Fishery Data Series No. 00-28

Sport Fishing Effort, Catch, and Harvest, and Inriver Abundance of Chilkat River Chinook Salmon near Haines, Alaska in 1999

by

Randolph P. Ericksen

November 2000

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

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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SPORT FISHING EFFORT, CATCH, HARVEST, AND INRIVER ABUNDANCE OF CHILKAT RIVER CHINOOK SALMON NEAR HAINES, ALASKA IN 1999

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 2000

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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 harvest of chinook salmon *Oncorhynchus tshawytscha* in the Chilkat Inlet sport fishery and escapement into the Chilkat River are estimated annually to monitor this important sport fishery and the salmon stock which supports it. An age-stratified mark-recapture experiment was used to estimate spawning abundance of chinook salmon age 1.2 and older returning to the Chilkat River in 1999. Angler effort and harvest of wild mature chinook salmon in the Haines marine boat fishery were estimated using a creel survey. Harvest of large (28 inches and greater in total length) chinook salmon and chartered angler effort and harvest were also estimated.

Three hundred two (302) medium and large (age 1.2 and older) chinook salmon were captured with drift gillnets and fish wheels and 298 were tagged with solid-core spaghetti tags in the lower Chilkat River between June 11 and August 9, 1999. We examined 315 medium and large chinook salmon on spawning tributaries to the Chilkat River, and 35 of these were marked. On the basis of these data, we estimated that 2,698 (SE = 418) chinook salmon age 1.2 and older immigrated into the Chilkat River during 1999. An estimated 427 (SE = 94) were medium (age 1.2) and 2,271 (SE = 408) were large (age ≥1.3) fish.

An estimated 6,206 angler-hours (SE = 736) of effort (6,097 targeted salmon hours, SE = 734) were expended for a harvest of 184 (SE = 24) chinook salmon (≥28 inches), of which 82 (SE = 11) were wild mature fish. Chartered anglers accounted for 14% of the targeted salmon effort and 33% 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 estimate the sport harvest and escapement of chinook salmon *Oncorhynchus tshawytscha* returning to the Chilkat River during 1999. 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 km^2 (Bugliosi 1988).

The Chilkat River produces the third or fourth largest run of chinook salmon in Southeast Alaska (Pahlke 1997). Previous studies indicate that Chilkat River chinook salmon rear primarily in the inside waters of northern Southeast Alaska (Pahlke 1991, Johnson et al. 1993, Ericksen 1996, 1999). 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 (Figure 1) in Southeast Alaska near Haines and targets mature chinook salmon returning to the Chilkat River. A creel survey has been used to estimate 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, 1998, 1999).

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.

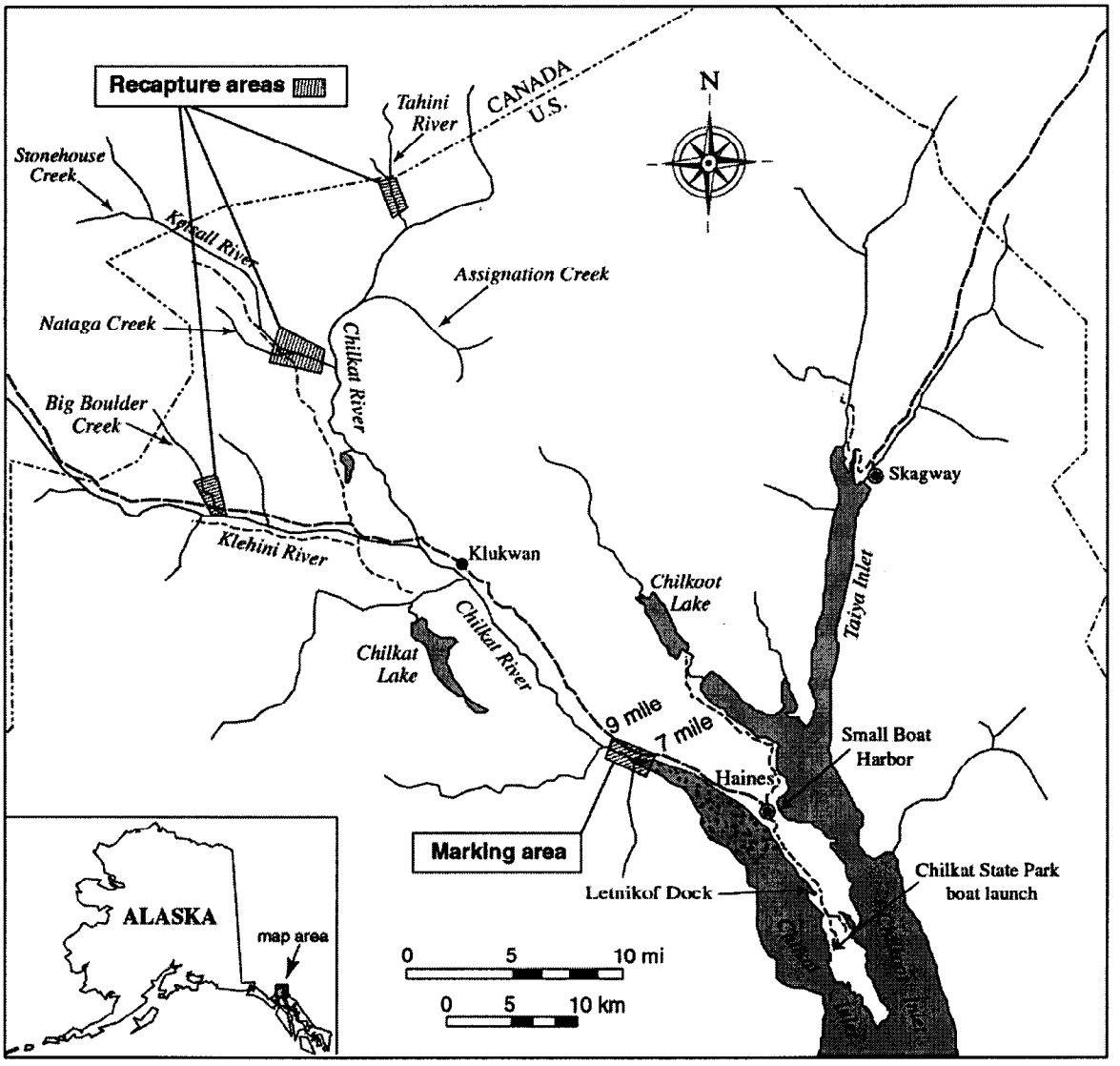


Figure 1.–Location of sampling sites and release sites of coded wire tagged chinook salmon near Haines and Skagway, Southeast Alaska, 1999.

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.

Because 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 radiotelemetry 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 indicate 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, 1999).

Mark-recapture experiments have been conducted annually since 1991 to estimate the escapement of large chinook salmon. Estimates have ranged between 3,675 (SE = 565) and 8,100 (SE = 1,193) fish (Johnson et al. 1992, 1993; Johnson 1994; Ericksen 1995–1999). Because abundance 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 1999 prevented sport fishing for chinook salmon near the mouth of the Chilkat River (see Ericksen 1998, 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 the sport harvest and escapement is the continuing goal of the Chilkat River chinook salmon research program.

Research objectives in 1999 were:

1. to estimate the 1999 immigration of medium (age 1.2) and 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 10 to June 27, 1999.

METHODS

INRIVER ABUNDANCE

An age-stratified mark-recapture experiment was used to estimate the number of medium (age 1.2) and large (≥age 1.3) chinook salmon returning to the Chilkat River in 1999. Marks were applied to fish (≥440 mm FL) captured in the lower Chilkat River with drift gillnets and fish wheels from June 13 through August 9, between the area adjacent to Haines Highway miles 7 and 9 (Figure 1). Chinook salmon were marked with a solid-core spaghetti tag, and a hole punch in the upper left operculum, 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 8 and September 7.

