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Abundance of the Chinook Salmon Escapement on the Stikine River, 2001

by

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and

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June 2003

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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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The abundance of large (≥660mm MEF) and small-medium (<660 mm MEF) chinook salmon *Oncorhynchus tshawytscha* that returned to spawn in the Stikine River above the U.S./Canada border in 2001 was estimated using mark-recapture and size composition data. Age, sex, and length compositions for the immigration were also estimated. Drift and set gillnets fished near the mouth of the Stikine River were used to capture 1,569 immigrant chinook salmon during May, June, July, and August of which 1,540 chinook salmon were marked. During July and August, chinook salmon were captured at spawning sites and inspected for tags. Marked fish were also recovered from Canadian commercial, test and aboriginal fisheries. Using a modified Petersen model, an estimated 66,646 (SE = 5,853) large fish immigrated to the Stikine River above Kakwan Point and Rock Island, and an immigration of 1,929 (SE = 274) small-medium chinook salmon was estimated using relative size composition data. Canadian fisheries on the Stikine River harvested 3,123 large and 174 small-medium chinook salmon, leaving a spawning escapement of 63,523 (SE = 5,853) large and 1,755 (SE = 274) small-medium fish. The total count of large fish at the Little Tahltan River live weir was 9,738, representing about 15% of the estimated spawning escapement of large fish. A foot survey and expansion factor were used to estimate an escapement of 2,108 large fish in Andrew Creek. Estimated age compositions of chinook salmon captured at Kakwan Point and Rock Island respectively, were 0.9% (SE = 0.3%) and 8.0% (SE = 2.0%) age-1.2 fish, 73.4% (SE = 1.3%) and 50.0% (SE = 3.7%) age-1.3 fish, and 25.2% (SE = 1.3%) and 23.9% (SE = 3.1%) age-1.4 fish; 391 and 119 males and 684 and 69 females were sampled. The estimated spawning escapement of 65,277 (SE = 6,016) chinook salmon was comprised of 1.0% (SE = 0.2%) age-1.2 fish, 74.6% (SE = 1.1%) age-1.3 fish, and 22.1% (SE = 1.0%) age-1.4 fish. The estimated spawning escapement included 32,183 (SE = 3,060) females. The feasibility of using mark-recapture, CPUE, and sibling ratio data to generate pre- and inseason abundance estimates for the inriver run of large chinook salmon was also investigated.

Key words: chinook salmon, *Oncorhynchus tshawytscha*, Stikine River, Little Tahltan River, Verrett River, Andrew Creek, mark-recapture, escapement, abundance, age and sex composition, pre-season, inseason, CPUE, sibling ratio

INTRODUCTION

Many chinook salmon *Oncorhynchus tshawytscha* stocks in the Southeast Alaska region were depressed in the mid- to late 1970s, relative to historical levels of production (Kissner 1982). The Alaska Department of Fish and Game (ADF&G) developed a structured program in 1981 to rebuild Southeast chinook salmon stocks over a 15-year period (roughly three life cycles; ADF&G 1981). In 1979, the Canadian Department of Fisheries and Oceans (DFO) initiated commercial fisheries on the transboundary Taku and Stikine rivers. The fisheries primarily target sockeye salmon and have been structured to limit the harvest of chinook salmon to incidental catches. In 1985, the Alaskan and Canadian programs were incorporated into a comprehensive coast wide rebuilding program under the auspices of the U.S./Canada Pacific Salmon Treaty (PST). The rebuilding program has been evaluated, in part, by monitoring trends in escapement for important stocks. Escapements in 11 rivers in Southeast Alaska and Canada are directly estimated or surveyed annually: the Situk, Alsek, Chilkat, Taku, King Salmon, Stikine, Unuk, Chickamin, Blossom, and Keta rivers, and Andrew Creek. Total escapements of chinook salmon have been estimated at least once in all 11 key index systems, providing expansion factors for index counts to estimate total escapement. Chinook salmon escapements in the Stikine River have rebounded to healthy levels since initiation of the rebuilding program (Pahlke et al. 2000).

The Stikine River is a transboundary river, originating in British Columbia (B.C.) and flowing to the sea near Wrangell, Alaska (Figure 1). It is one of more than 50 chinook salmon escapement indicator stocks included in annual assessments by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission (PSC) to determine stock status, effects of management regimes, and other requirements of the PST. The

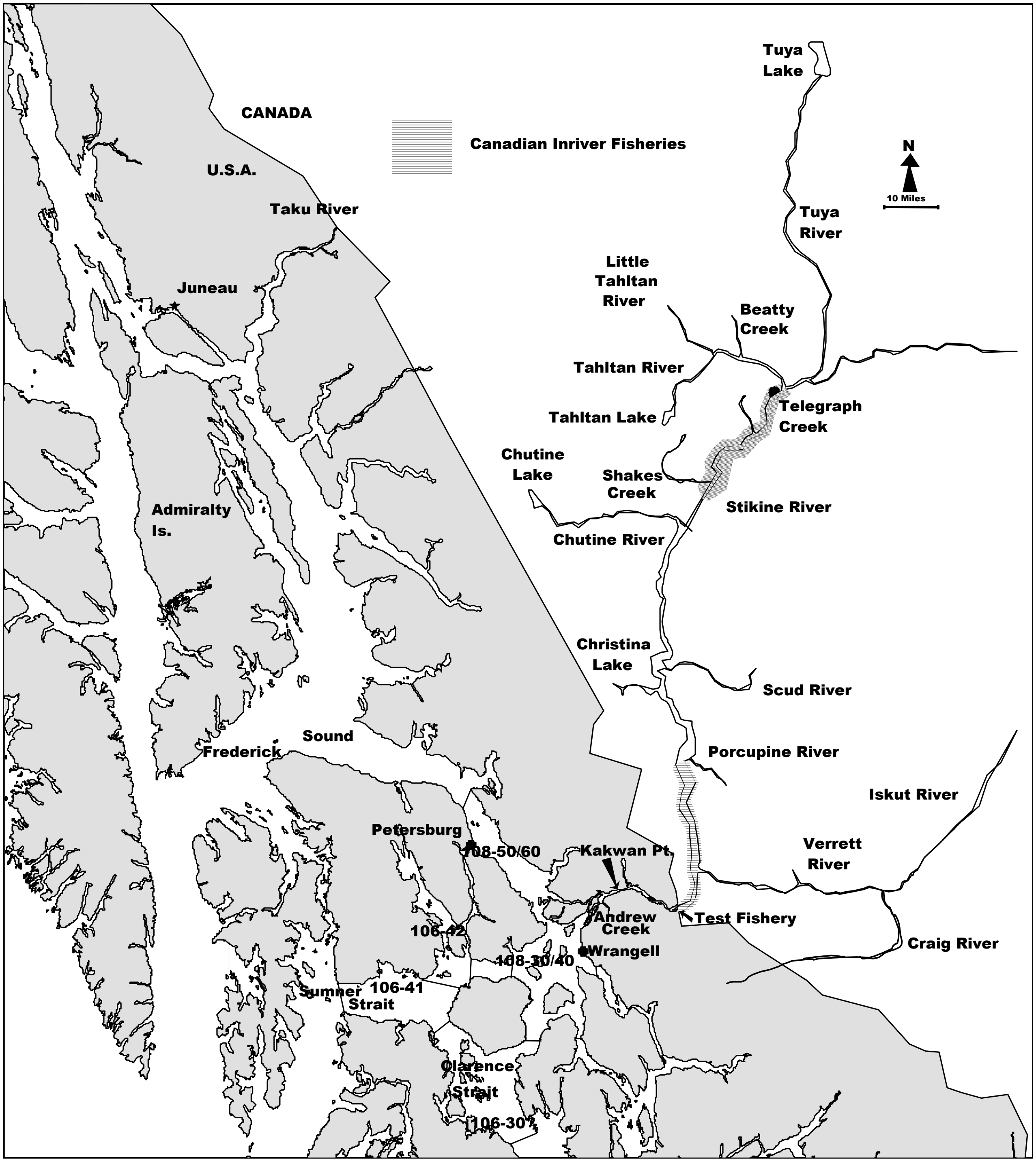


Figure 1.–Stikine River drainage, showing location of principal U.S. and Canadian fishing areas.

river is one of the largest producers of chinook salmon in Northern B.C. and Southeast Alaska.

The CTC is in the process of incorporating inriver abundance of Stikine River chinook salmon into the Pacific Salmon Commission (PSC) Chinook Model, which, among other things, produces pre-season forecasts of abundance for setting annual quotas for fisheries under the jurisdiction of the

PST. Hence, data from the Stikine River chinook salmon stock assessment project are not only essential for development of management tools for this stock, but other coastwide chinook salmon stocks as well.

A major sockeye salmon *O. nerka* enhancement program in the Stikine River has been ongoing since 1989 [Pacific Salmon Commission (PSC) 2000]. The run timing of sockeye salmon overlaps the latter component of the chinook salmon migration, and mature chinook salmon returning to the Stikine River are caught incidentally to sockeye salmon in U.S. marine gillnet fisheries in Districts 106 and 108 offshore of the river mouth, and in riverine Canadian commercial and test fisheries; aboriginal food fisheries target chinook salmon (Table 1, Figure 1). Stikine River chinook salmon are also caught in marine recreational fisheries near Wrangell and Petersburg, in the commercial troll fishery in Southeast Alaska, and in recreational fisheries in Canada. The terminal run exploitation of these populations is managed jointly by the U.S. and Canada through the PSC.

Helicopter surveys of the Little Tahltan River have been conducted annually since 1975, and a fish counting weir has been operated at the mouth of the Little Tahltan River since 1985 (Table 2). Since virtually all fish spawning in the Little Tahltan River spawn above the live weir, counts from the weir represent the spawning escapement to that tributary. Sufficient data have since been collected to establish a relationship between the two sources of information and spawning escapement estimates from surveys conducted prior to 1985 have been adjusted; discontinuation of aerial surveys has been recommended (Bernard et al. 2000). Historically, spawning escapement to the Stikine River was estimated by multiplying the live weir count in the Little Tahltan River by an expansion factor (4.0) thought to represent the proportion of the spawning escapement represented by that tributary (Pahlke 1996). The original expansion factor was based on professional judgment rather than empirical data, and in 1991 the Transboun-dary Technical Committee (TTC) of the PSC decided to use only the actual counts of escapement to the Little Tahltan River to assess rebuilding (PSC 1991).

The number of spawners that produces maximum sustained yield (S_{MSY}) for this stock has been estimated at 17,368 based on analysis of spawner-recruit data from the 1977 to 1991 brood years (Bernard et al. 2000). This estimate may be biased slightly low, but a more complex model that incorporates survival estimates and better estimates of harvest in marine fisheries should improve accuracy. This information will be acquired in the future from results of a smolt coded-wire tagging program that was initiated in 2000. Based on the estimate of S_{MSY}, an escapement goal range of 14,000 to 28,000 adult spawners (age-.3, -.4, and -.5 fish), which corresponds to Little Tahltan River live weir counts of 2,700 and 5,300, was recommended and accepted by the CTC and an internal review committee of ADF&G in spring 1999. The Pacific Scientific Advice Review Committee of DFO declined to pass judgment on this range in deference to a decision by the TTC; the TTC accepted the range in March, 2000.

The chinook salmon population in Andrew Creek, a lower river tributary in the U.S., has historically been treated as separate from those spawning upriver in Canada. Escapements into Andrew Creek have been assessed annually since 1975 by foot, airplane, or helicopter surveys. In addition, a weir was operated to collect hatchery brood stock from 1976 to 1984 and also provided escapement counts. Another weir was operated in 1997 and 1998 to count escapement, sample chinook salmon for age, sex and length data, and to recover tags. North Arm and Clear creeks, two small streams in the U.S., have been periodically surveyed by foot, helicopter, and fixed-wing aircraft.

Only large (typically age-.3, -.4, and -.5 fish) chinook salmon, approximately ≥660 mm mideye-to-fork length (MEF), are counted during aerial or foot surveys. No attempt is made to accurately count smaller (typically age-.1 and -.2 fish) chinook salmon <660 mm MEF. These smaller chinook salmon are primarily males that are considered "surplus" to the reproduction of the next generation (Mecum 1990). These smaller chinook salmon are easy to separate visually from older fish under most conditions because of their short, compact bodies and lighter color; they are, however, difficult to distinguish from other

Table 1.–Harvests of chinook salmon in Canadian fisheries in the Stikine River and U.S. fisheries near the mouth of the Stikine River, 1975–2001.

	United States		**Canada**											
			Commercial harvest, lower Stikine		Commercial harvest, upper Stikine		Inriver sport harvest[d], Tahltan River		Aboriginal fishery, Telegraph Creek		Lower river test fishery		**Total inriver** commercial, sport, aboriginal, test	
Year	District 108 gillnet[a]	Wrangell sport through mid-June[b]	Small-medium	Large	Small-medium[c]	Large	Small-medium	Large	Small-medium	Large	Small-medium	Large	Small-medium	Large
1975	1,534					178				1,024			–	1,202
1976	1,123					236				924			–	1,160
1977	1,443	1,463				62				100			–	162
1978	531	819				100				400			–	500
1979	91	813	63	712						850			63	1,562
1980	631	1,325		1,488		156				587			–	2,231
1981	283	1,068		664		154				586			–	1,404
1982	1,033	1,426		1,693		76				618			–	2,387
1983	47	1,346	430	492		75			215	851			645	1,418
1984	14	1,133	--	fishery	closed	--			59	643			59	643
1985	20	1,683	91	256		62			94	793	–	–	185	1,111
1986	102	1,825	365	806	41	104			569	1,026	12	27	987	1,963
1987	149	1,023	242	909	19	109			183	1,183	30	189	474	2,390
1988	207	1,361	201	1,007	46	175			197	1,178	29	269	473	2,629
1989	310	1,966	157	1,537	17	54			115	1,078	24	217	313	2,886
1990	557	2,630	680	1,569	20	48			259	633	18	231	977	2,481
1991	1,366	2,876	318	641	32	117			310	753	16	167	676	1,678
1992	967	2,674	89	873	19	56			131	911	182	614	421	2,454
1993	1,628	2,925	164	830	2	44			142	929	87	568	395	2,371
1994	1,996	1,625	158	1,016	1	76			191	698	78	295	428	2,085
1995	1,702	1,169	599	1,067	17	9			244	570	184	248	1,044	1,894
1996	1,717	1,578	221	1,708	44	41			156	722	76	298	497	2,769
1997	2,566	2,524	186	3,283	6	45			94	1,155	7	30	293	4,513
1998	460	720	359	1,585	0	12			95	538	11	25	465	2,160
1999	1,078	2,411	789	2,127	12	24			463	765	97	853	1,361	3,769
2000	1,692	2,191	936	1,274	2	7			386	1,100	334	389	1,658	2,770
2001	7	2,533	59	826	0	0	12	190	44	665	59[e]	1,442	174	3,123

[a] Small-medium chinook salmon are not reported in U.S. gillnet catch, not legal in U.S. sport catch.

[b] Hatchery contribution included in U.S. catches.

[c] Small-medium chinook salmon were not segregated in Canadian fisheries before 1983.

[d] Inriver harvest not estimated prior to 2001.

[e] Chinook and sockeye test fisheries: 1,836 large and 59 small-medium chinook salmon were inspected, and 394 large fish were released.

smaller species, such as pink *O. gorbuscha* and sockeye salmon.

