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Stock Assessment of Early-run Chinook Salmon of the Kenai River, 1999-2001

by

Timothy R. McKinley

March 2003

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

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

Spell out year, month, and week.

Physics and chemistry

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

General

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

Mathematics, statistics, fisheries

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

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ABSTRACT

The status of early-run chinook salmon *Oncorhynchus tshawytscha* of the Kenai River was assessed by coalescing information from creel surveys, inriver sonar project, educational harvests, inriver gillnetting project, and the Statewide Harvest Survey. In 1999, total return was an estimated 25,780 (SE = 370) chinook salmon, and spawning escapement was 17,276 (SE = 628) chinook salmon. In 2000, total return was 12,603 (SE = 234) and spawning escapement was 10,476 (SE = 329) chinook salmon. In 2001, total return was 16,874 (SE = 285) and spawning escapement was 14,075 (SE = 367) chinook salmon.

After incorporating 1999-2001 estimates, return-per-spawner for the 1986-1995 brood years ranged from 0.53 (SE = 0.28) to 3.89 (SE = 0.71). Sibling ratios averaged 5.09 (SD = 2.54) for age 5 to age 4, 2.33 (SD = 1.26) for age 6 to age 5, and 0.07 (SD = 0.05) for age 7 to age 6 chinook salmon.

Key words: Kenai River, chinook salmon, total return, spawning escapement, sibling ratios, brood tables, *Oncorhynchus tshawytscha*.

INTRODUCTION

Two stocks of chinook salmon *Oncorhynchus tshawytscha* return to the Kenai River (Figures 1 and 2) to spawn, both of which are highly prized by anglers for their size, relative to other chinook salmon stocks (Roni and Quinn 1995). An early run enters the river from late April through June, and a late run enters the river from late June through early August (Burger et al. 1985; Bendock and Alexandersdottir 1992). Early-run Kenai River chinook salmon migrate through Cook Inlet with stocks from other streams of the Kenai Peninsula (Anchor River, Deep Creek, Ninilchik River, Stariski Creek, and Kasilof River) and the Susitna River drainage (Figure 1). Early-run fish of the Kenai River are destined primarily for tributary spawning locations (Bendock and Alexandersdottir 1992) and are the focus of this report; late-run fish are destined almost exclusively for mainstem spawning locations and are the focus of a companion report.

Chinook salmon of Kenai River origin are harvested primarily in three fisheries. The first, a recreational marine fishery near Ninilchik Village along the eastern shore of Cook Inlet, probably accounts for the only significant marine harvest of early-run stocks. Second, an educational gillnet fishery operated in the Kenai River by the Kenaitze Indian tribe generally accounts for less than 200 fish annually (Nelson et al. 1999). Third, a major sport fishery occurs on the Kenai River itself. In addition, a subsistence gillnet fishery, established by the Board of Fisheries (BOF), harvested chinook salmon in Cook Inlet during 1992 and 1994. This fishery was prosecuted as a personal use fishery in 1995.

Prior to 1970, the sport fishery in the Kenai River comprised shorebased anglers targeting sockeye salmon *O. nerka* in July and coho salmon *O. kisutch* in August and early September. In 1973, large numbers of anglers began experimenting with a fishing method of bouncing brightly colored terminal gear along the river bottom from a drifting boat. This technique had been used effectively by anglers fishing for chinook salmon on rivers in the Pacific Northwest. It proved to be very effective for catching chinook salmon on the Kenai River, and the fishery expanded rapidly during the late 1970s and throughout the 1980s.

As fisheries targeting both the early and late runs of chinook salmon increased during the early 1980s, agency and public concerns about overexploitation began to grow. In 1988, the BOF adopted management plans for the early and late runs (McBride et al. 1989). These plans, in effect since 1989, define the early run as prior to 1 July and the late run as after 30 June. The

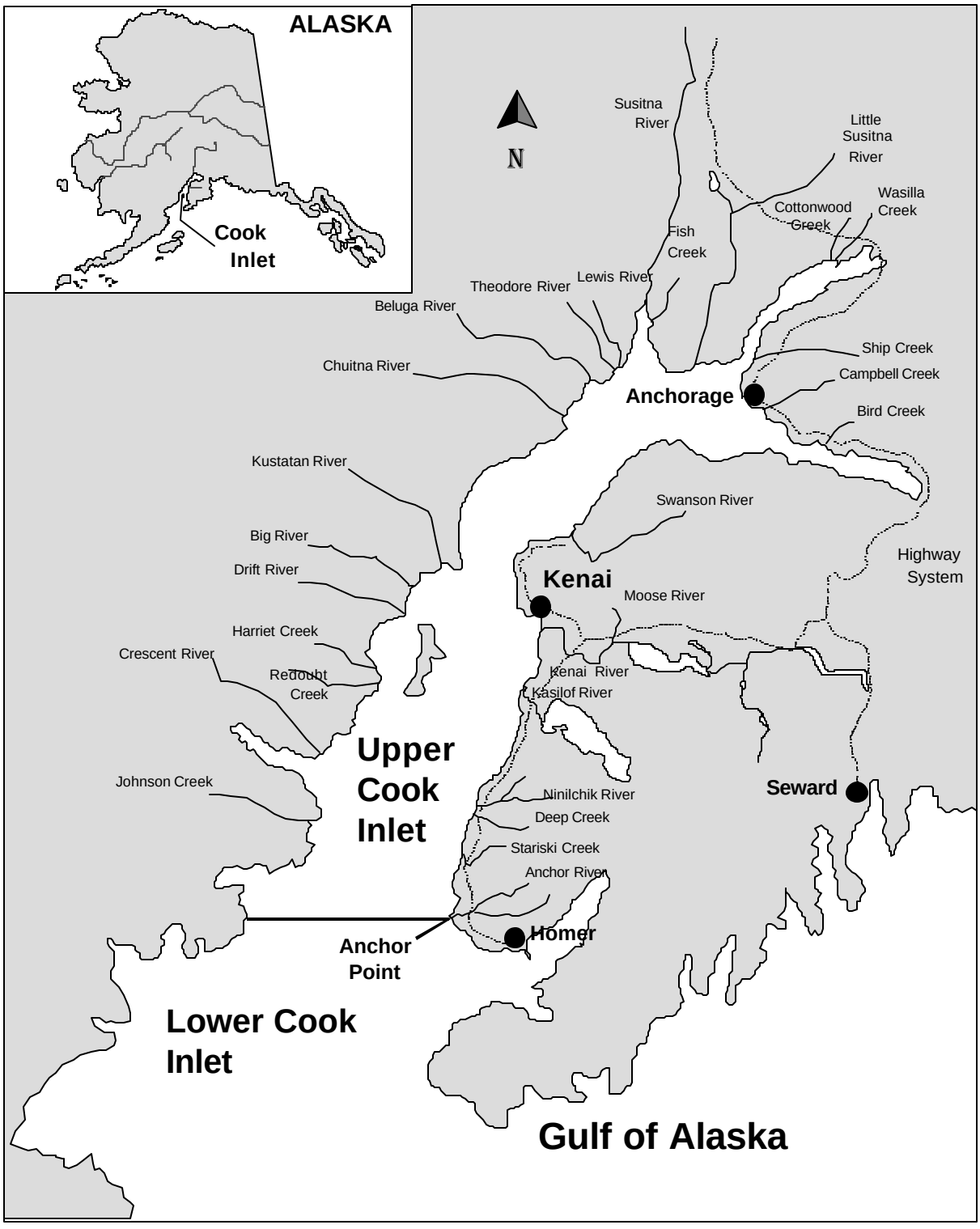

Figure 1.-Location of the Kenai River and other rivers of the Cook Inlet area.

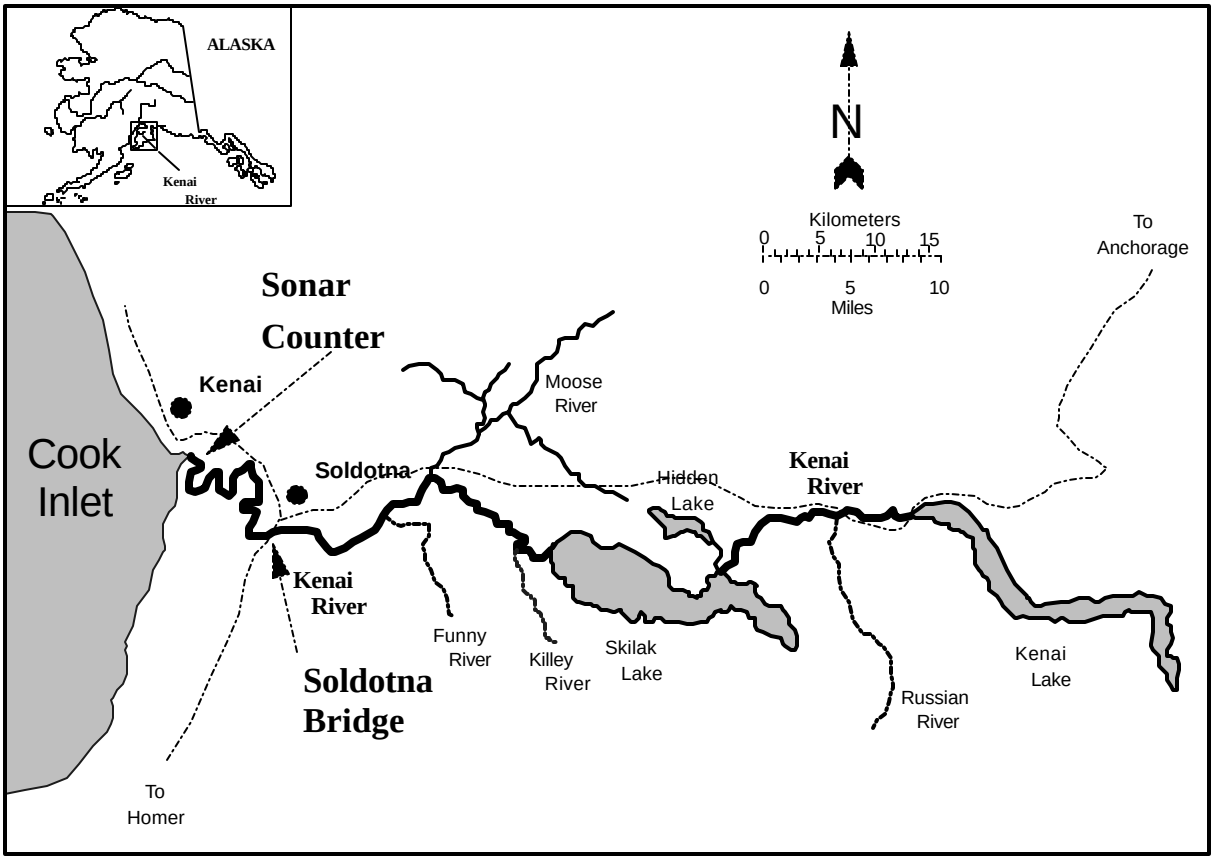

Figure 2.-The Kenai River drainage.

