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Optimal Production of Chinook Salmon from the Unuk River

by

Christie F. Hendrich,

Jan L. Weller,

Scott A. McPherson

and

David R. Bernard

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Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

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
milliliter	mL
millimeter	mm

Weights and measures (English)	
cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature	
day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

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

General	
Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
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
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)	
fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics	
all standard mathematical signs, symbols and abbreviations	
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	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
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.
minute (angular)	'
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
variance	
population	Var
sample	var

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by

Christie F. Hendrich,
Division of Sport Fish, Douglas

Jan L. Weller,
Division of Sport Fish, Ketchikan,

Scott A. McPherson,
Division of Sport Fish, Douglas
and

David R. Bernard,
Retired, Division of Sport Fish, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565
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Christie F. Hendrich,
Alaska Department of Fish and Game, Division of Sport Fish
802 3rd St., Douglas, AK 99824, P.O. Box 110024, Juneau, AK 99811, USA

Jan L. Weller,
Alaska Department of Fish and Game, Division of Sport Fish
2030 Sea Level Dr #20, Ketchikan, AK 99901, USA

Scott A. McPherson,
Alaska Department of Fish and Game, Division of Sport Fish
802 3rd St., Douglas, AK 99824, P.O. Box 110024, Juneau, AK 99811, USA

and
David R. Bernard
Retired, Division of Sport Fish, Anchorage

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ABSTRACT

Optimal production of adult Chinook salmon *Oncorhynchus tshawytscha* from the Unuk River was estimated using information from a stock assessment program (1981–2005) and catch sampling programs of the U.S. and Canadian troll, gillnet and recreational fisheries. Spawning abundance of large (≥660 mm MEF, primarily age-1.3 and older) fish was estimated from mark–recapture experiments (1997–2005), and from peak aerial and foot survey counts (1981–1996) expanded by a factor of 4.83. Spawning abundance of small (<660 mm MEF) fish was estimated either from mark–recapture experiments or their proportion seen in biological samples from the spawning tributaries. Age and sex composition for all years were also estimated from these samples. Bias in relative age and sex composition in escapements due to gear selectivity in years 1987 to 1990, 1994 and 1996 was corrected using sampling information from years with mark–recapture studies. Measurement error of spawning abundance was relatively low in all years. For brood years with coded wire tag (CWT) data (1982–1986 and 1992–1998), total fishing mortality, including incidental mortality and landed catch, was estimated from CWT recoveries by age. Abundance of harvested fish was estimated from expansions of CWT recoveries using the estimated marked fraction (θ) of CWTs in escapement samples. For brood years 1981 and 1987–1991, estimates of fishing mortality were estimated from averages in years with CWT data. Ricker spawner-recruit models were fit to four datasets: large adult spawners to age-.2 to -.5 returns, large adult spawners to age-.2 to -.5 returns with a marine survival covariate, and two large adult spawner to smolt datasets incorporating different time series. Point estimates of spawning abundance (S_{MSY}) that would on average produce maximum sustained yield (MSY) of age-1.2-1.5 returns ranged from 2,764 to 3,068 large spawners. Tests for autocorrelation in the fitted adult spawner to adult return model without the marine survival covariate were negative. We recommend that the Alaska Department of Fish and Game adopt a range of 1,800–3,800 large spawners for management purposes for this Chinook salmon stock. This recommendation comes from the model with the marine survival covariate, for which the point estimate was 2,764 with a 90% MSY range of 1,800–3,800 large spawners. The recommended range translates into 375–800 spawners counted in index escapement surveys. We also recommend continuation of current stock-assessment and harvest sampling programs.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Unuk River, spawning abundance, survey count, expansion factor, smolt abundance, age composition, harvest, coded wire tag, exploitation rate, escapement goal, stock-recruit analysis, sustained yield, survival.

INTRODUCTION

The Unuk River is a heavily glaciated transboundary river emptying in the northeast corner of Behm Canal 85 kilometers from Ketchikan (Figure 1). This approximately 2,570 km^2 drainage typically supports the fourth largest run of Chinook salmon *Oncorhynchus tshawytscha* in Southeast Alaska (SEAK) behind the Taku, Stikine, and Alsek rivers (Pahlke 2008). Most Chinook salmon spawn in the lower 39 kilometers of the 129-kilometer long river, a section that traverses the Misty Fjords National Monument (Mecum and Kissner 1989; Pahlke et al. 1996).

Chinook salmon from the Unuk River have a “stream type” life history. Adults enter the river during June and July and spawn from early August to early September. Nearly all juveniles reside for one year in freshwater before emigrating in spring as age-1.0 smolt. Early recoveries of coded wire tags (CWTs) suggested that members of the Unuk stock rear primarily within the confines of SEAK during their marine life (Mecum and Kissner 1989); however recoveries since that time indicate that some immature fish travel to waters off the Aleutian chain. Members of this stock are harvested in SEAK and northern British Columbia fisheries both as immature and adult salmon. Spawning salmon returning to the Unuk River are predominantly age-1.2, -1.3 and -1.4 fish. Age-1.5 fish represent less than 2% of the spawning population, and age-1.1 fish are incompletely enumerated and were ignored in the subsequent spawner-recruit analyses.

Assessment of the Unuk stock is part of the present comprehensive research and management program for stocks of Chinook salmon throughout SEAK, with initial assessments of the Unuk stock dating back to 1961 (Anthony et al. 1965; Mecum and Kissner 1989). Standardized (by time and area) survey counts have been conducted annually, by helicopter or foot, since 1977 in six

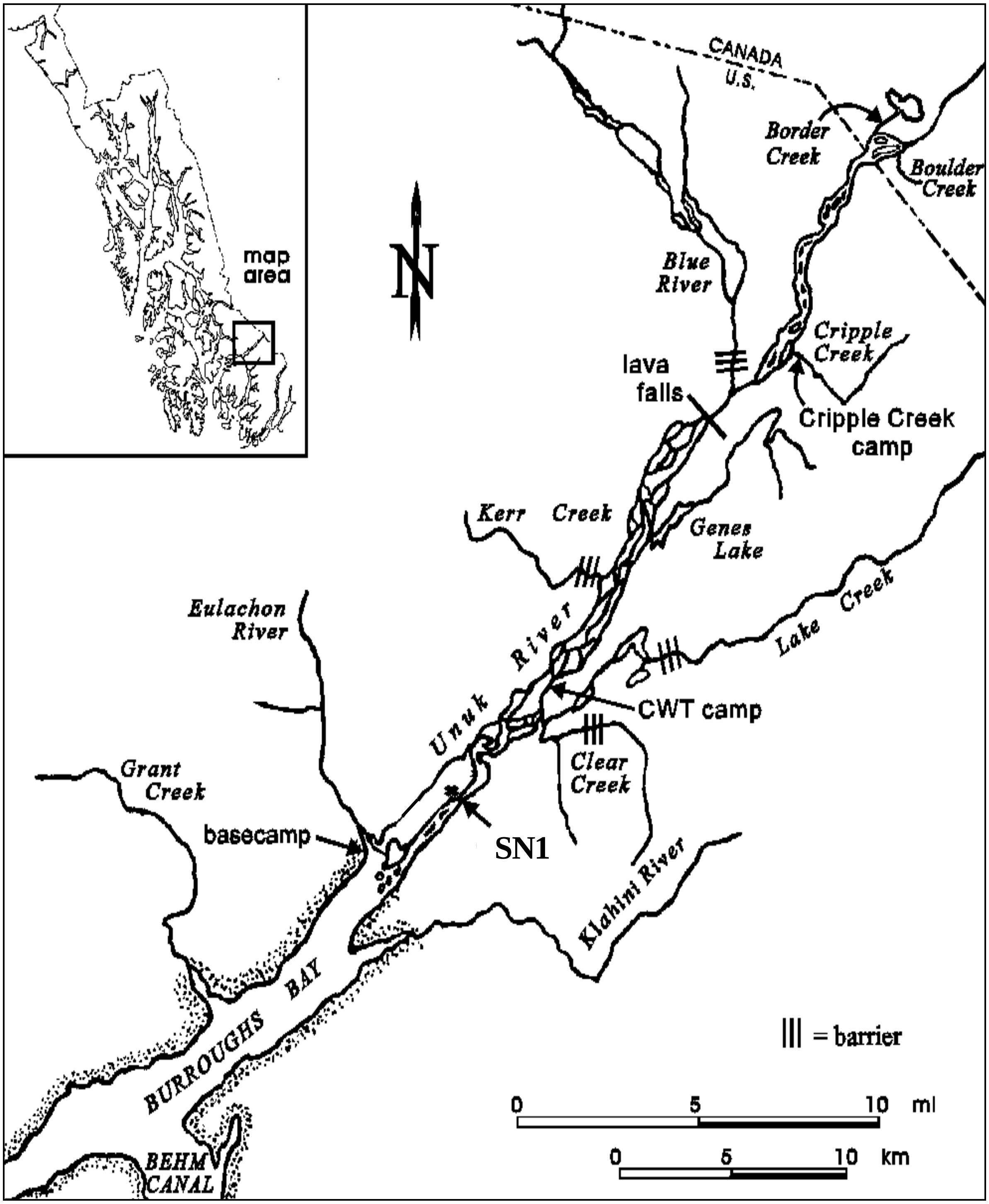

Figure 1.–Unuk River drainage in Southeast Alaska and northern British Columbia, showing major tributaries, barriers to Chinook salmon migration and location of ADF&G research sites.

U.S. tributaries: Eulachon River, and Clear, Cripple, Gene's Lake, Kerr and Lake creeks. The summation of the highest counts in each tributary is the survey count for that year. Only "large" (primarily age-.3 and older) Chinook salmon ≥660 mm MEF are counted. A radiotelemetry study was conducted in 1994 to estimate spawning distribution and to evaluate mark–recapture methods for estimating escapement. Results of that study indicate 80% of all spawning occurs in the standardized area for annual peak survey counts (Pahlke et al. 1996). Mark–recapture and coded wire tag (CWT) studies to estimate adult abundance, smolt abundance, and harvest rates were added to the stock assessment program in later years.

By the mid-1970s it was apparent that many Chinook salmon stocks in Southeast Alaska were depressed relative to historical levels (Kissner 1974). In response, most terminal and near-terminal commercial and recreational fisheries were closed to facilitate rebuilding of these stocks. In 1981 the management program was formalized and expanded into a 15-year (three life-cycle) rebuilding program for 11 stocks that included the Unuk stock (ADF&G 1981). The signing of the U.S./Canada Pacific Salmon Treaty (PST) in 1985 established a comprehensive coastwide rebuilding program for wild stocks of Chinook salmon, into which the existing Alaskan management and research program was incorporated. One objective of the PST (which was renegotiated in 1999 and 2008) is to manage stocks for harvests and escapements for maximum sustained yield (MSY).

Our principal objective in this document is to recommend the optimal escapement S_{MSY} expected to produce MSY of Chinook salmon from the Unuk River, and to describe the analyses and supporting data used to develop this recommendation. This is an update and expansion of work reported in McPherson and Carlile (1997), and includes the extensive body of stock assessment information obtained since that time (see Appendix A for a list of stock assessment projects conducted on the Unuk River from 1961 to 2005). Spawning escapements from 1981 to 2001 and returns from 1981 through 2005 were included in developing stock-recruit relationships for this stock. Escapement goals were derived from the analysis both in spawning abundance as estimated from mark–recapture studies and in the metric of survey counts.

STATISTICS

SPAWNING ABUNDANCE

Spawning abundance from 1997 to 2005 was estimated using two-event mark–recapture experiments (Weller and McPherson 2006a). In event one, adults were captured and marked in the lower river using set gillnets. Fish were examined for recovery of marks on the spawning grounds during the second event. Estimated abundance of large fish (≥660 mm MEF) was estimated from the marked fraction using Chapman's modification of the Petersen estimator (Seber 1982:60). Because probability of capture usually differed by size of fish in one or both events, abundance was stratified into separate estimates of large and small (<660 mm MEF) fish to produce unbiased estimates of spawning abundance. This stratification also provided the basis for expansions of survey counts of large fish to spawning abundance. Estimation of spawning abundance of small fish is mentioned in the next section and covered in further detail in Appendix B.

Abundance of large spawners in years without mark–recapture experiments was estimated indirectly from an expansion factor calculated from the relationship between mark–recapture estimates and survey counts in years (1997–2004) when both were completed successfully (Table 1). Due to delays from staffing issues in conducting survey counts in 2002, that year was not included in calculating the expansion factor. These staffing issues resulted in late and missing survey counts in three of the six tributaries surveyed annually for peak counts, i.e., Cripple and Clear creeks and the Eulachon River. For example, the peak survey count in 2002 for Cripple Creek on August 16th is a date beyond which 93% of historical peak counts had occurred, and in Clear Creek August 15th is a date beyond which 89% of historical peak counts had occurred. In all three systems, only one standard survey was completed after a major flood had washed any carcasses downstream, and outside of the historical peak survey count window in two of the three systems. Additionally, the number of fish sampled for biological data in these three systems exceeded the peak survey count, while the opposite occurred at the other three tributaries in the index (Genes Lake, Lake and Kerr creeks). The net result was that peak abundance was missed in 2002 where the majority of spawning takes place in the Unuk River drainage, atypical of past peak survey counts.

An expansion factor for calendar year t (π_t) for large spawners was estimated by:

$$\hat{\pi}_t = \hat{S}_t / C_t \qquad (1)$$

$$\mathrm{var}(\hat{\pi}_t) = \mathrm{var}(\hat{S}_t) / C_t^2 \qquad (2)$$

where t is the year with a mark–recapture estimate of large spawners $\hat{S}_t$ and C_t is the peak count of large spawners from the air in year t.

The mean or long-term expansion factor ($\bar{\pi}$) was estimated by:

$$\bar{\pi} = \sum_{t=1}^{k} \hat{\pi}_t \; / \; k \qquad (3)$$

$$\mathrm{var}(\bar{\pi}) = \frac{\sum_{t=1}^{k} \left(\hat{\pi}_t - \bar{\pi}\right)^2}{(k-1)} \qquad (4a)$$

$$\mathrm{var}(\pi) = \frac{\sum_{t=1}^{k} \left(\hat{\pi}_t - \bar{\pi}\right)^2}{(k-1)} - \frac{\sum_{t=1}^{k} \mathrm{var}(\hat{\pi}_t)}{k} \qquad (4b)$$

where k is the number of years with successful matched mark-recapture experiments and survey counts (seven years). Note that we used Eq (4a) for estimating the variance of π. Inclusion of the second term in Eq (4b) is designed to remove the measurement error from mark–recapture estimates from the expansion factor variance. Using Eq (4b) for the variance of π, the CV is 6.2%, whereas it is 12.2% using Eq (4a). The average CV for spawning abundance estimates in 1997–2004 (years with mark–recapture studies) is 10.2%. We did not believe that the CV of escapements for years without mark–recapture experiments should be less than the 1997–2004 studies and chose to use Eq (4a) in estimating the precision of spawning abundance for 1977–1996. We recommend that this issue be further investigated.

Estimated abundance (total escapement of large spawners) in a year y without a mark–recapture experiment was estimated by:

$$\hat{S}_t = \bar{\pi}\, C_t \qquad (5)$$

$$\mathrm{var}(\hat{S}_t) = C_t^2 \; \mathrm{var}(\bar{\pi}) \qquad (6)$$

The estimated mean expansion factor $\bar{\pi}$ was 4.83 (SE = 0.59), based on the 7 years of coupled estimates (Table 1). Estimated spawning

Table 1.–Peak survey counts, mark–recapture estimates and expansion factors $\hat{\pi}_t$ for the escapement of large Chinook salmon (≥660 mm MEF) in the Unuk River, 1997–2004.

	Year								
Statistic	1997	1998	1999	2000	2001	2002	2003	2004	Average [a]
Survey count C_t	636	840	680	1,341	2,019	897	1,121	1,008	1,092
M-R estimate $\hat{S}_t$	2,970	4,132	3,914	5,872	10,541	6,988	5,546	3,963	5,277
SE ($\hat{S}_t$)	277	413	490	644	1,181	805	433	325	
95% RP ($\hat{S}_t$)	18.3%	19.6%	24.5%	21.5%	22.0%	22.6%	15.3%	16.1%	19.6%
($\hat{S}_t$)lower 95% CI [b]	2,499	3,433	3,110	4,848	8,705	5,759	4,814	3,406	
($\hat{S}_t$) upper 95% CI [b]	3,636	4,974	5,071	7,347	13,253	8,677	6,530	4,684	
C_t / ($\hat{S}$)	21.4%	20.3%	17.4%	22.8%	19.2%	12.8%	20.2%	25.4%	21.0%
$\hat{\pi}_t$	4.67	4.92	5.76	4.38	5.22	7.79	4.95	3.93	4.83
SE ($\hat{\pi}_t$)	0.44	0.49	0.72	0.48	0.58	0.90	0.39	0.32	0.59
CV ($\hat{\pi}_t$)	9.3%	10.0%	12.5%	11.0%	11.2%	11.5%	7.8%	8.2%	12.2%

[a] Averages do not include 2002 because the foot survey counts in that year were conducted abnormally late due to staffing issues, atypical of other years.

[b] The 95% CIs were estimated from bootstrap methods.

abundance of large fish $\hat{S}_t$ for all available years ranged from just under 3,000 fish in 1979, 1990 and 1997 to over 10,000 fish in 1986 and 2001 (Table 2).

ESCAPEMENT-AT-AGE

We included production of age-.2 to -.5 fish in our analyses. The estimates of large spawners in Table 2 do not include most of the age-1.2 fish. The methods used to estimate spawning abundance of these smaller fish are detailed in Appendix B.

Escapements were sampled on the spawning grounds in 1982 and 1984–2005 to estimate relative age and sex composition and mean length; however, some of the samples collected prior to 1997 were biased because of the collection methods. Mark–recapture studies from 1997 to 2005 indicated that collecting carcasses or spearing moribund fish to obtain samples tended to be size-selective toward larger and older salmon. We employed methods to remove these sources of bias in age-sex proportions as detailed in Appendices B and C.

Relative age-sex composition for all other years was estimated within large and small size classes directly from proportions sampled on the spawning grounds. Proportions by age in the spawning ground samples, within a calendar year, were estimated by:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j} , \tag{7}$$

$$\text{var}[\hat{p}_{ij}] = \frac{\hat{p}_{ij}\ (1-\hat{p}_{ij})}{n_j - 1}, \tag{8}$$

where p_{ij} is the proportion in the population in age/sex group i in size group j, n_j is the number in the sample for which age and sex were successfully determined, and n_{ij} is the subset of n_j belonging to group i.

Estimated spawning abundance of age i fish in size group j is:

$$\hat{S}_{ij} = \hat{S}_i\ \hat{p}_{ij} \tag{9}$$

with variance estimated according to procedures in (Goodman 1960):

$$\begin{aligned} &\text{var}(\hat{S}_{ij}) = \text{var}(\hat{p}_{ij})\hat{S}^2 + \hat{p}_{ij}^2\,\text{var}(\hat{S}_i) \\ &- \text{var}(\hat{p}_{ij})\,\text{var}(\hat{S}_i) \end{aligned} \tag{10}$$

Broods returning in years with no or limited sampling for age composition (1977–1980 brood years; calendar years 1977–1984) were not included in estimation of optimal production. Estimates of escapement by calendar year, age, and large male and female fish and their associated SEs are in Table 3. Estimates of inriver returns of by age and brood year and their associated SEs are in Table 4.

SMOLT ABUNDANCE

Smolt abundance by brood year was estimated from two-event capture–recapture experiments. Coded wire tags were implanted into smolt and/or fingerlings from the 1982–1986 and 1992–2001 brood years. Trapping and tagging details and statistics for smolt and fingerlings tagged are detailed in Appendix D for brood years 1992–2004 (see Pahlke 1995a for 1982–1986 brood years). Using baited minor traps, young fish were captured in the lower to middle stretches of the Unuk River drainage where they rear (Kissner and Hubartt 1986). The fraction of brood year *y* tag in year *y*+2 as smolt was estimated by summing data on adults of that year class sampled on the spawning grounds or caught in the lower river tagging operations in years *y*+3, *y*+4, *y*+5, *y*+6 and *y*+7. Recovery from adults on the spawning grounds showed that tagged smolts represented all subpopulations in the Unuk River in near equal proportions. The estimated marked fraction of year class *y* was multiplied by the number tagged in year *y*+2 to estimate the number of smolt emigrating that year as per a simple, two-event mark–recapture experiment on a closed population (Seber 1982:60).

The estimated smolt abundance, return rates (survival) and associated SEs are presented in Table 5, along with the number of spawners, smolt/spawner and the adult recruits. Average smolt production from 1982 to 1986 and 1992–1998 was an estimated 331,187, and ranged from

Table 2.–Peak survey counts from aerial and foot surveys and estimated total spawning abundance with associated standard errors and approximate 95% CIs for large ($\geq$660 mm MEF) Chinook salmon spawning in the Unuk River from 1977 through 2005. Statistics in bold face come directly from mark–recapture experiments in 1997–2005; all other statistics are expanded from counts based on the relationship between counts and mark–recapture estimates of large spawners.

Year	Counts	$\hat{S}$	SE ($\hat{S}$)	CV($\hat{S}$)	-1.96 SE ($\hat{S}$)	+1.96 SE($\hat{S}$)
1977	974	4,706	572	12.2%	3,585	5,827
1978	1,106	5,344	649	12.2%	4,071	6,617
1979	576	2,783	338	12.2%	2,120	3,446
1980	1,016	4,909	597	12.2%	3,740	6,078
1981	731	3,532	429	12.2%	2,691	4,373
1982	1,351	6,528	793	12.2%	4,973	8,083
1983	1,125	5,436	660	12.2%	4,141	6,730
1984	1,837	8,876	1,079	12.2%	6,762	10,990
1985	1,184	5,721	695	12.2%	4,359	7,083
1986	2,126	10,273	1,248	12.2%	7,826	12,719
1987	1,973	9,533	1,158	12.2%	7,263	11,804
1988	1,746	8,437	1,025	12.2%	6,427	10,446
1989	1,149	5,552	675	12.2%	4,230	6,874
1990	591	2,856	347	12.2%	2,176	3,536
1991	655	3,165	385	12.2%	2,411	3,919
1992	874	4,223	513	12.2%	3,217	5,229
1993	1,068	5,160	627	12.2%	3,931	6,389
1994	711	3,435	417	12.2%	2,617	4,254
1995	772	3,730	453	12.2%	2,842	4,619
1996	1,167	5,639	685	12.2%	4,296	6,982
1997[a]	636	**2,970**	**277**	**9.3%**	**2,499**	**3,636**
1998[b]	840	**4,132**	**413**	**10.0%**	**3,433**	**4,974**
1999[c]	680	**3,914**	**490**	**12.5%**	**3,110**	**5,071**
2000[d]	1,341	**5,872**	**644**	**11.0%**	**4,848**	**7,347**
2001[e]	2,019	**10,541**	**1,181**	**11.2%**	**8,705**	**13,253**
2002[f]	897	**6,988**	**805**	**11.5%**	**5,759**	**8,677**
2003[g]	1,121	**5,546**	**433**	**7.8%**	**4,814**	**6,530**
2004[h]	1,008	**3,963**	**325**	**8.2%**	**3,406**	**4,684**
2005[i]	929	**4,742**	**396**	**8.4%**	**3,966**	**5,518**

[a] Estimates from Jones et al. (1998). CIs are from bootstrapping.

[b] Estimates from Jones and McPherson (1999). CIs are from bootstrapping.

[c] Estimates from Jones and McPherson (2000). CIs are from bootstrapping.

[d] Estimates from Jones and McPherson (2002). CIs are from bootstrapping.

[e] Estimates from Weller and McPherson (2003a). CIs are from bootstrapping.

[f] Estimates from Weller and McPherson (2003b). CIs are from bootstrapping.

[g] Estimates from Weller and McPherson (2004). CIs are from bootstrapping.

[h] Estimates from Weller and McPherson (2006a). CIs are from bootstrapping.

[i] Estimates from Weller and McPherson (2006b). CIs are from bootstrapping.

Table 3.–Estimated numbers of Chinook salmon by age and by large (≥660 mm MEF) females and males spawning in the Unuk River, 1985–2005. Bold numbers came directly from mark–recapture experiments. Standard errors are in parentheses. Years with numbers in italics were corrected for bias in age-sex composition.

Calendar year	Age 1.2	Age 1.3	Age 1.4	Age 1.5	Total	Large females	Large males
1985	3,103 (373)						
1986	7,132 (970)	5,123 (657)	4,800 (646)	92 (54)	17,147 (1,581)	6,757 (862)	3,516 (502)
1987	*2,011* (199)	*4,578* (546)	*4,261* (574)	50 (36)	*10,900* (1,175)	*5,741* (768)	*3,792* (562)
1988	*1,293* (244)	*3,358* (484)	*4,433* (577)	64 (37)	*9,148* (1,054)	*3,856* (574)	*4,580* (648)
1989	*337* (437)	*2,544* (347)	*2,721* (384)	80 (47)	*5,682* (804)	*3,393* (477)	*2,159* (356)
1990	*1,509* (216)	*707* (214)	*1,526* (293)	145 (84)	*3,887* (409)	*1,624* (304)	*1,232* (276)
1991	786 (114)	2,414 (300)	551 (94)	38 (19)	3,789 (401)	1,369 (187)	1,796 (234)
1992	1,319 (207)	1,914 (260)	2,232 (299)	30 (21)	5,496 (553)	2,836 (364)	1,388 (206)
1993	568 (93)	2,241 (291)	2,797 (357)	99 (33)	5,704 (634)	2,818 (360)	2,343 (306)
1994	*1,044* (287)	*1,383* (294)	*2,124* (292)	122 (42)	*4,673* (506)	*2,039* (287)	*1,396* (223)
1995	1,616 (486)	995 (327)	2,362 (438)	- -	4,974 (665)	1,989 (420)	1,741 (403)
1996	*736* (349)	*3,061* (409)	*2,319* (348)	187 (54)	*6,303* (769)	*2,661* (397)	*2,978* (429)
1997	**916** (151)	**1,240** (128)	**1,408** (143)	**59** (17)	**3,623** (315)	**1,658** (165)	**1,312** (135)
1998	**1,269** (235)	**2,595** (267)	**1,207** (140)	**35** (15)	**5,106** (475)	**2,087** (222)	**2,045** (219)
1999	**2,427** (540)	**1,918** (255)	**1,581** (215)	**16** (12)	**5,942** (729)	**1,998** (265)	**1,916** (256)
2000	**3,140** (947)	**3,499** (394)	**1,447** (185)	**50** (21)	**8,136** (1,145)	**2,506** (295)	**3,366** (385)
2001	**946** (127)	**6,923** (789)	**3,337** (404)	**21** (15)	**11,227** (1,188)	**5,697** (659)	**4,844** (567)
2002	**2,485** (697)	**2,887** (358)	**3,188** (392)	**66** (27)	**8,626** (1,060)	**3,330** (407)	**3,658** (443)
2003	**592** (68)	**3,942** (318)	**1,474** (139)	**46** (16)	**6,054** (440)	**2,874** (241)	**2,673** (227)
2004	**2,936** (334)	**1,289** (122)	**1,756** (160)	**19** (10)	**6,000** (470)	**1,645** (151)	**2,318** (202)
2005	**521** (106)	**3,808** (321)	**842** (97)	**13** (9)	**5,184** (433)	**1,947** (184)	**2,795** (249)

Table 4.–Estimated parent year escapement $\hat{S}_y$, and inriver returns by brood year $\hat{E}_y$ and age class $\hat{E}_{iy}$, for Unuk River Chinook salmon in brood years 1981–1998. Estimates in bold are directly from mark–recapture studies. Standard errors are in parentheses.

		Inriver returns by age class ($\hat{E}_{iy}$)								Total		
Brood year	$\hat{S}_y$	Age-1.2		Age-1.3		Age-1.4		Age-1.5		Age-.2-.5 ($\hat{E}_y$)	SE ($\hat{E}_y$)	CV ($\hat{E}_y$)
1981	3,532	3,103	(373)	5,123	(657)	4,261	(574)	64	(37)	12,552	(949)	5.7%
1982	6,528	7,132	(970)	4,578	(546)	4,433	(577)	80	(47)	16,223	(1,254)	5.8%
1983	5,436	2,011	(199)	3,358	(484)	2,721	(384)	145	(84)	8,235	(655)	6.7%
1984	8,876	1,293	(244)	2,544	(347)	1,526	(293)	38	(19)	5,401	(516)	8.6%
1985	5,721	337	(437)	707	(214)	551	(94)	30	(21)	1,626	(496)	30.0%
1986	10,273	1,509	(216)	2,414	(300)	2,232	(299)	99	(33)	6,254	(476)	5.3%
1987	9,533	786	(114)	1,914	(260)	2,797	(357)	122	(42)	5,619	(458)	5.1%
1988	8,437	1,319	(207)	2,241	(291)	2,124	(292)	-	-	5,684	(461)	5.9%
1989	5,552	568	(93)	1,383	(294)	2,362	(438)	187	(54)	4,500	(539)	9.2%
1990	2,856	1,044	(287)	995	(327)	2,319	(348)	**59**	(17)	4,417	(558)	11.8%
1991	3,165	1,616	(486)	3,061	(409)	**1,408**	(143)	**35**	(15)	6,121	(652)	9.8%
1992	4,223	736	(349)	**1,240**	(128)	**1,207**	(140)	**16**	(12)	3,199	(397)	12.4%
1993	5,160	**916**	(151)	**2,595**	(267)	**1,581**	(215)	**50**	(21)	**5,142**	(375)	7.3%
1994	**3,435**	**1,269**	(235)	**1,918**	(255)	**1,447**	(185)	**21**	(15)	**4,655**	(393)	8.4%
1995	3,730	**2,427**	(540)	**3,499**	(394)	**3,337**	(404)	**66**	(27)	**9,329**	(782)	8.4%
1996	5,639	**3,140**	(947)	**6,923**	(789)	**3,188**	(392)	**46**	(16)	**13,297**	(1,294)	9.7%
1997	**2,970**	**946**	(127)	**2,887**	(358)	**1,474**	(139)	**19**	(10)	**5,326**	(405)	7.6%
1998	**4,132**	**2,485**	(697)	**3,942**	(318)	**1,756**	(160)	**13**	(9)	**8,196**	(783)	9.6%

174,173 smolt produced from the 1986 year class to 510,516 smolt produced from the 1982 year class. The adult return rate for this time period averaged 0.0291 (2.91%), and ranged from 0.9% (y = 1992) to 5.3% (y = 1986). Mean fork length of tagged smolt varied little over the time series, from 65.8 mm to 75.3 mm. We found no relationship between smolt size and survival; i.e., year classes with larger smolt did not necessarily have higher marine survival (brood years 1982–1984, 1986 and 1992–1998; p-value = 0.48). We also saw no evidence of density-dependent growth in the relationship between smolt abundance and smolt size (brood years 1982–1984, 1986 and 1992–2001; p-value = 0.17).

FISHING MORTALITY

Recoveries of CWTs were used to estimate the harvest of Chinook salmon in marine waters (landed catch) directly for the 1982–1986 and 1992–1998 year classes. This entailed estimating the marked fraction from escapement sampling in order to expand CWTs recovered in marine fisheries. Sampling statistics and marked fractions (θ) by brood year estimated from tagged proportions in escapement samples are detailed in Appendix E. Landed catch and associated variance was estimated directly from recoveries expanded to numbers of fish using methods in Bernard and Clark (1996). Estimated landed catch by gear, temporal and geographic strata, and distribution for brood years 1992–2001 are detailed in Appendix E (Pahlke 1995a for 1982–1986 brood years). Note that the Unuk River drainage is closed to Chinook fishing.

Fishing mortality is the sum of landed catch and incidental mortality, those fish that are caught and released and estimated to have suffered mortality as a result of that experience. Incidental mortality by brood year was estimated based on CWTs recovered in marine fisheries and from algorithms used in annual exploitation rate analyses (John Carlile, ADF&G, personal communication) by the Pacific Salmon Commission's Chinook Technical Committee (CTC 2005). Cohort analysis embedded in that process estimates the landed catch and fishing mortality rates. Incidental

Table 5.–Estimated abundance of large spawners $\hat{S}_y$, large female spawners $\hat{S}_{fy}$, smolt abundance $\hat{N}_y$, and adult returns $\hat{R}_y$ (in adult equivalents), and mean fork length (FL) of smolts, smolts per parent and adult return rate for brood years 1982–1986 and 1992–2001. Adult returns are in adult equivalents and include incidental mortality. Spawners are large ($\geq$660 mm MEF) fish. Standard errors are in parentheses.

Brood Year	$\hat{S}_y$	$\hat{S}_{fy}$	$\hat{N}_y$	CV($\hat{N}_y$)	FL mm	$\hat{N}_y / \hat{S}_y$	$\hat{R}_y$	$\hat{R}_y / \hat{N}_y$
1982	6,528	3,779	510,516 (115,976)	22.7%	67.4	78.2 (20)	20,447	0.040 (0.0095)
1983	5,436	N/A	425,577 (99,312)	23.3%	69.0	78.3 (21)	11,167	0.026 (0.0065)
1984	8,876	4,985	344,772 (108,003)	31.3%	66.0	38.8 (13)	6,960	0.020 (0.0067)
1985	5,721	4,181	300,767 (111,989)	37.2%		52.6 (21)	2,598	0.009 (0.0038)
1986	10,273	6,757	174,173 (23,997)	13.8%	69.6	17.0 (3)	9,157	0.053 (0.0083)
1992	4,223	2,836	405,057 (75,165)	18.6%	75.3	95.9 (21)	3,842	0.009 (0.0021)
1993	5,160	2,818	188,746 (15,377)	8.1%	73.2	36.6 (5)	6,769	0.036 (0.0039)
1994	3,435	2,039	238,023 (23,377)	9.8%	70.2	69.3 (11)	6,002	0.025 (0.0032)
1995	3,730	1,989	314,609 (20,808)	6.6%	71.2	84.3 (12)	12,306	0.039 (0.0038)
1996	5,639	2,661	486,678 (27,627)	5.7%	65.8	86.3 (12)	16,424	0.034 (0.0034)
1997	2,970	1,658	313,589 (27,357)	8.7%	70.6	105.6 (13)	6,839	0.022 (0.0025)
1998	4,132	2,087	271,735 (18,216)	6.7%	71.5	65.8 (8)	10,081	0.037 (0.0040)
1999	3,914	1,998	294,676 (30,912)	10.5%	67.4	75.3 (12)		
2000	5,872	2,506	397,200 (28,551)	7.2%	68.6	67.6 (9)		
2001	10,541	5,697	353,532 (61,370)	17.4%	66.1	33.5 (7)		

mortality was calculated by estimating the number of fish released by a gear sector (e.g., troll, sport, gillnet or seine) multiplied by the gear-specific rate of mortality used by the CTC (CTC 1997), and then summed across gear types.

Both landed catch and incidental mortality were converted into adult equivalents (AEQs) for spawner-recruit analysis, because not all fish caught would have spawned in that year. Immature fish not harvested suffer at least one year of further natural mortality before spawning than do mature fish of the same age (McPherson and Carlile 1997). Mortalities of younger fish need to be converted to AEQs by the probability that with no harvest, a given age fish of a specific stock would accrue to the spawning escapement of the current or any future year (Morishima 2004). Exploitation, maturation and marine survival patterns also vary between cohorts, thus factors are both age and brood specific. Conversion factors for AEQs for the Unuk stock (Table 6) were calculated using cohort analysis on recoveries of CWTs as outlined by the Pacific Salmon Commission (PSC 2005). Marine survival was calculated as the fraction of total adult returns over the smolt abundance for the same brood year.

Marking juveniles with CWTs in the 1982–1986 and the 1992–1998 broods allowed for direct estimates of total fishing mortality and marine survival. We found no relationship between these estimates and estimates for local hatchery stocks (Southern Southeast Regional Aquaculture Association [SSRRA] and Little Port Walter [LPW]) in the same brood years (see Figures 2 and 3 below). Because of the lack of a relationship between the exploitation rates of either the SSRRA or the LPW stocks and that of the wild stock (adjusted R^2 = 0.095 and 0.021, correspondingly), we estimated fishing mortality

Table 6.–Adult equivalent conversion factors for harvested Chinook salmon from exploitation rate analysis, based on coded wire tag recoveries.

Brood Year	1.1	1.2	1.3	1.4	1.5
1982	0.6008	0.8405	0.9464	1	1
1983	0.6285	0.7959	0.9464	1	1
1984	0.6105	0.8034	0.9556	1	1
1985	0.5816	0.7892	0.9492	1	1
1986	0.5749	0.7898	0.9408	1	1
1992	0.5636	0.7959	0.9461	1	1
1993	0.5584	0.7873	0.95	1	1
1994	0.572	0.8028	0.949	1	1
1995	0.5665	0.7972	0.9445	1	1
1996	0.5735	0.8079	0.9617	1	1
1997	0.5593	0.7916	0.9554	1	1
1998	0.5779	0.8193	0.9621	1	1
1999	0.5806	0.8017	0.9506	1	1

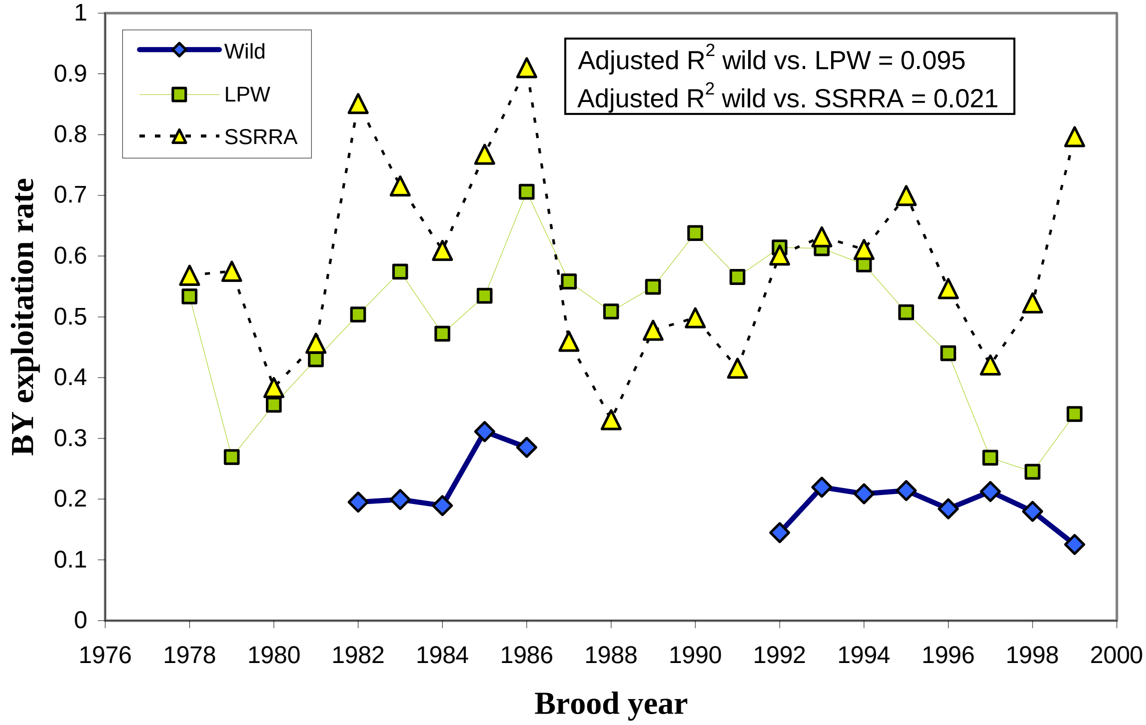

Figure 2.–Plot of Little Port Walter (LPW) and Southern Southeast Regional Aquaculture Association (SSRRA) hatchery and wild Unuk River Chinook salmon exploitation rates for brood years 1977–1999. Brood years 1977–1981 and 1987–1991 do not have wild harvest data. Exploitation rates are estimated from adult equivalent numbers including incidental mortality, and terminal hatchery harvests are combined with escapement.

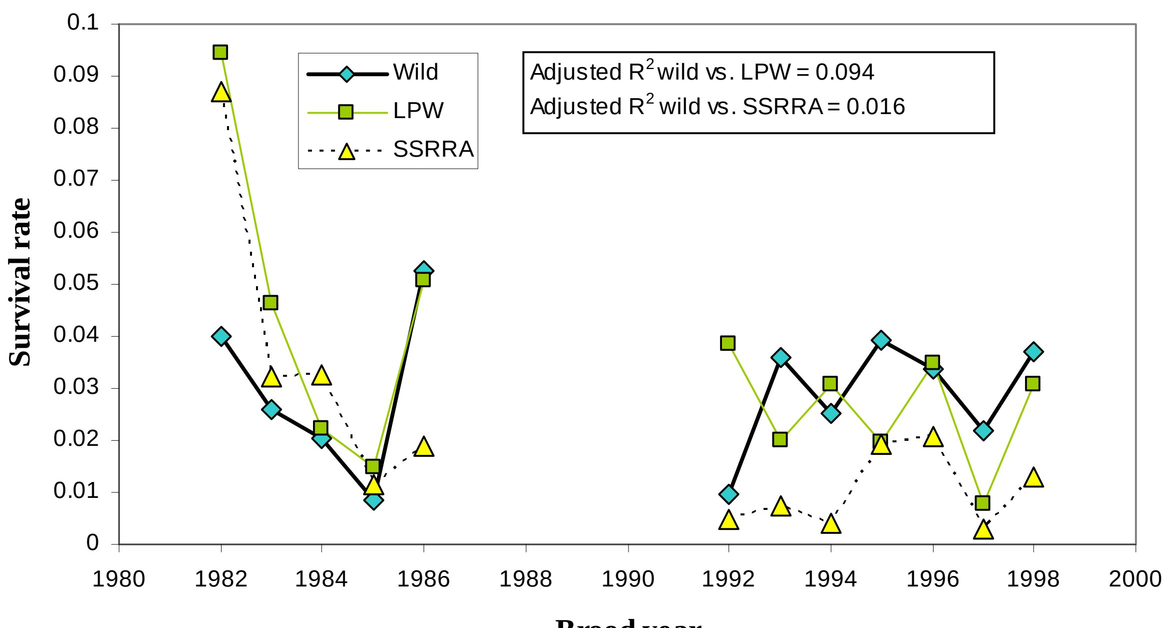

Figure 3.–Plot of Little Port Walter (LPW) and Southern Southeast Regional Aquaculture Association (SSRRA) hatchery and wild Unuk River Chinook salmon return rates for brood years 1982–1986 and 1992–1998. Brood years 1987–1991 do not have wild harvest data. Survival rates are estimated from total adult return rate, in adult equivalent numbers, from smolt.

for the 1981 and 1987–1991 brood years from the average ERs observed for broods with direct estimates from wild stock tagging in the Unuk River. Overall exploitation rates for the Unuk stock averaged 24% in AEQs (27 % in nominal currency), 27% (6% of total returns) of which was estimated as incidental mortality (see exploitation rate section for formulas). Hereafter in the text of this report, numbers incorporating harvest data are given in AEQs. Estimates of landed catch by age and brood year, and total landed catch and incidental mortality by brood year are in Table 7. Estimates of landed catch, incidental mortality, and total fishing mortality $F\hat{M}_y$ in AEQs by age and brood year are in Table 8.

Variances for incidental mortality by age were not directly estimated as these are not estimated in the algorithms used by the CTC in the exploitation rate/cohort analysis, from which the incidental mortalities in this report were derived. We assumed that the relative precision of the estimated total fishing mortality $F\hat{M}_y$ was proportional to that of the estimated landed catch $\hat{H}_y$ for year class y:

$$\frac{\sqrt{\operatorname{var}(F\hat{M}_y)}}{F\hat{M}_y} \approx \frac{\sqrt{\operatorname{var}(\hat{H}_y)}}{\hat{H}_y} \tag{11}$$

or:

$$SE(F\hat{M}_y) = F\hat{M}_y \frac{\sqrt{\operatorname{var}(\hat{H}_y)}}{\hat{H}_y} \tag{12}$$

and:

$$\operatorname{var}(I\hat{M}_y) = \operatorname{var}(F\hat{M}_y) - \operatorname{var}(\hat{H}_y)\ . \tag{13}$$

Using this assumption the CVs for $\hat{H}_y$ and $F\hat{M}_y$ averaged 23.6% and 60.9% for $I\hat{M}_y$.

