting, however, the BOF limited nonresident anglers to an annual limit of four chinook salmon in Southeast Alaska. Commercial fishing regulations are structured to reduce incidental harvests of mature chinook salmon in the Lynn Canal gillnet fishery.

Estimating harvest and escapement is the continuing goal of the Chilkat River chinook salmon research program.

Research objectives in 1997 were:

1. to estimate the 1997 immigration of large (≥ age 1.3) chinook salmon into the Chilkat River;
2. to estimate the age and sex compositions of the escapement of large chinook salmon in the Chilkat River; and,
3. to estimate the harvest of wild mature chinook salmon in the Haines spring marine boat sport fishery from May 12 to June 29, 1997.

METHODS

INRIVER ABUNDANCE

A mark-recapture experiment was used to estimate the number of large (≥age 1.3) chinook salmon returning to the Chilkat River in 1997. Marks were applied to fish (≥440 mm FL) captured in the lower Chilkat River with drift gillnets and fish wheels from June 12 through July 25, between the area adjacent to Haines Highway miles 7 and 9 (Figure 1). Chinook salmon were marked with a solid-core spaghetti tag, a hole punch in the upper left operculum, and a left axillary appendage clip, prior to release. Water depth (cm), and temperature (°C) were recorded daily at 0700 and 1330 hours near highway mile 8. Fish were examined for marks on three spawning tributaries of the Chilkat River between August 4 and September 2. Expected relative precision (for 95% confidence intervals) for the experiment was about ±30%.

Lower River Marking

Gillnets 21.3 m long and 3.0 m deep (70 ft x 10 ft) were drifted in the lower Chilkat River, from June 12 through July 21, 1997. The gillnets consisted of two equal-length panels: one with 17.1-cm (6.75-in.), and the other with 20.3-cm (8.0-in.) stretched nylon mesh. These nets were used because the 18.5-cm (7.25-in.) stretched nylon mesh used in previous years was not available. Each day an attempt was made to complete 43 drifts between 0600 and 1400 hours. Fishing was conducted from an 18-ft boat in three adjoining 0.5-km-long areas, which were marked along the same 1.5-km-long stretch of river used in previous years (Figure 3). This section of the river was about 100 m wide and 2 to 3 m deep. The 43 drifts took about 6 hours to complete when fish were not captured. Fishing continued uninterrupted from area 1 to area 2, and then to area 3 if fish were not captured. If a [0.5-km] drift was prematurely terminated because a fish was caught, or if the net became entangled or drifted into shallow water, the terminated drift was subsequently completed before a new drift was started. If 43 drifts could not be completed during the day, additional drifts were added to the next day's total to make up the balance.

Two three-basket aluminum fish wheels were installed by ADF&G Commercial Fisheries Management and Development Division (CFMAD) personnel early in the season to monitor the escapement of sockeye salmon *O. nerka* to the Chilkat River. The Division of Sport Fish provided funding for one technician to work on the fish wheels in exchange for CFMAD tagging of captured chinook. One fish wheel operated adjacent to the Haines Highway near mile 8 from June 9 through October 1, and another about 300 m upstream from June 10 through October 10. The wheels were located along the east bank of the river where the main flow was constrained primarily to one side of the floodplain. Fish wheels operated continuously except for maintenance.

Captured chinook salmon were placed in a water-filled tagging box (see Figure 4 *in* Johnson 1994), inspected for missing adipose fins, and measured to the nearest 5 mm, mid-eye-to-fork length (MEF). Fish were initially classified as "large," "medium," or "small," depending on their length: fish ≥660 mm MEF were designated as large, fish <660 and ≥440 mm MEF as medium, and fish <440 mm MEF as small. Healthy chinook salmon ≥440 mm MEF were scale sampled, visually "sexed," and marked with a uniquely numbered spaghetti tag threaded over a solid plastic core; a ¼-inch hole was punched into the upper edge of the left operculum as a

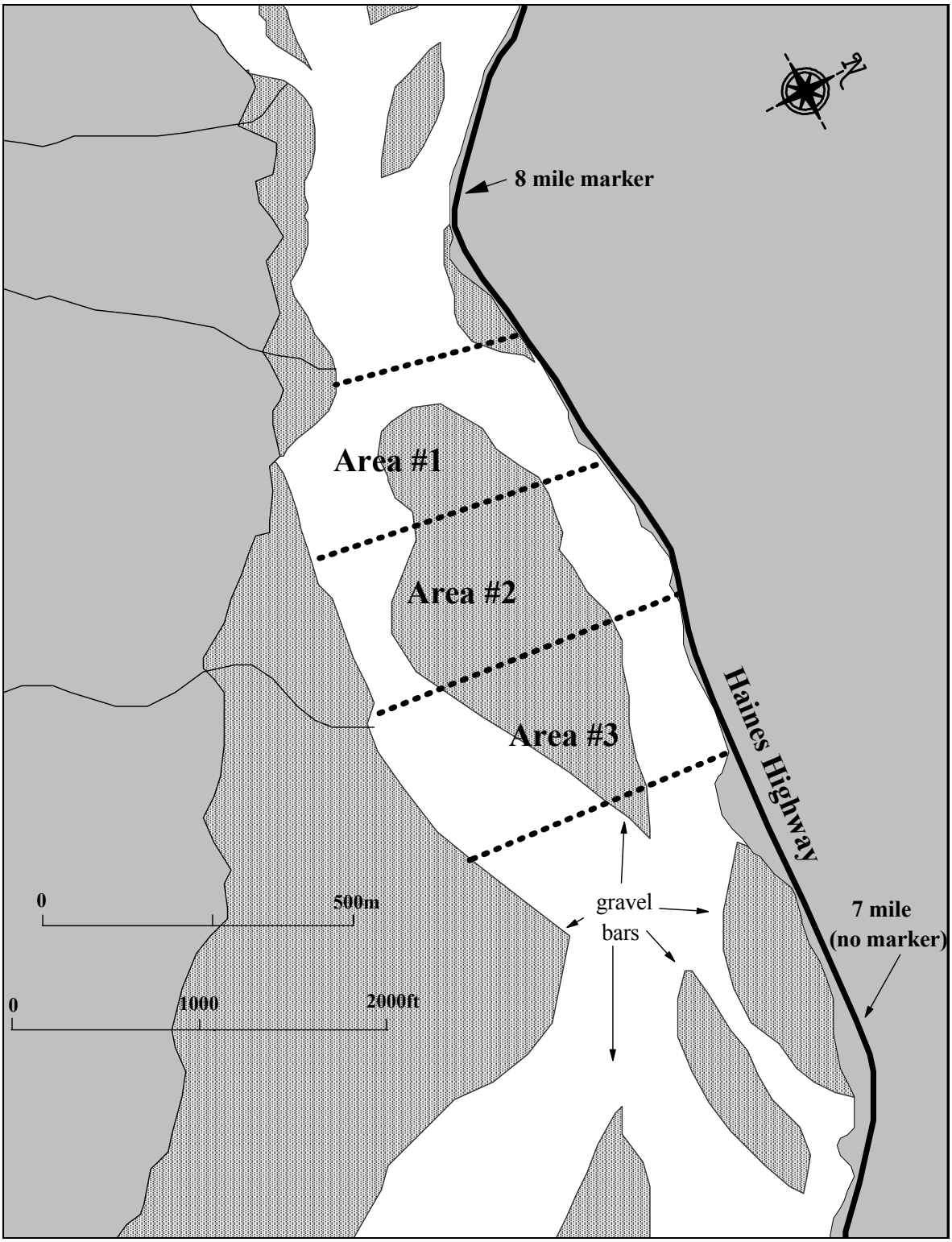


Figure 3.–Active river channel of the lower Chilkat River and location of drift gillnets in 1997.

secondary mark, and the left axillary appendage was clipped as a tertiary mark. Age of each fish was determined at the end of the season from scale pattern analysis (Olsen 1992). Each fish was then reclassified as large, medium, or small, using ocean age, rather than length, as criteria; fish with three or more ocean years of residence were classified as large, those with two ocean years as medium, and younger fish were classified as small. Any fish whose scales could not be aged was classified by length (as described above).

Spawning Ground Recovery

Escapements in the Kelsall and Tahini rivers (Figure 1), which comprised about 90% of the large chinook salmon spawning in the Chilkat River in 1991 and 1992 (Johnson et al. 1992, 1993), were sampled for marks by two teams of two people. Spawning grounds in the Kelsall River (including Nataga Creek) were sampled from August 4 to September 2. Spawning grounds in the Tahini River were sampled from August 5 to September 2. Chinook salmon were also sampled in Big Boulder Creek from August 7 through August 22. Chinook salmon were captured with gill nets, dip nets, bare hands, and spears. Double sampling was prevented by punching a hole in the lower edge of the left operculum of all captured fish.