In 1995, the DFO, in cooperation with the Tahltan First Nation (TFN), ADF&G, and the U.S. National Marine Fisheries Service (NMFS) instituted a project to determine the feasibility of a mark-recapture experiment to estimate abundance of chinook salmon spawning in the Stikine River above the U.S./Canada border. Since 1996, a revised, expanded mark-recapture study has been used to estimate annual abundance (Pahlke and Etherton 1998, 1999, 2000; Pahlke et al. 2000). In 1997, a radiotelemetry study to estimate distribution of spawners was also conducted in concert

Table 2.–Index and survey counts of large spawning chinook salmon in tributaries of the Stikine River, 1975–2001. Abbreviations: H = helicopter survey, F = foot survey, W = weir count, A = airplane survey; E = excellent visibility, N = normal visibility, P = poor visibility.

Year	Little Tahltan River		Mainstem Tahltan River	Beatty Creek	Andrew Creek	North Arm Creek	Clear Creek[b]
	Peak count	Weir count[a]					
1975	700 E(H)	–	2,908 E(H)	–	260 (F)	–	–
1976	400 N(H)	–	120 (H)	–	468 (W)	–	–
1977	800 P(H)	–	25 (A)	–	534 (W)	–	–
1978	632 E(H)	–	756 P(H)	–	400 (W)	24 E(F)	–
1979	1,166 E(H)	–	2,118 N(H)	–	382 (W)	16 E(F)	–
1980	2,137 N(H)	–	960 P(H)	122 E(H)	363 (W)	68 N(F)	–
1981	3,334 E(H)	–	1,852 P(H)	558 E(H)	654 (W)	84 E(F)	4 P(F)
1982	2,830 N(H)	–	1,690 N(F)	567 E(H)	947 (W)	138 N(F)	188 N(F))
1983	594 E(H)	–	453 N(H)	83 E(H)	444 (W)	15 N(F)	–
1984	1,294 (H)	–	–	126 (H)	389 (W)	31 N(F)	–
1985	1,598 E(H)	3,114	1,490 N(H)	147 N(H)	319 E(F)	44 E(F)	–
1986	1,201 E(H)	2,891	1,400 P(H)	183 N(H)	707 N(F)	73 N(F)	45 E(A)
1987	2,706 E(H)	4,783	1,390 P(H)	312 E(H)	788 E(H)	71 E(F)	122 N(F))
1988	3,796 E(H)	7,292	4,384 N(H)	593 E(H)	564 E(F)	125 N(F)	167 N(F)
1989	2,527 E(H)	4,715	-	362 E(H)	530 E(F)	150 N(A)	49 N(H)
1990	1,755 E(H)	4,392	2,134 N(H)	271 E(H)	664 E(F)	83 N(F)	33 P(H)
1991	1,768 E(H)	4,506	2,445 N(H)	193 N(H)	400 N(A)	38 N(A)	46 N(A)
1992	3,607 E(H)	6,627	1,891 N(H)	362 N(H)	778 E(H)	40 E(F)	31 N(A)
1993	4,010 P(H)	11,437	2,249 P(H)	757 E(H)	1,060 E(F)	53 E(F)	
1994	2,422 N(H)	6,373	–	184 N(H)	572 E(H)	58 E(F)	10 N(A)
1995	1,117 N(H)	3,072	696 E(H)	152 N(H)	343 N(H)	28 P(A)	1 E(A)
1996	1,920 N(H)	4,821	772 N(H)	218 N(H)	335 N(H)	35 N(F)	21 N(A)
1997	1,907 N(H)	5,547	260 P(H)	218 E(H)	293 N(F)	–	–
1998	1,385 N(H)	4,873	587 P(H)	125 E(H)	487 E(F)	35 N(A)	28 N(A)
1999	1,379 N(H)	4,738	–	–	605 E(A)	22 N(A)	1 N(A)
1990–1999 avg.	2,127	5,639	1,379	276	554	44	21
2000	2,720 N(H)	6,631	–	–	690 N(A)	35 N(A)	–
2001	4,158 E(H)	9,730	–	–	1,054 N(F)	54 N(F)	–

[a] Above-weir harvest and broodstock collections are removed from weir counts; in 2001 8 large female fish were removed.

[b] "Clear Creek" is a local name. The ADFG survey name is "West of Hot Springs," stream number 108-40-13A.

with the mark-recapture experiment (Pahlke and Etherton 1999).

Objectives of the 2001 study were:

(1) estimate abundance of large (≥660 mm MEF) chinook salmon spawning in the Stikine River above the U.S./Canada border,

(2) estimate the Little Tahltan weir count to spawning escapement expansion factor,

(3) estimate age, sex, and length compositions of chinook salmon spawning in the Stikine River above the U.S./Canada border,

(4) index abundance of chinook salmon spawning in Andrew Creek, and

(5) estimate age, sex and length composition of the chinook salmon spawning in Andrew Creek.

Using relative size composition data, we also estimated the abundance of small-medium (<660 mm MEF) chinook salmon

Additionally, results from the study provide information on the run timing through the lower Stikine River of chinook salmon bound for the various spawning areas, and other stock assessment and management information needs such as construction of spawner-recruit tables, sibling ratios, and inseason abundance estimation.

STUDY AREA

The Stikine River drainage covers about 52,000 km^2 (Bigelow et al. 1995), much of which is inaccessible to anadromous fish because of natural barriers. Principal tributaries include the Tahltan, Chutine, Scud, Iskut, and Tuya rivers (Figure 1). The lower river and most tributaries are glacially occluded (e.g., Chutine, Scud, and Iskut rivers). Only 2% of the drainage is in Alaska (Beak Consultants Limited 1981), and most of the chinook salmon spawning areas in the watershed are located in B.C., Canada in the Tahltan, Little Tahltan, and Iskut rivers (Pahlke and Etherton 1999). Andrew Creek, in the U.S. portion of the Stikine River, supports a small run of chinook salmon averaging about 5% of the above-border escapement. The upper drainage of the Stikine is accessible by the Telegraph Creek Road.

METHODS

KAKWAN POINT AND ROCK ISLAND TAGGING

Drift gillnets 120 feet (36.5 m) long, 18 feet (5.5 m) deep, of 7¼-inch (18.5-cm) stretch mesh, were fished near Kakwan Point (Figure 2) between May 7 and July 9. Two nets were fished daily, unless high water or staff shortages occurred. Nets were watched continuously, and fish were removed from the net immediately upon capture. Sampling effort was held reasonably constant across the temporal span of the migration. If fishing time was lost because of entanglements, snags, cleaning the net, etc., the lost time (processing time) was added on to the end of the day to bring fishing time to 4 hours per net.

Catches near Kakwan Point were augmented by chinook salmon captured and tagged during a sockeye salmon tagging project operated by DFO, ADF&G Commercial Fisheries Division (CFD), and TFN at Rock Island (Figure 2). Chinook salmon were caught in a 5- to 5⅜-inch (12.7- to 13.7-cm) stretch mesh set gillnet 120 feet (36.5 m) long and 18 feet (5.5 m) deep between June 16 and August 26. The net was watched continuously, and fish were removed from the net immediately upon capture. If more fish were caught than could be effectively sampled, or if high water rendered the net difficult to fish, the net was shortened. Sampling effort was held reasonably constant at about 7 hours per day.

Captured chinook salmon were placed in a plastic fish tote filled with water, quickly untangled or cut from the net, marked, measured for length (MEF, and post orbital hypural length POH), classified by sex and maturity, and sampled for scales. Fish were classified as 'large' if their MEF measurement was ≥660mm, as 'medium' if their MEF was 440–659mm or 'small' if their MEF was <440mm (Pahlke and Bernard 1996). Fish maturation was judged on a scale from 1 to 4, where 1 is a silver bright fish, 2 is a fish with slight coloration, 3 is a fish with obvious coloration and the onset of sexual dimorphism, and 4 is a fish with the characteristics listed in category 3 that released gametes upon capture. Presence or absence of sea lice (*Lepeophtheirus* sp.) was also noted. General health and appearance of the fish was recorded, including injuries caused by handling or predators. Each uninjured fish was marked with a uniquely numbered, blue spaghetti tag consisting of a 2-inch (~5-cm) section of Floy tubing shrunk and laminated onto a 15-inch (~38-cm) piece of 80-lb (~36.3-kg) monofilament fishing line using a modified design developed by Johnson et al. 1993. The monofilament was sewn through the musculature of the fish approximately ½ inch (20 mm) posterior and ventral to the dorsal fin and secured by crimping both ends in a metal sleeve. Each fish was also marked with a ¼-inch (7-mm) diameter hole in the upper (dorsal) portion of its left operculum applied with a paper punch, and by amputation of its left axillary appendage (McPherson et al. 1996). Fish that were seriously injured were sampled but not marked.

UPSTREAM SAMPLING

Pre- and post-spawning fish were sampled at the Little Tahltan River live and carcass weirs and post-spawning fish were speared at Verrett River. The Little Tahltan River flows southeast and empties into the Tahltan River approximately 30 km northwest of Telegraph Creek,

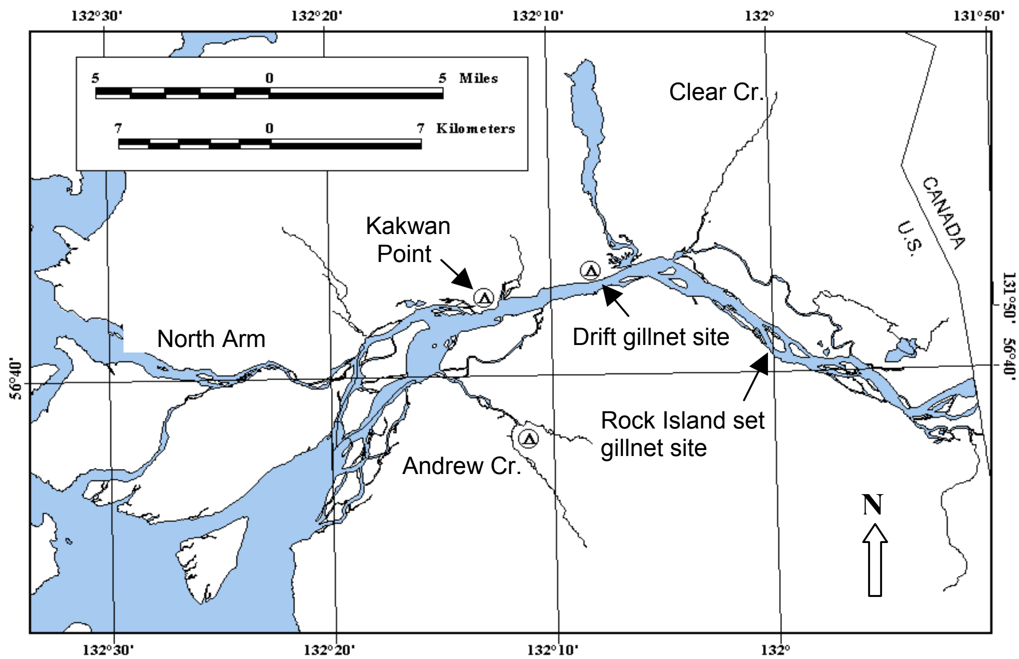


Figure 2.–Locations of drift and set gillnet sites on the lower Stikine River, 2001.

British Columbia. As fish accumulated below the live weir across the Little Tahltan River, a portion were captured with dip nets, inspected for tags and marks, and sampled for length, sex, and scales. Each sampled fish was marked with a hole punched in its lower left opercle to prevent resampling and released. In addition, some post-spawning fish and carcasses were sampled at a carcass weir upstream of the live weir.

Age, sex, length and marked composition data were collected at Verrett River (Figure 1) from August 4 to 11, 2001. Numbers of fish observed were recorded and carcasses and moribund chinook salmon were sampled to obtain scales and information on length, sex, and marks. Escapement counts, age, sex, length, and marked composition data were collected on Andrew Creek (Figure 2) by foot surveys in early August and additional surveys were conducted by airplane and helicopter. Age, sex, length, and marked composition data were also collected at Christina and Shakes creeks and the Craig River by foot surveys.

Catches in the lower and upper Canadian commercial gillnet, aboriginal, and recreational fisheries and in the U.S. gillnet and marine recreational fisheries were sampled to recover tags and obtain data to estimate age, sex, and length compositions.

ABUNDANCE

Abundance of large chinook salmon $\hat{N}_L$ was estimated with Chapman's modification of Petersen's estimator for a two-event mark-recapture experiment on a closed population (Seber 1982, p. 59–61). Fish captured by gillnet and marked in the lower river near Kakwan Point and at Rock Island were included in event 1, and sampling on the spawning grounds and the inriver test and commercial fisheries constituted the second event.

Handling and tagging have caused a downstream movement and/or a delay in continuing upstream migration of marked chinook salmon (Bernard et al. 1999). This 'sulking' behavior increases the probability of capture by commercial and recreational fisheries near the mouth of the Stikine River (Pahlke and Etherton 1999). Further, fish marked at Kakwan Point and Rock Island may spawn in Andrew Creek. Censoring marked chinook salmon killed in downstream fisheries or spawning in Andrew Creek reduces bias in the abundance estimate. No tags were recovered from the marine commercial gillnet fishery at the mouth of the

Stikine River (District 108) through sampling by CFD, but voluntarily returned tags were censored on a per tag basis. All marked fish caught in the U.S. recreational harvest were assumed to be reported and were also censored from the experiment on a per tag basis. A separate escapement estimate was calculated for Andrew Creek by expanding the peak count by a factor of 2.0 (Pahlke 1999). The number of marked fish recaptured in Andrew Creek was expanded by the fraction of the estimated escapement sampled and was then censored from the mark-recapture experiment.

The estimated number of large marked fish available for recapture on the spawning grounds and in the inriver test and commercial fisheries was $\hat{M}_L = T_L - \hat{H}_L$, where T_L was the initial number of large marked fish released near Kakwan Point and at Rock Island, and $\hat{H}_L$ was the number of large fish estimated to have moved downstream to be caught in U.S. fisheries or spawn in Andrew Creek.

Variance, bias, and confidence intervals for $\hat{N}_L$ were estimated with bootstrap procedures described in Buckland and Garthwaite (1991) as modified in McPherson et al. (1996) by establishing seven capture histories:

Capture history	Large	Source of statistics
Marked, but censored in recreational fishery	5	Returned
Marked, but censored in marine commercial fishery	2	Returned
Marked, but censored in Andrew Creek	31	Observed/0.0982
Marked and not sampled on spawning grounds and inriver fisheries	1,298	$\hat{M}_L - R_L$
Marked and recaptured on spawning grounds and inriver fisheries	118	R_L
Not marked but captured on spawning grounds and inriver fisheries	5,478	$C_L - R_L$
Not marked and not sampled on spawning grounds or inriver fisheries	59,752	$\hat{N}_L - \hat{M}_L - C_L + R_L$
Effective population for simulations	66,684	$\hat{N}_L^+$

A bootstrap sample was built by drawing with replacement a sample of size $\hat{N}_L^+$ (i.e., 66,684) from the empirical distribution defined by the capture histories. A new set of statistics from each bootstrap sample $\{\hat{M}_L{}^*, C_L{}^*, R_L{}^*, \hat{H}_L{}^*, T_L{}^*\}$ was generated, along with the new estimate $\hat{N}_L{}^*$, and 1,000 such bootstrap samples were drawn creating the empirical distribution $\hat{F}(\hat{N}_L{}^*)$, which is an estimate of $\mathrm{F}(\hat{N}_L)$. The difference between the average $\bar{\hat{N}}_L{}^*$ of the bootstrap estimates and $\hat{N}_L$ is an estimate of statistical bias in the later statistic (Efron and Tibshirani 1993, Section 10.2). Confidence intervals were estimated from $\hat{F}(\hat{N}^*)$ with the percentile method (Efron and Tibshirani 1993, Section 13.3). Variance was estimated as:

$$v\left(\hat{N}_L{}^*\right) = (B-1)^{-1} \sum_{b=1}^{B} \left(\hat{N}^*_{L(b)} - \bar{\hat{N}}_L{}^*\right)^2 \qquad (1)$$

where B is the number of bootstrap samples.