Kenai River Early-Run King Salmon Management Plan (5 AAC 56.070) mandates that the inriver sport fishery be managed to achieve a spawning escapement of 7,200-14,400 chinook salmon. In brief, bait, multiple hooks and fishing from boats on Mondays are prohibited unless the projected spawning escapement exceeds 14,400 fish; if the projected spawning escapement is below 7,200 fish the department restricts the sport fishery in order to achieve a spawning escapement of at least 7,200 fish (Figure 3).

In the 1999 Management Plan, catch-and-release fishing was the only option written into the plan as a potential restriction. In the 2000 and 2001 Management Plan, trophy fishing, defined as catch-and-release of fish less than 132 cm (52 in) was added as another option for restricting the sport fishery to achieve a spawning escapement of 7,200 chinook salmon. If the projected spawning escapement remains below 7,200 fish with trophy fishing restrictions, the sport fishery is closed until 1 July downstream of the Funny River and 10 July upstream of the Funny River. Sport fishing regulations, which are among the most restrictive in Alaska, are also detailed in the Plan, and include a daily bag and possession limit of one and a seasonal limit of two chinook salmon, closed areas, and restrictions on boats, guides, and guided anglers.

To implement the management plan, a comprehensive stock assessment program was initiated in the mid-1980s which includes creel surveys and estimation of inriver return by sonar. The objectives of this continuing program are two-fold: to model inriver return and fishery mortality

to effectively manage the fishery inseason; and to develop brood tables for long-term stock assessment.

This report focuses on long-term stock assessment, with a compilation of statistics for the 1999-2001 early run as well as historical statistics. Also included are estimates of inriver and total return by age, hook-and-release mortality by age, and spawning escapement by age. These are used to produce estimates of return by brood year and to assess the overall status of the early run. Historical assessment begins with the 1986 return because that is the first year for which age data are available for all components of the return.

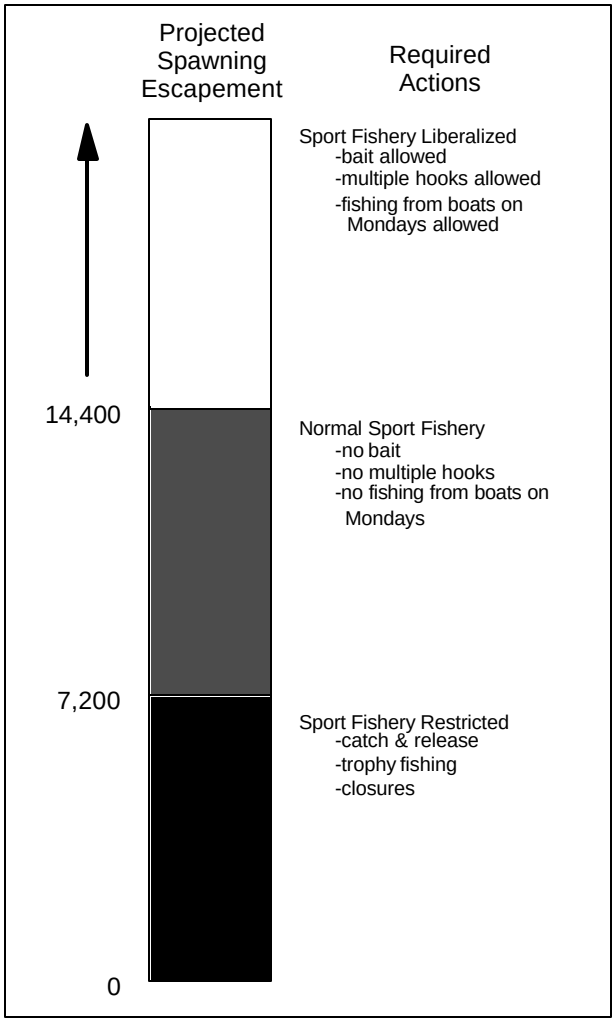

Figure 3.-Escapement levels and required actions according to the Kenai River Early Run Chinook Salmon Management Plan.

METHODS

Fishery and stock parameter estimates are derived from multiple sources; some are estimated directly and some indirectly (Table 1).

Table 1.-Summary of how stock parameter estimates are derived for early-run chinook salmon to the Kenai River.

Stock Parameter	Estimated directly (D) or indirectly (I)	How Estimated
Inriver return	D	Sonar at river mile 8.6
Personal use and Kenaitze educational harvest	D	Reported directly to ADF&G
Total return	I	Inriver return plus reported harvest in personal use and Kenaitze Educational fishery
Age composition of inriver return	D	Netting project near sonar site at river mile 8.6
Age composition of total return	I	Age composition of inriver return used as a surrogate
Sport catch, harvest, and effort below Soldotna Bridge	D	Onsite creel survey
Age composition of sport harvest below Soldotna Bridge	D	Collection of age samples in onsite creel survey
Age composition of hook-and-released fish above and below Soldotna Bridge	I	Age composition of inriver return used as a surrogate
Sport catch and harvest above Soldotna Bridge	D and I	Most recently: estimated by attributing a portion of the harvest in the SWHS to the early run stock
Age composition of sport harvest above Soldotna Bridge	I	Age composition of sport harvest below Soldotna Bridge used as a surrogate
Age composition of hook-and-released fish above and below Soldotna Bridge	I	Age composition of inriver return used as a surrogate
Hook-and-release mortalities	I	Multiplication of average of direct estimates of mortality rate from 1990 and 1991 (rate not specific to age or size), and the estimated number of released fish above and below the Soldotna Bridge
Escapement	I	Subtraction of all known inriver mortalities from the inriver return
Age composition of the escapement	I	Subtraction of all known inriver mortalities (by age) from the inriver return (by age)

INRIVER RETURN

Inriver returns of chinook salmon to the Kenai River have been estimated using two methods: a capture-recapture program from 1985-1990 (Hammarstrom and Larson 1986; Conrad and Larson 1987; Conrad 1988; Carlon and Alexandersdottir 1989; Alexandersdottir and Marsh 1990; Sonnichsen and Alexandersdottir 1991), and a hydroacoustic (sonar) program from 1984-2001 (Eggers et al. 1995; Bosch and Burwen 1999, 2000; Burwen and Bosch 1995a, 1995b, 1996, 1998; Miller et al. 2002*;* Miller and Burwen 2002; Miller 2003; Appendix B1). The sonar program was exploratory during the first 4 years of the study, and the two programs were conducted simultaneously from 1985-1990 to determine the best method for estimating inriver

return. Abundance estimates from the capture-recapture program were not available for 1990 because of closures to the inriver sport fishery (Sonnichsen and Alexandersdottir 1991). The capture-recapture program was terminated after 1990 because estimates from the two methods were similar for the early run, but for the late run capture-recapture estimates were double sonar estimates and were considered unreliable (Eggers et al. 1995). Also, the management plan implemented in 1989 required inseason estimates of abundance, which could not be provided by the capture-recapture method. Continued evaluation of the sonar project has resulted in improvements to inriver abundance estimates. Therefore, for inriver return estimates for this stock assessment report, we used estimates from the capture-recapture study for 1986 and 1987, and estimates of total passage from the sonar for 1988-1997. For 1998, we used the inriver return estimate that employed a 40 m range threshold to account for unexpectedly high sockeye salmon abundance during the early run (Bosch and Burwen 2000). For 1999-2001, we used estimates of upstream passage (Miller et al. 2002; Miller and Burwen 2002; Miller et al. 2003).

To estimate inriver return by age, the age/sex composition of the inriver return was sampled and the number of fish of each age class in the inriver return was estimated for 1986-2001 (Appendices A1 and A2). Prior to 1991, scale samples collected from chinook salmon captured with 7¼-inch mesh gillnets during capture-recapture studies provided the samples for this analysis (Sonnichsen and Alexandersdottir 1991). Although the capture-recapture program was discontinued in 1991, age, sex, and length samples were still collected using gillnets from 1991 through 2001 (Hammarstrom 1992-1994; King 1995-1997; Marsh 1999, 2000; Reimer et al. 2002; Reimer 2003). Thorough size selectivity analysis has not been conducted, but in 2002 netting with a second mesh size (5.0") that in theory results in minimal age and size selectivity for chinook salmon (when combined with samples from 7.5" mesh gear) will be tested.

SUBSISTENCE, EDUCATIONAL AND PERSONAL USE HARVEST

Harvests in subsistence, educational, and personal use fisheries for early-run chinook salmon were compiled annually by Sport Fish Division in Soldotna (Bethe et al. 2002; Gamblin et al. *In prep*).

TOTAL RETURN

Total return was estimated as the sum of inriver return (generally sonar) and subsistence (including personal use and educational) harvest. The variance of total return was the variance of the inriver return because subsistence harvests were considered measured without error. Age composition of the inriver return was applied to the total return to estimate total return by age, and variance of total return by age was estimated according to (Goodman 1960) (Appendices A1 and A3).