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 June 13 through July 22, 1999. The gillnets consisted of two equal-length panels: one of 17.1-cm (6.75-in.) and the other of 20.3-cm (8.0-in.) stretched nylon mesh. Each day we attempted to complete 43 drifts between 0600 and 1400 hours. Fishing was conducted from an 18-ft boat in six adjoining 0.5-km-long areas, which were marked along 3-km-long stretch of river (Figure 2). This area was about 100 m wide and 2 to 3 m deep and located slightly downriver from the area used prior to 1998 due to shoaling. The 43 drifts took about 6 hours to complete when fish were not captured. Fishing continued uninterrupted from area to area 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

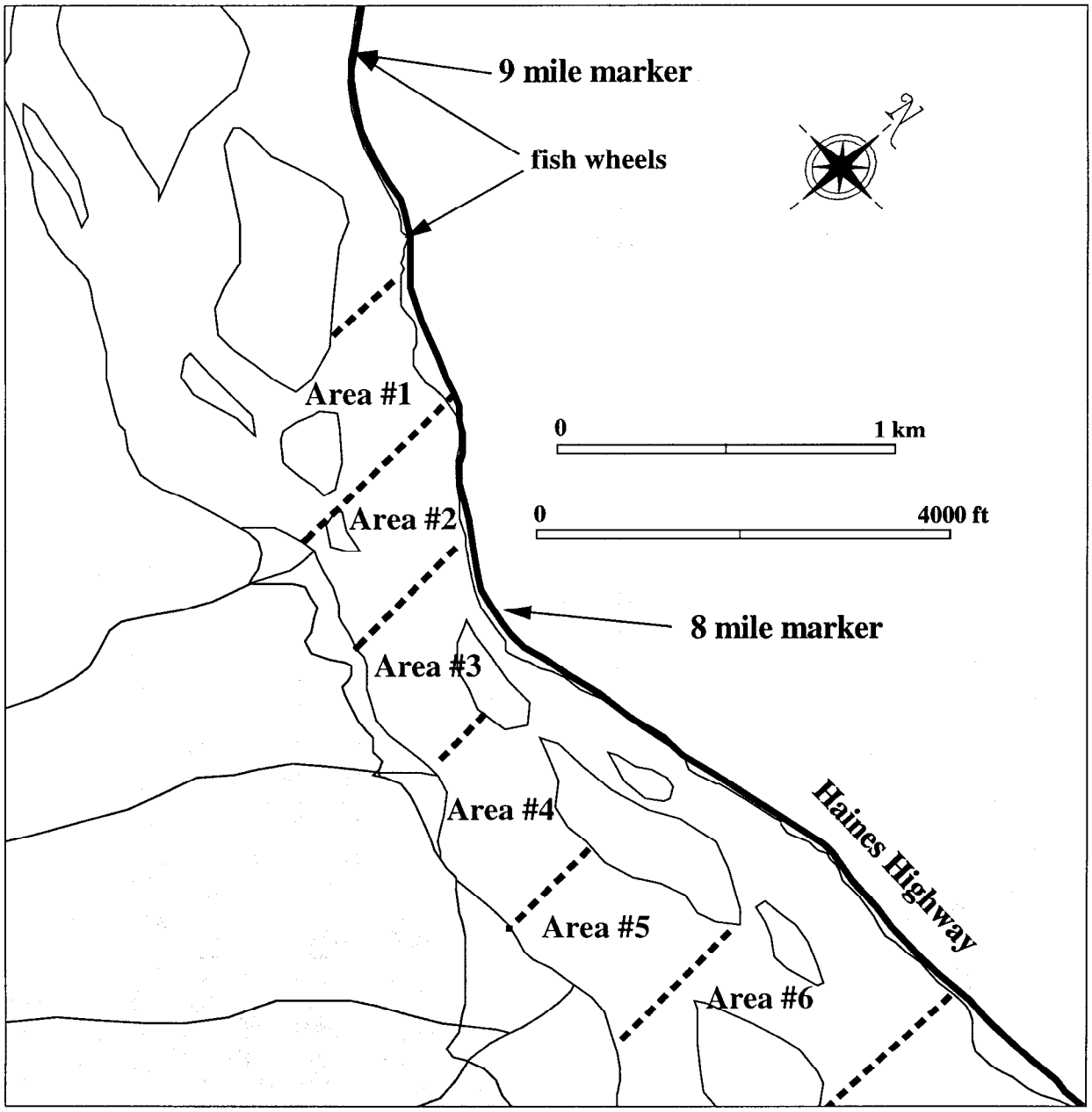


Figure 2.–Active lower Chilkat River channel, drift areas, and sites of fish wheels in 1999.

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 3-basket aluminum fish wheels were installed by ADF&G Commercial Fisheries Division (CF) personnel on June 7 and were operated through October 9 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 CF tagging of captured chinook. One fish wheel operated adjacent to the Haines Highway near mile 9 and the other about 300 m downstream (Figure 2).

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 were operated continuously except for maintenance.

Captured chinook salmon were placed in a water-filled tagging box (see Figure 3 *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 ≥440 and <660 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, and a ¼-inch hole was punched into the upper edge of the left operculum as a secondary mark. Age of each fish was determined at the end of the season by counting the annuli on the scales (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) were sampled for marks by two teams of two people. Spawning grounds in the Kelsall River (including Nataga Creek) were sampled from August 5 to September 4. Spawning grounds in the Tahini River were sampled from August 9 to September 7. Chinook salmon were also sampled in Big Boulder Creek from August 10 through August 27. Chinook salmon were captured with gillnets, 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).

Stratifying the experiment into medium (age 1.2) and large (age 1.3 and older) fish insures that abundance and age composition estimates for large fish are obtained by similar, robust methods each year (estimates for age 1.2 fish have not been possible in most years due to small sample sizes). This ensures that estimates are comparable with other years when it was not possible to estimate the number of medium fish. In addition, key experimental assumptions that sampling is unselective by fish size, age, and sex are strained when age 1.2 fish are pooled with large fish, and meaningful failures can be difficult to detect with a small sample size. Selectivity assumptions for a stratum of age 1.2 fish are, in contrast, robust. These fish are mostly (>95%) male and span a small range of lengths relative to fish age ≥1.3.

The validity of assumption (a) was tested through a series of hypothesis tests (all at $\alpha = 0.1$). First, a contingency table (chi-square statistic) was used to test the hypothesis that fish sampled at different spawning tributaries were marked at the same rate. Also, a contingency table was used to test the hypothesis that fish marked at different times in the emigration (e.g., early vs. late) were recaptured at the same rate. If either hypothesis was accepted, a simple Petersen model was used to estimate abundance; otherwise a Darroch estimator would be used.

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 during the second sampling event was tested with a Kolmogorov-Smirnov (K-S) 2-sample test comparing the size distribution of marked fish with those recaptured. Sex selective sampling for larger fish 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 significant differences were

observed between size or sex compositions, the abundance estimate could be stratified by size, age, and/or by sex to reduce bias. The remaining assumptions are considered in greater detail under the Discussion section.

Abundance (numbers immigrating) of medium, or 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 medium or large chinook salmon marked in the lower river, n_2 is the number examined on the spawning grounds, and m_2 is the subset of n_2 which had been marked in the lower river.

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 1995–1999) 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.

Size selectivity was investigated using two K-S tests: one described above, and the other comparing the lengths of fish marked in the lower river to those sampled on the spawning grounds.

Age and sex selectivity was investigated by contingency table analysis. The number of large (≥ age 1.3) chinook captured (by age or sex) in the lower river was compared with the number sampled on the spawning grounds. If sex compositions differed significantly, spawning ground samples alone were used to estimate sex composition, as sex determination is known to be more difficult early in the season while marking fish (Ericksen 1995–1998).