Mark-recapture methods could not be used to estimate the abundance of small-medium chinook salmon. However, abundance of small-medium fish was estimated indirectly by first estimating the number of small-medium fish that survived to spawn (i.e., spawning escapement):

$$\hat{N}_{SM,esc} = \hat{N}_{L,esc}\left(\frac{1}{\hat{\pi}} - 1\right) \qquad (2)$$

where $\hat{N}_{SM,esc}$ is the estimated spawning escapement of small-medium chinook salmon, $\hat{N}_{L,esc}$ is the estimated spawning escapement of large fish (= $\hat{N}_L$ - inriver harvest of large chinook salmon), and $\hat{\pi}$ is the estimated fraction of large fish in the population of chinook salmon (all sizes) spawning in the Little Tahltan River.

Variance and confidence intervals for $\hat{N}_{SM,esc}$ were estimated through simulation by treating the number of large chinook salmon in the Little Tahltan River as a binomial variable $n_L^* \sim \mathrm{binom}(\hat{\pi}, \mathrm{n})$, where n is the number of sampled fish (all sizes). A thousand such simulated samples were drawn for each $\hat{\pi}^* = n_L^* / n$, creating the empirical distribution $\hat{F}\left(\hat{\pi}^*\right)$ as an estimate of $F(\hat{\pi})$. Empirical distributions of $\hat{F}\left(\hat{N}_{L,esc}{}^*\right)$, i.e., $\hat{F}\left(\hat{N}_L{}^*\right)$ - inriver harvest of large fish, and $\hat{F}\left(\hat{\pi}^*\right)$ were matched through equation (2) to produce the distribution $\hat{F}\left(N^*_{SM,esc}\right)$, from which the estimate $v\left(N^*_{SM,esc}\right)$ and confidence intervals for $\hat{N}_{SM,esc}$ were produced with the methods described above.

Abundance of small-medium chinook salmon $\hat{N}_{SM}$ was finally estimated by adding $\hat{N}_{SM,esc}$ and the inriver harvest of small-medium fish. Variance and confidence intervals for $\hat{N}_{SM}$ were produced from the distribution $\hat{F}\left(N^*_{SM,esc}\right)$ - inriver harvest of small-medium fish.

The spawning escapement of large and small-medium chinook salmon was estimated by $\hat{N}_{esc} = \hat{N}_{L,esc} / \hat{\pi}$. Confidence intervals for $\hat{N}_{esc}$ and $v\left(\hat{N}_{esc}\right)$ were estimated per the procedures described above.

The validity of the mark-recapture experiment rests on several assumptions, including: (a) every fish has an equal probability of being marked in 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 between events; (b) *both* recruitment and 'death' (emigration) do not occur between events; (c) marking does not affect catchability (or mortality) of the fish; (d) fish do not lose their marks between events; (e) all recaptured fish are reported; and (f) double sampling does not occur (Seber 1982). Assumption (a) implies that fish are marked in proportion to abundance during immigration, or if it does not, that there is no difference in migratory timing among stocks bound for different spawning locations, since temporal mixing can not occur in the experiment. Assumption (a) also implies that sampling is not size-selective. If capture on the spawning grounds was not size-selective, fish of different sizes would be captured with equal probability. If assumption (a) was met, samples of fish taken in upper watershed (Little Tahltan River), in the Iskut River (Verrett River) and in the inriver test and commercial fisheries in the lower watershed would have similar rates of marked fish. Contingency table analysis was used to test the null hypothesis that such estimated rates are the same. Samples were stratified by size to detect and eliminate potential effects of size-selective sampling. Assumption (b) was met because the life history of chinook salmon isolates those fish returning to the Stikine River as a 'closed' population. Mortality rates from natural causes for marked and unmarked fish were assumed to be the same (assumption c). Past telemetry studies in the Stikine River have shown that chinook salmon captured in this study, but fitted with esophageal radio transmitters, survived to spawn (Pahlke and Etherton 1999). To avoid effects of tag loss (assumption d), all marked fish carried secondary (a dorsal opercle punch), and tertiary marks (the left axillary appendage was clipped). Similarly, all fish captured on the spawning grounds were inspected for marks, and a reward (Can$5) was given for each tag returned from the inriver commercial, aboriginal, and recreational fisheries (assumption e). Double sampling was prevented by an additional mark (ventral opercle punch, assumption f).

AGE, SEX, AND LENGTH COMPOSITION

Scale samples were collected, processed, and aged according to procedures in Olsen (1995). Five scales were collected from the preferred area of each fish (Welander 1940), mounted on gum cards and impressions were made in cellulose acetate (Clutter and Whitesel 1956). Age of each fish was determined later from the pattern of circuli on images of scales magnified 70×. Samples from Kakwan Point, Andrew Creek, Verrett River, and the Little Tahltan carcass weir were processed at the ADF&G Scale Aging Lab in Douglas; the Rock Island, lower inriver test and commercial gillnet fisheries, and Little Tahltan River live weir samples were processed at the DFO lab in Nanaimo, B.C., and all but the Rock Island samples were read again by the ADF&G. Samples collected from Christina and Shakes creeks and the Craig River were also processed by DFO.

Estimated age compositions for the Little Tahltan and Verrett rivers were compared to determine if the samples could be combined for the purpose of estimating spawning population proportions. For these tests, age-0. and -2. chinook salmon were pooled with age-1. fish of the same brood year, and only age classes common to each sample were compared.

The proportion of the spawning population composed of a given age within small-medium or large fish was estimated as a binomial variable from fish sampled in the Little Tahltan and Verrett rivers:

$$\hat{p}_{ij} = \frac{m_{ij}}{m_i} \tag{3}$$

$$v[\hat{p}_{ij}] = \frac{\hat{p}_{ij}(1 - \hat{p}_{ij})}{m_i - 1} \tag{4}$$

where $\hat{p}_{ij}$ is the estimated proportion of the population of age j in size category i, and m_{ij} is the number of chinook salmon of age j in size category i in the sample m taken in the Little Tahltan and Verrett rivers.

Numbers of spawning fish by age were estimated as the summation of products of estimated age composition and estimated spawning abundance within size category i:

$$\hat{N}_j = \sum_i \left(\hat{p}_{ij}\hat{N}_i\right) \tag{5}$$

with a sample variance calculated according to procedures in Goodman (1960):

$$v(\hat{N}_j) = \sum_i \begin{pmatrix} v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)\hat{p}_{ij}^2 \\ - v(\hat{p}_{ij})v(\hat{N}_i) \end{pmatrix} \tag{6}$$

Although there was some overlap between samples used to estimate $\{\hat{p}_{ij}\}$ and $\hat{\pi}$, $\hat{p}_{ij}$ and $\hat{N}_i$ were considered to be estimated independently because all of the n samples for $\hat{\pi}$ came from the Little Tahltan River, whereas m samples to determine age composition contained a subset of these n samples plus those drawn independently at Verrett River.

The proportion of the spawning population composed of a given age was estimated by:

$$\hat{p}_j = \frac{\hat{N}_j}{\hat{N}_{esc}} \tag{7}$$

Variance of $\hat{p}_j$ was approximated according to the procedures in Seber (1982, p. 8-9):

$$v(\hat{p}_j) = \frac{\sum_i \left(v(\hat{p}_{ij})\hat{N}^2{}_i + v(\hat{N}_i)(\hat{p}_{ij} - \hat{p}_j)^2\right)}{\hat{N}_{esc}^2} \tag{8}$$

Sex and age-sex composition for the spawning population and associated variances were also estimated with the equations above by first redefining the binomial variables in the samples to produce estimated proportions by sex $\hat{p}_k$, where k denotes sex, such that $\Sigma_k\ \hat{p}_k = 1$, and by age-sex, such that $\Sigma_j \Sigma_k\ \hat{p}_{jk} = 1$. Sex composition was estimated from samples collected on the spawning grounds since spawning and post-spawning fish provide more reliable sex composition estimates.

Age, sex, and age-sex composition and associated variances for the Kakwan Point, Rock Island, Little Tahltan and Verrett rivers, and the inriver fisheries samples were estimated with equations 3 and 4 by substituting n_{ij} for m_{ij} and n_i for m_i, where n_{ij} is the number of chinook salmon of age j in size category i in the sample n.

Estimates of mean length at age and their estimated variances were calculated with standard normal procedures.

RESULTS

KAKWAN POINT AND ROCK ISLAND TAGGING

Between May 8 and August 26, 1,454 large (≥660 mm MEF), 45 medium (440–659 mm MEF), and 41 small (<440 mm MEF) chinook salmon were captured, marked, and released at Kakwan Point and Rock Island (Table 3).

Drift gillnet effort near Kakwan Point was maintained at 4 hours per net per day (two nets fishing), although reduced sampling effort occurred on several days (Figure 3). We captured a total of 1,300 large and 22 small-medium chinook salmon (Appendix A1). Catch rates ranged from 0 to 7.21 large fish/hour, and the highest catch occurred on May 28 when 59 large fish were captured (Figure 4). The date of 50% cumulative catch of large fish was June 5. Catch rates for small- medium fish ranged from 0 to 0.33 fish/hour, and the date of 50% cumulative catch of small-medium fish was June 21. Catches were low in mid-June because of high water conditions (Figures 3 and 4, Appendix A1). Harbor seals killed or injured several fish before they could be removed from the nets, especially early in the season. In addition, 137 sockeye salmon were captured and released (Appendix A1).

Set gillnet effort at Rock Island was maintained at about 7.0 hours per day with one net fishing, although reductions in sampling effort occurred on several days because of high catch or water conditions (Figure 5; Appendix A2). We captured 178 large and 69 small-medium chinook salmon. Catch rates ranged from 0 to 1.69 large fish/hour, and the highest catch occurred on June 28, when 14 large fish were captured (Figure 6). Catch rates for small-medium fish ranged from 0 to 0.82 fish/hour, and the highest catch also occurred on June 28, when 7 small-medium fish were captured (Figure 6). In addition, 2,051 sockeye salmon were captured (Appendix A2).

UPSTREAM SAMPLING

The lower inriver test and commercial gillnet fisheries began May 7 and June 24, respectively, and harvested 2,268 large and 118 small-medium chinook salmon. An additional 394 large fish were inspected and released. Fifty-seven (57) large and 6 small-medium chinook salmon with tags were recovered. The aboriginal and commercial fisheries near Telegraph Creek harvested 665 large and 44 small-medium chinook salmon and 19 tags were recovered from large fish. Three large marked fish were reported from the Canadian recreational fishery on the Tahltan River, which was sampled in 2001; an estimated 12 small-medium and 190 large chinook were harvested. Five large marked fish were reported from the recreational fishery near Petersburg and Wrangell, and all marked fish in the recreational harvest were presumably reported. Two tags from large marked fish caught in the U.S. District 108 experimental troll fishery were voluntarily returned (Tables 1 and 3).

Technicians examined 1,411 chinook salmon for marks at the Little Tahltan River live weir, of which 1,367 were large fish. Twenty-two (22) large marked fish were recovered, and one of these fish had lost its numbered tag. No small-medium marked fish were recovered. An additional 501 (106 small, 35 medium, and 360 large) previously unsampled carcasses were examined above the weir, of which 4 large fish were marked (Table 3). Two of these had lost their tags, but they were identified by secondary and tertiary marks.

At Verrett River, 923 live and dead chinook salmon were examined (7 small, 14 medium, and 902 large); 21 marked fish were recovered (Table 3). One of these had lost its tag, but it was identified by secondary and tertiary marks.

At Andrew Creek 220 (1 small, 12 medium and 207 large) fish were examined in 2001. Spaghetti tags were recovered from 3 large fish, but no adipose finclipped fish were observed.

In addition to sampling at the Little Tahltan and Verrett rivers and Andrew Creek, the 2001 crew sampled fish at Christina and Shakes creeks and the Craig River. The latter three chinook spawning systems are located upstream of the U.S./ Canada border. The crew examined 285 (6 small, 15 medium, and 264 large) fish; 7 spaghetti tags were recovered from large fish, with no evidence of lost tags.

ABUNDANCE OF LARGE CHINOOK SALMON

The estimated abundance of large chinook salmon passing above Kakwan Point and Rock Island, based on fish inspected at Little Tahltan live weir and samples from Verrett River, the lower inriver commercial and test gillnet fisheries, and the upper gillnet fisheries is 66,646 salmon (SE = 5,853; bias = 0.76%; 95% CI: 56,521–78,982; $\hat{M}_L = 1{,}416$, $C = 5{,}596$, $R = 118$). For this estimate, all large marked fish intercepted by U.S. experimental troll (two fish) and recreational fisheries (five fish, assuming all marked fish in the recreational harvest were

Table 3.–Numbers of chinook salmon marked on lower Stikine River, removed by fisheries and inspected for marks in tributaries in 2001, by size category. Numbers in bold were used in mark-recapture estimates.

		Length (MEF) in mm			
		0–439 (small)	440–659 (medium)	≥660 (large)	Total
A. Released at Kakwan Point		1	20	1,295	1,316
B. Released at Rock Island		40	25	159	224
C. Removed by:					
1. U.S. recreational fisheries				5 [a]	5
2. U.S experimental troll				2 [a]	2
3. Andrew Creek				31 [b]	31
Subtotal of removals				38	38
D. Estimated number of marked fish remaining in mark-recapture experiment		41	45	**1,416**	1,502
E. Canadian recreational fisheries	Harvested	4	8	190	202
Tahltan River	Marked	0	0	3	3
	Marked/harvested	0.0000	0.0000	0.0158	0.0149
F. Inspected at:					
1. Little Tahltan live weir	Inspected	4	40	**1,367**	1,411
	Marked	0	0	**22**	22
	Marked/inspected	0.0000	0.0000	0.0161	0.0156
2. Little Tahltan carcass weir	Inspected	106	35	360	501
	Marked	0	0	4	4
	Marked/inspected	0.0000	0.0000	0.0111	0.0080
3. Verrett River	Inspected	7	14	**902**	923
	Marked	0	1	**20**	21
	Marked/inspected	0.0000	0.0714	0.0222	0.0228
Subtotal: Little Tahltan weir/Verrett	Inspected	11	54	**2,269**	2,334
	Marked	0	1	**42**	43
	Marked/inspected	0.0000	0.0185	0.0185	0.0184
G. Inriver commercial/test gillnet [c]	Harvested [d,e,f]	65	53	**2,662**	2,780
Lower	Marked	4	2	**57**	63
	Marked/harvested	0.0615	0.0377	0.0214	0.0227
I. Upriver gillnet	Harvested [g]	0	44	**665**	709
Commercial and aboriginal	Marked	0	0	**19**	19
	Marked/harvested	0.0000	0.000	0.0286	0.0268
Subtotal: inriver/upriver gillnet	Harvested	65	98	**3,327**	3,479
	Marked	4	2	**76**	82
	Marked/harvested	0.0615	0.0204	0.0228	0.0236
Total: Little Tahltan live weir, Verrett River, inriver/upriver gillnet	Inspected	76	152	**5,596**	5,824
	Marked	4	3	**118**	125
	Marked/inspected	0.0526	0.0197	0.0211	0.0215
H. Other upriver recoveries:					
1. Shakes Creek	Inspected	0	3	125	128
	Marked	0	0	2	2
	Marked/inspected	0.0000	0.0000	0.0160	0.0156
2. Christina Creek	Inspected	6	8	41	55
	Marked	0	0	2	2
	Marked/inspected	0.0000	0.0000	0.0488	0.0364

-continued-

Table 3.–continued.