PRODUCTION

Estimated production of adults $\hat{R}_y$ from brood year y was calculated:

$$\hat{R}_y = \sum_{i=2}^{5} \hat{S}_{1.i,y+i+2} + \sum_{i=1}^{5} \hat{H}_{1.i,y+i+2} + \sum_{i=1}^{5} I\hat{M}_{1.i,y+i+1} \tag{14}$$

as the sum of members of that year class accruing to estimated escapements $\hat{S}_y$, caught in marine harvests $\hat{H}_y$ and incidental mortalities $I\hat{M}_y$.

The estimated variance $\operatorname{var}(\hat{R}_y)$ was calculated as the sum of the variances of these three components as the sampling and estimation programs for each were independent:

$$\operatorname{var}(\hat{R}_y) = \sum_{i=2}^{5} \operatorname{var}(\hat{S}_{1.i,y+i+2}) + \sum_{i=1}^{5} \operatorname{var}(\hat{H}_{1.i,y+i+2}) + \sum_{i=1}^{5} \operatorname{var}(I\hat{M}_{1.i,y+i+1}) \tag{15}$$

where $\hat{S}_{1.i,y+i+2}$ is the estimated number of spawners age-1.i (1-freshwater age, i.e., age classes 1.2, 1.3, 1.4 and 1.5) in year $y+i+2$. Similarly, $\hat{H}_{1.i,y+i+2}$ is the estimated harvest of Chinook salmon age-.1 to age-.5 for brood year y, and $I\hat{M}_{1.i,y+i+2}$ is the corresponding number for incidental mortality. Note that age-1.1 fish are included in the harvest estimates, because the timing of the harvest of almost all of these fish indicates they would have spawned a year or more later. Abundance of age-1.1 fish in escapements was not estimated in almost all years and they were excluded from the analyses. Estimated inriver and total returns of age-2.-.5 fish (age classes 1.2, 1.3, 1.4 and 1.5) in the Unuk River escapements are shown in Table 9, with harvest and incidental mortality presented as total fishing mortality. Total returns ranged between 2,598 and 20,447 age-2.-.5 fish from the 1981–1998 brood years.

EXPLOITATION RATE

The estimated exploitation rate and its estimated variance were calculated as:

$$\hat{U}_y = \frac{F\hat{M}_y}{\hat{R}_y} \tag{16}$$

$$\operatorname{var}\left[\hat{U}_y\right] \approx \frac{\operatorname{var}[F\hat{M}_y]\,\hat{S}_y^2}{\hat{R}_y^4} + \frac{\operatorname{var}[\hat{S}_y]\,F\hat{M}_y^{\,2}}{\hat{R}_y^4} \tag{17}$$

The variance above was approximated with the delta method (Seber 1982:7-9).

Table 7.–Estimates of landed catch by brood year $\hat{H}_y$ and age class $\hat{H}_{iy}$, and of total incidental mortality $I\hat{M}_y$, for Chinook salmon from the Unuk River brood years 1981–1998. Total landed catch and incidental mortality estimates for brood years 1981 and 1987–1991(italicized) were approximated based on averages for 1982–1986 and 1993–1998. Standard errors are in parentheses.

Brood year	Landed catch by age class ($\hat{H}_{iy}$) Age 1.1		Age 1.2		Age 1.3	Age 1.4		Age 1.5		Total harvest Age-1.1–1.5 ($\hat{H}_y$)	SE($\hat{H}_y$)	Total Incidental Mortality ($I\hat{M}_y$)	SE ($I\hat{M}_y$)
PANEL A: NOMINAL NUMBERS													
1981										*3,163*	*(868)*	*1,448*	*(920)*
1982	294	(131)	1,876	(367)	841 (249)	267	(132)			3,278	(481)	1,894	(587)
1983	214	(214)	667	(308)	1,356 (423)	108	(107)	108	(107)	2,454	(586)	1,027	(589)
1984	312	(303)	105	(101)	557 (327)	247	(174)	-	-	1,221	(489)	675	(581)
1985	-	-	303	(168)	356 (225)	62	(61)	-	-	720	(287)	462	(374)
1986	24	(24)	829	(306)	465 (121)	967	(271)	-	-	2,285	(427)	1,124	(472)
1987										*1,416*	*(388)*	*648*	*(412)*
1988										*1,432*	*(393)*	*656*	*(417)*
1989										*1,134*	*(311)*	*519*	*(330)*
1990										*1,113*	*(305)*	*510*	*(324)*
1991										*1,542*	*(423)*	*706*	*(449)*
1992	35	(35)	81	(80)	268 (157)	155	(155)	-	-	539	(237)	207	(227)
1993	-	-	233	(98)	416 (124)	662	(192)	-	-	1,311	(249)	533	(247)
1994	-	-	147	(73)	591 (186)	362	(132)	-	-	1,100	(239)	434	(232)
1995	101	(73)	311	(92)	1,356 (233)	569	(132)	-	-	2,336	(292)	1,181	(329)
1996	19	(13)	714	(229)	1,055 (174)	755	(153)	-	-	2,543	(327)	1,064	(328)
1997	-	-	96	(50)	680 (171)	517	(181)	23	(23)	1,317	(255)	362	(201)
1998	59	(58)	245	(86)	908 (196)	359	(147)	-	-	1,571	(267)	593	(252)
PANEL B: ADULT EQUIVALENTS													
1981										*2,885*	*(792)*	*1,055*	*(736)*
1982	177	(78)	1,577	(308)	796 (236)	267	(132)	-	-	2,816	(413)	1,408	(462)
1983	135	(135)	530	(245)	1,284 (401)	108	(107)	108	(107)	2,165	(517)	767	(472)
1984	190	(185)	84	(81)	532 (313)	247	(174)	-	-	1,054	(422)	505	(460)
1985	-	-	239	(133)	338 (213)	62	(61)	-	-	638	(255)	334	(293)
1986	14	(14)	655	(242)	437 (114)	967	(271)	-	-	2,073	(387)	830	(380)
1987										*1,292*	*(354)*	*472*	*(330)*
1988										*1,307*	*(358)*	*478*	*(333)*
1989										*1,035*	*(284)*	*378*	*(264)*
1990										*1,015*	*(279)*	*371*	*(259)*
1991										*1,407*	*(386)*	*515*	*(359)*
1992	20	(20)	64	(64)	253 (149)	155	(155)	-	-	493	(217)	151	(182)
1993	-	-	183	(78)	395 (118)	662	(192)	-	-	1,240	(236)	386	(200)
1994	-	-	118	(58)	561(176)	362	(132)	-	-	1,041	(226)	307	(186)
1995	57	(41)	248	(73)	1,280 (220)	569	(132)	-	-	2,154	(269)	822	(257)
1996	11	(7)	577	(185)	1,015 (168)	755	(153)	-	-	2,357	(303)	770	(264)
1997	-	-	76	(40)	650 (163)	517	(181)	23	(23)	1,266	(245)	247	(160)
1998	34	(34)	201	(71)	874 (189)	359	(147)	-	-	1,467	(249)	418	(201)

Table 8.–Estimated landed catch ($\hat{H}_{iy}$), incidental mortality ($I\hat{M}_{iy}$), and total fishing mortality ($F\hat{M}_{iy}$) by brood year and age class, in adult equivalents (AEQs) for Unuk River Chinook salmon. Standard errors (in parentheses) by age were not calculated for incidental mortality or total mortality.

PANEL A: LANDED CATCH $\hat{H}_{iy}$)						($\hat{H}_y$)
Brood Year	Age 1.1	Age 1.2	Age 1.3	Age 1.4	Age 1.5	Total
1981						2,885 (792)
1982	177 (78)	1,577 (308)	796 (236)	267 (132)	- -	2,816 (413)
1983	135 (135)	530 (245)	1,284 (401)	108 (107)	108 (107)	2,165 (517)
1984	190 (185)	84 (81)	532 (313)	247 (174)	- -	1,054 (422)
1985	- -	239 (133)	338 (213)	62 (61)	- -	638 (255)
1986	14 (14)	655 (242)	437 (114)	967 (271)	- -	2,073 (387)
1987						1,292 (354)
1988						1,307 (358)
1989						1,035 (284)
1990						1,015 (279)
1991						1,407 (386)
1992	20 (20)	64 (64)	253 (149)	155 (155)	- -	493 (217)
1993	- -	183 (78)	395 (118)	662 (192)	- -	1,240 (236)
1994	- -	118 (58)	561 (176)	362 (132)	- -	1,041 (226)
1995	57 (41)	248 (73)	1,280 (220)	569 (132)	- -	2,154 (269)
1996	11 (7)	577 (185)	1,015 (168)	755 (153)	- -	2,357 (303)
1997	- -	76 (40)	650 (163)	517 (181)	23 (23)	1,266 (245)
1998	34 (34)	201 (71)	874 (189)	359 (147)	- -	1,467 (249)

PANEL B: INCIDENTAL MORTALITY ($I\hat{M}_{ay}$)						($I\hat{M}_y$)
Brood Year	Age-1.1	Age-1.2	Age-1.3	Age-1.4	Age-1.5	Total
1981						1,055 (736)
1982	499	775	129	6	-	1,408 (462)
1983	269	368	124	6	-	767 (472)
1984	145	310	43	7	-	505 (460)
1985	99	209	11	15	-	334 (293)
1986	246	385	159	41	-	830 (380)
1987						472 (330)
1988						478 (333)
1989						378 (264)
1990						371 (259)
1991						515 (359)
1992	46	78	20	7	-	151 (182)
1993	114	204	37	31	-	386 (200)
1994	119	148	31	9	-	307 (186)
1995	343	358	96	26	-	822 (257)
1996	268	381	105	15	-	770 (264)
1997	109	109	17	11	-	247 (160)
1998	178	200	21	18	-	418 (201)

-continued-

Table 8.–Page 2 of 2.

	PANEL C: TOTAL FISHING MORTALITY ($\hat{FM}_{ay}$)					($\hat{FM}_{y}$)	
Brood Year	Age-1.1	Age-1.2	Age-1.3	Age-1.4	Age-1.5	Total	
1981						3,941	(1,081)
1982	676	2,351	925	273	-	4,224	(620)
1983	404	899	1,407	114	-	2,932	(700)
1984	335	394	575	254	-	1,559	(625)
1985	99	448	349	76	-	973	(388)
1986	260	1,039	596	1,008	-	2,903	(542)
1987						1,764	(484)
1988						1,785	(490)
1989						1,413	(388)
1990						1,387	(380)
1991						1,922	(527)
1992	66	142	274	162	-	643	(283)
1993	114	387	432	693	-	1,627	(309)
1994	119	266	592	370	-	1,347	(293)
1995	400	606	1,376	594	-	2,977	(372)
1996	279	958	1,120	770	-	3,127	(402)
1997	109	185	667	528	-	1,513	(293)
1998	212	401	895	377	-	1,885	(320)

ANALYSIS

MEASUREMENT ERROR

Variation in our production estimates was comprised of random error in S and R across years (process error), and errors from sampling methods used to produce annual estimates $\hat{S}_y$ and $\hat{R}_y$ (measurement error). We were estimating abundance of both spawners and returns so that:

$$\ln\left(\hat{R}_y\right) = \ln\left(R_y\right) + v_y \tag{18}$$

and

$$\ln\left(\hat{S}_y\right) = \ln\left(S_y\right) + u_y \tag{19}$$

where u_y and v_y represent measurement error with means 0 and variance σ_u^2 and σ_v^2.

We were most concerned with errors associated with $\hat{S}$, which appears in both the independent and dependent variables of our log-transformed spawner-recruit equation. Measurement error in estimates of $\hat{S}$ can bias the true spawner-recruit relationship, indicating density dependence when it should not (Hilborn and Walters 1992:288). We evaluated the magnitude of spawning abundance measurement error relative to its total variation using variance among estimated annual spawning abundances and our estimates of sampling error from annual abundance estimation as per methods in Bernard et al. (2000).

Where σ_u^2 represents the measurement error associated with estimation of annual spawning abundance, total variation in estimated spawning abundance is expressed as:

$$Var[\ln(\hat{S})] = Var[\ln(S)] + \sigma_u^2 \tag{20}$$

We do not know the true quantities of any of these variances, but we have estimates of $Var[\ln(S)]$ across our annual estimated spawning abundances such that:

$$\text{var}[\ln(\hat{S})] = \frac{\sum[\ln(\hat{S}_y)] - \overline{\ln(\hat{S})}]^2}{n-1} \tag{21}$$

Estimates of measurement error were estimated from standard errors of log transformed annual abundance estimates $\ln\left(\hat{S}_y\right)$, which were

Table 9.–Estimated parent year escapement $\hat{S}_y$, inriver returns $\hat{E}_y$, total fishing mortality $F\hat{M}_y$, total returns $\hat{R}_y$, exploitation rate $\hat{U}_y$, and return rate $\hat{R}_y / \hat{S}_y$, for Unuk River Chinook salmon in nominal numbers (Panel A) and adult age equivalents (Panel B), brood years 1981–1998. Return rate is based on age- 1.2-1.5 spawners and returns. Exploitation rates for brood years 1987–1991 are from average in years 1982–1986 and 1987–1999. Standard errors are in parentheses.

Brood year	$\hat{S}_y$	$\hat{E}_y$	$F\hat{M}_y$	$\hat{R}_y$	$\hat{U}_y$	$\hat{R}_y / \hat{S}_y$
PANEL A: NOMINAL NUMBERS						
1981	3,532	12,552	4,610 (1,265)	17,162 (1,581)	0.269 (0.06)	3.6 (0.65)
1982	6,528	16,223	5,172 (759)	21,395 (1,466)	0.242 (0.03)	3.1 (0.43)
1983	5,436	8,235	3,481 (831)	11,715 (1,058)	0.297 (0.05)	1.6 (0.29)
1984	8,876	5,401	1,896 (760)	7,297 (918)	0.260 (0.08)	0.7 (0.12)
1985	5,721	1,626	1,182 (471)	2,808 (684)	0.421 (0.12)	0.3 (0.09)
1986	10,273	6,254	3,409 (637)	9,663 (795)	0.353 (0.05)	0.6 (0.07)
1987	9,533	5,619	2,064 (566)	7,683 (728)	0.269 (0.06)	0.5 (0.07)
1988	8,437	5,684	2,088 (573)	7,772 (735)	0.269 (0.06)	0.7 (0.09)
1989	5,552	4,500	1,653 (453)	6,153 (704)	0.269 (0.06)	0.8 (0.11)
1990	2,856	4,417	1,622 (445)	6,040 (713)	0.269 (0.06)	1.7 (0.27)
1991	3,165	6,121	2,248 (617)	8,369 (897)	0.269 (0.06)	2.2 (0.33)
1992	4,223	3,199	746 (254)	3,945 (472)	0.189 (0.06)	0.7 (0.11)
1993	5,160	5,142	1,844 (269)	6,986 (462)	0.264 (0.03)	1.2 (0.16)
1994	3,435	4,655	1,533 (257)	6,188 (470)	0.248 (0.03)	1.6 (0.22)
1995	3,730	9,329	3,518 (327)	12,847 (847)	0.274 (0.02)	2.6 (0.37)
1996	5,639	13,297	3,607 (354)	16,904 (1,341)	0.213 (0.02)	2.8 (0.39)
1997	2,970	5,326	1,679 (264)	7,005 (519)	0.240 (0.03)	1.9 (0.21)
1998	4,132	8,196	2,163 (285)	10,359 (833)	0.209 (0.03)	1.9 (0.24)
Avg 1981–1998	5,511	6,988	2,473	9,461	0.269	1.6
PANEL B: ADULT EQUIVALENTS						
Brood year	$\hat{S}_y$	$\hat{E}_y$	$F\hat{M}_y$	$\hat{R}_y$	$\hat{U}_y$	$\hat{R}_y / \hat{S}_y$
1981	3,532	12,552	3,941 (1,081)	16,493 (1,439)	0.239 (0.06)	3.5 (0.62)
1982	6,528	16,223	4,224 (620)	20,447 (1,399)	0.207 (0.03)	2.9 (0.41)
1983	5,436	8,235	2,932 (700)	11,167 (958)	0.263 (0.05)	1.5 (0.27)
1984	8,876	5,401	1,559 (625)	6,960 (810)	0.224 (0.07)	0.7 (0.11)
1985	5,721	1,626	973 (388)	2,598 (629)	0.374 (0.12)	0.3 (0.08)
1986	10,273	6,254	2,903 (542)	9,157 (722)	0.317 (0.04)	0.5 (0.06)
1987	9,533	5,619	1,764 (484)	7,383 (666)	0.239 (0.06)	0.5 (0.07)
1988	8,437	5,684	1,785 (490)	7,468 (672)	0.239 (0.06)	0.7 (0.09)
1989	5,552	4,500	1,413 (388)	5,913 (664)	0.239 (0.06)	0.7 (0.11)
1990	2,856	4,417	1,387 (380)	5,804 (675)	0.239 (0.06)	1.6 (0.26)
1991	3,165	6,121	1,922 (527)	8,043 (838)	0.239 (0.06)	2.1 (0.31)
1992	4,223	3,199	643 (283)	3,842 (488)	0.167 (0.06)	0.7 (0.11)
1993	5,160	5,142	1,627 (309)	6,769 (486)	0.240 (0.04)	1.2 (0.15)
1994	3,435	4,655	1,347 (293)	6,002 (490)	0.224 (0.04)	1.6 (0.22)
1995	3,730	9,329	2,977 (372)	12,306 (866)	0.242 (0.03)	2.5 (0.36)
1996	5,639	13,297	3,127 (402)	16,424 (1,354)	0.190 (0.02)	2.7 (0.38)
1997	2,970	5,326	1,513 (293)	6,839 (499)	0.221 (0.04)	1.9 (0.21)
1998	4,132	8,196	1,885 (320)	10,081 (846)	0.187 (0.03)	1.9 (0.24)
Avg 1981–1998	5,511	6,988	2,107	9,094	0.239	1.5

approximated using the delta method (Seber 1982: 7-9) such that:

$$\hat{\sigma}^2_{u,y} = \text{var}\left[\ln\left(\hat{S}_y\right)\right] \cong \text{var}\left(\hat{S}_y\right)\hat{S}_y^{-2} = CV^2\left(\hat{S}_y\right) \quad (22)$$

The overall expected measurement error for all years $\hat{\sigma}^2_u$ is then

$$\frac{\hat{\sigma}^2_{u,y}}{n} \quad (23)$$

Based on abundance estimates for the longest adult return time series in our analysis (1981–1998), the total variance in estimated spawning abundance $\text{var}[\ln(\hat{S})]$, including variation across years and measurement error, was 0.1825. Measurement error over this time series was $\hat{\sigma}^2_u$ = 0.0142. Thus, measurement error comprises on average 7.8% of the total variation in our spawning abundance estimates for this time series. Looking at our shortest time series (1982–1986 and 1992–1998), measurement error comprised 9.2% of the total variation (0.0139/0.1512). The relative proportion of measurement error would be far lower (2.6% and 3.4% respectively) had we used equation 4b (see spawning abundance section) to estimate variance for our mean expansion factor, π. However, even the higher estimates of measurement error are negligible, and were not given further consideration in our analyses.

PARAMETER ESTIMATES

Four different data sets were developed for spawner-recruit analysis:

1) large spawners to smolt production including brood years 1982–1986 and 1992–2001 (n=15);
2) large spawners to smolt production including brood years 1982–1986 and 1992–1998 (n=12);
3) large spawners to age-1.2 to -1.5 adult returns including brood years 1981–1998 (n=18); and
4) large spawners to age-1.2 to -1.5 adult returns including brood years 1982–1986 and 1992–1998, using marine survival (adult return rate of CWT broods) as a covariate (n=12).

The following linearized forms of the Ricker model (Ricker 1975) were investigated:

$$\ln\left(\frac{R}{S}\right) = \ln\alpha - \beta S + \varepsilon \quad (24)$$

$$\ln\left(\frac{R}{S}\right) = \ln\alpha - \beta S + \gamma Z_{\ln(surv)} + \varepsilon \quad (25)$$

Where R is total return, S is large spawners, and $Z_{ln(surv)}$ is the normalized log adult return rate from smolt in each brood year. The productivity parameter α is proportional to fecundity (Quinn and Deriso 1999:89), and in the absence of density dependence is an estimate of the number of returning adults that would result from a single adult spawner. Density dependence is represented by the capacity parameter β, the inverse of which is the estimated spawning level (S_{max}) that produces the maximum number of recruits. Parameter γ corresponds to marine survival. The natural log of survival estimates (adult return rates) were normalized to simplify solutions for reference point estimates, particularly for those derived iteratively. Normalizing the log of survival rates makes their expected value zero, which allows comparison of estimates of α and β in both the equations above. Note that the normalization results in an estimate of the coefficient for γ that is not close to one, as would otherwise be expected for the survival parameter. All parameters were estimated using linear regression.

The domed Ricker model was used to describe production because of evidence in our data against the asymptotic model of Beverton and Holt (1957). Fits of the Beverton-Holt model with both adult and smolt data sets produced nonsensical results with productivity parameters estimated as having negative values. The lack of a demonstrable relationship between size of smolts and their abundance indicated a lack of growth compensation, and thereby a lack of competition among young for food. Both pieces of evidence support that production is not limited by competition during rearing (the premise behind the development of the Beverton-Holt curve). Because our fits with the Ricker curve did produce reasonable parameter estimates, we continued our analysis with the Ricker model,

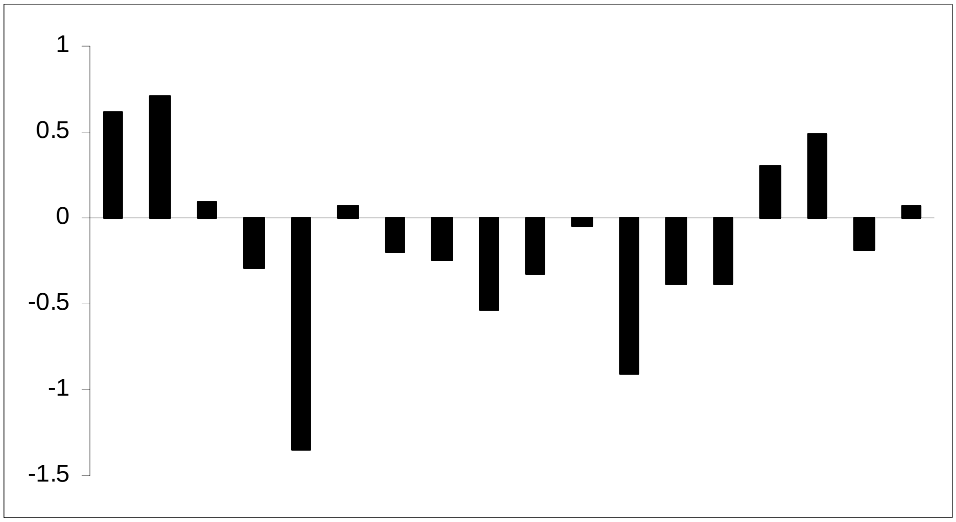

Figure 4.–Residuals from the fitted Ricker model of adult spawners to adult returns for brood years 1981–1998.

which contains the presumption that salmon production is limited by competition among adults during spawning.

Visual inspection of plots of residuals over time from fits to the Ricker model (Figure 4) indicated the possibility of non-random distribution of the residuals. Results of the Durbin-Watson test (Durbin and Watson 1951) for first order correlation were inconclusive. However, autocorrelation and partial autocorrelations functions run using the SYSTAT© statistical software package did not show the residuals to be significantly auto-correlated (Figure 5), which justified using a simple linear model without adding a parameter for an autoregressive effect. All autocorrelation tests were performed on the adult spawner-to-adult return dataset, as it was the longest (n = 18) and only continuous dataset we modeled.

We made parameter estimates comparable for all models by standardizing currency between spawners and recruits. We translated the estimated α for smolt production in our first two models by multiplying them by the average smolt-to-adult return rate, which was 0.0291, based on age-.2 to -.5 adults from the 1982–1986 and 1992–1998 brood years.

A further adjustment, τ, was needed for all four models, because the independent variable (spawners) was expressed in large fish and the independent variable (returns) included small and large fish (see McPherson et al. 2005). Fractions of age-1.2 salmon in the age-.2-.5 spawning population averaged 0.260 for brood years 1981–1998 making $\tau = 0.35$ [= 0.26/(1-0.26] for our adult return models. For our two smolt models, we needed to include small spawners that were age-1.1 and -1.2 fish in our adjustment and we averaged brood years with age-1.1 fish returning in years with weirs on the spawning grounds (1983, 1988 and 1989 broods). The average proportion in the age-.1-.5 spawning population was 0.311, making $\tau = 0.45$

Estimates of S_{MSY} were solved for iteratively with the equations:

$$1 = (1 - \hat{\beta}\hat{S}_{MSY})\,0.291[\exp(\ln\hat{\alpha} + \hat{\sigma}_{\varepsilon}^{2}/2)]\,(1+\tau)^{-1}\exp(-\hat{\beta}\hat{S}_{MSY}) \quad (26)$$

and

$$1 = (1 - \hat{\beta}\hat{S}_{MSY})[\exp(\ln\hat{\alpha} + \hat{\sigma}_{\varepsilon}^{2}/2)]\,(1+\tau)^{-1}\exp(-\hat{\beta}\hat{S}_{MSY}) \quad (27)$$

for the smolt (Eq 20) and adult (Eq 21) models respectively.

The term $\sigma_{\varepsilon}^{2}/2$ is a correction made for process error, which adjusts bias in the α parameter from non-linear transformation (Hilborn 1985). This allowed the estimate of mean versus median values for point estimates. Our estimate of $\hat{\sigma}_{\varepsilon}^{2}$ was the mean square error of residuals from linear

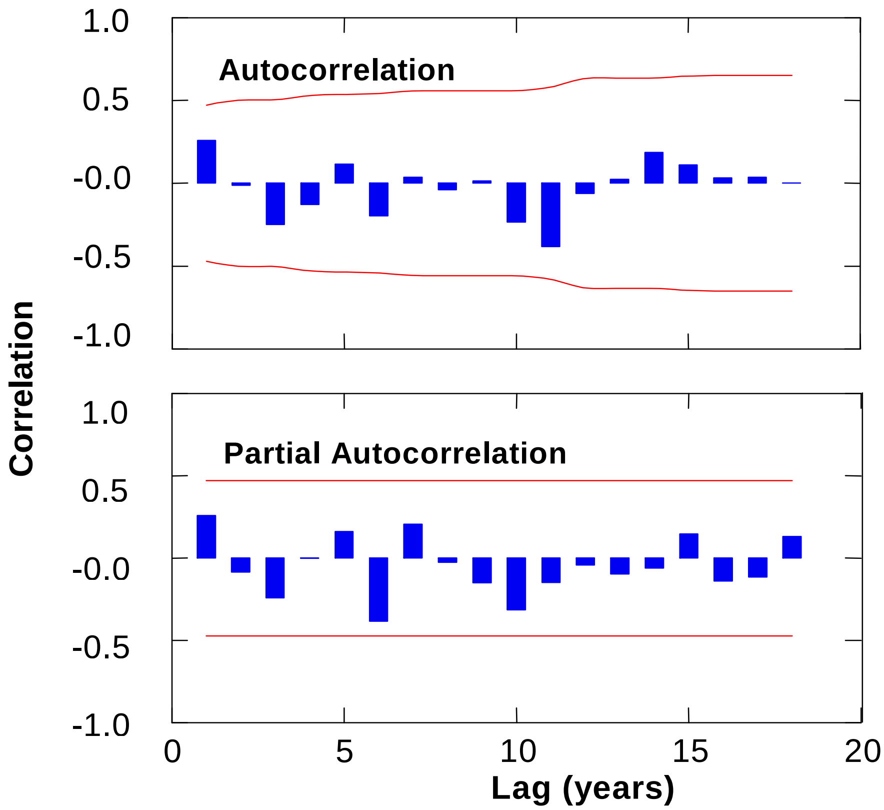

Figure 5.–Autocorrelation and partial autocorrelation functions for residuals from the fitted adult spawner-to-adult return stock-recruit relationship for Unuk River Chinook salmon for brood years 1981–1998.

regression. Estimates of S_{MSY} ranged between 2,764 and 3,068 large spawners over the four analyses. Ninety percent of MSY in small and large spawners for these two estimates would be expected at escapements of 1,800–3,834 and 2,000–4,251 large spawners, respectively. Full details of parameter estimates and reference points for each model are given in Table 10. Plots of predicted returns for all four fitted models as well as original annual return estimates are shown in Figures 6 through 8.

DISCUSSION

Stability of environment is presumed in statistical analysis of stock-recruit data. We found supporting evidence for stability in the data used in this report and auxiliary information regarding Chinook salmon from the Unuk River. The size of smolt was relatively invariant over 20 years of assessment, averaging about 69 mm FL and ranging from 66–75 mm FL (Table 5). There was negligible or no loss of habitat during our time series from human activities; the entire watershed is in a protected status with the exception of small private land holdings near tidewater. There have been dynamic natural changes in the watershed, such as channel changes across the floodplain throughout much of the lower and middle rivers. Yet, smolt production peaked at about 500,000 in 1982 during the earlier tagging period (1982–1986 broods) and again at 500,000 in 1996 during more recent efforts. Adult returns peaked early in the time series, dropped during the middle and returned to similar levels for the 1995 and 1996 broods (Table 9). Hence, outside of normal fluctuations, we see no evidence that return rates have changed over the two decades in this data set.

Contrast in the estimated spawning escapements is one consideration in stock-recruit analysis, with a ratio greater than 4:1 desirable. In our dataset the contrast was 3.7:1 (range between 2,856 and 10,541), which is relatively low. This is likely due to the low exploitation rates from

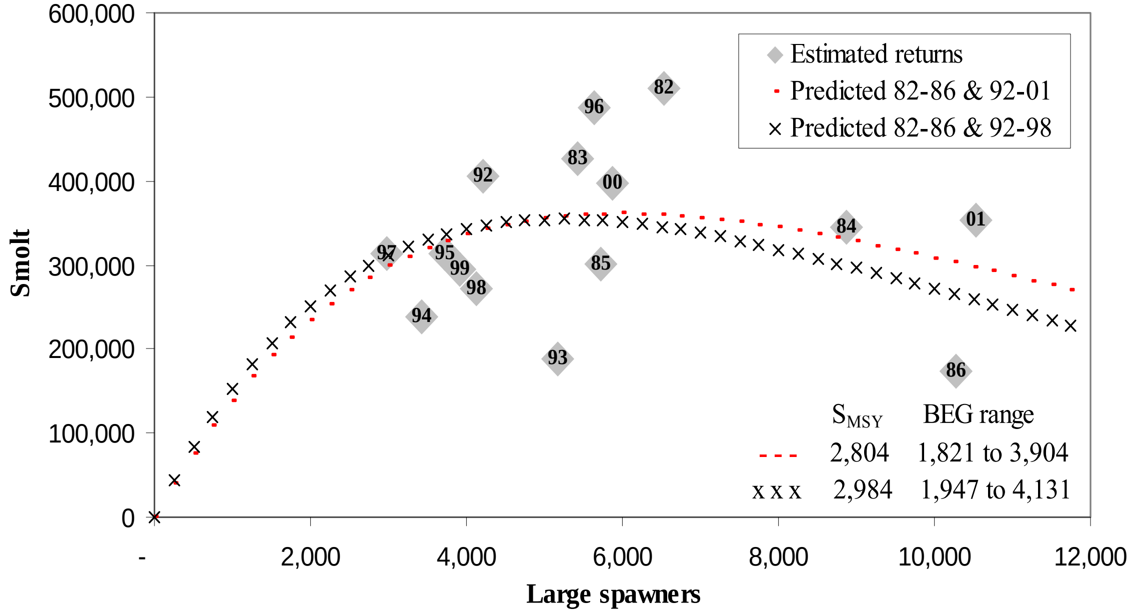

Figure 6.–Estimated production of Chinook salmon smolt in year classes 1982–1986 and 1992–2001 against the estimated spawning abundance of their large parents for the population in the Unuk River. Predicted returns are from Ricker model analyses using two different time series, 1982–1986 and 1992–2001, and 1982–1986 and 1992–1998. Estimates of S_{msy} and biological escapement goals have been transformed into small and large adult return numbers based on an average smolt to adult return rate of 0.0291.

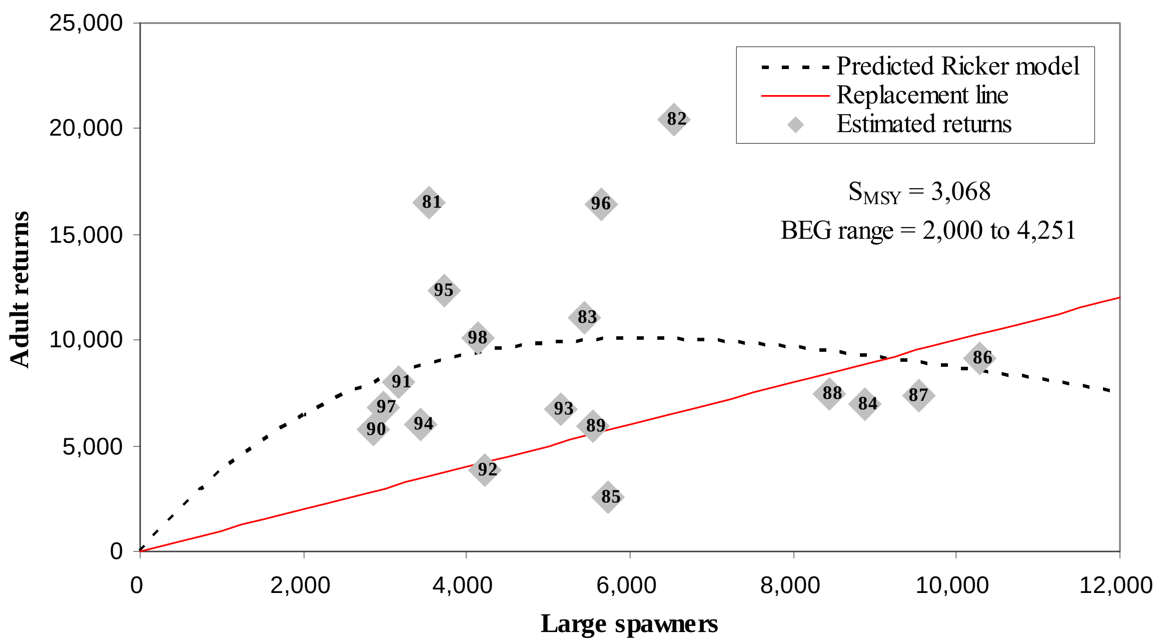

Figure 7.–Estimated production of Chinook salmon in year classes 1981–1998 against the estimated spawning abundance of their large parents for the population in the Unuk River.

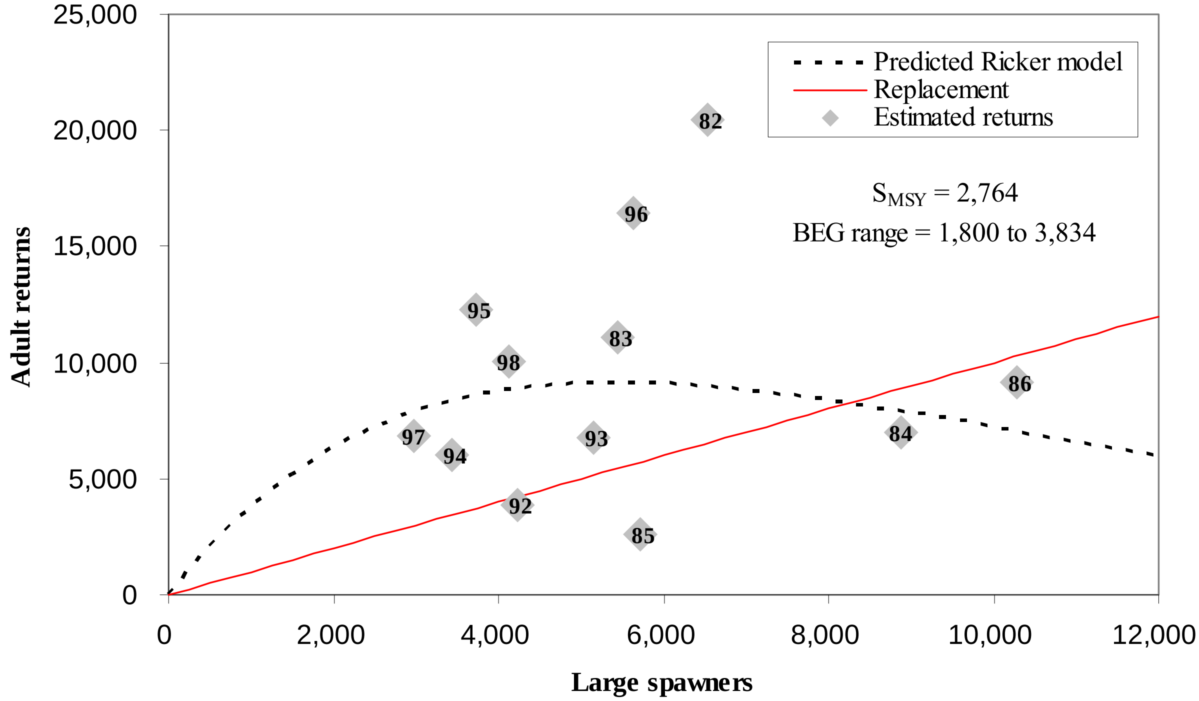

Figure 8.–Estimated production of Chinook salmon in year classes 1982–1986 and 1992–1998 against the estimated spawning abundance of their large parents for the population in the Unuk River. Predicted returns are based on Ricker model with a marine survival parameter.

protective management measures over the past 30 years and the stock size not being far from equilibrium. With exploitation rates at about half of the estimated optimum (24% on average), we may not see escapements higher than observed in 1986 and 2001 (about 10,000). However, in the event of changes in management or survival of this stock, we could see higher contrast in future escapements.

One compensating factor for low contrast is good precision in both estimates of spawners and recruits, which is the case for the datasets used in this report. The CV for spawning abundance estimates is 12% for survey count years and 10% for mark–recapture years. Whereas peak counts can be questionable indicators of spawning abundance in places where limited accessibility, visibility or other issues affect accurate counting, it appears that good coverage (a large fraction of spawning grounds surveyed and consistent survey counts with experienced surveyors) and reasonable counting conditions are producing consistent expansion factors for the Unuk stock of Chinook salmon. Similarly, the CVs for total returns averaged 10%.

The four datasets and associated models produced similar and defensible estimates for S_{MSY}. The inclusion of the marine survival parameter resulted in our best fitting model (adjusted R^2 of 0.72). Models from which the effects of marine survival were removed (i.e. adult spawner-to-smolt models) also outperformed the adult return model which did not account for marine survival. That model had the worst fit (adjusted R^2 of 0.32), however, its estimate of $\hat{S}_{MSY}$ is nearly the same as the adult spawner-to-smolt return model using the same time series (differs by only 40 fish). The difference between our lowest and highest estimates of $\hat{S}_{MSY}$ (and our best and worst fitting models) is 304 fish (see Table 10). In terms of optimal harvest rate $\hat{U}_{MSY}$, the difference is less than 5%. The similarity between model results is encouraging in consideration of potential reductions to stock assessment projects in the future due to budgetary constraints and program priorities.

Coded wire tagging experiments are a costly tool for wild stocks, and future funding is not

Table 10.–Estimates of parameters and their standard errors for four Unuk River Chinook salmon stock-recruit relationships using three traditional Ricker models and one generalized Ricker model with a covariate. Note that $\hat{\alpha}$ has been corrected for process error, and in smolt return models has also been adjusted by average smolt-to-adult return rate for standardized parameter comparison with adult return models. Escapement goal ranges are in large spawners expected to yield 90% MSY in small and large returns.

	Model and brood years			
	Adult to smolt 1982–1986 & 1992–2001	Adult to smolt 1982–1986 & 1992–1998	Adult to adult 1981–1998	Adult to adult & marine survival 1982–1986 & 1992–1998
n	15	12	18	12
$\ln(\hat{\alpha})$	5.055 (P = 3.47E-12)	5.166 (P = 2.75E-09)	1.363 (P = 0.00067)	1.471 (P = 0.00054)
$SE[\ln(\hat{\alpha})]$	0.2093	0.2649	0.3243	0.2809
$\hat{\sigma}^2$	0.0906	0.1064	0.2775	0.1136
τ	0.451	0.451	0.351	0.351
$\hat{\alpha}$	4.774	5.378	4.490	4.606
$SE\hat{\alpha}$			1.36	1.52
$\hat{\beta}$	0.0001673 (P = 0.0003)	0.0001918 (P = 0.0016)	0.0001638 (P = 0.0082)	0.0001849 (P = 0.0038)
$SE[\hat{\beta}]$	0.0000337	0.0000449	0.0000544	0.0000478
$\hat{\gamma}$				0.4984 (P = 0.00103)
$SE[\hat{\gamma}]$				0.1047
Adult return conversion factor	0.0291	0.0291		
R^2	0.65	0.65	0.36	0.77
$\hat{S}_{MSY}$	2,984	2,804	3,068	2,764
$SE[\hat{S}_{msy}]$			594	332
$\hat{U}_{MSY}$	49.9%	53.8%	50.3%	51.1%
$SE[\hat{S}_{msy}]$			0.10%	0.09%
BEG range	1,947–4,131	1,821–3,904	2,000–4,251	1,800–3,834
Index range	403–855	377–808	414–880	373–794

guaranteed. However, the superior fit that resulted when marine survival was accounted for in these spawner-recruit models demonstrates the benefit of having CWT information. Additionally, we did not find a correlation between exploitation rates nor marine survival trends that was consistent between the Unuk River wild stock and hatcheries in the region releasing this brood stock. This may be due, in part, to the geographic separation of the hatchery facilities and differences in estuarine or ocean survival. Being able to account for marine survival in an adult return model (versus smolt return model) has the advantage of not requiring transformation of smolt parameter estimates into equivalent adult estimates.

To evaluate the reliability of our model results, we estimated the probability of achieving 90% of the estimated MSY over a range of spawning escapements using bootstrapped replications of the original data (according to algorithms developed by S. Fleischman, (Ericksen and Fleischman 2006; Szarzi et al. 2007). Randomly selected regression residuals from the three parameter model were added to the 12 original fitted values of ln(R/S) to form a set of 12 simulated values of ln(R/S) for each replication. These simulated values were regressed against the original spawner and marine survival data to produce associated bootstrap parameter estimates, including $\hat{S}_{MSY}$ and $\hat{R}_{MSY}$. Predicted yield and MSY were calculated over a range of prospective escapement sizes using parameter estimates from 1,000 of these replications. The incidence of a spawning escapement of a particular size resulting in 90% or greater of the estimated MSY was tallied and averaged, producing the probability profile shown in Figure 9. The probability of achieving 90% of MSY or greater at spawning abundances within a BEG range of 1,800 and 3,800 large spawners is greater than 50%. The probability is maximized at 100% at a spawning abundance between approximately 2,400 and 3,000 large spawners.