SPORT HARVEST

Estimates of harvest in the marine sport fishery are not known. Catch and harvest of chinook salmon in the Kenai River sport fishery were estimated with an onsite creel survey (Conrad and Hammarstrom 1987; Hammarstrom 1988-1994; King 1995-1997; Marsh 1999, 2000; Reimer et al. 2002, Reimer 2003) and in the Statewide Harvest Survey (SWHS; Mills 1984-1994; Howe et al. 1995, 1996, 2001a, b, c, d; Walker et al. *In prep*). The creel survey provided estimates for the entire fishery for 1986-1989, and downstream of Naptowne Rapids to Cook Inlet in 1990. In those years, catch and harvest were estimated for three river sections (two in 1990): Cook Inlet to the Soldotna Bridge, Soldotna Bridge to Naptowne Rapids, and Naptowne Rapids to the outlet of Skilak Lake. In 1991 and 1992, catch and harvest were estimated for the Cook Inlet to

Soldotna Bridge area only because of restrictions and closures to the fishery above the Soldotna Bridge. Beginning in 1993, catch and harvest were only estimated in the Cook Inlet to Soldotna Bridge section because of logistical problems with sampling the fishery above the Soldotna Bridge. However, some sport fishing did occur upstream of the Soldotna Bridge.

Estimates of harvest and catch from creel surveys for the Cook Inlet to Soldotna Bridge area were used for all years. To account for harvest above the Soldotna Bridge, estimates from the SWHS (Mills 1984-1994; Howe et al. 1995, 1996, 2001a, b, c, d; Walker et al. *In prep*) were used. The SWHS provided estimates of harvest and catch of chinook salmon from the following sections of the Kenai River: Cook Inlet to the Soldotna Bridge, the Soldotna Bridge to Moose River, Moose River to the outlet of Skilak Lake, and the inlet of Skilak Lake to the outlet of Kenai Lake. However, using these estimates to account for harvest and catch upstream of the Soldotna Bridge was complicated by the fact that prior to 1996, catch, harvest, and their variances were estimated for the entire year in the SWHS rather than by run; beginning in 1996, the estimates were stratified into early (before 1 July) and late (after 30 June) runs. In addition, catch was not estimated in the SWHS prior to 1990.

Historically, the early run accounted for about half the total harvest above the Soldotna Bridge based on creel surveys (Conrad and Hammarstrom 1987; Hammarstrom 1988-1991) and the SWHS (Howe et al. 2001b, c, d). Therefore, we used 50% of the SWHS estimates from above the Soldotna Bridge to account for harvest above the Soldotna Bridge for 1986-1995 (and variance multiplied by 0.5^2). Catch was accounted for in the same manner for 1990-1995. For 1986-1989 we used estimates of harvest to account for catch above the Soldotna Bridge, assuming that catch equaled harvest. Our estimates of hook-and-release mortality are therefore biased low for those years because some fish were released alive. For 1996-2001, we used early-run (before 1 July) estimates of harvest and catch above the Soldotna Bridge from the SWHS (Howe et al. 2001a, b, c, d; Walker et al. *In prep*).

Age data obtained through the creel surveys (Conrad and Hammarstrom 1987; Hammarstrom 1988-1994; King 1995-1997; Marsh 1999, 2000; Reimer et al. 2002; Reimer 2003) were used to estimate age composition of the harvest in the surveyed area (Appendices A1 and A4).

Total harvest was the sum of harvest from Cook Inlet to the Soldotna Bridge plus harvest above the Soldotna Bridge. Total harvest by age was estimated by applying age proportions estimated from the creel survey samples to the total harvest (Appendices A1 and A4).

HOOK-AND-RELEASE MORTALITY

Some chinook salmon die that are hooked and then released by anglers during the inriver sport fishery. Hook-and-release mortality was estimated in 1990 and 1991 (Bendock and Alexandersdottir 1991, 1992). This information was used to estimate mortality for the remaining years (Appendices A1 and A5). Hook-and-release mortality by age was then estimated by applying composition estimates from the inriver return to annual estimates for hook-and-release mortality (Appendices A1 and A5).

SPAWNING ESCAPEMENT

Spawning escapement was estimated by subtracting total inriver mortality (sport harvest and hook-and-release mortality) from the inriver return for each age class and for the total (Appendices A1 and A6). For some age classes in some years, estimated harvest in the sport fishery was greater than the estimated inriver return. When this occurred, spawning escapement

for that age class was set to zero; thus, sometimes spawning escapement by age class did not sum to total escapement. Variance of spawning escapement by age class was estimated by summing, for each age class, the variances of inriver return, total inriver sport harvest, and hook-and-release mortality (Appendices A1 and A6).

RETURN PER SPAWNER

For each brood year, the individual age components in the return were summed (ages 0.5, 1.4, and 2.3 for age 5, for example), and then ages were summed across brood years (Appendices A1 and A7). Variance of return by age was the sum of the variances of the age components. Return per spawner was estimated by dividing the total number of fish returning for each brood year by the number of spawners for that brood year.

SIBLING RATIOS

The distribution of chinook salmon returning in each age class within a brood year may be a stable characteristic within a stock, and it may be possible to estimate future returns by brood year using the relationships between ages within a brood year, or sibling relationships. Sibling ratios were estimated as the ratio of the return at one age to the total return at one or more younger ages (Appendices A1 and A8).

RESULTS

INRIVER AND TOTAL RETURNS

The 1999 inriver return was an estimated 25,666 (SE = 370) chinook salmon (Miller et al. 2002; Table 2; Appendix B1). Age was determined for 324 chinook salmon captured with gillnets during the early run in 1999, and there was no significant difference ($\chi^2 = 0.24$, df = 2, P = 0.89) in the age composition between time strata (Reimer et al. 2002; Table 3). Fish aged 1.3 was the dominant age class (53.7%, SE = 2.8%) in the return.

In 1999, 114 early-run chinook salmon were harvested in the Kenaitze educational fishery (Bethe et al. 2002; Table 2). Total return was 25,780 (SE = 370) chinook salmon in 1999, the second highest on record.

The estimated 2000 inriver return was 12,479 (SE = 234) chinook salmon (Miller and Burwen 2002; Table 2; Appendix B1). In 2000, age was determined for 227 chinook salmon sampled from the inriver return. Because there was a significant difference ($\chi^2 = 13.2$, df = 2, P < 0.01) in the age composition between time strata, age composition was stratified (Reimer et al. 2002). Fish aged 1.4 was the dominant age class (46.5%, SE = 3.5%) in the return (Table 4).

In 2000, 124 early-run chinook salmon were harvested in the Kenaitze educational fishery (Gamblin et al. *In prep*; Table 2). Total return was 12,603 (SE = 234) chinook salmon.

The estimated 2001 inriver return was 16,676 (SE = 285) chinook salmon (Miller et al. 2003; Table 2; Appendix B1). In 2001, age was determined for 198 chinook salmon sampled from the inriver return, and there was no significant difference in the age composition between temporal strata ($\chi^2 = 2.459$, df = 2, P = 0.293; Reimer 2003). Fish aged 1.4 was the dominant age class (53.0%, SE = 3.6%) in the return (Table 5).

Table 2.-Inriver return (estimated by capture-recapture in 1986 and by sonar in 1987-2001), subsistence harvest, and total return of Kenai River chinook salmon, 1986-2001.

	Inriver Return		Subsis-	Total Return	
Year	Estimate	SE[a]	tence[b]	Estimate	SE[c]
1986	27,080	9,799		27,080	9,799
1987	25,643	5,928		25,643	5,928
1988[d]	20,880	449		20,880	449
1989[d]	17,992	389	73	18,065	389
1990	10,679	242	40	10,719	242
1991	10,931	269	2	10,933	269
1992	10,087	255	73	10,160	255
1993	19,921	386	118	20,039	386
1994	18,403	288	56	18,459	288
1995	21,884	396	37	21,921	396
1996	23,505	376	104	23,609	376
1997	14,963	236	122	15,085	236
1998	9,184	169	131	9,315	169
1999	25,666	370	114	25,780	370
2000	12,479	234	124	12,603	234
2001	16,676	285	198	16,874	285

[a] Accounts for sampling error only.

[b] Actual variance unknown. Proxy for actual variance is: [estimate * CV]2. Coefficient of variation (CV) is the average coefficient of variation for 1990–1994.

[c] Includes personal use and educational fisheries. Harvest is considered measured without error.

[d] SE of total return equals SE of inriver return because SE of subsistence, personal use, and educational harvest is considered zero.

In 2001, 198 early-run chinook salmon were harvested in the Kenaitze educational fishery (Gamblin et al. *In prep*; Table 2). Total return was 16,874 (SE = 285) in 2001.

Total returns by age for 1986-2001 are presented in Table 6.

SPORT HARVEST

In 1999, estimated harvest was 5,534 (SE = 393) chinook salmon and estimated catch was 7,186 (SE = 475) fish downstream of the Soldotna Bridge (Table 7; Reimer et al. 2002).

Above the Soldotna Bridge estimated harvest was 2,595 (SE = 272), and estimated catch was 5,015 (SE = 442) chinook salmon. Total estimated sport harvest in 1999 was 8,129 (SE = 478) chinook salmon, and total catch was 12,201 (SE = 649) chinook salmon (Table 7).

Table 3.-Estimated inriver return, by age class, of early-run chinook salmon to the Kenai River, 1999.

	Age Class					
	1.2	1.3	1.4	1.5	2.3	All
FEMALES						
Sample Size	2	80	64	1	1	148
Percent	0.6	24.7	19.8	0.3	0.3	45.7
SE Percent	0.4	2.4	2.2	0.3	0.3	2.8
Return	158	6,337	5,070	79	79	11,724
SE Return	112	622	573	79	79	731
MALES						
Sample Size	24	94	58	0	0	176
Percent	7.4	29.0	17.9	0.0	0.0	54.3
SE Percent	1.5	2.5	2.1	0.0	0.0	2.8
Return	1,901	7,446	4,595	0	0	13,942
SE Return	375	657	551	0	0	739
COMBINED						
Sample Size	26	174	122	1	1	324
Percent	8.0	53.7	37.7	0.3	0.3	100.0
SE Percent	1.5	2.8	2.7	0.3	0.3	
Return	2,060	13,784	9,664	79	79	25,666
SE Return	389	739	706	79	79	370

Source: Reimer et al. 2002

Age was determined for 249 sport-harvested fish during the early run in 1999, and age composition was significantly different (χ^2 = 6.4, df = 2, P = 0.04) for the three temporal strata, for ages 1.3 and 1.4 which made up >88% of the sample (Reimer et al. 2002). Therefore, estimates of age composition were stratified. Fish aged 1.4 was the dominant age class in the sport harvest (51.7%, SE = 3.2%; Table 8).