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 sex for medium and large fish were estimated by:

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

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

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

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

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

$$\text{var}[\hat{N}_a] = \text{var}[\hat{p}_a]\hat{N}^2 + \text{var}[\hat{N}]\hat{p}_a{}^2 - \text{var}[\hat{p}_a]\,\text{var}[\hat{N}] \qquad (6)$$

where $\hat{N}$ is the estimated abundance of large chinook salmon and $\hat{p}_a$ is the estimated proportion of age a fish. The abundance of chinook salmon by sex in each age class $\hat{N}_{a,sex}$ was then estimated by substituting $\hat{N}_{a,sex}$, $\hat{N}_a$, and proportion of age a fish by sex ($\hat{p}_{a,sex}$) for $\hat{N}_a$, $\hat{N}$, and $\hat{p}_a$ in equation 5 and 6.

HARVEST

1999 Haines Marine Sport Fishery Harvest

A stratified two-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 29, 30, 31, and June 5 and 6) at both high- and low-use sites. Each fishing day was defined as starting at 0800 hours and ending at civil twilight, which ranged from 2219 to 2349 hours.

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 10 to June 27, 1999, and contained morning/evening stratification and weekend/weekday stratification of evening strata during the peak of the season. Morning sampling strata lasted from 0800 hours until two hours before midday, and evening sampling strata lasted from two hours before midday until civil twilight. Thus, evening strata were four hours longer in duration than morning strata. This stratification scheme was designed to increase the precision of estimates by maximizing sampling during hours when most anglers exit the fishery. 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 10 through June 13) the evening strata at Letnikof Dock were further divided into weekday and weekend stratification. During this time, two mornings, two weekday evening, and two weekend/holiday evening periods were sampled each week. In total, 17 unique strata were sampled at Letnikof Dock in 1999.

Sampling at the Small Boat Harbor and Chilkat State Park boat launch was initiated on May 10 and May 17, respectively, and continued through June 27. 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 and last 7-day sampling periods at the Chilkat State Park boat launch, and the last 7-day 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, 11 changes (period moves) were made to the randomized sampling schedule at low-use sites. Eighteen (18) unique strata were sampled at the low-use harbors during 1999.

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 had an adipose fin; or (b) 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 of undetermined 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):

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

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

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

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

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

where f_{1h} was the sampling fraction for periods and f_{2hi} was the sampling fraction for boat-parties. Catch and effort was estimated similarly, substituting C and E for H in equation 7 through equation 10. Total harvests for the season were the sums across strata ΣH_h and $\Sigma var[H_h]$. Similarly, the effort and harvest by charter boat anglers were estimated by considering only data collected from chartered anglers in equation 7 through 10.

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.

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.

Contribution of Coded Wire Tagged Stocks

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.

The contribution of all tagged stocks to the 1999 Haines marine boat sport fishery were estimated:

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

where $\hat{H}_i$ is the estimated harvest of stock j in stratum i, $\hat{\theta}_i$ is the fraction of stock j marked with CWTs, n_i is the subset of $\hat{H}_i$ examined for missing adipose fins, m_{ij} is the number of decoded CWTs recovered from stock j, and $\lambda_i = (a_i't_i')/(a_i t_i)$ is the decoding rate for CWTs from recovered salmon. See Bernard and Clark (1996) for further details. Statistics were stratified by bi-week.

Variance of $\hat{r}_{ij}$ was estimated using the appropriate large-sample formulations in Bernard and Clark (1996, their Table 1) for wild or hatchery stocks harvested in recreational fisheries. The total contribution of one or more cohorts to one or more fisheries is the sum of harvests and variances from the individual cohorts and strata.

RESULTS

INRIVER ABUNDANCE

We captured 234 large (age 1.3 and older), 68 medium (age 1.2), and 147 small chinook salmon in the lower Chilkat River with drift gillnets and fish wheels between June 11 and August 9, 1999 (Table 1, Figure 3). Of those captured, 232 large and 66 medium chinook salmon were given an external spaghetti tag. One large (≥age 1.3) fish captured in the fish wheels had been previously caught and tagged by the drift gillnet crew, another large fish escaped before it was tagged, and two medium fish <440 mm in length were not tagged. Capture rates of large chinook salmon peaked on July 9. The mean date of migratory timing (weighted mean, Mundy 1984) in the lower river was also July 9 (Figure 4).

Fish captured in the gillnet were predominantly age 1.4 (61.1%) and classified as female (55.8%, Table 2). Those captured in the fish wheels were classified mostly as males (69.2%) and most commonly age 1.1 (43.7%, Table 2). Large chinook salmon captured in gillnets and fish wheels were not significantly different in size (K-S test, $d_{max} = 0.092$, $P = 0.717$) or age composition ($\chi^2 = 0.023$, df = 1, $P = 0.878$).

We examined 233 large, 82 medium, and 17 small chinook salmon on the spawning grounds for marks (Table 3). Twenty-three (23) large, 12 medium, and no small marked fish were recovered (Table 3). One large and one medium marked fish were recovered with missing tags but were identified as marked fish by the opercular punch. Also, one tag from a large fish recovered was so badly damaged that the tag number could not be read.

Similar fractions of large ($\chi^2 = 3.842$, df = 2, $P = 0.147$) and medium ($\chi^2 = 0.855$, df = 2, $P = 0.652$) chinook salmon sampled at each spawning tributary were marked. Thus, Petersen models were used to estimate abundance for each size group.

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 those tagged chinook salmon recaptured on the spawning grounds (K-S test, $d_{max} = 0.131$, $P = 0.894$, Figure 5, top). Also, there was no significant difference in the CDFs

Table 1.–Numbers of chinook salmon caught in the lower Chilkat River by time period, gear type and size, June 11 through August 9, 1999.

Time period	Drift gillnet			Fish wheels			Combined			
	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small	Total
6/11-6/15	1	0	0	0	0	0	1	0	0	1
6/16-6/20	1	1	0	0	1	3	1	2	3	6
6/21-6/25	6	1	0	1	7	33	7	8	33	48
6/26-6/30	7	1	2	14	8	10	21	9	12	42
7/01-7/05	19	3	1	20	6	10	39	9	11	59
7/06-7/10	32	3	0	36	13	55	68	16	55	139
7/11-7/15	26	3	1	28	11	22	54	14	23	91
7/16-7/20	13	3	0	18	4	8	31	7	8	46
7/21-7/25	3	2	0	4	1	2	7	3	2	12
7/26-7/30				3	0	0	3	0	0	3
7/31-8/04				1	0	0	1	0	0	1
8/05-8/09				1	0	0	1	0	0	1
	108	17	4	126	51	143	234	68	147	449