Translating $\hat{S}_{MSY}$ into equivalent index numbers, i.e., dividing $\hat{S}_{MSY}$ by our expansion factor of 4.83, all four of our models generate a biological escapement goal range that is lower than the existing one. Our most conservative estimate of 2,000–4,251 large spawners would be 414–880 spawners in index currency, versus the 1997 index escapement goal of 650–1,400 spawners

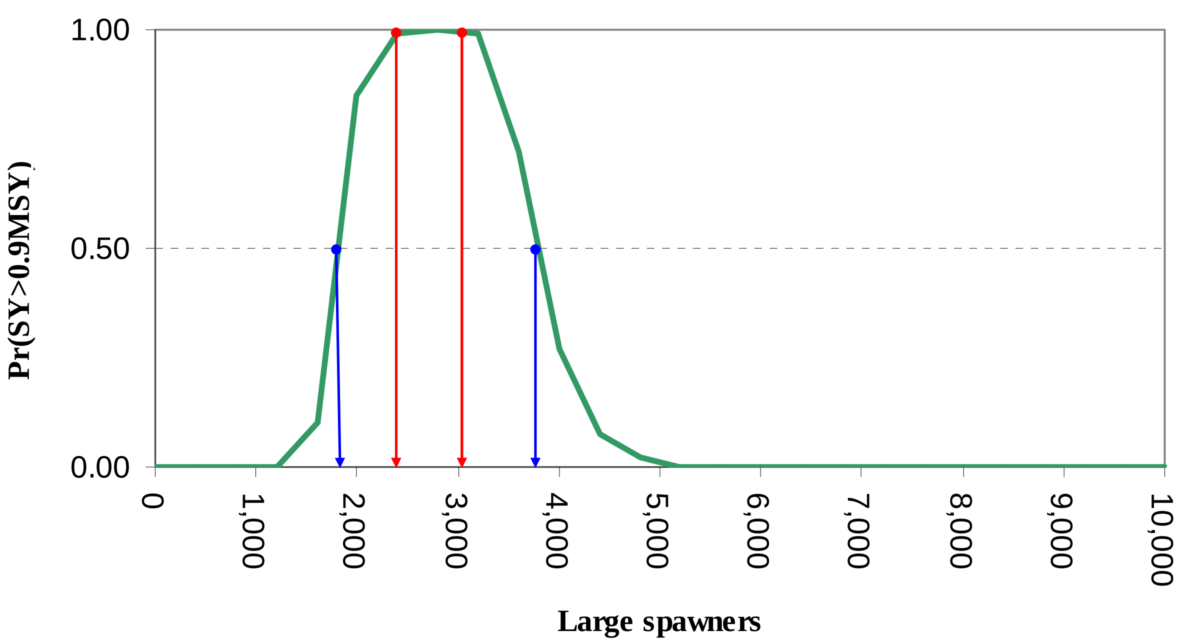

Figure 9.–Probability profile of achieving 90% of the estimated maximum sustained yield versus spawning magnitude for the stock of Chinook salmon spawning in the Unuk River.

(McPherson and Carlile 1997). There are several differences in the datasets upon which the two results are based. The 1997 BEG analysis incorporated different brood years, including 1977–1980 for which age composition had to be averaged from years when there was age sampling, and 1982–1984 and 1986 that were age- and sex-biased. Harvest data were also more limited for this time series, with only five tagged, wild broods available to estimate fishing mortality. Fishing mortality for the other years was estimated from hatchery harvest rates, which are poorly correlated with wild-stock rates. Broods with poor marine survival (1985 and 1987–1989) were removed from the analysis that provided the final recommendation, in order to reduce statistical bias. These years were clustered on the right-hand side of the spawner-recruit curve, and it was thought that they might distort the true spawner-recruit relationship. Finally, the prior index count expansion factor, based on a single year (1994) of mark–recapture results (Pahlke et al. 1996), was 6.77, versus the revised value of 4.83. This resulted in significantly higher spawner abundance estimates from peak survey counts. In comparison, the dataset used in the new analyses includes an additional nine complete brood years with six return years estimated during mark–recapture studies. Years without direct collection of age composition data were not included, and age composition estimates for bias-affected years were corrected. An additional seven years of wild Unuk River CWT data were used to estimate harvest, incidental mortality and marine survival. We did not remove brood years with poor marine survival, and rather the effects of marine survival were either removed (adult spawners to smolt production models) or accounted for (adult spawners to adult returns

Table 11.–Comparison of S_{MSY} and BEG estimates from McPherson & Carlile (1997) versus results from the same data using methodology from new analysis, and versus results using the updated dataset and the new analysis. All results based on large spawner to adult return relationship and Ricker model.

Analysis source	Brood years	Escapement expansion	α	β	Smsy	BEG (L)	BEG (U)
1997 report[a]	1977–1984 & 1986	6.67	6.78	0.0001360	5,454	3,500	9,200
				Index	818	**525**	**1,379**
1997 data/ new analysis[b]	1977–1984 & 1986	6.67	5.18	0.0001469	4,327	2,777	6,112
				Index	649	**416**	**916**
1997 report[a]	1977–1989	4.00	6.36	0.000245	3,118	2,000	5,390
						500	**1,348**
1997 data/ new analysis[b]	1977–1989	4.00	5.23	0.0002533	2,519	1,616	3,560
				Index	630	**404**	**890**
1997 data/ new analysis[b]	1977–1989	4.83	4.99	0.0002104	2,973	1,911	4,193
				Index	616	**396**	**868**
Updated data/ new analysis[c]	1981–1998	4.83	3.32	0.0001638	3,068	2,000	4,251
				Index	635	**414**	**880**

[a] Parameter estimates directly from McPherson & Carlile (1997); alpha has not been corrected for proportion of small-size fish in escapement or process error (represented by mean square error in the regression results). Smsy estimated from the bootstrap mean; Lower BEG range selected using the Eggers (1993) method; upper BEG range is high end of 95% CI.

[b] Spawner and return data directly from McPherson & Carlile (1997) with age 1.1 fish removed from escapement totals; alphas have been corrected for proportion of small-size fish in the escapement and process error. Smsy and BEG (90% MSY) range were iteratively solved for directly from parameter estimates. Estimate using the 4.83 expansion factor for escapement used harvest numbers with 4.0 expansion factor to calculate return totals.

[c] Most current spawner and return data as detailed in this report; alphas have been corrected for proportion of small-size fish in escapement and process error. Smsy and BEG (90% MSY) range were iteratively solved for directly from parameter estimates.

with marine survival covariate model) in three of the four models we investigated. Lastly, escapements from peak survey counts were estimated from a more precise expansion factor, based on seven years of mark–recapture data.

Analysis methods and criteria used for the BEG ranges further increased the magnitude of difference between the 1997 results and our new estimates. Estimates of α from the 1997 report were not corrected for process error or percentage of younger-age fish in the returns. In addition, rather than using point estimates generated directly from fitting the true data, the 1997 BEG was based on mean point estimates from bootstrap simulations of the estimated data. Upper and lower limits used for the BEG range were selected as the most conservative (higher) result from two methods of determination; Egger's (1993) guideline of 0.8 S_{MSY}, applied here to the bootstrap mean, was selected as the escapement minimum, while the maximum limit was chosen as the upper end of the 95% CI. Re-analyzing the 1997 dataset using the same methodology as in our more recent analyses results in a significantly lower BEG. Table 11 displays a comparison of these results as well as those from the 1997 data using a lower expansion factor of 4.0 and including the years with poor marine survival.

The higher index count expansion factor, unaccounted for proportions of younger-age fish in the escapement, and the omission of years with low marine survival all contributed to a more productive looking spawner-recruit relationship in the 1997 analysis. These factors, in conjunction with more conservative BEG criteria, resulted in a higher BEG. We believe the updated dataset provides a truer representation of the stock-recruit relationship, and the new analyses produce a more reliable estimate of optimal escapement.

CONCLUSIONS AND RECOMMENDATIONS

Ascertaining the resiliency of salmon populations as a resource requires observation of biological responses over time and varied conditions. Long term stock-assessment projects are uncommon coastwide, and we believe their preservation should continue to be a priority of the ADF&G and the Pacific Salmon Commission (PSC). Adverse conditions in certain river systems or characteristics of a particular stock can present insurmountable challenges to thorough stock assessment. The Unuk River has proven to be a favorable site for the acquisition of high quality data, adding to its value as an indicator of overall stock status. For this Chinook salmon stock we recommend the following:

Current escapement estimation projects should be continued. For the foreseeable future, and as long as funding is available, the mark–recapture experiment and peak survey counts should be continued. The peak survey counts are the longest existing continuous indicator of spawning abundance for Unuk River Chinook salmon, and require the least resources to implement. Should the mark–recapture study become no longer feasible, the survey counts will be solely relied upon for estimation of spawning abundance. Though conditions are stable at this time, and the quality of peak survey counts is very good, fishery, environmental and/or survey personnel dynamics could alter the relationship between survey counts and the true escapement. The mark–recapture study allows these changes to be monitored, and for effects of greater contrast in the data to be captured, should they occur. Additionally, biological sampling conducted as part of the mark–recapture experiment allows for accurate estimates of age and sex composition in the spawning population and marked fraction of CWT-tagged fish (θ).

Coded wire tagging should be continued. Coded wire tagging is at present the best means for estimating harvest contribution to total annual returns, and marine survival of natural Chinook salmon stocks. Genetic stock identification (GSI) is a promising technology that could ultimately provide a comparable means of estimating stock-specific harvest rates (PSC 2005). However, methods for implementing the GSI program are still developing, and further evaluation of its cost relative to CWT programs is needed. Without full parental genotyping (FPG), GSI sampling would not provide age structure information. Very large sample sizes would be required to obtain reliable estimates of harvest contribution for smaller stocks in particular. In the event that GSI or any alternative technology proves to be sufficiently effective and more efficient than CWT tagging, a period of overlap would be required to correlate the results of historical versus new methods. Harvest data from hatcheries using Unuk River stock reflect neither the trends nor the magnitude in harvest rates of wild Unuk River Chinook salmon, and thus are not a good surrogate for harvest rates of the natural stock. It is also prudent to represent the Unuk stock with the wild-stock CWT data in fishery modeling such as the PSC Chinook Model. Lastly, harvest rates for Unuk River Chinook salmon are applied to the Blossom and Keta rivers and are important for the estimation of total production of Chinook salmon in those systems.

An escapement goal range of 1,800 to 3,800 large spawners is recommended. The corresponding number in index equivalents would be 375 to 800 as counted in helicopter and foot peak survey counts. This recommendation is based on the adult-to-adult spawner-recruit model incorporating the marine survival parameter, because it has the best fit, and it does not require transformation of smolt numbers into adult returns.

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Tim Schantz 1964–2001
Greg Vaughn 1969–2005

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REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1981. Proposed management plan for Southeast Alaska Chinook salmon runs in 1981. Southeast Region, Alaska Department of Fish and Game Division of Commercial Fisheries. Regional Report 1J81-3, Juneau.

ADF&G (Alaska Department of Fish and Game). *Unpublished*. Length, sex, and scale sampling procedure for sampling using the ADF&G adult salmon age-length mark-sense form version 3.0. 1993 instructions developed by Commercial Fisheries Management and Development Division, Douglas.

Anthony, V., G. Finger, and R. Armstrong. 1965. King salmon (*Oncorhynchus tshawytscha*) spawning ground surveys in the Behm Canal area of southeastern Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries Informational Leaflet No. 63, Juneau. http://www.sf.adfg.state.ak.us/FedAidpdfs/afrbil.063.pdf

Bernard, D. R., and J. E. Clark. 1996. Estimating salmon harvest based on return of coded-wire tags. Canadian Journal of Fisheries and Aquatic Sciences 53:2323-2332.

Bernard, D. R., S. A. McPherson, K. A. Pahlke, and P. Etherton. 2000. Optimal production of Chinook salmon from the Stikine River. Alaska Department of Fish and Game, Fishery Manuscript No. 00-1, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms00-01.pdf

Beverton, R. J. H., and S. J. Holt. 1957. On the dynamics of exploited fish populations. Fisheries Investment Series 2, Vol. 19 U.K. Ministry of Agriculture and Fisheries, London.

Clark, J. E., and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in Southeastern Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 261, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/afrbil.261.pdf

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9. Westminster, British Columbia, Canada.

Cochran, W. G. 1977. Sampling techniques, *third edition.* John Wiley and Sons, New York.

CTC (Chinook Technical Committee). 1997. Description of calibration procedures and results of May 1997 calibration of the Pacific Salmon Commission Chinook Model. Pacific Salmon Commission Joint Chinook Technical Committee Report No. TCCHINOOK (97)-2, Vancouver, British Columbia, Canada.

CTC (Chinook Technical Committee). 2005. Annual exploitation rate analysis and model calibration. Pacific Salmon Commission Joint Chinook Technical Committee Report No. TCCHINOOK (05)-3. Vancouver, British Columbia, Canada.,

Durbin, J., and G. S. Watson. 1951. Testing for serial correlation in least squares regression. Biometrika 38:159-177.

Efron, B., and R. J. Tibshirani. 1993. *First Edition*. An introduction to the bootstrap. Chapman and Hall, New York, NY

Eggers, D. M. 1993. Robust harvest policies for Pacific salmon fisheries. Pages 85-106 *in* Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant Report No. 93-02, University of Alaska, Fairbanks, Alaska

Ericksen, R. P., and S. J. Fleischman. 2006. Optimal production of coho salmon from the Chilkat River. Alaska Department of Fish and Game, Fishery Manuscript No. 06-06, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms06-06.pdf

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Hilborn, R. 1985. Simplified calculation of optimum spawning stock size from Ricker's stock-recruitment curve. Canadian Journal of Fisheries and Aquatic Sciences 42:1833-4.

Hilborn, R., and C. J. Walters. 1992. Quantitative fisheries stock assessment. Chapman and Hall, New York.

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition. Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-41 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-41(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series No. 01-8, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-08.pdf

Hubartt, D. J., B. J. Frenette, and A. E. Bingham. 2001. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-34.pdf

Hubartt, D. J., and M. J. Jaenicke. 2004. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 04-21, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-21.pdf

Hubartt, D. J., and P. D. Kissner. 1987. A study of Chinook salmon in southeast Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 32, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-032.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-34.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-44.pdf

Johnson, R. E., and R. P. Marshall. 1990. Harvest estimates for selected sport fisheries in Yakutat, Alaska in 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-36, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-36.pdf

Jones III, E. L., and S. A. McPherson. 1999. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Unuk River, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-14.pdf

Jones III, E. L., and S. A. McPherson. 2000. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Unuk River, 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-22.pdf

Jones III, E. L., and S. A. McPherson. 2002. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Unuk River, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 02-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds02-17.pdf

REFERENCES CITED (Continued)

Jones III, E. L., S. A. McPherson, and A. B. Holm. 1999. Production of coho salmon from the Unuk River, 1997-1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-43, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-43.pdf

Jones III, E. L., S. A. McPherson, and D. L. Magnus. 1998. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Unuk River, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-23, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-23.pdf

Kissner, P. D. 1972. A study of Chinook salmon in Southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1972-1973, Project AFS-41-1, Juneau.

Kissner, P. D. 1974. Annual performance report for a study of Chinook salmon in Southeast Alaska. Alaska Dept. of Fish and Game, Division of Sport Fish, Federal Aid in Fish Distribution, Project AFS-41-2, Juneau.

Kissner, P. D. 1975. Status of important native Chinook salmon in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1974-1975, Project F-9-7, 16 (AFS 41-3), Juneau.

Kissner, P. D. 1976. Development of a Chinook salmon enhancement program. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1975-1976, Project F-9-8, 17 (AFS 41-4-A), Juneau.

Kissner, P. D. 1977. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1976-1977, Project F-9-8, 18 (AFS 41-5), Juneau.

Kissner, P. D. 1978. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1977-1978, Project F-9-10, 19 (AFS 41-6), Juneau. http://www.sf.adfg.state.ak.us/FedAidpdfs/FREDf-9-10(19)afs46-2.pdf

Kissner, P. D. 1979. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (AFS 41-7), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-11(20)AFS41-7.pdf

Kissner, P. D. 1980. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game, Sport Fish Division. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-12(21)AFS-41-8, Juneau. http://www.sf.adfg.state.ak.us/FedAidpdfs/FREDf-9-12(21)AFS41-8.pdf

Kissner, P. D. 1982. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (AFS 41-10), Juneau.

Kissner, P. D. 1984. Status of important native Chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25, (AFS 41-11)Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-16(25)AFS-41-11.pdf

Kissner, P. D. 1985. Status of important native Chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (AFS-41-12[a]), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-17(26)AFS-41-12(A).pdf

Kissner, P. D., and M. R. Bethers. 1981. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project AFS-41, 22 (AFS-41-9), Juneau.

Kissner, P. D., and D. J. Hubartt. 1986. Status of important native Chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (AFS-41-13), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-10-1(27)AFS-41-13.pdf

Koerner, J. F. 1977. The use of the coded wire tag injector under remote field conditions. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 172, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/afrbil.172.pdf

McPherson, S. A., D. R. Bernard, and J. H. Clark. 2000. Optimal production of Chinook salmon from the Taku River. Alaska Department of Fish and Game, Fishery Manuscript No. 00-2, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms00-02.pdf

McPherson, S. A., D. R. Bernard, M. S. Kelley, P. A. Milligan, and P. Timpany. 1997. Spawning Abundance of Chinook salmon in the Taku River in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-14.pdf

McPherson, S. A., and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal Chinook salmon stocks. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J97-06, Juneau.

McPherson, S. A., R. E. Johnson, and G. F. Woods. 2005. Optimal production of Chinook salmon from the Situk River. Alaska Department of Fish and Game, Fishery Manuscript No. 05-04, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/Fms05-04.pdf

Mecum, R. D. 1990. Escapements of Chinook salmon in southeast Alaska and transboundary rivers in 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-52, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-52.pdf

Mecum, R. D., and P. D. Kissner. 1989. A study of Chinook salmon in southeast Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 117, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-117.pdf

Morishima, G. S. 2004. In a nutshell: coded wire tags and the Pacific Salmon Commission's fishery regimes for Chinook and southern coho salmon. DRAFT Briefing Paper For June 2004 PSC CWT Workshop. Seattle, WA.

Oliver, G. T. 1990. Southeast Alaska port sampling project. Annual report for the period July 1, 1989 to June 30, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J90-34, Juneau.

Olsen, M. A. 1992. Abundance, age, sex, and size of Chinook salmon catches and escapements in Southeast Alaska in 1987. Alaska Department of Fish and Game, Technical Data Report No. 92-07, Juneau.

Olsen, M. A. 1995. Abundance, age, sex, and size of Chinook salmon catches and escapements in Southeast Alaska in 1988. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Technical Fisheries Report 95-02, Juneau.

Pahlke, K. A. 1991. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-36, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-36.pdf

Pahlke, K. A. 1992. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-32.pdf

Pahlke, K. A. 1993. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-46, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-46.pdf

Pahlke, K. A. 1994. Escapements of Chinook salmon in southeast Alaska and transboundary rivers in 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-32.pdf

Pahlke, K. A. 1995a. Coded wire tagging studies of Chinook salmon of the Unuk and Chickamin Rivers, Alaska, 1983-1993. Alaska Fishery Research Bulletin 2(2):93-113.

Pahlke, K. A. 1995b. Escapement of Chinook salmon in Southeast Alaska and Transboundary Rivers in 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds95-35.pdf

Pahlke, K. A. 1996. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-35.pdf

Pahlke, K. A. 1997. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-33, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-33.pdf

Pahlke, K. A. 1998. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-33, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-33.pdf

Pahlke, K. A. 1999. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-17.pdf

Pahlke, K. A. 2000. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-34.pdf

Pahlke, K. A. 2001. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-32.pdf

Pahlke, K. A. 2003a. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2001. Alaska Department of Fish and Game, Fishery Data Series No. 03-11, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-11.pdf

Pahlke, K. A. 2003b. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2002. Alaska Department of Fish and Game, Fishery Data Series No. 04-13, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-13.pdf

Pahlke, K. A. 2005. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 05-20, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/Fds05-20.pdf

Pahlke, K. A. 2008. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-20, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-20.pdf

Pahlke, K. A., S. A. McPherson, and R. P. Marshall. 1996. Chinook salmon research on the Unuk River, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 96-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-14.pdf

Pahlke, K. A., R. D. Mecum, and R. P. Marshall. 1990. Migratory patterns and fishery contributions of Chilkat River Chinook salmon. Alaska Department of Fish and Game, Fishery Data Series No. 90-50, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-50.pdf

PSC (Pacific Salmon Commission). 2005. Report of the expert panel on the future of the coded wire tag program for Pacific salmon. Pacific Salmon Comm. Tech. Rep. No. 18.,

Quinn, T. J., II, and R. Deriso. 1999. Quantitative fish dynamics. Oxford University Press, New York.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191:382.

Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, *second edition.* Griffin and Company, Ltd. London.

Szarzi, N. J., S. J. Fleischman, R. A. Clark, and C. M. Kerkvliet. 2007. Stock status and recommended escapement goal for Anchor River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript No. 07-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fms07-05

REFERENCES CITED (Continued)

Van Alen, B., K. A. Pahlke, and M. A. Olsen. 1987. Abundance, age, sex and size of Chinook salmon (*Oncorhynchus tshawytscha*) catches and escapements in Southeastern Alaska in 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 215, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/tdr.215.pdf

Van Alen, B. W., and M. A. Olsen. 1986. Abundance, age, sex, and size composition of Chinook salmon (*Oncorhynchus tshawytscha* Walbaum) catches and escapements in Southeastern Alaska, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 190, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/tdr.190.pdf

Van Alen, B. W., and D. S. Wood. 1983. Abundance, age, size, and sex composition of Chinook salmon (*Oncorhynchus tshawytscha*) catches and escapements in Southeastern Alaska, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 102, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/tdr.102.pdf

Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 03-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-05.pdf

Welander, A. D. 1940. A study of the development of the scale of Chinook salmon *Oncorhynchus tshawytscha*. Masters Thesis. University of Washington, Seattle.

Weller, J. L., and S. A. McPherson. 2003a. Estimation of the escapement of Chinook salmon in the Unuk River in 2001. Alaska Department of Fish and Game, Fishery Data Series 03-13, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-13.pdf

Weller, J. L., and S. A. McPherson. 2003b. Estimation of the escapement of Chinook salmon in the Unuk River in 2002. Alaska Department of Fish and Game, Fishery Data Series 03-15, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-15.pdf

Weller, J. L., and S. A. McPherson. 2004. Estimation of the escapement of Chinook salmon in the Unuk River in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-10, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-10.pdf

Weller, J. L., and S. A. McPherson. 2006a. Estimation of the escapement of Chinook salmon in the Unuk River in 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-07.pdf

Weller, J. L., and S. A. McPherson. 2006b. Estimation of the escapement of Chinook salmon in the Unuk River in 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-59, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-59.pdf

Wendt, K. L., and M. J. Jaenicke. *In prep*. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 2003. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

APPENDIX A

Appendix A1.–Bibliography of historical stock assessment studies conducted on Chinook salmon from the Unuk River.

Citation	Location	Objective(s)
Anthony et al. 1965	Unuk River	1961 exploratory watershed salmon inventory and peak survey counts by tributary, 1954–1956 Chinook harvest in Burroughs Bay by commercial drift gillnet fishery
Hubartt and Kissner 1987	Unuk River	1986 peak survey counts by tributary
	Cripple Creek	Adult length frequency and post spawn die-off estimation
	Unuk River	1983–1986 juvenile CWT summary and smolt lengths[a]
	Unuk River	1985–1986 adult CWT recovery summary[a]
Jones III et al. 1998	Unuk River	1997 escapement, ASL, and expansion factor estimation (MR study)[a]
Jones III and McPherson 1999	Unuk River	1998 escapement, ASL, and expansion factor estimation (MR study)[a]
Jones III and McPherson 2000	Unuk River	1999 escapement, ASL, and expansion factor estimation (MR study)[a]
Jones III and McPherson 2002	Unuk River	2000 escapement, ASL, and expansion factor estimation (MR study)[a]
Kissner 1972	Eulachon River	1950–1957, 1961, and 1972 peak survey counts
Kissner 1974	Eulachon River	1950–1957, 1961, and 1973 peak survey counts
Kissner 1975	Eulachon River	1950–1957, 1961, and 1973–1974 peak survey counts
Kissner 1976	Eulachon River	1950–1957, 1961, and 1973–1975 peak survey counts
Kissner 1977	Eulachon River	1950–1957, 1961, and 1973–1976 peak survey counts
Kissner 1978	Unuk River	1961–1969, 1972–1973, and 1975–1977 peak survey counts
	Unuk River	1977 CWT feasibility study[a]
Kissner 1979	Unuk River	1961–1969, 1972–1973, and 1975–1978 peak survey counts
	Unuk River	1978 CWT feasibility study[a]
Kissner 1980	Unuk River	1961–1969, 1972–1973, and 1975–1979 peak survey counts
Kissner 1982	Unuk River	1961–1969, 1972–1973, and 1975–1981 peak survey counts
Kissner 1984	Unuk River	1977–1983 peak survey counts by tributary
	Unuk River	1983 juvenile CWT summary and smolt lengths[a]
Kissner 1985	Unuk River	1977–1984 peak survey counts by tributary
	Unuk River	1984 juvenile CWT summary and smolt lengths[a]
Kissner and Bethers 1981	Unuk River	1961–1969, 1972–1973, and 1975–1980 peak survey counts
	Unuk River	1980 CWT feasibility study[a]
Kissner and Hubartt 1986	Unuk River	1985 peak survey counts by tributary
	Unuk River	1985 juvenile tagging and adult CWT recovery summaries[a]
McPherson and Carlile 1997	Unuk River	Escapement goal for peak survey counts, exploitation estimation, based on 1977–1989 brood year spawner-recruit data
Mecum 1990	Unuk River	1989 peak survey counts by tributary
Mecum and Kissner 1989	Unuk River	1960–1988 peak survey counts by tributary
	Unuk River	1988 juvenile CWT summary and smolt length[a]
	Unuk River	1985–1988 marine harvest, exploitation rate estimation
Olsen 1992	Unuk River	1987 escapement ASL estimation by tributary[a]
Olsen 1995	Unuk River	1988 escapement ASL estimation by tributary[a]
Pahlke 1991	Unuk River	1990 peak survey counts by tributary
Pahlke 1992	Unuk River	1991 peak survey counts by tributary
Pahlke 1993	Unuk River	1992 peak survey counts by tributary
Pahlke 1994	Unuk River	1993 peak survey counts by tributary
Pahlke 1995b	Unuk River	1994 peak survey counts by tributary

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Citation	Location	Objective(s)
Pahlke 1995a	Unuk River	1985–1993 escapement and ASL estimation[a]
	Unuk River	1984–1988 smolt abundance estimation (CWT studies)[a]
	Unuk River	1986–1993 marine harvest and exploitation estimation (CWT studies)[a]
Pahlke 1996	Unuk River	1995 peak survey counts by tributary
Pahlke 1997	Unuk River	1996 peak survey counts by tributary
Pahlke 1998	Unuk River	1997 peak survey counts by tributary
Pahlke 1999	Unuk River	1998 peak survey counts by tributary
Pahlke 2000	Unuk River	1999 peak survey counts by tributary
Pahlke 2001	Unuk River	2000 peak survey counts by tributary
Pahlke 2003a	Unuk River	2001 peak survey counts by tributary
Pahlke 2003b	Unuk River	2002 peak survey counts by tributary
Pahlke 2005	Unuk River	2003 peak survey counts by tributary
Pahlke et al. 1996	Unuk River	1994 escapement and ASL estimation (MR study)
	Unuk River	1994 escapement distribution (radiotelemetry study)
Van Alen et al. 1987	Cripple Creek	1985 escapement ASL estimation[a]
	Genes Lake	1985 escapement ASL estimation[a]
Van Alen and Olsen 1986	Cripple Creek	1984 escapement ASL estimation[a]
	Genes Lake	1984 escapement ASL estimation[a]
Van Alen and Wood 1983	Cripple Creek	1982 escapement ASL estimation[a]
Weller and McPherson 2003a	Unuk River	2001 escapement, ASL, and expansion factor estimation (MR study)[a]
Weller and McPherson 2003b	Unuk River	2002 escapement, ASL, and expansion factor estimation (MR study)[a]
Weller and McPherson 2004	Unuk River	2003 escapement, ASL, and expansion factor estimation (MR study)[a]
Weller and McPherson 2006a	Unuk River	2004 escapement, ASL, and expansion factor estimation (MR study)[a]
Weller and McPherson 2006b	Unuk River	2005 escapement, ASL, and expansion factor estimation (MR study)[a]

[a] ASL = age-sex-length, CWT = coded wire tag, M-R = mark–recapture.

APPENDIX B

Appendix B1.–Estimating Numbers of Spawning Chinook Salmon by Age and Sex.

Abundance by age and sex was estimated from the estimated abundance by size group and composition data collected on the spawning grounds. The abundance of large spawners was estimated from the expansion factor of 4.83 (SE = 0.59) in 1977–1996, and directly from mark–recapture programs in 1997–2005 (Tables 1 and 2 in main body). The abundance of small or age-1.2 fish was estimated as follows:

Calendar Years	Method of estimation of small fish	Formulation
1985, 1987–1990, 1994 and 1996	Regression	$\hat{S}_{1.2} = m(\sum_{i=1.3}^{1.5} \hat{S}_i + b,$
1986, 1991–1993, 1995, 2001 and 2003	Proportion on the spawning grounds	$\hat{S}_{Small} = \hat{S}_{Large}\left(\frac{1}{\hat{\phi}} - 1\right),$
1997–2000, 2002	Capture–recapture	$\hat{S}_{Small} = \frac{M_{Samll}\ C_{Small}}{R_{Small}}$

where $\hat{S}_{1.2}$ is the estimated spawning abundance of age-1.2 fish and *m* and *b* are regression parameters estimated from the 1993–1998 brood years; $\hat{S}_{Small}$ is the estimated abundance of small fish (400–659 mm MEF) and $\hat{S}_{Large}$ is the estimated spawning abundance of large fish.

Age proportions within size groups were estimated from the bias correction for large fish detailed in Appendix C, and the regression for age-1.2 fish above, for 1987–1990, 1994 and 1996. Age proportions within size groups were estimated directly from spawning grounds samples for both size groups in 1986, 1991–1993, 1995 and 1997–2005. Spawning grounds samples in these years were collected with unbiased sampling techniques. For the latter years, the proportion of the spawning population composed of a given age within a size class was estimated as a binomial variable:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j}$$

$$\mathrm{var}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1 - \hat{p}_{ij})}{n_j - 1}$$

where $\hat{p}_{ij}$ is the estimated proportion of the population of age *i* in size group *j*, n_{ij} is the number of Chinook salmon of age *i* of size group *j*, and n_j is the number of Chinook salmon in the sample *n* of size group *j*. Samples gathered at each spawning tributary were pooled together because no differences in age composition were apparent among tributaries sampled. Numbers of spawning fish by age were estimated as the sum of the products of estimated age composition and estimated abundance within a size category:

$$\hat{S}_i = \sum_j (\hat{p}_{ij}\hat{S}_j)$$

and

$$\mathrm{var}(\hat{S}_i) = \sum_j \begin{pmatrix} \mathrm{var}(\hat{p}_{ij})\hat{S}_j^2 + \mathrm{var}(\hat{S}_j)\hat{p}_{ij}^2 \\ - \mathrm{var}(\hat{p}_{ij})\,\mathrm{var}(\hat{S}_j) \end{pmatrix}$$

with variance calculated according to procedures in Goodman (1960).

The proportion of the spawning population composed of a given age was estimated as the summed totals across size categories:

$$\hat{p}_i = \frac{\hat{S}_i}{\hat{S}}$$

and

$$\mathrm{var}(\hat{p}_i) = \frac{\sum_j (\mathrm{var}(\hat{p}_{ij})\hat{S}_j^2 + \mathrm{var}(\hat{S}_j)(\hat{p}_{ij} - \hat{p}_i)^2)}{\hat{S}^2}$$

where $\hat{S}$ is the sum of fish of all sizes, and variance is approximated according to procedures in Seber (1982:8–9).

Sex composition and age-sex composition for the entire spawning population and its associated variances were also estimated using the above equations by first redefining the binomial variables in samples to produce estimated proportions by sex $\hat{p}_k$, where *k* denotes gender (male or female), such that $\sum_k \hat{p}_k = 1$, and by age-sex $\hat{p}_{ik}$, such that $\sum_{ik} \hat{p}_{ik} = 1$.

In conducting the annual mark–recapture studies, a great deal of time and effort has been expended to produce precise and unbiased estimates of total spawning abundance and by age and sex groups. Sample design is developed prior to implementation in order to produce statistics that are useable and to test assumptions of the two-event mark recapture estimates. Stratification by size is done to produce unbiased estimates and to develop the expansion factor for survey counts of large spawners. A radiotelemetry project was run in 1994 to determine that marked fish were largely unaffected by the tagging experience and that most (>80%) of the spawning occurred in the areas within the peak survey confines (Pahlke et al. 1996). Any marked fish that back out are removed from the experiments. Unbiased sampling methods are employed during collection of samples from or near the spawning grounds.

Table B1.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1986, determined using data sampled on the spawning grounds. Sample sizes are from weir samples only.

		Brood year and age class					
		1983	1982	1981	1980	1979	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	12	225	10			247
	p_{ijk} x100	4.9	91.1	4.0			100.0
	SE(p_{ijk}) x100	1.4	1.8	1.3			
	S_{ijk}	351	6,581	293			7,225
	SE(S_{ijk})	110	960	99			1,044
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes combined	Sample size	12	225	10			247
	p_{ij} x100	4.9	91.1	4.0			100.0
	SE(p_{ij}) x100	1.4	1.8	1.3			
	S_{ij}	351	6,581	293			7,225
	SE(S_{ij})	110	960	99			1,044
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		18	70	26	1	115
	p_{ijk} x100		5.4	20.8	7.7	0.3	34.2
	SE(p_{ijk}) x100		1.2	2.2	1.5	0.3	2.6
	S_{ijk}		550	2,140	795	31	3,516
	SE(S_{ijk})		142	345	177	31	502
Females	Sample size			88	131	2	221
	p_{ijk} x100			26.2	39.0	0.6	65.8
	SE(p_{ijk}) x100			2.4	2.7	0.4	2.6
	S_{ijk}			2,690	4,005	61	6,757
	SE(S_{ijk})			408	557	43	862
Sexes combined	Sample size		18	158	157	3	336
	p_{ij} x100		5.4	47.0	46.7	0.9	100.0
	SE(p_{ij}) x100		1.2	2.7	2.7	0.5	
	S_{ij}		550	4,831	4,800	92	10,273
	SE(S_{ij})		142	649	646	54	1,248
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	2.0	40.8	13.9	4.5	0.2	61.4
	SE(i_{ik}) x100	0.6	4.1	1.6	0.9	0.2	3.4
	S_{ik}	351	7,132	2,433	795	31	10,741
	SE(S_{ik})	110	970	359	177	31	1,158
Females	p_{ik} x100			15.4	22.9	0.3	38.6
	SE(i_{ik}) x100			1.9	2.4	0.2	3.4
	S_{ik}			2,690	4,005	61	6,757
	SE(S_{ik})			408	557	43	862
Sexes combined	p_j x100	2.0	40.8	29.3	27.4	0.5	100.0
	SE(p_i) x100	0.6	4.1	2.6	2.7	0.3	
	S_j	351	7,132	5,123	4,800	92	17,498
	SE(S_i)	110	970	657	646	54	1,627

Table B2.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1987, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1984	1983	1982	1981	1980	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		15	54	24		93
	p_{ijk} x100		7.4	22.5	9.9		24.5
	SE(p_{ijk}) x100		2.3	3.1	3.2		2.2
	S_{ijk}		701	2,147	944		3,792
	SE(S_{ijk})		236	392	322		352
Females	Sample size		1	119	165	2	287
	p_{ijk} x100		0.3	24.6	34.8	0.5	75.5
	SE(p_{ijk}) x100		0.3	2.6	2.6	0.4	2.2
	S_{ijk}		25	2,348	3,317	50	5,741
	SE(S_{ijk})		25	379	474	36	899
Sexes	Sample size		16	173	189	2	380
combined	p_{ij} x100		7.6	47.2	44.7	0.5	100.0
	SE(p_{ij}) x100		2.3	3.5	3.5	0.4	
	S_{ij}		726	4,496	4,261	50	9,533
	SE(S_{ij})		237	545	574	36	1,158
Panel B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes	p_j x100	1.5	18.2	41.4	38.5	0.5	100.0
combined	SE(p_i) x100	0.4	2.7	3.2	3.1	0.3	
	S_j	169	2,011	4,578	4,261	50	11,070
	SE(S_i)	43	199	546	574	36	1,178

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B3.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1988, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1985	1984	1983	1982	1981	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		18	77	51	1	147
	p_{ijk} x100		7.7	28.0	18.3	0.3	37.1
	SE(p_{ijk}) x100		2.3	4.2	3.5	0.3	2.4
	S_{ijk}		649	2,362	1,548	21	4,580
	SE(S_{ijk})		210	453	347	21	432
Females	Sample size			61	186	2	249
	p_{ijk} x100			11.0	34.2	0.5	62.9
	SE(p_{ijk}) x100			1.5	3.6	0.4	2.4
	S_{ijk}			929	2,885	43	3,856
	SE(S_{ijk})			169	461	30	676
Sexes combined	Sample size		18	138	237	3	396
	p_{ij} x100		7.7	39.0	52.5	0.8	100.0
	SE(p_{ij}) x100		2.3	4.2	4.0	0.4	
	S_{ij}		649	3,291	4,433	64	8,437
	SE(S_{ij})		210	484	577	37	1,025
PANEL B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes combined	p_j x100	0.5	14.1	36.5	48.2	0.7	100.0
	SE(p_i) x100	0.2	2.5	3.9	3.8	0.4	
	S_j	48	1,293	3,358	4,433	64	9,196
	SE(S_i)	18	244	484	577	37	1,031

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B4.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1989, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1986	1985	1984	1983	1982	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		5	34	11		50
	p_{ijk} x100		4.5	26.0	8.3		24.0
	SE(p_{ijk}) x100		2.4	4.0	2.7		3.0
	S_{ijk}		250	1,446	463		2,159
	SE(S_{ijk})		136	282	161		230
Females	Sample size			50	105	3	158
	p_{ijk} x100			19.0	40.7	1.4	76.0
	SE(p_{ijk}) x100			2.8	3.9	0.8	3.0
	S_{ijk}			1,055	2,258	80	3,393
	SE(S_{ijk})			203	349	47	538
Sexes	Sample size		5	84	116	3	208
combined	p_{ij} x100		4.5	45.1	49.8	1.4	100.0
	SE(p_{ij}) x100		2.4	4.0	4.0	0.8	
	S_{ij}		250	2,501	2,721	80	5,552
	SE(S_{ij})		136	347	384	47	675
PANEL B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes	p_j x100	1.6	5.8	44.0	47.1	1.4	100.0
combined	SE(p_i) x100	0.4	2.4	3.9	3.9	0.8	
	S_j	94	337	2,544	2,721	80	5,775
	SE(S_i)	20	437	347	384	47	676

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B5.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1990, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1987	1986	1985	1984	1983	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		6	6	3	1	16
	p_{ijk} x100		18.2	15.5	7.7	1.7	27.1
	SE(p_{ijk}) x100		7.8	6.2	4.7	1.7	5.8
	S_{ijk}		521	443	219	48	1,232
	SE(S_{ijk})		229	183	136	48	190
Females	Sample size			6	35	2	43
	p_{ijk} x100			7.7	45.8	3.4	72.9
	SE(p_{ijk}) x100			3.2	7.2	2.4	5.8
	S_{ijk}			220	1,307	97	1,624
	SE(S_{ijk})			94	259	68	302
Sexes combined	Sample size		6	12	38	3	59
	p_{ij} x100		18.2	23.2	53.5	5.1	100.0
	SE(p_{ij}) x100		7.8	6.3	7.8	2.9	
	S_{ij}		521	663	1,526	145	2,856
	SE(S_{ij})		229	205	293	84	347
PANEL B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes combined	p_j x100	1.5	38.2	17.9	38.7	3.7	100.0
	SE(p_i) x100	1.6	7.3	4.9	6.5	2.1	
	S_j	61	1,509	707	1,526	145	3,948
	SE(S_i)	61	216	214	293	84	454

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B6.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1991, determined using data sampled on the spawning grounds. Sample sizes are from weir samples only.

		Brood year and age class					
		1988	1987	1986	1985	1984	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	5	63	3			71
	p_{ijk} x100	7.0	88.7	4.2			100.0
	SE(p_{ijk}) x100	3.1	3.8	2.4			
	S_{ijk}	47	596	28			672
	SE(S_{ijk})	22	104	17			113
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes	Sample size						71
combined	p_{ij} x100	7.0	88.7	4.2			100.0
	SE(p_{ij}) x100	3.1	3.8	2.4			0.0%
	S_{ij}	47	596	28			672
	SE(S_{ij})	22	104	17			113
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		20	149	19	1	189
	p_{ijk} x100		6.0	44.7	5.7	0.3	56.8
	SE(p_{ijk}) x100		1.3	2.7	1.3	0.3	2.7
	S_{ijk}		190	1,416	181	10	1,796
	SE(S_{ijk})		47	192	46	10	234
Females	Sample size			102	39	3	144
	p_{ijk} x100			30.6	11.7	0.9	43.2
	SE(p_{ijk}) x100			2.5	1.8	0.5	2.7
	S_{ijk}			969	371	29	1,369
	SE(S_{ijk})			142	71	17	187
Sexes	Sample size		20	251	58	4	333
combined	p_{ij} x100		6.0	75.4	17.4	1.2	100.0
	SE(p_{ij}) x100		1.3	2.4	2.1	0.6	
	S_{ij}		190	2,386	551	38	3,165
	SE(S_{ij})		47	299	94	19	385
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	1.2	20.5	37.7	4.7	0.2	64.3
	SE(i_{ik}) x100	0.6	2.8	2.6	1.1	0.2	2.6
	S_{ik}	47	786	1,445	181	10	2,468
	SE(S_{ik})	22	114	193	46	10	260
Females	p_{ik} x100			25.3	9.7	0.7	35.7
	SE(i_{ik}) x100			2.3	1.5	0.4	2.6
	S_{ik}			969	371	29	1,369
	SE(S_{ik})			142	71	17	187
Sexes	p_j x100	1.2	20.5	62.9	14.4	1.0	100.0
combined	SE(p_i) x100	0.6	2.8	2.9	1.8	0.5	
	S_j	47	786	2,414	551	38	3,836
	SE(S_i)	22	114	300	94	19	401

Table B7.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1992, determined using data sampled on the spawning grounds. Sample sizes are from weir samples only.

