Fishery Data Series No. 01-30

Abundance of the Chinook Salmon Escapement on the Alsek River, 2000

by

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and

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December 2001

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

FISHERY DATA SERIES NO. 01-30

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ABSTRACT

Abundance of chinook salmon *Oncorhynchus tshawytscha* returning to spawn in the Alsek River in 2000 was estimated with a mark-recapture experiment conducted by the Alaska Department of Fish and Game, the Canadian Department of Fisheries and Oceans, and the Champaign/Aishihik First Nation. Age, sex, and length compositions for the immigration were also estimated. Set gillnets fished near the mouth of the Alsek River during May, June, and July, 2000 were used to capture 509 large (≥660 mm MEF) immigrant chinook salmon, of which, 479 were marked with individually numbered spaghetti tags, a hole punched in their left opercle, and removal of an axillary appendage. In addition, 44 medium (440-659 mm) fish were marked. During July and August, chinook salmon were captured at spawning sites and inspected for marks. We used a modified Petersen model to estimate that 8,432 (SE = 1,597) large chinook salmon immigrated into the Alsek River above Dry Bay. Canadian fisheries on the Tatshenshini River harvested an estimated 137 large chinook salmon, leaving an escapement of 8,295 large fish. We used a second Petersen model to estimate that a total of 9,202 (SE =1,625) chinook salmon ≥440 mm MEF immigrated into the Alsek River above Dry Bay. A total of 1,365 chinook salmon were counted at the Klukshu River weir, about 15% of the total estimated spawning escapement in the Alsek River.

An estimated 8% of the Alsek River escapement were age -1.2, 73% age -1.3, and 18% age -1.4, with 347 males and 418 females sampled.

Key words: chinook salmon, *Oncorhynchus tshawytscha*, Alsek River, Klukshu River, Tatshenshini River, mark-recapture, escapement, abundance

INTRODUCTION

The Alsek River originates in the Yukon Territory, Canada, and flows in a southerly direction into the Gulf of Alaska, southeast of Yakutat, Alaska (Figure 1). Chinook salmon *Oncorhynchus tshawytscha* returning to this river are caught primarily in commercial and subsistence set gillnet fisheries in the lower Alsek River and in recreational and aboriginal fisheries on the upper Tatshenshini River in Canada (Tables 1,2). Small harvests of this stock are also probably taken in marine recreational and commercial set gillnet and troll fisheries near Yakutat. Exploitation of this population is managed jointly by the U.S. and Canada through a subcommittee of the Pacific Salmon Commission (PSC) as part of the U.S./Canada Pacific Salmon Treaty (PST) adopted in 1985 (TTC 1999).

Counts of chinook salmon spawning in tributaries of the Alsek River have been collected since 1962 (Table 3). Since 1976, the Canadian Department of Fisheries and Oceans (DFO) has operated a weir at the mouth of the Klukshu River to count chinook, sockeye *O. nerka*, and coho salmon O. *kisutch*. The weir count is used as the index for the Alsek River. Prior to 1997, the proportion of the total chinook salmon escapement to the Alsek River drainage counted at the Klukshu River weir was unknown. The U.S. used a weir expansion of 1.56 (64%) to estimate total Alsek River chinook escapement, while Canada used an expansion of 2.5 (40%) (Pahlke 1997). A recent analysis of the biological escapement goal for Klukshu River chinook salmon used a range of 30% to 100%. A biological escapement goal (BEG) range of 1,100 to 2,300 chinook salmon spawners in the Klukshu River was recommended (McPherson et al. 1998). In 1991, the Transboundary River Technical Committee of the PSC recommended that an expansion factor not be adopted due to the lack of applicable studies (TTC 1991). Mark-recapture studies in 1997-1999 indicate that Klukshu River chinook salmon account for approximately 25% of the total run (Pahlke 2000; Pahlke and Etherton 2000). Annual spawning escapements of chinook salmon in the Klukshu River system have been estimated annually by subtracting from the weir count: (1) harvests taken upstream of the weir site in an aboriginal fishery and; (2) in a sport fishery (1976–1978 only); and (3) brood stock removed at the weir site.

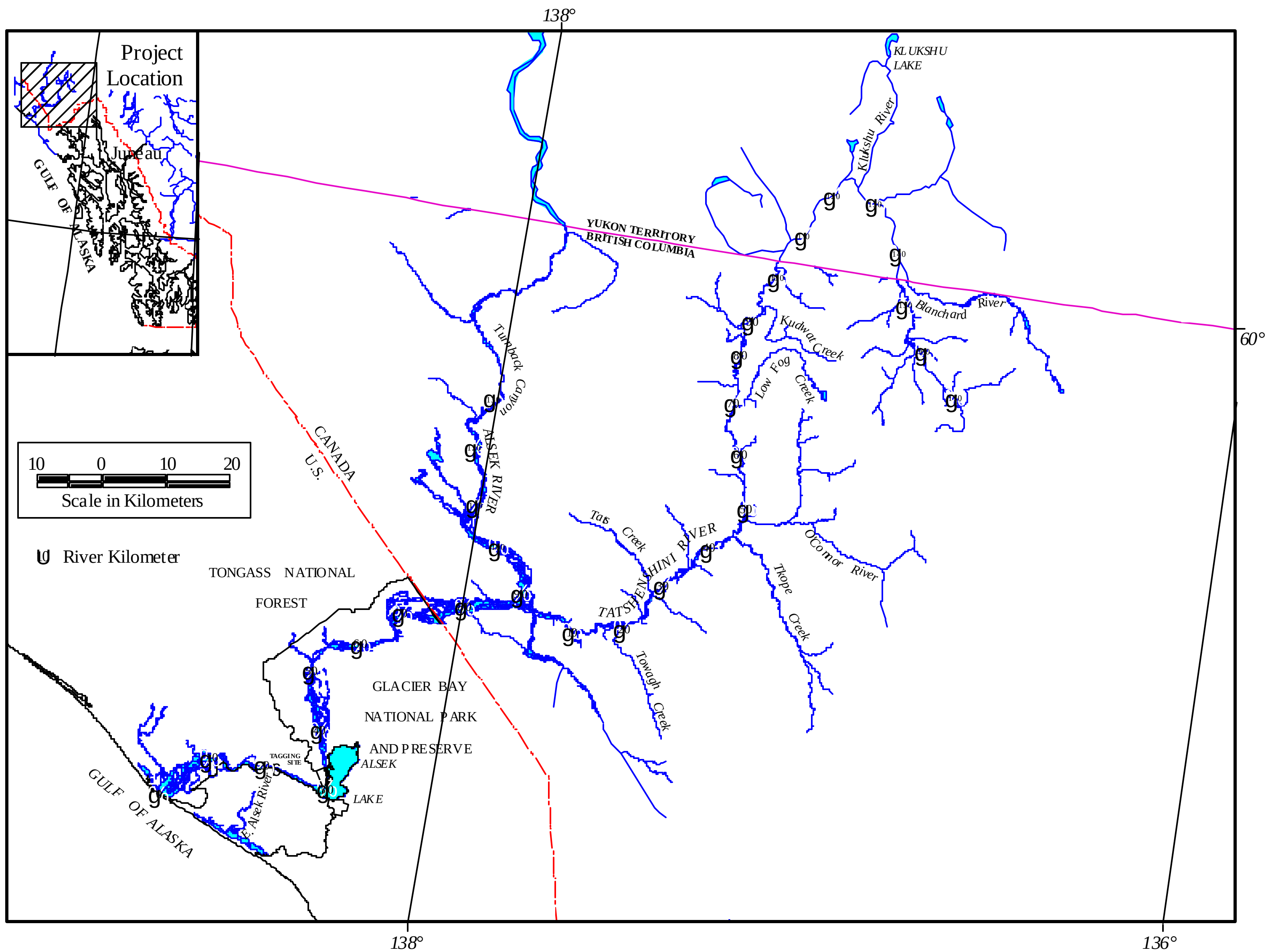

Figure 1.–Alsek River drainage, showing principal tributaries and river kilometers.

Table 1.–Estimated harvests of chinook salmon in the Canadian Alsek River aboriginal and sport fisheries, 1976–2000.

	Klukshu River aboriginal fishery			Canadian sport fishery			
Year	Below weir	Above weir	Total	Dalton Post	Blanchard River	Takhanne River	Total
1976	0	150	150	130	45	25	200
1977	0	350	350	195	67	38	300
1978	0	350	350	195	67	38	300
1979	0	1,300	1,300	422	146	82	650
1980	0	150	150	130	45	25	200
1981	0	150	150	150	200	50	400
1982	0	400	400	183	110	40	333
1983	0	300	300	202	60	50	312
1984	0	100	100	275	125	50	450
1985	0	175	175	170	20	20	210
1986	0	102	102	125	20	20	165
1987	0	125	125	326	113	63	502
1988	0	43	43	249	87	48	384
1989	0	234	234	215	75	41	331
1990	0	202	202	468	162	91	721
1991	268	241	509	384	29	17	430
1992	60	88	148	79	6	18	103
1993	88	64	152	170	25	42	237
1994	190	99	289	197	69	38	304
1995	320	260	580	601	330	113	1,044
1996	233	215	448	423	78	149	650
1997	72	160	232	195	69	34	298
1998	154	17	171	112	43	20	175
1999	211[a]	27	238	122	38	14	174
2000	21[b]	44	65	24	46	2	72

[a] Includes 8 fish harvested from Village Creek.

[b] Includes 4 fish harvested from Village Creek and 3 from Blanchard River.