Estimated sport harvest in 2000 was 1,149 (SE = 157) chinook salmon below the Soldotna Bridge, and estimated catch was 2,309 (SE = 229) chinook salmon (Reimer et al. 2002; Table 7). Above the Soldotna Bridge, estimated harvest was 669 (SE = 121) and catch was 2,397 (SE = 432) chinook salmon. Total harvest was 1,818 (SE = 198) and total catch was 4,706 (SE = 489) chinook salmon (Table 7).

In 2000, age was determined for 96 chinook salmon from the sport harvest. The age distribution did not differ significantly (χ^2 = 2.6, df = 2, P = 0.27) between temporal strata for ages 1.3 and 1.4 (93.5% of the sample; Reimer et al. 2002). Fish aged 1.4 was the dominant age class in the sport harvest (77.1%, SE = 4.3%; Table 9).

Table 4.-Estimated inriver return, by age class, of early-run chinook salmon to the Kenai River, 2000.

	Age						
	0.3	0.4	1.2	1.3	1.4	1.5	All
Stratum 1 (5/15-6/8)							
FEMALES							
Sample Size	1	0	0	23	38	0	62
Percent	1.0	0.0	0.0	22.3	36.9	0.0	60.2
SE Percent	1.0	0.0	0.0	4.1	4.8	0.0	4.8
Return	34	0	0	786	1,299	0	2,119
SE Return	34	0	0	147	173	0	183
MALES							
Sample Size	2	1	1	15	22	0	41
Percent	1.9	1.0	1.0	14.6	21.4	0.0	39.8
SE Percent	1.4	1.0	1.0	3.5	4.1	0.0	4.8
Return	68	34	34	513	752	0	1,402
SE Return	48	34	34	124	145	0	176
COMBINED							
Sample Size	3	1	1	38	60	0	103
Percent	2.9	1.0	1.0	36.9	58.3	0.0	100.0
SE Percent	1.7	1.0	1.0	4.8	4.9	0.0	0.0
Return	103	34	34	1,299	2,051	0	3,521
SE Return	59	34	34	173	183	0	109
Stratum 2 (6/9-6/30)							
FEMALES							
Sample Size	0	0	1	33	26	0	60
Percent	0.0	0.0	0.8	26.6	21.0	0.0	48.4
SE Percent	0.0	0.0	0.8	4.0	3.7	0.0	4.5
Return	0	0	72	2,384	1,878	0	4,335
SE Return	0	0	72	361	332	0	416
MALES							
Sample Size	0	0	13	24	26	1	64
Percent	0.0	0.0	10.5	19.4	21.0	0.8	51.6
SE Percent	0.0	0.0	2.8	3.6	3.7	0.8	4.5
Return	0	0	939	1,734	1,878	72	4,623
SE Return	0	0	248	322	332	72	417
COMBINED							
Sample Size	0	0	14	57	52	1	124
Percent	0.0	0.0	11.3	46.0	41.9	0.8	100.0
SE Percent	0.0	0.0	2.9	4.5	4.4	0.8	0.0
Return	0	0	1,011	4,118	3,757	72	8,958
SE Return	0	0	257	414	408	72	207

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Table 4.-Page 2 of 2.

	Age						
	0.3	0.4	1.2	1.3	1.4	1.5	All
Strata 1 and 2 Combined							
FEMALES							
Return	34	0	72	3,170	3,177	0	6,454
SE Return	34	0	72	390	374	0	454
Percent	0.3	0.0	0.6	25.4	25.5	0.0	51.7
SE Percent	0.3	0.0	0.6	3.1	3.0	0.0	3.5
MALES							
Return	68	34	973	2,247	2,630	72	6,025
SE Return	48	34	251	345	362	72	453
Percent	0.5	0.3	7.8	18.0	21.1	0.6	48.3
SE Percent	0.4	0.3	2.0	2.8	2.9	0.6	3.6
COMBINED							
Return	103	34	1,046	5,417	5,808	72	12,479
SE Return	59	34	259	448	447	72	234
Percent	0.8	0.3	8.4	43.4	46.5	0.6	100.0
SE Percent	0.5	0.3	2.1	3.5	3.5	0.6	

Source: Reimer et al. 2002.

Estimated sport harvest in 2001 was 1,428 (SE = 190) chinook salmon below the Soldotna Bridge, and estimated catch was 1,837 (SE = 216) chinook salmon (Reimer 2003; Table 7). Above the Soldotna Bridge, estimated harvest was 969 and catch was 3,757 chinook salmon. Standard errors are not yet available for estimates from the SWHS. Total harvest was 2,397 (SE = 190) and total catch was 5,594 (SE = 216) chinook salmon.

In 2001, age was determined for 71 chinook salmon from the sport harvest, and there was not a significant difference ($\chi^2 = 2.426$; df = 2, P = 0.297) in the age composition by temporal strata (Reimer 2003). Fish aged 1.4 was the dominant age class in the sport harvest (67.6%, SE = 5.6%; Table 10).

The total harvest of chinook salmon by age class for 1986-2001 is presented in Table 11.

HOOK-AND-RELEASE MORTALITY

In 1999, 4,072 (SE = 806) chinook salmon were released, resulting in an estimated hook-and-release mortality of 261 (SE = 171) chinook salmon (Table 12). In 2000, 2,888 (SE = 527) chinook salmon were released, resulting in an estimated 185 (SE = 121) hook-and-release mortalities (Table 12). In 2001, 3,197 (SE = 288) chinook salmon were released, resulting in an estimated 205 (SE = 131) hook-and-release mortalities (Table 12). In each of these years most hook-and-release mortalities were attributed to ages 1.3 and 1.4 (Table 13). Hook-and-release mortality by age for 1986-1998 is found in Appendix C1.

Table 5.-Estimated inriver return, by age class, of early-run chinook salmon to the Kenai River, 2001.

	Age Class					
	0.3	1.2	1.3	1.4	1.5	All
FEMALES						
Sample Size	2	5	23	58	2	90
Percent	1.0	2.5	11.6	29.3	1.0	45.5
SE Percent	0.7	1.1	2.3	3.2	0.7	3.5
Return	168	421	1,937	4,885	168	7,580
SE Return	119	187	382	547	119	606
MALES						
Sample Size	0	27	32	47	2	108
Percent	0.0	13.6	16.2	23.7	1.0	54.5
SE Percent	0.0	2.4	2.6	3.0	0.7	3.5
Return	0	2,274	2,695	3,958	168	9,096
SE Return	0	410	440	510	119	612
COMBINED						
Sample Size	2	32	55	105	4	198
Percent	1.0	16.2	27.8	53.0	2.0	100.0
SE Percent	0.7	2.6	3.2	3.6	1.0	
Return	168	2,695	4,632	8,843	337	16,676
SE Return	119	440	538	612	167	285

Source: Reimer 2003.

SPAWNING ESCAPEMENT

In 1999, spawning escapement was an estimated 17,276 (SE = 628) chinook salmon, the second highest ever recorded for the early run; spawning escapement in 2000 was 10,476 (SE = 329) chinook salmon; spawning escapement in 2001 was an estimated 14,075 (SE = 367), just below the upper end goal of 14,400 (Tables 14 and 15). The majority of these spawners were aged 1.3 and 1.4, although in 2001 about 17% were aged 1.2 (Table 15).

RETURN PER SPAWNER

Returns at age were estimated by return year (Table 16) and by brood year (Table 17). Of brood years with complete, or almost complete, return data (1986-1995), returns ranged from 9,863 (SE= 527) chinook salmon for brood year 1986 to 21,816 (SE = 912) fish for brood year 1994 (Table 17). Return per spawner ranged from 0.53 (SE = 0.28) for brood year 1986 (which was the highest escapement measured) to 3.89 (SE = 0.71) for brood year 1988 (which was the lowest escapement measured; Table 17).

SIBLING RELATIONSHIPS

Average sibling return ratios, after incorporating data from 1999-2001, were 5.09 (SD = 2.54) for age 5 to age 4; 2.33 (SD = 1.26) for age 6 to age 5; and 0.07 (SD = 0.05) for age 7 to age 6 (Table 18).

Table 6.-Estimated total return, by age class, of early-run chinook salmon to the Kenai River, 1986-2001.

	Age Class										
	0.3	0.4	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	All
1986											
Inriver Return %	0.0	0.0	15.5	42.0	34.5	7.8	0.0	0.0	0.0	0.1	100.0
SE %	0.0	0.0	1.0	1.3	1.3	0.7	0.0	0.0	0.0	0.1	
Total Return	0	0	4,191	11,384	9,349	2,116	0	0	0	40	27,080
SE Total Return	0	0	1,537	4,133	3,399	788	0	0	0	30	9,799
1987											
Inriver Return %	0.0	0.0	1.5	38.4	57.3	2.2	0.0	0.0	0.1	0.4	100.0
SE %	0.0	0.0	0.4	1.6	1.6	0.5	0.0	0.0	0.1	0.2	
Total Return	0	0	393	9,859	14,683	577	0	0	26	105	25,643
SE Total Return	0	0	134	2,312	3,417	178	0	0	26	56	5,928
1988											
Inriver Return %	0.0	0.0	1.8	15.8	71.3	10.7	0.3	0.0	0.1	0.0	100.0
SE %	0.0	0.0	0.5	1.3	1.6	1.1	0.2	0.0	0.1	0.0	
Total Return	0	0	373	3,302	14,888	2,237	53	0	27	0	20,880
SE Total Return	0	0	99	281	465	236	38	0	27	0	449
1989											
Inriver Return %	0.0	0.0	4.1	15.5	71.0	9.4	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	0.8	1.4	1.7	1.1	0.0	0.0	0.0	0.0	
Total Return	0	0	749	2,791	12,819	1,706	0	0	0	0	18,065
SE Total Return	0	0	137	254	415	203	0	0	0	0	389
1990											
Inriver Return %	0.0	0.0	7.2	26.6	59.8	6.4	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	1.2	2.0	2.3	1.1	0.0	0.0	0.0	0.0	
Total Return	0	0	775	2,851	6,409	684	0	0	0	0	10,719
SE Total Return	0	0	129	228	282	122	0	0	0	0	242
1991											
Inriver Return %	0.0	0.0	7.3	22.4	65.1	5.2	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	1.7	2.7	3.1	1.5	0.0	0.0	0.0	0.0	
Total Return	0	0	801	2,451	7,116	566	0	0	0	0	10,933
SE Total Return	0	0	188	306	385	160	0	0	0	0	269
1992											
Inriver Return %	0.0	0.0	8.1	28.5	58.1	5.3	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	1.7	2.9	3.2	1.4	0.0	0.0	0.0	0.0	
Total Return	0	0	826	2,891	5,906	537	0	0	0	0	10,160
SE Total Return	0	0	179	302	353	146	0	0	0	0	255

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Table 6.-Page 2 of 3.