The validity of the mark-recapture experiment rests on several assumptions: (a) that every fish has an equal probability of being marked during event 1, or that every fish has an equal probability of being captured in event 2, or that marked fish mix completely with unmarked fish; (b) that recruitment and "death" (emigration) do not both occur between sampling events; (c) that marking does not affect catchability (or mortality) of the fish; (d) fish do not lose marks between sample events; (e) all recovered marks are reported; and (f) that double sampling does not occur (Seber 1982).

The validity of assumption (a) was tested through a series of hypothesis tests. First, a 3×2 contingency table (chi-square statistic) was used to test the hypothesis ($\alpha = 0.05$) that fish sampled at the three spawning tributaries were marked at the same rate. If this hypothesis was accepted, a simple Petersen model was used to estimate abundance; otherwise a Darroch estimator would be used. Assumption (a) implies that tagging occurs in proportion to abundance during immigration or, if it does not, that no difference in the immigration timing, sex and age composition occurs between stocks bound for different spawning locations. The possibility of selective sampling was also investigated because assumption (a) could be violated if the sampling rate varied by size (or sex) of the fish. The hypothesis that fish of different sizes were captured with equal probability was tested with a Kolmogorov-Smirnov (K-S) 2-sample test comparing the size distribution of marked fish with those recaptured. Sex selective sampling was tested using a 2×2 contingency table comparing the number of males and females caught in the lower river with those caught on the spawning grounds. If selective sampling was apparent the abundance estimate could be stratified by age and/or by sex. The remaining assumptions are considered in greater detail under the Discussion section.

Abundance (numbers immigrating) of large chinook salmon was estimated using the Chapman's modified Petersen estimator for a closed population (Seber 1982):

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

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

where n_1 is the number of large chinook salmon marked in the lower river, n_2 is the number of large chinook salmon examined on the spawning grounds, and m_2 is the number of marked fish recaptured on the spawning grounds.

Age and Sex Composition of the Escapement

Age and sex composition estimates can be biased due to sampling methods. Fish wheels can be selective for smaller fish (Ericksen 1995) and for males (Ericksen 1995, 1996, 1997) in some years.

Carcass surveys are known to be selective for females in some situations (Pahlke et al. 1996). In addition, significant variation in age and/or sex compositions between spawning areas can bias composition estimates for the entire drainage.

All chinook salmon caught in the lower river and all live and dead chinook encountered on the spawning grounds were sampled, whenever possible, for age, length, and sex. Age compositions were tabulated separately for fish in the lower river gillnet, fish wheels, and in each escapement sampling location (tributary). Age composition, mean length-at-age, and variances of the catch in each gear type were calculated using standard normal statistics.

Age and sex selectivity was determined by comparing the numbers of large (≥ age 1.3) by age and sex captured in gillnet and spawning ground samples with contingency table analysis (α = 0.1). Age (or sex) composition of the escapement was obtained from pooled samples when no selectivity was found, or from separate unbiased samples as appropriate. Proportions by age (or proportions by sex) were estimated by:

$$\hat{p}_i = \frac{n_i}{n} \tag{3}$$

$$var[\hat{p}_i] = \frac{\hat{p}_i\ (1 - \hat{p}_i)}{n - 1} \tag{4}$$

where p_i is the proportion in the population in age/sex group i, n_i is the number in the sample belonging to group i, and n is the number in the sample that are successfully aged (or sexed).

The abundance at age of chinook salmon in the escapement was estimated as:

$$\hat{N}_{AGE} = \hat{N}\,\hat{p}_i \tag{5}$$

$$\begin{aligned} &\mathrm{var}[\hat{N}_{AGE}] = \\ &\quad \mathrm{var}[\hat{p}_i]\hat{N}^2 + \mathrm{var}[\hat{N}]\hat{p}_i - \mathrm{var}[\hat{p}_i]\,\mathrm{var}[\hat{N}] \end{aligned} \tag{6}$$

where $\hat{N}$ is the estimated abundance of large chinook salmon and $\hat{p}_i$ is the estimated proportion of age i fish. The abundance of chinook salmon by sex in each age class $\hat{N}_{SEX}$ was then estimated by substituting $\hat{N}_{AGE}$ and proportion of age i fish by sex for $\hat{N}$ and $\hat{p}_i$ in equation 5 and 6.

HAINES MARINE SPORT FISHERY HARVEST

A stratified multi-stage direct expansion creel survey was used to estimate the harvest of chinook salmon in the Haines marine boat sport fishery. Temporal stratification included 7-day (weekly) periods at one high-use site and 14-day (biweekly) periods at two low-use sites. However, a separate temporal stratum existed during the two weekends of the Haines Derby (May 24, 25, 26, 31, and June 1) at both high- and low-use sites. Each fishing day was defined as starting at 0800 hours and ending at civil twilight.

The three access locations were the Letnikof Dock (the high-use site), the Chilkat State Park boat launch, and the Small Boat harbor (Figure 1). Prior surveys indicate that anglers landing their catch at the Letnikof Dock account for 62–93% of the harvest of chinook salmon. Sampling at each location had days as primary sampling units and boat-parties as secondary units.

Sampling at Letnikof Dock occurred from May 12 to June 29, 1997 contained morning/evening stratification and weekend/weekday stratification of evening strata during the peak of the season. Morning sampling strata lasted from 0800 to two hours before midday, and evening sampling strata lasted from two hours before midday to civil twilight. Thus, evening strata were four hours longer in duration than morning strata. This stratification scheme was designed to maximize sampling during hours when most of the anglers exited the fishery, increasing the precision of the estimates. Random selections determined primary units to sample in each stratum. Two morning and three evening strata were sampled each week, except as noted below.

During the peak of the fishery (May 12 through June 15) the evening strata at Letnikof Dock were further divided into weekday and weekend stratification. During this stratum, two morning, two weekday evening, and two weekend/holiday

were further divided into weekday and weekend stratification. During this stratum, two morning, two weekday evening, and two weekend/holiday evening periods were sampled each week. In total, 17 unique strata were sampled at Letnikof Dock in 1997.

Sampling at the Small Boat Harbor and Chilkat State Park boat launch was initiated on May 12 and May 19, respectively, and continued through June 29. There was no type of day stratification at the low-use sites, so each sampling biweekly period was divided into 14 morning and 14 evening periods of equal length, except for the first 7 day sampling period at the Small Boat Harbor. Random selections determined primary units to sample in each morning and evening stratum. To accommodate the impossibility of sampling three sites simultaneously with only two technicians, 12 changes (period moves) were made to the randomized sampling schedule at low-use sites. Sixteen unique strata were sampled at the low-use harbors during 1997. Sampling densities with two technicians were expected to yield an overall relative precision (for 95% confidence intervals) of about ±35%.

During each sample period, all sport fishing boats returning to the harbor were counted. Boat-parties returning to the dock were interviewed to determine: the number of rods fished; hours fished; type of trip (charter or non-charter); target species (chinook salmon, Pacific halibut *Hippoglossus stenolepis*); and number of fish kept and/or released by species. Interviewing boat-parties also included sampling all harvests of chinook salmon for maturity and missing adipose fins. Maturity was also determined (Ericksen 1994, Appendix A) in order to estimate the harvest of wild mature fish assumed to be returning to the Chilkat River. Chinook salmon were defined to be wild if: (a) they were not adipose finclipped; or (b) if they were the progeny of gametes taken from the Chilkat River drainage and were CWTd and released as fry back into their natal stream. In rare cases, some parties were not interviewed, or maturity status could not be determined. When one or more boat-parties could not be interviewed, total effort and catch for the stratum was estimated by expanding by the total number of parties returning to the dock during that period. Similarly, when a boat-party had fish with a non-determinant maturity status, interview information for that boat-party was ignored and expansions (by sample period) were made from harvests by remaining boat-parties and the total number of boat-parties counted.

The harvest in each stratum ($\hat{H}_h$) was estimated (Cochran 1977):

$$\hat{H}_h = D_h \overline{H}_h \tag{7}$$

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h} \tag{8}$$

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \tag{9}$$

where h_{hij} = harvest on boat j in sampling days (periods) i stratum h,
m_{hi} = number of boat parties interviewed in day i,
M_{hi} = number of boat-parties counted in day i,
d_h = number of days (morning or evening periods) sampled in stratum h,
and
D_h = number of days in stratum h.