Aerial surveys to count spawning chinook salmon have been conducted by the Alaska Department of Fish and Game (ADF&G) with a helicopter since 1981. Prior to 1981, surveys were made from fixed-wing aircraft. The escapement to the Klukshu River is difficult to count by aerial, boat or foot surveys because of deep pools and overhanging vegetation. However, surveys of the Klukshu River are conducted annually to provide some continuity in the database in the event that funding for the weir is discontinued. The Blanchard and Takhanne rivers and Goat Creek, three smaller tributaries of the Tatshenshini River, are also surveyed annually, but counts from these surveys are not used to index escapements.

Only large (typically age-.3, -.4, and -.5) chinook salmon ≥660 mm mideye-to-fork length (MEF) are counted during aerial or foot surveys. No attempt is made to accurately count small (typically age-.1 ≤439 mm MEF) or medium (440–659 mm and age-.2) chinook salmon. These chinook salmon, also called jacks, are primarily males that are considered to be surplus to spawning escapement needs (Mecum 1990). They are easy to separate visually from their older counterparts under most conditions, because of their shorter, compact bodies and lighter color. They are, however, difficult to distinguish from other smaller species such as sockeye salmon.

In 1997, ADF&G, in cooperation with DFO, instituted a project to determine the feasibility of a mark-recapture experiment to estimate abundance of chinook salmon spawning in the Alsek River drainage. The results of the feasibility project were encouraging, and in 1998 a revised, expanded mark-recapture study was conducted along with a radio tracking study to estimate spawning distribution (Pahlke et al. 1998).

Table 2.–Annual harvests of chinook salmon in the U.S. Alsek River commercial and subsistence/personal use gillnet fisheries, 1941–2000.

Year(s)	Commercial harvest	Year(s)	Commercial harvest	Subsistence/ personal use
1941	3,943	1971	1,222	
1942	0	1972	1,827	
1943	0	1973	1,757	
1944	2,173	1974	1,162	
1945	6,226	1975	1,379	
1941–1945 Average	2,468	1971–1975 Average	1,469	
1946	1,161	1976	512	
1947	266	1977	1,402	
1948	853	1978	2,441	
1949	72	1979	2,525	
1950	unknown	1980	1,382	
1946–1949 Average	588	1976–1980 Average	1,652	
1951	151	1981	779	
1952	2,020	1982	532	
1953	1,383	1983	93	
1954	1,833	1984	46	
1955	2,883	1985	213	
1951–1955 Average	1,654	1981–1985 Average	333	
1956	3,253	1986	481	22
1957	1,800	1987	347	27
1958	888	1988	223	13
1959	969	1989	228	20
1960	525	1990	78	85
1956–1960 Average	1,487	1986–1990 Average	271	38
1961	2,120	1991	103	38
1962	2,278	1992	301	15
1963	131	1993	300	38
1964	591	1994	805	60
1965	719	1995	670	51
1961–1965 Average	1,168	1991–1995 Average	436	34
1966	934	1996	771	60
1967	225	1997	568	38
1968	215	1998	550	63
1969	685	1999	482	44
1970	1,128	2000	677	45
1966–1970 Average	637	1996–2000 Average	609	50

The project was continued in 1999 and 2000 without the radiotelemetry study. The 2000 study had two objectives: (1) to estimate the abundance of large (≥660 mm MEF) spawning chinook in the Alsek River; and (2) to estimate the age, sex, and length compositions of chinook salmon spawning in the Alsek River. Results from the study provide a survey expansion factor; i.e., an estimate of the fraction of escapement to the Alsek River counted at the Klukshu River weir. Results also provide information on the run timing through the lower Alsek River of chinook salmon bound for the various spawning areas.

Table 3.–Escapement of chinook salmon to the Klukshu River and counts of spawning adults in other tributaries of the Alsek River, 1962–2000.

Year[a]	Klukshu River: Aerial count		Klukshu River: Weir count	Above-weir harvest: AF	Above-weir harvest: Sport	Above-weir harvest: Brood	Escape-ment[b]	Blanchard River		Takhanne River		Goat Creek	
1962	86	(A)	–	–	–		86	–		–		–	
1963	–		–	–	–		–	–		–		–	
1964	20	(A)	–	–	–		20	–		–		–	
1965	100		–	–	–		100	100		250		–	
1966	1,000		–	–	–		1,000	100		200		–	
1967	1,500		–	–	–		1,500	200		275		–	
1968	1,700		–	–	–		1,700	425		225		–	
1969	700		–	–	–		700	250		250		–	
1970	500		–	–	–		500	100	(F)	100		–	
1971	300	(A)	–	–	–		300	–		205	(F)	–	
1972	1,100		–	–	–		1,100	12	(A)	250		38	(F)
1973	–		–	–	–		–	–		49	(A)	–	
1974	62		–	–	–		62	52	(A)	132	(F)	–	
1975	58		–	–	–		58	81	(A)	177	(A)	–	
1976	–		1,278	150	64		1,064	–		38	(F)	16	(F)
1977	–		3,144	350	96		2,698	–		38	(F)	–	
1978	–		2,976	350	96		2,530	–		50	(F)	–	
1979	–		4,404	1,300	0		3,104	–		–		–	
1980	–		2,673	150	0		2,487	–		–		–	
1981	–		2,113	150	0		1,963	35	(H)	11	(H)	–	
1982	633	N(H)	2,369	400	0		1,969	59	(H)	241	(H)	13	(H)
1983	917	N(H)	2,537	300	0		2,237	108	(H)	185	(H)	–	
1984	–		1,672	100	0		1,572	304	(H)	158	(H)	28	(H)
1985	–		1,458	175	0		1,283	232	(H)	184	(H)	–	
1986	738	P(H)	2,709	102	0		2,607	556	(H)	358	(H)	142	(H)
1987	933	E(H)	2,616	125	0		2,491	624	(H)	395	(H)	85	(H)
1988	–		2,037	43	0		1,994	437	E(H)	169	E(H)	54	E(H)
1989	893	E(H)	2,456	234	0	20	2,202	–		158	E(H)	34	E(H)
1990	1,381	E(H)	1,915	202	0	15	1,698	–		325	E(H)	32	E(H)
1991	–		2,489	241	0	25	2,223	121	N(H)	86	E(H)	63	E(H)
1992	261	P(H)	1,367	88	0	36	1,243	86	P(H)	77	N(H)	16	N(H)
1993	1,058	N(H)	3,303	64	0	18	3,221	326	N(H)	351	E(H)	50	N(H)
1994	1,558	N(H)	3,727	99	0	8	3,620	349	N(H)	342	E(H)	67	N(H)
1995	1,053	E(H)	5,678	260	0	21	5,397	338	P(H)	260	P(H)	–	
1996	788	N(H)	3,599	215	0	2	3,382	132	N(H)	230	N(H)	12	N(H
1997	718	P(H)	2,989	160	0	0	2,829	109	P(H)	190	P(H)	–	
1998	–		1,364	17	0	0	1,347	71	P(H)	136	N(H)	39	N(H)
1999	500	P(H)	2,193	27	0	0	2,166	371	E(H)	194	N(H)	51	N(H)
1990–1999 average	915		2,862	137	0	13	2,713	211		219		41	
2000	–		1,365	44	0	0	1,321	168	N(H)	152	N(H)	33	N(H)

— = no survey; (A) = aerial survey from fixed wing aircraft; (H) = helicopter survey; E = excellent survey conditions; N = normal conditions; P = poor conditions.

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

[b] Klukshu River escapement = weir count minus above weir aboriginal and sport fishery, and broodstock.

STUDY AREA

The Alsek River drainage covers about 28,000 km^2 (Bigelow et al. 1995). The drainage supports spawning populations of anadromous Pacific salmon, including chinook salmon; however, most anadromous production in the Alsek drainage is limited to the Tatshenshini River because of a velocity barrier on the lower Alsek near Lowell Glacier (Turnback Canyon, rkm 130)(Figure 1). Significant numbers of chinook salmon have been observed spawning in various tributary streams of the Tatshenshini River, including the Klukshu River, the Blanchard River, the Takhanne River, and Goat Creek (Figure 2). Other significant spawning areas probably exist downstream of the confluence of the Klukshu and Tatshenshini rivers such as in mainstream areas of the Tatshenshini and Alsek rivers. Small numbers of chinook have been documented spawning in Village, Kane, Silver, Bridge, Detour, O'Connor, Low Fog and Stanley creeks, and the Bridge River. The Klukshu and upper Tatshenshini rivers are accessible by road from the Haines Highway.

METHODS

The number of large chinook salmon in the Alsek River escapement was estimated from a two-event mark-recapture experiment for a closed population (Seber 1982:59–61). Fish captured by set gillnets in the lower river near Dry Bay and marked were included in event 1. Chinook salmon captured upstream on or near their spawning grounds constituted event 2 in the mark-recapture experiment.

DRY BAY TAGGING

Set gillnets 120 feet (36.5 m) long, 18 feet (5.5 m) deep, and made of 7.25-inch (18.5-cm) stretch mesh, were fished on the lower Alsek River, between May 15 and June 11. From June 12 through June 30, sockeye gear ($5^{3/8}$-inch, 13.5cm), was alternated with the larger mesh gear for several hours per day. From July 1 on only sockeye gear was fished. One net was fished daily, unless high water prevented fishing. The primary fishing site was at approximately river kilometer (rkm) 19, just above the Dry Bay commercial fishery boundary. The tagging site is below all known spawning areas, and is upstream of any tidal influence. Other nearby sites were fished when water levels were too high to safely fish the primary site. Nets were watched continuously, and a captured fish was removed from the net as soon as it was observed. Sampling effort was held reasonably constant across the temporal span of the migration. If fishing time was lost due to 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 9 hours per day.