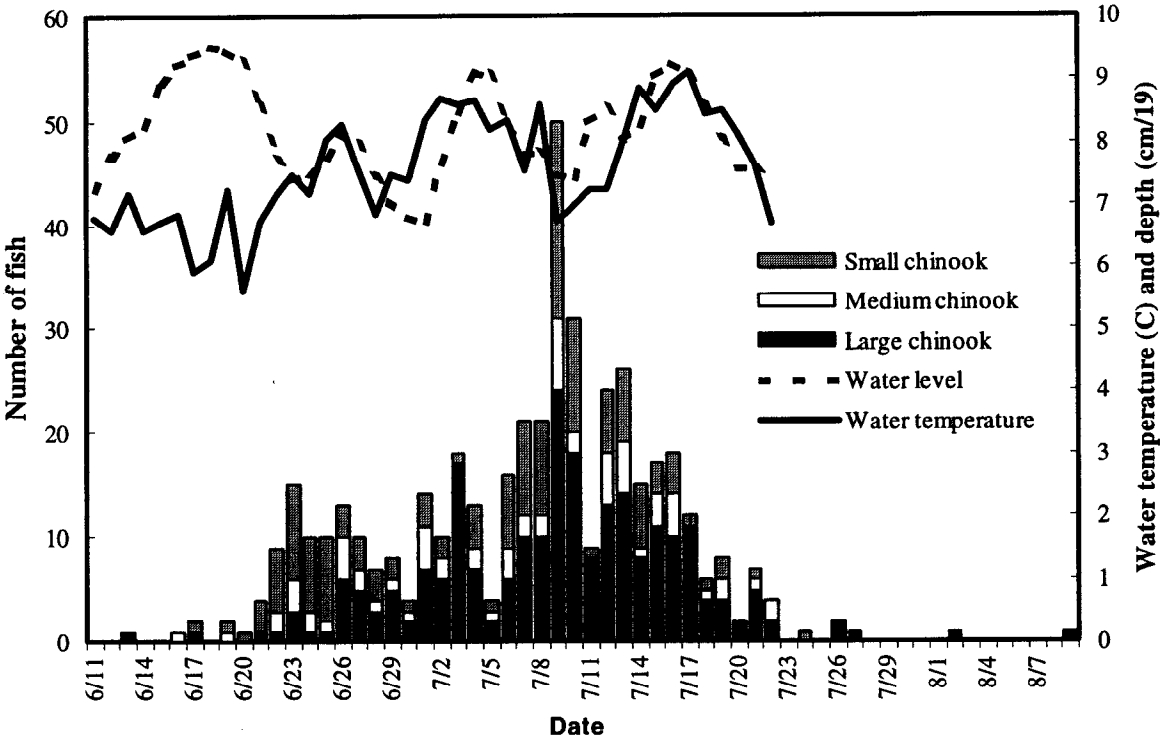


Figure 3.–Daily water depth (cm/19), temperature (°C), and catches of small (<age 1.2), medium (age 1.2), and large (≥1.3) chinook salmon in drift gillnets and fish wheels operating in the lower Chilkat River June 11 through August 9, 1999.

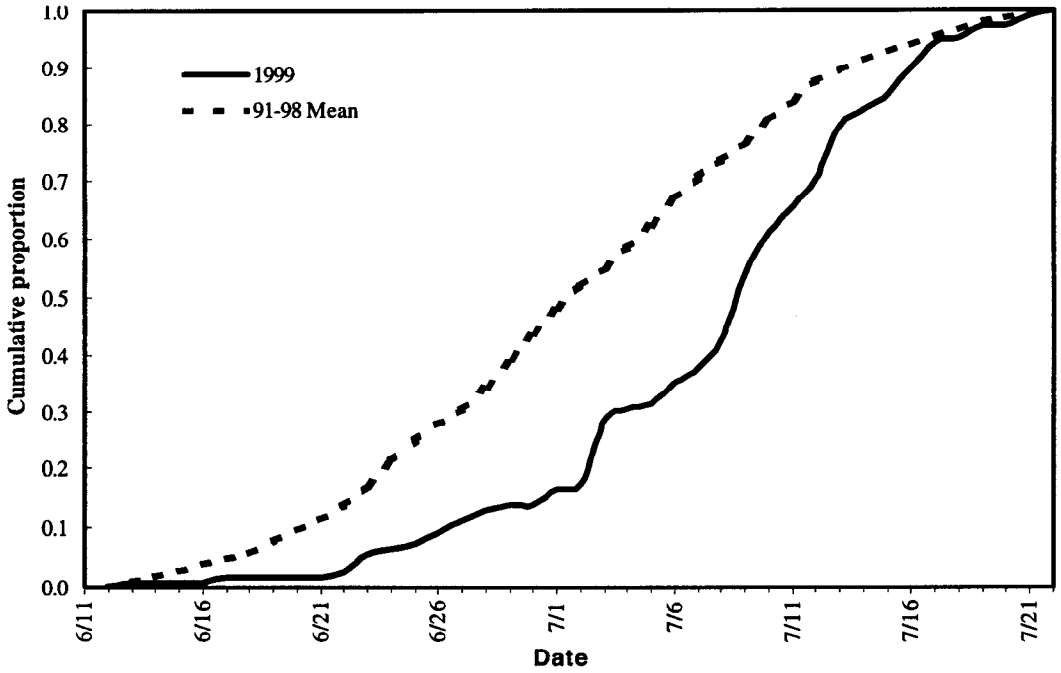


Figure 4.–Cumulative proportion of large (≥1.3) chinook salmon captured with drift gillnets in the lower Chilkat River in 1999 compared to the mean cumulative proportion, 1991–1998.

Table 2.–Age composition and mean length-at-age (measured in mm from mideye to fork of tail) of chinook salmon sampled during tagging operations on the Chilkat River, by gear type, 1999.

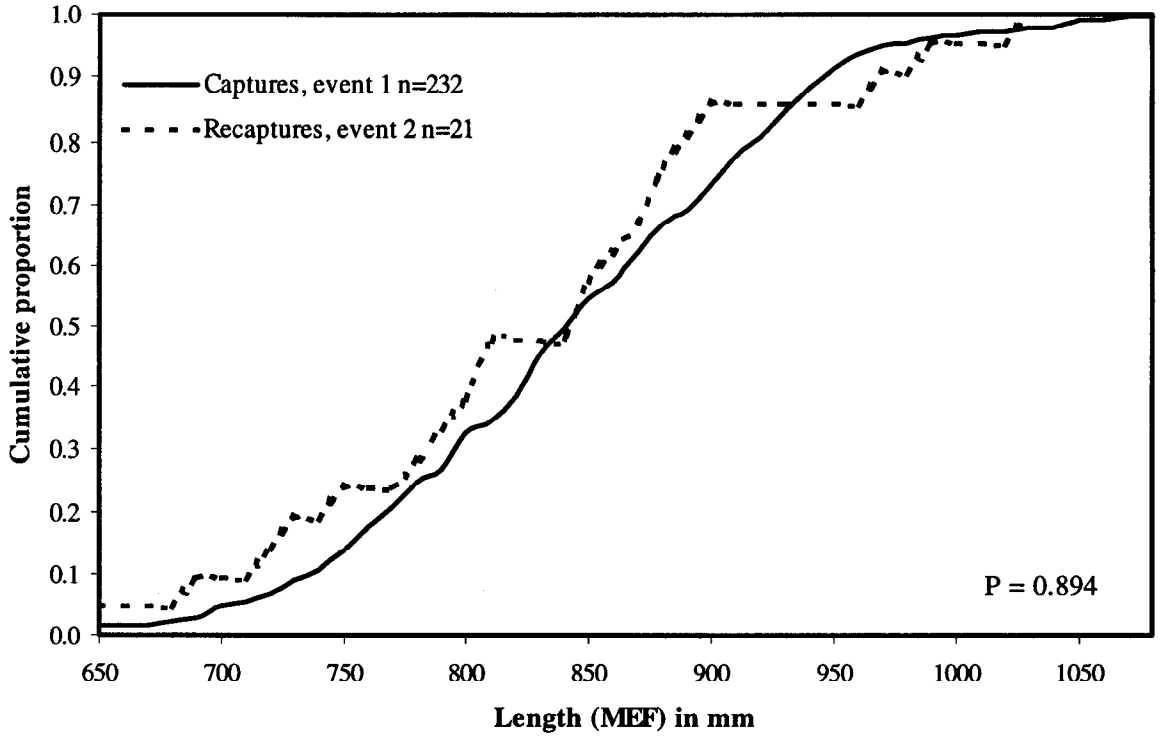
		Brood year and age class						
		1996	1995	1994	1993	1992	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
				DRIFT GILLNET				
Males	Sample size	3	16	13	19	1	52	57
	Percent	5.8	30.8	25.0	36.5	1.9		44.2
	SD	3.2	6.4	6.0	6.7	1.9		4.4
	Mean length	395	618	741	924	970		
	SD	23.1	9.4	22.0	16.8			
Females	Sample size	0	1	7	47	1	56	72
	Percent		1.8	12.5	83.9	1.8		55.8
	SD		1.8	4.4	4.9	1.8		4.4
	Mean length		680	798	860	910		
	SD			10.1	7.2			
All fish	Sample size	3	17	20	66	2	108	129
	Percent	2.8	15.7	18.5	61.1	1.9		
	SD	1.6	3.5	3.7	4.7	1.3		
	Mean length	395	622	761	878	940		
	SD	23.1	9.5	15.8	7.8	30.0		
				FISH WHEELS				
Males	Sample size	122	35	11	26	2	196	211
	Percent	62.2	17.9	5.6	13.3	1.0		69.2
	SD	3.5	2.7	1.6	2.4	0.7		2.6
	Mean length	349	578	740	898	1020		
	SD	3.2	13.6	15.7	17.8	85.0		
Females	Sample size	0	12	13	52	6	83	94
	Percent		14.5	15.7	62.7	7.2		30.8
	SD		3.9	4.0	5.3	2.8		2.6
	Mean length		614	766	846	884		
	SD		12.5	13.6	9.4	49.0		
All fish	Sample size	122	47	24	78	8	279	305
	Percent	43.7	16.8	8.6	28.0	2.9		
	SD	3.0	2.2	1.7	2.7	1.0		
	Mean length	349	587	754	863	918		
	SD	3.2	10.8	10.4	9.0	45.2		

[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, 1999.