		Brood year and age class					
		1989	1988	1987	1986	1985	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	4	84	3			91
	p_{ijk} x100	4.4	92.3	3.3			100.0
	SE(p_{ijk}) x100	2.2	2.8	1.9			
	S_{ijk}	59	1,229	44			1,331
	SE(S_{ijk})	30	204	26			217
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes combined	Sample size	4	84	3			91
	p_{ij} x100	4.4	92.3	3.3			100.0
	SE(p_{ij}) x100	2.2	2.8	1.9			
	S_{ij}	59	1,229	44			1,331
	SE(S_{ij})	30	204	26			217
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		6	60	24	2	92
	p_{ijk} x100		2.1	21.4	8.6	0.7	32.9
	SE(p_{ijk}) x100		0.9	2.5	1.7	0.5	2.8
	S_{ijk}		90	905	362	30	1,388
	SE(S_{ijk})		38	151	83	21	206
Females	Sample size			64	124		188
	p_{ijk} x100			22.9	44.3		67.1
	SE(p_{ijk}) x100			2.5	3.0		2.8
	S_{ijk}			965	1,870		2,836
	SE(S_{ijk})			158	259		364
Sexes combined	Sample size		6	124	148	2	280
	p_{ij} x100		2.1	44.3	52.9	0.7	100.0
	SE(p_{ij}) x100		0.9	3.0	3.0	0.5	
	S_{ij}		90	1,870	2,232	30	4,223
	SE(S_{ij})		38	259	299	21	513
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	1.1	23.8	17.1	6.5	0.5	48.9
	SE(i_{ik}) x100	0.5	3.5	2.0	1.3	0.4	3.3
	S_{ik}	59	1,319	949	362	30	2,719
	SE(S_{ik})	30	207	153	83	21	299
Females	p_{ik} x100			17.4	33.7		51.1
	SE(i_{ik}) x100			2.1	2.8		3.3
	S_{ik}			965	1,870		2,836
	SE(S_{ik})			158	259		364
Sexes combined	p_j x100	1.1	23.8	34.5	40.2	0.5	100.0
	SE(p_i) x100	0.5	3.5	2.8	3.0	0.4	
	S_j	59	1,319	1,914	2,232	30	5,554
	SE(S_i)	30	207	260	299	21	557

Table B8.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1993, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1990	1989	1988	1987	1986	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	7	55	4			66
	p_{ijk} x100	10.4	82.1	6.0			98.5
	SE(p_{ijk}) x100	3.8	4.7	2.9			1.5
	S_{ijk}	63	498	36			598
	SE(S_{ijk})	25	89	19			102
Females	Sample size				1		1
	p_{ijk} x100				1.5		1.5
	SE(p_{ijk}) x100				1.5		1.5
	S_{ijk}				9		9
	SE(S_{ijk})				9		9
Sexes combined	Sample size	7	55	4	1		67
	p_{ij} x100	10.4	82.1	6.0	1.5		100.0
	SE(p_{ij}) x100	3.8	4.7	2.9	1.5		
	S_{ij}	63	498	36	9		607
	SE(S_{ij})	25	89	19	9		103
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		7	153	77		237
	p_{ijk} x100		1.3	29.3	14.8		45.4
	SE(p_{ijk}) x100		0.5	2.0	1.6		2.2
	S_{ijk}		69	1,513	761		2,343
	SE(S_{ijk})		27	210	122		306
Females	Sample size			70	205	10	285
	p_{ijk} x100			13.4	39.3	1.9	54.6
	SE(p_{ijk}) x100			1.5	2.1	0.6	2.2
	S_{ijk}			692	2,027	99	2,818
	SE(S_{ijk})			114	270	33	360
Sexes combined	Sample size		7	223	282	10	522
	p_{ij} x100		1.3	42.7	54.0	1.9	100.0
	SE(p_{ij}) x100		0.5	2.2	2.2	0.6	
	S_{ij}		69	2,205	2,788	99	5,160
	SE(S_{ij})		27	290	357	33	627
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	1.1	9.8	26.9	13.2		51.0
	SE(i_{ik}) x100	0.4	1.7	1.9	1.4		2.2
	S_{ik}	63	568	1,549	761		2,941
	SE(S_{ik})	25	93	211	122		322
Females	p_{ik} x100			12.0	35.3	1.7	49.0
	SE(i_{ik}) x100			1.4	2.1	0.5	2.2
	S_{ik}			692	2,036	99	2,827
	SE(S_{ik})			114	270	33	360
Sexes combined	p_j x100	1.1	9.8	38.9	48.5	1.7	100.0
	SE(p_i) x100	0.4	1.7	2.1	2.2	0.5	
	S_j	63	568	2,241	2,797	99	5,768
	SE(S_i)	25	93	291	357	33	635

Table B9.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1994, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1991	1990	1989	1988	1987	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		4	30	31	3	68
	p_{ijk} x100		2.7	18.9	17.9	1.2	26.9
	SE(p_{ijk}) x100		1.5	3.8	4.5	0.7	2.8
	S_{ijk}		91	648	616	41	1,396
	SE(S_{ijk})		52	151	172	24	147
Females	Sample size			43	136	6	185
	p_{ijk} x100			13.5	43.5	2.4	73.1
	SE(p_{ijk}) x100			2.5	4.2	1.0	2.8
	S_{ijk}			463	1,495	81	2,039
	SE(S_{ijk})			101	232	34	320
Sexes	Sample size		4	73	167	9	253
combined	p_{ij} x100		2.7	32.4	61.4	3.6	100.0
	SE(p_{ij}) x100		1.5	3.6	3.8	1.2	
	S_{ij}		91	1,112	2,110	122	3,435
	SE(S_{ij})		52	182	289	42	417
PANEL B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes	p_j x100		22.3	29.6	45.4	2.6	100.0
combined	SE(p_i) x100		3.0	4.4	4.2	0.9	
	S_j		1,044	1,383	2,124	122	4,674
	SE(S_i)		287	294	292	42	507

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B10.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1995, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1992	1991	1990	1989	1988	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size		11				11
	p_{ijk} x100		100.0				100.0
	SE(p_{ijk}) x100						
	S_{ijk}		1,243				1,243
	SE(S_{ijk})		438				438
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes combined	Sample size		11				11
	p_{ij} x100		100.0				100.0
	SE(p_{ij}) x100						
	S_{ij}		1,243				1,243
	SE(S_{ij})		438				438
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		3	6	5		14
	p_{ijk} x100		10.0	20.0	16.7		46.7
	SE(p_{ijk}) x100		5.6	7.4	6.9		9.3
	S_{ijk}		373	746	622		1,741
	SE(S_{ijk})		211	290	267		403
Females	Sample size			2	14		16
	p_{ijk} x100			6.7	46.7		53.3
	SE(p_{ijk}) x100			4.6	9.3		9.3
	S_{ijk}			249	1,741		1,989
	SE(S_{ijk})			174	403		420
Sexes combined	Sample size		3	8	19		30
	p_{ij} x100		10.0	26.7	63.3		100.0
	SE(p_{ij}) x100		5.6	8.2	8.9		
	S_{ij}		373	995	2,362		3,730
	SE(S_{ij})		211	327	438		453
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100		32.5	15.0	12.5		60.0
	SE(i_{ik}) x100		7.6	5.7	5.3		7.9
	S_{ik}		1,616	746	622		2,984
	SE(S_{ik})		486	290	267		595
Females	p_{ik} x100			5.0	35.0		40.0
	SE(i_{ik}) x100			3.5	7.7		7.9
	S_{ik}			249	1,741		1,989
	SE(S_{ik})			174	403		420
Sexes combined	p_j x100		32.5	20.0	47.5		100.0
	SE(p_i) x100		7.6	6.4	8.0		
	S_j		1,616	995	2,362		4,974
	SE(S_i)		486	327	438		630

Table B11.–Age and sex composition of large and combined Chinook salmon escapement in the Unuk River in 1996, determined using data sampled on the spawning grounds. Bias-correction for spear and carcass samples has been applied to proportions by age of large male fish age-1.2 to -1.4 and female fish age-1.3 and -1.4.

		Brood year and age class					
		1993	1992	1991	1990	1989	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		8	98	40	4	150
	p_{ijk} x100		2.0	32.7	17.0	1.0	38.3
	SE(p_{ijk}) x100		1.1	4.6	4.1	0.5	2.5
	S_{ijk}		114	1,845	961	58	2,978
	SE(S_{ijk})		61	340	259	29	296
Females	Sample size			107	126	9	242
	p_{ijk} x100			20.8	24.1	2.3	61.7
	SE(p_{ijk}) x100			3.1	2.9	0.8	2.5
	S_{ijk}			1,173	1,359	129	2,661
	SE(S_{ijk})			224	233	45	445
Sexes combined	Sample size		8	205	166	13	392
	p_{ij} x100		2.0	53.5	41.1	3.3	100.0
	SE(p_{ij}) x100		1.1	4.4	4.4	0.9	
	S_{ij}		114	3,018	2,319	187	5,639
	SE(S_{ij})		61	407	348	54	685
PANEL B: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON[a]							
Sexes combined	p_j x100		11.7	48.6	36.8	3.0	100.0
	SE(p_i) x100		2.4	4.1	4.0	0.8	
	S_j		736	3,061	2,319	187	6,304
	SE(S_i)		349	409	348	54	702

[a] Age compositions were not estimated for small fish. Age-1.2 escapement and standard error estimates have been adjusted using coefficient of regressed age-1.2 returns versus age-1.3 to -1.5 returns estimated for brood years 1993–1998. Estimates of age-1.1 fish are biased low because of sampling methods.

Table B12.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1997, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1994	1993	1992	1991	1990	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOKK SALMON							
Males	Sample size	10	131	2	1		144
	p_{ijk} x100	6.9	91.0	1.4	0.7		100.0
	SE(p_{ijk}) x100	2.1	2.4	1.0	0.7		
	S_{ijk}	49	638	10	5		701
	SE(S_{ijk})	18	145	7	5		158
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes combined	Sample size	10	131	2	1		144
	p_{ij} x100	6.9	91.0	1.4	0.7		100.0
	SE(p_{ij}) x100	2.1	2.4	1.0	0.7		
	S_{ij}	49	638	10	5		701
	SE(S_{ij})	18	145	7	5		158
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		60	156	69	3	288
	p_{ijk} x100		9.2	23.9	10.6	0.5	44.2
	SE(p_{ijk}) x100		1.1	1.7	1.2	0.3	1.9
	S_{ijk}		273	711	314	14	1,312
	SE(S_{ijk})		42	83	46	8	135
Females	Sample size		1	114	239	10	364
	p_{ijk} x100		0.2	17.5	36.7	1.5	55.8
	SE(p_{ijk}) x100		0.2	1.5	1.9	0.5	1.9
	S_{ijk}		5	519	1,089	46	1,658
	SE(S_{ijk})		5	65	116	15	165
Sexes combined	Sample size		61	270	308	13	652
	p_{ij} x100		9.4	41.4	47.2	2.0	100.0
	SE(p_{ij}) x100		1.1	1.9	2.0	0.5	
	S_{ij}		278	1,230	1,403	59	2,970
	SE(S_{ij})		43	128	143	17	277
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	1.3	24.8	19.6	8.7	0.4	54.8
	SE(i_{ik}) x100	0.5	3.2	1.6	1.1	0.2	2.6
	S_{ik}	49	911	720	319	14	2,013
	SE(S_{ik})	18	151	83	46	8	208
Females	p_{ik} x100		0.1	14.1	29.7	1.2	45.2
	SE(i_{ik}) x100		0.1	1.4	2.1	0.4	2.6
	S_{ik}		5	519	1,089	46	1,658
	SE(S_{ik})		5	65	116	15	165
Sexes combined	p_j x100	1.3	24.9	33.8	38.4	1.6	100.0
	SE(p_i) x100	0.5	3.2	2.2	2.4	0.4	
	S_j	49	916	1,240	1,408	59	3,671
	SE(S_i)	18	151	128	143	17	319

Table B13.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1998, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1995	1994	1993	1992	1991	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	40	167	6			213
	p_{ijk} x100	18.7	78.0	2.8			99.5
	SE(p_{ijk}) x100	2.7	2.8	1.1			0.5
	S_{ijk}	224	935	34			1,192
	SE(S_{ijk})	62	229	15			289
Females	Sample size			1			1
	p_{ijk} x100			0.5			0.5
	SE(p_{ijk}) x100			0.5			0.5
	S_{ijk}			6			6
	SE(S_{ijk})			6			6
Sexes combined	Sample size	40	167	7			214
	p_{ij} x100	18.7	78.0	3.3			100.0
	SE(p_{ij}) x100	2.7	2.8	1.2			
	S_{ij}	224	935	39			1,198
	SE(S_{ij})	62	229	17			290
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		57	235	56	1	349
	p_{ijk} x100		8.1	33.3	7.9	0.1	49.5
	SE(p_{ijk}) x100		1.0	1.8	1.0	0.1	1.9
	S_{ijk}		334	1,377	328	6	2,045
	SE(S_{ijk})		54	156	53	6	219
Females	Sample size			201	150	5	356
	p_{ijk} x100			28.5	21.3	0.7	50.5
	SE(p_{ijk}) x100			1.7	1.5	0.3	1.9
	S_{ijk}			1,178	879	29	2,087
	SE(S_{ijk})			137	108	13	222
Sexes combined	Sample size		57	436	206	6	705
	p_{ij} x100		8.1	61.8	29.2	0.9	100.0
	SE(p_{ij}) x100		1.0	1.8	1.7	0.3	
	S_{ij}		334	2,555	1,207	35	4,132
	SE(S_{ij})		54	266	140	15	413
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	4.2	23.8	26.5	6.2	0.1	60.7
	SE(i_{ik}) x100	1.0	3.4	2.0	0.9	0.1	2.7
	S_{ik}	224	1,269	1,411	328	6	3,238
	SE(S_{ik})	62	235	157	53	6	362
Females	p_{ik} x100			22.2	16.5	0.5	39.3
	SE(i_{ik}) x100			1.8	1.5	0.2	2.7
	S_{ik}			1,184	879	29	2,092
	SE(S_{ik})			137	108	13	223
Sexes combined	p_j x100	4.2	23.8	48.7	22.7	0.7	100.0
	SE(p_i) x100	1.0	3.4	3.0	1.9	0.3	
	S_j	224	1,269	2,595	1,207	35	5,330
	SE(S_i)	62	235	267	140	15	505

Table B14.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 1999, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1996	1995	1994	1993	1992	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401-659 mm MEF) CHINOOK SALMON							
Males	Sample size	24	201	1			226
	p_{ijk} x100	10.6	88.5	0.4			99.6
	SE(p_{ijk}) x100	2.0	2.1	0.4			0.4
	S_{ijk}	240	2,007	10			2,257
	SE(S_{ijk})	78	535	10			599
Females	Sample size				1		1
	p_{ijk} x100				0.4		0.4
	SE(p_{ijk}) x100				0.4		0.4
	S_{ijk}				10		10
	SE(S_{ijk})				10		10
Sexes	Sample size	24	201	1	1		227
combined	p_{ij} x100	10.6	88.5	0.4	0.4		100.0
	SE(p_{ij}) x100	2.0	2.1	0.4	0.4		
	S_{ij}	240	2,007	10	10		2,267
	SE(S_{ij})	78	535	10	10		602
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		48	128	56	1	233
	p_{ijk} x100		10.1	26.9	11.8	0.2	48.9
	SE(p_{ijk}) x100		1.4	2.0	1.5	0.2	2.3
	S_{ijk}		395	1,053	460	8	1,916
	SE(S_{ijk})		73	154	81	8	256
Females	Sample size		3	104	135	1	243
	p_{ijk} x100		0.6	21.8	28.4	0.2	51.1
	SE(p_{ijk}) x100		0.4	1.9	2.1	0.2	2.3
	S_{ijk}		25	855	1,110	8	1,998
	SE(S_{ijk})		14	130	161	8	266
Sexes	Sample size		51	232	191	2	476
combined	p_{ij} x100		10.7	48.7	40.1	0.4	100.0
	SE(p_{ij}) x100		1.4	2.3	2.2	0.3	
	S_{ij}		419	1,908	1,571	16	3,914
	SE(S_{ij})		76	255	215	12	490
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	3.9	38.9	17.2	7.4	0.1	67.5
	SE(i_{ik}) x100	1.0	5.5	2.2	1.2	0.1	3.7
	S_{ik}	240	2,402	1,062	460	8	4,173
	SE(S_{ik})	78	540	154	81	8	652
Females	p_{ik} x100		0.4	13.8	18.1	0.1	32.5
	SE(i_{ik}) x100		0.2	1.9	2.3	0.1	3.7
	S_{ik}		25	855	1,120	8	2,008
	SE(S_{ik})		14	130	161	8	266
Sexes	p_j x100	3.9	39.3	31.0	25.6	0.3	100.0
combined	SE(p_i) x100	1.0	5.4	3.6	3.1	0.2	
	S_j	240	2,427	1,918	1,581	16	6,181
	SE(S_i)	78	540	255	215	12	776

Table B15.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2000, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1997	1996	1995	1994	1993	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	1	152	4			157
	p_{ijk} x100	0.6	96.8	2.5			100.0
	SE(p_{ijk}) x100	0.6	1.4	1.3			
	S_{ijk}	15	2,205	58			2,278
	SE(S_{ijk})	15	938	36			968
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes	Sample size	1	152	4			157
combined	p_{ij} x100	0.6	96.8	2.5			100.0
	SE(p_{ij}) x100	0.6	1.4	1.3			
	S_{ij}	15	2,205	58			2,278
	SE(S_{ij})	15	938	36			968
PANEL B: AGE COMPOSITION OF LARGE ≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		108	242	55	2	407
	p_{ijk} x100		15.2	34.1	7.7	0.3	57.3
	SE(p_{ijk}) x100		1.3	1.8	1.0	0.2	1.9
	S_{ijk}		893	2,001	455	17	3,366
	SE(S_{ijk})		126	243	77	12	385
Females	Sample size		5	174	120	4	303
	p_{ijk} x100		0.7	24.5	16.9	0.6	42.7
	SE(p_{ijk}) x100		0.3	1.6	1.4	0.3	1.9
	S_{ijk}		41	1,439	992	33	2,506
	SE(S_{ijk})		19	184	136	17	295
Sexes	Sample size		113	416	175	6	710
combined	p_{ij} x100		15.9	58.6	24.6	0.8	100.0
	SE(p_{ij}) x100		1.4	1.8	1.6	0.3	
	S_{ij}		935	3,440	1,447	50	5,872
	SE(S_{ij})		130	392	185	21	644
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	0.2	38.0	25.3	5.6	0.2	69.3
	SE(i_{ik}) x100	0.2	7.3	3.1	1.0	0.1	4.0
	S_{ik}	15	3,099	2,059	455	17	5,644
	SE(S_{ik})	15	946	245	77	12	1,042
Females	p_{ik} x100		0.5	17.7	12.2	0.4	30.7
	SE(i_{ik}) x100		0.2	2.5	1.8	0.2	4.0
	S_{ik}		41	1,439	992	33	2,506
	SE(S_{ik})		19	184	136	17	295
Sexes	p_j x100	0.2	38.5	42.9	17.8	0.6	100.0
combined	SE(p_i) x100	0.2	7.2	5.1	2.5	0.3	
	S_j	15	3,140	3,499	1,447	50	8,150
	SE(S_i)	15	947	394	185	21	1,163

Table B16.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2001, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1998	1997	1996	1995	1994	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401–659 mm MEF) CHINOOK SALMON							
Males	Sample size	8	64	2			74
	p_{ijk} x100	10.8	86.5	2.7			100.0
	SE(p_{ijk}) x100	3.6	4.0	1.9			
	S_{ijk}	83	665	21			769
	SE(S_{ijk})	31	111	15			124
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes	Sample size	8	64	2			74
combined	p_{ij} x100	10.8	86.5	2.7			100.0
	SE(p_{ij}) x100	3.6	4.0	1.9			
	S_{ij}	83	665	21			769
	SE(S_{ij})	31	111	15			124
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		26	352	86	2	466
	p_{ijk} x100		2.6	34.7	8.5	0.2	46.0
	SE(p_{ijk}) x100		0.5	1.5	0.9	0.1	1.6
	S_{ijk}		270	3,659	894	21	4,844
	SE(S_{ijk})		60	439	136	15	567
Females	Sample size		1	312	235		548
	p_{ijk} x100		0.1	30.8	23.2		54.0
	SE(p_{ijk}) x100		0.1	1.5	1.3		1.6
	S_{ijk}		10	3,243	2,443		5,697
	SE(S_{ijk})		10	394	307		659
Sexes	Sample size		27	664	321	2	1,014
combined	p_{ij} x100		2.7	65.5	31.7	0.2	100.0
	SE(p_{ij}) x100		0.5	1.5	1.5	0.1	
	S_{ij}		281	6,903	3,337	21	10,541
	SE(S_{ij})		62	789	404	15	1,181
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	0.7	8.3	32.5	7.9	0.2	49.6
	SE(i_{ik}) x100	0.3	1.2	1.5	0.8	0.1	1.6
	S_{ik}	83	935	3,680	894	21	5,613
	SE(S_{ik})	31	127	439	136	15	580
Females	p_{ik} x100		0.1	28.7	21.6		50.4
	SE(i_{ik}) x100		0.1	1.4	1.3		1.6
	S_{ik}		10	3,243	2,443		5,697
	SE(S_{ik})		10	394	307		659
Sexes	p_j x100	0.7	8.4	61.2	29.5	0.2	100.0
combined	SE(p_i) x100	0.3	1.2	1.6	1.4	0.1	
	S_j	83	946	6,923	3,337	21	11,310
	SE(S_i)	31	127	789	404	15	1,187

Table B17.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2002, determined using data sampled on the spawning grounds.

		Brood year and age class					
		1999	1998	1997	1996	1995	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401-659 mm MEF) CHINOOK SALMON							
Males	Sample size		104	1			105
	p_{ijk} x100		98.1	0.9			99.1
	SE(p_{ijk}) x100		1.3	0.9			0.9
	S_{ijk}		1,607	15			1,623
	SE(S_{ijk})		677	15			684
Females	Sample size		1				1
	p_{ijk} x100		0.9				0.9
	SE(p_{ijk}) x100		0.9				0.9
	S_{ijk}		15				15
	SE(S_{ijk})		15				15
Sexes	Sample size		105	1			106
combined	p_{ij} x100		99.1	0.9			100.0
	SE(p_{ij}) x100		0.9	0.9			
	S_{ij}		1,623	15			1,638
	SE(S_{ij})		684	15			690
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		76	152	105	2	335
	p_{ijk} x100		11.9	23.8	16.4	0.3	52.3
	SE(p_{ijk}) x100		1.3	1.7	1.5	0.2	2.0
	S_{ijk}		830	1,660	1,146	22	3,658
	SE(S_{ijk})		130	224	167	16	443
Females	Sample size		3	111	187	4	305
	p_{ijk} x100		0.5	17.3	29.2	0.6	47.7
	SE(p_{ijk}) x100		0.3	1.5	1.8	0.3	2.0
	S_{ijk}		33	1,212	2,042	44	3,330
	SE(S_{ijk})		19	174	266	22	407
Sexes	Sample size		79	263	292	6	640
combined	p_{ij} x100		12.3	41.1	45.6	0.9	100.0
	SE(p_{ij}) x100		1.3	1.9	2.0	0.4	
	S_{ij}		863	2,872	3,188	66	6,988
	SE(S_{ij})		134	357	392	28	805
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100		28.3	19.4	13.3	0.3	61.2
	SE(i_{ik}) x100		5.9	2.1	1.6	0.2	3.5
	S_{ik}		2,437	1,675	1,146	22	5,280
	SE(S_{ik})		690	225	167	16	815
Females	p_{ik} x100		0.6	14.1	23.7	0.5	38.8
	SE(i_{ik}) x100		0.3	1.7	2.4	0.3	3.5
	S_{ik}		48	1,212	2,042	44	3,346
	SE(S_{ik})		25	174	266	22	408
Sexes	p_j x100		28.8	33.5	37.0	0.8	100.0
combined	SE(p_i) x100		5.9	3.1	3.5	0.3	
	S_j		2,485	2,887	3,188	66	8,626
	SE(S_i)		697	358	392	28	1,060

Table B18.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2003, determined using data sampled on the spawning grounds.

		Brood year and age class					
		2000	1999	1998	1997	1996	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401-659 mm MEF) CHINOOK SALMON							
Males	Sample size	31	80	2			113
	p_{ijk} x100	27.4	70.8	1.8			100.0
	SE(p_{ijk}) x100	4.2	4.3	1.2			
	S_{ijk}	191	494	12			698
	SE(S_{ijk})	37	64	9			80
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes	Sample size	31	80	2			113
combined	p_{ij} x100	27.4	70.8	1.8			100.0
	SE(p_{ij}) x100	4.2	4.3	1.2			
	S_{ij}	191	494	12			698
	SE(S_{ij})	37	64	9			80
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		15	371	78	2	466
	p_{ijk} x100		1.6	38.4	8.1	0.2	48.2
	SE(p_{ijk}) x100		0.4	1.6	0.9	0.1	1.6
	S_{ijk}		86	2,128	447	11	2,673
	SE(S_{ijk})		23	187	60	8	227
Females	Sample size		2	314	179	6	501
	p_{ijk} x100		0.2	32.5	18.5	0.6	51.8
	SE(p_{ijk}) x100		0.1	1.5	1.2	0.3	1.6
	S_{ijk}		11	1,801	1,027	34	2,873
	SE(S_{ijk})		8	163	106	14	241
Sexes	Sample size		17	685	257	8	967
combined	p_{ij} x100		1.8	70.8	26.6	0.8	100.0
	SE(p_{ij}) x100		0.4	1.5	1.4	0.3	
	S_{ij}		97	3,929	1,474	46	5,546
	SE(S_{ij})		25	317	139	17	433
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	3.1	9.3	34.3	7.2	0.2	54.0
	SE(i_{ik}) x100	0.6	1.1	1.5	0.8	0.1	1.6
	S_{ik}	191	580	2,140	447	11	3,371
	SE(S_{ik})	37	68	188	60	8	241
Females	p_{ik} x100		0.2	28.8	16.4	0.6	46.0
	SE(i_{ik}) x100		0.1	1.4	1.1	0.2	1.6
	S_{ik}		11	1,801	1,027	34	2,873
	SE(S_{ik})		8	163	106	14	241
Sexes	p_j x100	3.1	9.5	63.1	23.6	0.7	100.0
combined	SE(p_i) x100	0.6	1.1	1.6	1.3	0.3	
	S_j	191	592	3,941	1,474	46	6,244
	SE(S_{ij})	37	69	317	139	17	440

Table B19.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2004, determined using data sampled on the spawning grounds.

		Brood year and age class					
		2001	2000	1999	1998	1997	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401-659 mm MEF) CHINOOK SALMON							
Males	Sample size	12	314	8			334
	p_{ijk} x100	3.6	93.5	2.4			99.4
	SE(p_{ijk}) x100	1.0	1.4	0.8			0.4
	S_{ijk}	76	1,976	50			2,101
	SE(S_{ijk})	24	318	19			337
Females	Sample size		2				2
	p_{ijk} x100		0.6				0.6
	SE(p_{ijk}) x100		0.4				0.4
	S_{ijk}		13				13
	SE(S_{ijk})		9				9
Sexes	Sample size	12	316	8			
combined	p_{ij} x100	3.6	94.0	2.4			100.0
	SE(p_{ij}) x100	1.0	1.3	0.8			
	S_{ij}	76	1,988	50			2,114
	SE(S_{ij})	24	320	19			339
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		193	178	108		479
	p_{ijk} x100		23.6	21.7	13.2		58.5
	SE(p_{ijk}) x100		1.5	1.4	1.2		1.7
	S_{ijk}		934	861	523		2,318
	SE(S_{ijk})		96	91	63		202
Females	Sample size		3	78	255	4	340
	p_{ijk} x100		0.4	9.5	31.1	0.5	41.5
	SE(p_{ijk}) x100		0.2	1.0	1.6	0.2	1.7
	S_{ijk}		15	377	1,234	19	1,645
	SE(S_{ijk})		8	51	120	10	151
Sexes	Sample size		196	256	363	4	819
combined	p_{ij} x100		23.9	31.3	44.3	0.5	100.0
	SE(p_{ij}) x100		1.5	1.6	1.7	0.2	
	S_{ij}		948	1,239	1,756	19	3,963
	SE(S_{ij})		98	120	160	10	325
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	1.2	47.9	15.0	8.6		72.7
	SE(i_{ik}) x100	0.4	3.1	1.3	0.9		2.0
	S_{ik}	76	2,909	912	523		4,419
	SE(S_{ik})	24	332	93	63		393
Females	p_{ik} x100		0.4	6.2	20.3	0.3	27.3
	SE(i_{ik}) x100		0.2	0.8	1.7	0.2	2.0
	S_{ik}		27	377	1,234	19	1,658
	SE(S_{ik})		12	51	120	10	151
Sexes	p_j x100	1.2	48.3	21.2	28.9	0.3	100.0
combined	SE(p_i) x100	0.4	3.1	1.6	2.1	0.2	
	S_j	76	2,937	1,289	1,756	19	6,077
	SE(S_i)	24	335	122	160	10	470

Table B20.–Age and sex composition of small, large and combined Chinook salmon escapement in the Unuk River in 2005, determined using data sampled on the spawning grounds.

		Brood year and age class					
		2002	2001	2000	1999	1998	
		1.1	1.2	1.3	1.4	1.5	Total
PANEL A: AGE COMPOSITION OF SMALL (401-659 mm MEF) CHINOOK SALMON							
Males	Sample size	45	71	13			129
	p_{ijk} x100	34 .9	55 .0	10 .1			100 .0
	SE(p_{ijk}) x100	4 .2	4 .4	2 .7			0 .0
	S_{ijk}	237	374	68			679
	SE(S_{ijk})	67	101	25			176
Females	Sample size						
	p_{ijk} x100						
	SE(p_{ijk}) x100						
	S_{ijk}						
	SE(S_{ijk})						
Sexes combined	Sample size	45	71	13			129
	p_{ij} x100	34 .9	55 .0	10 .1			100 .0
	SE(p_{ij}) x100	4 .2	4 .4	2 .7			
	S_{ij}	237	374	68			679
	SE(S_{ij})	67	101	25			176
PANEL B: AGE COMPOSITION OF LARGE (≥660 mm MEF) CHINOOK SALMON							
Males	Sample size		22	373	39	1	435
	p_{ijk} x100		3 .0	50 .5	5 .3	0 .1	58 .9
	SE(p_{ijk}) x100		0 .6	1 .8	0 .8	0 .1	1 .8
	S_{ijk}		141	2,397	251	6	2,795
	SE(S_{ijk})		32	218	44	6	249
Females	Sample size		1	209	92	1	303
	p_{ijk} x100		0 .1	28.3	12 .5	0 .1	41 .1
	SE(p_{ijk}) x100		0 .1	1 .7	1 .2	0 .1	1 .8
	S_{ijk}		6	1,343	591	6	1,947
	SE(S_{ijk})		6	137	76	6	184
Sexes combined	Sample size		23	582	131	2	738
	p_{ij} x100		3 .1	78 .9	17 .8	0 .3	100
	SE(p_{ij}) x100		0 .6	1 .5	1 .4	0 .2	
	S_{ij}		148	3,740	842	13	4,742
	SE(S_{ij})		33	320	97	9	396
PANEL C: AGE COMPOSITION OF SMALL AND LARGE (>400 mm MEF) CHINOOK SALMON							
Males	p_{ik} x100	4 .4	9 .5	45 .5	4 .6	0 .1	64 .1
	SE(i_{ik}) x100	1 .2	1 .7	2 .0	0 .7	0 .1	2 .0
	S_{ik}	237	515	2,645	251	6	3,474
	SE(S_{ik})	67	106	220	44	6	305
Females	p_{ik} x100		0 .1	24 .8	10 .9	0 .1	35 .9
	SE(i_{ik}) x100		0 .1	1 .7	1 .1	0 .1	2 .0
	S_{ik}		6	1,343	591	6	1,947
	SE(S_{ik})		6	137	76	6	184
Sexes combined	p_j x100	4 .4	9 .6	70 .2	15 .5	0 .2	100
	SE(p_i) x100	1 .2	1 .7	2 .5	1 .3	0 .2	
	S_j	237	521	3,808	842	13	5,421
	SE(S_i)	67	106	321	97	9	433

APPENDIX C

Since 1997, mark–recapture studies have shown that some, but not all of the gear types used to sample fish on the Unuk River spawning grounds have produced unbiased estimates of age and sex composition (McPherson et al. 1997; Jones III et al. 1998; Jones III and McPherson 1999-2000, 2002; Weller and McPherson 2003a-b, 2004, 2006a). Employing a variety of capture methods that included snagging or dipnetting moribund salmon, lure fishing or gillnetting pre-spawning fish, or capturing pre-spawning salmon as they passed through a weir produced unbiased estimates of age-sex composition. Capture methods exclusively limited to spearing moribund fish or opportunistically selecting carcasses on the spawning grounds produced estimates biased towards large female spawners. Samples from the different tributaries were pooled in these investigations, as no significant differences in age-sex composition had been shown across tributaries within a sampling method (Weller and McPherson 2006a). With some exceptions, spearing and carcass sampling were the methods used to collect data prior to 1997, a circumstance which indicates some potential for bias in statistics for those early years. Fortunately, information was available to adjust for that bias.

We adapted a correction designed by David Bernard that was previously used for Taku River Chinook salmon (McPherson et al. 2000) to produce relatively unbiased annual estimates of relative age and sex composition. Mark–recapture studies in the Taku River showed that sampling in three tributaries with a mix of methods produced unbiased estimates of age and sex composition (McPherson et al. 1997). Samples collected with a different combination of methods (a carcass weir and carcass sampling) from a fourth tributary were shown to be skewed to males and larger females, respectively. The data series from this fourth tributary was considerably longer than the series for the other tributaries. An average relationship was estimated between unbiased statistics from the three tributaries and biased statistics from the fourth tributary for those years with mark–recapture experiments. This estimated relationship was then used to adjust statistics from the fourth tributary in earlier years with no mark–recapture experiments.

The same approach was used for our work on the Unuk River, only statistics were not segregated by tributary, but directly by the method (gear) used to collect samples. Mark–recapture experiments in 1997–2001 showed that age and sex groups had heterogeneous probabilities of capture when moribund fish were speared or carcasses were opportunistically selected (hereafter called unrepresentative methods). In the same years, age and sex groups had homogenous probabilities of being sampled when other gear types (fishing lures, gillnets, dipnets, snagging gear) were used in addition to the unrepresentative methods.

Development of the correction begins with an estimate for data collected with representative methods in years with mark–recapture experiments. The true fraction θ_a of the population comprised of age-sex group a is

$$\theta_a = \frac{N_a}{N}$$

where N is the number of spawners in the Unuk River and N_a is the subset of those spawners in age-sex group a. An estimate of θ_a was calculated from n samples taken with representative methods:

$$\hat{\theta}_{a,t} = \frac{n_{a,t}}{n_t}$$

where n_t is the pooled number of samples from our representative methods, $n_{a,t}$ is the number of those samples from age-sex group a, and t is the year of sampling (1997–2001). By using representative methods each salmon has an equal probability of being sampled regardless of the age-sex group to which it belongs.

In contrast, salmon have a different probability of capture depending on their age and/or sex when sampled with unrepresentative methods. If ρ_a is the probability of sampling a fish in group *a* on the Unuk River with unrepresentative methods, the expected number of Chinook salmon of that group in a randomly drawn sample, *m*, from the Unuk River is:

$$\mathrm{E}[m_a] = N_a \rho_a$$

A similar equation applies for all age-sex groups. Because $N_a = N\theta_a$, $N_b = N\theta_b$, etc:

$$\mathrm{E}[m_a] = N\theta_a \rho_a$$

$$\mathrm{E}[m_b] = N\theta_b \rho_b$$

and so on. If the equation for group *a* is divided into the equation for group *b* and rearranged:

$$\frac{\rho_b}{\rho_a} = \frac{\theta_a \mathrm{E}[m_b]}{\theta_b \mathrm{E}[m_a]}$$

Our estimates of relative age-sex composition are functions of probabilities of capture that are relative in magnitude. Thus, ρ_a can arbitrarily be set to one, and the above equation reduces to:

$$\hat{w}_b = \frac{\hat{\theta}_a m_b}{\hat{\theta}_b m_a}$$

where $\hat{w}_b$ is the estimate of ρ_b relative to ρ_a. Weighted estimates for other groups can also be calculated relative to group *a*. Substituting the estimates of θ_a and θ_b derived from representative methods into the equation above, we produced weighted adjustments for unrepresentative sampling for each age-sex group in each year (1997–2001) as:

$$\hat{w}_{b,t} = \frac{n_{a,t} m_{b,t}}{n_{b,t} m_{a,t}}$$

For Unuk River Chinook salmon, solutions to $\{\boldsymbol{w}\}$ were calculated for large age-1.3 and 1.4 females and age- 1.3-1.5 males for years 1997–2001. Probabilities of capture were scaled to age 1.3 males, as that was the group with the largest sample size. Elements were averaged across years to produce expansion factors $\overline{w}$ (Table C1). Numbers of females under age 1.3 were few (<0.1%) and were considered inconsequential. The same applies to age-1.5 fish of both sexes and small males over age 1.2 (each representing less than 2% of samples). We chose to apply the correction to large fish only. Because the majority of age-1.2 males are of small size (>73% of age-1.2 males), we had to later correct those numbers by regressing this age and size group relative to age-1.3 to age-1.5 fish combined. Age-1.1 fish were ignored.

Table C2 contains the adjusted estimates for relative age-sex composition for large Chinook salmon spawning in the Unuk River from 1986–2005. For years 1997–2005, estimates of relative age-sex composition for spawners were calculated directly from proportions from data collected with representative methods in the second of the two-event mark–recapture studies. Estimates in 1993 and 1995 (no mark–recapture studies) were calculated from spawning grounds sampling with representative methods (a variety including dipnetting and snagging moribund fish). For years 1986, 1991 and 1992, estimates of age-sex composition were derived solely from sampling with the live weir on Cripple Creek. In all other years, estimates were calculated from spear and carcass statistics with weighted adjustments:

$$\hat{\theta}_a = \frac{m_a}{m_a + m_b \overline{w}_b^{-1} + m_c \overline{w}_c^{-1} + \ldots}$$

$$\hat{\theta}_b = \frac{m_b \overline{w}_b^{-1}}{m_a + m_b \overline{w}_b^{-1} + m_c \overline{w}_c^{-1} + \ldots}$$

and so on for remaining age-sex groups. Estimated variances for $\{\hat{\theta}_t\}$ in bias-corrected year t were obtained through simulation. During the kth iteration of a simulation, two vectors of new sample sizes ${}_k$ and $\{\mathbf{m}_i'\}_k$ were generated from the probability distributions multinom (n_i, $\{\hat{\theta}_i\}$) and multinom (m_i, $\{\hat{\phi}_i\}$) where i represents one of the years with mark–recapture experiments drawn at random with replacement. Elements of the vector $\{\hat{\phi}_i\}$ are estimates of relative age-sex composition from spear and carcass samples in year i:

$$\hat{\phi}_{a,i} = \frac{m_{a,i}}{m_{a,i} + m_{b,i} + m_{c,i} + \ldots}$$

and so forth. A new set of weights were calculated for each vector of simulated sample sizes for each year from 1997–2001:

$$\hat{w}'_{b,\, i(k)} = \frac{\hat{\theta}'_{a,i(k)} m'_{b,i(k)}}{\hat{\theta}'_{b,i(k)} m'_{a,i(k)}}$$

and similarly for the other groups. Elements from each group were averaged across years. Simulated estimates of relative age-sex composition for each bias-corrected year t were then calculated as:

$$\hat{\theta}'_{a,t(k)} = \frac{m'_{a,t(k)}}{m'_{a,t(k)} + m'_{b,t(k)} \overline{\hat{w}'}^{-1}_{b,(k)} + m'_{c,t(k)} \overline{\hat{w}'}^{-1}_{c,(k)} + \ldots}$$

$$\hat{\theta}'_{b,t(k)} = \frac{m'_{b,t(k)} \overline{\hat{w}'}^{-1}_{b,(k)}}{m'_{a,t(k)} + m'_{b,t(k)} \overline{\hat{w}'}^{-1}_{b,(k)} + m'_{c(k)} \overline{\hat{w}'}^{-1}_{c,(k)} + \ldots}$$

and so on. Variance for each element in $\{\hat{\theta}_t\}$ was approximated as follows:

$$v(\hat{\theta}_{a,t}) \cong \frac{\sum_{k=1}^{K} (\hat{\theta}'_{a,t(k)} - \overline{\theta}'_{a,t})^2}{K-1}$$

$$v(\hat{\theta}_{b,t}) \cong \frac{\sum_{k=1}^{K} (\hat{\theta}'_{b,t(k)} - \overline{\theta}'_{b,t})^2}{K-1}$$

and so forth, where K (= 92) is the number of iterations. The process was repeated for the next year. These calculations of estimated variance incorporate the measurement (sampling error) from spear and carcass sampling in bias corrected years (1987–1990, 1994 and 1996), the measurement error from mark–recapture and spear and carcass sampling in 1997–2001, and the process error (interannual variation) among years.

Simulation also provided a means of estimating the statistical bias in the procedures used to estimate {$\boldsymbol{\theta}$} (Table C3). Relative statistical bias was estimated by subtracting estimates of $\hat{\theta}_{a,t}$ from the mean $\overline{\theta}'_{a,t}$ of simulated values $\hat{\theta}'_{a,t(k)}$ and dividing the difference by $\hat{\theta}_{a,t}$ (from Efron and Tibshirani 1993:124-6).

Table C1.–Solutions to {w} for estimation of the age-sex composition of Chinook salmon in the Unuk River during mark–recapture years 1997–2001.

Gender	Age	1997	1998	1999	2000	2001	Average
Females	1.3	1.916	2.248	1.952	2.215	1.744	2.015
Females	1.4	2.480	1.446	2.027	2.465	1.471	1.978
Males	1.2	1.040	0.634	1.011	0.830	0.738	0.851
Males	1.3	1.000	1.000	1.000	1.000	1.000	1.000
Males	1.4	1.357	0.484	0.631	1.467	1.116	1.011

Table C2.–Estimates of relative age composition (ages 1.2 through 1.5) for large (>660 mm MEF) spawning Chinook salmon in the Unuk River, 1986–2005. Estimates for 1987–1990, 1994 and 1996 have been adjusted for bias resulting from spear and carcass sampling. Age compositions in 1986, 1991 and 1992 are based on live-weir samples from Cripple Creek. In all other years estimates are derived from spawning ground samples collected with demonstrably representative methods. Standard errors are in parentheses.

Year	Age 1.2	Age 1.3	Age 1.4	Age 1.5
1986	0.054	0.470	0.467	0.009
	(0.012)	(0.027)	(0.027)	(0.005)
1987	0.076	0.472	0.447	0.005
	(0.023)	(0.035)	(0.035)	(0.004)
1988	0.077	0.390	0.525	0.008
	(0.023)	(0.042)	(0.040)	(0.004)
1989	0.024	0.404	0.558	0.014
	(0.024)	(0.040)	(0.040)	(0.008)
1990	0.182	0.232	0.535	0.051
	(0.078)	(0.063)	(0.078)	(0.029)
1991	0.060	0.754	0.174	0.012
	(0.013)	(0.024)	(0.021)	(0.006)
1992	0.021	0.443	0.529	0.007
	(0.009)	(0.030)	(0.030)	(0.005)
1993	0.013	0.427	0.540	0.019
	(0.005)	(0.022)	(0.022)	(0.006)
1994	0.027	0.324	0.614	0.036
	(0.015)	(0.036)	(0.038)	(0.012)
1995	0.100	0.267	0.633	-
	(0.056)	(0.082)	(0.089)	-
1996	0.020	0.535	0.411	0.033
	(0.011)	(0.044)	(0.044)	(0.009)
1997	0.094	0.414	0.472	0.020
	(0.011)	(0.019)	(0.020)	(0.005)
1998	0.081	0.618	0.292	0.009
	(0.010)	(0.018)	(0.017)	(0.003)
1999	0.107	0.487	0.401	0.004
	(0.014)	(0.023)	(0.022)	(0.003)
2000	0.159	0.586	0.246	0.008
	(0.014)	(0.018)	(0.016)	(0.003)
2001	0.027	0.655	0.317	0.002
	(0.005)	(0.015)	(0.015)	(0.001)
2002	0.123	0.411	0.456	0.009
	(0.013)	(0.019)	(0.020)	(0.004)
2003	0.018	0.708	0.266	0.008
	(0.004)	(0.015)	(0.014)	(0.003)
2004	0.239	0.313	0.443	0.005
	(0.015)	(0.016)	(0.017)	(0.002)
2005	0.096	0.702	0.155	0.020
	(0.017)	(0.025)	(0.013)	(0.002)

Table C3.–Estimated relative statistical bias in $\{\hat{\theta}\}$ by age-sex group of spawning Chinook salmon in the Unuk River across bias corrected years (1987–1990, 1994 and 1996).

	Female age 1.3	Female age 1.4	Male age 1.2	Male age 1.3	Male age 1.4
Average	0.4%	1.0%	1.6%	-1.8%	0.3%
Maximum	2.1%	2.0%	4.9%	3.5%	4.0%
Minimum	-1.4%	-0.2%	-4.3%	-6.2%	-8.1%

APPENDIX D

Chinook salmon fingerlings were generally captured from late September through the end of October from 1993 to 2004 (Table D1). Smolt were captured from late March through late April or early May from 1994 to 2004 (Tables D2 and D3). G-40 minnow traps, baited with salmon roe, were fished daily for 24 h/d in the mainstem of the Unuk River between approximately river km 3 and 19 (Figure 1). Approximately 60 traps were set and checked daily by a two-person crew in 1993, 1994, and spring 1995. Two additional crewmembers tagged the previous day's catch, with assistance from the trapping crew as necessary. Beginning in fall of 1995, the entire 4-person crew set and checked traps, with the number of traps fished daily rising to approximately 120/d. Generally, one 2-person crew was responsible for traps set upstream of Base Camp (km 14), one 2-person crew was responsible for downstream traps, and the entire crew tagged fish subsequent to trapping (Figure 1).