Captured chinook salmon were placed in a plastic fish tote filled with water, quickly untangled or cut from the net, tagged, scale sampled, and their length and sex recorded during a visual examination (as per Johnson et al. 1993). Fish were classified as "large" if their mideye to fork length (MEF) was $\geq$660 mm, "medium" if between 440 and 659 mm or "small" if <440 mm (Pahlke and Bernard 1996). General health and appearance of the fish were noted, including injuries due to handling or predators. Each uninjured fish was marked with a uniquely numbered, blue spaghetti tag, consisting of a 2" (~5-cm) section of Floy tubing shrunk onto a 15" (~38-cm) piece of 80-lb (~36.3-kg) monofilament fishing line. The monofilament was sewn through the musculature of the fish approximately 20 mm posterior and ventral to the dorsal fin and secured by crimping both ends in a line crimp. Each fish was also marked with a ¼-inch-diameter (6-mm) hole in the upper (dorsal) portion of the left operculum applied with a paper punch, and by amputation of the left axillary appendage (as per McPherson et al. 1996). Fish that were seriously injured were sampled for length, scales and sex but not tagged.

SPAWNING GROUND SAMPLING

During event 2, pre- and post spawning fish were sampled at the Klukshu River weir. As fish entered a trap in the weir, a portion were captured, sampled for length, sex, scales, inspected for marks, given a hole punch in the left operculum to prevent resampling, and released. Fish were sampled in proportion to the historical run timing at the weir, with a sample goal of 800 fish. The remaining fish were passed through the weir

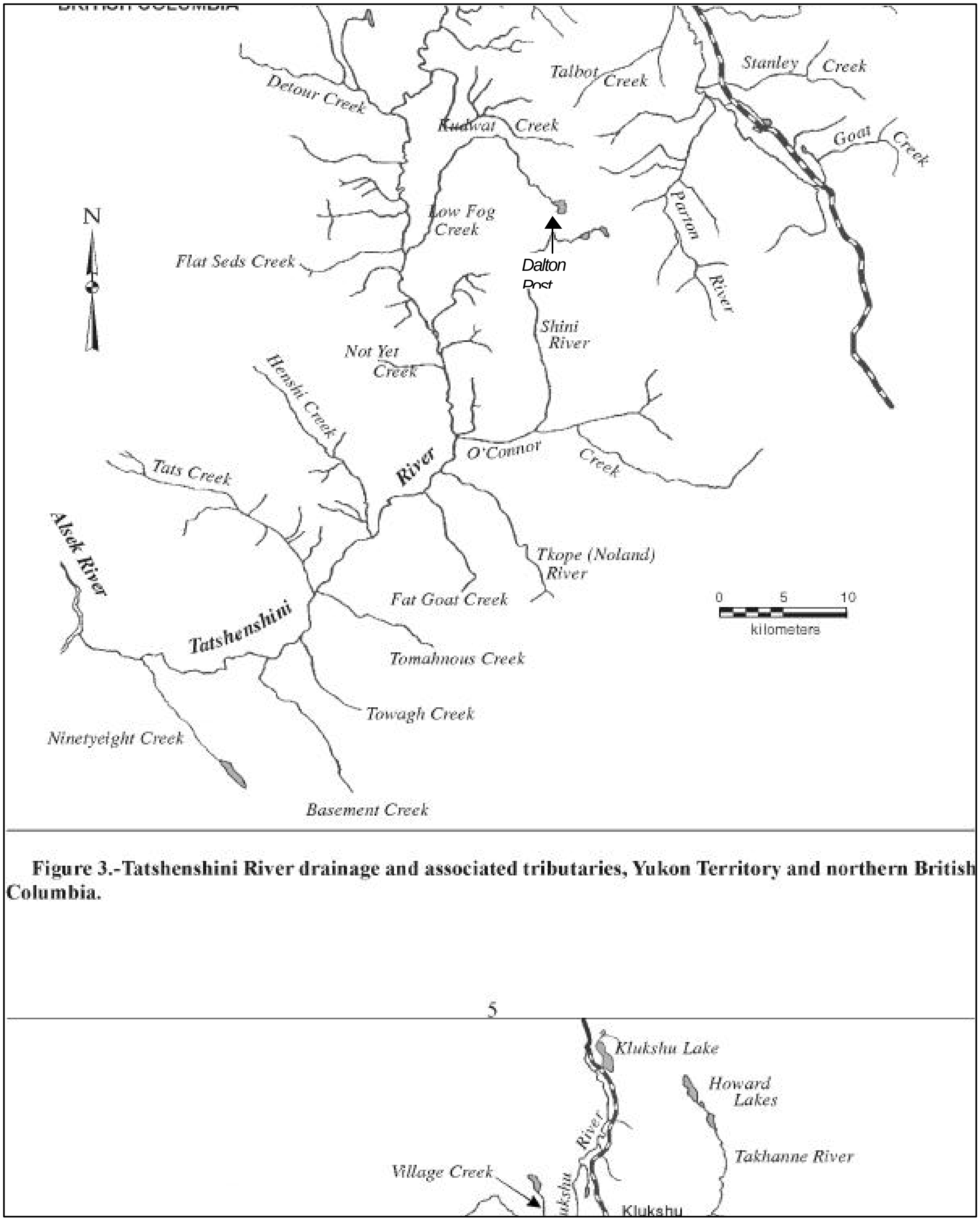

Figure 2.–Tatshenshini River drainage and associated tributaries, Yukon Territory and northern British Columbia.

without being individually handled, while an observer counted them and recorded the presence of spaghetti tags. In addition, some post-spawning fish and carcasses were sampled upstream of the weir. Foot surveys of the spawning areas on the Blanchard and Takhanne rivers and Goat and Low Fog creeks, were conducted August 1–12, 2000. Carcasses and moribund chinook salmon were sampled for length, sex, scales and marks.

FISHERY SAMPLING

Catches in Canadian fisheries in the upper Tatshenshini River and the U.S. gillnet fisheries below the tagging site, were sampled for data on age, sex, and length and were inspected for tags.

ABUNDANCE

The number of marked fish on the spawning grounds was estimated by subtracting the estimated number of marked fish removed by fishing in U.S. fisheries (censored from the experiment) from the number of fish tagged in event 1 (Table 4). Handling and tagging has caused a downstream movement and/or a delay in continuing upstream migration of marked chinook salmon in other studies (Pahlke and Etherton 1999, Bernard et al. 1999, Bendock and Alexandersdottir 1992, Johnson et al. 1992, Milligan et al. 1984). This behavior puts fish marked in June and July at risk of capture in the downstream commercial fishery in U.S. waters that begins in mid-June; fish marked earlier would have no such risk. Censoring marked chinook salmon killed in this fishery avoided bias in estimates of abundance from this phenomenon. The tagging program was well publicized with a reward for each tag recovered, and almost the entire catch goes through one processor where a high proportion of the U. S. catch was inspected for tags. This censoring makes estimates germane to the number of spawning fish, not to the number passing by Dry Bay.

Because of a reward (Can$2 for spaghetti tag) for each tag returned from the inriver Canadian recreational and aboriginal fisheries, tags from all marked fish caught in these fisheries were considered recovered.

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; (b) *both* recruitment and "death" (emigration) do not occur between sampling events; (c) marking does not affect catchability (or mortality) of the fish; (d) fish do not lose their marks between sample events; (e) all recovered marks are reported; and (f) double sampling does not occur (Seber 1982). Assumption (a) implies that tagging must occur 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. We attempted to meet assumption (a) by fishing the same gear in a standardized method throughout the chinook salmon migration. Assumption (a) also implies that sampling is not size or sex-selective. If capture on the spawning grounds was not size-selective, fish of different sizes would be captured with equal probability. The same is true for sex-selective sampling on the spawning grounds. If assumption (a) was met, fish sampled in upper Tatshenshini (Blanchard and Goat creeks) and Klukshu River spawning sites and the recreational fishery would be marked at similar rates. Contingency table analysis was used to test the assumption of proportional tagging. The hypothesis that fish of different sizes were captured with equal probability was also tested using two Kolmogorov-Smirnov (K-S) 2-sample tests (α = 0.05). Assumption (b) was met because the life history of chinook salmon isolates those fish returning to the Alsek River as a "closed" population. We assumed tagged and untagged fish experience the same mortality (assumption c) due to natural causes, and censoring was used to adjust the potentially higher harvest rate of marked fish in the U.S. commercial fishery.

To minimize effects of tag loss, all marked fish received secondary (a dorsal left opercle punch), and tertiary marks (the left axillary appendage was clipped). Similarly, we inspected all fish captured on the spawning grounds for marks

Table 4.–Numbers of chinook salmon marked on lower Alsek River, removed by fisheries and inspected for marks in tributaries in 2000, by length group. Numbers in bold used in mark-recapture estimate.

		Length (MEF)			
		Small 0–439 mm	Medium 440–659 mm	Large ≥660 mm	Total
A. Released at Dry Bay with marks		0	44	479	523
B. Removed by:					
1. U.S. sport fisheries		0	0	0	0
2. U.S. gillnet		0	2	20	22
Subtotal of removals		0	2	20	22
C. Estimated number of marked fish remaining in mark-recapture experiment		0	42	**459**	**501**
D. Spawning ground samples					
Klukshu weir	Observed [a]				1,133
	Marked				34
	Marked/observed				0.0300
E. Inspected at:					
1a. Klukshu weir live	Inspected	3	22	**207**	**232**
	Marked	0	2	**13**	**15**
	Marked/inspected		0.0909	0.0628	0.0647
1b. Klukshu weir carcass	Inspected	3	16	**57**	**76**
	Marked	0	0	**4**	**4**
	Marked/inspected			0.0702	0.0526
1c. Klukshu River foot survey	Inspected	0	5	**67**	**72**
	Marked	0	0	**1**	**1**
	Marked/inspected			0.0149	0.0139
2. Blanchard/Goat	Inspected	0	6	**108**	**114**
	Marked	0	1	**5**	**6**
	Marked/ inspected		0.1666	0.0463	0.0526
3. Sport fishery	Harvest				72
	Marked				0
	Marked/inspected				0.0000
4. Aboriginal fishery	Harvest				65
	Marked				2
	Marked/inspected				0.0308

[a] Does not include fish inspected in 1a.