	Age Class										
	0.3	0.4	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	All
1993											
Inriver Return %	0.0	0.0	4.0	28.0	63.2	3.6	0.0	0.3	0.9	0.0	100.0
SE %	0.0	0.0	1.1	2.5	2.7	1.0	0.0	0.3	0.5	0.0	
Total Return	0	0	792	5,604	12,669	731	0	61	183	0	20,039
SE Total Return	0	0	216	508	587	208	0	61	105	0	386
1994											
Inriver Return %	0.0	0.0	3.5	20.0	70.7	4.2	0.0	0.2	0.7	0.7	100.0
SE %	0.0	0.0	0.9	1.9	2.1	0.9	0.0	0.2	0.4	0.4	
Total Return	0	0	651	3,700	13,051	773	0	41	122	122	18,459
SE Total Return	0	0	160	352	444	174	0	41	70	70	288
1995											
Inriver Return %	0.0	0.0	4.9	20.4	69.8	4.4	0.0	0.0	0.0	0.4	100.0
SE %	0.0	0.0	1.4	2.7	3.1	1.4	0.0	0.0	0.0	0.4	
Total Return	0	0	1,072	4,482	15,296	974	0	0	0	97	21,921
SE Total Return	0	0	316	596	727	302	0	0	0	97	396
1996											
Inriver Return %	0.0	0.0	7.9	28.7	61.3	2.1	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	1.5	2.5	2.7	0.8	0.0	0.0	0.0	0.0	
Total Return	0	0	1,854	6,776	14,479	499	0	0	0	0	23,609
SE Total Return	0	0	351	598	674	187	0	0	0	0	376
1997											
Inriver Return %	0.0	0.0	4.2	34.8	59.9	1.1	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	1.0	2.5	2.5	0.5	0.0	0.0	0.0	0.0	
Total Return	0	0	637	5,254	9,035	159	0	0	0	0	15,085
SE Total Return	0	0	156	379	406	79	0	0	0	0	236
1998											
Inriver Return %	0.0	0.0	18.9	36.8	41.1	3.2	0.0	0.0	0.0	0.0	100.0
SE %	0.0	0.0	2.3	2.9	2.9	1.0	0.0	0.0	0.0	0.0	
Total Return	0	0	1,765	3,432	3,824	294	0	0	0	0	9,315
SE Total Return	0	0	219	274	281	97	0	0	0	0	169

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Table 6.-Page 3 of 3.

	Age Class										
	0.3	0.4	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	All
1999											
Inriver Return %	0.0	0.0	8.0	53.7	37.7	0.3	0.0	0.0	0.3	0.0	100.0
SE %	0.0	0.0	1.5	2.8	2.7	0.3	0.0	0.0	0.3	0.0	
Total Return	0	0	2,069	13,845	9,707	80	0	0	80	0	25,780
SE Total Return	0	0	391	742	709	80	0	0	80	0	370
2000											
Inriver Return %	0.8	0.3	8.4	43.4	46.5	0.6	0.0	0.0	0.0	0.0	100.0
SE %	0.5	0.3	2.1	3.5	3.5	0.6	0.0	0.0	0.0	0.0	
Total Return	104	35	1,056	5,470	5,865	73	0	0	0	0	12,603
SE Total Return	59	35	261	452	452	73	0	0	0	0	234
2001											
Inriver Return %	1.0	0.0	16.2	27.8	53.0	2.0	0.0	0.0	0.0	0.0	100.0
SE %	0.7	0.0	2.6	3.2	3.6	1.0	0.0	0.0	0.0	0.0	
Total Return	170	0	2,727	4,687	8,948	341	0	0	0	0	16,874
SE Total Return	120	0	445	544	619	169	0	0	0	0	285

DISCUSSION

Our current stock assessment program accounts for most sources of nearshore harvest. However, we lack harvest estimates of early-run Kenai River chinook salmon in the marine sport fishery in Cook Inlet. Although probably not significant at this point, estimates of harvest may become necessary in the future.

Harvests of early-run fish in July above the Soldotna Bridge are not accounted for in this assessment. This information would have to be collected directly through an onsite creel survey or as part of a tagging project. Even with an onsite creel survey there would be subjectivity as to whether a fish harvested in July is from the early-run or late-run stock. There have been inseason management actions in the upstream area, and additional areas upstream of the bridge have been closed since an onsite creel was last conducted, so trends from prior creel surveys may not be valid now. For this reason, a table of total harvests of chinook salmon in July above the Soldotna Bridge (which are by default apportioned as late-run fish) is included in this report (Table 19).

CHANGES IN THE MANAGEMENT PLAN

Changes were made to the Kenai River Early-Run King Salmon Management Plan at BOF meetings in the spring of 1999 and 2000. Changes made in 1999, which were based on recommendations from a departmental Committee on Biological Escapement Goals (Fried 1991) and a previous escapement goal report (Eggers 1993), broadened the escapement goal range in which no inseason action would be taken. It was thought that the new escapement range would produce returns that maximized yield. The BOF fitted a management plan around this escapement range, with the intention that inseason management actions would be required only

Table 7.-Summary of historical harvest and catch in the inriver sport fishery for early-run chinook salmon, Kenai River, 1986–2001.

	Harvest						Catch					
	CI-SB[a]		SB-KL[b]		Total		CI-SB[a]		SB-KL[b]		Total	
Year	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1986	6,337	459	1,819	233	8,156	515	10,122	684	1,819	233	11,941	723
1987	11,224	836	2,333	366	13,557	912	16,007	1,103	2,333	366	18,340	1,162
1988	11,949	697	3,260	423	15,209	815	17,266	839	3,260	423	20,526	940
1989	6,711	490	1,683	165	8,394	517	9,034	603	1,683	165	10,717	625
1990	723	167	1,084	154	1,807	227	3,285	389	2,818	208	6,103	441
1991	891	169	1,054	122	1,945	209	3,716	426	2,030	150	5,746	452
1992	1,365	151	876	92	2,241	177.042	3,901	307	2,028	182	5,929	357
1993	6,846	382	2,496	173	9,342	419	9,906	523	3,910	272	13,816	589
1994	4,722	300	3,449	205	8,171	363	6,399	404	6,230	389	12,629	561
1995	7,733	420	2,484	155	10,217	448	11,360	541	4,434	313	15,794	625
1996	4,166	290	2,457	203	6,623	354	5,552	320	5,562	687	11,114	758
1997	4,942	619	1,495	173	6,437	643	6,782	775	5,123	871	11,905	1,166
1998	648	89	522	85	1,170	123	1,869	239	3,274	499	5,143	554
1999	5,534	393	2,595	272	8,129	478	7,186	475	5,015	442	12,201	649
2000	1,149	157	669	121	1,818	198	2,309	229	2,397	432	4,706	489
2001	1,428	190	969	0	2,397	190	1,837	216	3,757	0	5,594	216

[a] Cook Inlet to the Soldotna Bridge. From creel surveys: Conrad and Hammarstrom 1987; Hammarstrom 1988-1994; King 1995-1997; Marsh 1999; Reimer et al. 2002; Reimer 2003.

[b] Soldotna Bridge to the outlet of Kenai Lake. From the Statewide Harvest Survey; see text for methods for estimating harvest and catch in this area. Estimates for 1996-1998 are revised estimates. SE not yet available for 2001.

Table 8.-Estimated harvest, by age class, of early-run chinook salmon in the Kenai River sport fishery (Soldotna Bridge to Cook Inlet), 1999.

	Ages						
	1.1	1.2	1.3	1.4	1.5	2.2	All
Stratum 1 (5/15-5/31)							
FEMALES							
Sample Size	0	0	5	14	0	0	19
Percent	0.0	0.0	17.9	50.0	0.0	0.0	67.9
SE Percent	0.0	0.0	7.4	9.6	0.0	0.0	9.0
Harvest	0	0	96	270	0	0	366
SE Harvest	0	0	44	76	0	0	90
MALES							
Sample Size	0	1	2	4	2	0	9
Percent	0.0	3.6	7.1	14.3	7.1	0.0	32.1
SE Percent	0.0	3.6	5.0	6.7	5.0	0.0	9.0
Harvest	0	19	39	77	39	0	173
SE Harvest	0	19	27	39	27	0	60
COMBINED							
Sample Size	0	1	7	18	2	0	28
Percent	0.0	3.6	25.0	64.3	7.1	0.0	100.0
SE Percent	0.0	3.6	8.3	9.2	5.0	0.0	0.0
Harvest	0	19	135	347	39	0	539
SE Harvest	0	19	52	87	27	0	113
Stratum 2 (6/01-6/15)							
FEMALES							
Sample Size	0	2	25	15	0	0	42
Percent	0.0	2.4	30.5	18.3	0.0	0.0	51.2
SE Percent	0.0	1.7	5.1	4.3	0.0	0.0	5.6
Harvest	0	38	473	284	0	0	795
SE Harvest	0	27	95	73	0	0	123
MALES							
Sample Size	0	3	15	21	1	0	40
Percent	0.0	3.7	18.3	25.6	1.2	0.0	48.8
SE Percent	0.0	2.1	4.3	4.8	1.2	0.0	5.6
Harvest	0	57	284	398	19	0	758
SE Harvest	0	33	73	87	19	0	120
COMBINED							
Sample Size	0	5	40	36	1	0	82
Percent	0.0	6.1	48.8	43.9	1.2	0.0	100.0
SE Percent	0.0	2.7	5.6	5.5	1.2	0.0	0.0
Harvest	0	95	758	682	19	0	1,553
SE Harvest	0	42	120	114	19	0	172

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Table 8.-Page 2 of 2.