		Inspected[a]											Marked					
		Large				Medium				Small			Large			Medium		
	Dates	M	F	U	Total	M	F	U	Total	M	F	Total	M	F	Total	M	F	Total
Kelsall	8/05-9/04	62	51	8	121	12	2	0	14	1	0	1	8	6	14	3	0	3
Tahini	8/09-9/07	24	28	1	53	49	0	1	50	14	0	14	4	3	7	6	0	6
Big Boulder	8/10-8/27	26	33	0	59	17	0	1	18	2	0	2	0	2	2	3	0	3
Total		112	112	9	233	78	2	2	82	17	0	17	12	11	23	12	0	12

[a] M = male, F = female, U = not sexed.



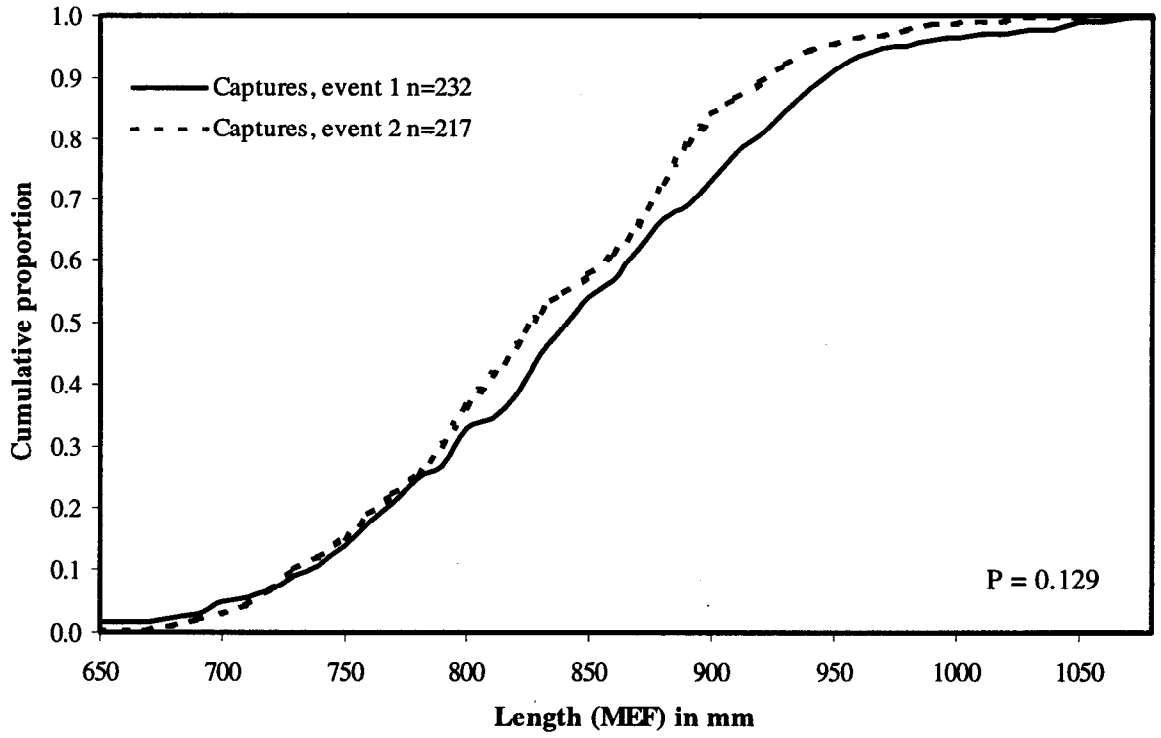


Figure 5.–Cumulative distribution function (CDF) of MEF lengths of large (≥1.3) chinook salmon marked in the lower Chilkat River versus lengths of marked fish recaptured on the spawning grounds (top) and versus lengths of large fish examined for marks on the spawning grounds (bottom), 1999.

of marked and recaptured age 1.2 fish (K-S test, $d_{max} = 0.356$, P = 0.152) These results suggest the second sampling event was not size-selective and further stratification was not necessary. Thus, we estimate that 2,698 (SE = 418) chinook salmon ≥age 1.2 immigrated into the Chilkat River in 1999. Of those, 427 (SE = 94) were medium (age 1.2) and 2,271 (SE = 408) were large (≥age 1.3) fish. These estimates are germane to the time of tagging in the lower river since an unquantified removal occurs (from natural mortality and subsistence fishery harvest) between the two sampling events.

Age and Sex Composition of the Escapement

We sampled 321 chinook salmon on the spawning grounds for age and sex. Of those sampled, 286 were successfully aged (Table 4). The CDF of lengths of large fish sampled in the lower river was not significantly different from the CDF of those examined for marks on the spawning grounds (K-S test, $d_{max} = 0.111$, P = 0.129, Figure 5, bottom). Similarly, age compositions of large fish were not significantly different between gillnet and fish wheel ($\chi^2 = 0.0234$, df = 1, P = 0.878) or between spawning tributaries, excluding Big Boulder Creek ($\chi^2 = 0.528$, df = 1, P = 0.467). The age composition of Big Boulder Creek samples was significantly different from other spawning ground samples, so these samples were not used to estimate age or sex composition. The age composition of large fish was not significantly different between marking and recovery events ($\chi^2 = 0.359$, df = 1, P = 0.549). In conjunction with results above that suggest no size selectivity, neither sampling event appeared to have been size (or age) selective for large fish and both sampling events should be used to estimate age composition of the escapement.

Sex composition of large chinook salmon was significantly different between marking and recovery events ($\chi^2 = 9.121$, df = 1, P = 0.0025), but not between the Tahini and Kelsall River spawning grounds ($\chi^2 = 0.408$, df = 1, P = 0.523). Therefore, only the Tahini and Kelsall River samples were used to estimate sex composition by age in the escapement.

The majority (61%) of the estimated escapement of medium and large chinook salmon in 1999 were age 1.4 fish (1993 brood year, Table 5). The remainder of the escapement was composed of 16% age 1.2, 20% age 1.3, and 3% age 1.4 fish. Most (61%) of the fish were males (Table 5).

HARVEST

1999 Haines Marine Sport Fishery Harvest

An estimated total of 6,206 (SE = 736) angler-hours of effort was expended in the Haines marine boat fishery between May 10 and June 27, 1999 to catch and harvest 184 (SE = 24) large chinook salmon (Table 6). This was based on a sample of 214 boat-parties who fished 2,011 angler-hours (1,971 salmon-hours), and harvested 81 large (28 inches or greater total length) chinook salmon (Table 6). An estimated 82 (SE = 11) of the chinook salmon harvested in this fishery were wild mature fish assumed to be returning to the Chilkat River. About 98% (6,097 salmon-hours, SE = 734) of angler effort targeted chinook salmon, and the remainder was directed toward other species, primarily Pacific halibut. Anglers caught an estimated 388 (SE = 75) small (sublegal, <28 inches total length) chinook salmon of which 16 (SE = 13) were kept. Eighty-eight percent (88%) of the estimated salmon effort and 89% of the estimated harvest of chinook salmon occurred between May 24 and June 20 (Table 6).