(assumption e), and double sampling was prevented by an additional mark (ventral opercle punch) (assumption f). Variance, statistical bias, and confidence intervals for the abundance estimate were estimated with modifications of bootstrap procedures in Buckland and Garthwaite (1991).

AGE, SEX, AND LENGTH COMPOSITION OF ESCAPEMENT

All fish captured at the Dry Bay tagging site and spawning ground surveys were sampled for scales to enable age determination (Olsen 1995). In addition, a portion of the Canadian aboriginal and recreational harvests was sampled to get length, sex and age data. 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× (Olsen 1995). Dry Bay scale samples were processed at the ADF&G scale aging lab in Douglas, AK, all other samples were processed at the DFO lab in Nanaimo, B.C. All scales were read by one staff member of the scale aging lab, unusual or questionable scales were read again by one or more staff.

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 on the spawning grounds:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_i} \qquad (1)$$

$$v[\hat{p}_{ij}] = \frac{\hat{p}_{ij}(1 - \hat{p}_{ij})}{n_i - 1} \qquad (2)$$

where $\hat{p}_{ij}$ is the estimated proportion of the population of age j in size category i, n_{ij} is the number of chinook salmon of age j in size category i, and n_i is the number of chinook salmon in the sample n of size category i taken on the spawning grounds.

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

$$\hat{N}_j = \sum_i (p_{ij}\hat{N}_i) \qquad (3)$$

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

$$v(\hat{N}_j) = \sum_i \begin{pmatrix} v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)\hat{p}_{ij} \\ - v(\hat{p}_{ij})v(\hat{N}_i) \end{pmatrix} \qquad (4)$$

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

$$\hat{p}_j = \frac{\hat{N}_j}{\hat{N}} \qquad (5)$$

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

$$v(\hat{p}_j) = \frac{\sum_i \left(v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)(\hat{p}_{ij} - \hat{p}_j)^2 \right)}{\hat{N}^2} \qquad (6)$$

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 samples to produce estimated proportions by sex $\hat{p}_k$, where k denotes sex, such that $\sum_k \hat{p}_k = 1$, and by age-sex, such that $\sum_{jk} \hat{p}_{jk} = 1$.

Age, sex, and age-sex composition and associated variances for the Dry Bay, and Alaska commercial fisheries samples were also estimated as described above.

Estimated age composition of chinook salmon captured in the different spawning areas was compared using a chi-square test, prior to combining these samples. Estimated age composition of the gillnet samples was compared with estimated age composition from data pooled across spawning grounds using another chi-square test. Estimates of mean length at age and their estimated variances were calculated with standard normal procedures.

RESULTS

DRY BAY TAGGING

Between May 10 and July 23, 2000, 509 large ($\geq$660 mm MEF) and 54 small and medium chinook salmon were captured in the lower Alsek River. Of these, 479 large and 44 medium fish were sampled, marked and released (Table 4, Appendix A1). Set gillnet effort was maintained at 9 hours per day, although reduced sampling effort occurred on several days (Figure 3; Appendix A1). Catch rates ranged from 0 to 5.8 fish/net-hour and peaked on June 10, when 52 large chinook were captured (Figure 4). The date of 50% cumulative catch was June 10. The sex ratio of chinook salmon caught in the gillnets was skewed towards females (313 females, 210 males). In addition, each healthy sockeye salmon captured was marked with a spaghetti tag and released (Appendix A1).

FISHERY SAMPLING

The inriver U.S. commercial gillnet fishery harvested 677 chinook salmon—including 22 tagged fish and U.S. subsistence and personal use fisheries harvested 45 more (Tables 2, 4).

SPAWNING GROUND SAMPLING

Two hundred thirty-two (232) chinook salmon (207 were large fish) were examined for marks at the Klukshu River weir, and 15 (13 large) marked fish were recovered (Table 4). The sex ratio of fish sampled at the weir was 96 females, 136 males. No tag loss was noted in the sample of fish examined. The remaining 1,133 fish passing through the weir were not physically examined for marks; however, each fish was observed from a distance, and the presence of 34 additional spaghetti tags was noted. Size category and sex of each fish was not estimated. Seventy-six (76) carcasses were sampled at or above the weir, with 4 marked fish recovered, and 72 more fish were examined during foot surveys upriver from the weir, with one mark recovered.

At Blanchard River, 92 chinook carcasses were examined for marks, with 5 marked fish recovered (Table 4). At Goat Creek on the upper Tatshenshini River, 4 chinook salmon were sampled, on the Takhanne River 14 fish were sampled and at Low Fog Creek 4 fish were sampled, 1 tagged fish was recaptured.

The aboriginal fishery near Dalton Post harvested only 65 chinook salmon with two tags reported. The entire catch was not sampled, but all tagged fish harvested are assumed to have been reported because of the close proximity of the DFO camp and signs posted describing the tagging study and reward program. The sport fishery near Dalton Post harvested approximately 72 chinook with additional fish released. Only 5 fish were examined by DFO technicians, and no tagged fish were recovered or reported.

ABUNDANCE

The mark-recapture estimate for large fish only is 8,432 fish (SE = 1,597). An estimated 459 marked fish moved upstream, 23 of which were found in the 439 fish inspected upstream at the weir or on the spawning grounds (Table 4). A 95% confidence interval around estimated abundance past Dry Bay estimated from bootstrapping is 6,072–13,223 fish; estimated statistical bias is 4.25%. After subtracting the Canadian inriver harvest which is primarily large fish, the estimated number of large spawners in the entire Alsek River is 8,295 fish.

Marked fractions of medium and large chinook salmon sampled on the spawning grounds were not significantly different (0.0612 vs 0.0524, χ^2 = 0.061, df = 1, P = 0.805). The combined length distributions of medium and large fish marked in Dry Bay were not significantly different from length distributions for fish recaptured on the spawning grounds (P = 0.71; Figure 5, bottom). Length distributions of marked chinook salmon were also not significantly different from all fish sampled on the spawning grounds (P = 0.141; Figure 5). Thus, there was no evidence of size-selectivity during either sampling event, and a single unstratified abundance estimate could be

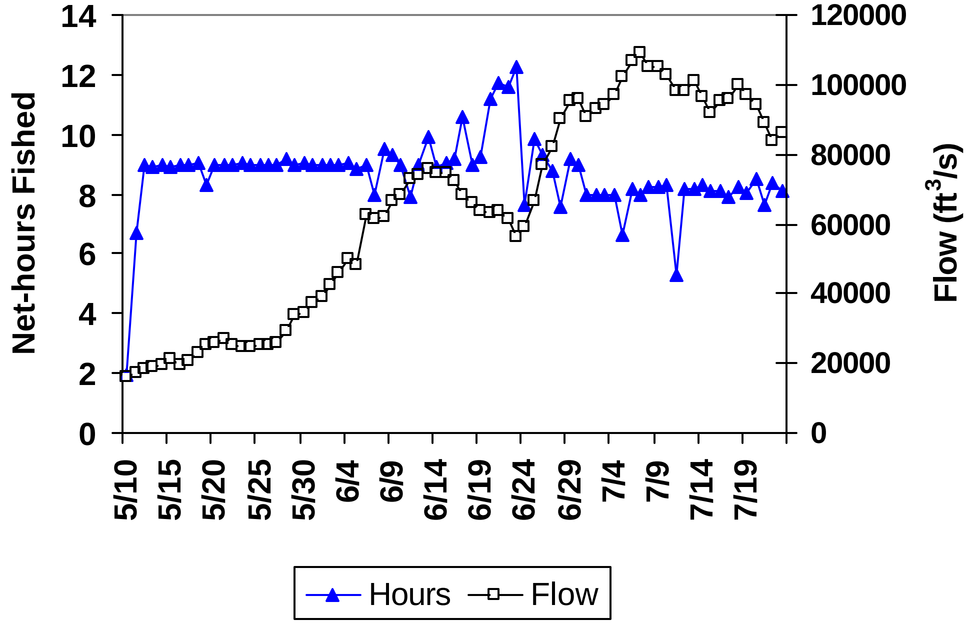

Figure 3.–Daily fishing effort (hours) and river flow (ft^3/s), Alsek River near Dry Bay, 2000. Flow information from USGS water information system.

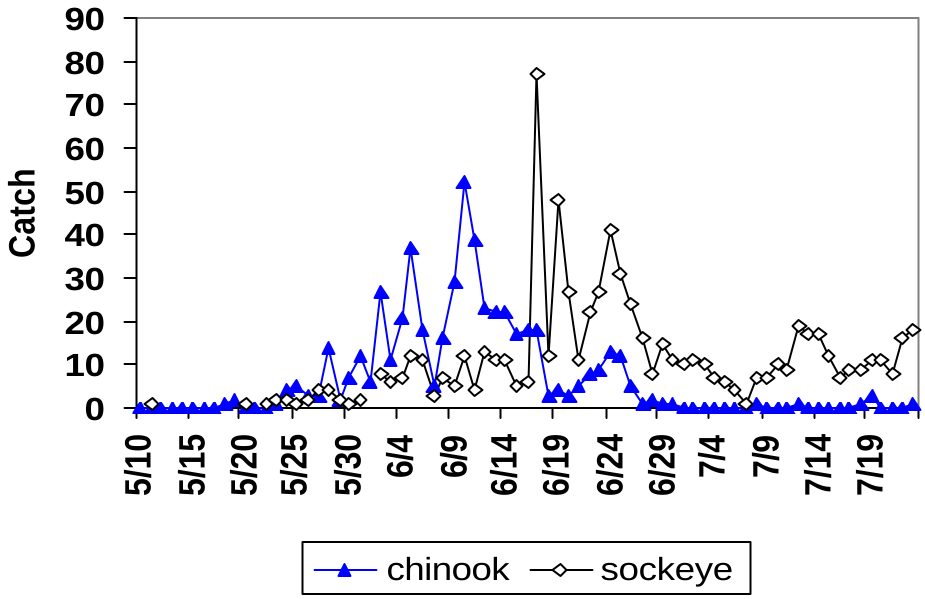

Figure 4.–Daily catch of chinook and sockeye salmon, lower Alsek River, 2000.