The variance of the harvest by stratum is estimated:

$$var\left[\hat{H}_h\right] = (1 - f_{1h}) D_h^2 \frac{\sum_{i=1}^{d_h} (\hat{H}_{hi} - \overline{H}_h)^2}{d_h(d_h - 1)} + D_h \sum_{i=1}^{d_h} M_{hi}^2 (1 - f_{2hi}) \frac{\sum_{j=1}^{m_{hi}} (h_{hij} - \overline{h}_{hi})^2}{d_h m_{hi}(m_{hi} - 1)} \tag{10}$$

where f_{1h} is the sampling fraction for periods and f_{2hi} is the sampling fraction for boat-parties. Catch and effort is estimated similarly, substituting C and E for H in equation 7 through equation 10. Total harvests for the season are the sums across strata ΣH_h and $\Sigma var[H_h]$.

Chinook salmon sampled in the angler harvest were measured to the nearest 5 mm in fork length. Five scales were removed from the left side of each sampled fish (right side if left side scales were regenerated), along a line two scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 3,500 lb/in^2 at a temperature of 97°C) was used for age determination. Scales were aged using procedures in Olsen (1992). Information recorded for each chinook salmon sampled included sex, length, maturity, and presence or absence of adipose fins.

Technicians retained heads from chinook salmon missing adipose fins, and a locking plastic strap with a unique number was inserted through the jaw of the head. Heads and CWT recovery data were sent to the ADF&G CWT Processing Laboratory in Juneau, where any tags present were removed, decoded, and corresponding information entered into the tag lab database.

Contribution of Coded Wire Tagged Stocks

Statistics from the Haines marine boat sport fishery were expanded to estimate harvest of hatchery fish for each stratum. A subset n_i of the catch in each stratum was counted and inspected to find recaptured fish. Of those a_i salmon in this sample without adipose fins, heads were retrieved from a subset, marked, and sent to Juneau for dissection. Of the a_i' heads that arrived in Juneau, all were passed through a magnetometer to detect a CWT. Of the t_i tags detected, t_i' were successfully decoded under a microscope after dissection of which m_{ij} had come from a cohort from a given release site.

The estimated harvest of a cohort was calculated from Bernard and Clark (1996), as

$$\hat{r}_{ij} = \hat{H}_i \left(\frac{m_{ij}}{\lambda_i n_i} \right) \theta_i^{-1} \qquad (11)$$

where $\hat{H}_i$ is the estimated harvest for a stratum, θ is the fraction of hatchery fish marked, and $\lambda_i = (a_i' t_i')/(a_i t_i)$. The total harvest of hatchery fish $\hat{T}_i$ in a stratum was estimated as the sum of the estimated cohort harvests $\sum_j \hat{r}_{ij}$ in that stratum, and the variance as

$$\begin{aligned} \hat{var}[\hat{T}_i] = \sum \hat{r}_{ij}^2 [G(\hat{H}_i) \\ + G(\hat{p}_{ij}) - G(\hat{H}_i) G(\hat{p}_{ij})] \\ + 2 \sum_j \sum_{k>j} \hat{r}_{ij} \hat{r}_{ik} G(\hat{H}_i) \end{aligned} \qquad (12)$$

where G( ) is the squared coefficient of variation for the specified variable, $\hat{p}_{ij}$ is the estimated fraction of tagged fish from a cohort in the harvest, and $G[\hat{p}_{ij}]$ was calculated from Table 2 in Bernard and Clark (1996):

$$G[\hat{p}_{ij}] = \frac{1 - \lambda_i \hat{\phi}_i \theta}{m_{ij}} \qquad (13)$$

where ϕ_i is the fraction of harvest sampled (n_i / H_i). Finally, the total harvest of hatchery fish was calculated as

$$\hat{T} = \sum_i \hat{r}_i \qquad (14)$$

and its variance:

$$var[\hat{T}] = \sum_i \hat{var}[\hat{T}_i] \qquad (15)$$

Age composition and mean length-at-age of chinook salmon in the sport fishery harvest, and associated variances were estimated using standard normal statistics. This calculation for a stratified sampling program is warranted when there is no trend in the age composition or sampling is proportional over time. Because sampling was not proportional in all strata, a chi-square statistic was used to test whether there was a change in the age composition over time.

RESULTS

INRIVER ABUNDANCE

We captured 322 large (age 1.3 and older), 21 medium (age 1.2), and 22 small chinook salmon in the lower Chilkat River with drift gillnets and fish wheels between June 12 and July 25, 1997 (Table 1, Figure 4). Of the 322 large fish captured, 317 were given an external spaghetti tag. Four large (≥age 1.3) fish captured in the fish wheels had been previously marked in the drift gillnet. Also, one large fish captured in the fish wheels escaped prior to being sampled or marked. Capture rates of large chinook salmon peaked on June 30. The mean date of migratory timing (weighted mean, Mundy 1984) in the lower river was also June 30 (Figure 5). Fish captured in the gillnet were predominantly age 1.4 (75.6%) and female (Table 2). Similarly, age 1.4 was dominant (59.0%) in fish wheels, although these fish were classified as mostly males (63.4%, Table 2). Large chinook salmon captured in gillnets and fish wheels were significantly different in size (K-S test, $d_{max} = 0.258$, $P < 0.001$).

We examined 967 large, 25 medium, and 7 small chinook salmon on the spawning grounds for marks (Table 3). Thirty-seven (37) large, 2 medium and no small marked fish were recovered (Table 3). Ten of the 39 marked fish recovered were missing their tags but were identified by the opercular punch. The probability of capturing a marked chinook salmon on the three spawning tributaries was not significantly different ($\chi^2 = 0.625$, df = 2, P = 0.731); thus data from all spawning areas were combined to estimate abundance.

The cumulative distribution function (CDF) of lengths of large chinook salmon marked in the lower Chilkat River was not significantly different from the CDF of large tagged chinook salmon recaptured on the spawning grounds (K-S test, $d_{max} = 0.168$, P = 0.348, Figure 6, top). This result suggests the second sampling event was not size-selective for large fish. Thus, an estimated 8,100 (SE = 1,193) large chinook salmon immigrated into the Chilkat River in 1997 under the Petersen model ($n_1 = 317$, $n_2 = 967$, $m_2 = 37$). This estimate is germane to the time of tagging in the lower river, since an unquantified removal occurs (due to natural mortality and subsistence fishery harvest) between the two sampling events.

Age and Sex Composition of the Escapement

We sampled 895 chinook salmon on the spawning grounds for age and sex. Of those sampled, 805 were successfully aged (Table 4). The CDF of lengths of marked fish was not significantly different from the CDF of large chinook salmon

Table 1.–Number of chinook salmon caught in the lower Chilkat River by time period, gear type, and size, June 12 through July 25, 1997.

Time period	Drift gillnet		Fish wheels			Combined			
	Large	Medium	Large	Medium	Small	Large	Medium	Small	Total
6/12-6/16	3	0	1	1	0	4	1	0	5
6/17-6/21	9	0	7	0	0	16	0	0	16
6/22-6/26	37	1	3	1	0	40	2	0	42
6/27-7/01	74	0	68	7	2	142	7	2	151
7/02-7/06	38	1	36	7	8	74	8	8	90
7/07-7/11	10	0	3	1	7	13	1	7	21
7/12-7/16	13	0	6	1	4	19	1	4	24
7/17-7/21	5	0	7	0	1	12	0	1	13
7/22-7/25	0	0	2	1	0	2	1	0	3
Total	189	2	133	19	22	322	21	22	365

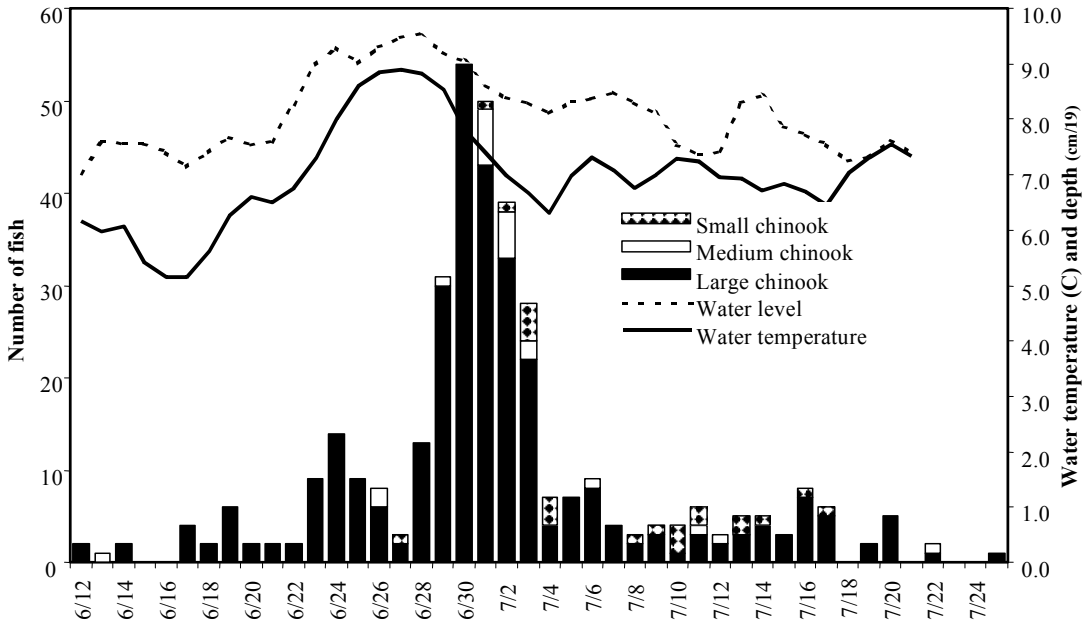


Figure 4.–Daily water depth (cm/19), temperature (°C), and catch of small (<age 1.2), medium (age 1.2), and large (≥age 1.3) chinook salmon in drift gillnets and fish wheels operating in the lower Chilkat River, June 11 through August 10, 1997.