		Length (MEF) in mm			
		0–439 (small)	440–659 (medium)	≥660 (large)	Total
3. Craig River	Inspected	0	4	98	102
	Marked	0	0	3	3
	Marked/inspected	0.0000	0.0000	0.0306	0.0294
Subtotal: other upriver recoveries	Inspected	6	15	264	285
	Marked	0	0	7	7
	Marked/inspected	0.0000	0.0000	0.0265	0.0246
Andrew Creek	Inspected	1	12	207	220
	Marked	0	0	3	3
	Marked/inspected	0.0000	0.0000	0.0145	0.0136

[a] Voluntary returns.

[b] The number of marked large chinook salmon that were recaptured in Andrew Creek (3) was expanded by the fraction of the estimated escapement sampled (number large fish sampled/escapement of large fish = 207/2,108).

[c] Chinook and sockeye salmon test fisheries.

[d] The inriver test fishery harvest of 59 small-medium fish was apportioned into small and medium size categories using length sample data: 16/18(59) = 52 small, 2/18(59) = 7 medium.

[e] The inriver commercial fishery harvest of 59 small-medium fish was apportioned into small and medium size categories using length sample data: 3/14(59) = 13 small, 11/14(59) = 46 medium.

[f] Of these 2,662 large fish, 394 were released during the chinook test fishery.

[g] Upriver commercial and aboriginal harvest of small-medium fish could not be segregated into small and medium size categories

reported) were censored from the experiment. An additional 31 fish were censored from the experiment through expansion of the number of marked fish recovered in Andrew Creek (3) by the fraction of the estimated escapement sampled (Table 3).

Evidence from upstream sampling supports the supposition that every large chinook salmon passing by Kakwan Point and Rock Island had a near equal chance of being marked regardless of when they passed these sites. The majority of fish bound for the Little Tahltan River pass by these sites in May and June, and the majority of fish bound for Verrett River pass by in June and early July. The lower inriver test and commercial fisheries began on May 7 and June 24, respectively, and the upriver gillnet fisheries began in July, so these fisheries would exploit fish passing these sites from early May through August. Marked fractions (Table 3) estimated for large fish at the Little Tahltan live weir (0.0161), Verrett River (0.0222), the lower inriver commercial and test gillnet fisheries (0.0214), and the upriver gillnet fisheries (0.0286) were not significantly different (χ^2 = 3.37, df = 3, P = 0.34). Recovery rates for large chinook salmon tagged at Kakwan Point and Rock Island during the period of project overlap (June 16 to July 10) were also compared:

	Kakwan Point	Rock Island
Released	406	131
Recaptured	23	9
Fraction	0.057	0.069

These marked fractions were not significantly different (χ^2 = 0.23, df = 1, P = 0.63).

Size-selective sampling did not appear to occur during events 1 or 2 (Appendix A3). Although the size distributions of fish marked at Kakwan

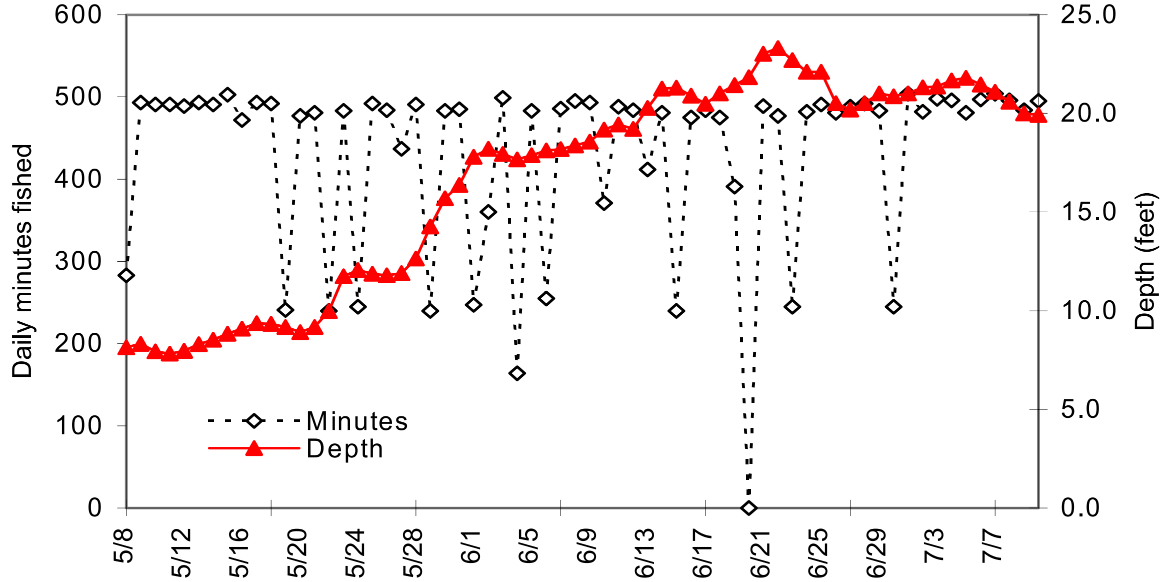


Figure 3.–Daily drift gillnet fishing effort (minutes) and river depth (feet) near Kakwan Point, lower Stikine River, 2001.

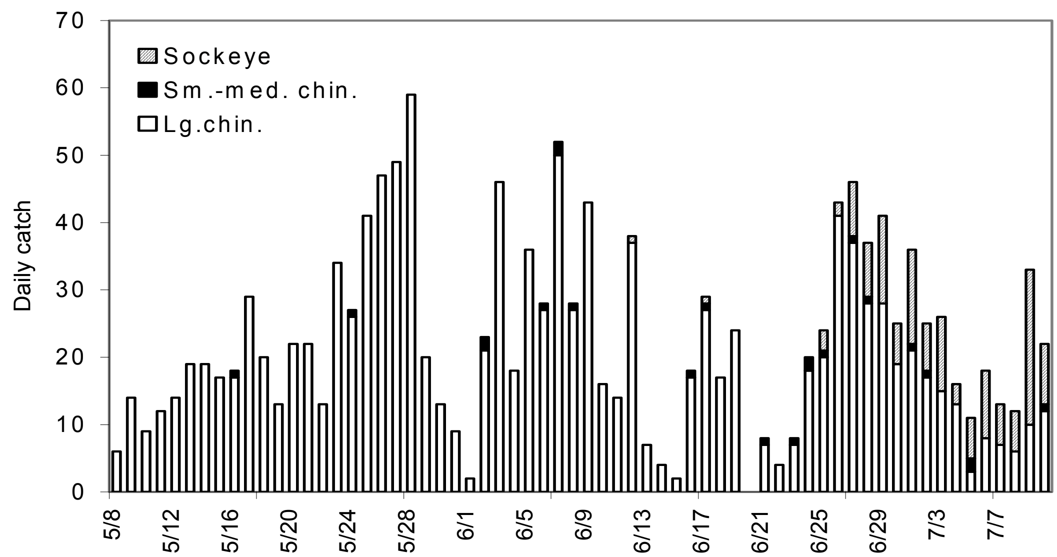


Figure 4.–Daily catch of chinook and sockeye salmon near Kakwan Point, lower Stikine River, 2001.

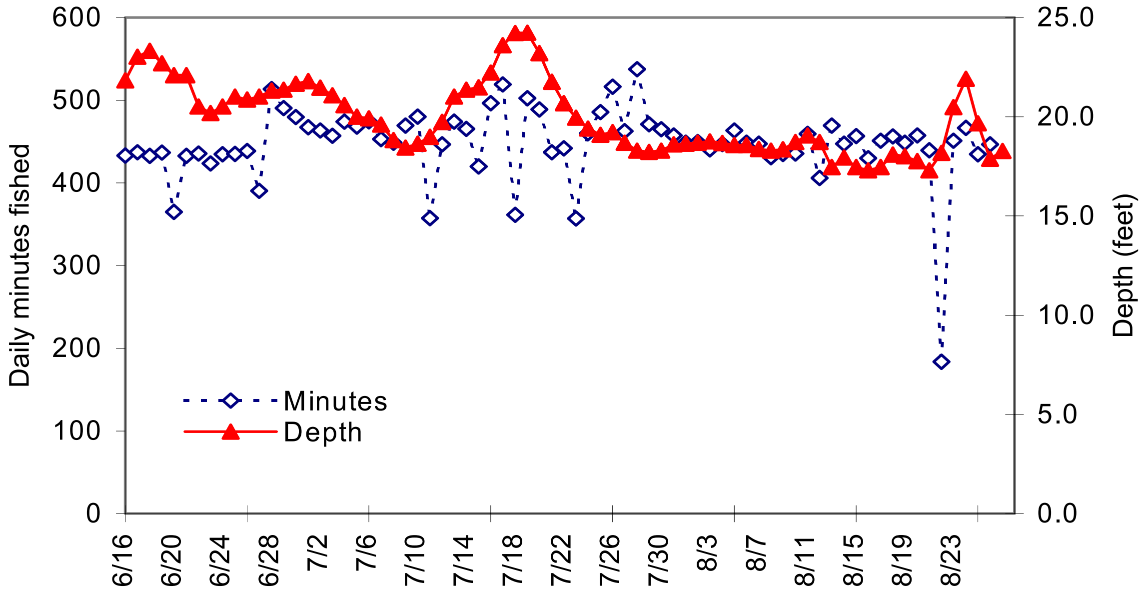


Figure 5.–Daily set gillnet fishing effort (minutes) and river depth (feet) at Rock Island, lower Stikine River, 2001.

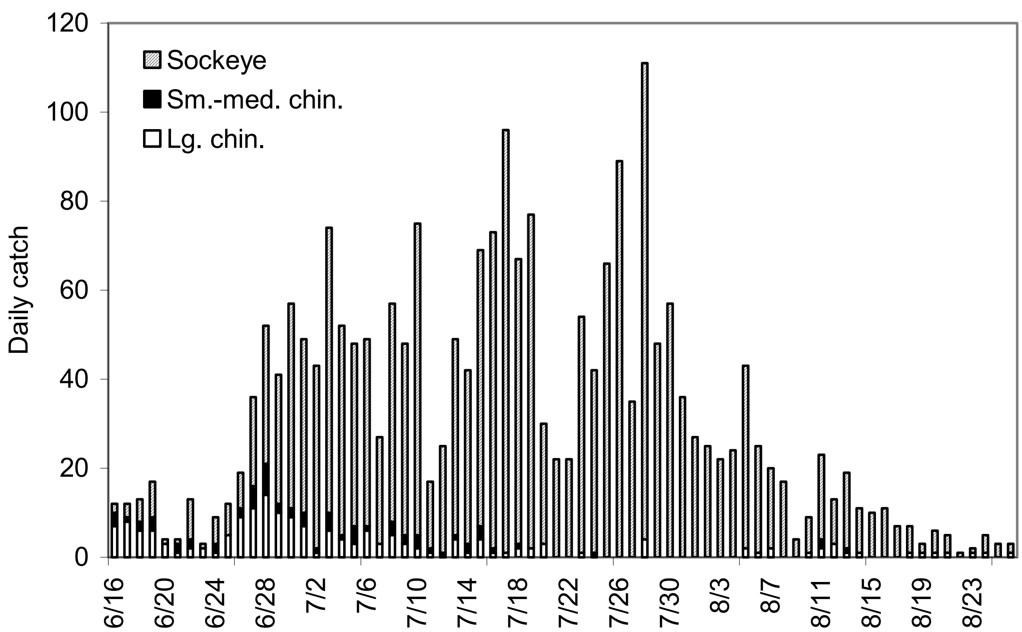


Figure 6.–Daily catch of chinook and sockeye salmon at Rock Island, lower Stikine River, 2001.

Point and Rock Island versus combined samples of fish inspected at the live weir on the Little Tahltan River, Verrett River, in the lower inriver commercial and test gillnet fisheries, and the upriver gillnet fisheries were significantly different (Kolmogorov-Smirnov: $d_{max} = 0.79$; n = 1,452, 3,047; $P < 0.01$), sample sizes were very large and the Kolmogorov-Smirnov test was probably sensitive to small differences. Inspection of the cumulative distribution function (cdf) plots for marked and inspected samples (Figure 7) supports the conclusion that their size distributions were similar. The size distributions of fish marked at Kakwan Point and Rock Island and recaptured at the weir, Verrett River, and in the inriver fisheries were not significantly different (Kolmogorov-Smirnov: $d_{max} = 0.10$; n = 1,452, 118; $P = 0.23$), and cdf plots were once again similar (Figure 8).

Additional evidence from upstream sampling also supports the supposition that every large chinook salmon passing by Kakwan Point and Rock Island had a near equal chance of being marked regardless of their size. Pooled length samples of large fish from the Little Tahltan River live weir, Verrett River, the lower inriver commercial and test gillnet fisheries, and upriver gillnet fisheries were arbitrarily split into two groups at the median length of large fish (800 mm MEF) to permit comparison of marked fractions:

	660–800 mm	>800 mm
Marked	62	56
Unmarked	2,730	2,748
Marked	0.023	0.020

These marked fractions were not significantly different ($\chi^2 = 0.34$, df = 1, $P = 0.56$).

Finally, evidence from upstream sampling also supports the supposition that every large chinook salmon had a near equal chance of being captured upstream regardless of their size. Pooled length samples of large fish from the Little Tahltan live weir, Verrett River, the lower inriver commercial and test gillnet fisheries, and the upriver gillnet fisheries were again split into two size groups as were samples of large fish marked at Kakwan Point and Rock Island. After censoring marked fish that were removed by U.S. recreational and experimental troll fisheries (five fish ≤800 and two fish >800 mm MEF), the fractions (rates) of recaptured fish were compared as surrogates for probabilities of capture upstream:

	660– 800 mm	>800 mm
Released	678	769
Recaptured	62	56
Fraction	0.091	0.073

These fractions recaptured were not significantly different ($\chi^2 = 1.42$, df = 1, $P = 0.23$).

A foot survey was conducted at Andrew Creek on August 16, where 1,054 large chinook salmon were counted. The total escapement of large chinook salmon to Andrew Creek was estimated by expanding the survey count by a factor of 2.0 (Pahlke 1999), resulting in an estimate of 2,108 large fish.

ABUNDANCE OF SMALL-MEDIUM CHINOOK SALMON

A nominally sufficient number of small-medium chinook salmon were marked and recaptured in 2001 to estimate abundance, but size-selective sampling was evident and the minimum number of recaptures required for an unbiased estimate (7 recoveries; Seber 1982, p. 60) precluded stratification by size. The size distributions of fish marked at Kakwan Point and Rock Island versus samples of fish inspected in the lower inriver fisheries and Verrett River (Figure 9) were marginally different (Kolmogorov-Smirnov: $d_{max} = 0.18$; n = 86, 84; $P = 0.11$), and although the length distributions of fish marked at Kakwan Point and Rock Island and recaptured at Verrett River and in the lower inriver fisheries were similar (Kolmogorov-Smirnov: $d_{max} = 0.24$; n = 86, 7; $P = 0.75$), the recapture sample was too small to detect a difference (Figure 10; Appendix A3). Poorer results were obtained when samples from the Little Tahltan River live and carcass weirs were included.

Abundance of small-medium chinook salmon was consequently estimated at 1,929 (SE = 274, bias = 0.57%, 95% CI: 1,469 to 2,478) according to the previously described procedure.