	Ages						
	1.1	1.2	1.3	1.4	1.5	2.2	All
Stratum 3 (6/16-6/30)							
FEMALES							
Sample Size	0	7	30	40	1	1	79
Percent	0.0	5.0	21.6	28.8	0.7	0.7	56.8
SE Percent	0.0	1.9	3.5	3.9	0.7	0.7	4.2
Harvest	0	173	743	991	25	25	1,956
SE Harvest	0	66	140	163	25	25	239
MALES							
Sample Size	1	7	15	34	3	0	60
Percent	0.7	5.0	10.8	24.5	2.2	0.0	43.2
SE Percent	0.7	1.9	2.6	3.7	1.2	0.0	4.2
Harvest	25	173	371	842	74	0	1,486
SE Harvest	25	66	97	150	43	0	204
COMBINED							
Sample Size	1	14	45	74	4	1	139
Percent	0.7	10.1	32.4	53.2	2.9	0.7	100.0
SE Percent	0.7	2.6	4.0	4.2	1.4	0.7	0.0
Harvest	25	347	1,114	1,832	99	25	3,442
SE Harvest	25	94	174	230	50	25	335
Strata 1, 2, and 3 Combined							
FEMALES							
Harvest	0	211	1,313	1,544	25	25	3,117
SE Harvest	0	71	175	195	25	25	283
Percent	0.0	3.8	23.7	27.9	0.4	0.4	56.3
SE Percent	0.0	1.3	2.7	2.9	0.4	0.4	3.2
MALES							
Harvest	25	249	694	1,317	132	0	2,417
SE Harvest	25	76	125	177	54	0	244
Percent	0.4	4.5	12.5	23.8	2.4	0.0	43.7
SE Percent	0.4	1.3	2.1	2.7	1.0	0.0	3.2
COMBINED							
Harvest	25	461	2,007	2,861	156	25	5,534
SE Harvest	25	105	218	271	60	25	393
Percent	0.4	8.3	36.3	51.7	2.8	0.4	100.0
SE Percent	0.4	1.8	3.1	3.2	1.1	0.4	
TOTAL HARVEST							
Harvest	36	677	2,948	4,202	230	36	8,129
SE Harvest	36	151	304	359	88	36	478

Table 9.-Estimated harvest, by age class, of early-run chinook salmon in the Kenai River sport fishery (Soldotna Bridge to Cook Inlet), 2000.

	Age Class						
	0.2	1.1	1.2	1.3	1.4	1.5	All
FEMALES							
Sample Size	0	0	0	8	47	3	58
Percent	0.0	0.0	0.0	8.3	49.0	3.1	60.4
SE Percent	0.0	0.0	0.0	2.8	5.1	1.8	5.0
Harvest	0	0	0	96	563	36	694
SE Harvest	0	0	0	35	96	21	111
MALES							
Sample Size	1	1	1	8	27	0	38
Percent	1.0	1.0	1.0	8.3	28.1	0.0	39.6
SE Percent	1.0	1.0	1.0	2.8	4.6	0.0	5.0
Harvest	12	12	12	96	323	0	455
SE Harvest	12	12	12	35	69	0	84
COMBINED							
Sample Size	1	1	1	16	74	3	96
Percent	1.0	1.0	1.0	16.7	77.1	3.1	100.0
SE Percent	1.0	1.0	1.0	3.8	4.3	1.8	
Harvest	12	12	12	192	886	36	1,149
SE Harvest	12	12	12	51	130	21	157
TOTAL HARVEST							
Harvest	19	19	19	303	1,401	57	1,818
SE Harvest	19	19	19	77	171	33	198

occasionally, and that those actions would more likely be correct ones. The only change made in 2000 was to reinstate trophy fishing as an inseason management option to slow the fishery while achieving the low end escapement goal of 7,200 chinook salmon.

INSEASON MANAGEMENT

The Department has taken inseason management action in 12 of 13 years since the first plan took effect in the 1989 season. The fishery was restricted six times, liberalized six times, and no action taken in only 1 year (Table 20). The most recent management plans are simpler and have target ranges that more closely fit the department's management abilities. But even with these changes, inseason actions have been taken in 2 of the last 3 years (Table 20).

Projections of final inriver return using mean run timing have generally been accurate beginning in the first few days of June. As an example, using the mean of run timing information for all years with sonar through 2001, the difference in the return projection (using sonar estimates

Table 10.-Estimated harvest, by age class, of early-run chinook salmon in the Kenai River sport fishery (Soldotna Bridge to Cook Inlet), 2001.

	Age Class					
	0.2	1.2	1.3	1.4	1.5	All
FEMALES						
Sample Size	0	4	6	31	0	41
Percent	0.0	5.6	8.5	43.7	0.0	57.7
SE Percent	0.0	2.8	3.3	5.9	0.0	5.9
Harvest	0	80	121	623	0	825
SE Harvest	0	40	50	118	0	138
MALES						
Sample Size	1	5	6	17	1	30
Percent	1.4	7.0	8.5	23.9	1.4	42.3
SE Percent	1.4	3.1	3.3	5.1	1.4	5.9
Harvest	20	101	121	342	20	603
SE Harvest	20	45	50	85	20	116
COMBINED						
Sample Size	1	9	12	48	1	71
Percent	1.4	12.7	16.9	67.6	1.4	100.0
SE Percent	1.4	4.0	4.5	5.6	1.4	
Harvest	20	181	241	965	20	1,428
SE Harvest	20	61	71	151	20	190
TOTAL HARVEST						
Harvest	34	304	405	1,620	34	2,397
SE Harvest[a]	34	98	112	186	34	190

[a] Does not account for SE above the Soldotna Bridge, which is not yet available.

through 4 June) versus the actual return was -1,632 fish (6%) for 1999; -989 fish (8%) for 2000; and +619 fish (4%) for 2001 (Figure 4).

Tracking the age composition of the return inseason could provide warning of an impending low return. Historically, age-1.4 fish predominate during May, a mix of age classes is observed during 1-15 June, then age-1.4 fish again predominate during 16-30 June (Figure 5, top panel). A particularly weak return might be indicated if relatively fewer age-1.4 fish are observed during May. For example, the lowest inriver return for the 1986-2001 period was experienced in 1998 (Table 2). Percentage of age-1.4 fish was markedly lower in May than for the 1986-2001 runs combined (Figure 5, bottom panel). Inseason trends in age composition will be further analyzed to determine their predictive utility.

Table 11.-Estimated total harvest, by age class, of early-run chinook salmon in the Kenai River sport fishery, 1986-2001.

	Age Class								
	0.2	1.1	1.2	1.3	1.4	1.5	2.2	2.4	All
1986									
Harvest	0	15	583	2,957	3,874	728	0	0	8,156
SE Harvest	0	15	96	249	299	108	0	0	515
1987									
Harvest	0	0	116	4,220	8,498	636	0	87	13,557
SE Harvest	0	0	58	406	647	139	0	50	912
1988									
Harvest	0	26	291	1,855	11,950	1,033	0	53	15,209
SE Harvest	0	26	88	230	691	169	0	37	815
1989									
Harvest	0	92	275	2,202	5,275	550	0	0	8,394
SE Harvest	0	65	112	305	442	157	0	0	517
1990									
Harvest	0	0	102	102	1,349	255	0	0	1,807
SE Harvest	0	0	51	51	193	81	0	0	227
1991									
Harvest	0	0	0	166	1,573	207	0	0	1,945
SE Harvest	0	0	0	82	202	91	0	0	209
1992									
Harvest	0	0	94	377	1,698	71	0	0	2,241
SE Harvest	0	0	47	91	167	41	0	0	177
1993									
Harvest	0	0	290	1,868	6,636	483	0	64	9,342
SE Harvest	0	0	96	235	388	123	0	46	419
1994									
Harvest	0	0	303	675	6,960	233	0	0	8,171
SE Harvest	0	0	83	124	346	73	0	0	363
1995									
Harvest	0	0	0	378	8,451	1,387	0	0	10,217
SE Harvest	0	0	0	216	569	396	0	0	448
1996									
Harvest	0	0	414	1,288	4,760	161	0	0	6,623
SE Harvest	0	0	97	169	309	61	0	0	354
1997									
Harvest	0	0	200	680	5,278	280	0	0	6,437
SE Harvest	0	0	90	170	562	107	0	0	643
1998									
Harvest	0	0	15	228	851	76	0	0	1,170
SE Harvest	0	0	15	58	107	34	0	0	123
1999									
Harvest	0	36	677	2,948	4,202	230	36	0	8,129
SE Harvest	0	36	151	304	359	88	36	0	478
2000									
Harvest	19	19	19	303	1,401	57	0	0	1,818
SE Harvest	19	19	19	77	171	33	0	0	198
2001									
Harvest	34	0	304	405	1,620	34	0	0	2,397
SE Harvest	34	0	98	112	186	34	0	0	190

Table 12.-Estimated hook-and-release mortalities of early-run chinook salmon, Kenai River, 1986-2001.