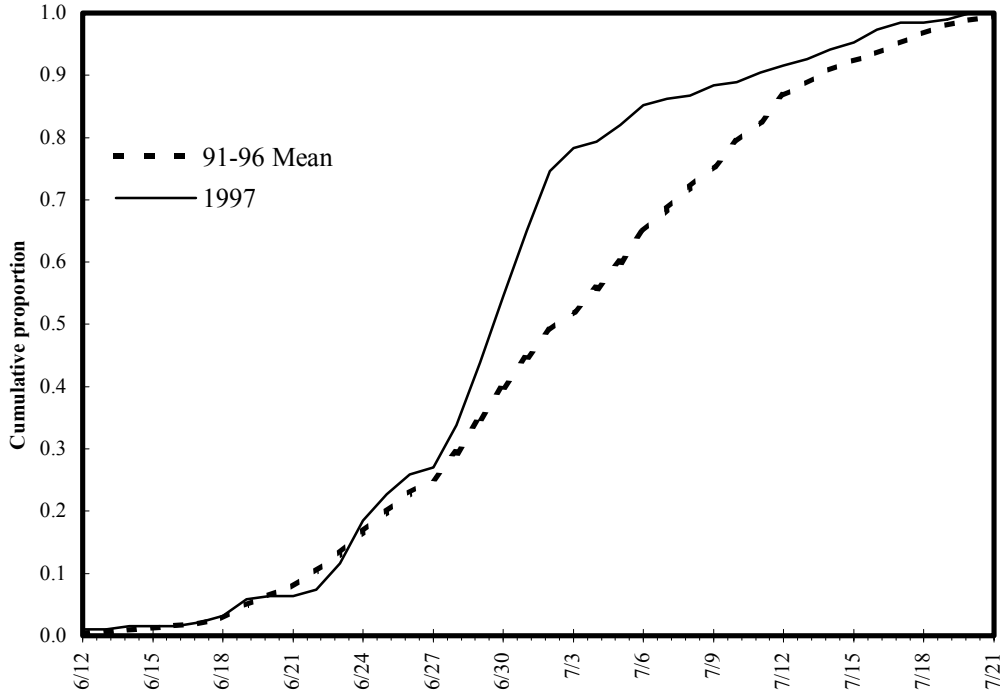


Figure 5.–Cumulative proportion of large (≥age 1.3) chinook salmon captured with drift gillnets in the lower Chilkat River in 1997 compared to mean cumulative proportion, 1991–1996.

Table 2.–Age composition of chinook salmon sampled for age during tagging activities on the Chilkat River, by gear type, 1997.

	Brood year and age class					
	1994 1.1	1993 1.2	1992 1.3	1991 1.4	**Total aged**	**Total sampled**
GILLNET, MILE 7.5						
Male						
Sample size	0	0	20	46	66	81
Percent			30.3	69.7		42.6
SD			5.7	5.7		3.6
Mean length			774	919		
SD			11.6	4.7		
Female						
Sample size	0	1	19	78	98	109
Percent		1.0	19.4	79.6		57.4
SD		1.0	4.0	4.1		3.6
Mean length		550	794	882		
SD			11.6	4.7		
All fish						
Sample size	0	1	39	124	164	190
Percent		0.6	23.8	75.6		
SD		0.6	3.3	3.4		
Mean length		550	784	895		
SD			10.8	4.8		
FISHWHEELS 8 AND 9 MILE						
Male						
Sample size	15	15	18	41	89	104
Percent	16.9	16.9	20.2	46.1		63.4
SD	4.0	4.0	4.3	5.3		3.8
Mean length	332	546	764	860		
SD	11.8	17.7	20.3	10.7		
Female						
Sample size	0	1	8	41	50	60
Percent		2.0	16.0	82.0		36.6
SD		2.0	5.2	5.4		3.8
Mean length		510	759	840		
SD			19.6	7.4		
All fish						
Sample size	15	16	26	82	139	164
Percent	10.8	11.5	18.7	59.0		
SD	2.6	2.7	3.3	4.2		
Mean length	332	543	763	850		
SD	11.8	16.7	15.1	6.6		

[a] Includes fish that were not assigned an age.

Table 3.–Number of chinook salmon inspected for marks and number of marked fish recaptured during tag recovery surveys in the Chilkat River drainage, by location, size, and sex, 1997.

		Number inspected											Number marked[a]						
		Large[b]				Medium[b]				Small[b]			Large[c]			Medium			Small
	Dates	M	F	U[d]	Total	M	F	U	Total	M	F	Total	M	F	Total	M	F	Total	Total
Kelsall	8/04-9/02	212	246	12	470	10	0	0	10	2	0	2	8	12	20	1	0	1	0
Nataga	8/07-8/27	7	10	0	17	1	0	0	1	1	0	1	1	0	1	0	0	0	0
Tahini	8/05-9/02	152	244	4	400	7	0	1	7	3	0	3	6	7	13	1	0	1	0
Big Boulder	8/07-8/22	33	42	5	80	7	0	0	7	1	0	1	1	2	3	0	0	0	0
Total		404	542	21	967	25	0	1	25	7	0	7	16	21	37	2	0	2	0

[a] Also included under number of fish inspected; no small marked fish were recovered on the spawning grounds.

[b] Fish were defined as "large" if they were 3 yr or greater ocean age, "medium" if they were 2 yr ocean age, and "small" if they were less than 1 yr ocean age.

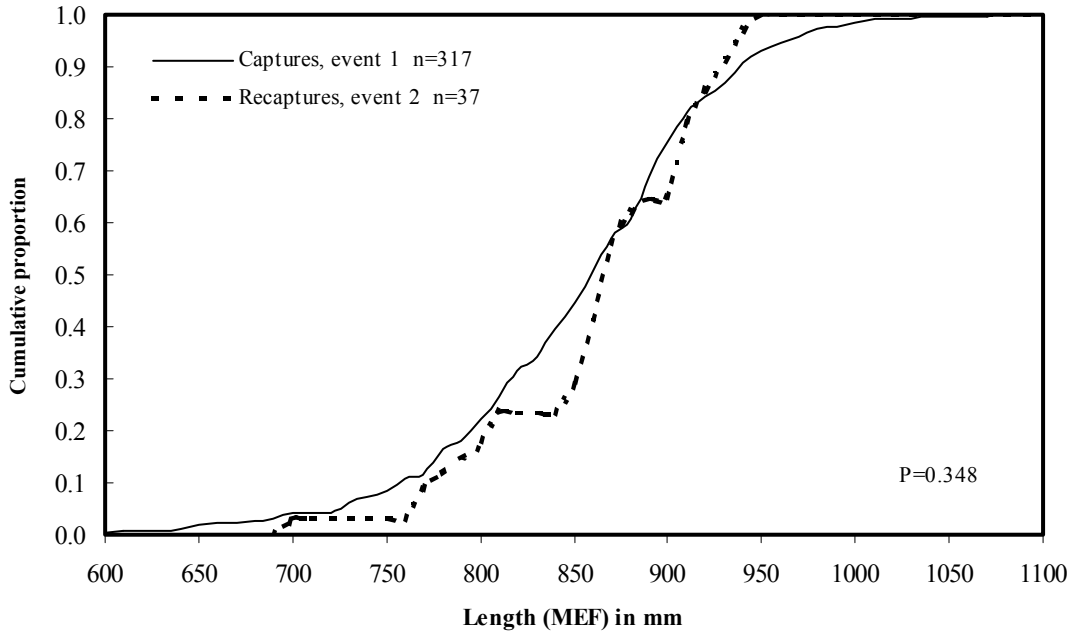
[c] Seven marked large fish (3 males and 4 females) sampled from the Kelsall River, and 3 (2 males and 1 female) from the Tahini River were missing tags but were identified by the secondary marks.