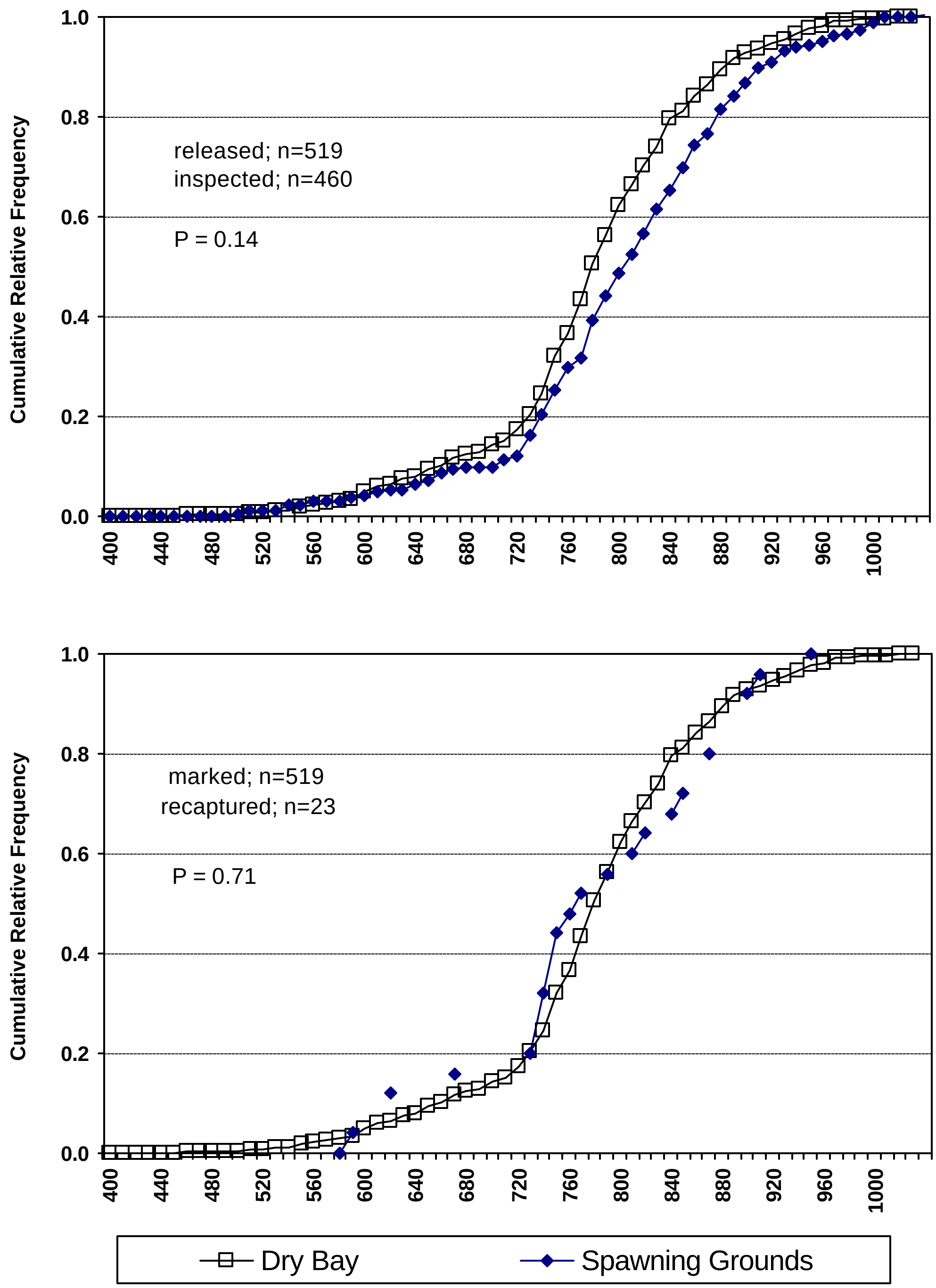

Figure 5.–Cumulative relative frequency of chinook salmon captured in event 1 (Dry Bay gillnet) **and marked chinook salmon recaptured in event 2** (spawning ground sampling, Klukshu weir)**, Alsek River, 2000**.

calculated for medium and large chinook salmon combined. An estimated 9,202 (SE = 1,645; M = 501, R = 26, C = 494) large and medium chinook salmon passed upstream of Dry Bay in 2000. The 95% CI is 6,805–14,308 fish; estimated statistical bias is 3.1%.

Samples taken at the weir, from carcasses above the weir and from a foot survey of the Klukshu River were pooled because their marked fractions are not significantly different (χ^2 = 2.624, df =2, P = 0.269). Marked fractions of the pooled Klukshu River samples were not significantly different from samples collected on the Blanchard and Takhanne rivers and Goat Creek (χ^2 = 0.0012, df =1, P = 0.972 Table 4). Tests on large fish only, had similar results with no significant differences in marked fractions. The estimated harvests in the sport and aboriginal fisheries were the lowest on record and sample sizes were too small to be included in the mark-recapture analysis.

AGE, SEX, AND LENGTH COMPOSITION OF ESCAPEMENT

Age 1.3 chinook salmon were again the most common in all samples, constituting an estimated 76% of fish sampled in Dry Bay, 71% at the weir across the Klukshu River, and 59% at Blanchard River/Goat Creek, (Appendix A3–A8). Age 1.4 fish were the second most common and age 1.2 fish third. Sampled populations were an estimated 40–56% males. Estimated age compositions were not significantly different for fish at Dry Bay and at the pooled Klukshu River samples (χ^2 = 1.099, df = 2, P = 0.577). Estimated age composition of fish in the pooled Klukshu River sample differed from estimates for fish at the other spawning ground locations (χ^2 = 17.506, df = 2, P = 0.0002), however estimated age composition of all spawning ground samples pooled differed only slightly from the fish tagged at Dry Bay (χ^2 = 4.499, df = 2, P = 0.105) so the samples were pooled. The pooled estimate of age composition was used to estimate the abundance by age and sex of the estimated total escapement to the Alsek River (Table 5).

DISCUSSION

Length and age composition data in this study indicate that meaningful size selective sampling probably did not occur during gillnet fishing and during spawning ground sampling (Seber 1982). The lengths of fish captured in event 1 and fish captured in event 2 at the Klukshu River and other spawning grounds were not significantly different. The lengths of tagged fish recovered on the spawning grounds and at the Klukshu weir do not indicate size selection during either event 1 or 2.

Results from statistical tests on mean age compositions also show little indication of gear selectivity. Tagging rates were not significantly different between the recovery strata, or between large and medium size chinook salmon. In previous studies the large mesh (7 ¼ in) gillnets used in the tagging operation were selective towards larger fish, and that required that the mark-recapture analysis be stratified by size. In the 2000 study, smaller mesh sockeye salmon gear was fished in addition to the larger chinook gear. In addition, spawning ground samples were collected with a variety of gear from pre-spawning and post-spawning fish and carcasses. These changes decreased the size selectivity observed in previous years and eliminated the need to stratify the population estimate by size. Sampling in both events is likely to underestimate the abundance of the small (<439 mm MEF) jacks, which are difficult to see or capture.

Observation of fish passing by the Klukshu weir boosted sample sizes, but did not provide age, size, sex, or tag loss data. The blue tag used in the study was designed to prevent predators from targeting on marked fish. Unfortunately, this same quality would hamper recognition at a distance by technicians as well, which may explain why the tagged rate of inspected/handled fish at the weir was higher than the rate for fish merely observed while in transit through the weir.

Daily catch in gillnets is dependent not only on effort but on river conditions which can change dramatically from day to day. Sampling effort in 2000 was kept as consistent as possible; however, changing river conditions often made

Table 5.–Estimated abundance and composition by age and sex of the escapement of chinook salmon in the Alsek River in 2000.

		Brood year and age class									
		1997	**1996**	**1996**	**1995**	**1995**	**1994**	**1994**	**1993**	**1993**	
		1.1	**2.1**	**1.2**	**2.2**	**1.3**	**2.3**	**1.4**	**2.4**	**1.5**	**Total**
Males	n	3	2	51	4	211	0	76	0	0	347
	%	0.4	0.3	6.7	0.5	27.6	0.0	9.9	0.0	0.0	45.4
	SE of %	0.2	0.2	0.9	0.3	1.6	0.0	1.1	0.0	0.0	1.8
	Escapement	36	24	613	48	2,538	0	914	0	0	4,174
	SE of esc.	21	17	137	25	477	0	191	0	0	764
Females	n	0	0	9	0	349	2	58	0	0	418
	%	0.0	0.0	1.2	0.0	45.6	0.3	7.6	0.0	0.0	54.6
	SE of %	0.0	0.0	0.4	0.0	1.8	0.2	1.0	0.0	0.0	1.8
	Escapement	0	0	108	0	4,198	24	698	0	0	5,028
	SE of esc.	0	0	40	0	768	17	152	0	0	914
Sexes	n	3	2	60	4	560	2	134	0	0	765
combined	%	0.4	0.3	7.8	0.5	73.2	0.3	17.5	0.0	0.0	100.0
	SE of %	0.2	0.2	1.0	0.3	1.6	0.2	1.4	0.0	0.0	0.0
	Escapement	36	24	722	48	6,736	24	1,612	0	0	9,202
	SE of esc.	21	17	156	25	1,213	17	314	0	0	1,645

fishing difficult. Variations on three different set net sites were fished, depending on river conditions.