Year	Sport Catch	Sport Harvest	Number Released	SE Released	Proportion Mortality[a]	SE Prop. Mort	Hook-and-Release Mortality	SE Mortality
1986	11,941	8,156	3,785	887	0.0640	0.0408	242	161
1987	18,340	13,557	4,783	1,477	0.0640	0.0408	306	208
1988	20,526	15,209	5,317	1,244	0.0640	0.0408	340	225
1989	10,717	8,394	2,323	811	0.0640	0.0408	149	103
1990	6,103	1,807	4,296	496	0.0880	0.0250	378	115
1991	5,746	1,945	3,801	497	0.0400	0.0200	152	78
1992	5,929	2,241	3,688	399	0.0640	0.0408	236	152
1993	13,816	9,342	4,474	723	0.0640	0.0408	286	186
1994	12,629	8,171	4,458	668	0.0640	0.0408	285	185
1995	15,794	10,217	5,577	769	0.0640	0.0408	357	231
1996	11,114	6,623	4,491	836	0.0640	0.0408	287	188
1997	11,905	6,437	5,468	1,331	0.0640	0.0408	350	233
1998	5,143	1,170	3,973	567	0.0640	0.0408	254	164
1999	12,201	8,129	4,072	806	0.0640	0.0408	261	171
2000	4,706	1,818	2,888	527	0.0640	0.0408	185	121
2001	5,594	2,397	3,197	288	0.0640	0.0408	205	131

Note: Rows may not sum exactly because of rounding.

[a] Estimated directly for 1990 and 1991; other years are the average of estimates made for 1990 and 1991.

The sport fishery in 1999 could have been liberalized earlier; even allowing bait on 16 June, resulting escapement was 2,876 fish over the upper end goal of 14,400. This is the second highest escapement since the department has been estimating escapement for the early run. Although the unrealized yield represents a loss to fishers, the returns from such a high escapement will better our understanding of the spawner-recruit relationship for this stock.

Rescinding the restriction of the sport fishery in 2000 was correct; final escapement was 3,276 fish over the low end goal of 7,200. Whether the fishery could have been prosecuted fully without a restriction is debatable, even with postseason information. The question is essentially whether the sport fishery would have harvested more than the surplus ~3,300 fish in that time (an additional 12 days of fishing in the lower and middle river). Regardless, when the restriction was announced on Sunday 11 June (effective Tuesday 13 June), there were only 3,863 chinook salmon in the river (most recent estimate, through 10 June); on average 41% of the return is in the river through 10 June.

The 2001 season is the only year that no inseason action has been taken in the early run since a management plan was first developed for this fishery (just prior to the 1989 season). Final escapement in 2001 with a regular fishery was near the upper end of the escapement goal.

Table 13.-Estimated hook-and-release mortalities by age class for early-run chinook salmon, Kenai River, 1999-2001.

	Ages							
	0.3	0.4	1.2	1.3	1.4	1.5	2.3	All
1999								
Inriver Return %	0.0	0.0	8.0	53.7	37.7	0.3	0.3	100
Inriver Return % SE	0.0	0.0	1.5	2.8	2.7	0.3	0.3	
Hook-&-Release Mortality	0	0	21	140	98	1	1	261
Hook-&-Release SE	0	0	14	92	65	1	1	171
2000								
Inriver Return %	0.8	0.3	8.4	43.4	46.5	0.6	0.0	100
Inriver Return % SE	0.5	0.3	2.1	3.5	3.5	0.6	0.0	
Hook-&-Release Mortality	2	1	15	80	86	1	0	185
Hook-&-Release SE	1	1	11	53	56	1	0	121
2001								
Inriver Return %	1.0	0.0	16.2	27.8	53.0	2.0	0.0	100
Inriver Return % SE	0.7	0.0	2.6	3.2	3.6	1.0	0.0	
Hook-&-Release Mortality	2	0	33	57	108	4	0	205
Hook-&-Release SE	2	0	22	37	70	3	0	131

Table 14.-Summary of population estimates for early-run chinook salmon of the Kenai River, 1986–2001.

Year	Deep Creek Marine Harvest	Eastside Set Net Harvest	Drift Gillnet Harvest	Subsistence[a]	Inriver Return	Total Return	Kenai River Sport Harvest	Hook-and-Release Mortality	Spawning Escapement
1986	Unknown	Closed	Closed		27,080	27,080	8,156	242	18,682
1987	Unknown	Closed	Closed		25,643	25,643	13,557	306	11,780
1988	Unknown	Closed	Closed		20,880	20,880	15,209	340	5,331
1989	Unknown	Closed	Closed	73	17,992	18,065	8,394	149	9,449
1990	Unknown	Closed	Closed	40	10,679	10,719	1,807	378	8,494
1991	Unknown	Closed	Closed	2	10,931	10,933	1,945	152	8,834
1992	Unknown	Closed	Closed	73	10,087	10,160	2,241	236	7,610
1993	Unknown	Closed	Closed	118	19,921	20,039	9,342	286	10,293
1994	Unknown	Closed	Closed	56	18,403	18,459	8,171	285	9,947
1995	Unknown	Closed	Closed	37	21,884	21,921	10,217	357	11,310
1996	Unknown	Closed	Closed	104	23,505	23,609	6,623	287	16,595
1997	Unknown	Closed	Closed	122	14,963	15,085	6,437	350	8,176
1998	Unknown	Closed	Closed	131	9,184	9,315	1,170	254	7,760
1999	Unknown	Closed	Closed	114	25,666	25,780	8,129	261	17,276
2000	Unknown	Closed	Closed	124	12,479	12,603	1,818	185	10,476
2001	Unknown	Closed	Closed	198	16,676	16,874	2,397	205	14,075

[a] Includes personal use and educational.

Table 15.-Estimated escapement by age class of early-run chinook salmon to the Kenai River, 1986–2001.

	Age Class													
	0.2	0.3	0.4	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	All
1986														
Inriver Return	0	0	0	0	4,191	11,384	9,349	2,116	0	0	0	40	0	27,080
SE Return	0	0	0	0	1,537	4,133	3,399	788	0	0	0	30	0	9,799
Harvest	0	0	0	15	583	2,957	3,874	728	0	0	0	0	0	8,156
SE Harvest	0	0	0	15	96	249	299	108	0	0	0	0	0	515
H-&-R Mortality[a]	0	0	0	0	37	102	84	19	0	0	0	0	0	242
SE H-&-R	0	0	0	0	25	68	55	13	0	0	0	0	0	161
Escapement[b]	0	0	0	0	3,571	8,326	5,391	1,368	0	0	0	40	0	18,682
SE Escapement	0	0	0	0	1,540	4,141	3,412	795	0	0	0	30	0	9,813
1987														
Inriver Return	0	0	0	0	393	9,859	14,683	577	0	0	26	105	0	25,643
SE Return	0	0	0	0	134	2,312	3,417	178	0	0	26	56	0	5,928
Harvest	0	0	0	0	116	4,220	8,498	636	0	0	0	87	0	13,557
SE Harvest	0	0	0	0	58	406	647	139	0	0	0	50	0	912
H-&-R Mortality[a]	0	0	0	0	5	118	175	7	0	0	0	1	0	306
SE H-&-R	0	0	0	0	3	80	119	5	0	0	0	1	0	208
Escapement[b]	0	0	0	0	273	5,521	6,009	0	0	0	26	17	0	11,780
SE Escapement	0	0	0	0	146	2,348	3,480	0	0	0	26	76	0	6,001
1988														
Inriver Return	0	0	0	0	373	3,302	14,888	2,237	53	0	27	0	0	20,880
SE Return	0	0	0	0	99	281	465	236	38	0	27	0	0	449
Harvest	0	0	0	26	291	1,855	11,950	1,033	0	0	0	53	0	15,209
SE Harvest	0	0	0	26	88	230	691	169	0	0	0	37	0	815
H-&-R Mortality[a]	0	0	0	0	6	54	243	36	1	0	0	0	0	340
SE H-&-R	0	0	0	0	4	36	161	24	1	0	0	0	0	225
Escapement[b]	0	0	0	0	75	1,394	2,695	1,167	52	0	26	0	0	5,331
SE Escapement	0	0	0	0	133	365	849	291	38	0	27	0	0	958
1989														
Inriver Return	0	0	0	0	746	2,780	12,767	1,699	0	0	0	0	0	17,992
SE Return	0	0	0	0	137	253	414	202	0	0	0	0	0	389
Harvest	0	0	0	92	275	2,202	5,275	550	0	0	0	0	0	8,394
SE Harvest	0	0	0	65	112	305	442	157	0	0	0	0	0	517
H-&-R Mortality[a]	0	0	0	0	6	23	105	14	0	0	0	0	0	149
SE H-&-R	0	0	0	0	4	16	73	10	0	0	0	0	0	103
Escapement[b]	0	0	0	0	465	555	7,386	1,134	0	0	0	0	0	9,449
SE Escapement	0	0	0	0	177	397	610	257	0	0	0	0	0	655

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Table 15.-Page 2 of 4.

	Age Class													
	0.2	0.3	0.4	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	All
1990														
Inriver Return	0	0	0	0	773	2,840	6,385	682	0	0	0	0	0	10,679
SE Return	0	0	0	0	129	227	282	121	0	0	0	0	0	242
Harvest	0	0	0	0	102	102	1,349	255	0	0	0	0	0	1,807
SE Harvest	0	0	0	0	51	51	193	81	0	0	0	0	0	227
H-&-R Mortality[a]	0	0	0	0	27	101	226	24	0	0	0	0	0	378
SE H-&-R	0	0	0	0	9	32	69	8	0	0	0	0	0	115
Escapement[b]	0	0	0	0	643	2,638	4,810	403	0	0	0	0	0	8,494
SE Escapement	0	0	0	0	139	235	349	146	0	0	0	0	0	351
1991														
Inriver Return	0	0	0	0	801	2,450	7,115	565	0	0	0	0	0	10,931
SE Return	0	0	0	0	188	306	385	160	0	0	0	0	0	269
Harvest	0	0	0	0	0	166	1,573	207	0	0	0	0	0	1,945
SE Harvest	0	0	0	0	0	82	202	91	0	0	0	0	0	209
H-&-R Mortality[a]	0	0	0	0	11	34	99	8	0	0	0	0	0	152
SE H-&-R	0	0	0	0	6	18	51	4	0	0	0	0	0	78
Escapement[b]	0	0	0	0	790	2,250	5,443	351	0	0	0	0	0	8,834
SE Escapement	0	0	0	0	188	317	438	184	0	0	0	0	0	349
1992														
Inriver Return	0	0	0	0	820	2,870	5,864	533	0	0	0	0	0	10,087
SE Return	0	0	0	0	177	300	351	145	0	0	0	0	0	255
Harvest	0	0	0	0	94	377	1,698	71	0	0	0	0	0	2,241
SE Harvest	0	0	0	0	47	91	167	41	0	0	0	0	0	177
H-&-R Mortality[a]	0	0	0	0	19	67	137	12	0	0	0	0	0	236
SE H-&-R	0	0	0	0	13	43	88	8	0	0	0	0	0	152
Escapement[b]	0	0	0	0	707	2,426	4,028	450	0	0	0	0	0	7,610
SE Escapement	0	0	0	0	184	316	398	151	0	0	0	0	0	346
1993														
Inriver Return	0	0	0	0	787	5,571	12,594	727	0	61	182	0	0	19,921
SE Return	0	0	0	0	215	505	584	207	0	61	105	0	0	386
Harvest	0	0	0	0	290	1,868	6,636	483	0	0	0	64	0	9,342
SE Harvest	0	0	0	0	96	235	388	123	0	0	0	46	0	419
H-&-R Mortality[a]	0	0	0	0	11	80	181	10	0	1	3	0	0	286
SE H-&-R	0	0	0	0	8	52	118	7	0	1	2	0	0	186
Escapement[b]	0	0	0	0	486	3,622	5,778	233	0	60	179	0	0	10,293
SE Escapement	0	0	0	0	235	560	711	241	0	61	105	0	0	600

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Table 15.-Page 3 of 4.