[d] Fish sampled with no sex information.

examined for marks on the spawning grounds (K-S test, d_{max} = 0.067, P = 0.250, Figure 6, bottom). Sex composition of the large chinook salmon sampled also was not significantly different between the marking and recovery events (χ^2 = 0793, df = 1, P = 0.373). In conjunction with results showing no size or sex selectivity, these results suggest that neither sampling event was size (or sex) selective for large fish and both sampling events should be used to estimate age and sex composition of the escapement. However, age compositions of large fish were significantly different between spawning tributaries (χ^2 = 0.602, df = 2, P = 0.049), and sex composition of large fish sampled was significantly different between gillnet and fish wheels (χ^2 = 4.11, df = 1, P = 0.043. Therefore, because the age composition of large fish between fish wheel and gillnet was nearly identical (χ^2 > 0.001, df = 1, P = 0.978) these samples were pooled to estimate the age composition of the escapement. Similarly, sex compositions of age 1.3 fish (χ^2 = 0.556, df = 1, P = 0.456) and age 1.4 fish (χ^2 = 0.395, df = 1, P = 0.529) were not significantly different between the gillnet and Tahini and Kelsall rivers, so these samples were pooled to estimate sex composition by age in the escapement. Sex composition of age 1.3 fish from Big Boulder was significantly different (χ^2 = 7.92, df = 2, P = 0.019) from those from other spawning grounds so these samples were not included. The results of this analysis are shown in Table 5.

HAINES MARINE SPORT FISHERY HARVEST

An estimated total of 9,439 (SE = 861) angler-hours of effort were expended in the Haines marine boat fishery between May 12 and June 29, 1997 to catch and harvest 381 (SE = 46) large chinook salmon (Table 6). This was based on a sample of 367 boat-parties who fished 3,334 angler-hours (3,193 salmon-hours), and harvested 213 large (28 inches or greater total length) chinook salmon (Table 6). An estimated 311 (SE = 41) of the chinook salmon harvested in this fishery were wild mature fish assumed to be returning to the Chilkat River. About 93% (8,758 salmon-hours, SE = 697) of angler effort targeted chinook salmon, and the remainder was directed toward other species, primarily Pacific halibut. Anglers caught an estimated 61 (SE = 14) small (sublegal, <28 inches total length) chinook salmon of which 14 (SE = 14) were kept. Seventy-nine percent (79%) of the estimated salmon effort and 81% of the estimated harvest of chinook salmon occurred between May 19 and June 15 (Table 6).



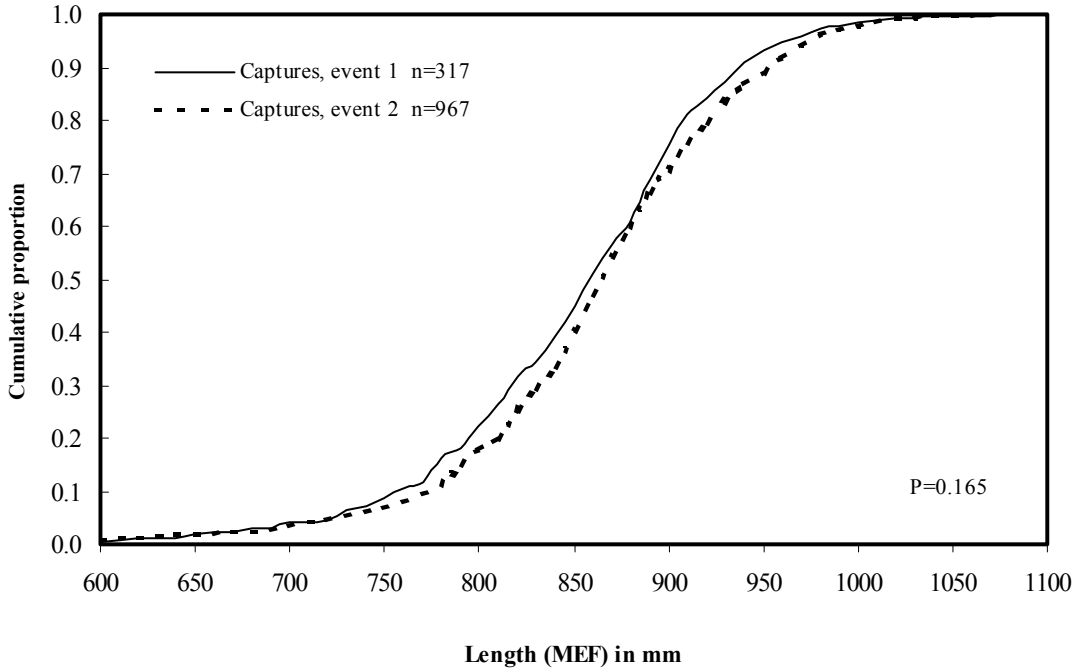


Figure 6.–Cumulative distribution function (CDF) of lengths (MEF) of large (≥age 1.3) chinook salmon marked in the lower Chilkat River versus lengths of marked fish recaptured on the spawning grounds (top) and versus lengths of large fish examined for marks on the spawning grounds (bottom), 1997.

Table 4.–Age composition of chinook salmon sampled during recovery surveys on the Chilkat River drainage, by spawning tributary, 1997.

		Brood year and age class							
		1994 1.1	1993 1.2	1992 1.3	1991 1.4	1991 2.3	1990 1.5	Total aged	Total sampled[a]
TAHINI RIVER									
Males	Sample size	3	5	22	104	0	0	134	145
	Percent	2.2	3.7	16.4	77.6				39.7
	SD	1.3	1.6	3.2	3.6				2.6
	Mean length	332	605	760	913				
	SD	20.9	22.7	21.0	6.9				
Females	Sample size	0	0	20	171	2	0	193	220
	Percent			10.4	88.6	1.0			60.3
	SD			2.2	2.3	0.7			2.6
	Mean length			799	881	848			
	SD			8.4	3.5	12.5			
All fish	Sample size	3	5	42	275	2	0	327	365
	Percent	0.9	1.5	12.8	84.1	0.6			
	SD	0.5	0.7	1.9	2.0	0.4			
	Mean length	332	605	779	893	848			
	SD	20.9	22.7	11.3	3.5	12.5			
BIG BOULDER CREEK									
Males	Sample size	1	7	14	14	0	0	36	41
	Percent	2.8	19.4	38.9	38.9				48.8
	SD	2.7	6.6	8.1	8.1				5.5
	Mean length	330	553	772	905				
	SD		25.8	12.1	12.4				
Females	Sample size	0	0	1	38	0	0	39	43
	Percent			2.6	97.4				51.2
	SD			2.5	2.5				5.5
	Mean length			775	854				
	SD				7.9				
All fish	Sample size	1	7	15	52	0	0	76	84
	Percent	1.3	9.3	21.0	68.4				
	SD	1.3	3.3	4.7	5.4				
	Mean length	330	553	772	868				
	SD		25.8	11.3	7.3				
KELSALL RIVER/NATAGA CREEK									
Males	Sample size	2	9	46	132	0	1	190	209
	Percent	1.1	4.7	24.2	69.5		0.5		46.9
	SD	0.7	1.5	3.1	3.3		0.5		2.4
	Mean length	378	534	740	907		970		
	SD	47.5	16.8	13.5	5.5				
Females	Sample size	0	0	29	181	1	1	212	237
	Percent			13.7	85.4	0.5	0.5		53.1
	SD			2.4	2.4	0.5	0.5		2.4
	Mean length			790	860	900	865		
	SD			12.2	3.6				
All fish	Sample size	2	9	75	313	1	2	402	446
	Percent	0.5	2.2	18.7	77.9	0.2	0.5		
	SD	0.4	0.7	1.9	2.1	0.2	0.4		
	Mean length	378	534	758	880	865	935		
	SD	47.5	16.8	10.0	3.4		35.0		

[a] Includes fish that were not assigned an age. Not all fish examined for marks were scale sampled (i.e., carcass decayed, part of body missing, etc.).

Table 5.–Estimated abundance of chinook salmon in the 1997 Chilkat River escapement, by age and sex.

	Brood year and age class		
	1992	1991	
	1.3	1.4	**Total**
Male	1,096	2,546	3,642
SE	214	402	455
Female	847	3,611	4,458
SE	172	558	584
All fish	1,943	6,157	8,100
SE	354	930	1,193

Angling pressure for chinook salmon was relatively light during the first and last week, so our coverage of the fishery for mature chinook salmon was essentially complete.

Estimates by site are presented in Appendices A1 through A3. Charter boat anglers accounted for about 16% of the salmon effort (923 salmon-hours, SE = 155), and 21% of the harvest (79, SE = 23) of chinook salmon in this fishery.