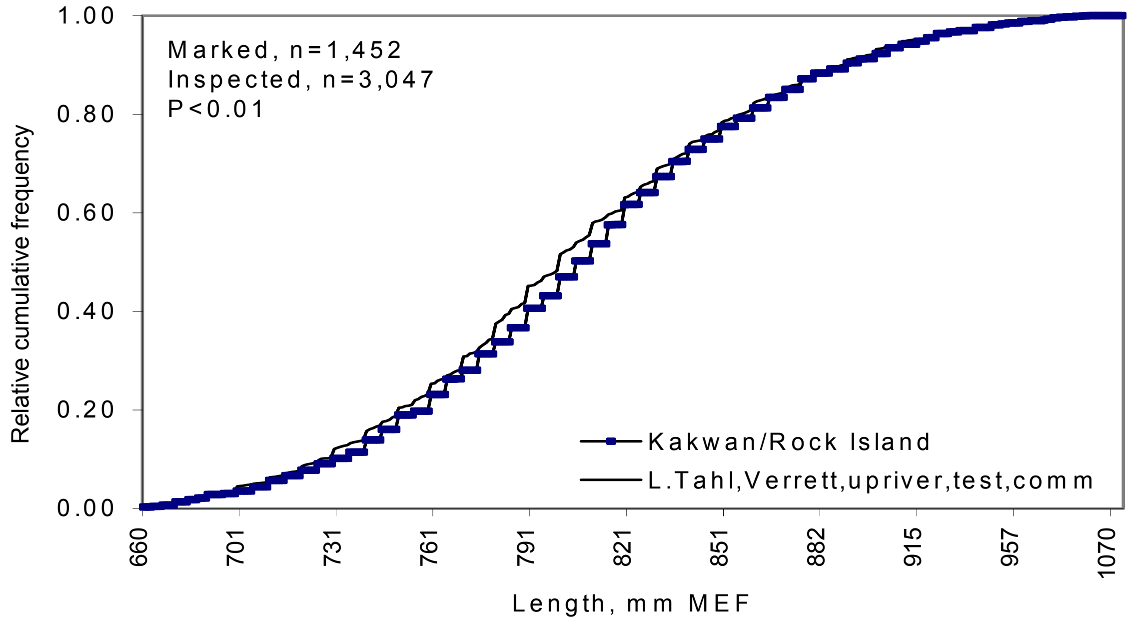


Figure 7.–Cumulative relative frequency of large chinook salmon (≥660 mm MEF) captured at Kakwan Point and Rock Island, and inspected at the weir on the Little Tahltan River, at Verrett River, and in the commercial and test fisheries in the lower Stikine River, 2001.

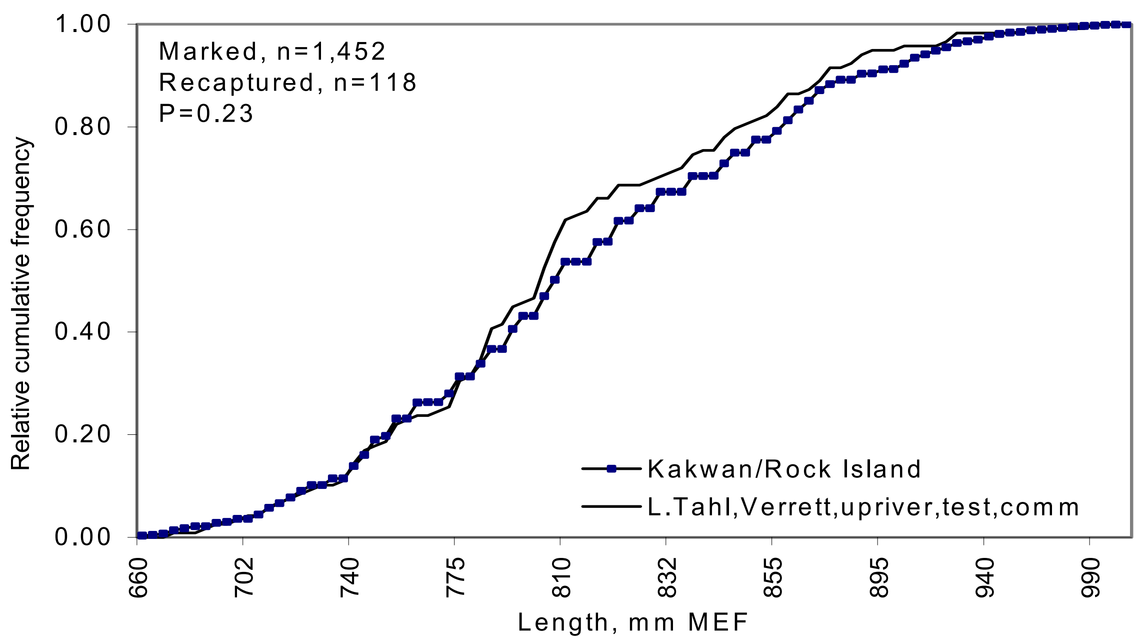


Figure 8.–Cumulative relative frequency of large chinook salmon (≥660 mm MEF) captured at Kakwan Point and Rock Island, and recaptured at the weir on the Little Tahltan River, at Verrett River, and in the commercial and test fisheries in the lower Stikine River, 2001.

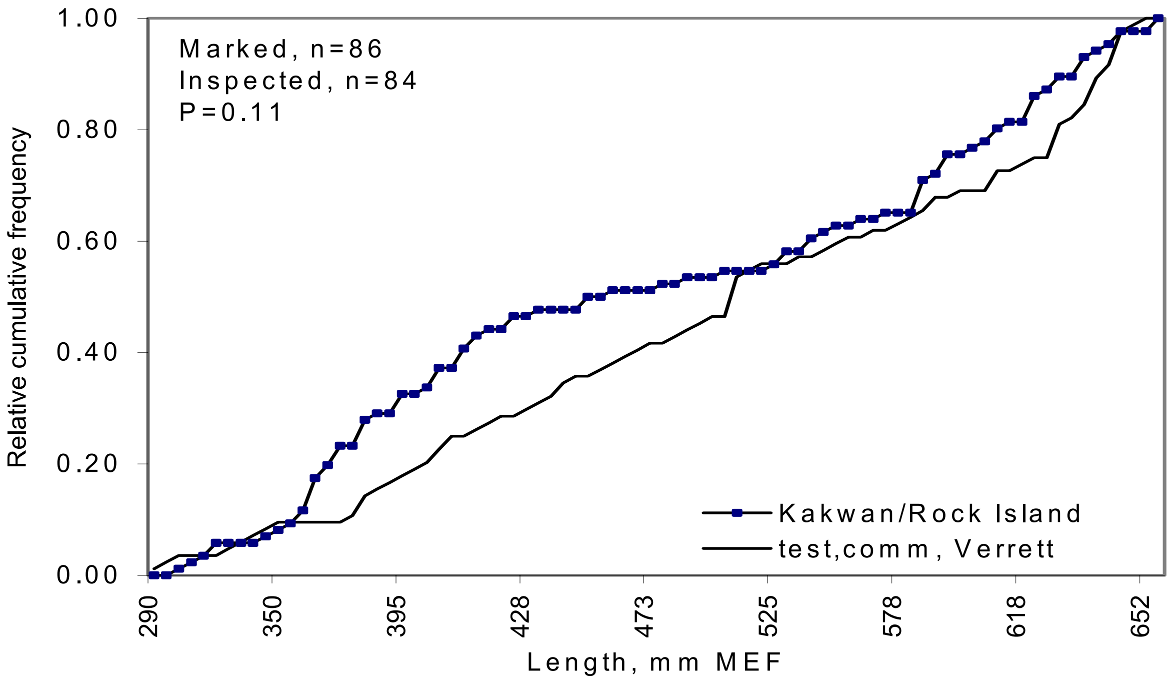


Figure 9.–Cumulative relative frequency of small-medium chinook salmon (<660 mm MEF) captured at Kakwan Point and Rock Island, and inspected at the Little Tahltan River, Verrett River, and in the commercial and test fisheries in the lower Stikine River, 2001.

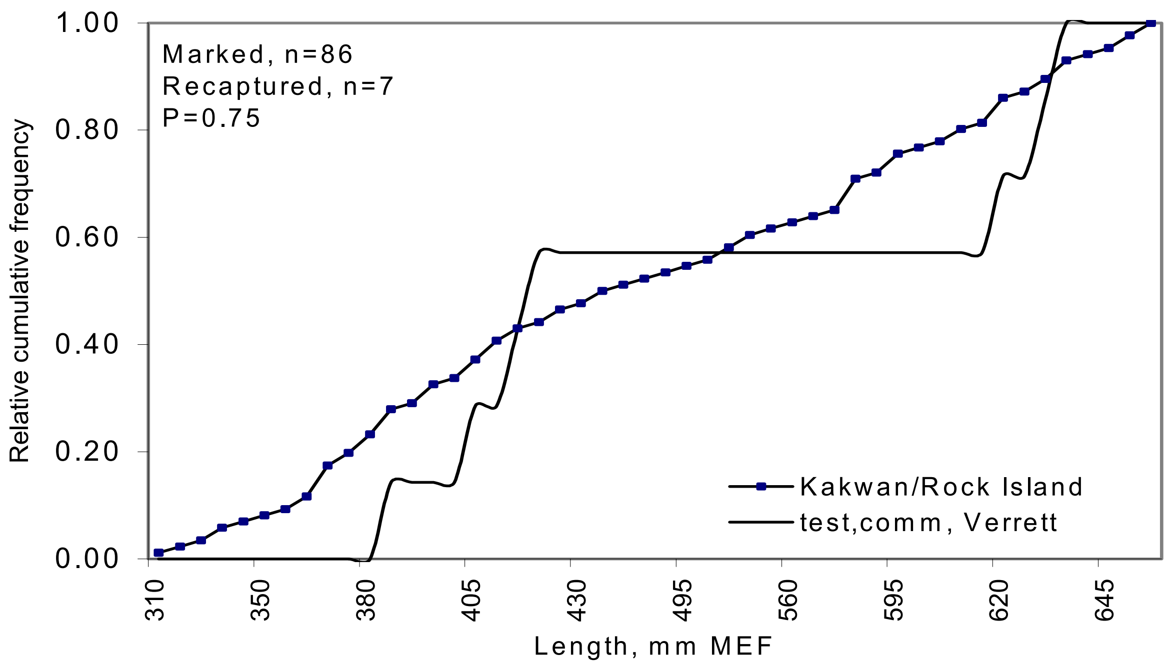


Figure 10.–Cumulative relative frequency of small-medium chinook salmon (<660 mm MEF) captured at Kakwan Point and Rock Island, and recaptured in the Little Tahltan River, Verrett River, and in the commercial and test fisheries in the lower Stikine River, 2001.

AGE, SEX, AND LENGTH COMPOSITION

Age-1.3 chinook salmon dominated all samples except those from Andrew Creek, constituting an estimated 73% of fish captured at Kakwan Point, 50% at Rock Island, 68% in the lower inriver test and commercial fisheries, 73% at Verrett River, 77% at the Little Tahltan River live weir, and 57% at the Little Tahltan River carcass weir. Age-1.4 fish dominated the Andrew Creek sample at 55%, followed by age-1.3 fish at 41%. The predominance of age-1.3 (1996 brood year) chinook salmon in 2001 follows a strong return of age-1.2 fish in 2000, when this age class accounted for 31% of the spawning escapement (Der Hovanisian et al. 2001). There was also a high incidence of age-1.1 fish in the Rock Island (17%) and Little Tahltan carcass weir (21%) samples (Appendices A4-A10).

Age composition estimates for age-1.1 and –1.2 fish in the small-medium size category that were sampled at the Little Tahltan River live and carcass weirs (A7 and A8) were significantly different (Fisher exact test, P = 0.001) because of the high incidence of age-1.1 fish in the carcass weir sample, but were similar for age-1.3 and –1.4 fish (Fisher exact test, P = 0.58). Among large fish, composition estimates were similar for age-1.3 and –1.4 fish (χ^2 = 0.03, df = 1, P = 0.87) and for age-1.2 and 1.5 fish (Fisher exact test, P = 1.00). Composition estimates across size categories were significantly different (χ^2 = 218, df = 4, P < 0.001), again because of the high incidence of age-1.1 fish in the carcass weir sample. Although the live and carcass weir samples were different, the difference can be attributed to the tendency of small fish to pass through the live weir undetected, and bias in carcass weir 'catches' towards males, which tend to be younger, smaller fish (McPherson et al. 1996). While the relative bias introduced by each problem is unknown, the combined samples are considered to be the most representative of the Little Tahltan River population.

Age composition estimates for age-1.1 and -1.2 small-medium chinook salmon from Verrett River and combined samples from the Little Tahltan River live and carcass weirs were not significantly different (Fisher exact test, P = 0.13). Samples for age-1.1 and –1.2 fish were then combined and compared with estimates for age-1.3 small-medium fish, and this comparison also was not significant (Fisher exact test, P = 0.11). Among large fish, composition estimates for age-1.2, -1.3, and –1.4 fish were not significantly different (χ^2 = 3.83, df = 2, P = 0.15). However, comparison of estimates across size categories for age-1.1, 1.2, -1.3, and –1.4 fish were significantly different (χ^2 = 38.2, df = 3, P < 0.001). In spite of this last test result, the within-size category tests suggested that the samples could be combined.

Spawning escapement by age and sex (Table 4) for chinook salmon of all sizes was estimated on the basis of combined samples collected at the Little Tahltan River live and carcass weirs, and Verrett River. The estimated spawning escapement of 65,277 (SE = 6,016, bias = 0.79%, 95% CI: 55,0581 to 77, 925) was composed of 1% age-1.2 fish, 75% age-1.3 fish, and 22% age-1.4 fish. The estimated spawning escapement included 32,183 (SE = 3,060) females.

DISCUSSION

In the initial years of this study, there were inconsistencies between results from tests for size-selective sampling and the length distribution of samples of large fish taken at Kakwan Point and the spawning grounds. Capture probabilities suggested that selective sampling had not occurred, whereas length distributions implied that it had. These discrepancies were attributed to differences in migratory timing among stocks, differences in the size of fish across stocks, and differences in time of sampling. Chinook salmon spawning in the Little Tahltan River tend to pass Kakwan Point earlier than do fish bound for Verrett River and are larger, while Verrett River fish enter later and are usually smaller than chinook salmon spawning in other tributaries. The commercial and test fisheries also began after half the run passed Kakwan Point, which consequently resulted in interception of smaller fish. In 2000 and 2001 we augmented catches of chinook salmon at Kakwan Point with fish captured at Rock Island. Because the tagging operation at Rock Island extends into August and a smaller mesh net is used, smaller fish late in the run are tagged more intensively than they had been in the past. In

Table 4.–Estimated age and sex composition by size category of the spawning escapement of chinook salmon in the Stikine River, 2001.