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 14% of the salmon effort (879 salmon-hours, SE = 138), and 33% of the harvest (61, SE = 14) of chinook salmon in this fishery.

Anglers returning to Letnikof Dock (the high-use site) were responsible for 61% of the estimated salmon effort (3,726 salmon-hours, SE = 310) and 51% of the estimated harvest (93, SE = 11) of large chinook salmon (Appendix A1). Anglers returning to the Chilkat State Park boat launch and the Small Boat Harbor accounted for an estimated 173 (SE = 116) and 2,198 (SE = 655) salmon-hours of effort, respectively, and took respective harvests of 0 and 91 (SE = 22) large chinook salmon (Appendices A2 and A3).

Table 4.–Age composition and mean length-at-age (measured in mm from mid-eye to fork of tail) of chinook salmon sampled during recovery surveys on the Chilkat River drainage, by spawning tributary, 1999.

		Brood year and age class						
		1996	1995	1994	1993	1992	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
TAHINI RIVER								
Males	Sample size	14	47	7	15	0	83	87
	Percent	16.9	56.6	8.4	18.1			75.7
	SD	4.1	5.4	3.1	4.2			4.0
	Mean length	371	599	770	925			
	SD	10.5	8.7	25.8	13.3			
Females	Sample size	0	0	6	17	0	23	28
	Percent			26.1	73.9			24.3
	SD			9.2	9.2			4.0
	Mean length			754	855			
	SD			26.4	10.7			
All fish	Sample size	14	47	13	32	0	106	115
	Percent	13.2	44.3	12.3	30.2			
	SD	3.3	4.8	3.2	4.5			
	Mean length	371	599	763	888			
	SD	10.5	8.7	17.9	10.4			
BIG BOULDER CREEK								
Males	Sample size	1	15	16	7	0	39	45
	Percent	2.6	38.5	41.0	17.9			57.7
	SD	2.5	7.8	7.9	6.1			5.6
	Mean length	430	611	788	892			
	SD		7.6	15.6	20.4			
Females	Sample size	0	0	16	12	0	28	33
	Percent			57.1	42.9			42.3
	SD			9.4	9.4			5.6
	Mean length			760	830			
	SD			13.2	7.8			
All fish	Sample size	1	16	32	19	0	68	78
	Percent	1.5	23.5	47.1	27.9			
	SD	1.5	5.1	6.1	5.4			
	Mean length	430	611	774	854			
	SD		17.0	10.4	11.3			
KELSALL RIVER/NATAGA CREEK								
Males	Sample size	1	12	13	38	2	66	75
	Percent	1.5	18.2	19.7	57.6	3.0		58.6
	SD	1.5	4.7	4.9	6.1	2.1		4.4
	Mean length	395	613	809	895	1028		
	SD		21.6	18.5	8.8	122.5		
Females	Sample size	0	2	10	34	0	46	53
	Percent		4.3	21.7	73.9			41.4
	SD		3.0	6.1	6.5			4.4
	Mean length		643	779	819			
	SD		7.5	10.4	7.0			
All fish	Sample size	1	14	23	72	2	112	128
	Percent	0.9	12.5	20.5	64.3	1.8		
	SD	0.9	3.1	3.8	4.5	1.3		
	Mean length	395	617	796	859	1,028		
	SD		18.7	11.7	7.3	122.5		

[a] Includes fish 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 medium and large chinook salmon in the 1999 Chilkat River escapement, by age and sex.

	Brood year and age class				
	1995 1.2	1994 1.3	1993 1.4	1992 1.5	Total
Male	413	297	844	80	1,634
SE	91	75	174	27	212
Female	14	237	812		1,064
SE	10	65	169		181
All fish	427	534	1,656	80	2,698
SE	94	109	302	27	418

Age and Length of Harvest

We sampled a total of 80 chinook salmon for age and length in the angler harvest; 69 of these were assigned an age. The age composition of the harvest during May was not significantly different from that during June (χ^2 = 0.513, df = 2, P = 0.774), so samples were pooled over time. The age composition of fish landed at the Small Boat Harbor was significantly different from that of fish landed at the Letnikof Dock (χ^2 = 14.41, df = 1, P < 0.001), so these samples were analyzed separately.

We sampled 64 chinook salmon for age and length at the Chilkat Inlet harbors (Letnikof Dock and Chilkat State Park boat launch), and 55 of these were assigned an age (Table 7). The harvest

Table 6.–Sampling statistics and estimated effort, catch, and harvest of chinook salmon in the Haines marine boat sport fishery, by biweek, May 10 through June 27, 1999.

		May 24–June 06				
	May 10–23	Non-derby	Derby	June 07–20	June 21–27	Total
Boats counted	32	30	64	65	23	214
Angler-hours sampled	197	174	1,038	472	130	2,011
Salmon-hours sampled	175	174	1,034	462	126	1,971
Chinook sampled	6	7	44	19	5	81
Sampled for ad-clips	5	7	44	19	5	80
Ad-clips	0	0	5	1	0	6
Angler-hours						
Estimate	315	581	3,202	1,612	496	6,206
Variance	7,647	40,778	441,927	36,411	14,365	541,128
Salmon-hours						
Estimate	293	581	3,192	1,563	468	6,097
Variance	7,647	40,778	444,852	35,140	9,661	538,078
Large chinook catch						
Estimate	9	26	49	88	12	184
Variance	9	58	38	448	45	598
Large chinook kept						
Estimate	9	26	49	88	12	184
Variance	9	58	38	448	45	598
Wild mature chinook kept (excluding hatchery and immature fish)						
Estimate	7	20	34	16	5	82
Variance	9	40	38	32	3	122
Small chinook catch						
Estimate	4	21	163	172	28	388
Variance	9	105	3,264	1,621	672	5,671
Small chinook kept						
Estimate	0	0	0	2	14	16
Variance	0	0	0	3	168	171

Table 7.–Estimated age composition and mean length-at-age (measured in mm from snout to fork of tail) of harvested chinook salmon in the Haines marine boat sport fishery by location, May 10 through June 27, 1999.

		Brood year and age class						
		1995 0.3	1995 1.2	1994 1.3	1993 1.4	1992 1.5	Total aged	Total sampled[a]
CHILKAT INLET HARBORS								
Males	Sample size	0	5	12	11	0	28	31
	Percent		17.9	42.9	39.3			48.4
	SE		7.4	9.5	9.4			6.3
	Mean length		724	847	1,011			
	SE		21.8	26.0	22.4			
Females	Sample size	1	1	11	13	1	27	33
	Percent	3.7	3.7	40.7	48.1	3.7		51.6
	SE	3.7	3.7	9.6	9.8	3.7		6.3
	Mean length	740	655	836	955	1,020		
	SE			21.3	16.4			
Combined	Sample size	1	6	23	24	1	55	64
	Percent	1.8	10.9	41.8	43.6	1.8		
	SE	1.8	4.2	6.7	6.7	1.8		
	Mean length	740	713	842	981	1,020		
	SE		21.5	16.2	14.3			
SMALL BOAT HARBOR								
Males	Sample size	0	4	1	1	0	6	6
	Percent		66.7	16.7	16.7			37.5
	SE		21.1	16.7	16.7			12.5
	Mean length		678	930	1,109			
	SE		30.7					
Females	Sample size	0	4	4	0	0	8	10
	Percent		50.0	50.0				62.5
	SE		18.9	18.9				12.5
	Mean length		679	744				
	SE		26.1	6.4				
Combined	Sample size	0	8	5	1	0	14	16
	Percent		57.1	35.7	7.1			
	SE		13.7	13.3	7.1			
	Mean length		678	781	1,109			
	SE		17.3	41.9				

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

Table 8.–Contribution estimates of coded wire tagged chinook salmon to the Haines marine boat sport fishery, with statistics used for computing estimates by biweek, 1999. Because fish sampled at the weigh-in station during the Haines king salmon derby could have been landed at the Small Boat Harbor, samples for the May 24–June 6 biweek were combined.