Anglers returning to the Letnikof Dock (the high-use site) were responsible for 76% of the estimated salmon effort (6,678 salmon-hours, SE = 622) and 85% of the estimated harvest (322, SE = 42) of large chinook salmon (Appendix A1). Anglers returning to the Chilkat State Park boat launch and the Small Boat Harbor accounted for an estimated 484 (SE = 176) and 1,758 (SE = 216) salmon-hours of effort, respectively, and took respective harvests of 12 (SE = 8) and 47 (SE = 17) large chinook salmon (Appendices A2 and A3).

Age and Length of Harvest

We sampled a total of 213 chinook salmon for age and length in the angler harvest; 171 of these were assigned an age. The age composition of the harvest during May was not significantly different from that during June (χ^2 = 0.309, df = 1, P = 0.578) so samples were pooled over time. Fish landed at the Small Boat Harbor were more likely to be from hatchery releases in Taiya Inlet (Figure 1), so these samples were analyzed separately.

We sampled 202 chinook salmon for age and length at the Chilkat Inlet harbors (Letnikof Dock and Chilkat State Park boat launch), and 164 of these were assigned an age (Table 7). Most (52.0%, SE = 3.5%) of the chinook harvested were female. The predominant age class was age 1.4 (84.8%, SE = 2.8%).

We sampled 11 chinook salmon for age and length at the Small Boat Harbor and 7 of these were assigned an age (Table 7). Two of those sampled were less than 28 inches in total length (caught in the Taiya Inlet terminal harvest area for hatchery chinook salmon).

Contribution of Coded Wire Tagged Stocks

Hatchery-reared chinook salmon released into the Chilkat River drainage (1991 brood), fish with CWTs from Taiya Inlet releases (1991–1992 broods), and fish released in Auke Bay, near Juneau (1991 brood) were recovered in the 1997 Haines marine creel survey (Table 8). Nineteen (19) of the 213 chinook salmon sampled between May 12 and June 29, were missing their adipose fins. Fish landed at the Small Boat Harbor were more likely to be from hatchery releases in Taiya Inlet so these samples were analyzed separately. However, we sampled only one adipose fin clipped chinook salmon from this harbor and one other that was entered into the Haines Salmon Derby. Both of these fish were sampled during the second biweek (May 19 through June 1). Samples were pooled during this biweek over all harbors because derby fish were sampled at the derby weigh-in station located at the Letnikof Dock regardless of where they were landed. Twenty-seven (SE = 7) of the estimated 381 chinook salmon harvested in the Haines marine boat sport fishery were of hatchery origin, 8 of which (SE = 3) were from fry releases into tributaries (Tahini River and Big Boulder Creek) of the Chilkat River (Table 8).

A list of computer files used in this analysis is found in Appendix A4.

Table 6.–Total estimated effort, catch, and harvest of chinook salmon in the Haines marine boat sport fishery, by biweek, May 12 through June 29, 1997.

		May 19–June 01				
	May 12–May 18	Non-derby	Derby	**June 02–June 15**	**June 16–June 29**	**Total**
Boats counted	48	64	89	95	71	367
Angler-hours sampled	318	432	1,374	731	479	3,334
Salmon-hours sampled	284	424	1,374	709	402	3,193
Chinook sampled	21	17	121	40	14	213
Sampled for ad-clips	21	17	121	40	14	213
Ad-clips	0	1	14	3	1	19
Angler-hours						
Estimate	613	1,406	3,832	1,700	1,888	9,439
Variance	25,992	18,681	326,508	84,125	286,034	741,340
Salmon-hours						
Estimate	498	1,379	3,832	1,700	1,349	8,758
Variance	23,459	16,602	326,508	84,125	35,315	486,009
Large chinook catch						
Estimate	35	58	136	114	38	381
Variance	35	110	118	1,711	146	2,120
Large chinook kept						
Estimate	35	58	136	114	38	381
Variance	35	110	118	1,711	146	2,120
Wild mature chinook kept (excluding hatchery and immature fish)						
Estimate	19	44	112	107	29	311
Variance	13	58	94	1,396	94	1,655
Small chinook catch						
Estimate	3	3	23	11	21	61
Variance	4	6	104	51	42	207
Small chinook kept						
Estimate	0	0	0	0	14	14
Variance	0	0	0	0	168	168

DISCUSSION

Several assumptions, as noted above, underlie our estimate of abundance. Considerable efforts were made to catch and mark fish in proportion to their abundance (assumption a) during the immigration by sampling uniformly across the escapement. Sampling effort for tags on the Kelsall and Tahini rivers (where >90% of spawning occurred in 1991 and 1992), was fairly constant across the time when spawning fish die and are available for sampling. Previous research on the Chilkat River (Johnson et al. 1992, 1993) suggests immigration timing is similar for Tahini and Kelsall River stocks. Tagging ratios on the Tahini ($p = 0.033$) and Kelsall-Nataga ($p = 0.043$) rivers were very similar. Carcass surveys are known to be selective for females in some situations (Pahlke et al. 1996). While some selection may have occurred in this study, I could not detect a significant difference from the battery of tests applied. The assumption of no recruitment during the experiment is reasonable since tagging effort was relatively constant and continued until only about one fish a day was being caught. I could not test assumption (c) directly;

Table 7.–Estimated age composition and mean length-at-age of harvested chinook salmon in the Haines marine boat sport fishery, by location, May 12 through June 29, 1997.

		Brood year and age class					
		1994 1.1	1993 1.2	1992 1.3	1991 1.4	**Total aged**	**Total sampled[a]**
				CHILKAT INLET HARBORS			
Males	Sample size	0	0	18	62	80	97
	Percent			22.5	77.5		48.0
	SE			4.7	4.7		3.5
	Mean length[b]			809	1,010		
	SE			12.8	10.7		
Females	Sample size	0	0	7	77	84	105
	Percent			8.3	91.7		52.0
	SE			3.0	3.0		3.5
	Mean length			793	960		
	SE			34.1	5.8		
All fish	Sample size	0	0	25	139	164	202
	Percent			15.2	84.8		
	SE			2.8	2.8		
	Mean length			804	982		
	SE			12.5	6.1		
				SMALL BOAT HARBOR			
Males	Sample size	1	1	1	1	4	6
	Percent	25.0	25.0	25.0	25.0		54.5
	SE	25.0	25.0	25.0	25.0		15.7
	Mean length	375	540	760	990		
	SE						
Females	Sample size	0	0	1	2	3	5
	Percent			33.3	66.7		45.5
	SE			33.3	33.3		15.7
	Mean length			870	903		
	SE				60.1		
All fish	Sample size	1	1	2	3	7	11
	Percent	14.3	14.3	28.6	42.9		
	SE	14.3	14.3	18.4	20.2		
	Mean length	375	540	815	932		
	SE			77.8	46.7		

[a] Includes fish that were not assigned an age.

[b] Length measured snout to fork of tail in mm.

however, recovery rates of fish marked in the gillnet (p = 0.125) were marginally, but not significantly different from those marked in the fish wheels (p = 0.047), (χ^2 = 3.449, df = 1, P = 0.063). This suggests that the method of marking fish did not greatly affect mortality rates. The observed difference between the recapture rates may have resulted from poor tagging methods at the fish wheels, which were operated by less experienced technicians. Of the 39 marked fish recaptured, 10 were missing tags. If these fish were all marked at the fish wheel, recapture rates would be nearly identical (p = 0.125) between the two gear types. These fish were still identified as marked fish by the secondary (opercular-punch) and tertiary (axillary process clip) mark. Because all fish had secondary (and tertiary) marks, assumption (d) was satisfied. Personnel sampling on the spawning tributaries carefully examined each fish for marks; therefore failure of assumption (e) is unlikely.

Table 8.–Contribution estimates of coded wire tagged chinook salmon to the Haines marine sport fishery, and statistics used for computing estimates by biweek, 1997.

Hatchery	Release site	Tag code	Brood year	Biweek	Harvest[a] N	Harvest[a] Var[N]	Sample n	Adclp a	Heads a'	Detect t	Decode t'	Tags m	Contribution $\hat{r}$	Contribution SE
Hidden Falls	Taiya Inlet	04-40-56	1991	June 2-15	100	1,543	38	3	3	2	2	1	3	2
		04-41-26, 28, 29,33	1992	May 19 - June 1	194	228	138	15	14	10	10	6	9	2
		04-41-28	1992	June 2-15	100	1,543	38	3	3	2	2	1	3	2
		Release site contribution											14	4
Gastineau	Tahini River	04-01-020602,603	1991	May 19 - June 1	194	228	138	15	14	10	10	3	5	2
		Release site contribution											5	2
Gastineau	Big Boulder	04-01-020601	1991	June 16-29	31	104	11	1	1	1	1	1	3	2
		Release site contribution											3	2
Snettisham	Auke Bay	04-40-33	1991	May 19 - June 1	194	228	138	15	14	10	10	1	5	5
		Release site contribution											5	5

[a] Harvest estimates are for Chilkat Inlet Harbors (Letnikof dock and Chilkat State Park boat launch) only except during the second biweek (May 19–June 1) when the estimates include the Small Boat Harbor. The Haines king salmon derby occurred during the second biweek. Because fish sampled at the derby weigh-in station could have been landed at the Small Boat Harbor samples were combined during this biweek.