		Brood year and age class									
		1998	1997	1997	1996	1996	1995	1995	1994	1994	
		1.1	2.1	1.2[a]	2.2	1.3	2.3	1.4	2.4	1.5	Total
PANEL A. SMALL AND MEDIUM CHINOOK SALMON (<660 MM MEF)											
Females	n			2		5					7
	%			1.2		3.0					4.2
	SE of %			0.8		1.3					1.6
	Escapement			21		53					74
	SE of esc.			15		24					29
Males	n	101		28		27	1	2			159
	%	60.8		16.9		16.3	0.6	1.2			95.8
	SE of %	3.8		2.9		2.9	0.6	0.8			1.6
	Escapement	1,068		296		285	11	21			1,681
	SE of esc.	179		69		67	11	15			264
Combined	n	101		30		32	1	2			166
	%	60.8		18.1		19.3	0.6	1.2			100.0
	SE of %	3.8		3.0		3.1	0.6	0.8			0.0
	Escapement	1,068		316		338	11	21			1,755
	SE of esc.	179		72		75	11	15			274
PANEL B. LARGE CHINOOK SALMON (≥660 MEF)											
Females	n			1		582	4	240		3	830
	%			0.1		35.4	0.2	14.6		0.2	50.5
	SE of %			0.1		1.2	0.1	0.9		0.1	1.2
	Escapement			39		22,515	155	9,285		116	32,109
	SE of esc.			39		2,205	78	1,018		68	3,060
Males	n			7[a]		668	2	133		2	812
	%			0.4		40.7	0.1	8.1		0.1	49.5
	SE of %			0.2		1.2	0.1	0.7		0.1	1.2
	Escapement			271		25,842	77	5,145		77	31,413
	SE of esc.			105		2,502	55	637		55	2,998
Combined	n			8		1,250	6	373		5	1,642
	%			0.5		76.1	0.4	22.7		0.3	100.0
	SE of %			0.2		1.1	0.1	1.0		0.1	0.0
	Escapement			309		48,358	232	14,430		193	63,523
	SE of esc.			112		4,505	97	1,482		88	5,853
PANEL C. SMALL, MEDIUM AND LARGE CHINOOK SALMON											
Females	n			3		587	4	240		3	837
	%			0.1		34.6	0.2	14.2		0.2	49.3
	SE of %			0.1		1.2	0.1	0.9		0.1	1.2
	Escapement			60		22,568	155	9,285		116	32,183
	SE of esc.			42		2,205	78	1,018		68	3,060
Males	n	101		35[a]		695	3	135		2	971
	%	1.6		0.9		40.0	0.1	7.9		0.1	50.7
	SE of %	0.3		0.2		1.2	0.1	0.7		0.1	1.2
	Escapement	1,068		567		26,128	88	5,166		77	33,094
	SE of esc.	179		125		2,503	56	638		55	3,010
Combined	n	101		38		1,282	7	375		5	1,808
	%	1.6		1.0		74.6	0.4	22.1		0.3	100.0
	SE of %	0.3		0.2		1.1	0.1	1.0		0.1	0.0
	Escapement	1,068		627		48,696	243	14,451		193	65,277
	SE of esc.	179		133		4,506	97	1,482		88	6,016

[a] One age-0.3 male included in age-1.2 age class.

2001, the test fishery also began at the same time tagging at Kakwan Point was initiated, thereby increasing the opportunity to recover fish early in the run. The net effect has been that length distributions of large fish sampled during events 1 and 2 are similar (Figures 7 and 8). The marked sample in 2001 also had the second highest number of small and medium fish to date (86 versus 237, 58, 24, 28, and 43 in 2000, 1999, 1998, 1997, and 1996, respectively).

In the 1996 study, discrepancies among estimates of abundance and observed tagging rates in samples arose because of sampling problems in the Little Tahltan River and at Kakwan Point. Daily catch is dependent not only on effort, but also on river conditions (stage), which can change dramatically from day to day. Sampling effort in 1996 was erratic at Kakwan Point. In an attempt to correct these problems we added another technician to the tagging crew in 1997. We were able to increase the total fishing effort at Kakwan Point from 362 net-hours in 1996 to about 460 net-hours in subsequent years, thus maintaining a higher level of effort. With addition of the Rock Island project in 2000, fishing effort was substantially increased. We also increased the sample size of fish physically inspected at the Little Tahltan weir and Verrett River. The fractions marked in samples taken at the Little Tahltan River, Verrett River, and the lower river commercial and test fisheries were not statistically different in 2001, indicating every fish had an equal chance of being marked in event 1. This was in spite of high water conditions that affected the catch per net hour at Kakwan around mid-June (Figure 3). The setnet operation at Rock Island and high water conditions, which may delay migrant fish, could have offset the reduction in fishing efficiency at Kakwan Point.

To make the abundance estimate of large chinook salmon past Kakwan Point and Rock Island comparable to other estimates of spawning escapement, harvests in the commercial, test, and aboriginal fisheries should be subtracted. The final estimate of the spawning escapement for large chinook salmon in 2001 is 63,523 (= 66,646-3,123).

The total weir count in 2001 of 9,738 large fish in the Little Tahltan River is 15% of the estimated spawning escapement, for an expansion factor of 6.52 for weir counts to spawning escapement. This statistic is the largest expansion factor estimated thus far:

Year	Estimated expansion	SE	Source
1996	6.00	0.41	M-R experiment[a]
1997	4.86	0.53	M-R experiment[b]
1997	5.48	0.95	Telemetry study
1998	5.32	0.81	M-R experiment
1999	4.21	0.68	M-R experiment
2000	4.15	0.48	M-R experiment
2001	6.52	0.60	M-R experiment
Avg.	**5.22**	**0.64**	

[a] Modified from data in Pahlke and Etherton (1998).

[b] Modified from data in Pahlke and Etherton (1999).

Still, the average expansion factor of 5.22 is greater than the factor of 4.0 that was traditionally used to expand weir counts in the Little Tahltan River.

Estimated age compositions for the population in the Stikine River tend to differ from those in the nearby Taku River. Age-1.1 and -1.2 fish are common in the Taku chinook salmon run, often making up 20% or more of the return. These age classes usually constitute a much smaller percentage of the Stikine River run. They were uncommon in 1996 through 1998, and more prevalent in 1999 and 2000 (about 23 and 31% of the spawning escapement, respectively), rivaling returns to the Taku River. In 2001, fish <660 mm MEF comprised 29% of the carcass sample collected above the Little Tahltan River live weir, while this group comprised only 3% of the weir sample. This suggests that the smaller fish may be able to pass through the weir unobserved, or are misidentified.

Chinook salmon of hatchery origin were not found in samples collected in Andrew Creek in 2001. However, one fish with an adipose fin clip was recovered during tagging operations at Rock Island, one was recovered from the lower inriver fisheries, and one was recovered from the Craig River. One had been tagged and released at Little Port Walter, the second at the Taku River, and the third at Crystal Lake/Earl West Cove (Appendix

A11). With the exception of the fish that was recovered in the Craig River, these fish were not spawning when captured and may have only temporarily entered the Stikine River.

The U.S. and Canada signed a new PST agreement in June 1999, which included a specific directive in Annex IV of the treaty to develop abundance-based management of Stikine River chinook salmon by 2004. In 2001 the feasibility of an inseason mark-recapture experiment to estimate the abundance of large chinook salmon was investigated. Tagging data from Kakwan Point and recovery data from the Canadian chinook salmon test fishery were collected concurrently from early May to the beginning of the lower inriver commercial fishery on June 24. Kakwan Point data collected after June 22 were omitted to allow for travel time to the test fishery (a minimum of 1 day as estimated by tag recoveries). The data were temporally stratified:

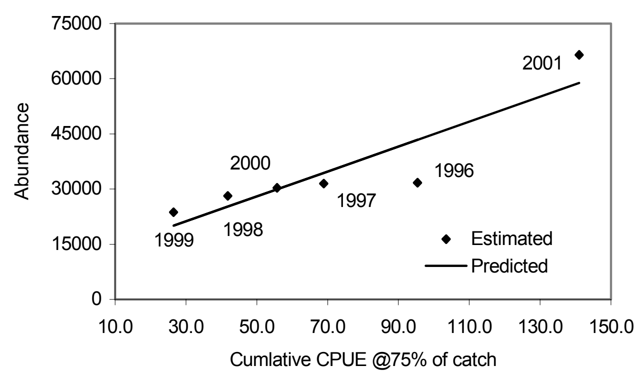
Release strata, *i*	Recovery strata, *j* 5/8–6/4	6/5–6/23	Released
5/8–5/21	4	1	228
5/22–6/22	3	18	757
Unmarked	595	1,027	
p_j	0.0118	0.0185	

Capture probabilities were similar to those seen on the spawning grounds and were not significantly different ($\chi^2 = 1.05$, df = 1, P = 0.31), so a pooled Peterson estimate of 60,218 (SE = 11,131) was valid. Statistical bias was low (4%), but precision was relatively poor (CV = 18%). A stratified estimate was also calculated according to the procedures in Darroch (1961), and bootstrap methods (Efron 1982) were used to estimate variance and statistical bias:

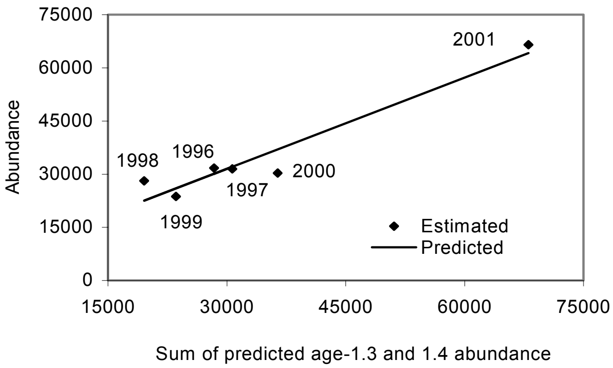
	Recovery strata, *j* 5/5–6/4	6/5–6/23	Total
Original:			
N_j	25,436	39,298	64,735
Bootstrap:			
N_j	24,557	42,688	67,245
$SE[N_j]$			24,486
$P_j < 0$	144	2	
$0 < p_j \leq 1$	845	991	
$P_j > 1$	4	0	
7 zero determinants in 1000 bootstrap samples			

Statistical bias was low (4%), but precision was poor (CV = 38%), and there were a large number of nonsensical p_j values and some zero determinants. Given that approximately 76% of the run of large fish had passed Kakwan Point by June 22 (Appendix A1), the pooled and stratified estimates should have been about 76% of the postseason estimate, or 50,651 (66,646 x 0.76); however, the estimates could be positively biased because of tagging-induced travel time delays. These analyses indicate that, given quota limits on the test fishery sample, tagging rates need to be increased in May to boost recoveries. Additional information, such as preseason forecasts, will also be required to corroborate inseason estimates.

Preliminary analysis suggests there may be a linear relationship ($R^2 = 0.77$, P = 0.01) between cumulative CPUE at Kakwan Point and estimated abundance of large chinook salmon, although 2001 data drives the regression. Cumulative CPUE data at 75% of the catch at Kakwan Point (the historic average date at which 75% of the catch at Kakwan Point has occurred is June 21, just prior to the start of the lower inriver commercial fishery) was regressed on abundance estimates from 1996 to 2001:

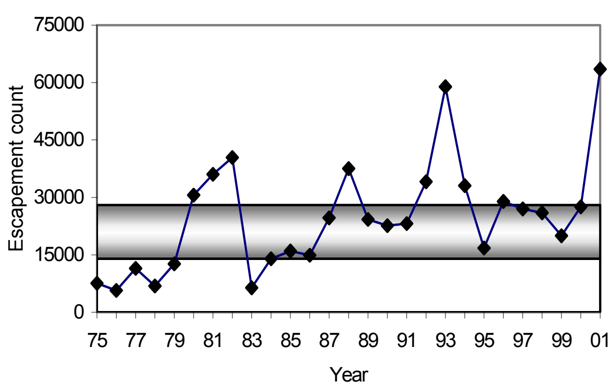


In additional analyses, previous-year abundance estimates of age-1.2 males and age-1.3 fish were used to predict current-year abundance of age-1.3 and age-1.4 fish. The sum of the predictions were then regressed on current-year estimates of large chinook salmon abundance:



The regression may be meaningful (R^2 = 0.91, $P < 0.01$), but the 2001 data again drive the regression. However, if these relationships persist as data accumulate, they or similar models may be useful for forecasting and substantiation of in-season estimates.

The 1999 PST agreement states that we will manage Southeast Alaska chinook stocks for MSY escapement goals (Chapter 3, Attachment 1, footnote 5). Retrospectively, estimated escapements have met or exceeded the escapement goal range (established in 2000) of 14,000 to 28,000 adult spawners since 1985. The ADF&G and DFO assessment is that chinook salmon in the Stikine River have recovered from the recruitment overfishing and poor survival of the 1970s (Bernard et al. 2000).



CONCLUSIONS AND RECOMMENDATIONS

This was the sixth year of estimating the spawning escapement of chinook salmon to the Stikine River. We continue to improve our methods and mark-recapture estimates. Drift gillnets are an effective method of capturing enough large chinook salmon migrating up the Stikine River for a post-season estimate, but may be inadequate for inseason management. The use of a set gillnet at Rock Island in 2000 and 2001 has proven effective and will hopefully in the future provide a larger marked release group of chinook salmon earlier in the run and more tagged fish <600 mm MEF. The results of six years of study also confirm that counts of salmon through the Little Tahltan River live weir are a useful index (i.e., the counts represent a relatively constant percentage of the run) of chinook salmon escapement to the Stikine River. However, the weir counts do not serve as a timely indicator of run strength for inseason abundance-based management per the 1999 PST. In 2000 we started the test fishing operation in early May to cover the entire chinook salmon migration and continued that effort in 2001. Preliminary analysis indicates that tagging rates need to be increased to obtain meaningful in-season abundance estimates. Since tagging effort at Kakwan Point has been maximized, we recommend initiating the tagging operation at Rock Island in early May. Use of a 6-inch net in the test fishery should be continued to mitigate size-selective sampling. Models that describe the relationship between CPUE and abundance data are encouraging, but CPUE varies with changing river conditions and may not be a good indicator of run strength in some years. Other indicators, such as a pre-season forecast utilizing brood year strength, may be useful early in the season. Sampling rates at the weir should be maintained or increased and efforts continued to ensure that smaller fish are not passing unobserved.

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APPENDIX A

Appendix A1.–Drift gillnet daily effort (minutes fished), catches, and catch per hour near Kakwan Point, Stikine River, 2001.

							Large chinook		Small-medium chinook	
Date	Minutes	Lg. chin.	Sm-med chin.	Sockeye	Temp	Depth	Fish/hour	Cum. percent	Fish/hour	Cum. percent
5/08/01	283	6	0	0	7.0	8.14	1.27	0.00	0.00	0.00
5/09/01	493	14	0	0	4.0	8.33	1.70	0.02	0.00	0.00
5/10/01	491	9	0	0	6.0	7.94	1.10	0.02	0.00	0.00
5/11/01	491	12	0	0	6.0	7.83	1.47	0.03	0.00	0.00
5/12/01	489	14	0	0	6.5	7.97	1.72	0.04	0.00	0.00
5/13/01	493	19	0	0	6.0	8.30	2.31	0.06	0.00	0.00
5/14/01	491	19	0	0	6.5	8.53	2.32	0.07	0.00	0.00
5/15/01	503	17	0	0	6.5	8.84	2.03	0.08	0.00	0.00
5/16/01	472	17	1	0	7.0	9.09	2.16	0.10	0.13	0.05
5/17/01	493	29	0	0	7.0	9.37	3.53	0.12	0.00	0.05
5/18/01	492	20	0	0	7.0	9.33	2.44	0.14	0.00	0.05
5/19/01	241	13	0	0	6.0	9.17	3.24	0.15	0.00	0.05
5/20/01	477	22	0	0	7.0	8.91	2.77	0.16	0.00	0.05
5/21/01	481	22	0	0	6.5	9.17	2.74	0.18	0.00	0.05
5/22/01	240	13	0	0	9.0	9.98	3.25	0.19	0.00	0.05
5/23/01	483	34	0	0	7.0	11.75	4.22	0.22	0.00	0.05
5/24/01	245	26	1	0	7.0	12.06	6.37	0.24	0.24	0.09
5/25/01	492	41	0	0	7.5	11.88	5.00	0.27	0.00	0.09
5/26/01	484	47	0	0	8.0	11.80	5.83	0.30	0.00	0.09
5/27/01	437	49	0	0	8.0	11.90	6.73	0.34	0.00	0.09
5/28/01	491	59	0	0	8.5	12.64	7.21	0.39	0.00	0.09
5/29/01	240	20	0	0	8.5	14.27	5.00	0.40	0.00	0.09
5/30/01	483	13	0	0	8.0	15.70	1.61	0.41	0.00	0.09
5/31/01	485	9	0	0	7.5	16.37	1.11	0.42	0.00	0.09
6/01/01	247	2	0	0	7.5	17.81	0.49	0.42	0.00	0.09
6/02/01	360	21	2	0	7.5	18.20	3.50	0.44	0.33	0.18
6/03/01	499	46	0	0	8.0	17.95	5.53	0.47	0.00	0.18
6/04/01	164	18	0	0	8.5	17.68	6.59	0.49	0.00	0.18
6/05/01	483	36	0	0	8.0	17.88	4.47	0.51	0.00	0.18
6/06/01	255	27	1	0	8.0	18.12	6.35	0.53	0.24	0.23
6/07/01	486	50	2	0	8.5	18.18	6.17	0.57	0.25	0.32
6/08/01	495	27	1	0	8.5	18.38	3.27	0.59	0.12	0.36
60/9/01	493	43	0	0	8.5	18.57	5.23	0.63	0.00	0.36
6/10/01	371	16	0	0	8.5	19.19	2.59	0.64	0.00	0.36
6/11/01	488	14	0	0	8.5	19.44	1.72	0.65	0.00	0.36
6/12/01	484	37	0	1	8.5	19.22	4.59	0.68	0.00	0.36
6/13/01	412	7	0	0	9.0	20.28	1.02	0.68	0.00	0.36
6/14/01	481	4	0	0	9.0	21.26	0.50	0.69	0.00	0.36
6/15/01	240	2	0	0	9.5	21.30	0.50	0.69	0.00	0.36
6/16/01	475	17	1	0	8.5	20.90	2.15	0.70	0.13	0.41
6/17/01	484	27	1	1	9.0	20.48	3.35	0.72	0.12	0.45
6/18/01	475	17	0	0	9.0	21.01	2.15	0.73	0.00	0.45
6/19/01	391	24	0	0	10.0	21.43	3.68	0.75	0.00	0.45
6/20/01	0	0	0	0	9.5	21.83	0.00	0.75	0.00	0.45
6/21/01	489	7	1	0	8.0	23.02	0.86	0.76	0.12	0.50
6/22/01	477	4	0	0	8.5	23.32	0.50	0.76	0.00	0.50
6/23/01	245	7	1	0	8.5	22.70	1.71	0.77	0.24	0.55
6/24/01	482	18	2	0	8.0	22.10	2.24	0.78	0.25	0.64
6/25/01	491	20	1	3	8.0	22.10	2.44	0.80	0.12	0.68
6/26/01	481	41	0	2	9.0	20.52	5.11	0.83	0.00	0.68

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Appendix A1.–Page 2 of 2.