Hatchery	Release site	Tag code	Brood year	Biweek	Harvest N	Harvest SE[N]	Sample *n*	Adclip *a*	Head *a'*	Detect *t*	Decode *t'*	Tags *m*	Contribution *r*	Contribution SE
ALL AREA RECOVERIES														
Gastineau	Fish Creek	04-44-38	1993	5/24–6/6	75	10	51	5	5	4	4	1	7	7
Gastineau	Auke Bay	04-37-37, 38	1994	5/24–6/6	75	10	51	5	5	4	4	2	11	10
Gastineau	Gastineau	50-04-23	1995	5/24–6/6	75	10	51	5	5	4	4	1	13	12
				Subtotal									**31**	**16**
SMALL BOAT HARBOR RECOVERIES														
Gastineau	Fish Creek	50-04-01	1994	6/7–6/20	70	20	10	1	1	1	1	1	26	26
				Subtotal									**26**	**26**
	TOTAL												**57**	**30**

was about evenly split between males (48.4%, SE = 6.3%) and females (51.6%, SE = 6.3%). The predominant age classes were age 1.3 (41.8%, SE = 6.7%) and 1.4 (43.6%, SE = 6.7%).

We sampled 16 chinook salmon for age and length at the Small Boat Harbor and 14 of these were assigned an age (Table 7). Two of those sampled were <28 inches in total length (caught in the Taiya Inlet terminal harvest area for hatchery chinook salmon).

Contribution of Coded Wire Tagged Stocks

Chinook salmon incubated and reared at the Douglas Island Pink and Chum, Inc. (DIPAC) Gastineau hatchery facility that were released into Auke Bay (1994 brood), Fish Creek (1993 and 1994 broods), and Gastineau Channel (1995 brood) were recovered in the 1999 Haines marine creel survey (Table 8). Six (6) of the 80 chinook salmon sampled between May 10 and June 27 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, two adipose finclipped chinook salmon landed at the Small Boat Harbor were entered into the Haines Salmon Derby. Thus, samples were pooled over all harbors during this biweek (May 24 through June 6) because derby fish were sampled at the Letnikof Dock derby weigh-in station regardless of where they were landed. Fifty-seven (57; SE = 30) of the estimated 184 large chinook salmon harvested in the Haines marine boat sport fishery were of hatchery origin (Table 8).

Computer files used in this analysis are listed in Appendix A5.

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) by sampling uniformly across the escapement. Also, sampling effort for tag recovery on the Kelsall and Tahini rivers (where >90% of spawning occurred in 1991 and 1992; Johnson et al. 1992, 1993) 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 of large chinook salmon found on the Tahini (P = 0.116) and Kelsall-Nataga (P = 0.132) rivers in 1999 were similar. Although carcass surveys are known to be selective for females in some situations (Pahlke et al. 1996), I could not detect a significant difference from the battery of tests

applied in this study. The assumption of no recruitment during the experiment is reasonable, because tagging effort was relatively constant and continued until only about one fish per day was being caught. I could not test the assumption that marking does not affect catchability directly. However, recovery rates were not significantly different between large fish marked in the gillnet and those marked in the fish wheels, ($\chi^2 = 0.360$, df = 1, P = 0.549). This suggests fish marked at the fish wheels and gillnets had similar mortality rates. Because all fish had secondary marks that were not lost, assumption (d) was satisfied. Personnel sampling on the spawning tributaries carefully examined each fish for marks; therefore failure of assumption (e) is unlikely.

The immigration timing of chinook salmon through the lower Chilkat River was about one week later than average. The mean date of migratory timing (Mundy 1984) was July 9. In contrast, the mean date for past years was July 2 (Figure 4).

The 1999 immigration of large chinook salmon 2,271 (SE = 408) is the lowest abundance estimated since 1991 (Table 9). This is the result of poor 1993 and 1994 brood year returns to the Chilkat River (Table 9).

Sex was estimated with uncertainty early in the season. Seven out of 32 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). All of these fish were sexed as female when tagged and as males on the spawning grounds 1999.

Sport fishing harvest patterns observed during 1999 were different those observed in recent years. During 1999, 51% of the estimated harvest of chinook salmon was landed at the Letnikof Dock. Since 1995, the harvest from this dock has averaged 79%. In contrast, 49% of the estimated harvest was landed at the Small Boat Harbor. Also, no chinook salmon were sampled at the Chilkat State Park boat launch where on average 14% of the harvest has occurred in recent years.

The 1999 estimated harvest of large chinook salmon is lower than, but similar to, the harvest during the last nine years (1988, 1989, 1990, 1993, 1994, 1995, 1996, 1997, and 1998) the fishery was open (Table 10, Figure 6). Also, sport

Table 9.–Estimated annual age compositions and brood year returns of large (≥age 1.3) chinook salmon immigrating into the Chilkat River, 1991–1999. Age compositions were estimated from pooled age samples of large chinook salmon from the drift gillnet and Tahini and Kelsall spawning tributaries prior to the 1997 return.

Return year		Age class 1.3	1.4	1.5	Total
1991	Abundance[a]	2,714	2,995	187	5,897
	SE	489	541	23	1,005
1992	Abundance[b]	1,689	3,595		5,284
	SE	309	662		949
1993	Abundance[c]	2,217	2,180	75	4,472
	SE	432	425	10	851
1994	Abundance[d]	2,405	4,276	115	6,795
	SE	382	681	15	1,057
1995	Abundance[e]	450	3,077	263	3,790
	SE	93	664	52	805
1996	Abundance[f]	4,077	788	54	4,920
	SE	632	120	6	751
1997	Abundance[g]	1,943	6,157		8,100
	SE	354	930		1,193
1998	Abundance[h]	1,016	2,440	219	3,675
	SE	169	381	48	565
1999	Abundance	534	1,656	80	2,271
	SE	109	302	27	408
Avg.	Percent	37.7	60.1	2.2	
	abundance	1,894	3,018	110	5,023

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		1,239	152
1991	4,077	6,157	219	10,453	1,126
1992	1,943	2,440	80	4,463	521
1993	1,016	1,656		2,673	347
1994	534			534	109
Avg.	1,894	3,021	115	5,030	

[a] Data taken from Johnson et al. (1992).
[b] Data taken from Johnson et al. (1993).
[c] Data taken from Johnson (1994).
[d] Data taken from Ericksen (1995).
[e] Data taken from Ericksen (1996).
[f] Data taken from Ericksen (1997).
[g] Data taken from Ericksen (1998).
[h] Data taken from Ericksen (1999).

Table 10.–Estimated angler effort, and large (≥28") chinook salmon catch and harvest in the Haines marine boat sport fishery for similar sample periods, 1984–1999.

		Effort				Large (28") chinook salmon				
Year	Survey dates	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[n]	5/12-6/29	9,432	861	8,758	697	381	46	381	46	0.044
1998[o]	5/11-6/28	8,200	811	7,546	747	222	60	215	56	0.029
1999	5/10-6/27	6,206	736	6,097	734	184	24	184	24	0.030
1984–86 average		21,903		20,990		1,479		1,469		0.081
1987-90 average		24,456		19,227		521		513		0.027
1993–99 average		9,289		8,193		290		271		0.035

[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 was provided.

[j] Ericksen (1994).

[k] Ericksen (1995).

[l] Ericksen (1996).

[m] Ericksen (1997).

[n] Ericksen (1998).

[o] Ericksen (1999).