The tagging study conducted in 1998 used radio-telemetry data to estimate the distribution and migratory timing of spawning chinook salmon in the Alsek and Tatshenshini rivers (Pahlke et al. 1999). About 46% of the spawning fish were tracked to areas in the lower and middle Tatshenshini River, downstream from the mouth of the Klukshu River. These fish spawn primarily in glacial waters where they are difficult to see or sample. Studies on the Stikine, Unuk and Chickamin rivers have shown, in general, chinook salmon migrating to lower tributaries migrated upriver later in the year than fish heading to spawning areas much farther upriver (Pahlke and Etherton 1999; Pahlke et al. 1996; Pahlke 1997). That trend was not apparent in the Alsek River study, with fish spawning in the lower and middle Tatshenshini River, and those heading to the upper Tatshenshini River, including the Klukshu, Blanchard, Takhanne rivers and Goat Creek; all passing through Dry Bay in a similar pattern. With no significant differences in run timing, it would be unlikely that fish going to different tributaries would be marked at different rates.

Traditional indicators of chinook salmon escapement to the Alsek River indicate a below average escapement in 2000. The count at the Klukshu weir was similar to the poor count in 1998 and within the escapement goal range, but below the recent 10-year average of 2,862. Index counts in the Blanchard and Takhanne rivers were also below average. The number of large chinook salmon tagged at the set nets in Dry Bay increased from 245 in 1998 and 402 in 1999, to 479 in 2000, due primarily to the experience gained in operation of the nets the previous three years. However, the number of fish sampled at the Klukshu River weir did not increase, and sample sizes at the other recovery sites were also low.

In 2000, 89.2% of the fish inspected at the weir were large fish, resulting in an estimated escapement through the weir of 1,218 large chinook salmon. This was about 15% of the mark-recapture estimated escapement of large fish, or an expansion factor ($\hat{p}_i$) of 6.81 (SE = 1.31). Expansion factors $\hat{p}_i$ for 1998 and 1999 were estimated at 6.33 (SE = 1.38) and 6.97 (SE = 1.74), respectively. The average over these three estimates is $\bar{p}$ = 6.70 and its estimated variance $v(p)$ = 0.11 (SE = 0.33).

We used the following equations to estimate the expansion factor for counts $C_{W,t}$ at the weir on the Klukshu River into estimates of abundance N_t of large chinook salmon spawning in the Alsek River, where t is year, k is the number of estimates of π, π is the ratio (expansion factor) where i denotes years with mark-recapture experiments.

$\hat{p}_i = \hat{N}_i C_{W,i}^{-1}$
$v(\hat{\pi}_i) = v(\hat{N}_i) C_{W,i}^{-2}$
$\bar{\pi} = \frac{\sum_{i=1}^{k} \hat{\pi}_i}{k}$
$v(p) = \frac{\sum_{i=1}^{k} (\hat{p}_i - \bar{p})^2}{k-1}$

CONCLUSION AND RECOMMENDATIONS

This was the third attempt at estimating the total escapement of chinook salmon to the Alsek River. It appears feasible to conduct a mark-recapture experiment with acceptable results using methods developed in 1997 and 1998. Set gillnets are an effective method of capturing large chinook salmon migrating up the Alsek River, although the tagging crew must respond to fluctuating river conditions which rapidly change the effectiveness of the gear. Sample sizes in both events 1 and 2 must be increased to achieve an acceptably precise estimate of abundance, and the samples at the Klukshu River must be collected in a representative and random manner.

The results of the study indicate that the Klukshu River weir is a valid index of chinook salmon escapement to the Alsek River.

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APPENDIX A

Appendix A1.–Gillnet daily effort (hours fished), catches, and catch per net hour, and river flow (ft^3/s) near Dry Bay, lower Alsek River, 2000.

Date	Net hours	Chin. gear	Sock. gear	Large chinook	CPUE	Cum. total	%	Small–no tag	Small chinook	Sock-eye	Flow
5/10	1.9	1.9				0	0.000				16000
5/11	6.7	6.7				0	0.000			1	17200
5/12	9.0	9.0				0	0.000				18200
5/13	8.9	8.9				0	0.000				18700
5/14	9.0	9.0				0	0.000				19300
5/15	8.9	8.9				0	0.000				21000
5/16	9.0	9.0				0	0.000				19700
5/17	9.0	9.0				0	0.000				20800
5/18	9.0	9.0		1	0.11	1	0.002				23100
5/19	8.3	8.3		2	0.24	3	0.006				25300
5/20	9.0	9.0			0.00	3	0.006			1	26000
5/21	9.0	9.0			0.00	3	0.006				26700
5/22	9.0	9.0			0.00	3	0.006			1	25400
5/23	9.0	9.0		1	0.11	4	0.008			2	24700
5/24	9.0	9.0		4	0.44	8	0.017		1	2	24900
5/25	9.0	9.0		5	0.56	13	0.027			1	25000
5/26	9.0	9.0		3	0.33	16	0.033			2	25400
5/27	9.0	9.0		3	0.33	19	0.040			4	25700
5/28	9.2	9.2		13	1.53	32	0.067		1	4	29000
5/29	9.0	9.0		2	0.22	34	0.071		1	2	33900
5/30	9.0	9.0		7	0.77	41	0.086		2	1	34400
5/31	9.0	9.0		12	1.33	53	0.111		1	2	37100
6/1	9.0	9.0		6	0.67	59	0.123		1		38800
6/2	9.0	9.0		26	3.00	85	0.177		2	8	42600
6/3	9.0	9.0		10	1.22	95	0.198			6	45800
6/4	9.1	9.1		20	2.32	115	0.240	1	4	7	49900
6/5	8.8	8.8		37	4.19	152	0.317	1	3	12	48400
6/6	9.0	9.0		18	2.00	170	0.355	1	1	11	62400
6/7	8.0	8.0		4	0.63	174	0.363	1		3	61500
6/8	9.5	9.5		16	1.68	190	0.397			7	62000
6/9	9.3	9.3		27	3.11	217	0.453	2	1	5	66400
6/10	9.0	9.0		52	5.78	269	0.562	2	1	12	68500
6/11	7.9	7.9		38	4.95	307	0.641		5	4	73200
6/12	9.0	4.5	4.5	21	2.56	328	0.685		1	13	74300
6/13	9.9	5.0	5.0	22	2.22	350	0.731		1	11	75600
6/14	8.9	4.5	4.5	18	2.46	368	0.768			11	74800
6/15	9.0	4.5	4.5	13	1.88	381	0.795		3	5	74500
6/16	9.2	4.6	4.6	16	1.96	397	0.829		1	6	72300
6/17	10.6		9.2	13	1.70	410	0.856	2	3	77	68100
6/18	9.0	9.0		3	0.33	413	0.862		2	12	66000
6/19	9.3		9.3	4	0.43	417	0.871		1	48	63700
6/20	11.2	5.0	6.2	3	0.27	420	0.877			27	62900
6/21	11.7	6.0	5.7	5	0.43	425	0.887		1	11	63900
6/22	11.6	6.3	5.3	8	0.69	433	0.904			22	61200
6/23	12.3	12.3		9	0.73	442	0.923		2	27	56400
6/24	7.6	3.4	4.2	12	1.71	454	0.948		1	41	59200

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Appendix A1.–Page 2 of 2.

Date	Net hours	Chin. gear	Sock. gear	Large chinook	CPUE	Cum. total	%	Small– no tag	Small chinook	Sock-eye	Flow
6/25	9.9	9.9		10	1.22	464	0.969		1	31	66800
6/26	9.3	9.3		4	0.54	468	0.977		2	24	76800
6/27	8.3	5.0	3.3	1	0.12	469	0.979			16	82200
6/28	7.5		7.5	1	0.27	470	0.981			8	89900
6/29	9.2		9.2	1	0.11	471	0.983		1	15	95300
6/30	9.0		9.0	1	0.11	472	0.985			11	96100
7/1						472	0.985			10	90900
7/2						472	0.985			11	93200
7/3						472	0.985			10	94000
7/4						472	0.985			7	97300
7/5						472	0.985			6	102000
7/6						472	0.985			4	107000
7/7						472	0.985			1	109000
7/8				1		473	0.987			7	105000
7/9						473	0.987			7	105000
7/10						473	0.987			10	103000
7/11						473	0.987			9	98000
7/12				1		474	0.990			19	98200
7/13						474	0.990			17	101000
7/14						474	0.990			17	96300
7/15						474	0.990			12	92100
7/16						474	0.990			7	95400
7/17						474	0.990			9	95600
7/18				1		475	0.992			9	99700
7/19				3		478	0.998			11	97100
7/20						478	0.998			11	93900
7/21						478	0.998			8	89000
7/22						478	0.998			16	83900
7/23				1		479	1.000			18	86400
totals	468.0	374.8	93.2	479		479		10	44	12	87600

Appendix A2.–Daily and cumulative counts of Klukshu River sockeye, chinook and coho salmon through the Klukshu River weir, 2000.