Date	Minutes	Lg. chin.	Sm-med chin.	Sockeye	Temp	Depth	Large chinook Fish/hour	Large chinook Cum. Percent	Small-medium chinook Fish/hour	Small-medium chinook Cum. Percent
6/27/01	488	37	1	8	9.0	20.19	4.55	0.86	0.12	0.73
6/28/01	492	28	1	8	8.5	20.52	3.41	0.88	0.12	0.77
6/29/01	483	28	0	13	8.5	21.01	3.48	0.90	0.00	0.77
6/30/01	245	19	0	6	9.0	20.87	4.65	0.91	0.00	0.77
7/01/01	504	21	1	14	9.5	21.02	2.50	0.93	0.12	0.82
7/02/01	482	17	1	7	10.0	21.32	2.12	0.94	0.12	0.86
7/03/01	498	15	0	11	10.0	21.37	1.81	0.95	0.00	0.86
7/04/01	496	13	0	3	10.0	21.67	1.57	0.96	0.00	0.86
7/05/01	481	3	2	6	10.0	21.80	0.37	0.97	0.25	0.95
7/06/01	497	8	0	10	8.5	21.47	0.97	0.97	0.00	0.95
7/07/01	504	7	0	6	8.5	21.09	0.83	0.98	0.00	0.95
7/08/01	496	6	0	6	8.0	20.59	0.73	0.98	0.00	0.95
7/09/01	484	10	0	23	8.0	20.01	1.24	0.99	0.00	0.95
7/10/01	495	12	1	9	9.0	19.92	1.45	1.00	0.12	1.00
Total	459 hrs	1300	22	137						

Appendix A2.–Set gillnet daily effort (minutes fished), catches, and catch per hour, at Rock Island, Stikine River, 2001.

Date	Minutes	Lg. chin.	Sm-med chin.	Sockeye	Temp	Depth	Large chinook Fish/hour	Large chinook Cum. percent	Small-medium chinook Fish/hour	Small-medium chinook Cum. percent
06/16/01	433	7	3	2	8.5	20.90	0.97	0.04	0.42	0.04
06/17/01	437	8	1	3	9.0	20.48	1.10	0.08	0.14	0.06
06/18/01	433	6	2	5	9.0	21.01	0.83	0.12	0.28	0.09
06/19/01	437	6	3	8	10.0	21.43	0.82	0.15	0.41	0.13
06/20/01	365	3	0	1	9.5	21.83	0.49	0.17	0.00	0.13
06/21/01	433	1	2	1	8.0	23.02	0.14	0.17	0.28	0.16
06/22/01	436	2	2	9	8.5	23.32	0.28	0.19	0.28	0.19
06/23/01	424	2	0	1	8.5	22.70	0.28	0.20	0.00	0.19
06/24/01	435	1	2	6	8.0	22.10	0.14	0.20	0.28	0.22
06/25/01	435	5	0	7	8.0	22.10	0.69	0.23	0.00	0.22
06/26/01	439	9	2	8	9.0	20.52	1.23	0.28	0.27	0.25
06/27/01	391	11	5	20	9.0	20.19	1.69	0.34	0.77	0.32
06/28/01	514	14	7	31	8.5	20.52	1.64	0.42	0.82	0.42
06/29/01	491	10	2	29	8.5	21.01	1.22	0.48	0.24	0.45
06/30/01	480	9	2	46	9.0	20.87	1.13	$\boxed{0.53}$	0.25	0.48
07/01/01	468	7	3	39	9.5	21.02	0.90	0.57	0.39	$\boxed{0.52}$
07/02/01	464	1	1	41	10.0	21.32	0.13	0.57	0.13	0.54
07/03/01	457	6	4	64	10.0	21.37	0.79	0.61	0.53	0.59
07/04/01	474	4	1	47	10.0	21.67	0.51	0.63	0.13	0.61
07/05/01	468	3	4	41	10.0	21.80	0.38	0.65	0.51	0.67
07/06/01	475	6	1	42	8.5	21.47	0.76	0.68	0.13	0.68
07/07/01	453	3	0	24	8.5	21.09	0.40	0.70	0.00	0.68
07/08/01	449	5	3	49	8.0	20.59	0.67	0.72	0.40	0.72
07/09/01	470	3	2	43	8.0	20.01	0.38	0.74	0.26	0.75
07/10/01	480	2	3	70	9.0	19.92	0.25	0.75	0.38	0.80
07/11/01	358	1	1	15		19.60	0.17	0.76	0.17	0.81
07/12/01	447	0	1	24		18.83	0.00	0.76	0.13	0.83
07/13/01	474	4	1	44		18.45	0.51	0.78	0.13	0.84
07/14/01	466	1	2	39		18.65	0.13	0.79	0.26	0.87
07/15/01	420	4	3	62		18.99	0.57	0.81	0.43	0.91
07/16/01	497	1	1	71		19.73	0.12	0.81	0.12	0.93
07/17/01	519	1	0	95		21.02	0.12	0.82	0.00	0.93
07/18/01	362	2	1	64		21.37	0.33	0.83	0.17	0.94
07/19/01	503	2	0	75		21.48	0.24	0.84	0.00	0.94
07/20/01	489	3	0	27		22.23	0.37	0.86	0.00	0.94
07/21/01	437	0	0	22		23.60	0.00	0.86	0.00	0.94
07/22/01	442	0	0	22		24.22	0.00	0.86	0.00	0.94
07/23/01	357	1	0	53		24.23	0.17	0.87	0.00	0.94
07/24/01	460	0	1	41		23.20	0.00	0.87	0.13	0.96
07/25/01	486	0	0	66		21.76	0.00	0.87	0.00	0.96
07/26/01	517	0	0	89		20.69	0.00	0.87	0.00	0.96
07/27/01	463	0	0	35		19.95	0.00	0.87	0.00	0.96
07/28/01	538	4	0	107		19.40	0.45	0.89	0.00	0.96
07/29/01	471	0	0	48		19.09	0.00	0.89	0.00	0.96
07/30/01	465	0	0	57		19.22	0.00	0.89	0.00	0.96
07/31/01	458	0	0	36		18.69	0.00	0.89	0.00	0.96
08/01/01	449	0	0	27		18.29	0.00	0.89	0.00	0.96
08/02/01	450	0	0	25		18.22	0.00	0.89	0.00	0.96
08/03/01	441	0	0	22		18.29	0.00	0.89	0.00	0.96
08/04/01	447	0	0	24		18.61	0.00	0.89	0.00	0.96

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Appendix A2.–Page 2 of 2.

Date	Minutes	Lg. chin.	Sm-med chin.	Sockeye	Temp	Depth	Large chinook Fish/hour	Large chinook Cum. percent	Small-medium chinook Fish/hour	Small-medium chinook Cum. percent
08/05/01	464	2	0	41		18.64	0.26	0.90	0.00	0.96
08/06/01	449	1	0	24		18.70	0.13	0.90	0.00	0.96
08/07/01	448	2	0	18		18.76	0.27	0.92	0.00	0.96
08/08/01	431	0	0	17		18.67	0.00	0.92	0.00	0.96
08/09/01	435	0	0	4		18.58	0.00	0.92	0.00	0.96
08/10/01	436	1	0	8		18.58	0.14	0.92	0.00	0.96
08/11/01	460	2	2	19		18.38	0.26	0.93	0.26	0.99
08/12/01	406	3	0	10		18.29	0.44	0.95	0.00	0.99
08/13/01	470	1	1	17		18.36	0.13	0.96	0.13	1.00
08/14/01	448	1	0	10		18.73	0.13	0.96	0.00	1.00
08/15/01	457	0	0	10		19.05	0.00	0.96	0.00	1.00
08/16/01	430	0	0	11		18.72	0.00	0.96	0.00	1.00
08/17/01	451	0	0	7		17.47	0.00	0.96	0.00	1.00
08/18/01	456	1	0	6		17.94	0.13	0.97	0.00	1.00
08/19/01	449	1	0	2		17.47	0.13	0.97	0.00	1.00
08/20/01	458	1	0	5		17.30	0.13	0.98	0.00	1.00
08/21/01	440	1	0	4		17.47	0.14	0.98	0.00	1.00
08/22/01	184	0	0	1		18.09	0.00	0.98	0.00	1.00
08/23/01	451	1	0	1		18.01	0.13	0.99	0.00	1.00
08/24/01	467	1	0	4		17.77	0.13	0.99	0.00	1.00
08/25/01	435	0	0	3		17.30	0.00	0.99	0.00	1.00
08/26/01	447	1	0	2		18.17	0.13	1.00	0.00	1.00
Total	537 hrs	178	69	2,051						

Appendix A3.–Detection of size-selectivity in sampling and its effects on estimation of size composition.

Results of hypothesis tests (K-S and χ^2) on lengths of fish MARKED during the first event and RECAPTURED during the second event	Results of hypothesis tests (K-S) on lengths of fish MARKED during the first event and INSPECTED during the second event
Case I	
"Accept H_o"	"Accept H_o"
There is no size-selectivity during either event	
Case II	
"Accept H_o"	"Reject H_o"
There is no size-selectivity during the second sampling event but there is during the first	
Case III	
"Reject H_o"	"Accept H_o"
There is size-selectivity during both sampling events	
Case IV	
"Reject H_o"	"Reject H_o"
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown	

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

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

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

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

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

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Case III or IV: Size-selective sampling in both sampling events

n_i	Number of unique fish sampled during **SECOND** event **ONLY** within stratum *i*
n_{ij}	Number of unique fish of age *j* sampled during the **SECOND** event **ONLY** within stratum *i*
$\hat{p}_{ij} = \dfrac{n_{ij}}{n_i}$	Estimated fraction of fish of age *j* in stratum *i*. Note that $\sum_j \hat{p}_{ij} = 1$
$v(\hat{p}_{ij}) = \dfrac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_i - 1}$	An unbiased of variance [1]
$\hat{N}_i$	Estimated abundance in stratum *i* from the mark-recapture experiment
$\hat{N}_j = \sum_i (\hat{p}_{ij}\hat{N}_i)$	Estimated abundance of fish in age group *j* in the population
$v(\hat{N}_j) = \sum_i (v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)\hat{p}^2{}_{ij} - v(\hat{p}_{ij})v(\hat{N}_i))$	An unbiased estimate of variance [2]
$\hat{p}_j = \dfrac{\hat{N}_j}{\sum_i \hat{N}_i} = \dfrac{\hat{N}_j}{\hat{N}}$	Estimated fraction of fish in age group *j* in the population
$v(\hat{p}_j) = \dfrac{\sum_i (v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)(\hat{p}_{ij} - \hat{p}_j)^2)}{\hat{N}^2}$	An approximate estimate of variance [3]

[1] page 52 in Cochran, W.G. 1977. Sampling techniques, 3rd ed. John Wiley and Sons, Inc. New York.

[2] from methods in Goodman, L.G. 1960. On the exact variance of a product. Journal of the American Statistical Association.

[3] from the delta method, page 8 in Seber, G.A.F. 1982. The estimation of animal abundance and related parameters, 2nd ed. Charles Griffin and Company, Limited. London.

Appendix A4.–Estimated age and sex composition and mean length by age of chinook salmon passing by Kakwan Point , 2001.

		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n		4		2						6
	% age comp.		26.7		13.3						40.0
	SE of %		11.8		9.1						13.1
	Avg. length		604		645						569
	SE		11		10						20
Males	n	1	6		2						9
	% age comp.	6.7	40.0		13.3						60.0
	SE of %	6.7	13.1		9.1						13.1
	Avg. length.	410	587		595						569
	SE		7		10						20
Sexes combined	n	1	10		4						15
	% age comp.	6.7	66.7		26.7						100.0
	SE of %	6.7	12.6		11.8						0.0
	Avg. length.	410	594		620						588
	SE		6		16						14
Large chinook salmon											
Females	n				503		172	2	1		678
	% age comp.				47.5		16.2	0.20	0.1		64.0
	SE of %				1.5		1.1	0.10	0.1		1.5
	Avg. length				785		852	788	880		802
	SE				2		3	38			2
Males	n				282		99	1			382
	% age comp.				26.6		9.3	0.1			36.0
	SE of %				1.4		0.9	0.1			1.5
	Avg. length.				803		892	825			826
	SE				4		6				4
Sexes combined	n				785		271	3	1		1,060
	% age comp.				74.1		25.6	0.3	0.1		100.0
	SE of %				1.3		1.3	0.2	0.1		0.0
	Avg. length.				791		867	800	880		810
	SE				2		3	25			2
Small, medium, and large chinook salmon											
Females	n		4		505		172	2	1		684
	% age comp.		0.4		47.0		16.0	0.2	0.1		63.6
	SE of %		0.2		1.5		1.1	0.1	0.1		1.5
	Avg. length		604		784		852	788	880		800
	SE		11		2		3	38			2
Males	n	1	6		284		99	1			391
	% age comp.	0.1	0.6		26.4		9.2	0.1			36.4
	SE of %	0.1	0.2		1.3		0.9	0.1			1.5
	Avg. length.	410	587		801		892	825			820
	SE		7		4		6				4
Sexes combined	n	1	10		789		271	3	1		1,075
	% age comp.	0.1	0.9		73.4		25.2	0.30	0.1		100.0
	SE of %	0.1	0.3		1.3		1.3	0.2	0.1		0.0
	Avg. length.	410	594		790		867	800	880		807
	SE		6		2		3	25			2

Appendix A5.–Estimated age and sex composition and mean length by age of chinook salmon passing by Rock Island , 2001.