Minnow traps were checked once daily when catches were normal and water levels stable. In order to maximize efficiency and minimize mortality, unusually high catch rates would necessitate twice daily trap checks, as would times of rapid river level fluctuation. Traps were generally located in the preferred habitat of juvenile Chinook salmon: mainstem and major sloughs with cover, close proximity to stream flow, and gravel or cobblestone substrate. Isolated holes were also fished, particularly in the spring, where receding water levels had trapped and concentrated numbers of juvenile Chinook salmon. In the spring of 1994 and 1995 an 8 ft rotary screw trap was also used to capture smolt (Table D2). The screw trap was placed on pontoons, had the ability to be raised and lowered as needed, and was cabled to a rock wall on the mainstem at approximately river km 14. The screw trap was checked daily.

Juvenile fish were removed from the minnow and screw traps during each visit, transported to holding pens at camp, and tagged and marked each day. Chinook salmon were separated from other species by using a combination of external morphological characteristics (see Jones III et al. 1999 for details). All live Chinook salmon were tranquilized in a water solution of tricaine methane-sulfonate (MS 222) buffered with sodium bicarbonate. To alleviate stress, the anesthetic solution was kept near ambient river temperature by frequent water changes, and numbers of smolt tranquilized at any one time were kept small (<100) to limit their exposure. All smolt ≥50 mm FL not missing adipose fins were tagged following procedures described in Koerner (1977) and their adipose fins were excised. All captured smolt missing an adipose fin were subsequently passed through a magnetic tag detector to test for the presence of a CWT.

All tagged fish were held overnight. A random subsample of 50–100 fish was checked for tag retention the following morning. If the retention rate was less than 98%, then all held fish were checked for retention, and those having shed their tags were retagged. The daily estimate of fish tagged and released (valid tagged) equals the number tagged, minus the number of overnight mortalities, times the proportion estimated to have retained their tags. The number of fish tagged, the number that died in the holding pen, and the estimated number of fish that had shed their tags were compiled and recorded on ADF&G CWT Tagging Summary and Release Information Forms. These forms were submitted to the ADF&G Commercial Fishery Divisions Mark, Tag, and Age Laboratory in Juneau after the field season.

Systematically drawn samples of captured juvenile Chinook salmon were measured for length to estimate the mean length of the populations within ± 1 mm for 95% relative precision (Table D5). Using procedures in Cochran (1977), sample size n was determined as:

$$n = \frac{z^2 + s^2}{d^2} \qquad (1)$$

where z is the percentile of the normal distribution used as the central value in a two-tailed test of size (in this case 1.96), s is the estimated within-group standard deviation, and d is the expected difference between population means, in this case ± 1 mm. Within-group standard deviation was estimated as seven mm for fall fingerlings and six mm for spring smolt based on studies conducted on the Unuk River in the early 1980s (Hubartt and Kissner 1987). A minimum of 188 fall fingerlings and 138 spring smolt were therefore systematically measured for length, to the nearest 1 mm FL, each fall and spring from 1994–2004. All juvenile Chinook salmon measured for lengths were also weighed to the nearest 0.1 gram, except in 1994 (nearest g) and 1995 (no weights recorded).

Table D1.–Number of Unuk River Chinook salmon fingerlings caught in the fall and subsequently released with valid coded wire tags, mean fingerling length and weight, and water temperature and depth, 1993–2004.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1993							
10-Oct	59	1,895	32.1			442	8	98.6	428				
11-Oct	99	2,731	27.6										
12-Oct	95	1,722	18.1										
13-Oct						408		100.0	408				
14-Oct	79	1,838	23.3			4,829	5	100.0	4,824				
15-Oct	48	1,174	24.5			2,787	5	99.7	2,773				
16-Oct	44	942	21.4			1,279		99.7	1,275			6.0	0.0
17-Oct	37	563	15.2			1,119		95.0	1,063				
18-Oct	47	493	10.5	2		493	2	99.0	486			5.5	19.0
19-Oct													
20-Oct	64	725	11.3	13	1	725		97.2	705			5.5	3.0
21-Oct	93	423	4.5			423		97.2	411			5.0	8.5
22-Oct	42	1,013	24.1	92		1,013	2	97.2	983			5.0	20.0
23-Oct													
24-Oct													
25-Oct	62	441	7.1			441	2	98.6	433				
Total	769	13,959		107	1	13,959	24		13,789				
Max.	99	2,731	32.1	92	1	4,829	8	100.0	4,824			6.0	20.0
Min.	37	423	4.5	0	0	408	0	95.0	408			5.0	0.0
Mean	64	1,163	18.2	10	0	1,269	2	99.0	1,254			5.4	10.1

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Table D1.–Page 2 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1994							
5-Oct	50	84	1.7										
6-Oct	32	72	2.3										
7-Oct						156		100.0	156	73.9	4.9		14.0
8-Oct	102	672	6.6			672		100.0	672				12.5
9-Oct	96	749	7.8	4		749	1	99.0	738	70.0	3.8		12.5
10-Oct	122	967	7.9	19		967		100.0	967				9.5
11-Oct	110	1,080	9.8	70	5	1,080	1	99.9	1,073				8.5
12-Oct	100	1,162	11.6	35	3	1,162		100.0	1,162	67.9	3.8		6.0
13-Oct	98	1,016	10.4	36	1	1,016		100.0	1,016				7.0
14-Oct	89	1,128	12.7	49	3	1,128	1	100.0	1,127	69.7	3.8		
15-Oct	95	1,423	15.0	80	3	1,423		100.0	1,423			1.5	5.0
16-Oct	85	631	7.4	63		631		100.0	631	68.5	3.5		37.0
17-Oct													62.0
18-Oct													
19-Oct	100	235	2.4	6	1	235		100.0	235				15.0
20-Oct	76	430	5.7	24	1	430		100.0	430				11.0
21-Oct	104	947	9.1	114	1	947		100.0	947				5.0
22-Oct	119	1,418	11.9	208	2	1,418		100.0	1,418				4.0
23-Oct	109	1,403	12.9	153		1,403		100.0	1,403				2.0
24-Oct	112	1,023	9.1	105	2	1,023		100.0	1,023	69.7	3.2		4.0
25-Oct	84	655	7.8	108	3	655		100.0	655				18.0
26-Oct	102	335	3.3	65		335		100.0	335				18.0
27-Oct	102	855	8.4	132		855		100.0	855				18.0
28-Oct	98	913	9.3	119	4	913		100.0	913				11.0
29-Oct	93	1,158	12.5	166	1	1,158		100.0	1,158				7.0
30-Oct	90	1,029	11.4	167	2	1,029	1	100.0	1,028				5.0
31-Oct	94	632	6.7	66	1	632		100.0	632				2.0
1-Nov	89	529	5.9	103	2	529		100.0	529				0.0
Total	2,351	20,546		1,892	35	20,546	4		20,526				
Max.	122	1,423	15.0	208	5	1,423	1	100.0	1,423	73.9	4.9		62.0
Min.	32	72	1.7	0	0	156	0	99.0	156	67.9	3.2		0.0
Mean	94	822	8.7	79	1	856	0	99.9	855	69.2	3.6		12.3

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Table D1.–Page 3 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1995							
6-Oct	112	3,250	29.0	0	0								
7-Oct	120	3,065	25.5	0	0	3,250	3	100.0	3,247			6.5	8.0
8-Oct	68	3,065	45.1	28	0	3,065		100.0	3,065			6.5	11.5
9-Oct						3,065		98.0	3,004			6.5	12.0
10-Oct	122	2,160	17.7	221	6	2,160		100.0	2,160			6.5	10.5
11-Oct	132	1,244	9.4	209	4	1,244		100.0	1,244			6.0	12.0
12-Oct	174	2,988	17.2	469	16	2,988		100.0	2,988			5.5	9.5
13-Oct	110	1,658	15.1	273	10	1,658	9	100.0	1,649			5.0	12.0
14-Oct													
15-Oct	213	3,131	14.7	616	22	3,131		100.0	3,131			5.0	8.0
16-Oct	190	2,633	13.9	447	13	2,633		100.0	2,633			4.5	9.0
17-Oct	111	2,062	18.6	209	4	2,062	1	100.0	2,061			4.5	0.0
18-Oct	171	2,675	15.6	458	11	2,675		94.0	2,515	65.3		5.5	3.5
19-Oct	115	1,350	11.7	347	15	1,350		98.0	1,323			5.0	5.0
20-Oct	119	1,344	11.3	358	21	1,344		96.4	1,296			5.0	10.5
21-Oct	140	1,714	12.2	513	19	1,714		100.0	1,714			5.0	7.0
22-Oct	159	1,528	9.6	398	15							4.5	2.5
23-Oct	187	1,797	9.6	469	17							4.5	2.5
24-Oct	171	1,643	9.6	427	15	1,959	3	98.0	1,917	65.0		5.0	3.0
25-Oct	171	1,643	9.6	428	16	4,651		100.0	4,651	66.3		5.0	5.0
26-Oct	151	1,673	11.1	442	20	1,673		96.2	1,609			5.0	6.5
Total	2,736	40,623		6,312	224	40,622	16		40,207				
Max.	213	3,250	45.1	616	22	4,651	9	100.0	4,651			6.5	12.0
Min.	0	0	9.4	0	0	1,244	0	94.0	0			4.5	0.0
Mean	144	2,138	14.8	332	12	2,390	1	97.2	1,915	65.3		5.3	7.3

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Table D1.–Page 4 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1996							
29-Sep												5.0	10.0
30-Sep	166	2,025	12.2	0		2,025	1	100.0	2,024			4.0	7.5
1-Oct	212	4,327	20.4	8		2,827		100.0	2,827	66.4	3.3	3.0	3.5
2-Oct	239	2,906	12.2	68		3,306		100.0	3,306	66.5	3.3	4.5	1.0
3-Oct	181	2,395	13.2	58		1,795	1	100.0	1,794			5.0	2.0
4-Oct	141	1,648	11.7	51		3,348	1	100.0	3,347			5.0	12.0
5-Oct	141	2,191	15.5	97		2,191		100.0	2,191			5.0	9.0
6-Oct	177	2,693	15.2	377	1	2,693	2	100.0	2,691	66.9	3.3	6.0	7.0
7-Oct	116	806	6.9	84		806	14	100.0	792			6.0	29.5
8-Oct												5.5	27.5
9-Oct													
10-Oct												5.5	46.0
11-Oct												5.0	26.0
12-Oct	94	333	3.5	37		333		100.0	333	69.3	3.7	4.5	15.5
13-Oct	78	623	8.0	67		623		100.0	623			5.0	11.0
14-Oct	109	1,358	12.5	0								4.5	10.5
15-Oct	253	2,947	11.6	759		4,305	9	100.0	4,296			4.0	7.5
16-Oct	264	3,102	11.8	577	1	3,102		100.0	3,102			3.5	5.0
17-Oct	244	2,744	11.2	567	1	2,744	1	100.0	2,743	67.3	3.4	3.5	3.0
18-Oct	238	2,760	11.6	590	2	2,760	1	100.0	2,759	67.3	3.3	3.5	2.5
19-Oct	179	2,596	14.5	545		2,596		100.0	2,596			3.5	0.0
20-Oct	230	2,330	10.0	803	3	2,330		100.0	2,330	70.3	3.8	3.0	0.0
21-Oct	131	1,425	10.9	411		1,425	2	100.0	1,423			4.0	5.0
22-Oct												4.0	11.0
Total	3,193	39,209		5,099	8	39,209	32		39,177				
Max.	264	4,327	20.4	803	3	4,305	14	100.0	4,296	70.3	3.8	6.0	46.0
Min.	78	333	3.5	9	0	333	0	100.0	333	66.4	3.3	3.0	0.0
Mean	177	2,178	12.3	283	0	2,306	2	100.0	2,305	67.3	3.4	4.5	11.0

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Table D1.–Page 5 of 13.

Date	Traps checked[a]	Catch[b,f]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1997							
4-Oct	301	12,985	43.1			2,217	4	100.0	2,213				8.0
5-Oct	157	6,125	39.0			6,195	2	100.0	6,193			5.0	7.0
6-Oct	255	10,863	42.6	42		8,067		100.0	8,067			5.0	8.0
7-Oct	287	10,917	38.0	96	2	7,788	2	100.0	7,786			5.0	6.5
8-Oct	158	5,031	31.8	622	7	9,748	2	98.7	9,619			4.0	4.5
9-Oct	158	5,795	36.7	640		9,033	14	96.0	8,658	62.3	2.9[g]	3.0	3.5
10-Oct	154	3,743	24.3										
11-Oct				1,586	49	7,573	3	98.7	7,472			2.0	1.0
12-Oct	156	4,494	28.8	978	30	3,258	4	98.0	3,189			2.0	0.0
13-Oct	122	2,315	19.0	1,269	39	3,551		98.0	3,480	60.2	2.4[g]		17.0
14-Oct												4.0	24.0
15-Oct												4.0	26.0
16-Oct	50	174	3.5	17	18	174		98.0	171			4.0	30.0
17-Oct													
18-Oct	54	366	6.8										
19-Oct	101	2,550	25.2	444		2,916	1	100.0	2,915			4.5	13.0
20-Oct	106	2,186	20.6	289	15	2,186		98.0	2,142			4.5	11.0
Total	2,059	67,544		5,983	160	62,706	32		61,905				
Max.	301	12,985	43.1	1,586	49	9,748	14	100.0	9,619	62.3	2.9	5.0	30.0
Min.	50	174	3.5	0	0	174	0	96.0	171	60.2	2.4	2.0	0.0
Mean	158	5,196	32.8	499	13	5,226	3	98.4	2,948	61.6	2.7	3.4	11.4

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Table D1.–Page 6 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1998							
3-Oct	42	1,423	33.9									6.0	6.0
4-Oct	130	2,246	17.3	2		1,395		100.0	1,395			6.0	6.0
5-Oct	150	2,321	15.5	2		3,619	9	100.0	3,610			6.0	9.5
6-Oct	134	1,497	11.2	4	1	2,484	1	100.0	2,483			6.0	18.0
7-Oct	111	712	6.4	28		712		100.0	712	68.8		5.5	15.5
8-Oct	83	1,960	23.6									4.5	11.0
9-Oct	107	2,494	23.3	27		4,455	1	100.0	4,454			4.5	5.0
10-Oct	134	3,015	22.5	110	4	2,533	1	100.0	2,532	66.8		4.5	5.0
11-Oct	105	2,784	26.5	184	10	3,268	2	100.0	3,266			4.0	5.0
12-Oct	128	1,861	14.5	118	2	481		98.3	473			4.0	0.5
13-Oct	180	2,326	12.9	444	10	3,493	2	100.0	3,491	67.1	3.3	5.0	3.0
14-Oct	126	2,326	18.5	317	8	2,375	1	100.0	2,374			5.0	3.0
15-Oct	122	2,326	19.1	374	14	2,320	1	100.0	2,319			5.0	1.0
16-Oct	151	1,790	11.9	412	13	2,961		96.0	2,843	65.7	3.1	5.0	0.0
17-Oct	109	1,271	11.7	260	11	1,271	14	100.0	1,257			4.5	9.0
18-Oct	96	734	7.6	243	8	734	3	100.0	731	69.8	3.8	4.0	8.0
19-Oct													
20-Oct													
21-Oct	42	448	10.7									4.5	10.0
22-Oct	105	740	7.0	258	10	1,121	4	100.0	1,117	67.7	3.4	4.5	13.0
23-Oct	93	760	8.2	170	6	831		100.0	831			4.5	8.5
Total	2,148	33,034		2,953	97	34,053	39		33,888				
Max.	180	3,015	33.9	444	14	3,609	14	100.0	4,454	69.8	3.8	6.0	18.0
Min.	42	448	6.4	0	0	481	0	96.0	473	65.7	3.1	4.0	0.0
Mean	113	1,739	15.4	185	6	2,128	2	99.3	2,118	67.4	3.3	4.9	7.2

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Table D1.–Page 7 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1999							
3-Oct												7.0	8.0
4-Oct	115	2,148	18.7			804		100.0	804			6.0	3.0
5-Oct	111	2,074	18.7			3,418	2	100.0	3,416			6.0	1.5
6-Oct	127	1,943	15.3	11		1,943		100.0	1,943			6.0	0.0
7-Oct	136	1,629	12.0	77	2	1,629	5	100.0	1,624			6.0	17.0
8-Oct												6.0	20.0
9-Oct	48	536	11.2									6.0	12.0
10-Oct	109	1,218	11.2	82		1,754		100.0	1,754			6.0	6.5
11-Oct	127	1,481	11.7	71	2	1,481	1	100.0	1,480			6.0	5.5
12-Oct	151	1,441	9.5	76		1,441	2	100.0	1,439			5.5	2.0
13-Oct	143	1,180	8.3	79	1	1,180		100.0	1,180	63.4	2.9	5.0	11.0
14-Oct	140	927	6.6									5.0	15.5
15-Oct	70	456	6.5	110		1,383	1	100.0	1,382			5.0	5.0
16-Oct	72	969	13.5	88		969	3	100.0	966			5.0	5.0
17-Oct	55	675	12.3	109		675		100.0	675			6.0	28.0
Total	1,404	16,677		703	5	16,677	14		16,663				
Max.	151	2,148	18.7	110	2	3,418	5	100.0	3,416			7.0	28.0
Min.	48	675	6.5	0	0	675	0	100.0	675			5.0	0.0
Mean	108	1,283	11.9	64	0	1,516	1	100.0	1,515			5.8	9.3

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Table D1.–Page 8 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2000							
3-Oct												5.5	11.0
4-Oct	89	1,911	21.5									5.5	8.0
5-Oct	97	566	5.8									5.5	11.0
6-Oct	189	1,554	8.2			4,052	49	100.0	4,003			6.0	14.0
7-Oct	128	1,697	13.3	1	1	3,799	3	100.0	3,796			6.0	16.0
8-Oct	104	1,116	10.7	28		988	2	100.0	986			5.0	28.0
9-Oct	104	1,827	17.6	47		1,634	1	100.0	1,633			4.5	20.0
10-Oct	105	1,416	13.5	66		1,079		100.0	1,079			4.0	14.0
11-Oct	118	1,467	12.4	133		1,442	1	100.0	1,441	63.4	3.1	4.0	10.0
12-Oct	104	1,123	10.8	107		950		100.0	950			5.0	23.0
13-Oct	118	776	6.6									5.0	31.0
14-Oct	111	377	3.4	53		879	3	100.0	876			4.0	23.0
15-Oct	123	1,030	8.4									4.0	18.0
16-Oct	93	1,001	10.8	184	1	1,776	2	100.0	1,774	68.3	4.0	4.0	18.0
17-Oct	139	1,418	10.2	124	1	1,202	1	100.0	1,201			4.5	13.0
18-Oct	124	1,473	11.9	108		1,363	2	100.0	1,361	66.4	3.7	4.5	12.0
19-Oct	145	1,983	13.7	102	1	1,659		100.0	1,659			5.0	15.0
20-Oct	124	1,339	10.8	117		1,165	1	100.0	1,164			4.0	11.0
21-Oct	111	1,034	9.3	90		839	2	100.0	837	65.6	3.9	4.0	9.0
22-Oct	98	1,212	12.4	68		994		100.0	994			4.5	19.0
23-Oct	81	550	6.8									5.0	28.0
24-Oct	65	921	14.2	73		766	1	100.0	765	69.4	3.9	5.0	20.0
25-Oct	107	1,208	11.3	161		989	1	100.0	988			4.0	9.0
26-Oct	134	1,461	10.9	152		1,394		100.0	1,394			3.5	8.0
27-Oct	116	1,687	14.5	128		1,457	1	100.0	1,456			4.0	5.0
28-Oct	130	1,960	15.1	148		1,767	2	100.0	1,765	67.4	3.5	5.0	3.0
29-Oct	130	2,011	15.5	224		1,806	3	100.0	1,803			4.0	0.0
Total	2,987	34,118		2,114	4	32,000	75		31,925				
Max.	189	2,011	21.5	224	1	4,052	49		4,003	69.4	4.0	6.0	28.0
Min.	65	377	3.4	0	0	766	0		765	63.4	3.1	3.5	0.0
Mean	115	1,312	11.4	101	0	1,524	4	100.0	1,520	65.9	3.5	4.6	14.7

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Table D1.–Page 9 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2001							
27-Sep													18.0
28-Sep	42	371	8.8										16.5
29-Sep	89	1,482	16.7			1,853	7	100.0	1,846			7.0	14.5
30-Sep	97	1,306	13.5			1,306		100.0	1,306			6.0	30.0
1-Oct	83	953	11.5	14		953		100.0	953			6.0	19.0
2-Oct	101	1,534	15.2	15		1,534		100.0	1,534	61.1	3.0	6.0	12.0
3-Oct	146	2,877	19.7	25	1	2,877	5	100.0	2,872			7.0	9.0
4-Oct	134	2,276	17.0	72		2,276	5	100.0	2,271			6.0	7.0
5-Oct	150	2,932	19.5	89		2,932	3	100.0	2,929			6.0	4.0
6-Oct	156	2,703	17.3	133		2,703	5	100.0	2,698			7.0	3.5
7-Oct	156	2,950	18.9	150		2,950	8	100.0	2,942			6.0	3.0
8-Oct	149	2,317	15.6	146		2,317	5	100.0	2,312			6.0	5.5
9-Oct	163	2,615	16.0	221	1	2,615	6	100.0	2,609			6.0	4.5
10-Oct	156	2,334	15.0	252		2,334	4	99.0	2,307			6.0	6.5
11-Oct	166	1,760	10.6	271	2	1,760	3	100.0	1,757			6.0	3.0
12-Oct	161	2,105	13.1	283	3	2,105	8	100.0	2,097	63.7	2.9	5.0	10.0
13-Oct	122	1,420	11.6	152	1	1,420	14	100.0	1,406			4.5	8.0
14-Oct	153	1,581	10.3	288	2	1,581	1	100.0	1,580			5.0	3.0
15-Oct	156	2,063	13.2	388	5	2,063	5	100.0	2,058			4.5	0.0
16-Oct	162	1,226	7.6	275		1,226	3	100.0	1,223			4.5	8.0
17-Oct	143	1,031	7.2	169	1	1,031		100.0	1,031	63.6	2.9	4.5	5.0
18-Oct	144	956	6.6	180	1	956	1	100.0	955			4.5	9.0
19-Oct	138	1,429	10.4	222	2	1,429	2	100.0	1,427			4.5	17.0
20-Oct	94	1,081	11.5	169		1,081	3	100.0	1,078			4.5	8.0
21-Oct	112	1,093	9.8	273	1	1,093	2	100.0	1,091	62.3	2.7	4.5	5.0
22-Oct	118	1,018	8.6	320		1,018	1	100.0	1,017			4.5	3.0
23-Oct	113	1,072	9.5	315		1,072		100.0	1,072			4.5	0.0
Total	3,404	44,485		4,422	20	44,485	91		44,371				
Max.	166	2,950	19.7	388	5	2,950	14	100.0	2,942	63.7	3.0	7.0	30.0
Min.	42	371	6.6	0	0	953	0	99.0	953	61.1	2.7	4.5	0.0
Mean	131	1,711	13.1	177	1	1,779	4	100.0	1,775	62.7	2.9	5.0	8.6

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Table D1.–Page 10 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2002							
28-Sep	78	499	6.4			499	15	100.0	484			7.0	22.0
29-Sep	118	498	4.2									6.0	17.0
30-Sep	144	1,253	8.7			1,751	5	100.0	1,746	59.2	2.5	6.0	12.0
1-Oct	150	2,648	17.7	2		2,648	7	100.0	2,641			5.0	9.0
2-Oct	155	1,931	12.5	19		1,931	9	100.0	1,922			5.0	20.0
3-Oct	171	1,002	5.9	10		1,002	7	100.0	995	62.5	2.9	6.0	12.0
4-Oct	184	2,578	14.0	96		2,578	4	100.0	2,574			5.0	7.0
5-Oct	172	3,110	18.1	68		3,110	4	100.0	3,106			5.0	5.0
6-Oct	96	1,613	16.8	79		1,613	2	100.0	1,611			6.0	20.0
7-Oct	53	71	1.3									6.0	23.0
8-Oct	50	63	1.3									6.0	22.0
9-Oct	128	747	5.8	31		881	3	100.0	878	61.2	2.7	5.0	17.0
10-Oct	162	1,712	10.6	116	1	1,712	5	100.0	1,707			6.0	12.0
11-Oct	176	2,248	12.8	236		2,248	8	100.0	2,240			3.0	7.0
12-Oct	168	2,781	16.6	209		2,781	4	100.0	2,777			4.0	4.0
13-Oct	168	2,673	15.9	195		2,673	6	100.0	2,667	61.0	2.6	4.0	5.0
14-Oct	170	2,739	16.1	312	2	2,739	1	100.0	2,738			5.0	5.0
15-Oct	171	3,099	18.1	242		3,099	5	100.0	3,094			5.0	4.0
16-Oct	172	3,052	17.7	303	2	3,052	8	100.0	3,044			5.0	5.0
17-Oct	188	3,898	20.7	448	2	3,898	7	100.0	3,891			5.0	6.0
18-Oct	204	3,149	15.4	404	1	3,149	5	100.0	3,144	61.1	2.6	4.0	4.0
19-Oct	207	3,391	16.4	573	2	3,391	30	100.0	3,361			4.0	3.0
20-Oct	144	2,258	15.7	510	2	2,258	3	100.0	2,255			5.0	11.0
21-Oct	147	1,019	6.9									4.0	9.0
22-Oct	174	1,418	8.1	526	1	2,437	9	100.0	2,428	60.2	2.5	4.0	5.0
23-Oct	156	1,929	12.4	385	11	1,929	2	100.0	1,927			3.0	3.0
24-Oct	138	1,861	13.5									3.0	1.0
25-Oct	114	1,457	12.8	556	2	3,318	2	100.0	3,316	59.5	2.3	3.0	0.0
Total	4,158	54,697		5,320	26	54,697	151		54,546				
Max.	207	3,898	20.7	573	11	3,898	30		3,361	62.5	2.9	7.0	23.0
Min.	53	63	1.3	0	0	499	1		484	59.2	2.3	3.0	0.0
Mean	149	1,953	13.2	231	1	2,378	7	100.0	2,372	60.8	2.6	4.8	9.6

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Table D1.–Page 11 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2003							
27-Sep												7.0	26.0
28-Sep	111	914	8.2									6.0	23.5
29-Sep	133	1,095	8.2			2,009	22	100.0	1,987			7.0	25.0
30-Sep	169	3,076	18.2			3,076	6	100.0	3,070	66.9	3.3	6.0	23.0
1-Oct	156	1,346	8.6	1		1,346	39	100.0	1,307	61.6	2.7	6.0	20.0
2-Oct	159	1.917	12.1	19		1,917	29	100.0	1,888	64.7	3.2	6.0	18.0
3-Oct	183	2,484	13.6	40		2,484	3	100.0	2,481	66.1	3.9	6.0	16.0
4-Oct	173	2,791	16.1	63		2,791	4	100.0	2,787	64.0	3.1	6.0	15.0
5-Oct	187	2,516	13.5	114	2	2,516	2	100.0	2,514	63.5	3.1	6.0	14.0
6-Oct	176	2,014	11.4	127		2,014	4	100.0	2,010	65.4	3.3	6.0	16.0
7-Oct	89	1,198	13.5									6.0	23.0
8-Oct				65		1,198	2	100.0	1,196	68.3	3.7	6.0	18.0
9-Oct	173	2,560	14.8	150		2,560	43	100.0	2,517	62.3	2.7	6.0	11.0
10-Oct	163	2,530	15.5	116		2,530	14	100.0	2,516	64.2	3.0	6.0	10.0
11-Oct	176	3,276	18.6	134		3,276	3	100.0	3,273	62.3	2.7	5.0	7.0
12-Oct	136	1,694	12.5	56		1,694	3	100.0	1,691	61.8	2.5	5.0	4.0
13-Oct	112	2,950	26.3	85		2,950	131	100.0	2,819	65.0	3.1	5.0	2.0
14-Oct	180	3,122	17.3	171	1	3,122	2	100.0	3,120	64.3	2.9	6.0	3.0
15-Oct	171	3,019	17.7	175		3,019	4	100.0	3,015	62.0	2.7	5.0	1.0
16-Oct	158	3,076	19.5	166	1	3,076	6	100.0	3,070	68.2	4.1	5.0	0.0
17-Oct	130	2,464	19.0	142		2,464	2	100.0	2,462	62.0	2.6	5.0	0.0
18-Oct	52	775	14.9	79		775		100.0	775	59.4	2.3	5.0	1.0
Total	2,987	44,817		1,703	4	44,817	319		44,498				
Max.	187	3,276	26.3	175	2	3,276	131	100.0	3,273	68.3	4.1	7.0	26.0
Min.	52	775	8.2	0	0	775	0	100.0	775	59.4	2.3	5.0	0.0
Mean	149	2,241	15.0	90	0	2,359	17	100.0	2,342	64.3	3.1	5.8	12.6

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Table D1.–Page 12 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2004							
19-Sep	129	1,866	14.5			1,866	1	100	1,865	55.2	2.9	5.0	1.0
20-Sep	184	3,922	21.3			3,922		100	3,922	58.4	2.5	5.0	0.0
21-Sep												5.0	41.5
22-Sep												5.0	51.5
23-Sep												5.0	40.5
24-Sep													
25-Sep													51.5
26-Sep												4.0	35.5
27-Sep	60	144	2.4									5.0	31.5
28-Sep												5.0	39.5
29-Sep	60	296	4.9	4		440		100	440	62.5	2.9	4.0	28.5
30-Sep	59	738	12.5			738	1	100	737	58.6	2.6	4.0	24.5
1-Oct	55	836	15.2			836	2	100	834	60.6	2.8	4.0	20.5
2-Oct	148	1,769	12.0	15		1,769	4	100	1,765	58.8	2.7	5.0	19.5
3-Oct	177	2,427	13.7	38		2,427	2	100	2,425	60.0	2.8	5.0	19.5
4-Oct	183	2,769	15.1	68		2,769	4	100	2,765	61.9	2.8	5.0	19.5
5-Oct	189	1,490	7.9	77	1	1,490	30	100	1,460	62.2	2.9	5.0	33.5
6-Oct												5.0	44.5
7-Oct												5.0	
8-Oct												5.0	38.0
9-Oct	126	817	6.5	35		817	1	100	816	59.8	2.7	5.0	29.5
10-Oct	171	1,246	7.3	64		1,246	2	100	1,244	62.2	3.1	5.0	29.5
11-Oct	170	1,218	7.2	36		1,218	4	100	1,214	60.9	2.9	4.0	33.5
12-Oct	184	1,246	6.8	47		1,246		100	1,246	60.9	2.8	4.0	24.5
13-Oct												5.0	
14-Oct												5.0	
15-Oct												5.0	40.5
16-Oct	168	275	1.6									4.0	33.5
17-Oct	190	590	3.1	62	1	865	2	100	863	64.4	3.3	3.0	26.5
18-Oct	184	1,048	5.7	65		1,048	2	100	1,046	61.8	2.8	2.0	22.0
19-Oct	189	1,508	8.0	94		1,508	2	100	1,506	63.5	3.0	1.0	18.5
20-Oct	188	1,492	7.9	100		1,492		100	1,492	61.6	2.8	1.0	15.5
21-Oct	195	1,489	7.6	86		1,489		100	1,489	62.3	3.1	2.0	14.0

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Table D1.–Page 13 of 13.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2004							
Total	3,009	27,186		791	2	27,186	57		27,129				
Max.	195	3,922	21.3	100	1	3,922	30		3,922	63.5	3.3	5.0	51.5
Min.	55	144	1.6	0	0	440	0		440	55.2	2.5	1.0	0.0
Mean	150	1,359	9.0	44	<1	1,510	3		1,507	60.9	2.9	4.3	28.6

[a] Equals the total number of trap checks that day, i.e., individual traps checked twice daily would count as two traps checked.

[b] Equals the number of previously uncaptured Chinook fingerlings captured.

[c] Equals the average number of previously uncaptured Chinook fingerling per trap check.

[d] Total valid tagged equals total tagged minus overnight mortalities times percent tag retention.

[e] Depth standardized such that 0 in represents minimal depth recorded each season.

[f] An estimated 4,838 fingerlings escaped from the net pens prior to tagging in 1997.

[g] Approximately every fifth fingerling measured for length was weighed in 1997.

Table D2.–Number of Unuk River Chinook salmon smolt caught in the spring and subsequently released with valid coded wire tags, mean smolt length and weight, and water temperature and depth, 1994–1995.

Date	Traps checked[a]	Number captured in minnow traps[b]	Minnow trap CPUE[c]	Number captured in screw trap	Number recaptured with tags	Number recaptured without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
							1994							
3-May	49	251	5											
4-May	56	287	5											
5-May	57	293	5	30	13	1	861		100.0	861	72.0	4.1	5.0	0.0
6-May	35	128	4	35									4.0	3.0
7-May				71									4.0	4.0
8-May				44										0.0
9-May				15	14		293		100.0	293	74.0	4.0	5.0	1.0
10-May	65	278	4	50									4.0	4.0
11-May	43	232	5	39	25		599		100.0	599	73.8	4.3	5.0	6.0
12-May				95									4.0	14.0
13-May				17									4.0	7.0
14-May	26	140	5	16									4.0	4.0
15-May	5	21	4	8	7		297		100.0	297	75.8	4.8	5.0	1.0
16-May	51	72	1	64									5.0	3.0
17-May	36	20	1	155									5.0	10.0
18-May	22	11	1	168	18	2	490	10	100.0	480	76.4	4.7	5.0	16.0
19-May	14	11	1	16									5.0	20.0
20-May				35									5.0	23.0
21-May				24	2		86	1	100.0	85	81.9	5.0	5.0	25.0
22-May				18									5.0	22.0
23-May				9			27		100.0	27			5.0	19.0
Total	459	1,744	42	909	79	3	2,653	11		2,642				
Max.	65	293	5	168	25	2	861	10		861	81.9	5.0	5.0	25.0
Min.	5	11	1	8	0	0	27	0		27	72.0	4.0	4.0	0.0
Mean	38	145	3	48	11	0	379	2	100.0	377	75.3	4.6	4.7	9.6

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Table D2.–Page 2 of 3.

Date	Traps checked[a]	Number captured in minnow traps[b]	Minnow trap CPUE[c]	Number captured in screw trap	Number recaptured with tags	Number recaptured without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
1995														
5-Apr	23	34	1											5.5
6-Apr	64	102	2										3.5	3.5
7-Apr	57	47	1										3.5	2.0
8-Apr	72	147	2											2.0
9-Apr	73	211	3										3.0	4.0
10-Apr	26	88	3		170	6	629		100.0	629	68.8		2.0	3.0
11-Apr	82	247	3										2.0	2.0
12-Apr	59	206	3											1.0
13-Apr	67	147	2		103	8	600	1	100.0	599	68.3		3.0	1.0
14-Apr	49	156	3											0.5
15-Apr	42	120	3										3.0	0.0
16-Apr	4	5	1											0.5
17-Apr	69	158	2		100	5	439		100.0	439	69.1			0.0
18-Apr	48	137	3											0.5
19-Apr	78	150	2										3.0	1.5
20-Apr	75	137	2		86	3	424		100.0	424			3.0	1.0
21-Apr	61	136	2											1.5
22-Apr	2	3	2										4.0	3.0
23-Apr	44	129	3	3										6.0
24-Apr	53	125	2	5	92	4	401		100.0	401	72.7			9.0
25-Apr	49	115	2	3										13.0
26-Apr	53	111	2	6									4.0	14.0
27-Apr	31	64	2	2	81	5	301		100.0	301			3.0	18.5
28-Apr	38	41	1										2.5	23.0
29-Apr	1	2	2											22.0
30-Apr				8									3.0	25.0
1-May				8									3.0	21.0
2-May	57	84	1	16									3.5	19.0
3-May	34	58	2	4									4.0	17.5
4-May	58	90	2		87	2	311		100.0	311	75.1		4.0	21.0
5-May	53	61	1										4.0	22.0
6-May	53	62	1		26		123		100.0	123	75.4		4.0	20.5

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Table D2.–Page 3 of 3.

Date	Traps checked[a]	Number captured in minnow traps[b]	Minnow trap CPUE[c]	Number captured in screw trap	Number recaptured with tags	Number recaptured without tags	Total tagged	Overnight mortalities	Tag retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1995								
Total	1,475	3,173	63	55	745	33	3,228	1		3,227				
Max.	78	247	3	16	170	8	629	1		629	75.4		4.0	23.0
Min.	1	2	1	0	26	0	123	0		123	68.3		2.0	0.0
Mean	49	106	2	4	93	4	404	0	100.0	293	70.7		3.3	8.9

[a] Equals the total number of trap checks that day, i.e. individual traps checked twice daily would count as two traps checked.

[b] Equals the number of previously uncaptured Chinook salmon smolt captured.

[c] Equals the average number of previously uncaptured Chinook salmon smolt per trap check.

[d] Total valid tagged equals total tagged minus overnight mortalities times percent tag retention.

[e] Depth standardized such that 0 in represents minimal depth recorded.

Table D3.–Number of Unuk River Chinook salmon smolt caught in the spring and subsequently released with valid coded wire tags, mean smolt length and weight, and water temperature and depth, 1996–2004.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1996							
8-Apr												1.5	2.0
9-Apr	87	353	4.1									2.5	0.0
10-Apr	91	318	3.5									4.5	2.0
11-Apr	102	288	2.8									4.5	2.0
12-Apr	106	456	4.3									2.5	2.0
13-Apr	51	278	5.5	441	38	1,693		100.0	1,693			3.5	3.0
14-Apr	97	537	5.5	105	19	537	44	100.0	493			3.0	4.0
15-Apr	109	347	3.2	61	9	347		100.0	347	70.9	3.6	3.5	5.0
16-Apr	114	592	5.2							70.0	3.6	3.5	9.0
17-Apr	118	528	4.5	298	34	1,120		100.0	1,120			3.5	14.0
18-Apr	109	395	3.6									3.5	12.0
19-Apr	108	417	3.9	193	34	812		100.0	812			3.5	11.5
20-Apr	57	311	5.5									3.0	10.5
21-Apr	108	362	3.4									3.5	8.0
22-Apr	119	654	5.5	314	20	1,326		100.0	1,326	69.3	3.1	4.0	9.0
23-Apr	121	533	4.4	117	11	533		100.0	533			3.5	13.0
24-Apr	115	384	3.3	129	7	384	5	100.0	379	70.7	3.8	3.5	13.0
25-Apr	114	209	1.8									3.5	14.0
26-Apr	60	320	5.3	168	14	529		100.0	529			4.0	12.5
27-Apr	92	223	2.4	91	11	224		100.0	224			4.0	14.0
Total	1,878	7,505		1,917	197	7,505	49		7,456				
Max.	121	654	5.5	441	38	1,693	44		1,693	70.9	3.8	4.5	14.0
Min.	51	209	1.8	61	7	224	0		224	69.3	3.1	1.5	0.0
Mean	99	395	4.0	192	20	751	5	100.0	678	70.2	3.5	3.4	8.0

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Table D3.–Page 2 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1997							
28-Mar	77	358	4.6									2.0	3.5
29-Mar	100	413	4.1									1.0	4.0
30-Mar	105	420	4.0									1.5	3.0
31-Mar	106	518	4.9	656	4	1,709		100.0	1,709	71.4	3.5	2.0	2.5
1-Apr	114	527	4.6									2.0	0.0
2-Apr	117	443	3.8	259	2	970		100.0	970			0.5	7.0
3-Apr	108	248	2.3									2.0	5.0
4-Apr	81	574	7.1	160	1	822		100.0	822	71.8	3.8	1.0	3.0
5-Apr	135	673	5.0									1.5	1.0
6-Apr	133	712	5.4									1.0	0.5
7-Apr	105	550	5.2	368		1,935		100.0	1,935			2.0	1.0
8-Apr	128	741	5.8									2.0	1.5
9-Apr	138	908	6.6	274		1,649		100.0	1,649	70.6	3.5	2.0	2.5
10-Apr	126	897	7.1									2.0	3.5
11-Apr	119	1,073	9.0									2.0	5.0
12-Apr	112	710	6.3	416	2	2,680		100.0	2,680			2.5	5.5
13-Apr	118	823	7.0	122	1	823		100.0	823			3.0	6.5
14-Apr	98	591	6.0									3.0	7.5
15-Apr	106	477	4.5	166		1,068		100.0	1,068	71.3	3.7	3.0	8.0
16-Apr	94	313	3.3	51	2	313	4	100.0	309			2.0	13.5
17-Apr	101	379	3.8	89		379		100.0	379			2.0	14.5
18-Apr	65	173	2.7	49	1	173		100.0	173			1.5	14.0
Total	2,386	12,521		2,610	13	12,521	4		12,517				
Max.	138	1,073	9.0	656	4	2,680	4		2,680	71.8	3.8	3.0	14.5
Min.	65	173	2.3	49	0	173	0		173	70.6	3.5	0.5	0.0
Mean	108	569	5.2	237	1	1,138	0	100.0	1,138	71.2	3.6	1.9	5.1

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Table D3.–Page 3 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
1998													
27-Mar	37	490	13.2										
28-Mar	185	2,452	13.3										
29-Mar				549	31	2,942	1	100.0	2,941	64.6	2.6	2.0	1.5
30-Mar	149	1,706	11.4										
31-Mar	155	1,774	11.4	504	38	3,480	2	99.0	3,443	67.5	3.1	3.0	4.0
1-Apr	90	749	8.3									3.5	3.0
2-Apr	175	1,457	8.3										
3-Apr	135	1,124	8.3	366	20	1,916	1	99.0	1,896			3.0	1.5
4-Apr	173	1,440	8.3										
5-Apr				563	33	2,855	1	100.0	2,854	66.2	2.9	3.5	0.5
6-Apr	184	1,597	8.7										
7-Apr	174	1,511	8.7										
8-Apr				477	37	3,108	2	100.0	3,106	63.6	2.5	4.0	1.0
9-Apr	149	1,123	7.5										
10-Apr	27	203	7.5	192	7	1,326	1	100.0	1,325			3.0	0.5
11-Apr	131	753	5.7										
12-Apr	140	804	5.7										
13-Apr				244	22	1,557	1	100.0	1,556			4.0	0.0
Total	1,904	17,184		2,895	188	17,184	9		17,121				
Max.	185	2,452	13.3	563	38	3,480	2	100.0	3,443	67.5	3.1	4.0	4.0
Min.	27	203	5.7	192	7	1,326	1	99.0	1,325	63.6	2.5	2.0	0.0
Mean	136	1,227	9.0	414	27	2,455	1	99.6	2,446	65.8	2.8	3.3	1.5

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Table D3.–Page 4 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						1999							
5-Apr	69	342	4.9										
6-Apr	107	526	4.9										
7-Apr	110	295	2.7										
8-Apr	110	409	3.7	414	78	1,345	1	100.0	1,344	69.3	3.6	4.0	0.5
9-Apr	110	254	2.3							66.7	2.9	4.0	0.0
10-Apr	101	571	5.6	183	34	617		100.0	617			4.0	0.0
11-Apr	71	433	6.1										
12-Apr	98	286	2.9	154	28	867	1	100.0	866			2.0	1.0
13-Apr	83	311	3.7										
14-Apr	116	498	4.3										
15-Apr	130	653	5.0										
16-Apr	68	431	6.3	469	70	2,331	1	100.0	2,330	72.7	4.1		
17-Apr	30	90	3.0										2.0
18-Apr	94	411	4.4										
19-Apr	20	19	1.0	44	6	310	1	100.0	309			4.0	8.5
20-Apr	70	164	2.3										
21-Apr	93	181	1.9										
22-Apr	112	250	2.2	109	17	519		100.0	519	68.5	3.3	3.0	7.0
23-Apr	58	136	2.3									4.0	7.0
24-Apr	115	210	1.8										
25-Apr	52	66	1.3										
26-Apr	90	139	1.5	73	3	544	1	100.0	543	69.6	3.4	4.5	7.0
27-Apr	114	216	1.9										
28-Apr	128	363	2.8										
29-Apr	52	107	2.1	114	15	657	1	100.0	656			4.0	7.0
30-Apr	133	291	2.2	135	14	430		100.0	430	71.8	3.9	4.0	6.0
1-May	108	302	2.8	87	10	334		100.0	334	77.8	5.1	4.0	5.5
Total	2,442	7,954		1,782	275	7,954	6		7,948				
Max.	133	653	6.3	469	78	2,331	1		2,330	77.8	5.1	4.5	7.0
Min.	20	19	1.0	44	3	310	0		309	66.7	2.9	2.0	0.0
Mean	90	295	3.3	178	28	795	1	100.0	795	70.6	3.7	5.2	6.4