	Sockeye				Chinook				Coho			
Date	Daily	Daily prop.	Cum.	Cum prop.	Daily	Daily prop.	Cum.	Cum prop.	Daily	Daily prop.	Cum.	Cum prop.
6-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
7-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
8-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
9-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
10-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
11-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
12-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
13-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
14-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
15-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
16-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
17-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
18-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
19-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
20-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
21-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
22-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
23-Jun	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
24-Jun	0	0.000	0	0.000	1	0.001	1	0.001	0	0.000	0	0.000
25-Jun	0	0.000	0	0.000	0	0.000	1	0.001	0	0.000	0	0.000
26-Jun	0	0.000	0	0.000	6	0.004	7	0.005	0	0.000	0	0.000
27-Jun	0	0.000	0	0.000	6	0.004	13	0.010	0	0.000	0	0.000
28-Jun	0	0.000	0	0.000	1	0.001	14	0.010	0	0.000	0	0.000
29-Jun	0	0.000	0	0.000	1	0.001	15	0.011	0	0.000	0	0.000
30-Jun	0	0.000	0	0.000	0	0.000	15	0.011	0	0.000	0	0.000
1-Jul	0	0.000	0	0.000	0	0.000	15	0.011	0	0.000	0	0.000
2-Jul	0	0.000	0	0.000	0	0.000	15	0.011	0	0.000	0	0.000
3-Jul	0	0.000	0	0.000	0	0.000	15	0.011	0	0.000	0	0.000
4-Jul	0	0.000	0	0.000	0	0.000	15	0.011	0	0.000	0	0.000
5-Jul	0	0.000	0	0.000	2	0.001	17	0.012	0	0.000	0	0.000
6-Jul	0	0.000	0	0.000	0	0.000	17	0.012	0	0.000	0	0.000
7-Jul	0	0.000	0	0.000	2	0.001	19	0.014	0	0.000	0	0.000
8-Jul	0	0.000	0	0.000	3	0.002	22	0.016	0	0.000	0	0.000
9-Jul	0	0.000	0	0.000	3	0.002	25	0.018	0	0.000	0	0.000
10-Jul	0	0.000	0	0.000	10	0.007	35	0.026	0	0.000	0	0.000
11-Jul	0	0.000	0	0.000	8	0.006	43	0.032	0	0.000	0	0.000
12-Jul	0	0.000	0	0.000	4	0.003	47	0.034	0	0.000	0	0.000
13-Jul	0	0.000	0	0.000	3	0.002	50	0.037	0	0.000	0	0.000
14-Jul	0	0.000	0	0.000	17	0.012	67	0.049	0	0.000	0	0.000
15-Jul	0	0.000	0	0.000	12	0.009	79	0.058	0	0.000	0	0.000
16-Jul	0	0.000	0	0.000	4	0.003	83	0.061	0	0.000	0	0.000
17-Jul	0	0.000	0	0.000	9	0.007	92	0.067	0	0.000	0	0.000
18-Jul	0	0.000	0	0.000	11	0.008	103	0.075	0	0.000	0	0.000
19-Jul	0	0.000	0	0.000	11	0.008	114	0.084	0	0.000	0	0.000
20-Jul	1	0.000	1	0.000	15	0.011	129	0.095	0	0.000	0	0.000

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Appendix A2.–Page 2 of 3.

	Sockeye				Chinook				Coho			
Date	Daily	Daily prop.	Cum.	Cum prop.	Daily	Daily prop.	Cum.	Cum prop.	Daily	Daily prop.	Cum.	Cum prop.
21-Jul	3	0.001	4	0.001	17	0.012	146	0.107	0	0.000	0	0.000
22-Jul	5	0.001	9	0.002	45	0.033	191	0.140	0	0.000	0	0.000
23-Jul	8	0.001	17	0.003	229	0.168	420	0.308	0	0.000	0	0.000
24-Jul	2	0.000	19	0.003	51	0.037	471	0.345	0	0.000	0	0.000
25-Jul	4	0.001	23	0.004	28	0.021	499	0.366	0	0.000	0	0.000
26-Jul	2	0.000	25	0.005	90	0.066	589	0.432	0	0.000	0	0.000
27-Jul	38	0.007	63	0.011	128	0.094	717	0.525	0	0.000	0	0.000
28-Jul	10	0.002	73	0.013	136	0.100	853	0.625	0	0.000	0	0.000
29-Jul	0	0.000	73	0.013	27	0.020	880	0.645	0	0.000	0	0.000
30-Jul	3	0.001	76	0.014	87	0.064	967	0.708	0	0.000	0	0.000
31-Jul	3	0.001	79	0.014	43	0.032	1,010	0.740	0	0.000	0	0.000
1-Aug	18	0.003	97	0.017	21	0.015	1,031	0.755	0	0.000	0	0.000
2-Aug	1	0.000	98	0.018	20	0.015	1,051	0.770	0	0.000	0	0.000
3-Aug	31	0.006	129	0.023	23	0.017	1,074	0.787	0	0.000	0	0.000
4-Aug	6	0.001	135	0.024	33	0.024	1,107	0.811	0	0.000	0	0.000
5-Aug	7	0.001	142	0.026	49	0.036	1,156	0.847	0	0.000	0	0.000
6-Aug	32	0.006	174	0.031	24	0.018	1,180	0.864	0	0.000	0	0.000
7-Aug	7	0.001	181	0.033	16	0.012	1,196	0.876	0	0.000	0	0.000
8-Aug	4	0.001	185	0.033	55	0.040	1,251	0.916	0	0.000	0	0.000
9-Aug	3	0.001	188	0.034	9	0.007	1,260	0.923	0	0.000	0	0.000
10-Aug	9	0.002	197	0.035	5	0.004	1,265	0.927	0	0.000	0	0.000
11-Aug	1	0.000	198	0.036	6	0.004	1,271	0.931	0	0.000	0	0.000
12-Aug	2	0.000	200	0.036	16	0.012	1,287	0.943	0	0.000	0	0.000
13-Aug	2	0.000	202	0.036	15	0.011	1,302	0.954	0	0.000	0	0.000
14-Aug	10	0.002	212	0.038	7	0.005	1,309	0.959	0	0.000	0	0.000
15-Aug	25	0.005	237	0.043	1	0.001	1,310	0.960	0	0.000	0	0.000
16-Aug	0	0.000	237	0.043	5	0.004	1,315	0.963	0	0.000	0	0.000
17-Aug	1	0.000	238	0.043	2	0.001	1,317	0.965	0	0.000	0	0.000
18-Aug	25	0.005	263	0.047	4	0.003	1,321	0.968	0	0.000	0	0.000
19-Aug	3	0.001	266	0.048	2	0.001	1,323	0.969	0	0.000	0	0.000
20-Aug	8	0.001	274	0.049	4	0.003	1,327	0.972	0	0.000	0	0.000
21-Aug	0	0.000	274	0.049	2	0.001	1,329	0.974	0	0.000	0	0.000
22-Aug	22	0.004	296	0.053	2	0.001	1,331	0.975	0	0.000	0	0.000
23-Aug	10	0.002	306	0.055	8	0.006	1,339	0.981	0	0.000	0	0.000
24-Aug	6	0.001	312	0.056	1	0.001	1,340	0.982	0	0.000	0	0.000
25-Aug	3	0.001	315	0.057	6	0.004	1,346	0.986	0	0.000	0	0.000
26-Aug	5	0.001	320	0.058	4	0.003	1,350	0.989	0	0.000	0	0.000
27-Aug	3	0.001	323	0.058	2	0.001	1,352	0.990	0	0.000	0	0.000
28-Aug	6	0.001	329	0.059	3	0.002	1,355	0.993	0	0.000	0	0.000
29-Aug	0	0.000	329	0.059	3	0.002	1,358	0.995	0	0.000	0	0.000
30-Aug	5	0.001	334	0.060	1	0.001	1,359	0.996	0	0.000	0	0.000
31-Aug	11	0.002	345	0.062	2	0.001	1,361	0.997	0	0.000	0	0.000
1-Sep	4	0.001	349	0.063	0	0.000	1,361	0.997	0	0.000	0	0.000
2-Sep	2	0.000	351	0.063	1	0.001	1,362	0.998	0	0.000	0	0.000
3-Sep	2	0.000	353	0.064	0	0.000	1,362	0.998	0	0.000	0	0.000
4-Sep	2	0.000	355	0.064	0	0.000	1,362	0.998	0	0.000	0	0.000

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Appendix A2.–Page 3 of 3.