Table 9.–Parameters used to estimate abundance of large (≥age 1.3) chinook salmon to the Chilkat River, 1991–1997.

	1991[a]	1992[b]	1993[c]	1994[d]	1995[e]	1996[f]	1997
Drift gillnet	(5/22-7/19)	(6/01-7/23)	(6/15-7/22)	(6/14-7/22)	(6/13-7/21)	(6/11-7/22)	(6/12-7/20)
Marked	80	148	159	212	121	188	189
Fish wheels	(5/05-7/19)			(6/16-7/22)	(6/14-8/9)	(6/22-9/15)	(6/13-7/25)
Marked	145	N/A	N/A	84	59	45	128
SPAWNING GROUND RECOVERIES							
Kelsall/Nataga	(8/06-9/05)	(7/29-9/04)	(8/09-9/05)	(8/04-9/03)	(8/06-9/04)	(8/06-9/05)	(8/04-9/02)
Captures	507	571	445	482	240	328	487
Recoveries	15	18	15	24	11	13	21
Tahini gillnet	(7/22-8/09)	(7/16-8/17)	(7/22-8/11)				
Captures	155	158	90		N/A		
Recoveries	9	4	4		N/A		
Tahini carcass[g]	(8/11-9/03)	(8/14-8/31)	(8/20-9/01)	(8/10-9/03)	(8/07-9/04)	(8/08-9/06)	(8/05-9/02)
Captures	39	156	43	250	84	257	400
Recoveries	2	1	1	5	4	14	13
Big Boulder	(8/05-9/12)	(7/31-8/15)	(8/04-8/10)	(8/03-8/19)	(8/04-9/05)	(8/09-9/03)	(8/07-8/22)
Captures	30	20	36	44	59	129	80
Recoveries	0	0	1	4	2	6	3
ALL RECOVERY AREAS							
Captures	733 [h]	905	614	776	383	714	967
Recoveries	27 [h]	23	21	33	17	33	37
Abundance	5,897	5,284	4,472	6,795	3,790	4,920	8,100
SE	1,005	949	851	1,057	805	751	1,193
Rel. Precision[i]	0.33	0.35	0.37	0.30	0.42	0.30	0.29

[a] Johnson et al. (1992).

[b] Johnson et al. (1993).

[c] Johnson (1994).

[d] Ericksen (1995).

[e] Ericksen (1996).

[f] Ericksen (1997).

[g] Sampling was not consistent at this site prior to 1994.

[h] Includes capture data from additional tributaries not listed.

[i] Relative precision = 1.96 standard error/estimate.

The immigration of chinook salmon through the lower Chilkat River was unusual during 1997. Most (56.5%) of the large chinook salmon were caught during the 5-day period between June 29 and July 3 (Figure 4). On average, immigration timing is more protracted (Figure 5).

The 1997 immigration of 8,100 (SE = 1,193) is the largest abundance estimated since 1991 (Table 9). We estimate that 76% (6,157, SE = 930) of the large chinook salmon entering the Chilkat River were age 1.4 (Table 10). On average, age 1.4 fish constitute 58.6% of the abundance in the Chilkat River (Table 10). In contrast, age 1.3 fish which normally account for 39.4% of the abundance were less abundant (1,934, SE = 354, 23.9%) in the population. Thus, the high abundance estimated in 1997 is largely due to a very strong 1991 brood year. The estimated return from this brood year is by far the highest on record (Table 10).

Table 10.–Estimated annual age compositions (from age samples of large chinook salmon from the drift gillnet) and brood year returns of large (≥age 1.3) chinook salmon immigrating into the Chilkat River, 1991–1997.

Return year		Age class 1.3	1.4	1.5	Total
1991[a]	Abundance	2,714	2,995	187	5,897
	SE	489	541	23	1,005
1992[b]	Abundance	1,689	3,595	0	5,284
	SE	309	662	0	949
1993[c]	Abundance	2,217	2,180	75	4,472
	SE	432	425	10	851
1994[d]	Abundance	2,405	4,276	115	6,795
	SE	382	681	15	1,057
1995[e]	Abundance	450	3,077	263	3,790
	SE	93	664	52	805
1996[f]	Abundance	4,077	788	54	4,920
	SE	632	120	6	751
1997	Abundance	1,943	6,157	0	8,100
	SE	354	930	0	1,193
Average percent		39.4	58.6	2.1	
Average abundance		2,214	3,295	116	5,625

BROOD YEAR RETURNS

Brood year	Age class 1.3	1.4	1.5	Total	SE
1986	2,714	3,595	75	6,385	823
1987	1,689	2,180	115	3,983	525
1988	2,217	4,276	263	6,755	809
1989	2,405	3,077	54	5,536	766
1990	450	788	0	1,239	152
1991	4,077	6,157		10,235	1,131
1992	1,943			1,943	3,314
Avg.	2,214	3,345	101	5,154	

[a] Johnson et al. (1992).
[b] Johnson et al. (1993).
[c] Johnson (1994).
[d] Ericksen (1995).
[e] Ericksen (1996).
[f] Ericksen (1997).

Sex was estimated with significant uncertainty early in the season. Five out of 29 tagged fish that were recaptured on the spawning grounds were sexed incorrectly during the marking event, as judged by sex determination on the spawning ground (where sexual dimorphism is more evident). However, these fish were nearly evenly split between males (2) and females (3). Therefore, sex composition estimates should be relatively unbiased.

Sport fishing effort and harvest patterns observed during 1997 were similar to those observed in recent years. During 1997, 76% of the estimated salmon effort and 85% of the estimated harvest of chinook salmon originated from the Letnikof Dock. The 1997 estimated harvest of large chinook salmon is similar to the harvest during the last seven years (1988, 1989, 1990, 1993, 1994, 1995 and 1996) the fishery was open (Table 11, Figure 7). Sport fishing effort was also similar to that observed in recent years. Catch of large chinook salmon per salmon hour of effort (CPUE) in 1997 was somewhat higher than that observed in recent years, but was lower than that observed during the mid-1980s (Table 11) when anglers were allowed to fish to the mouth of the river. The 1997 effort and harvest did not approach the levels that prompted fishery restrictions in 1987 despite elimination of the seasonal limit. Thus, it appears that the seasonal limit regulation did not limit the harvest significantly.

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Table 11.–Estimated angler effort and large (≥28") chinook salmon catch and harvest in the Haines marine boat sport fishery for similar sample periods, 1984–1997. Note that anglers were allowed to fish in Chilkat Inlet to the mouth of the river until 1987 and the fishery was closed in 1991 and 1992.

		Effort				Large (≥28") chinook salmon				
Year	**Survey dates**	Total angler-hours	SE	Salmon-hours	SE	Catch	SE	Harvest	SE	**CPUE**[a]
1984[b]	5/06-6/30	10,253	– [c]	9,855	– [c]	1,072	– [c]	1,072	– [c]	0.109
1985[d]	4/15-7/15	21,598	– [c]	20,582	– [c]	1,705	– [c]	1,696	– [c]	0.083
1986[e]	4/14-7/13	33,857	– [c]	32,533	– [c]	1,659	– [c]	1,638	– [c]	0.051
1987[f]	4/20-7/12	26,621	2,557	22,848	2,191	1,094	189	1,094	189	0.048
1988[g]	4/11-7/10	36,222	3,553	32,723	3,476	505	103	481	101	0.015
1989[h]	4/24-6/25	10,526	999	9,363	922	237	42	235	42	0.025
1990[i]	4/23-6/21	– [i]	– [i]	11,972	1,169	248	60	241	57	0.021
1993[j]	4/26-7/18	11,919	1,559	9,069	1,479	349	63	314	55	0.038
1994[k]	5/09-7/03	9,726	723	7,682	597	269	41	220	32	0.035
1995[l]	5/08-7/02	9,457	501	8,606	483	255	42	228	41	0.030
1996[m]	5/06-6/30	10,082	880	9,596	866	367	43	354	41	0.038
1997	5/12-6/29	9,432	861	8,758	697	381	46	381	46	0.044
1984–86 average		21,903		20,990		1,479		1,469		0.070
1987-90 average		24,456		19,227		521		513		0.027
1993–97 average		10,123		8,742		324		299		0.037

[a] Catch of large chinook salmon per salmon hour of effort.