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Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2000							
28-Mar	26	53	2.0										2.0
29-Mar	28	44	1.6										1.0
30-Mar	85	370	4.4									4.0	1.0
31-Mar	105	453	4.3									4.0	2.5
1-Apr	88	276	3.1	120		1,195	2	100.0	1,193	68.7	3.4	1.5	11.0
2-Apr												3.0	7.5
3-Apr												3.0	7.5
4-Apr												3.5	6.0
5-Apr	103	758	7.4									4.0	4.5
6-Apr	120	729	6.1	86	1	1,487		100.0	1,487			4.0	3.0
7-Apr	84	278	3.3									3.0	2.5
8-Apr	99	433	4.4									3.0	2.0
9-Apr	110	431	3.9									3.5	1.5
10-Apr	107	557	5.2									3.5	1.0
11-Apr				126	2	1,699		100.0	1,699	72.1	3.8	4.0	0.5
12-Apr	115	564	4.9									4.5	1.0
13-Apr	116	509	4.4									4.0	2.5
14-Apr	98	307	3.1	109		1,380		100.0	1,380	69.8	3.6	2.0	1.5
15-Apr	108	689	6.4									3.0	1.0
16-Apr	117	743	6.4	85		1,432		100.0	1,432			4.0	0.5
17-Apr												4.0	0.5
18-Apr	122	742	6.1									4.5	0.0
19-Apr	105	598	5.7									4.5	0.5
20-Apr	133	640	4.8	141		1,980		100.0	1,980	69.1	3.5	4.5	1.0
21-Apr	83	314	3.8									4.0	3.0
22-Apr	113	428	3.8									4.5	5.0
23-Apr	122	462	3.8	159		1,204	1	100.0	1,203	72.5	3.9	4.5	4.0
24-Apr	97	216	2.2									4.5	3.0
25-Apr	119	266	2.2	63	1	482		100.0	482			4.5	2.5
26-Apr	101	131	1.3									4.5	2.0
27-Apr	105	137	1.3	67		268		100.0	268			4.5	3.5
28-Apr	127	596	4.7									4.5	5.0
29-Apr	87	408	4.7	88		1,004		100.0	1,004	76.2	4.5	4.5	5.0
30-Apr	99	295	3.0									4.5	5.5

Table D3.–Page 6 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2000							
1-May	92	274	3.0									4.5	8.5
2-May	94	280	3.0	96		848		100.0	848			4.5	8.0
3-May	125	188	1.5									4.5	8.0
4-May	113	170	1.5	74		357		100.0	357	74.9	4.5	4.5	9.5
Total	3,346	13,336		1,214	4	13,336	3		13,333				
Max.	127	758	7.4	159	2	1,980	2		1,980	76.2	4.5	4.5	11.0
Min.	26	44	1.3	63	0	268	0		268	68.7	3.4	1.5	0.0
Mean	101	404	4.0	101	0	1,111	0	100.0	1,111	71.5	3.8	3.9	3.5

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Table D3.–Page 7 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2001							
1-Apr	91	784	8.6									3.0	0.5
2-Apr	93	1,140	12.3	336	9	1,924		100.0	1,924	68.1	3.2	4.0	0.5
3-Apr	81	845	10.4									4.0	0.0
4-Apr	89	1,016	11.4	196	4	1,861		100.0	1,861			4.0	0.0
5-Apr	120	1,077	9.0									4.5	0.0
6-Apr	94	1,398	14.9									5.5	0.0
7-Apr				184	7	2,475		100.0	2,475	66.6	3.1	4.0	0.0
8-Apr	138	1,410	10.2									3.0	0.0
9-Apr	118	854	7.2	123	2	2,264	1	100.0	2,263			3.5	0.0
10-Apr	109	731	6.7									3.5	0.5
11-Apr	119	1,225	10.3									3.0	0.5
12-Apr				100	2	1,956	1	100.0	1,955	67.2	3.1	3.0	0.5
13-Apr	143	1,175	8.2									3.0	0.5
14-Apr	209	1,073	5.1									4.0	1.0
15-Apr				110	5	2,248	1	100.0	2,247			4.0	1.0
16-Apr	147	845	5.7									4.0	1.0
17-Apr	96	379	3.9									4.0	3.0
18-Apr	167	529	3.2	155	2	1,753		100.0	1,753			3.5	3.5
19-Apr	166	488	2.9	6	1	488	1	100.0	487	69.6	4.0	3.5	4.0
20-Apr	185	523	2.8	82	1	523		100.0	523			3.0	4.0
21-Apr	157	414	2.6	57	1	414		100.0	414			3.5	4.5
22-Apr	148	375	2.5	40	1	375		100.0	375			3.5	5.0
23-Apr	126	284	2.3	45	1	284		100.0	284	65.7	3.3	3.5	5.0
Total	2,596	16,565		1,434	36	16,565	4		16,561				
Max.	209	1,410	14.9	336	9	2,475	1		2,475	69.6	4.0	5.5	5.0
Min.	81	284	2.3	6	1	284	0		284	65.7	3.1	3.0	0.0
Mean	130	828	6.4	120	3	1,380	0	100.0	1,380	67.4	3.3	3.7	1.5

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Table D3.–Page 8 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
2002													
3-Apr	53	235	4.4										
4-Apr	89	362	4.1	216	2	597		100.0	597				
5-Apr	98	340	3.5									2.0	0.5
6-Apr	116	468	4.0	179		808		100.0	808			2.0	0.5
7-Apr	135	589	4.4							71.3	4.0	2.0	0.0
8-Apr	130	746	5.7	216	1	1,335	2	100.0	1,333			2.0	0.0
9-Apr	143	603	4.2	113		603		100.0	603			2.0	0.0
10-Apr	93	380	4.1									3.0	0.5
11-Apr	133	487	3.7	148	2	867		100.0	867			2.0	1.0
12-Apr	141	434	3.1	90		434		100.0	434			3.0	1.5
13-Apr	134	432	3.2									3.0	2.0
14-Apr	128	432	3.4	124	2	864	2	100.0	862			3.0	3.5
15-Apr	146	503	3.4									3.0	5.5
16-Apr	157	753	4.8	263	2	1,256		100.0	1,256	69.4	3.5	3.0	5.5
17-Apr	157	801	5.1	116		801		100.0	801			3.0	5.0
18-Apr	166	916	5.5	136		916		100.0	916			3.0	5.0
19-Apr	168	693	4.1									4.0	5.5
20-Apr	123	507	4.1	148	1	1,200		100.0	1,200			4.0	7.5
21-Apr	161	289	1.8	37		289		100.0	289			4.0	8.5
22-Apr	138	329	2.4									4.0	9.5
23-Apr	126	301	2.4									4.0	8.5
24-Apr	129	308	2.4	201		938		100.0	938	67.4	3.2	4.0	8.5
25-Apr	129	730	5.7	65	1	730	25	100.0	705	68.1	3.9	4.0	8.0
26-Apr	128	363	2.8	58	1	363	1	100.0	362			4.0	7.0
27-Apr	125	306	2.4	60		306		100.0	306			4.0	7.5
Total	3,246	12,307		2,170	12	12,307	30		12,277				
Max.	168	916	5.7	263	2	1,335	25			71.3	4.0	4.0	9.5
Min.	53	235	1.8	37	0	289	0			67.4	3.2	2.0	0.0
Mean	130	615	3.8	136	1	769	2	100.0	767	68.6	3.5	3.1	4.4

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Table D3.–Page 9 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
2003													
7-Apr	59	301	5.1										0.0
8-Apr	92	469	5.1	245	5	770		100.0	770				0.2
9-Apr	90	380	4.2	89	4	380	1	100.0	379			3.3	0.5
10-Apr	96	431	4.5	60	1	431		100.0	431	64.4	3.0	3.3	0.8
11-Apr	102	599	5.9	75	7	599		100.0	599	63.5	2.9	3.9	1.5
12-Apr	114	587	5.1	60	7	587		100.0	587	65.8	3.1	3.9	1.5
13-Apr	125	449	3.6	78	3	449		100.0	449			3.3	2.8
14-Apr	114	573	5.0									3.3	4.5
15-Apr	119	598	5.1	202	6	1,171		100.0	1,171	63.4	2.9	3.9	6.5
16-Apr	115	465	4.0	42	1	465		100.0	465			3.9	7.0
17-Apr	119	423	3.6									3.9	7.5
18-Apr	119	422	3.5	122	6	845	1	100.0	844	64.9	3.0	3.3	6.5
19-Apr	123	446	3.6	54	3	446		100.0	446	63.6	2.8	3.3	5.5
20-Apr	138	762	5.5	79	4	762		100.0	762	66.8	3.2	3.9	5.5
21-Apr	130	555	4.3									4.4	6.8
22-Apr	145	619	4.3	159	2	1,174		100.0	1,174	63.7	2.9	4.4	10.5
23-Apr	153	529	3.5	49	2	529		100.0	529			4.4	9.3
24-Apr	147	346	2.4									3.9	9.5
25-Apr	130	306	2.4	88	2	652		100.0	652	70.0	3.9	3.9	20.5
26-Apr												3.3	33.5
27-Apr												3.3	30.5
28-Apr	58	105	1.8	23	0	105		100.0	105	67.8	3.5	4.4	27.0
29-Apr	122	109	0.9									5.0	26.5
30-Apr				33	0	109	1	100.0	108			5.0	27.5
1-May	137	159	1.2									4.4	29.0
2-May	130	151	1.2	108	2	310	1	100.0	309	64.8	3.2	4.4	25.0
3-May												3.9	20.5
4-May	104	194	1.9									4.4	16.5
5-May	119	221	1.9	118	1	415	1	100.0	414	69.3	3.6	4.4	14.5
6-May	89	241	2.7									4.4	12.5
7-May	116	315	2.7	88	0	556	1	100.0	555	72.5	4.1		12.5
8-May	151	406	2.7									5.0	13.5
9-May	140	376	2.7									5.0	16.0
10-May	114	306	2.7	264	6	1,088		100.0	1,088	68.7	3.5	5.0	19.5

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Table D3.–Page 10 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2003							
Total	3,510	11,843		2,036	62	11,843	6		11,837				
Max.	153	762	5.9	264	7	1,174	1		1,174	72.5	4.1	5.0	33.5
Min.	59	105	0.9	23	0	105	0		105	63.4	2.8	3.3	0.0
Mean	117	395	3.4	102	3	592	0	100.0	592	66.1	3.2	4.1	12.7

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Table D3.–Page 11 of 11.

Date	Traps checked[a]	Catch[b]	CPUE[c]	Recaptures with tags	Recaptures without tags	Total tagged	Overnight mortalities	Tag Retention (%)	Total valid tagged[d]	Mean length (mm)	Mean weight (g)	Water temp (°C)	Water depth (in)[e]
						2004							
28-Mar	61	771	12.6										
29-Mar	91	1,150	12.6	268	8	1,921	2	100.0	1,919	65.8	3.2	2.0	3.3
30-Mar	86	585	6.8									2.0	7.3
31-Mar	47	319	6.7	99	3	904	2	100.0	902	67.7	3.3	1.5	4.8
1-Apr	110	1,012	9.2									2.0	1.5
2-Apr	125	1,149	9.2	203	11	2,161	2	100.0	2,159	67.7	3.4	2.0	0.0
3-Apr	142	949	6.7	118	4	949	1	100.0	948	67.3	3.2	2.0	2.8
4-Apr	139	1,004	7.2	110		1,004	3	100.0	1,001	65.7	2.9	2.0	5.8
5-Apr	161	1,050	6.5	92	2	1,050	2	100.0	1,048	64.1	2.9	2.0	5.5
6-Apr	61	316	5.2									2.0	3.5
7-Apr	155	804	5.2	100	2	1,120		100.0	1,120	67.4	3.1	3.0	2.3
8-Apr	161	1,014	6.3	79	4	1,014		100.0	1,014	68.8	3.5	3.0	3.8
9-Apr	164	1,042	6.4	90	3	1,042		100.0	1,042	67.8	3.2	3.0	4.8
10-Apr	152	757	5.0	73	3	757	1	100.0	756	62.9	2.5	4.0	5.0
11-Apr	149	431	2.9									3.0	14.3
12-Apr	110	318	2.9	73	3	749		100.0	749	63.8	2.6	3.0	20.8
13-Apr	105	214	2.0									3.0	22.8
14-Apr	126	256	2.0									3.0	21.3
15-Apr	120	244	2.0	101	3	714	1	100.0	713	66.9	2.8	2.0	20.3
16-Apr	104	340	3.3	50	3	340		100.0	340	67.5	3.1	2.0	15.8
17-Apr	111	685	6.2	42	3	685		100.0	685	67.7	3.2	4.0	13.3
Total	2,480	14,410		1,498	52	14,410	14		14,396				
Max.	164	1,150	12.6	268	11	2,161	3	100.0	2,159	68.8	3.5	4.0	22.8
Min.	47	214	2.0	42	0	340	0	100.0	340	62.9	2.5	1.5	0.0
Mean	118	686	5.8	107	4	1,029	1	100.0	1,028	66.5	3.1	2.5	8.9

[a] Equals the total number of trap checks that day, i.e. individual traps checked twice daily would count as two traps checked.

[b] Equals the number of previously uncaptured Chinook salmon smolt captured.

[c] Equals the average number of previously uncaptured Chinook salmon smolt per trap check.

[d] Total valid tagged equals total tagged minus overnight mortalities times percent tag retention.

[e] Depth standardized such that 0 in represents minimal depth recorded each season.

Table D4.–Numbers of Unuk River Chinook salmon fall fry and spring smolt captured and tagged with coded wire tags, 1992 brood year to 2003.

Brood year	Year tagged	Fall/spring	Tag code	Dates tagged	Number tagged	Valid tagged
1992	1993	Fall	04-38-03	10/13–10/22/93	10,304	10,263
1992	1993	Fall	04-38-04	10/25/1993	439	433
1992	1993	Fall	04-38-05	10/16–10/21/93	3,192	3,093
1992	1994	Spring	04-42-06	5/05–5/23/94	2,642	2,642
1992 brood year total					16,577	16,431
1993	1994	Fall	04-33-49	10/07–10/24/94	1,706	1,699
1993	1994	Fall	04-33-50	10/07–10/22/94	11,149	11,138
1993	1994	Fall	04-35-57	10/22–11/01/94	7,687	7,687
1993	1995	Spring	04-42-13	4/10–5/05/95	3,227	3,227
1993 brood year total					23,769	23,751
1994	1995	Fall	04-35-56	10/07–10/10/95	11,537	11,479
1994	1995	Fall	04-35-58	10/11–10/16/95	11,645	11,645
1994	1995	Fall	04-35-59	10/17–10/24/95	11,100	10,823
1994	1995	Fall	04-42-31	10/25–10/26/95	6,324	6,261
1994	1996	Spring	04-42-07	4/13–4/23/96	6,099	6,099
1994	1996	Spring	04-42-08	4/23–4/26/96	1,357	1,357
1994 brood year total					48,062	47,664
1995	1996	Fall	04-42-18	9/30–10/15/96	3,753	3,753
1995	1996	Fall	04-42-36	10/16–10/19/96	11,200	11,200
1995	1996	Fall	04-47-12	10/20–10/21/96	24,224	24,224
1995	1997	Spring	04-38-29	3/31–4/18/97	12,517	12,517
1995 brood year total					51,694	51,694
1996	1997	Fall	04-47-13	10/04–10/11/97	24,303	24,181
1996	1997	Fall	04-47-14	10/06–10/11/97	22,975	22,584
1996	1997	Fall	04-47-15	10/11–10/20/97	15,396	15,150
1996	1998	Spring	04-43-39	3/29–4/05/98	5,987	5,987
1996	1998	Spring	04-46-46	4/08–4/13/98	11,188	11,132
1996 brood year total					79,849	79,034
1997	1998	Fall	04-01-39	10/04–10/13/98	22,374	22,374
1997	1998	Fall	04-01-40	10/13–10/23/98	11,640	11,524
1997	1999	Spring	04-01-44	4/08–5/01/99	7,948	7,948
1997 brood year total					41,962	41,846
1998	1999	Fall	04-01-42	10/04–10/17/99	16,661	16,661
1998	2000	Spring	04-02-56	4/01–4/27/00	11,124	11,124
1998	2000	Spring	04-02-57	4/29–5/4/00	2,209	2,209
1998 brood year total					29,994	29,994
1999	2000	Fall	04-03-74	10/06–10/20/00	21,853	21,853
1999	2000	Fall	04-02-88	10/20–10/29/00	10,082	10,082
1999	2001	Spring	04-01-45	4/2–4/23/01	16,561	16,561
1999 brood year total					48,496	48,496
2000	2001	Fall	04-02-92	9/29–10/05/01	10,950	10,950
2000	2001	Fall	04-04-57	10/05–10/09/01	11,231	11,231
2000	2001	Fall	04-04-58	10/09–10/14/01	11,223	11,201
2000	2001	Fall	04-04-60	10/14–10/23/01	10,990	10,990
2000	2002	Spring	04-05-38	04/04–04/24/02	10,908	10,904
2000	2002	Spring	04-05-39	04/25–04/26/02	1,093	1,067
2000 brood year total					56,395	56,343

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Table D4.–Page 2 of 2.

Brood year	Year tagged	Fall/spring	Tag code	Dates tagged	Number tagged	Valid tagged
2001	2002	Fall	04-05-23	9/28–10/05/02	11,449	11,402
2001	2002	Fall	04-05-24	10/05–10/13/02	11,564	11,538
2001	2002	Fall	04-05-25	10/13–10/17/02	11,798	11,778
2001	2002	Fall	04-05-26	10/17–10/20/02	11,467	11,425
2001	2002	Fall	04-46-52	10/20–10/25/02	8,419	8,403
2001	2003	Spring	04-08-07	04/08–05/10/03	11,360	11,354
2001	2003	Spring	04-08-43	5/10/2003	483	483
2001 brood year total					66,540	66,383
2002	2003	Fall	04-08-42	9/29–10/10/03	23,416	23,255
2002	2003	Fall	04-08-10	10/10–10/14/03	11,609	11,464
2002	2003	Fall	04-04-61	10/14–10/18/03	9,792	9,779
2002	2004	Spring	04-09-75	3/29–4/10/04	11,678	11,666
2002	2004	Spring	04-09-76	4/10–4/1704	2,732	2,730
2002 brood year total					59,227	58,894
2003	2004	Fall	04-09-77	9/19–10/03/04	11,799	11,789
2003	2004	Fall	04-09-78	10/03–10/19/04	11,464	11,417
2003	2004	Fall	04-09-81	10/19–10/21/04	3,923	3,923
2003 brood year total					27,186	27,129

Table D5.–Mean length, weight, and associated statistics of Unuk River Chinook salmon smolt and fingerlings, 1978–2004.

			Length						Weight					
Sample year	Brood year	Spring/ fall	Mean sample date	Sample size	Mean length	Variance	SD	SE	Mean sample date	Sample size	Mean weight	Variance	SD	SE
1978	1977	Fall	1-Dec	50	64.7									
1982	1980	Spring	15-Apr	650	67.4									
1982	1981	Fall	13-Dec	246	68.2									
1983	1981	Spring	10-Apr	703	69.0									
1983	1982	Fall	30-Oct	500	63.8									
1984	1982	Spring	7-Apr	650	67.4									
1985	1983	Spring	11-Apr	703	69.0	44.0	6.6	0.25						
1986	1984	Spring	2-Apr	400	66.0	49.4	7.0	0.35						
1988	1986	Spring	13-Apr	423	69.6	41.4	6.4	0.31						
1994	1992	Spring	14-May	327	75.3	52.3	7.2	0.40	14-May	327	4.6	1.9	1.4	0.08
1994	1993	Fall	16-Oct	393	69.2	40.3	6.4	0.32	16-Oct	393	3.6	1.5	1.2	0.06
1995	1993	Spring	24-Apr	260	73.2	60.7	7.8	0.48						
1995	1994	Fall	20-Oct	823	65.3	38.9	6.2	0.22						
1996	1994	Spring	19-Apr	291	70.2	41.2	6.4	0.38	19-Apr	291	3.5	1.2	1.1	0.06
1996	1995	Fall	11-Oct	804	67.3	33.9	5.8	0.21	11-Oct	804	3.4	0.8	0.9	0.03
1997	1995	Spring	7-Apr	327	71.2	36.2	6.0	0.33	7-Apr	327	3.6	0.9	1.0	0.05
1997	1996	Fall	10-Oct	624	61.6	44.8	6.7	0.27	11-Oct	133	2.7	1.0	1.0	0.09
1998	1996	Spring	2-Apr	421	65.8	61.8	7.9	0.38	2-Apr	421	2.8	1.3	1.1	0.06
1998	1997	Fall	14-Oct	398	67.4	46.3	6.8	0.34	17-Oct	243	3.3	1.2	1.1	0.07
1999	1997	Spring	18-Apr	266	70.6	67.4	8.2	0.50	18-Apr	266	3.7	1.7	1.3	0.08
1999	1998	Fall	13-Oct	93	63.4	52.5	7.3	0.75	13-Oct	93	2.9	1.2	1.1	0.12
2000	1998	Spring	17-Apr	271	71.5	56.9	7.5	0.46	17-Apr	270	3.8	1.7	1.3	0.08
2000	1999	Fall	17-Oct	257	65.9	43.5	6.6	0.41	17-Oct	257	3.5	1.2	1.1	0.07
2001	1999	Spring	12-Apr	173	67.4	30.3	5.5	0.42	12-Apr	173	3.3	0.7	0.8	0.06
2001	2000	Fall	13-Oct	485	62.7	45.8	6.8	0.31	13-Oct	485	2.9	0.9	0.9	0.04
2002	2000	Spring	20-Apr	367	68.6	43.4	6.6	0.34	20-Apr	367	3.5	1.2	1.1	0.06
2002	2001	Fall	14-Oct	540	60.8	37.5	6.1	0.26	14-Oct	540	2.6	0.7	0.8	0.03
2003	2001	Spring	23-Apr	333	66.1	57.7	7.6	0.42	23-Apr	333	3.2	1.3	1.1	0.06
2003	2002	Fall	9-Oct	443	64.0	54.3	7.4	0.35	9-Oct	443	3.0	1.5	1.2	0.06
2004	2002	Spring	7-Apr	383	66.5	44.2	6.7	0.34	7-Apr	383	3.1	1.0	1.0	0.05
2004	2003	Fall	6-Oct	597	60.9	50.7	7.1	0.29	6-Oct	597	2.9	0.8	0.9	0.04

APPENDIX E

Estimation of the fraction of juveniles tagged (θ)

Marine harvest estimation requires that the proportion of juveniles tagged with CWTs (θ) be estimable (Bernard and Clark 1996). In a wild stock such as the Unuk River, the number of juveniles in the population is unknown during the tagging process; therefore θ is estimated as the ratio of tagged to untagged returning adults sampled inriver (Pahlke et al. 1990). The tagged fraction of a particular brood year θ_b is estimated by inriver sampling of returning Chinook salmon for age and coded wire tags during each year i in which fish from that brood year return:

$$\theta_b = \frac{\left(\frac{\sum m_{bi}}{\sum g_{bi}}\right)\sum a_{bi}}{\sum n_{bi}} \qquad (1)$$

where n_{bi} equals the number of fish inspected for CWTs from brood year b during return year i, a_{bi} equals the total number of fish inspected that were missing an adipose fin from brood year b during return year i, g_{bi} equals the number of adipose fin clipped fish sacrificed to recover CWTs from brood year b during return year i, and m_{bi} equals the number of CWTs from fish sacrificed in return year i with valid brood year b tag codes.

An unbiased estimate of θ_b requires that three conditions be met:

1) Juvenile tagging results in similar proportions of adults with tags between tributaries;
2) Age-sex-length (ASL) and CWT samples are representative of the spawning population; and
3) Ages for tagged and untagged fish are determined at the same rate.

Chi-square tests are used to determine the validity of conditions 1 and 3. Regarding condition 2, tests of spawning grounds samples collected from 1997–2004 have consistently found no evidence of size or gender selectivity (Pahlke et al. 1996; Jones III et al. 1998; Jones III and McPherson 1999-2000, 2002; Weller and McPherson 2003a-b, 2004, 2006a). Samples collected in 1996 are presumed representative as they were collected by methods identical to those used in 1997–2004. Small sample size (54) in 1995, when only returning age-1.1 adults could possess CWTs, would produce negligible bias, if any, and would be limited to a small portion of one brood year.

Returning adult Chinook salmon of all sizes were sampled on the spawning grounds for CWTs in 1982 and from 1984–2004. Sample sites included Boundary Lake Creek (also known as Border Creek); Chum, Clear, Cripple, Gene's Lake, Kerr, and Lake Creeks; and the Eulachon River (Figure 1). From 1998–2004, for Chinook salmon missing adipose fins, all fish <700 mm MEF (jacks), as well as spawned-out fish of all sizes, were sacrificed to retrieve CWTs. Prior to 1998, all Chinook salmon missing adipose fins were sacrificed to retrieve CWTs.

In 1994 and from 1997–2004, all Chinook salmon captured in the lower river set gillnets during mark–recapture experiments were sampled for CWTs. In 1997 and 1998, all Chinook salmon missing adipose fins were sacrificed to retrieve CWTs. In 1999 all fish missing adipose fins <660 mm MEF (jacks) were sacrificed to retrieve CWTs. From 2000–2004 the threshold length for sacrificing fish with missing adipose fins to recover CWTs was increased to 700 mm MEF.

A total of 12,115 adult Chinook salmon from the 1992–2001 brood years were sampled for ASL information and inspected for the presence or absence of adipose fins in the Unuk River from 1995–2004. Of these fish, 1,178 were missing adipose fins; 565 (562 random and three select samples) of which had their heads collected to recover CWTs. Of the 565 heads examined for CWTs, 522 (92.4%) had valid Unuk River Chinook salmon tag codes, one carried a valid Unuk River coho salmon tag code, one possessed a Crystal Lake/Neets Bay Hatchery tag code, one possessed a Deer Mountain Hatchery/Ketchikan Creek tag code, and 41 heads (7.3%) were absent CWTs. The heads of all fish sacrificed to recover CWTs were sent to the ADF&G Division Commercial Fisheries Mark, Tag and Age Laboratory in Juneau, Alaska for detection and decoding of CWTs.

All fish captured on the spawning grounds and in set gillnets, regardless of health, were sampled for ASL data. Length was measured to the nearest 5 mm MEF, and sex was determined from secondary maturation characteristics. Four (1993–2000) or five scales (2001–2004) were taken about 1 in apart from the preferred area on the left side of the fish. The preferred area is two to three rows above the lateral line and between the posterior terminus of the dorsal fin and the anterior margin of the anal fin (Welander 1940). Scales were mounted on gum cards that held scales from 10 fish (ADF&G *Unpublished).* The age of each fish was later determined from the pattern of circuli (Olsen 1992), seen on images of scales impressed into acetate cards magnified 70× (Clutter and Whitesel 1956).

Age cannot be determined from all scale samples, primarily due to regeneration, or to a much lesser extent, sampling error (inverted, excessively dirty, or lost scales for example). Regenerated (macrocentric) scales lack circuli prior to the age of their formation (to replace a missing scale) from which age is determined. Notation for regenerated scales with marine water (MW) circuli but lacking freshwater (FW) circuli are herein referred to as age-R.- scales. Regenerated scales with neither FW nor MW circuli, or incomplete MW circuli, are referred to as age-R.R scales. Kolmogorov-Smirnov (K-S) two-sample tests ($\alpha = 0.1$) were used to compare size distributions of fish with legible scales and fish of age-R.R to investigate whether different-sized fish were successfully aged with equal probability.

Of the 12,109 adult Chinook salmon from the 1992–2001 brood years that were randomly sampled for ASL data (excludes the two fish with non-Unuk River CWTs and the fish with an invalid coded wire tag code), 10,439 (86.21%) had scales from which both freshwater (FW) and marine water (MW) ages could be determined (Table E1). A total of 10,427 (99.89%) of these fish were determined to have a FW age of one year while 12 (0.11%) had a FW age of either zero or two years. ASL samples from which marine age could be determined, but not freshwater age, comprised 1,487 (12.28%) of the total samples collected. Neither FW nor MW age could be determined from 183 (1.51%) ASL samples (Table E1).

An unbiased estimate of θ_b requires that ages of tagged and untagged fish be determined at the same rate. No significant difference was found in the proportion of fish missing adipose fins between samples of known and unknown FW age and a MW age of one (χ^2 = 0.72, df = 1, P = 0.40), 2 (χ^2 = 0.48, df = 1, P = 0.49), 3 (χ^2 = 0.06, df = 1, P = 0.80), 4 (χ^2 = 0.06, df = 1, P = 0.80), or 5 years (χ^2 = 0.26, df = 1, P = 0.61). However, of those fish sampled with legible MW ages and illegible FW ages, valid tags were recovered from 41 of 76 fish missing adipose fins. Rather than exclude these fish from θ_b estimations, all fish of unknown FW age and known MW age were presumed to have a FW age of one year (Table E1). Based upon the observed relative frequencies of FW ages, this approach would be expected to result in a relatively negligible error rate of less than 2 of 1,489 cases.

The length distributions of fish with unknown MW age were significantly different than the length distributions of fish with known MW age (P < 0.01). This is evidence that the proportion of successfully determined ages varied by size, and therefore age class. To preclude this bias, fish of unknown age were first presumed to have a FW age of 1 year, with a resulting likelihood of error approaching zero. An age probability distribution by length for fish of known MW age was then constructed for each sample year.

Mutually exclusive length intervals were then determined for each MW age based upon the age-at-length probability distributions for each sample year. Fish lengths were then used to estimate unknown MW ages.

Estimated tagging fractions (θ_b) ranged from 2.8% (1992 brood year) to 10.7% (1996 brood year) for brood years tagged from which all age classes have returned through 2004 (Table E1). The mean tag fraction for the 1992–2000 brood years is 8.4%.

Harvest Sampling

The Pacific States Marine Fisheries Commission (PSMFC) and PST guidelines require that a minimum of 20% of harvested Chinook salmon be randomly sampled each year for CWTs (Johnson and Marshall 1990). Consequently, Chinook salmon harvested in commercial fisheries were sampled for CWTs in Alaska by ADF&G Division of Commercial Fisheries personnel as part of their port sampling activities (Oliver 1990). Similarly, ADF&G Division of Sport Fish personnel sampled Chinook salmon harvested in recreational fisheries during marine creel census activities.

The port-sampling project randomly sampled individual landings as well as tender deliveries (i.e., vessels that purchased fish from individual fisherman on the fishing grounds and subsequently delivered the purchased fish to processors). In both cases, information collected included harvest type, harvest date(s), harvest location, gear type(s), number of Chinook salmon inspected for missing adipose fins, and the number of Chinook salmon observed with missing adipose fins. All samples were classified as either random, select (non-random), or voluntary; tagged fish brought to the attention of samplers by fishermen or processors would be considered select rather than random, while tagged fish that were turned in by individual fishers would be considered voluntary. Harvest type includes 16 categories-those relevant to this study were traditional fishery, terminal area, experimental area, Metlakatla Indian Community (MIC) fishing in federally established reserve waters adjacent to Annette Island, and private non-profit (PNP) hatchery harvests managed for cost recovery.

Creel surveys and/or catch sampling were randomly conducted from 1994–2004 at marine boat landing sites in Haines, Petersburg, Wrangell, Sitka, Juneau, Craig, Ketchikan, Kake (1995), Elfin Cove (2000, 2002–2004), and Gustavus (2002–2004) during times of peak sport fishing activity, e.g., April through September. Information collected from individual fishers included harvest type, harvest date, harvest location, number of Chinook salmon inspected for missing adipose fins, and the number of Chinook salmon observed with missing adipose fins. Harvest types relevant to this study were marine boat (MB), marine roadside (MR), derby fishing in which the sampled fish was entered (DE), and derby fishing in which sampled fish were taken home (DT). Each sample was classified as either random, select, or voluntary.

In both port and creel sampling, each sampled fish that was missing an adipose fin was measured for snout to fork of tail length (SF) to the nearest 5 mm, a uniquely numbered cinch tag was placed around the jaw for identification, and the head was collected when possible, all by ADF&G staff. Sampling information and recovered heads were forwarded weekly to the ADF&G Division Commercial Fisheries Mark, Tag and Age Laboratory in Juneau, Alaska for detection and decoding of tags.

Of the estimated 461,636 juvenile Unuk River Chinook salmon implanted with CWTs from the 1992–2001 brood years, 413 have been recovered in Alaskan marine commercial (excluding trawl) and recreational fisheries through 2004. Of the 408 recoveries with specific capture location information, 98% (399) were recovered in Southeast Alaska: 243 from the Southeast Quadrant, 115 in the Northwest Quadrant, 31 in the Northeast Quadrant, and 10 in the Southwest Quadrant. The remaining nine tags were recovered in Kodiak (three), lower Cook Inlet (three), and upper Cook Inlet (three).

Of the 413 Alaska marine fishery recoveries, 7 were voluntary, 24 were select, and 382 were random. The voluntary recoveries were from recreational fisheries in Ketchikan (6) and Homer (1). The select recoveries were primarily from recreational (13) and troll fisheries (8), with one recovery from both the purse seine and PNP fisheries, and one recovery from an unknown commercial gear group. The majority of random recoveries were from troll (65%), recreational (23%), and drift gill net (7%) fisheries. Purse seine (2%), private non-profit hatchery cost recovery (2%), and set gillnet (<1%) fisheries accounted for the balance of random Alaska marine fishery recoveries. The data sets from 11 random recoveries were insufficiently complete to estimate contribution by preferred strata.

National Marine Fisheries Service (NMFS) trawl fishery observers in the Gulf of Alaska/Bering Sea recovered 6 (random) tags from 1998–2004. One tag was recovered south of Chignik Bay off the Alaska Peninsula in 1998; 2 tags were recovered in 1999 near outer Deadman Bay off the southern tip of Kodiak Island; the fourth tag was recovered in 2000 west of Marmot Bay off the west coast of Afognak Island; the fifth tag was recovered in 2000 within US NMFS statistical area 610, which is an area bounded by the Aleutian Islands to the North, Dixon Entrance to the South, and longitudes 159°W and 170°W; and the sixth tag was recovered in 2004 in the Bering Sea North of Unimak Pass in the Aleutian Islands. NMFS also recovered 2 (select) tags during research trawls southeast of Middleton Island in the Gulf of Alaska in 2002.

A total of 15 tags have been recovered in commercial and recreational fisheries in British Columbia by Canadian Department of Fisheries and Oceans personnel from 1999–2004. Three of these tags were voluntary recreational fishery recoveries from Vira Sound (1999), Langara Island (2000), and Dundas Island (2000). Seven tags were random recoveries from commercial mixed net and purse seine fisheries: 5 from Area 3, an area bounded by the International Boundary, Dundas Island, and the Canadian mainland with a western edge approximately midway between Graham and Dundas Islands, 1 recovery from Area 4, an area extending due south from the southern boundary of Area 3 to below Cape George on Porcher Island, and 1 from Area 1. Two tags were random recoveries from the Area 1 troll fishery, a fishery that extends south from the International Boundary to the north shore of Graham Island. Three tags (all random, one without associated catch information) were recovered from the Area 2W troll fishery that extends westward from Graham Island's western shoreline.

Fishery Contribution Estimation

Contribution is defined as the harvest of a particular stock in a given fishery divided by the total harvest in that same fishery (Pahlke 1995a). In SEAK , creel surveys were used to estimate recreational harvest, by fortnight and fishery, from 2001–2004 (Hubartt and Jaenicke 2004; Hubartt et al. 2001; Wendt and Jaenicke *In prep*). Mail surveys conducted by the ADF&G Division Sport Fish were used to estimate recreational harvest in Cook Inlet in 1999, 2000, 2002, and 2003, and in SEAK from 1998–2000 Howe et al. 2001a-b; Walker et al. 2003; Jennings et al. 2006a-b). In Alaska, all commercial harvests were reported on fish tickets and were stratified by statistical week and district fished (experimental troll, drift gillnet and purse seine fisheries) or by period and quadrant fished (traditional and terminal troll fisheries). Canadian and U.S. trawl harvest estimates were obtained from the Regional Mark Processing Center (RMPC, http://www.rmpc.org/), the central database for the storage and retrieval of coastwide CWT, harvest, and effort information.

Random recoveries of Unuk River CWTs from sampled fisheries with known catch/sample type 1 (following RMIS (RMPC) methodology) were used to estimate harvest contributions. Select recoveries were not used to estimate harvest contributions. Voluntary recoveries of Unuk River CWTs from fisheries with unknown catch were used to estimate harvest contributions, but only in otherwise unsampled strata (sample type 3). In sample type 3 cases, an awareness approximation is used to expand the recovery. The awareness approximation is based on extrapolations of data from previous years according to protocols established by the Chinook Technical Committee of the Pacific Salmon Commission (Brian Riddell, CDFO, Nanaimo, personal communication). In such cases, the estimated contribution $\hat{r}_{ib}$ of brood year b to fishery stratum i is:

$$\hat{r}_{ib} = 4m_{ib}\theta_b^{-1};\ \mathrm{var}\left(\hat{r}_{ib}\right) = \left(\hat{r}_{ib}\right)^2 \qquad (2)$$

where 4 equals the awareness approximation, m_{ib} equals the number of voluntary CWT recoveries with relevant tag codes from brood year *b* in fishery stratum *i*, and θ_b equals the fraction of juveniles tagged in brood year *b*. Sample type 4 was used for recoveries from the recreational fishery in Cook Inlet, where catch was unknown and recoveries were expanded using annual estimates of harvest generated by the Statewide Harvest Survey.

For random recoveries, the estimated contribution $\hat{r}_{ib}$ of brood year *b* to fishery stratum *i* is:

$$\hat{r}_{ib} = H_i\left(\frac{m_{ib}}{\lambda_i n_i}\right)\theta_b^{-1};\ \lambda_i = \frac{a_i' t_i'}{a_i t_i} \qquad (3)$$

where H_i equals the total harvest in the fishery, n_i equals the number of fish inspected for CWTs, a_i equals the number of fish inspected that were missing an adipose fin, a_i' equals the number of adipose clipped fish whose heads arrived at the ADF&G Mark, Tag and Age Laboratory, t_i equals the number of fish heads with CWTs, t_i' equals the number of CWTs that were successfully removed from fish heads and decoded, m_i equals the number of randomly recovered CWTs with relevant tag codes, and θ_b equals the fraction of juveniles tagged from a particular brood year.

An unbiased estimate of the variance of $\hat{r}_{ib}$ can be calculated according to procedures in Clark and Bernard (1987) when H_i and θ_b are known without error. In this case however, H_i is estimated with error in recreational fisheries, and as it is not possible to CWT every Unuk River juvenile Chinook salmon, θ_b is therefore also estimated with error. Equations listed in Table 2 of Bernard and Clark (1996) were therefore used to obtain unbiased estimates of the variance of $\hat{r}_{ib}$.

RMIS methodology was followed in determination of the temporal characteristics of each recovery expansion; sampling period type and sampling period. Sampling period type 1 is defined as encompassing an annual escapement period, with the sampling period possibly running across calendar years. This sample type was used for recoveries from winter trawl fisheries in the Gulf of Alaska and Bering Sea. Sampling period is 1 in this instance (escapement year). Sampling period type 2 is bi-weekly in nature, with possible sampling periods of 1–26, and was used for recreational fishery recoveries. Sampling period type 5 is by calendar month, with sampling periods of 1–12. Sampling period type 7 is by statistical week, with each week defined as beginning on Monday; sampling periods in this case run from 1-54. Sampling period type 8 is seasonal in nature; sampling period 1 is spring, 2 is summer, 3 is fall, and 4 is winter. RMIS methodology was also used to define the level of spatial resolution, or estimation level, for each recovery expansion. In increasing order of resolution, estimation level 2 is defined as sector (Gulf of Alaska for example), 3 is region (Quadrant), 4 is area (Ketchikan or Sitka for example), and 5 is location (District for instance).

Total harvest of the 1992–1998 brood year returns to the Unuk River ranged from 539 (SE = 237; 1992 brood year) to 2,543 (SE = 327; 1996 brood year) and averaged 1,521 fish annually (Table E2). Estimated harvest of the 1992–2001 broods in return years 1995–2004 averaged 1,618 fish with a range of 749 (SE = 213) in 1998 to 2,431 (SE = 352) in 2000 (Table E3). Age-1.3 and age-1.4 fish comprised an estimated

49.3% and 29.8% of the estimated annual harvest of Unuk River Chinook salmon from 1998 to 2004, respectively. On average, age-1.2 fish comprised 19.5% of the estimated harvest.

Troll Fisheries

Since 1995, troll fisheries have harvested an estimated 5,610 (SE = 415) Chinook salmon from the 1992–2001 Unuk River brood year returns, approximately 47% of the total estimated harvest of these fish (Table E3). Troll fisheries in SEAK accounted for an estimated 95.9% of this harvest (5,380; SE = 409), with troll fisheries in British Columbia harvesting the remaining 4.1% (231 fish; SE = 133). In SE Alaska, experimental troll fisheries harvested an estimated 2,587 (SE = 265) fish while traditional summer and winter troll fisheries harvested an estimated 2,770 (SE = 311) fish, 49.4% of the total troll harvest (Table E6). Terminal troll fisheries in southern SEAK harvested an estimated 23 (SE = 16) fish, 0.4 % of the total estimated troll harvest (Table E6).

In each return year from 1995–2004, the first traditional troll fishery in SEAK to open was the winter troll fishery. This fishery is divided into two temporal segments, with the first part open from 11 October to 31 December (herein referred to as winter^1), and the second segment (winter^2) open from 1 January until approximately 14 April. From 1998–2004, an estimated annual average of 61 fish of Unuk River origin were harvested in the Northwest Quadrant during the winter^1 fishery, an estimated contribution rate of approximately 0.4% per year (Table E4). The annual contribution rate in the Northeast quadrant to the winter^1 fishery was estimated to be 0.8%, or 16 (SE = 3) fish per year. Only five Unuk River Chinook salmon were harvested annually from the Southeast Quadrant, and no recoveries occurred in the Southwest Quadrant of the winter^1 fishery. An estimated annual average of 61 (SE = 45) fish of Unuk River origin were harvested in the Northwest Quadrant of the winter^2 fishery, an estimated contribution rate of 0.4% (Table E4). The annual contribution to the Northeast Quadrant of this fishery was estimated to be 3 fish; no recoveries occurred in either the Southeast or Southwest quadrants.

Between 1997–2004, Chinook salmon originating from the Unuk River were harvested in 24 separate (spring) experimental troll fisheries (Table E5). On average, estimated annual contributions were greatest to the District 101-29 (140 fish), District 101-45 (65 fish), and District 113-95 (26 fish) fisheries. Fisheries with the largest (average) estimated proportion of Unuk fish in the harvest included District 107-10 (20.7%), District 107-20 (20.2%), and District 101-90 (7.2%). Experimental troll fisheries in the Southeast Quadrant harvested an average of 242 fish of Unuk River origin per year from 1998–2004 (Table E5). During that time, experimental troll fisheries in the Northwest and Northeast quadrants harvested an estimated 80 and 32 fish of Unuk River origin per year, respectively.

The first traditional summer troll fishery, summer^1, began on 1 July of each year from 1995–2004. The duration of this fishery depends on annual catch quotas and inseason estimates of the harvest rate, and ranged from 5 days in 2000 to 39 days in 2003. From 1998 to 2004, an estimated average of 70 fish of Unuk origin were harvested each year in the Northwest Quadrant of this fishery, a contribution rate of approximately 0.1% (Table E4). An average of 23 fish of Unuk origin were harvested annually in the Northeast Quadrant, and roughly a dozen fish were harvested annually in each of the Southwest and Southeast quadrants of this fishery during these years.