		Age class									
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n				3						3
	% age comp.				5.3						5.3
	SE of %				3.0						3.0
	Avg. length				575						575
	SE				48						48
Males	n	31	15	1	7						54
	% age comp.	54.4	26.3	1.8	12.3						94.7
	SE of %	6.7	5.9	1.8	4.4						3.0
	Avg. length.	373	514	395	588						441
	SE	6	22		25						14
Sexes combined	n	31	15	1	10						57
	% age comp.	54.7	26.3	1.8	17.5						100.0
	SE of %	6.7	5.9	1.7	4.9						0.0
	Avg. length.	373	514	395	584						448
	SE	6	22		21						14
Large chinook salmon											
Females	n				35		30	1			66
	% age comp.				26.7		22.9	0.8			50.4
	SE of %				3.9		3.6	0.8			4.4
	Avg. length				768		831	830			797
	SE				9		12				8
Males	n				49	1	15				65
	% age comp.				37.4	0.8	11.5				49.6
	SE of %				4.2	0.8	2.8				4.4
	Avg. length.				776	730	850				792
	SE				8		19				8
Sexes combined	n				84	1	45	1			131
	% age comp.				64.1	0.8	34.4	0.8			100.0
	SE of %				4.2	0.8	4.2	0.8			0.0
	Avg. length.				772	730	837	830			795
	SE				6		10				6
Small, medium, and large chinook salmon											
Females	n				38		30	1			69
	% age comp.				20.2		16.0	0.5			36.7
	SE of %				2.9		2.7	0.5			3.5
	Avg. length				752		831	830			788
	SE				12		12				10
Males	n	31	15	1	56	1	15				119
	% age comp.	16.5	8.0	0.5	29.8	0.5	8.0				63.3
	SE of %	2.7	2.0	0.5	3.3	0.5	2.0				3.5
	Avg. length.	373	514	395	752	730	850				633
	SE	6	22		11		19				18
Sexes combined	n	31	15	1	94	1	45	1			188
	% age comp.	16.5	8.0	0.5	50.0	0.5	23.9	0.5			100.0
	SE of %	2.7	2.0	0.5	3.7	0.5	3.1	0.5			0.0
	Avg. length.	373	514	395	752	730	837	830			690
	SE	6	22		8		10				13

Appendix A6.–Estimated age and sex composition and mean length by age of chinook salmon harvested in the Canadian commercial and test gillnet fisheries on the Lower Stikine River, 2001.

		Age class									
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n		4		1						5
	% age comp.		9.3		2.3						11.6
	SE of %		4.5		2.3						4.9
	Avg. length		548		630						564
	SE		37								33
Males	n	16	13		9						38
	% age comp.	37.2	30.2		20.9						88.4
	SE of %	7.5	7.1		6.3						4.9
	Avg. length.	395	528		601						490
	SE	13	19		20						17
Sexes combined	n	16	17		10						43
	% age comp.	37.2	39.5		23.3						100.0
	SE of %	7.5	7.5		6.5						0.0
	Avg. length.	395	533		604						498
	SE	13	17		18						16
Large chinook salmon											
Females	n		1		160		44				205
	% age comp.		0.2		34.3		9.4				44.0
	SE of %		0.2		2.2		1.4				2.3
	Avg. length		670		796		861				809
	SE				5		11				5
Males	n		2		176		82		1		261
	% age comp.		0.4		37.8		17.6		0.2		56.0
	SE of %		0.3		2.2		1.8		0.2		2.3
	Avg. length.		674		807		889		960		833
	SE		6		6		9				5
Sexes combined	n		3		336		126		1		466
	% age comp.		0.6		72.1		27.0		0.2		100.0
	SE of %		0.4		2.1		2.1		0.2		0.0
	Avg. length.		673		802		880		960		822
	SE		4		4		7				4
Small, medium, and large chinook salmon											
Females	n		5		161		44				210
	% age comp.		1.0		31.6		8.6				41.3
	SE of %		0.4		2.1		1.2				2.2
	Avg. length		572		795		861				803
	SE		38		5		11				5
Males	n	16	15		185		82		1		299
	% age comp.	3.1	2.9		36.3		16.1		0.2		58.7
	SE of %	0.8	0.8		2.1		1.6		0.2		2.2
	Avg. length.	395	548		797		889		960		789
	SE	13	21		6		9				8
Sexes combined	n	16	20		346		126		1		509
	% age comp.	3.1	3.9		68.0		24.8		0.2		100.0
	SE of %	0.8	0.9		2.1		1.9		0.2		0.0
	Avg. length.	395	554		796		879		960		795
	SE	13	18		4		7				5

Appendix A7.–Estimated age and sex composition and mean length by age of chinook salmon at Little Tahltan River live weir, 2001.

		Age class									
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n				2						2
	% age comp.				8.0						8.0
	SE of %				5.5						5.5
	Avg. length				634						634
	SE				18						18
Males	n	2	6		14		1				23
	% age comp.	8.0	24.0		56.0		4.0				92.0
	SE of %	5.5	8.7		10.1		4.0				5.5
	Avg. length.	406	556		613		610				580
	SE	4	27		11						16
Sexes combined	n	2	6		16		1				25
	% age comp.	8.0	24.0		64.0		4.0				100.0
	SE of %	5.5	8.7		9.8		4.0				0.0
	Avg. length.	406	556		615		610				584
	SE	4	27		10						15
Large chinook salmon											
Females	n				319		112	4	1		436
	% age comp.				37.6		13.2	0.5	0.1		51.4
	SE of %				1.7		1.2	0.2	0.1		1.7
	Avg. length				781		834	804	857		795
	SE				2		3	6			2
Males	n		3		338		68	1	2		412
	% age comp.		0.4		39.9		8.0	0.10	0.2		48.6
	SE of %		0.2		1.7		0.9	0.10	0.2		1.7
	Avg. length.		752		781		870	839	879		796
	SE		26		3		6		47		3
Sexes combined	n		3		657		180	5	3		848
	% age comp.		0.4		77.5		21.2	0.6	0.4		100.0
	SE of %		0.2		1.4		1.4	0.3	0.2		0.0
	Avg. length.		752		781		847	811	871		795
	SE		16		2		3	8	28		2
Small, medium, and large chinook salmon											
Females	n				321		112	4	1		438
	% age comp.				36.8		12.8	0.5	0.1		50.2
	SE of %				1.6		1.1	0.2	0.1		1.7
	Avg. length				780		834	804	857		794
	SE				2		3	6			2
Males	n	2	9		352		69	1	2		435
	% age comp.	0.2	1.0		40.3		7.9	0.1	0.2		49.8
	SE of %	0.2	0.3		1.7		0.9	0.1	0.2		1.7
	Avg. length.	406	621		774		866	839	879		784
	SE	4	38		3		7		47		4
Sexes combined	n	2	9		673		181	5	3		873
	% age comp.	0.2	1.0		77.1		20.7	0.6	0.3		100.0
	SE of %	0.2	0.3		1.4		1.4	0.3	0.2		0.0
	Avg. length.	406	621		777		846	811	871		789
	SE	4	38		2		4	8	28		2

Appendix A8.–Estimated age and sex composition and mean length by age of dead chinook salmon (carcasses) above the weir on the Little Tahltan River, 2001.

		Age class									
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n		1		2						3
	% age comp.		0.8		1.5						2.3
	SE of %		0.8		1.1						1.3
	Avg. length		555		630						605
	SE				5						25
Males	n	96	20		10		1	1			128
	% age comp.	73.3	15.3		7.6		0.8	0.8			97.7
	SE of %	3.9	3.2		2.3		0.8	0.8			1.3
	Avg. length.	349	492		592		350	579			392
	SE	3	14		20						8
Sexes combined	n	96	21		12		1	1			131
	% age comp.	73.3	16.0		9.2		0.8	0.8			100.0
	SE of %	3.9	3.2		2.5		0.8	0.8			0.0
	Avg. length.	349	495		598		350	579			397
	SE	3	14		17						8
Large chinook salmon											
Females	n		1		92		48		2		143
	% age comp.		0.3		28.2		14.7		0.6		43.9
	SE of %		0.3		2.5		2.0		0.4		2.8
	Avg. length		673		776		848		830		800
	SE				4		5		65		4
Males	n		2		157		23	1			183
	% age comp.		0.6		48.2		7.1	0.3			56.1
	SE of %		0.4		2.8		1.4	0.3			2.8
	Avg. length.		851		821		870	770			827
	SE		44		35		13				30
Sexes combined	n		3		249		71	1	2		326
	% age comp.		0.9		76.4		21.8	0.3	0.6		100.0
	SE of %		0.5		2.4		2.3	0.3	0.4		0.0
	Avg. length.		791		804		855	770	830		815
	SE		64		22		5		65		17
Small, medium, and large chinook salmon											
Females	n		2		94		48		2		146
	% age comp.		0.4		20.6		10.5		0.4		31.9
	SE of %		0.3		1.9		1.4		0.3		2.2
	Avg. length		614		773		848		830		796
	SE		59		5		5		65		5
Males	n	96	22		167		24	2			311
	% age comp.	21.0	4.8		36.5		5.3	0.4			68.1
	SE of %	1.9	1.0		2.3		1.0	0.3			2.2
	Avg. length.	349	524		807		849	675			648
	SE	3	26		34		25	96			22
Sexes combined	n	96	24		261		72	2	2		457
	% age comp.	21.0	5.3		57.1		15.8	0.4	0.4		100.0
	SE of %	1.9	1.0		2.3		1.7	0.3	0.3		0.0
	Avg. length.	349	532		795		848	675	830		695
	SE	3	25		22		9	96	65		15

Appendix A9.–Estimated age and sex composition and mean length by age of moribund and recently expired chinook salmon in Verrett River, 2001.

		Small and medium chinook salmon									
		Age class									
		1.1	**1.2**	**2.1**	**1.3**	**2.2**	**1.4**	**2.3**	**1.5**	**2.4**	**Total**
Females	n		1		1						2
	% age comp.		10.0		10.0						20.0
	SE of %		10.0		10.0						13.3
	Avg. length		580		645						613
	SE										33
Males	n	3	2		3						8
	% age comp.	30.0	20.0		30.0						80.0
	SE of %	15.3	13.3		15.3						13.3
	Avg. length.	350	538		633						503
	SE	29	53		12						49
Sexes	n	3	3		4						10
combined	% age comp.	30.0	30.0		40.0						100.0
	SE of %	15.3	15.3		16.3						0.0
	Avg. length.	350	552		636						525
	SE	29	33		9						42
		Large chinook salmon									
Females	n				171		80				251
	% age comp.				36.5		17.1				53.6
	SE of %				2.2		1.7				2.3
	Avg. length				766		833				788
	SE				3		5				3
Males	n		2[a]		173		42				217
	% age comp.		0.4		37.0		9.0				46.4
	SE of %		0.3		2.2		1.3				2.3
	Avg. length.		725		788		858				801
	SE		65		4		9				4
Sexes	n		2		344		122				468
combined	% age comp.		0.4		73.5		26.1				100.0
	SE of %		0.3		2.0		2.0				0.0
	Avg. length.		725		777		842				794
	SE		65		2		5				3
		Small, medium, and large chinook salmon									
Females	n		1		172		80				253
	% age comp.		0.2		36.0		16.7				52.9
	SE of %		0.2		2.2		1.7				2.3
	Avg. length		580		766		833				786
	SE				3		5				3
Males	n	3	4[a]		176		42				225
	% age comp.	0.6	0.8		36.8		8.8				47.1
	SE of %	0.4	0.4		2.2		1.3				2.3
	Avg. length.	350	631		785		858				790
	SE	29	64		4		9				6
Sexes	n	3	5		348		122				478
combined	% age comp.	0.6	1.0		72.8		25.5				100.0
	SE of %	0.4	0.5		2.0		2.0				0.0
	Avg. length.	350	621		776		842				788
	SE	29	51		3		5				3

[a] One (1) age-0.3 male included in age-1.2 age class.

Appendix A10.–Estimated age and sex composition and mean length by age of chinook salmon in Andrew Creek, 2001.

		1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	Total
Small and medium chinook salmon											
Females	n										
	% age comp.										
	SE of %										
	Avg. length										
	SE										
Males	n		3		5						8
	% age comp.		37.5		62.5						100.0
	SE of %		18.3		18.3						0.0
	Avg. length.		538		615						586
	SE		49		17						24
Sexes combined	n		3		5						8
	% age comp.		37.5		62.5						100.0
	SE of %		18.3		18.3						0.0
	Avg. length.		538		615						586
	SE		49		17						24
Large chinook salmon											
Females	n				35		61		1		97
	% age comp.				19.9		34.7		0.6		55.1
	SE of %				3.0		3.6		0.6		3.8
	Avg. length				803		854		850		835
	SE				7		6				5
Males	n		1		37		41				79
	% age comp.		0.6		21.0		23.3				44.9
	SE of %		0.6		3.1		3.2				3.8
	Avg. length.		715		779		888				835
	SE				11		8				9
Sexes combined	n		1		72		102		1		176
	% age comp.		0.6		40.9		58.0		0.6		100.0
	SE of %		0.6		3.7		3.7		0.6		0.0
	Avg. length.		715		790		868		850		835
	SE				7		5				5
Small, medium, and large chinook salmon											
Females	n				35		61		1		97
	% age comp.				19.0		33.2		0.5		52.7
	SE of %				2.9		3.5		0.5		3.7
	Avg. length				803		854		850		835
	SE				7		6				5
Males	n		4		42		41				87
	% age comp.		2.2		22.8		22.3				47.3
	SE of %		1.1		3.1		3.1				3.7
	Avg. length.		583		759		888				812
	SE		56		13		8				12
Sexes combined	n		4		77		102		1		184
	% age comp.		2.2		41.8		55.4		0.5		100.0
	SE of %		1.1		3.6		3.7		0.5		0.0
	Avg. length.		583		779		868		850		824
	SE		56		8		5				6

Appendix A11.–Origin of coded-wire tags recovered from chinook salmon collected in the Stikine River, 2001.

Year	Head	Tag code	Brood year	Agency	Rearing	Recovery site	Location	Date released	Release site	Tag ratio
2001	230634	32128	1996	NMFS	H	Rock Island	Little Port Walter	5/15/98	Little Port Walter	1.086
2001	230635	44634	1995	ADFG	W	Inriver fisheries	Taku River	6/3/97	Taku River	1.002
2001	65928	44709	1996	ADFG	H	Craig River	Crystal Lake	5/24/98	Earl West Cove	12.61

Appendix A12.–Computer files used to estimate the spawning abundance of chinook salmon in the Stikine River in 2001.

File name	Description
CAPTPROB01.xls	EXCEL spreadsheet with chi-square capture probability tests.
INSEASON01.xls	EXCEL spreadsheet with 2001 CPUE and brood-year strength models.
LGSTIK01.BAS	QBASIC bootstrap program for estimating the abundance of large chinook salmon, variance, bias, and confidence intervals
LGSTIK01.DAT	Input file for LGSTIK01.BAS
LGSTIK01.OUT	Output file from LGSTIK01.BAS
POSTSEASON01.xls	EXCEL spreadsheet with 2001 post-season abundance estimates including bootstrap output for variance and bias estimation
PROPSTIK.BAS	QBASIC bootstrap program for estimating the proportion of large chinook salmon in the spawning population
PROPSTIK.DAT	Input file for PROPSTIK.BAS
PROPSTIK.OUT	Output file from PROPSTIK.BAS
STIKMR-CPUE01.xls	EXCEL spreadsheet with Kakwan Point and Rock Island catch-effort, hydrology, and temperature data including charts.
SIZESELPOST01.xls	EXCEL spreadsheet with Kolmogorov-Smirnov size-selectivity tests including charts.
STIKMR-TAG&ASL01.xls	EXCEL spreadsheet with Kakwan Point, Rock Island, and spawning ground tag, recovery, and age-sex-size data.