[b] Neimark (1985).

[c] Estimates of variance were not provided until 1987.

[d] Mecum and Suchanek (1986).

[e] Mecum and Suchanek (1987).

[f] Bingham et al. (1988).

[g] Suchanek and Bingham (1989).

[h] Suchanek and Bingham (1990).

[i] Suchanek and Bingham (1991); no estimate of total angler effort and harvest provided.

[j] Ericksen (1994).

[k] Ericksen (1995).

[l] Ericksen (1996).

[m] Ericksen (1997).

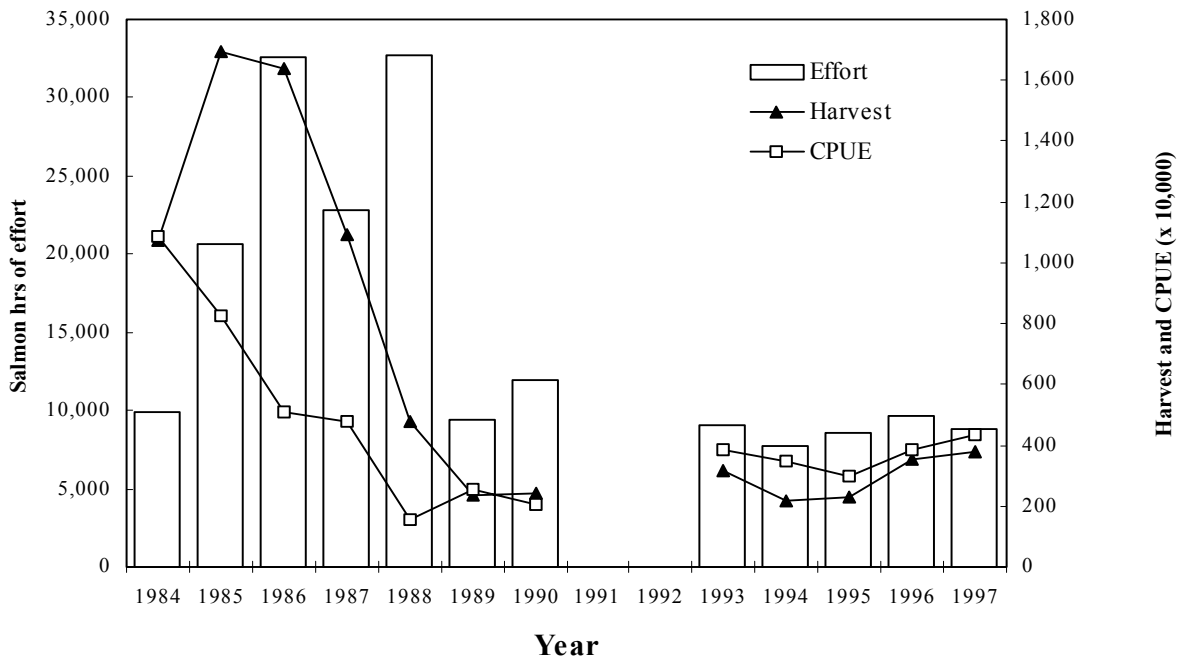

Figure 7.–Estimated angler effort for, and harvest and catch of, large chinook salmon per salmon hour of effort (CPUE) in the Haines spring marine boat sport fishery, 1984–1997. (Note that anglers were allowed to fish in Chilkat Inlet to the mouth of the river until 1987 and the fishery was closed in 1991 and 1992). Data were taken from Table 11.

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APPENDIX A

Appendix A1.–Sampling statistics, estimated effort, catch, and harvest of chinook salmon at the Letnikof Dock by week, May 12 through June 29, 1997.

		May 19–June 01						
	May 12 May 18	Non-derby	Derby	June 02 June 08	June 09 June 15	June 16 June 22	June 23 June 29	Total
Boats counted	40	52	73	49	41	30	19	304
Angler-hrs. sampled	238	355	1,214	402	289	170	157	2,825
Salmon-hrs. sampled	237	353	1,214	386	283	170	157	2,800
Chinook sampled	19	13	120	11	27	9	1	200
Sampled for ad-clips	19	13	120	11	27	9	1	200
Ad-clips	0	1	13	1	2	1	0	18
Angler-hours								
Estimate	334	1,064	3,034	806	614	449	377	6,678
Variance	4,335	8,483	289,703	46,086	26,363	11,331	976	387,277
Salmon-hours								
Estimate	334	1,064	3,034	806	614	449	377	6,678
Variance	4,335	8,483	289,703	46,086	26,363	11,331	976	387,277
Large chinook catch								
Estimate	28	39	131	25	75	22	2	322
Variance	0	78	98	34	1,509	59	3	1,781
Large chinook kept								
Estimate	28	39	131	25	75	22	2	322
Variance	0	78	98	34	1,509	59	3	1,781
Wild mature chinook kept (excluding hatchery and immature fish)								
Estimate	15	30	112	25	68	20	2	272
Variance	4	42	94	34	1,194	49	3	1,420
Small chinook catch								
Estimate	3	3	23	0	4	0	0	33
Variance	4	6	104	0	9	0	0	123

Appendix A2.–Sampling statistics, estimated effort, catch, and harvest of chinook salmon at the Chilkat State Park boat launch by biweek, May 19 through June 29, 1997.

	May 19–June 01				
	Non-derby	Derby	June 02 June 15	June 16 June 29	Total
Boats counted	3	3	4	2	12
Angler-hrs. sampled	10	28	29	16	83
Salmon-hrs. sampled	10	28	29	14	81
Chinook sampled	1	0	0	1	2
Sampled for ad-clips	1	0	0	1	2
Ad-clips	0	0	0	0	0
Angler-hours					
Estimate	43	140	203	112	498
Variance	492	15,680	6,594	8,400	31,166
Salmon-hours					
Estimate	43	140	203	98	484
Variance	492	15,680	6,594	8,232	30,998
Large chinook catch					
Estimate	5	0	0	7	12
Variance	16	0	0	42	58
Large chinook kept					
Estimate	5	0	0	7	12
Variance	16	0	0	42	58
Wild mature chinook kept (excluding hatchery and immature fish)					
Estimate	5	0	0	7	12
Variance	16	0	0	42	58
Small chinook catch					
Estimate	0	0	7	0	7
Variance	0	0	42	0	42

Appendix A3.–Sampling statistics, estimated effort, catch, and harvest of chinook salmon at the Small Boat Harbor by biweek, May 12 through June 29, 1997.

		May 19–June 01				
	May 12 May 18	Non-derby	Derby	June 02 June 15	June 16 June 29	Total
Boats counted	8	9	13	1	20	51
Angler-hrs. sampled	80	67	132	11	136	426
Salmon-hrs. sampled	47	61	132	11	61	312
Chinook sampled	2	3	1	2	3	11
Sampled for ad-clips	2	3	1	2	3	11
Ad-clips	0	0	1	0	0	1
Angler-hours						
Estimate	279	299	658	77	950	2,263
Variance	21,657	9,706	21,125	5,082	265,327	322,897
Salmon-hours						
Estimate	164	272	658	77	425	1,758
Variance	19,124	7,627	21,125	5,082	14,776	46,609
Large chinook catch						
Estimate	7	14	5	14	7	47
Variance	35	16	20	168	42	281
Large chinook kept						
Estimate	7	14	5	14	7	47
Variance	35	16	20	168	42	281
Wild mature chinook kept (excluding hatchery and immature fish)						
Estimate	4	9	0	14	0	27
Variance	9	0	0	168	0	177
Small chinook catch						
Estimate	0	0	0	0	21	21
Variance	0	0	0	0	42	42
Small chinook kept						
Estimate	0	0	0	0	14	14
Variance	0	0	0	0	168	168

Appendix A4.–Computer data files used in the analysis of this report.

FILE NAME	DESCRIPTION
F0810MA7.DTA	Mark-sense ASCII file containing angler interview data from the Haines marine sport fishery in 1997.
HAINE.PRG	Dbase program to generate SAS data file from mark-sense file.
HAINESCT.PRN	Count file (text) used in HAMC96.SAS to expand for missing interview data.
HAMC97.SAS	SAS program to estimate effort and harvest in the Haines marine sport fishery using HAINESCT.PRN and output from HAINE.PRG.
97AWL.XLS	Excel workbook containing all age-length data from the Haines sport fishery, and tagging and recovery efforts in the Chilkat River drainage during 1997.
97POPEST.XLS	Excel workbook used to estimate 1997 abundance of Chilkat River chinook.
97SPAWN.XLS	Excel workbook containing raw data from chinook sampled on the Chilkat River spawning tributaries during 1997.
97TAGS.XLS	Excel workbook containing raw data from chinook captured in the lower Chilkat River during 1997.