If the summer harvest quota was not reached during the initial summer^1 opening in a particular year (July), one or more additional summer openings in August/September (herein collectively referred to as summer^2) were established in order to harvest the number of Chinook salmon remaining under the summer quota. In the Northwest Quadrant an average of 55 Unuk River fish were harvested annually in the summer^2 fishery. The estimated contribution rate of Unuk River fish to the harvest in summer^2 fisheries in the Southeast and Northeast quadrants of these fisheries was estimated to average 1.9% and 1.4%, respectively, from 1998–2004 (Table E4).

Recreational Fisheries

Since 1995, recreational fisheries harvested an estimated 4,338 (SE = 526) Chinook salmon from the 1992–2001 Unuk River brood year returns, an estimated 36.3% of the total estimated harvest of these fish (Table E3). Recreational fisheries in SEAK accounted for 3,971 (SE = 521) of these fish, with Cook Inlet and British Columbia recreational fisheries harvesting an estimated 261 (SE = 110) and 106 (SE = 70) fish respectively (Table E6). On average the Ketchikan recreational fishery harvested an estimated 423 fish of Unuk origin each year from 1998–2004 (Table E4). The estimated contribution rate to the Ketchikan fishery averaged 5.7% and ranged from 12% in 2001 to 0.0% in 1998. An average of 81 fish per year of Unuk River origin was harvested in the Sitka recreational fishery since 1998. The Craig recreational fishery harvested an average of 32 (contribution rate = 0.4%) fish per year of Unuk River origin, with contributions since 1998 estimated to have only occurred in 1999, 2001, and 2002 (Table E4). A single tag recovery occurred in each of the Juneau, Wrangell, and Petersburg recreational fisheries from 1998 to 2004, indicating a negligible contribution of Unuk River fish to these fisheries.

Drift Gillnet Fisheries

From 1995 to 2004, drift gillnet fisheries in the Southeast Quadrant harvested an estimated 1,246 (SE = 418) Chinook salmon from the 1992–2001 Unuk River brood year returns (Table E6). The contribution rate averaged 11.0% per year since 1998 in the District 106 drift gillnet fishery (108 fish; SE = 66) (Table E4). However, contributions to this fishery were estimated to have occurred in only three of seven years, with the estimated contribution rate of 22% (594 fish; SE = 387) in 2004 being a notable outlier relative to the estimates from previous years. In 2004, a total of 2,735 Chinook salmon were harvested in the District 106 drift gillnet fishery, of which 1,088 were harvested during statistical weeks 27 and 28. Less than 4% of the fish harvested during statistical weeks 27 and 28 were sampled for CWTs, resulting in comparatively imprecise estimates for the contribution of Unuk River Chinook salmon to this fishery, as well as substantially decreasing the precision of the overall 2004 Unuk River harvest estimate. From 1998–2003, fish of Unuk River origin contributed an estimated average of 28 (SE = 13) fish per year to this fishery, an average contribution rate of 4% per year.

The District 101 (Tree Point) drift gillnet fishery harvested an estimated 13 (SE = 10) fish per year of Unuk origin since 1998 (Table E4). The MIC drift gillnet fishery at Annette Island harvested an estimated 16 (SE = 13) fish per year of Unuk origin during this same period (Table E4). The contribution rate to both fisheries averaged 1% per year from 1998–2004. The District 108 fishery was estimated to have harvested 69 (SE = 69) fish of Unuk River origin in 2004, the only year a Unuk River CWT was recovered from this fishery (Table E4).

Miscellaneous Fisheries

High seas trawl fisheries in the Gulf of Alaska and Bering Sea harvested an estimated total of 232 (SE = 96) Chinook salmon of Unuk River origin from the 1992–2001 brood year returns (Table E6). The contribution rate of these stocks to the high seas trawl fishery averaged 0.24% from 1998 to 2001. Commercial net fisheries in northern British Columbia harvested an estimated 189 (SE = 14) Unuk River fish since 1999. The Neets Bay private non-profit hatchery harvested an estimated 188 (SE = 14) fish of Unuk River origin during cost recovery fisheries in District 101-95 from 1999–2004.

Since 1995, purse seine fisheries harvested an estimated 104 (SE = 46) Chinook salmon from the 1992–2001 Unuk River brood year returns. Of this harvest, 76 (SE = 9) were from the District 112-22 (Hidden Falls) terminal harvest fishery and 15 (SE = 4) were from the District 110 traditional fishery (Table E2). All Unuk River CWT recoveries from purse seine fisheries were of age-1.1 fish.

An estimated 16 (SE = 15) Chinook salmon of Unuk River origin were harvested in Kodiak set gillnet fisheries from 1997–1999 (Table E2). Chinook salmon harvested in Kodiak fisheries were not sampled for CWTs prior to 1997 or after 1999.

Harvest by Location

Of the estimated 11,942 (SE = 821) Chinook salmon harvested from the 1992–2001 Unuk River brood year returns, approximately 91.4% were harvested in SEAK, 4.4% in British Columbia, and 4.2% in Kodiak, Cook Inlet, and the Gulf of Alaska combined (Table E6).

In SEAK, an estimated 6,627 (SE = 663) of these fish, 55.3% of the total, were harvested in the Southeast Quadrant (Table E6). Of the harvest of Unuk River stocks in the Southeast quadrant, 95% occurred during statistical weeks 22-29, and 55% occurred in weeks 25–27 (Figure E1). Pahlke (1995a) estimated that the Southeast Quadrant accounted for 45% of the total harvest from the 1982–1986 broods (Figure E2); however, no Alaskan harvest other than SEAK was sampled for CWTs during this time. Of total harvest, excluding sampled fisheries outside SEAK, the Southeast Quadrant accounted for an estimated 55% of the harvest of the 1992–2001 broods (Figure E3), and 56% of the total for the 1992–1998 brood years (those years with complete returns through 2004) (Figure E4). Including all sampled Alaskan fisheries, the Southeast Quadrant accounted for 55% of the total harvest from the 1992–2001 broods and 52% from the 1992–1998 broods (Figures E5 and E6).

Approximately 27% of the total estimated harvest of Unuk River stocks occurred in the Northwest Quadrant of SEAK (3,274 fish; SE = 381) (Table E6). Of these fish, 83% were harvested by troll fisheries (65% in traditional and 18% in experimental troll fisheries) and the remaining 17% of harvest occurred in the Sitka recreational fishery. In this quadrant, 53% of the harvest of Unuk River stocks occurred during statistical weeks 19–29, 32% in weeks 34–47, and the remaining 15% were harvested during weeks 9–17 (Figure E1).

An estimated 685 (SE = 159) fish were harvested from the 1992–2001 Unuk River brood year returns in the Northeast Quadrant (Table E6). Approximately 75% of these fish were harvested in troll fisheries, 11% in purse seine fisheries, and 14% in recreational fisheries. In the Southwest quadrant, of the estimated harvest of 322 (SE = 120; Table E6) fish of Unuk River origin, 70% were harvested in the recreational fishery and 30% were harvested in the traditional summer[1] troll fishery. All harvest occurred between statistical weeks 22–28 (Figure E3). The Northeast Quadrant accounted for 17% of total harvest of the 1982–1986 broods Pahlke (1995a), and from 6–7% of harvest from either the 1992–1998 or 1992–2001 brood years (Figures E2-E6).

In British Columbia, an estimated 525 (SE = 168) fish of Unuk River origin were harvested (Table E6). Approximately 44% of these fish were harvested in troll fisheries, commercial net fisheries accounted for 36% of the harvest, and the remaining 20% were harvested in recreational fisheries. All harvest occurred between statistical weeks 19–30 (Figure E1). Fisheries in British Columbia accounted for 11% of total harvest of the 1982–1986 broods (Pahlke 1996), and between 4 and 5% of harvest from either 1992–1998 or 1992–2001 brood years (Figures E2-E6).

Approximately 2% of the estimated harvest of Unuk River Chinook salmon from the 1992–2001 brood year returns occurred in Cook Inlet (261 fish; SE = 110) (Table E6). Four of five recoveries occurred between 11 May and 14 May (in years 2000–2002), while the fifth recovery occurred on 5 June 1999. All recoveries were from the recreational fisheries of Anchor Point and Homer. Alaskan fisheries other than those in SEAK accounted for an estimated 5% of total harvest from the 1992–1998 broods (Figure E6).

Table E1.–Numbers of Unuk River Chinook salmon examined for adipose finclips, sacrificed for CWT sampling purposes, valid CWTs decoded, percent of the marked fraction carrying germane CWTS, percent sampled with adipose finclips, and estimated fraction of the sample carrying valid CWTs, 1992–2001 brood years.

						Number of valid tags					Marked fraction (θ)	
Brood year	Age class	Year examined	Number examined	Adipose fin clips	Number sacrificed	Fall	Spring	Total	Percent valid tags	Percent adipose fin clips	Valid %	Event
1992	1.3	1997	137	7	7	6	1	7	100.0	5.1	5.1	1
1992	1.4	1998	129	6	6	2	2	4	66.7	4.7	3.1	1
1992	R.3 → 1.3	1997	25									1
1992	R.4 → 1.4	1998	10									1
1992	R.R → 1.4	1998	1									1
1992	1.3	1997	237	3	3	3		3	100.0	1.3	1.3	2
1992	1.4	1998	164	7	4	1	2	3	75.0	4.3	3.2	2
1992	1.5	1999	1									2
1992	2.2	1997	1									2
1992	R.3 → 1.3	1997	33	1	1	1		1	100.0	3.0	3.0	2
1992	R.4 → 1.4	1998	20	2	1	1		1	100.0	10.0	10.0	2
1992	R.R → 1.3	1997	4									2
1992	1.2	1996	33									1+2
1992 brood year total			795	26	22	14	5	19	86.4	3.3	2.8	1&2
1993	1.2	1997	89	7	7	6	1	7	100.0	7.9	7.9	1
1993	1.3	1998	318	28	28	22	3	25	89.3	8.8	7.9	1
1993	1.4	1999	131	8	1	1		1	100.0	6.1	6.1	1
1993	1.5	2000	3									1
1993	R.2 → 1.2	1997	17	2	2	2		2	100.0	11.8	11.8	1
1993	R.3 → 1.3	1998	30	3	3	2	1	3	100.0	10.0	10.0	1
1993	R.4 → 1.4	1999	10	2								1
1993	R.R → 1.3	1998	1									1
1993	1.1	1996	3	1	1	1		1	100.0	33.3	33.3	2
1993	1.2	1997	178	23	23	17	2	19	82.6	12.9	10.7	2
1993	1.3	1998	352	28	15	11	3	14	93.3	8.0	7.4	2
1993	1.4	1999	172	24	18	13	4	17	94.4	14.0	13.2	2
1993	1.5	2000	5									2
1993	2.2	1998	1									2
1993	R.2 → 1.2	1997	12	3	3	3		3	100.0	25.0	25.0	2
1993	R.3 → 1.3	1998	35	4	2	1	1	2	100.0	11.4	11.4	2
1993	R.4 → 1.4	1999	12									2
1993	R.5 → 1.5	2000	1									2
1993	R.R → 1.1	1996	1									2
1993	R.R → 1.2	1997	4									2
1993 brood year total			1,375	133	103	79	15	94	91.3	9.7	8.8	1&2
1994	R.2 → 1.2	1998	11									1
1994	R.3 → 1.3	1999	17									1
1994	R.4 → 1.4	2000	10									1
1994	R.R → 1.2	1998	2									1
1994	R.R → 1.3	1999	1	1						100.0		1
1994	1.1	1997	51	4	4	2	2	4	100.0	7.8	7.8	2
1994	1.2	1998	189	20	17	10	5	15	88.2	10.6	9.3	2
1994	1.3	1999	212	25	12	5	5	10	83.3	11.8	9.8	2
1994	1.4	2000	134	10	7	3	3	6	85.7	7.5	6.4	2
1994	1.5	2001	1									2
1994	2.1	1998	1									2

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Table E1.–Page 2 of 4.

Brood year	Age class	Year examined	Number examined	Adipose fin clips	Number sacrificed	Number of valid tags: Fall	Number of valid tags: Spring	Number of valid tags: Total	Percent valid tags	Percent adipose fin clips	Marked fraction (θ): Valid %	Marked fraction (θ): Event
1994	R.2 → 1.2	1998	12	1	1		1	1	100.0	8.3	8.3	2
1994	R.3 → 1.3	1999	23									2
1994	R.4 → 1.4	2000	25									2
1994	R.R → 1.1	1997	5									2
1994	R.R → 1.2	1998	1									2
1994	R.R → 1.3	1999	2									2
1994 brood year total			1,040	92	53	25	21	46	86.8	8.8	7.7	1&2
1995	1.1	1998	7	1	1	1		1	100.0	14.3	14.3	1
1995	1.2	1999	171	18	16	11	5	16	100.0	10.5	10.5	1
1995	1.3	2000	314	26	3	1	2	3	100.0	8.3	8.3	1
1995	1.4	2001	175	18	2	1	1	2	100.0	10.3	10.3	1
1995	1.5	2002	1									1
1995	R.1 → 1.1	1998	3									1
1995	R.R → R.2	1999	2									1
1995	R.2 → 1.2	1999	27	4	3	3		3	100.0	14.8	14.8	1
1995	R.3 → 1.3	2000	41	7						17.1		1
1995	R.4 → 1.4	2001	32	4						12.5		1
1995	R.R → 1.3	2000	3									1
1995	R.R → 1.4	2001	1									1
1995	0.2	1998	1									2
1995	1.1	1998	62	12	11	6	4	10	90.9	19.4	17.6	2
1995	1.2	1999	234	29	23	13	10	23	100.0	12.4	12.4	2
1995	1.3	2000	339	42	15	7	5	12	80.0	12.4	9.9	2
1995	1.4	2001	250	27	14	9	5	14	100.0	10.8	10.8	2
1995	1.5	2002	5	1	1	1		1	100.0	20.0	20.0	2
1995	2.4	2002	1									2
1995	R.1 → 1.1	1998	5									2
1995	R.2 → 1.2	1999	26	3	3	2	1	3	100.0	11.5	11.5	2
1995	R.3 → 1.3	2000	40	2	2	2		2	100.0	5.0	5.0	2
1995	R.4 → 1.4	2001	53	4	3	2	1	3	100.0	7.5	7.5	2
1995	R.R → 1.1	1998	4	2	2	1	1	2	100.0	50.0	50.0	2
1995	R.R → 1.2	1999	2									2
1995	R.R → 1.3	2000	5									2
1995	R.R → 1.4	2001	1									2
1995 brood year total			1,805	200	99	59	35	94	94.9	11.1	10.5	1&2
1996	1.1	1999	4									1
1996	1.2	2000	263	35	23	17	6	23	100.0	13.3	13.3	1
1996	1.3	2001	505	54	9	7	2	9	100.0	10.7	10.7	1
1996	1.4	2002	244	22	2	1	1	2	100.0	9.0	9.0	1
1996	R.2 → 1.2	2000	24	2	2		2	2	100.0	8.3	8.3	1
1996	R.3 → 1.3	2001	54	4						7.4		1
1996	R.4 → 1.4	2002	34	4						11.8		1
1996	R.R → 1.2	2000	6									1
1996	R.R → 1.3	2001	6	2						33.3		1
1996	R.R → 1.4	2002	5									1
1996	0.1	1998	2									2
1996	1.1	1999	55	5	5	4	1	5	100.0	9.1	9.1	2
1996	1.2	2000	240	29	21	15	5	20	95.2	12.1	11.5	2
1996	1.3	2001	554	71	32	19	9	28	87.5	12.8	11.2	2

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Table E1.–Page 3 of 4.

Brood year	Age class	Year examined	Number examined	Adipose fin clips	Number sacrificed	Number of valid tags: Fall	Number of valid tags: Spring	Number of valid tags: Total	Percent valid tags	Percent adipose fin clips	Marked fraction (θ): Valid %	Marked fraction (θ): Event
1996	1.4	2002	227	27	8	7	1	8	100.0	11.9	11.9	2
1996	1.5	2003	6	1						16.7		2
1996	R.1 → 1.1	1999	2	1	1					50.0		2
1996	R.2 → 1.2	2000	3	3	3	1	1	2	66.7	100.0	66.7	2
1996	R.3 → 1.3	2001	51	5	1					9.8		2
1996	R.4 → 1.4	2002	39	5	5	3	2	5	100.0	12.8	12.8	2
1996	R.5 → 1.5	2003	1									2
1996	R.R → 1.1	1999	4									2
1996	R.R → 1.2	2000	5									2
1996	R.R → 1.3	2001	7	1	1	1		1	100.0	14.3	14.3	2
1996	R.R → 1.4	2002	2									2
1996 brood year total			2,343	271	113	75	30	105	92.9	11.6	10.7	1&2
1997	0.4	2002	1									1
1997	1.1	2000	1									1
1997	1.2	2001	88	16	14	9	3	12	85.7	18.2	15.6	1
1997	1.3	2002	297	27	1	1		1	100.0	9.1	9.1	1
1997	1.4	2003	128	11						8.6		1
1997	1.5	2004	3	2						66.7		1
1997	2.2	2002	1									1
1997	R.2 → 1.2	2001	13	1	1					7.7		1
1997	R.3 → 1.3	2002	57	5						8.8		1
1997	R.4 → 1.4	2003	24	3						12.5		1
1997	R.R → 1.1	2000	1									1
1997	R.R → 1.3	2002	4									1
1997	1.1	2000	10	1	1		1	1	100.0	10.0	10.0	2
1997	1.2	2001	80	8	7	3	2	5	71.4	10.0	7.1	2
1997	1.3	2002	214	18	6	3	3	6	100.0	8.4	8.4	2
1997	1.4	2003	187	13	3	2		2	66.7	7.0	4.6	2
1997	1.5	2004	3									2
1997	R.2 → 1.2	2001	8	1	1					12.5		2
1997	R.3 → 1.3	2002	24	6						25.0		2
1997	R.4 → 1.4	2003	38	4	3	2		2	66.7	10.5	7.0	2
1997	R.R → 1.3	2002	2									2
1997	R.R → 1.4	2003	2									2
1997 brood year total			1,186	116	37	20	9	29	78.4	9.8	7.7	1&2
1998	0.4	2003	1									1
1998	1.1	2001	9	1	1		1	1	100.0	11.1	11.1	1
1998	1.2	2002	218	15	14	8	6	14	100.0	6.9	6.9	1
1998	1.3	2003	411	47	2		2	2	100.0	11.4	11.4	1
1998	1.4	2004	170	13						7.6		1
1998	2.2	2003	1									1
1998	R.2 → 1.2	2002	32	3	2	2		2	100.0	9.4	9.4	1
1998	R.3 → 1.3	2003	80	7	2	1	1	2	100.0	8.8	8.8	1
1998	R.4 → 1.4	2004	39	6						15.4		1
1998	R.R → 1.1	2001	3									1
1998	R.R → 1.2	2002	5									1
1998	R.R → 1.3	2003	8	1						12.5		1
1998	R.R → 1.4	2004	11	1						9.1		1
1998	1.1	2001	17	2	2		2	2	100.0	11.8	11.8	2

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						Number of valid tags					Marked fraction (θ)	
Brood year	Age class	Year examined	Number examined	Adipose fin clips	Number sacrificed	Fall	Spring	Total	Percent valid tags	Percent adipose fin clips	Valid %	Event
1998	1.2	2002	146	7	4	2	2	4	100.0	4.8	4.8	2
1998	1.3	2003	511	49	19	8	11	19	100.0	9.6	9.6	2
1998	1.4	2004	263	28	1	1		1	100.0	10.6	10.6	2
1998	R.1 → 1.1	2001	1									2
1998	R.2 → 1.2	2002	17	1	1		1	1	100.0	5.9	5.9	2
1998	R.3 → 1.3	2003	93	11	5	2	3	5	100.0	11.8	11.8	2
1998	R.4 → 1.4	2004	55	3						5.5		2
1998	R.R → 1.1	2001	1									2
1998	R.R → 1.2	2002	1									2
1998	R.R → 1.3	2003	9	2						22.2		2
1998	R.R → 1.4	2004	4									2
1998 brood year total			2,106	197	53	24	29	53	100.0	9.4	9.4	1&2
1999	0.2	2002	1									1
1999	1.2	2003	39	7	5	2	3	5	100.0	17.9	17.9	1
1999	1.3	2004	110	8	1	1		1	100.0	7.3	7.3	1
1999	R.2 → 1.2	2003	12	2	2		1	1	50.0	16.7	8.3	1
1999	R.3 → 1.3	2004	29	7	1		1	1	100.0	24.1	24.1	1
1999	R.R → 1.2	2003	1									1
1999	R.R → 1.3	2004	4									1
1999	1.1	2002	2									2
1999	1.2	2003	83	5	5	4	1	5	100.0	6.0	6.0	2
1999	1.3	2004	193	29	1	1		1	100.0	15.0	15.0	2
1999	R.2 → 1.2	2003	11	1	1	1		1	100.0	9.1	9.1	2
1999	R.3 → 1.3	2004	49	3						6.1		2
1999	R.R → 1.1	2002	1									2
1999	R.R → 1.2	2003	1									2
1999	R.R → 1.3	2004	11	2						18.2		2
1999 brood year total			547	64	16	9	6	15	93.8	11.7	11.0	1&2
2000	1.1	2003	7	1	1		1	1	100.0	14.3	14.3	1
2000	1.2	2004	255	17	13	8	4	12	92.3	6.7	6.2	1
2000	R.1 → 1.1	2003	2									1
2000	R.2 → 1.2	2004	83	4	3	2	1	3	100.0	4.8	4.8	1
2000	R.R → 1.1	2003	5									1
2000	R.R → 1.2	2004	10	1	1		1	1	100.0	10.0	10.0	1
2000	1.1	2003	39	2	2	1	1	2	100.0	5.1	5.1	2
2000	1.2	2004	373	28	26	14	12	26	100.0	7.5	7.5	2
2000	R.1 → 1.1	2003	4									2
2000	R.2 → 1.2	2004	76	12	9	5	4	9	100.0	15.8	15.8	2
2000	R.R → 1.1	2003	15	1	1	1		1	100.0	6.7	6.7	2
2000	R.R → 1.2	2004	7									2
2000 brood year total			876	66	56	31	24	55	98.2	7.5	7.4	1&2
2001	1.1	2004	1									1
2001	R.1 → 1.1	2004	1									1
2001	1.1	2004	31	7	7	5	2	7	100.0	22.6	22.6	2
2001	R.1 → 1.1	2004	1									2
2001	R.R → 1.1	2004	2									2
2001 brood year total			36	7	7	5	2	7	100.0	19.4	19.4	1&2

Table E2.–Estimated marine harvest of adult Chinook salmon, 1992–2001 brood years, bound for the Unuk River from 1995–2004.

PANEL A: 1992 BROOD YEAR

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Terminal seine	District 112-22	1995	1.1	1	7	26	4	208	0	208	14	14	14	14	1	35	35
Drift gillnet	District 106	1996	1.2	1	7	27	4	91	0	40	5	5	5	5	1	81	80
Experimental troll	District 101-45	1997	1.3	1	7	26	5	241	0	81	5	5	5	5	1	106	105
Traditional troll	NW Quadrant	1997	1.3	1	7	3	3	99,338	0	36,047	1,247	1,222	1,130	1,130	1	100	99
Drift gill net	District 106	1997	1.3	1	7	27	4	258	0	157	15	14	13	13	1	62	62
Recreational DE	Sitka	1998	1.4	1	8	1	4	14,355	0	3,337	119	118	111	110	1	155	155
1992 Brood year total								114,491	0	39,870	1,405	1,378	1,278	1,277	6	539	237

PANEL B: 1993 BROOD YEAR

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Traditional troll	NW Quadrant	1997	1.2	1	7	3	3	99,338	0	36,047	1,247	1,222	1,130	1,130	1	32	31
Traditional troll	NW Quadrant	1997	1.2	1	7	5	3	21,448	0	7,245	348	343	311	311	1	34	34
Traditional troll	NW Quadrant	1997	1.2	1	7	6	3	7,949	0	1,245	95	95	90	90	1	72	72
Traditional troll	NE Quadrant	1997	1.2	1	7	4	3	1,106	0	711	73	73	68	68	1	18	17
Drift gill net	District 106	1997	1.2	1	7	25	4	277	0	198	12	11	10	10	1	17	17
Drift gill net	District 106	1997	1.2	1	7	26	4	326	0	97	9	9	9	9	1	38	38
Drift gill net	District 101MIC	1997	1.2	1	7	27	4	77	0	40	8	8	8	8	1	22	21
Traditional troll	NW Quadrant	1998	1.3	1	7	1	3	20,709	0	7,067	331	330	307	307	1	33	33
Traditional troll	NW Quadrant	1998	1.3	1	7	3	3	60,545	0	22,610	837	814	754	754	1	31	31
Traditional troll	NE Quadrant	1998	1.3	1	7	3	3	19,323	0	10,238	377	375	347	347	2	43	30
Traditional troll	NE Quadrant	1998	1.3	1	7	4	3	619	0	112	9	9	9	9	1	63	62
Traditional troll	NW Quadrant	1998	1.3	1	7	4	3	34,340	0	11,946	652	637	584	583	1	33	33
Traditional troll	NE Quadrant	1998	1.3	1	7	5	3	930	0	516	68	65	62	62	1	21	21
Traditional troll	NW Quadrant	1998	1.3	1	7	5	3	12,915	0	3,125	216	216	207	206	1	47	47
Experimental troll	District 101-45	1998	1.3	1	7	25	5	209	0	197	32	32	32	32	2	24	16
Experimental troll	District 101-45	1998	1.3	1	7	26	5	105	0	105	16	16	16	16	1	11	11
Terminal troll	SE Quadrant	1998	1.3	1	7	24	4	54	0	46	5	5	5	5	1	13	13
Recreational MB	Juneau	1998	1.3	1	8	16	4	1,297	0	310	54	49	46	46	1	52	52
Trawl	Gulf of Alaska	1998	1.3	1	1	1	2	16,941	0	4,432	100	100	100	100	1	43	43
Traditional troll	NW Quadrant	1999	1.4	1	7	1	3	12,321	0	3,096	188	187	174	174	1	45	45
Experimental troll	District 113-95	1999	1.4	1	7	25	5	142	0	29	4	4	4	4	1	55	55
Traditional troll	NW Quadrant	1999	1.4	1	7	3	3	67,195	0	22,737	999	992	906	904	1	34	33
Experimental troll	District 101-29	1999	1.4	1	7	23	5	131	0	131	16	16	13	13	3	34	19

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Table E2.–Page 2 of 10.

PANEL B: 1993 BROOD YEAR

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Recreational DE	Petersburg	1999	1.4	1	8	1	4	2,209	0	579	29	29	25	24	1	45	44
Recreational MB/DE	Ketchikan	1999	1.4	1	8	1	4	3,051	0	642	65	63	56	56	4	222	110
Recreational MB	Ketchikan	1999	1.4	1	8	2	4	5,696	0	639	63	62	52	52	1	103	102
Recreational MB	Craig	1999	1.4	1	8	1	4	2,863	0	524	27	26	22	22	1	64	64
Recreational	Vira Sd CDFO	1999	1.4	3	5	5	3		0						1	23	23
Mixed net & seine	Area 000 CDFO	1999	1.4	1	7	27	3	2,426	0	755	12	12	10	10	1	36	36
1993 brood year total								394,542	0	135,419	5,892	5,800	5,357	5,352	36	1,311	249

PANEL C: 1994 BROOD YEAR

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Traditional troll	NW Quadrant	1998	1.2	1	7	3	3	60,545	0	22,610	837	814	754	754	1	36	35
Traditional troll	NW Quadrant	1998	1.2	1	7	4	3	34,340	0	11,946	652	637	584	583	2	77	54
Recreational DE	Juneau	1998	1.2	1	8	17	4	1,485	0	583	89	86	79	79	1	34	34
Traditional troll	NW Quadrant	1999	1.3	1	7	3	3	67,195	0	22,737	999	992	906	904	3	117	66
Experimental troll	District 101-29	1999	1.3	1	7	24	5	218	0	188	17	16	15	15	1	16	16
Experimental troll	District 101-45	1999	1.3	1	7	25	5	152	0	104	14	14	14	14	1	19	19
Experimental troll	District 107-20	1999	1.3	1	7	26	5	90	0	33	2	2	2	2	1	36	35
Drift gill net	District 101	1999	1.3	1	7	26	4	510	0	315	5	5	5	5	1	21	21
Drift gill net	District 101	1999	1.3	1	7	27	4	417	0	343	26	25	21	21	1	16	16
Recreational	Homer	1999	1.3	4	2	11	4		0						1	52	33
Recreational	Ketchikan	1999	1.3	1	8	1	4	3,051	0	642	65	63	56	56	2	128	90
Recreational MB	Ketchikan	1999	1.3	1	8	2	4	5,696	0	639	63	62	52	52	1	118	117
Recreational MB	Sitka	1999	1.3	1	8	3	4	1,754	0	354	16	15	15	15	1	69	68
Traditional troll	NE Quadrant	2000	1.4	1	7	1	3	1,671	0	905	53	53	47	47	1	24	24
Traditional troll	NW Quadrant	2000	1.4	1	7	1	3	14,898	0	4,534	331	331	313	313	2	86	60
Experimental troll	District 113-95	2000	1.4	1	7	23	5	67	0	67	5	5	4	4	1	13	13
Experimental troll	District 101-45	2000	1.4	1	7	26	5	458	0	273	32	31	27	27	1	23	22
Experimental troll	District 101-45	2000	1.4	1	7	27	5	641	0	641	66	66	59	59	2	26	18
Recreational DE	Ketchikan	2000	1.4	1	8	1	4	2,740	0	497	33	33	28	28	2	144	101
Recreational MB	Sitka	2000	1.4	1	8	1	4	8,063	0	2,236	112	112	107	107	1	47	46
1994 Brood year total								203,991	0	69,647	3,417	3,362	3,088	3,085	27	1,100	239

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Table E2.–Page 3 of 10.

PANEL D: 1995 BROOD YEAR																		
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_i	SE[r_i]
Traditional seine	District 110	1998	1.1	1	7	28	4	63	0	63	8	8	8	8	1	10	9
Terminal seine	District 112-22	1998	1.1	1	7	27	4	1,833	0	812	76	76	74	74	1	21	21
Traditional troll	SE Quadrant	1999	1.2	1	7	3	3	2,015	0	1,410	80	80	77	77	1	14	13
Traditional troll	SW Quadrant	1999	1.2	1	7	3	3	7,861	0	5,043	159	158	143	143	1	15	14
Traditional troll	SE Quadrant	1999	1.2	1	7	4	3	340	0	295	33	33	30	30	3	33	18
Traditional troll	NW Quadrant	1999	1.2	1	7	5	3	16,299	0	7,072	616	612	575	574	4	88	43
Traditional set gillnet	Kodiak	1999	1.2	1	7	24	4	48	0	29	3	3	3	3	1	16	15
Private non-profit	District 101-95	1999	1.2	1	7	27	3	187	0	86	5	5	5	5	1	21	20
Trawl	Gulf of Alaska	1999	1.2	1	1	1	3	30,600	0	6,175	145	145	145	145	2	94	66
Mixed net and seine	Area 000 CDFO	1999	1.2	1	7	27	3	2,426	0	755	12	12	10	10	1	31	30
Traditional troll	NE Quadrant	2000	1.3	1	7	1	3	1,671	0	905	53	53	47	47	1	18	17
Traditional troll	NW Quadrant	2000	1.3	1	7	1	3	14,898	0	4,534	331	331	313	313	2	62	43
Traditional troll	NW Quadrant	2000	1.3	1	7	3	3	45,953	0	18,283	966	955	856	853	3	73	41
Traditional troll	NW Quadrant	2000	1.3	1	7	4	3	11,618	0	5,023	323	320	297	296	2	45	31
Traditional troll	NW Quadrant	2000	1.3	1	7	5	3	23,605	0	8,848	751	732	679	678	5	130	57
Traditional troll	NW Quadrant	2000	1.3	1	7	6	3	5,497	0	2,858	239	236	228	228	2	37	25
Traditional troll	NW Quadrant	2000	1.3	1	7	7	3	10,157	0	3,354	286	286	263	263	5	144	63
Traditional troll	SE Quadrant	2000	1.3	1	7	4	3	344	0	244	19	19	19	19	1	13	13
Experimental troll	District 110-31	2000	1.3	1	7	24	5	199	0	170	17	17	16	16	1	11	11
Experimental troll	District 113-35	2000	1.3	1	7	26	5	2,186	0	672	48	48	45	45	1	31	30
Experimental troll	District 113-37	2000	1.3	1	7	26	5	141	0	18	4	4	4	4	1	74	74
Experimental troll	District 101-29	2000	1.3	1	7	25	5	148	0	148	10	10	10	10	1	10	9
Experimental troll	District 101-29	2000	1.3	1	7	26	5	627	0	613	44	44	42	42	1	10	9
Experimental troll	District 101-45	2000	1.3	1	7	23	5	81	0	81	10	10	10	10	1	10	9
Experimental troll	District 101-45	2000	1.3	1	7	24	5	136	0	136	11	11	10	10	1	10	9
Experimental troll	District 101-45	2000	1.3	1	7	25	5	472	0	300	24	24	22	22	1	15	14
Experimental troll	District 101-45	2000	1.3	1	7	26	5	458	0	273	32	31	27	27	2	33	23
Experimental troll	District 101-45	2000	1.3	1	7	27	5	641	0	641	66	66	59	59	1	10	9
Experimental troll	District 101-45	2000	1.3	1	7	29	5	83	0	67	11	10	8	8	1	13	12
Experimental troll	District 105-41	2000	1.3	1	7	25	5	89	0	89	14	14	13	13	1	10	9
Experimental troll	District 105-41	2000	1.3	1	7	26	5	63	0	63	4	4	4	4	1	10	9
Experimental troll	District 106-30	2000	1.3	1	7	25	5	29	0	26	2	2	2	2	1	11	10
Drift gill net	District 106	2000	1.3	1	7	26	4	215	0	71	9	9	5	5	3	86	49
Drift gill net	District 106	2000	1.3	1	7	28	4	237	0	184	14	14	13	13	1	12	12

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Table E2.–Page 4 of 10.

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
PANEL D: 1995 BROOD YEAR																	
Recreational DE	Ketchikan	2000	1.3	1	8	1	4	2,740	0	497	33	33	28	28	3	157	90
Recreational MB	Ketchikan	2000	1.3	1	8	2	4	8,032	0	624	55	54	47	47	1	125	124
Recreational MB	Sitka	2000	1.3	1	8	1	4	8,063	0	2,236	112	112	107	107	1	34	34
Recreational	Anchor Point	2000	1.3	4	2	10	4		0						1	38	25
Recreational	Area 002 CDFO	2000	1.3	3	5	5	3		0						1	20	20
Recreational	Area 001 CDFO	2000	1.3	3	5	6	3		0						1	64	64
Mixed net and seine	Area 003 CDFO	2000	1.3	1	7	26	3	3,994	0	1,429	9	8	8	8	1	30	29
Mixed net and seine	Area 003CDFO	2000	1.3	1	7	29	3	3,689	0	2,712	30	30	28	28	1	13	12
Traditional troll	NW Quadrant	2001	1.4	1	7	1	3	9,337	0	3,522	328	327	309	309	2	51	35
Traditional troll	SE Quadrant	2001	1.4	1	7	3	3	1,693	0	902	66	58	53	53	1	20	20
Experimental troll	District 101-29	2001	1.4	1	7	22	5	84	0	69	3	3	3	3	1	12	11
Experimental troll	District 101-29	2001	1.4	1	7	23	5	568	0	369	23	23	21	21	2	29	20
Experimental troll	District 101-29	2001	1.4	1	7	25	5	636	0	476	18	18	15	15	1	13	12
Experimental troll	District 101-29	2001	1.4	1	7	26	5	545	0	222	16	16	13	13	1	23	23
Experimental troll	District 101-45	2001	1.4	1	7	25	5	783	0	399	26	26	22	22	2	37	26
Experimental troll	District 108-30	2001	1.4	1	7	23	5	170	0	84	3	3	2	2	1	19	19
Experimental troll	District 108-30	2001	1.4	1	7	24	5	124	0	119	9	9	9	9	1	10	9
Experimental troll	District 109-51	2001	1.4	1	7	22	5	284	0	149	19	19	18	18	1	18	18
Experimental troll	District 113-62	2001	1.4	1	7	21	5	79	0	75	7	7	7	7	1	10	9
Experimental troll	District 113-62	2001	1.4	1	7	25	5	113	0	82	7	7	6	6	1	13	13
Experimental troll	District 113-95	2001	1.4	1	7	20	5	86	0	86	8	8	6	6	1	10	9
Experimental troll	District 113-95	2001	1.4	1	7	22	5	384	0	320	23	23	17	17	1	11	11
Private non-profit	District 101-95	2001	1.4	1	7	26	5	150	0	140	14	14	12	12	3	31	17
Traditional troll	Area 000 CDFO	2001	1.4	1	7	17	3	202	0	202	16	16	16	16	1	10	9
Recreational DE	Sitka	2001	1.4	1	2	11	4	591	0	591	31	31	31	31	1	10	9
Recreational DE	Ketchikan	2001	1.4	1	2	11	4	439	0	390	32	31	30	30	3	33	18
Recreational MB	Ketchikan	2001	1.4	1	2	12	4	829	95,632	143	22	21	18	18	1	58	57
Recreational	Ketchikan	2001	1.4	3	2	12	4		0						1	38	38
Recreational	Ketchikan	2001	1.4	3	2	13	4		0						1	38	38
Recreational MB	Anchor Point	2001	1.4	4	2	10	4		0						2	76	76
1995 Brood year total								224,835	95,632	85,179	5,335	5,279	4,888	4,882	96	2,266	284

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PANEL E: 1996 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_i	SE[r_i]
Terminal seine	District 112-22	1999	1.1	1	7	28	4	911	0	906	78	76	69	69	2	19	13
Traditional troll	SE Quadrant	2000	1.2	1	7	3	3	1,233	0	884	46	45	43	43	1	13	13
Traditional troll	SW Quadrant	2000	1.2	1	7	3	3	2,411	0	1,625	41	38	35	35	1	15	14
Traditional troll	NW Quadrant	2000	1.2	1	7	7	3	10,157	0	3,354	286	286	263	263	1	28	28
Experimental troll	District 114-27	2000	1.2	1	7	26	5	88	0	73	6	6	6	6	1	11	11
Experimental troll	District 101-29	2000	1.2	1	7	24	5	95	0	94	8	8	8	8	1	9	9
Experimental troll	District 101-29	2000	1.2	1	7	26	5	627	0	613	44	44	42	42	2	19	13
Experimental troll	District 101-45	2000	1.2	1	7	23	5	81	0	81	10	10	10	10	1	9	9
Experimental troll	District 101-45	2000	1.2	1	7	26	5	458	0	273	32	31	27	27	1	16	16
Drift gill net	District 101	2000	1.2	1	7	27	4	265	0	99	8	8	5	5	1	25	24
Drift gill net	District 106	2000	1.2	1	7	27	4	298	0	224	23	23	20	20	1	12	12
Drift gill net	District 106	2000	1.2	1	7	28	4	237	0	184	14	14	13	13	1	12	11
Drift gill net	District 106	2000	1.2	1	7	29	4	277	0	123	14	14	13	13	1	21	20
Private non-profit	District 101-95	2000	1.2	1	7	28	5	267	0	214	24	24	22	22	1	12	11
Recreational MB	Ketchikan	2000	1.2	1	8	2	4	8,032	0	624	55	54	47	47	3	366	210
Recreational DE	Sitka	2000	1.2	1	8	1	4	8,063	0	2,236	112	112	107	107	1	34	33
Trawl	Gulf of Alaska	2000	1.2	1	1	1	2	26,676	0	6,589	84	84	84	84	2	75	53
Mixed net and seine	Area 004 CDFO	2000	1.2	1	7	27	3	5,700	0	1,469	15	15	13	13	1	36	36
Experimental troll	District 113-41	2001	1.3	1	7	20	5	319	0	177	11	11	10	10	1	17	16
Experimental troll	District 113-95	2001	1.3	1	7	25	5	551	0	402	30	30	28	28	1	13	12
Experimental troll	District 114-21	2001	1.3	1	7	24	5	200	0	110	6	6	5	5	1	17	16
Experimental troll	District 101-21	2001	1.3	1	7	26	5	27	0	27	3	3	3	3	1	9	9
Experimental troll	District 101-29	2001	1.3	1	7	23	5	568	0	369	23	23	21	21	7	100	37
Experimental troll	District 101-29	2001	1.3	1	7	25	5	636	0	476	18	18	15	15	2	25	17
Experimental troll	District 101-29	2001	1.3	1	7	26	5	545	0	222	16	16	13	13	1	23	22
Experimental troll	District 101-45	2001	1.3	1	7	22	5	85	0	54	7	7	7	7	1	15	14
Experimental troll	District 101-45	2001	1.3	1	7	23	5	52	0	36	3	3	3	3	1	13	13
Experimental troll	District 101-45	2001	1.3	1	7	24	5	811	0	286	28	28	28	27	2	55	38
Experimental troll	District 101-45	2001	1.3	1	7	25	5	783	0	399	26	26	22	22	2	37	25
Experimental troll	District 101-45	2001	1.3	1	7	28	5	254	0	257	21	21	19	19	1	9	9
Experimental troll	District 105-41	2001	1.3	1	7	20	5	78	0	57	2	2	1	1	1	13	12
Traditional troll	NW Quadrant	2001	1.3	1	7	3	3	54,077	0	24,142	1,387	1,378	1,252	1,247	3	63	36
Traditional troll	SE Quadrant	2001	1.3	1	7	3	3	1,693	0	902	66	58	53	53	1	20	19
Traditional troll	SW Quadrant	2001	1.3	1	7	3	3	8,269	0	5,980	231	212	191	191	2	28	19
Traditional troll	SE Quadrant	2001	1.3	1	7	4	3	1,001	0	792	84	83	72	72	1	12	11

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Table E2.–Page 6 of 10.