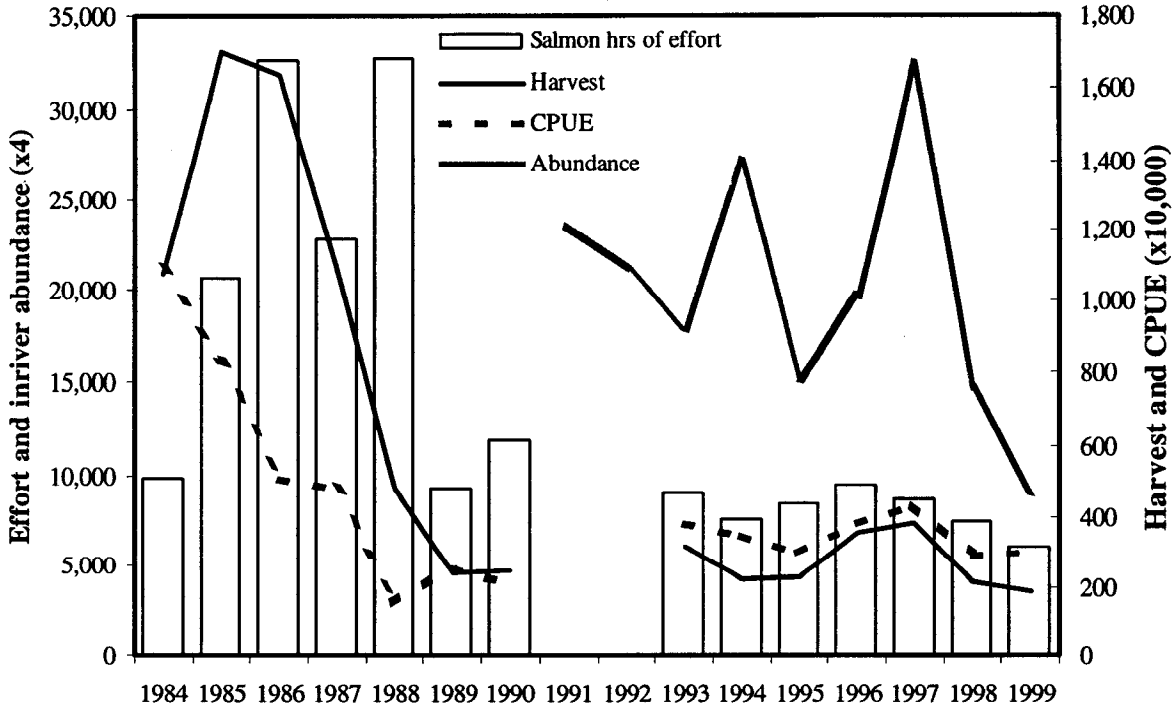


Figure 6.–Estimated angler effort for, and harvest and catch of large chinook salmon per salmon hour of effort (CPUE) in the Haines spring marine boat sport fishery, 1984–1999 and estimated inriver abundance of large chinook salmon in the Chilkat River, 1991–1999. Data taken from Tables 9 and 10 (fishery closed in 1991 and 1992).

fishing effort was lower than observed in recent years. Catch of large chinook salmon per salmon hour of effort (CPUE) in 1999 was similar to that observed in recent years, but much lower than that observed during the mid-1980s (Table 10, Figure 6) when anglers were allowed to fish to the mouth of the river.

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APPENDIX A

Appendix A1.–Sampling statistics and estimated effort, catch, and harvest of chinook salmon at the Letnikof Dock by week, May 10 through June 27, 1999.

			May 24 - June 06					
	May 10-May 16	May 17-May 23	Non-derby	Derby	June 07-June 13	June 14-June 20	June 21-June 27	Total
Boats counted	17	13	24	53	34	17	17	175
Angler-hs. sampled	96	88	151	805	274	85	90	1,589
Salmon-hs. sampled	74	88	151	801	274	79	90	1,557
Chinook sampled	4	2	4	44	5	4	2	65
Sampled for ad-clips	3	2	4	44	5	4	2	64
Ad-clips	0	0	0	5	0	0	0	0
Angler-hours								
Estimate	108	119	476	2,039	605	216	216	3,779
Variance	240	844	34,572	52,702	1,021	3,260	925	93,564
Salmon-hours								
Estimate	86	119	476	2,029	605	195	216	3,726
Variance	240	844	34,572	55,627	1,021	2,997	925	96,226
Large chinook catch								
Estimate	4	5	12	49	11	7	5	93
Variance	0	9	42	38	0	28	3	120
Large chinook kept								
Estimate	4	5	12	49	11	7	5	93
Variance	0	9	42	38	0	28	3	120
Wild mature chinook kept (excluding hatchery and immature fish)								
Estimate	2	5	6	34	9	7	5	68
Variance	0	9	24	38	4	28	3	106
Small chinook catch								
Estimate	0	4	21	143	34	12	0	214
Variance	0	9	105	2,944	69	40	0	3,167
Small chinook kept								
Estimate	0	0	0	0	0	2	0	2
Variance	0	0	0	0	0	3	0	3

Appendix A2.–Sampling statistics and estimated effort, catch, and harvest of chinook salmon at the Chilkat State Park boat launch by biweek, May 10 through June 27, 1999.

	May 17-May 23	May 24 - June 06 Non-Derby	May 24 - June 06 Derby	June 07-June 20	June 21-June 27	Total
Boats counted	0	0	1	3	1	5
Angler-hs. sampled	0	0	1	16	8	25
Salmon-hs. sampled	0	0	1	16	8	25
Chinook sampled	0	0	0	0	0	0
Sampled for ad-clips	0	0	0	0	0	0
Ad-clips	0	0	0	0	0	0
Angler-hours						
Estimate	0	0	5	112	56	173
Variance	0	0	20	10,752	2,688	13,460
Salmon-hours						
Estimate	0	0	5	112	56	173
Variance	0	0	20	10,752	2,688	13,460
Large chinook catch						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0
Large chinook kept						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0
Wild mature chinook kept (excluding hatchery and immature fish)						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0
Small chinook catch						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0
Small chinook kept						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0

Appendix A3.–Sampling statistics and estimated effort, catch, and harvest of chinook salmon at the Small Boat Harbor by biweek, May 10 through June 27, 1999.

	May 10-May 23	May 24 - June 06 Non-Derby	May 24 - June 06 Derby	June 07-June 20	June 21-June 27	Total
Boats counted	2	6	10	11	5	34
Angler-hs. sampled	13	23	232	97	32	397
Salmon-hs. sampled	13	23	232	93	28	389
Chinook sampled	0	3	0	10	3	16
Sampled for ad-clips	0	3	0	10	3	16
Ad-clips	0	0	0	1	0	1
Angler-hours						
Estimate	88	105	1,158	679	224	2,254
Variance	6,563	6,206	389,205	21,378	10,752	434,104
Salmon-hours						
Estimate	88	105	1,158	651	196	2,198
Variance	6,563	6,206	389,205	20,370	6,048	428,392
Large chinook catch						
Estimate	0	14	0	70	7	91
Variance	0	16	0	420	42	478
Large chinook kept						
Estimate	0	14	0	70	7	91
Variance	0	16	0	420	42	478
Wild mature chinook kept (excluding hatchery and immature fish)						
Estimate	0	14	0	0	0	14
Variance	0	16	0	0	0	16
Small chinook catch						
Estimate	0	0	20	126	28	174
Variance	0	0	320	1,512	672	2,504
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
F2008100M011999.DTA	Mark-sense ASCII file containing angler interview data from the Haines marine sport fishery in 1999.
HAINE9.PRG	Dbase program to generate SAS data file from mark-sense file.
HAINESCT.PRN	Count file (text) used in HAMC99.SAS to expand for missing interview data.
HAMC99.SAS	SAS program to estimate effort and harvest in the Haines marine sport fishery using HAINESCT.PRN and output from HAINE9.PRG.
99SPORTAWL.XLS	Excel workbook containing all age-length data from the Haines sport fishery during 1999.
99POPEST.XLS	Excel workbook used to estimate 1999 abundance of Chilkat River chinook.
99SPAWN.XLS	Excel workbook containing raw data from chinook sampled on the Chilkat River spawning tributaries during 1999.
99TAGS.XLS	Excel workbook containing raw data from chinook captured in the lower Chilkat River during 1999.
RUNRECON.XLS	Excel workbook used to estimate the number of large chinook salmon in the 1999 Chilkat River escapement by age and sex.