Date	Sockeye Daily	Sockeye Daily prop.	Sockeye Cum.	Sockeye Cum prop.	Chinook Daily	Chinook Daily prop.	Chinook Cum.	Chinook Cum prop.	Coho Daily	Coho Daily prop.	Coho Cum.	Coho Cum prop.
5-Sep	27	0.005	382	0.069	0	0.000	1,362	0.998	0	0.000	0	0.000
6-Sep	128	0.023	510	0.092	0	0.000	1,362	0.998	0	0.000	0	0.000
7-Sep	135	0.024	645	0.116	1	0.001	1,363	0.999	0	0.000	0	0.000
8-Sep	39	0.007	684	0.123	0	0.000	1,363	0.999	0	0.000	0	0.000
9-Sep	17	0.003	701	0.126	2	0.001	1,365	1.000	0	0.000	0	0.000
10-Sep	6	0.001	707	0.127	0	0.000	1,365	1.000	0	0.000	0	0.000
11-Sep	2	0.000	709	0.128	0	0.000	1,365	1.000	2	0.000	2	0.000
12-Sep	5	0.001	714	0.129	0	0.000	1,365	1.000	1	0.000	3	0.001
13-Sep	1	0.000	715	0.129	0	0.000	1,365	1.000	1	0.000	4	0.001
14-Sep	11	0.002	726	0.131	0	0.000	1,365	1.000	5	0.001	9	0.002
15-Sep	160	0.029	886	0.160	0	0.000	1,365	1.000	28	0.006	37	0.008
16-Sep	267	0.048	1,153	0.208	0	0.000	1,365	1.000	36	0.007	73	0.015
17-Sep	685	0.123	1,838	0.331	0	0.000	1,365	1.000	78	0.016	151	0.031
18-Sep	1,245	0.224	3,083	0.555	0	0.000	1,365	1.000	92	0.019	243	0.050
19-Sep	192	0.035	3,275	0.590	0	0.000	1,365	1.000	42	0.009	285	0.059
20-Sep	172	0.031	3,447	0.621	0	0.000	1,365	1.000	70	0.014	355	0.073
21-Sep	100	0.018	3,547	0.639	0	0.000	1,365	1.000	63	0.013	418	0.087
22-Sep	844	0.152	4,391	0.791	0	0.000	1,365	1.000	219	0.045	637	0.132
23-Sep	568	0.102	4,959	0.893	0	0.000	1,365	1.000	181	0.037	818	0.169
24-Sep	457	0.082	5,416	0.976	0	0.000	1,365	1.000	217	0.045	1,035	0.214
25-Sep	54	0.010	5,470	0.985	0	0.000	1,365	1.000	186	0.038	1,221	0.253
26-Sep	23	0.004	5,493	0.990	0	0.000	1,365	1.000	144	0.030	1,365	0.282
27-Sep	3	0.001	5,496	0.990	0	0.000	1,365	1.000	165	0.034	1,530	0.317
28-Sep	4	0.001	5,500	0.991	0	0.000	1,365	1.000	140	0.029	1,670	0.346
29-Sep	3	0.001	5,503	0.991	0	0.000	1,365	1.000	103	0.021	1,773	0.367
30-Sep	0	0.000	5,503	0.991	0	0.000	1,365	1.000	27	0.006	1,800	0.373
1-Oct	0	0.000	5,503	0.991	0	0.000	1,365	1.000	15	0.003	1,815	0.376
2-Oct	0	0.000	5,503	0.991	0	0.000	1,365	1.000	11	0.002	1,826	0.378
3-Oct	4	0.001	5,507	0.992	0	0.000	1,365	1.000	156	0.032	1,982	0.410
4-Oct	0	0.000	5,507	0.992	0	0.000	1,365	1.000	76	0.016	2,058	0.426
5-Oct	0	0.000	5,507	0.992	0	0.000	1,365	1.000	162	0.034	2,220	0.459
6-Oct	1	0.000	5,508	0.992	0	0.000	1,365	1.000	333	0.069	2,553	0.528
7-Oct	20	0.004	5,528	0.996	0	0.000	1,365	1.000	445	0.092	2,998	0.620
8-Oct	1	0.000	5,529	0.996	0	0.000	1,365	1.000	116	0.024	3,114	0.644
9-Oct	2	0.000	5,531	0.996	0	0.000	1,365	1.000	121	0.025	3,235	0.669
10-Oct	7	0.001	5,538	0.998	0	0.000	1,365	1.000	229	0.047	3,464	0.717
11-Oct	2	0.000	5,540	0.998	0	0.000	1,365	1.000	206	0.043	3,670	0.760
12-Oct	7	0.001	5,547	0.999	0	0.000	1,365	1.000	513	0.106	4,183	0.866
13-Oct	1	0.000	5,548	0.999	0	0.000	1,365	1.000	162	0.034	4,345	0.899
14-Oct	1	0.000	5,549	1.000	0	0.000	1,365	1.000	136	0.028	4,481	0.927
15-Oct	1	0.000	5,550	1.000	0	0.000	1,365	1.000	84	0.017	4,565	0.945
16-Oct	0	0.000	5,550	1.000	0	0.000	1,365	1.000	111	0.023	4,676	0.968
17-Oct	1	0.000	5,551	1.000	0	0.000	1,365	1.000	154	0.032	4,830	1.000
18-Oct	0	0.000	5,551	1.000	0	0.000	1,365	1.000	2	0.000	4,832	1.000
Total	5,551				1,365				4,832			
Catch above weir			129				44				41	
Total escapement			5,422				1,321				4,791	

Appendix A3.–Estimated age composition and mean length of chinook salmon in the Dry Bay set gillnet catch, by sex and age class, 2000.

		Brood year and age class							
		1997	1996	1996	1995	1995	1994	1994	Total
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	
Females	*n*		5		260		32		297
	% age comp.		1.7		87.5		10.8		59.6
	SE of %		0.7		1.9		1.8		2.2
	Average length		627		785		886		
	SD length		24		43		47		
	SE length		11		3		8		
Males	*n*		35		120		46		201
	% age comp.		17.4		59.7		22.9		40.4
	SE of %		2.7		3.5		3.0		2.2
	Average length		599		794		926		
	SD length		59		73		46		
	SE length		10		7		7		
Total	*n*		40		380		78		498
	% age comp.		8.0		76.3		15.7		100.0
	SE of %		1.2		1.9		1.6		
	Average length		602		788		910		
	SD length		56		54		50		
	SE length		9		3		6		

Appendix A4.–Estimated age composition and mean length of chinook salmon at the Klukshu River, by sex and age class, 2000.

		Brood year and age class							
		1997	1996	1996	1995	1995	1994	1994	Total
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	
Females	*n*		4		62		11	2	79
	% age comp.		5.1		78.5		13.9	2.5	44.1
	SE of %		2.5		4.7		3.9	1.8	3.7
	Average length		567		775		834	828	
	SD length		58		51		46	47	
	SE length		29		6		14	33	
Males	*n*	3	14	2	66	4	11		100
	% age comp.	3.0	14.0	2.0	66.0	4.0	11.0		55.9
	SE of %	1.7	3.5	1.4	4.8	2.0	3.1		3.7
	Average length	428	616	434	806	679	934		
	SD length	15	124	141	80	170	67		
	SE length	9	33	100	10	85	20		
Total	*n*	3	18	2	128	4	22	2	179
	% age comp.	1.7	10.1	1.1	71.5	2.2	12.3	1.1	100.0
	SE of %	1.0	2.3	0.8	3.4	1.1	2.5	0.8	
	Average length	428	605	434	783	679	883	828	
	SD length	15	113	141	87	170	75	47	
	SE length	9	27	100	8	85	16	33	

Appendix A5.–Estimated age composition and mean length of chinook salmon on the Blanchard River and Goat Creek, by sex and age class, 2000.

		Brood year and age class							Total
		1997	1996	1996	1995	1995	1994	1994	
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	
Females	*n*				27		15		42
	% age comp.				64.3		35.7		47.7
	SE of %				7.5		7.5		5.4
	Average length				789		877		
	SD length				35		47		
	SE length				7		12		
Males	*n*		2		25		19		46
	% age comp.		4.3		54.3		41.3		52.3
	SE of %		3.0		7.4		7.3		5.4
	Average length		560		782		938		
	SD length				84		40		
	SE length				17		9		
Total	*n*		2		52		34		88
	% age comp.		2.3		59.1		38.6		100.0
	SE of %		1.6		5.3		5.2		0
	Average length		560		786		914		
	SD length		[a]		64		52		
	SE length				9		9		

[a] No length recorded from one fish.

Appendix A6.–Estimated age composition of chinook salmon on the Alsek River all spawning ground samples pooled, by sex and age class, 2000.

		Brood year and age class							Total
		1997	1996	1996	1995	1995	1994	1994	
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	
Females	*n*		9		349		58	2	418
	% age comp.		2.2		83.5		13.9	0.5	54.6
	SE of %		0.7		1.8		1.7	0.3	1.8
Males	*n*	3	51	2	211	4	76		347
	% age comp.	0.9	14.7	0.6	60.8	1.2	21.9		45.4
	SE of %	0.5	1.9	0.4	2.6	0.6	2.2		1.8
Total	*n*	3	60	2	560	4	134	2	765
	% age comp.	0.4	7.8	0.3	73.2	0.5	17.5	0.3	100
	SE of %	0.2	1.0	0.2	1.6	0.3	1.4	0.2	

Appendix A7.–Estimated age composition and mean length of chinook salmon harvested in the Dry Bay commercial set gill net fishery, Alsek River, 2000, by sex and age class. Mesh size ≤ 6".

		Brood year and age class							
		1997	1996	1996	1995	1995	1994	1994	Total
		1.1	1.2	2.1	1.3	2.2	1.4	2.3	
Females	*n*		4		142		24		170
	% age comp.		2.4		83.5		14.1		49.7
	SE of %		1.2		2.9		2.7		2.7
	average length		648		787		863		
	SD length		20		60		59		
	SE length		10		5		12		
Males	*n*	1	76		82		13		172
	% age comp.	0.6	44.2		47.7		7.6		50.3
	SE of %	0.6	3.8		3.8		2.0		2.7
	average length	340	555		789		914		
	SD length		61		109		29		
	SE length		7		12		8		
Total	*n*	1	80		224		37		342
	% age comp.	0.3	23.4		65.5		10.8		100.0
	SE of %	0.3	2.3		2.6		1.7		0
	average length	340	560		788		878		
	SD length		63		75		67		
	SE length		7		5		11		

Appendix A8.–Computer files used to estimate the spawning abundance and distribution of chinook salmon in the Alsek River in 2000.

File name	Description
Alsek00.xls	EXCEL spreadsheet with gillnet tagging data--daily effort, catch by species, and water depth by site; gillnet charts.
Sumcksamples2000.xls	Age, Sex, Length (ASL) data from tagging site and spawning ground samples.
KstestAlsek00.xls	KS tests
Kscharts00.xls	cumulative relative frequency charts and data
kluCHNweir.xls	Klukshu weir tags and ASL data