PANEL E: 1996 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_i	SE[r_i]
Traditional troll	Area 000 CDFO	2001	1.3	1	7	19	3	226	0	226	13	13	13	12	1	10	10
Mixed net and seine	Area 003 CDFO	2001	1.3	1	7	26	3	4,485	0	1,486	27	26	24	24	1	29	29
Drift gill net	District 106	2001	1.3	1	7	25	4	336	0	147	10	10	7	7	1	21	21
Drift gill net	District 101MIC	2001	1.3	1	7	26	4	1,037	0	249	14	14	13	13	1	39	38
Recreational DE	Sitka	2001	1.3	1	2	11	4	591	0	591	31	31	31	31	1	9	9
Recreational DE	Ketchikan	2001	1.3	1	2	11	4	439	0	390	32	31	30	30	3	32	18
Recreational DT	Ketchikan	2001	1.3	1	2	12	4	56	786	14	1	1	1	1	1	37	37
Recreational MB	Ketchikan	2001	1.3	1	2	12	4	829	95,632	143	22	21	18	18	3	169	97
Recreational MB	Ketchikan	2001	1.3	1	2	13	4	1,567	56,236	413	48	46	42	42	3	110	63
Recreational MB	Ketchikan	2001	1.3	1	2	14	4	1,438	226,515	305	33	33	29	29	1	44	43
Recreational MB	Craig	2001	1.3	1	2	14	4	1,117	0	268	7	7	7	7	1	39	38
Recreational DE	Juneau	2001	1.3	1	2	17	4	200	0	200	13	13	12	12	1	9	9
Recreational	Ketchikan	2001	1.3	3	2	21	4		0						1	37	37
Traditional troll	NW Quadrant	2002	1.4	1	7	1	3	8,378	0	1,886	310	310	256	256	2	83	58
Traditional troll	NW Quadrant	2002	1.4	1	7	3	3	129,680	0	43,374	2,801	2,771	2,052	2,049	2	56	39
Experimental troll	District 109-62	2002	1.4	1	7	22	5	20	0	19	2	2	2	2	1	10	9
Experimental troll	District 113-41	2002	1.4	1	7	24	5	707	0	297	17	17	13	13	1	22	22
Experimental troll	District 113-95	2002	1.4	1	7	21	5	671	0	549	21	21	18	18	1	11	11
Experimental troll	District 114-27	2002	1.4	1	7	17	5	25	0	25	1	1	1	1	1	9	9
Experimental troll	District 114-50	2002	1.4	1	7	24	5	476	0	376	25	24	19	19	1	12	12
Experimental troll	District 101-21	2002	1.4	1	7	24	5	214	0	96	9	9	7	7	1	21	20
Experimental troll	District 101-21	2002	1.4	1	7	25	5	680	0	432	45	45	33	33	1	15	14
Experimental troll	District 101-29	2002	1.4	1	7	21	5	299	0	206	14	14	11	11	1	14	13
Experimental troll	District 101-29	2002	1.4	1	7	22	5	471	0	404	28	28	27	27	1	11	10
Experimental troll	District 101-29	2002	1.4	1	7	23	5	1,307	0	857	63	62	61	61	5	72	31
Experimental troll	District 101-29	2002	1.4	1	7	25	5	351	0	155	9	9	8	8	1	21	21
Experimental troll	District 101-90	2002	1.4	1	7	23	5	72	0	72	8	8	8	8	2	19	12
Experimental troll	District 106-30	2002	1.4	1	7	21	5	8	0	8	1	1	1	1	1	9	9
Terminal troll	SE Quadrant	2002	1.4	1	7	24	4	27	0	27	2	2	2	2	1	9	9
Private non-profit	District 101-95	2002	1.4	1	7	26	5	3,032	0	540	60	60	52	52	1	52	52
Traditional troll	Area 005 CDFO	2002	1.4	1	7	21	3	15,656	0	3,609	403	403	392	390	1	41	40
Recreational MB	Craig	2002	1.4	1	2	11	4	789	0	121	8	8	7	7	2	121	85
Recreational DE	Ketchikan	2002	1.4	1	2	10	4	261	0	231	19	19	15	15	1	11	10
Recreational DE	Ketchikan	2002	1.4	1	2	11	4	793	0	723	72	71	64	63	7	74	26
Recreational MB	Ketchikan	2002	1.4	1	2	12	4	1,846	155,036	325	33	33	27	27	1	53	52
Recreational DE	Sitka	2002	1.4	1	2	11	4	467	0	467	36	36	34	33	1	10	9
1996 brood year total								314,376	534,205	113,584	7,100	7,017	5,907	5,893	108	2,543	327

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PANEL F: 1997 BROOD YEAR

Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Traditional troll	NW Quadrant	2001	1.2	1	7	3	3	54,077	0	24,142	1,387	1,378	1,252	1,247	1	30	29
Traditional troll	NW Quadrant	2001	1.2	1	7	4	3	28,528	0	10,776	986	975	880	876	1	35	35
Traditional troll	SE Quadrant	2001	1.2	1	7	4	3	1,001	0	792	84	83	72	72	1	17	16
Recreational DE	Ketchikan	2001	1.2	1	2	12	4	311	0	269	34	34	31	31	1	15	15
Traditional troll	NE Quadrant	2002	1.3	1	7	1	3	1,985	0	761	57	57	50	50	2	68	47
Traditional troll	NW Quadrant	2002	1.3	1	7	3	3	129,680	0	43,374	2,801	2,771	2,052	2,049	1	39	39
Traditional troll	SW Quadrant	2002	1.3	1	7	3	3	51,881	0	33,852	1,412	1,392	1,099	1,093	1	20	20
Traditional troll	NW Quadrant	2002	1.3	1	7	5	3	16,581	0	4,504	929	928	630	628	1	48	48
Experimental troll	District 113-01	2002	1.3	1	7	21	5	78	0	78	3	3	3	3	1	13	13
Experimental troll	District 113-95	2002	1.3	1	7	20	5	534	0	494	23	23	19	19	1	14	14
Experimental troll	District 101-29	2002	1.3	1	7	24	5	1,088	0	546	35	33	29	29	2	55	38
Experimental troll	District 101-29	2002	1.3	1	7	25	5	351	0	155	9	9	8	8	1	30	29
Experimental troll	District 101-90	2002	1.3	1	7	23	5	72	0	72	8	8	8	8	1	13	13
Private non-profit	District 101-95	2002	1.3	1	7	26	5	3,032	0	540	60	60	52	52	1	73	73
Traditional troll	Area 001 CDFO	2002	1.3	1	7	23	3	15,546	0	3,593	148	148	132	131	1	57	56
Recreational	Homer	2002	1.3	4	2	10	4		0						1	52	52
Recreational DE	Ketchikan	2002	1.3	1	2	10	4	261	0	231	19	19	15	15	2	29	20
Recreational DE	Ketchikan	2002	1.3	1	2	11	4	793	0	723	72	71	64	63	3	44	25
Recreational MB	Ketchikan	2002	1.3	1	2	13	4	1,744	89,176	454	28	28	28	28	1	50	50
Recreational MB	Ketchikan	2002	1.3	1	2	14	4	1,080	35,457	192	15	15	13	13	1	73	73
Traditional troll	NW Quadrant	2003	1.4	1	7	1	3	26,879	0	5,317	1,179	1,156	633	633	1	67	67
Experimental troll	District 109-51	2003	1.4	1	7	19	5	212	0	105	11	11	11	11	1	26	26
Experimental troll	District 114-50	2003	1.4	1	7	23	5	150	0	122	10	10	10	10	2	32	22
Experimental troll	District 101-29	2003	1.4	1	7	25	5	1,002	0	639	52	48	45	45	2	44	31
Experimental troll	District 101-29	2003	1.4	1	7	26	5	1,044	0	922	72	70	55	55	2	30	21
Experimental troll	District 101-45	2003	1.4	1	7	24	5	179	0	113	10	10	10	10	1	21	20
Experimental troll	District 102-50	2003	1.4	1	7	23	5	182	0	186	12	12	10	10	1	13	12
Recreational MB	Wrangell	2003	1.4	1	2	10	4	545	0	86	4	4	3	3	1	83	82
Recreational DE	Sitka	2003	1.4	1	2	11	4	419	0	419	19	19	17	17	1	13	13
Recreational MB	Sitka	2003	1.4	1	2	11	4	2,782	237,329	487	24	24	24	24	1	74	74
Traditional troll	Area 001 CDFO	2003	1.4	1	7	20	3	10,368	0	1,194	51	51	50	50	1	113	113
Experimental troll	District 101-29	2004	1.5	1	7	25	5	1,244	0	714	44	43	36	36	1	23	23
1997 brood year total								353,628	361,962	135,852	9,598	9,493	7,341	7,319	40	1,317	255

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Table E2.–Page 8 of 10.

PANEL G: 1998 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	*H*	var[*H*]	n_i	*a*	*a'*	*t*	*t'*	m_{ij}	r_j	SE[r_j]
Recreational MB	Ketchikan	2001	1.1	1	2	14	4	44	348	8	2	2	1	1	1	59	58
Traditional troll	NW Quadrant	2002	1.2	1	7	4	3	61,395	0	21,787	2,083	2,057	1,444	1,438	1	31	30
Traditional troll	SE Quadrant	2002	1.2	1	7	3	3	3,870	0	1,676	146	146	118	117	1	25	24
Traditional troll	SE Quadrant	2002	1.2	1	7	4	3	2,073	0	1,236	115	114	92	92	3	54	30
Experimental troll	District 101-29	2002	1.2	1	7	23	5	1,307	0	857	63	62	62	61	1	17	16
Drift gill net	District 101MIC	2002	1.2	1	7	25	4	397	0	183	12	12	12	12	2	46	32
Recreational MB	Ketchikan	2002	1.2	1	2	12	4	1,846	155,036	325	33	33	27	27	1	61	60
Recreational DE	Sitka	2002	1.2	1	2	11	4	467	0	467	36	36	34	33	1	11	11
Experimental troll	District 109-62	2003	1.3	1	7	22	5	268	0	46	5	5	5	5	1	62	62
Traditional troll	NW Quadrant	2003	1.3	1	7	3	3	187,173	0	52,928	3,003	2,947	2,199	2,167	1	39	39
Traditional troll	SW Quadrant	2003	1.3	1	7	3	3	37,330	0	20,596	982	961	708	695	1	20	20
Traditional troll	NW Quadrant	2003	1.3	1	7	5	3	8,935	0	2,875	410	408	222	219	1	34	33
Experimental troll	District 113-31	2003	1.3	1	7	21	5	300	0	140	10	10	8	8	1	23	22
Experimental troll	District 113-35	2003	1.3	1	7	25	5	1,465	0	201	12	12	9	9	1	78	77
Experimental troll	District 101-45	2003	1.3	1	7	27	5	327	0	169	20	20	20	20	1	21	20
Experimental troll	District 102-50	2003	1.3	1	7	23	5	182	0	186	12	12	10	10	1	10	10
Experimental troll	District 102-50	2003	1.3	1	7	26	5	168	0	171	11	11	7	7	1	11	10
Experimental troll	District 108-30	2003	1.3	1	7	19	5	10	0	2	1	1	1	1	1	53	53
Experimental troll	District 108-30	2003	1.3	1	7	22	5	179	0	104	6	6	6	6	1	18	18
Recreational MB	Ketchikan	2003	1.3	1	2	11	4	235	5,486	41	2	2	2	2	1	61	61
Recreational DE	Ketchikan	2003	1.3	1	2	11	4	562	0	508	44	42	39	39	1	12	12
Recreational MB	Ketchikan	2003	1.3	1	2	12	4	1,722	202,928	394	35	35	30	30	2	93	65
Recreational	Homer	2003	1.3	3	2	12	4		0						1	43	43
Recreational MB	Ketchikan	2003	1.3	1	2	13	4	2,503	571,144	453	33	31	30	30	2	126	88
Recreational MB	Sitka	2003	1.3	1	2	17	4	2,316	249,524	651	50	50	35	35	1	38	38
Traditional troll	NW Quadrant	2004	1.4	1	7	5	3	9,672	0	2,510	354	354	210	209	1	41	41
Experimental troll	District 113-35	2004	1.4	1	7	26	5	2,132	0	714	48	47	39	39	1	33	32
Experimental troll	District 113-95	2004	1.4	1	7	19	5	313	0	245	7	7	6	6	1	14	13
Experimental troll	District 109-51	2004	1.4	1	7	18	5	151	0	89	11	11	10	10	1	18	18
Experimental troll	District 105-51	2004	1.4	1	7	22	5	125	0	88	5	5	4	4	1	15	15
Experimental troll	District 101-29	2004	1.4	1	7	23	5	932	0	513	41	38	34	34	1	21	20
Experimental troll	District 101-29	2004	1.4	1	7	25	5	1,244	0	714	44	43	36	36	1	19	19
Experimental troll	District 101-29	2004	1.4	1	7	26	5	1,079	0	883	53	53	46	46	1	13	13
Experimental troll	District 107-10	2004	1.4	1	7	24	5	40	0	40	4	4	4	4	1	11	10
Trawl	Bering Sea	2004	1.4	1	1	1	2	51,134	0	28,783	9	9	9	9	1	19	18
Recreational	Ketchikan	2004	1.4	3	2	13	4		0						3	128	128
Recreational DE	Ketchikan	2004	1.4	1	2	11	4	880	0	744	63	61	58	58	1	13	13
Recreational DE	Ketchikan	2004	1.4	1	2	12	4	368	0	325	27	24	22	22	1	14	13
1998 brood year total								385,918	1,184,466	143,777	7,942	7,815	5,721	5,663	56	1,571	267

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PANEL H: 1999 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Experimental troll	District 114-50	2003	1.2	1	7	25	5	322	0	214	11	11	9	9	1	14	13
Recreational MB	Ketchikan	2003	1.3	1	2	12	4	1,722	202,928	394	35	35	30	30	1	40	39
Mixed net and seine	Area 003 CDFO	2003	1.3	1	7	28	3	703	0	471	17	17	17	17	1	14	13
Traditional troll	NW Quadrant	2004	1.4	1	7	3	3	138,726	0	33,927	2,002	1,965	1,502	1,487	1	38	38
Traditional troll	NW Quadrant	2004	1.4	1	7	5	3	9,672	0	2,510	354	354	210	209	1	35	35
Experimental troll	District 101-29	2004	1.4	1	7	23	5	932	0	513	41	38	34	34	1	18	17
Experimental troll	District 101-29	2004	1.4	1	7	27	5	715	0	373	31	31	31	31	1	17	17
Experimental troll	District 102-50	2004	1.4	1	7	27	5	79	0	74	4	4	3	3	1	10	9
Drift gill net	District 101MIC	2004	1.4	1	7	25	4	112	0	42	2	2	2	2	1	24	24
Drift gill net	District 106	2004	1.4	1	7	26	4	465	0	133	7	7	7	7	1	32	31
Drift gill net	District 106	2004	1.4	1	7	27	4	801	0	22	4	4	4	4	1	332	331
Recreational DE	Ketchikan	2004	1.4	1	2	11	4	880	202,928	744	63	61	58	58	1	11	11
Recreational MB	Sitka	2004	1.4	1	2	12	4	6,826	651,330	1,089	45	42	39	39	1	61	61
1999 brood year total								161,955	1,057,186	40,506	2,616	2,571	1,946	1,930	13	646	347

PANEL I: 2000 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Traditional seine	District 106	2003	1.1	1	7	32	4	136	0	136	18	18	13	13	1	14	13
Experimental troll	District 109-51	2004	1.2	1	7	19	5	178	0	37	4	4	4	4	1	65	65
Traditional troll	NE Quadrant	2004	1.2	1	7	3	3	4,423	0	1,619	106	105	87	87	1	37	37
Traditional troll	SE Quadrant	2004	1.2	1	7	5	3	1,413	0	594	38	38	35	35	1	32	32
Traditional troll	NW Quadrant	2004	1.2	1	7	5	3	9,672	0	2,510	354	354	210	209	1	52	52
Experimental troll	District 101-29	2004	1.2	1	7	27	5	715	0	373	31	31	31	31	1	26	25
Experimental troll	District 106-30	2004	1.2	1	7	25	5	95	0	80	8	8	8	8	1	16	16
Experimental troll	District 107-10	2004	1.2	1	7	24	5	40	0	40	4	4	4	4	1	14	13
Experimental troll	District 107-10	2004	1.2	1	7	26	5	20	0	20	1	1	1	1	1	14	13
Drift gill net	District 101	2004	1.2	1	7	26	4	560	0	586	26	26	20	20	1	13	12
Drift gill net	District 101	2004	1.2	1	7	28	4	316	0	323	9	9	9	9	1	13	13
Drift gill net	District 106	2004	1.2	1	7	25	4	195	0	73	4	4	4	4	1	36	36
Drift gill net	District 106	2004	1.2	1	7	28	4	287	0	20	2	2	2	2	1	194	193
Drift gill net	District 108	2004	1.2	1	7	25	4	1,897	0	371	6	6	6	6	1	69	69
Test fishery	District 113	2004	1.2	1	7	33	4	26	0	26	4	4	4	4	1	14	13
Recreational MB	Ketchikan	2004	1.2	1	2	15	4	215	6,556	94	10	10	7	7	1	31	30
2000 brood year total								20,188	6,556	6,902	625	624	445	444	16	639	235

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PANEL J: 2001 BROOD YEAR																	
Fishery description	Fishery location	Year	Age	Sample type	Sampling period type	Sampling period	Estimation level	H	var[H]	n_i	a	a'	t	t'	m_{ij}	r_j	SE[r_j]
Traditional seine	District 110	2004	1.1	1	7	30	4	126	0	126	28	28	27	27	1	5	5
Test fishery	District 113	2004	1.1	1	7	45	4	8	0	8	2	2	1	1	1	5	5
2001 brood year total								134	0	134	30	30	28	28	2	10	7

Table E3.–Estimated marine harvest of Chinook salmon of Unuk River origin (1992–2001 brood years) by return year and gear, 1995–2004. Standard errors are in italics beneath estimates.

Return	Age	Gear type							
year	classes	Troll[a]	Recreational[b]	Drift gill net[c]	Purse seine[d]	PNP[e]	Trawl	Other[f]	Total
1995	1.1				35				35
					35				*35*
1996	1.1-1.2			81					81
				80					*80*
1997	1.1-1.3	361		140					501
		169		*77*					*185*
1998	1.1-1.4	433	242		31		43		749
		123	*167*		*23*		*43*		*213*
1999	1.1-1.5	505	823	38	19	21	94	83	1,583
		124	*238*	*26*	*13*	*20*	*66*	*49*	*283*
2000	1.1-1.5	1,069	1,028	169		12	75	79	2,431
		167	*296*	*62*		*11*	*53*	*48*	*352*
2001	1.1-1.5	845	814	60		31		29	1,779
		122	*189*	*44*		*17*		*29*	*232*
2002	1.1-1.5	919	589	46		125			1,680
		158	*122*	*32*		*89*			*245*
2003	1.1-1.5	895	584		14			14	1,506
		165	*182*		*13*			*13*	*271*
2004	1.1-1.5	583	258	713	5		19	19	1,597
		137	*147*	*394*	*5*		*18*	*14*	*443*
Total		5,610	4,338	1,246	104	188	232	223	11,942
		415	*526*	*418*	*46*	*94*	*96*	*77*	*821*
Percent		47.0	36.3	10.4	0.9	1.6	1.9	1.9	100.0

[a] Includes all troll fisheries regardless of location, excepting PNP (see footnote f below).

[b] Includes all recreational fisheries regardless of location.

[c] Does not include Canadian drift gillnet fisheries, in which recoveries are grouped with purse seine fisheries.

[d] Does not include Canadian purse seine fisheries, in which recoveries are grouped with drift gillnet fisheries.

[e] Gear type is not known for PNP fisheries and may include troll, drift gillnet, and/or purse seine.

[f] Includes test fisheries, set gill net and Canadian mixed net and seine.

Table E4.–Chinook salmon harvest H and the estimated contribution of fish bound to the Unuk River $\hat{r}$ to selected Southeast Alaska marine fisheries, by return year and Quadrant, 1998–2004.

	Year																
	1998		1999		2000		2001		2002		2003		2004		Mean 1998–2004		
Fishery	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	Percent
PANEL A: SOUTHEAST QUADRANT																	
Winter troll 1[a]	135		448		185		550		1,162		1,185		1,413	32	725	5	0.6
Experimental troll[b]	1,057	35	1,843	105	4,962	241	7,175	442	7,715	295	7,075	374	11,607	201	5,919	242	4.1
Summer troll 1[c]	4,115		2,015	14	1,233	13	1,693	40	3,870	25	8,939		11,727		4,799	13	0.3
Summer troll 2[de]	626		340	33	997	13	1,001	29	2,073	54			1,659		957	18	1.9
Terminal troll	203	13	305		1,550		2,086		1,012	9	650		287		870	3	0.4
Ketchikan recreational	4,386		9,816	570	10,890	791	5,608	671	7,211	395	7,162	333	6,853	197	7,418	423	5.7
Wrangell recreational	795		2,617		2,557		1,955		1,375		2,105	83	1,805		1,887	12	0.6
Petersburg recreational	1,155		2,607	45	1,492		1,853		2,414		1,519		1,691		1,819	6	0.4
District 101 gillnet	1,098		1,844	38	1,183	25	1,379		828		677		1,998	26	1,287	13	1.0
MIC gillnet[f]	270		729		2,560		3,447	39	1,268	46	692		1,523	24	1,498	16	1.0
District 106 gillnet	518		518		1,220	144	1,057	21	446		422		2,735	594	988	108	11.0
District 108 gillnet	460		1,049		1,671		7		25		312		7,410	69	1,562	10	0.6
District 101-95 PNP[g]	269		1,585	21	2,261	12	9,593	31	6,992	125	6,353		8,336		5,056	27	0.5
SE subtotal	15,087	49	25,716	825	32,761	1,239	37,404	1,273	36,391	950	37,091	789	59,044	1,144	34,785	895	2.8
PANEL B: SOUTHWEST QUADRANT																	
Summer troll 1[ce]	18,782		7,861	15	2,411	15	8,269	28	51,881	20	7,330		39,143		23,668	11	<0.0
Craig recreational	9,088		7,184	64	5,435		6,965	39	11,133	121	8,234		13,403		8,777	32	0.4
SW subtotal	27,870		15,045	79	7,846	15	15,234	67	63,014	142	45,564		52,546		32,446	43	0.1
PANEL C: NORTHEAST QUADRANT																	
Winter troll 1[a]	875		2,159		1,617	42	891		1,985	68	1,555		4,235		1,902	16	0.8
Winter troll 2[h]	930	21	672		646		370		844		2,130		1,513		1,015	3	0.3
Experimental troll[b]	10,314		7,212		4,219	11	7,240	18	4,183	10	9,231	89	9,482	98	7,412	32	0.4
Summer troll 1[c]	19,323	43	1,045		1,171		815	63	1,572		7,131	20	4,423	37	5,069	23	0.5
Summer troll 2[de]	619	63	445		966		406		703				1,290		633	9	1.4
Juneau recreational	7,480	87	9,524		8,622		4,524	9	6,417		5,384		6,215		6,881	14	0.2
NE subtotal	39,541	213	21,057		17,241	53	14,246	91	15,704	78	25,431	109	27,158	136	22,911	97	0.4

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Table E4.–Page 2 of 2.

	Year																
	1998		1999		2000		2001		2002		2003		2004		Mean 1998–2004		
Fishery	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	Percent
PANEL D: NORTHWEST QUADRANT																	
Winter troll 1[a]	20,709	33	12,321	45	14,784	148	9,337	51	8,378	83	26,879	67	28,273		17,240	61	0.4
Winter troll 2[h]	12,915	47	16,299	88	10,160	172	16,155		16,581	48	8,935	34	9,672	129	12,960	74	0.6
Experimental troll[b]	7,824		9,274	55	11,809	130	13,777	90	25,712	82	19,146	159	33,985	46	17,361	80	0.5
Summer troll 1[c]	60,545	67	67,195	150	45,953	73	54,077	30	129,680	96	187,173	39	138,726	38	97,621	70	0.1
Summer troll 2[de]	34,340	110	15,377		40,717	212	28,528	35	61,395	31			38,607		31,281	55	0.2
Sitka recreational	24,547	155	28,548	69	18,888	115	20,779	19	24,834	21	24,124	126	31,358	61	24,725	81	0.3
NW subtotal	160,880	413	149,014	408	142,311	849	142,653	224	266,580	360	266,257	425	280,621	275	201,188	422	0.2

[a] Winter troll 1 open from January 1 through April 30, closes earlier if quota reached.

[b] Experimental troll fishery open during Period 2 in all years. In 2000 it was also open during period 3.

[c] Summer troll 1, first traditional summer troll fishery of each year, open during part or all of Period 3; first day of fishing is 1 July.

[d] Summer troll 2, includes all subsequent traditional summer troll openings.

[e] No Summer troll 2 fishery in 2003.

[f] Metlakatla Indian Community.

[g] Neets Bay private non-profit hatchery harvest, multiple commercial gears utilized.

[h] Winter troll 2 open from ~October 1 to December 31 (~statistical weeks 41–54).

Table E5.–Estimated total harvest H and contribution $\hat{r}$ of Unuk River Chinook salmon for selected Southeast Alaska experimental area troll fisheries, 1997–2004. Shaded areas indicate years in which a fishery was not open.

	Year																			
	1997		1998		1999		2000		2001		2002		2003		2004		Average 1999–2004[a]			
Experimental area	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	H	$\hat{r}$	Percent Unuk
District 101-21							111		27	9	923	35					354	15	4.2
District 101-29	211		352		683		1,273	48	2,015	225	4,010	219	2,712	210	5,612	138	2,718	140	5.1
District 101-45	530	106	608	35	379		1,880	163	3,155	166	876		1,693	58	1,579		1,594	65	4.1
District 101-90									117		157	32	9		158		110	8	7.2
District 102-50													697	34	617	10	657	22	3.3
District 105-41							489	19	644	13	843		872		971		764	6	0.8
District 106-30	184		22		137		431	11	370		284		350		472	16	341	4	1.3
District 107-10			5				86								96	38	91	19	20.7
District 107-20			52		128	36									48		88	18	20.2
District 108-30	135		14		405		417		585	29	323		742	72	602		512	17	3.3
District 109-51	5,036		1,340		1,177		880		1,626	18	2,376		2,316	26	1,931	98	1,718	24	1.4
District 109-62			283		2,012		985		1,352		125	10	5,044	62	5,799		2,553	12	0.5
District 110-31	1,507		435		1,192		771	11	642		216		130		413		561	2	0.3
District 113-01											4,299	13	2,464		1,682		2,815	4	0.2
District 113-31											1,323		1,635	23	2,052		1,670	8	0.5
District 113-35	9,839		4,471		4,543		3,954	31	4,674		7,914		4,756	78	10,075	33	5,986	24	0.4
District 113-37			151		565		660	74	730		3,129		1,013		1,351		1,241	12	1.0
District 113-41	2,702		417		1,365		3,610		2,135	17	2,282	22	2,892		5,604		2,981	6	0.2
District 113-62	3,389		1,054		735		697		701	23	1,095		931		4,302		1,410	4	0.3
District 113-95					702	55	690	13	2,468	34	1,484	25	1,165	12	1,687	14	1,366	26	1.9
District 114-21	568		181		165		104		617	17	71		146		28		189	3	1.5
District 114-27	466		157		574		1,040	11	941		513	9	282		697		675	3	0.5
District 114-50											2,463	12	1,505	46	1,944		1,971	19	1.0

[a] Average includes only those years a fishery was open.

Table E6.–Estimted marine harvest of Chinook salmon of Unuk River origin (1992–2001 brood years) by gear and harvest location, 1995–2004. Standard errors are in italics beneath estimates.

	Harvest location								
Fishery	Kodiak	Cook Inlet	Gulf of Alaska & Bering Sea	Northwest Quadrant[a]	Northeast Quadrant[a]	Southwest Quadrant[a]	Southeast Quadrant[a]	British Columbia	Total
Recreational		261		565	96	224	3,086	106	4,338
		110		*210*	*62*	*113*	*459*	*70*	*537*
Experimental troll				563	226		1,798		2,587
				143	*98*		*200*		*265*
Traditional troll				2,127	291	98	253	230	3,000
				284	*100*	*40*	*67*	*133*	*338*
Terminal troll							23		23
							16		*16*
Drift gillnet							1,246		1,246
							418		*418*
Purse seine					72		33		104
					42		*18*		*46*
Mixed net and seine								189	189
								74	*74*
Set gillnet	16								16
	15								*15*
Trawl			232						232
			96						*96*
PNP							188		188
							94		*94*
Test				19					19
				14					*14*
Total	16	261	232	3,274	685	322	6,627	525	11,942
	15	*110*	*96*	*381*	*159*	*120*	*663*	*168*	*821*
Percent	0.1	2.2	1.9	27.4	5.7	2.7	55.5	4.4	100

[a] Southeast Alaska

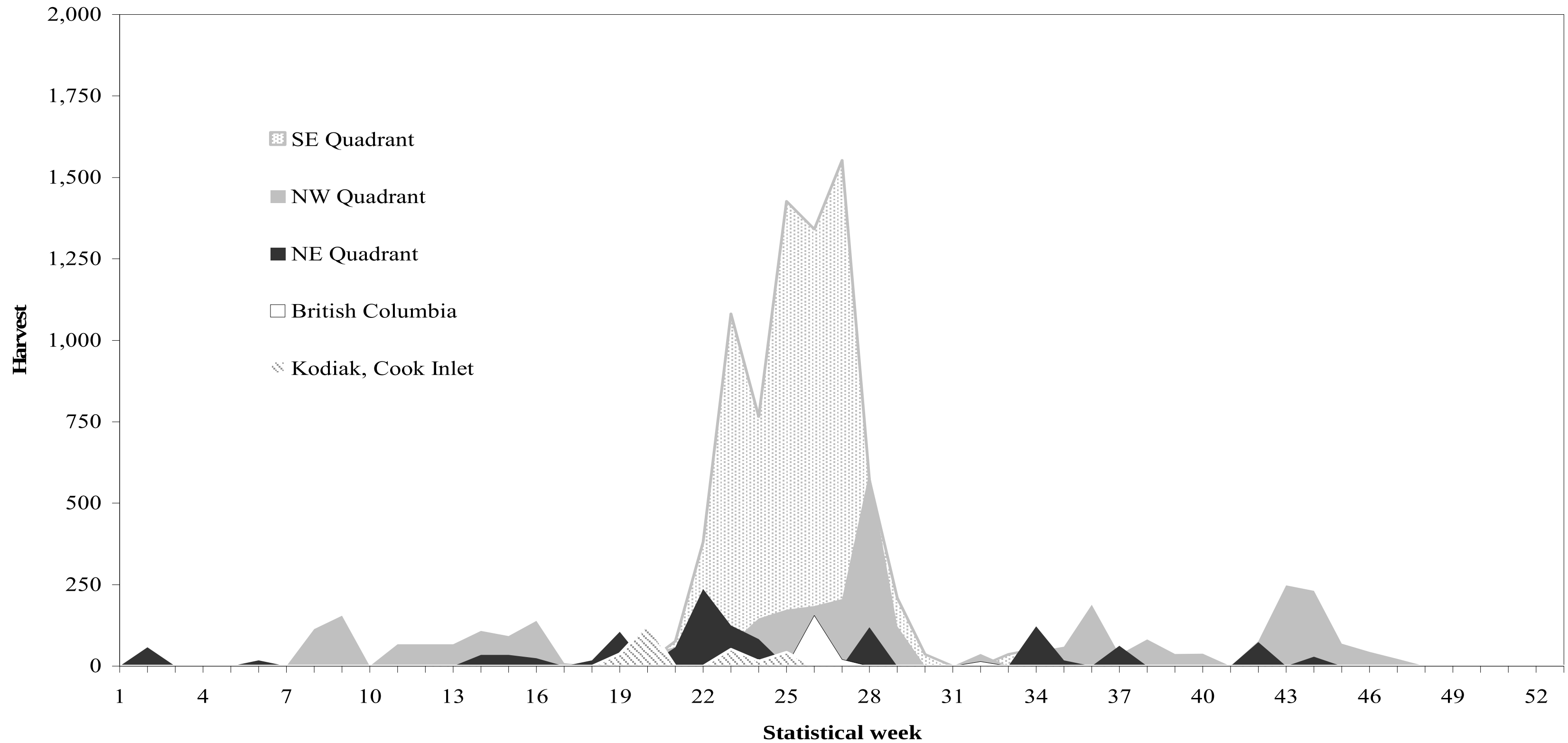

Figure.E1.–Total estimated marine harvest of Unuk River Chinook salmon (1992–2001 brood years) from 1995–2004 by statistical week and location. Does not include estimated harvests from trawl fisheries in the Gulf of Alaska or from the Southwest Quadrant of Southeast Alaska.

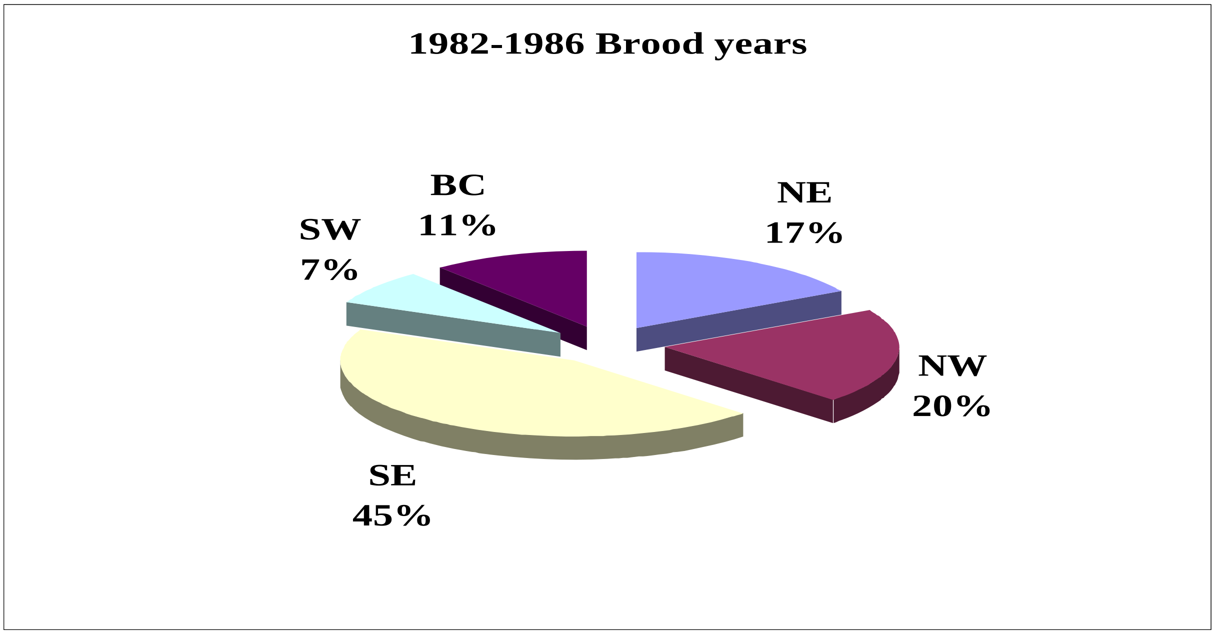

Figure E2.–Proportion of total estimated harvest of Unuk River Chinook salmon, brood years 1982–1986, by location. BC indicates British Columbia; NE, NW, SE, and SW denote the Northeast, Northwest, Southeast, and Southwest Quadrants in Southeast Alaska, respectively.

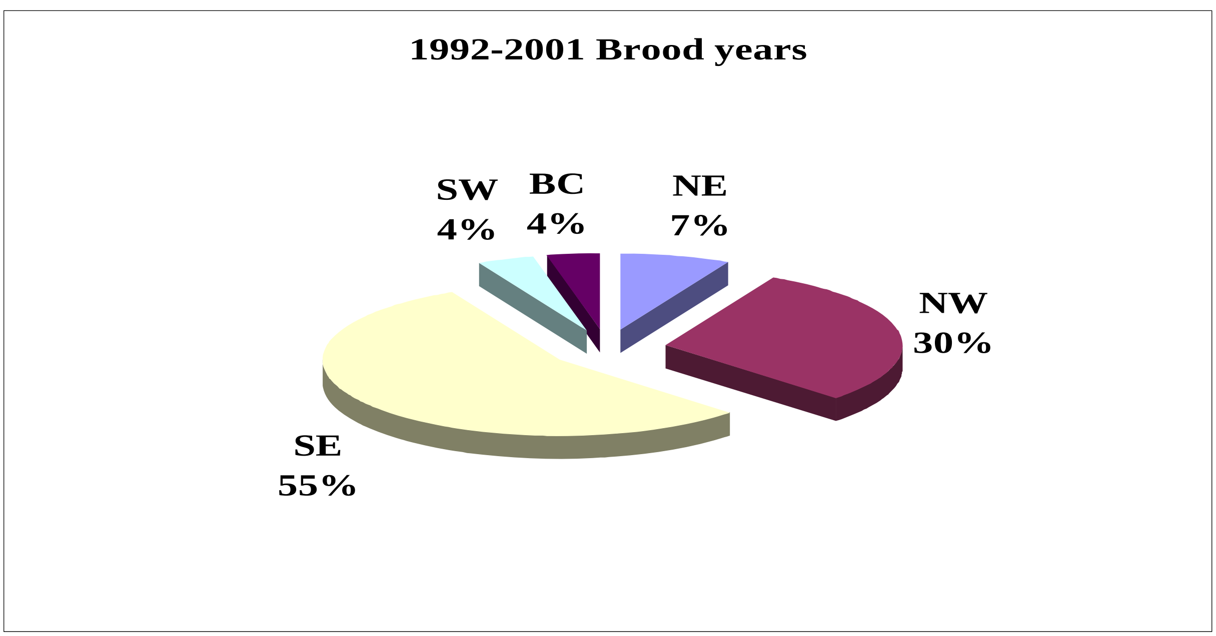

Figure E3.–Proportion of total estimated harvest of Unuk River Chinook salmon, brood years 1992–2001, by location. BC indicates British Columbia; NE, NW, SE, and SW denote the Northeast, Northwest, Southeast, and Southwest Quadrants in Southeast Alaska, respectively. Total harvest excludes harvest in locations other than these areas.

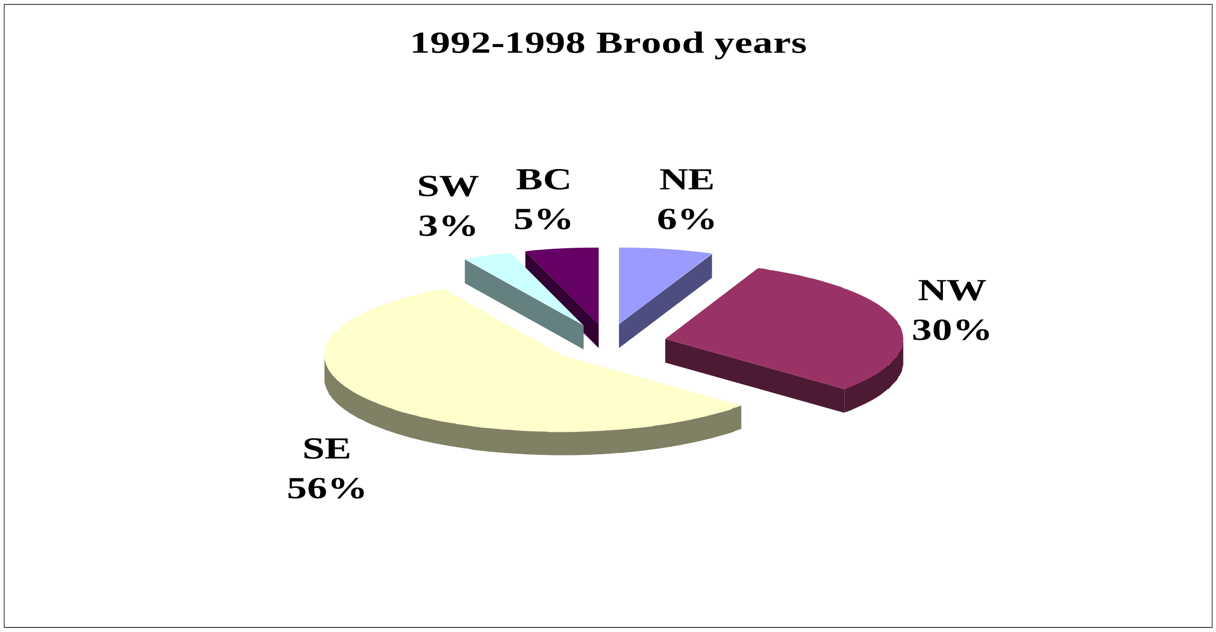

Figure E4.–Proportion of total estimated harvest of Unuk River Chinook salmon, brood years 1992–1998, by location. BC indicates British Columbia; NE, NW, SE, and SW denote the Northeast, Northwest, Southeast, and Southwest Quadrants in Southeast Alaska, respectively. Total harvest excludes harvest in locations other than these areas.

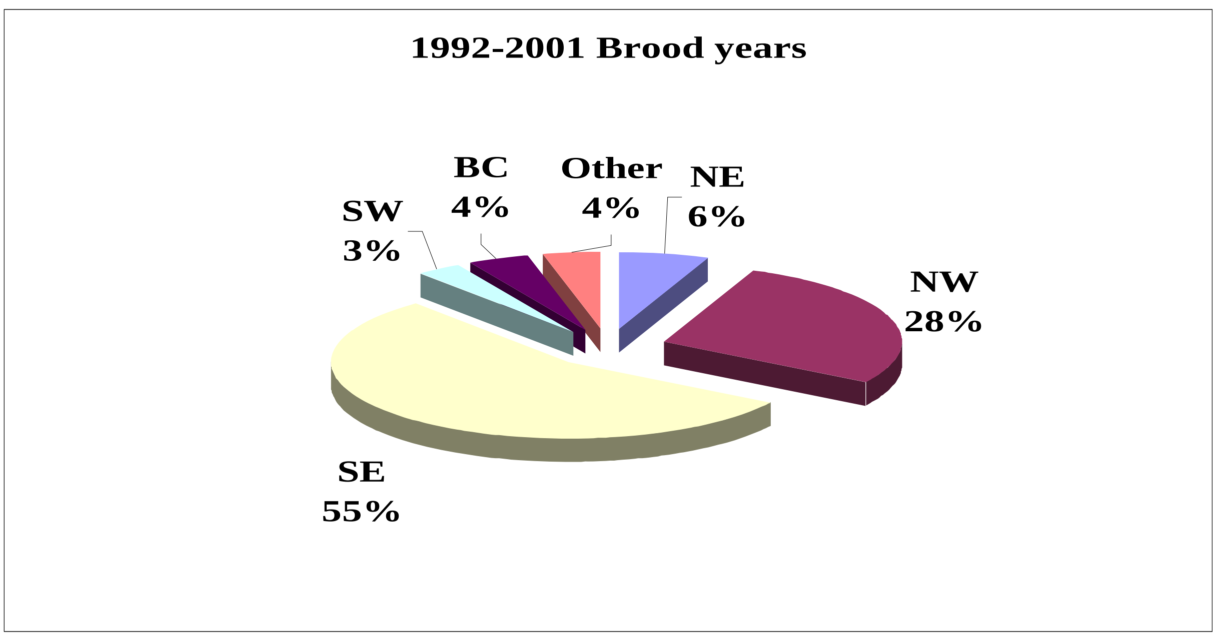

Figure E5.–Proportion of total estimated harvest of Unuk River Chinook salmon, brood years 1992–2001, by location. BC indicates British Columbia; NE, NW, SE, and SW denote the Northeast, Northwest, Southeast, and Southwest Quadrants in Southeast Alaska, respectively.

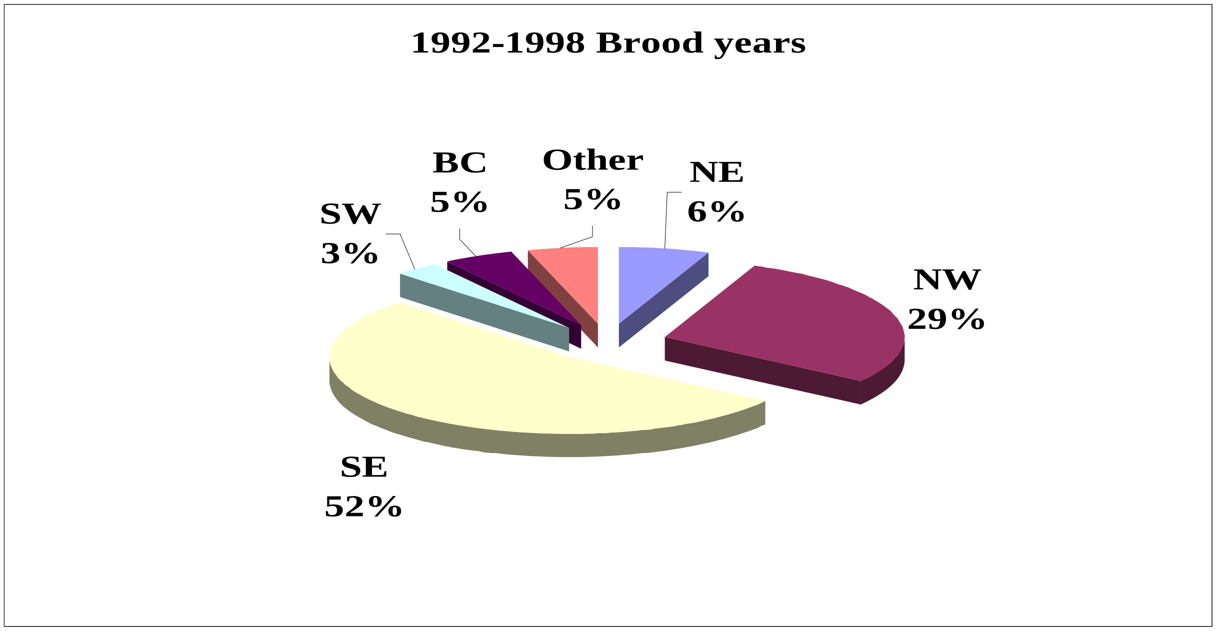

Figure E6.–Proportion of total estimated harvest of Unuk River Chinook salmon, brood years 1992–1998, by location. BC indicates British Columbia; NE, NW, SE, and SW denote the Northeast, Northwest, Southeast, and Southwest Quadrants in Southeast Alaska, respectively.