	Age Class													
	0.2	0.3	0.4	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	All
1994														
Inriver Return	0	0	0	0	649	3,689	13,012	770	0	41	122	122	0	18,403
SE Return	0	0	0	0	160	351	443	174	0	41	70	70	0	288
Harvest	0	0	0	0	303	675	6,960	233	0	0	0	0	0	8,171
SE Harvest	0	0	0	0	83	124	346	73	0	0	0	0	0	363
H-&-R Mortality[a]	0	0	0	0	10	57	202	12	0	1	2	2	0	285
SE H-&-R	0	0	0	0	7	37	131	8	0	1	1	1	0	185
Escapement[b]	0	0	0	0	336	2,956	5,850	525	0	40	120	120	0	9,947
SE Escapement	0	0	0	0	180	374	577	189	0	41	70	70	0	499
1995														
Inriver Return	0	0	0	0	1,070	4,474	15,270	973	0	0	0	97	0	21,884
SE Return	0	0	0	0	316	595	726	302	0	0	0	97	0	396
Harvest	0	0	0	0	0	378	8,451	1,387	0	0	0	0	0	10,217
SE Harvest	0	0	0	0	0	216	569	396	0	0	0	0	0	448
H-&-R Mortality[a]	0	0	0	0	17	73	249	16	0	0	0	2	0	357
SE H-&-R	0	0	0	0	12	48	161	11	0	0	0	2	0	231
Escapement[b]	0	0	0	0	1,052	4,023	6,570	0	0	0	0	96	0	11,310
SE Escapement	0	0	0	0	316	635	936	0	0	0	0	97	0	641
1996														
Inriver Return	0	0	0	0	1,846	6,746	14,415	497	0	0	0	0	0	23,505
SE Return	0	0	0	0	349	595	671	186	0	0	0	0	0	376
Harvest	0	0	0	0	414	1,288	4,760	161	0	0	0	0	0	6,623
SE Harvest	0	0	0	0	97	169	309	61	0	0	0	0	0	354
H-&-R Mortality[a]	0	0	0	0	23	82	176	6	0	0	0	0	0	287
SE H-&-R	0	0	0	0	15	54	115	4	0	0	0	0	0	188
Escapement[b]	0	0	0	0	1,410	5,376	9,479	330	0	0	0	0	0	16,595
SE Escapement	0	0	0	0	363	621	748	196	0	0	0	0	0	550
1997														
Inriver Return	0	0	0	0	632	5,211	8,962	158	0	0	0	0	0	14,963
SE Return	0	0	0	0	155	376	403	79	0	0	0	0	0	236
Harvest	0	0	0	0	200	680	5,278	280	0	0	0	0	0	6,437
SE Harvest	0	0	0	0	90	170	562	107	0	0	0	0	0	643
H-&-R Mortality[a]	0	0	0	0	15	122	210	4	0	0	0	0	0	350
SE H-&-R	0	0	0	0	10	81	139	3	0	0	0	0	0	233
Escapement[b]	0	0	0	0	417	4,410	3,475	0	0	0	0	0	0	8,176
SE Escapement	0	0	0	0	180	420	705	0	0	0	0	0	0	723

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Table 15.-Page 4 of 4.

	Age Class													
	0.2	0.3	0.4	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	All
1998														
Inriver Return	0	0	0	0	1,740	3,384	3,770	290	0	0	0	0	0	9,184
SE Return	0	0	0	0	216	270	277	95	0	0	0	0	0	169
Harvest	0	0	0	0	15	228	851	76	0	0	0	0	0	1,170
SE Harvest	0	0	0	0	71	1,151	5,265	363	0	0	0	0	0	123
H-&-R Mortality[a]	0	0	0	0	48	94	104	8	0	0	0	0	0	254
SE H-&-R	0	0	0	0	31	61	68	6	0	0	0	0	0	164
Escapement[b]	0	0	0	0	1,677	3,062	2,815	206	0	0	0	0	0	7,760
SE Escapement	0	0	0	0	219	283	305	101	0	0	0	0	0	266
1999														
Inriver Return	0	0	0	0	2,060	13,784	9,664	79	0	0	79	0	0	25,666
SE Return	0	0	0	0	389	739	706	79	0	0	79	0	0	370
Harvest	0	0	0	36	677	2,948	4,202	230	0	36	0	0	0	8,129
SE Harvest	0	0	0	36	151	304	359	88	0	36	0	0	0	478
H-&-R Mortality[a]	0	0	0	0	21	140	98	1	0	0	1	0	0	261
SE H-&-R	0	0	0	0	14	92	65	1	0	0	1	0	0	171
Escapement[b]	0	0	0	0	1,362	10,696	5,364	0	0	0	78	0	0	17,276
SE Escapement	0	0	0	0	418	805	794	0	0	0	79	0	0	628
2000														
Inriver Return	0	103	34	0	1,046	5,417	5,808	72	0	0	0	0	0	12,479
SE Return	0	59	34	0	259	448	447	72	0	0	0	0	0	234
Harvest	19	0	0	19	19	303	1,401	57	0	0	0	0	0	1,818
SE Harvest	19	0	0	19	19	77	171	33	0	0	0	0	0	198
H-&-R Mortality[a]	0	2	1	0	15	80	86	1	0	0	0	0	0	185
SE H-&-R	0	1	1	0	11	53	56	1	0	0	0	0	0	121
Escapement[b]	0	101	34	0	1,011	5,034	4,320	14	0	0	0	0	0	10,476
SE Escapement	0	59	34	0	260	458	482	79	0	0	0	0	0	329
2001														
Inriver Return	0	168	0	0	2,695	4,632	8,843	337	0	0	0	0	0	16,676
SE Return	0	119	0	0	440	538	612	167	0	0	0	0	0	285
Harvest	34	0	0	0	304	405	1,620	34	0	0	0	0	0	2,397
SE Harvest	34	0	0	0	98	112	186	34	0	0	0	0	0	190
H-&-R Mortality[a]	0	2	0	0	33	57	108	4	0	0	0	0	0	205
SE H-&-R	0	2	0	0	22	37	70	3	0	0	0	0	0	131
Escapement[b]	0	166	0	0	2,358	4,170	7,114	299	0	0	0	0	0	14,075
SE Escapement	0	119	0	0	451	551	643	171	0	0	0	0	0	367

[a] H-&-R = Hook-and-Release.

[b] For some age classes in some years, estimated harvest in the sport fishery was greater than estimated inriver return. When this occurred, spawning escapement for that age class was set to zero, and spawning escapement by age class will not sum to total escapement.

Table 16.-Age composition by return year of early-run chinook salmon to the Kenai River, 1986–2001.

Return Year	(0.2, 1.1) Age 3	(0.3, 1.2, 2.1) Age 4	(0.4, 1.3, 2.2) Age 5	(0.5, 1.4, 2.3) Age 6	(1.5, 2.4) Age 7	(1.6, 2.5) Age 8	Total Return
1986 Est.	0	4,191	11,384	9,349	2,156	0	27,080
SE	0	1,537	4,133	3,399	788	0	9,799
1987 Est.	0	393	9,859	14,709	682	0	25,643
SE	0	134	2,312	3,417	187	0	5,928
1988 Est.	0	373	3,302	14,914	2,237	53	20,880
SE	0	99	281	466	236	38	449
1989 Est.	0	749	2,791	12,819	1,706	0	18,065
SE	0	137	254	415	203	0	389
1990 Est.	0	775	2,851	6,409	684	0	10,719
SE	0	129	228	282	122	0	242
1991 Est.	0	801	2,451	7,116	566	0	10,933
SE	0	188	306	385	160	0	269
1992 Est.	0	826	2,891	5,906	537	0	10,160
SE	0	179	302	353	146	0	255
1993 Est.	0	792	5,665	12,852	731	0	20,039
SE	0	216	512	596	208	0	386
1994 Est.	0	651	3,741	13,173	894	0	18,459
SE	0	160	354	450	188	0	288
1995 Est.	0	1,072	4,482	15,296	1,072	0	21,921
SE	0	316	596	727	318	0	396
1996 Est.	0	1,854	6,776	14,479	499	0	23,609
SE	0	351	598	674	187	0	376
1997 Est.	0	637	5,254	9,035	159	0	15,085
SE	0	156	379	406	79	0	236
1998 Est.	0	1,765	3,432	3,824	294	0	9,315
SE	0	219	274	281	97	0	169
1999 Est.	0	2,069	13,845	9,787	80	0	25,780
SE	0	391	742	713	80	0	370
2000 Est.	0	1,159	5,505	5,865	73	0	12,603
SE	0	268	453	452	73	0	234
2001 Est.	0	2,898	4,687	8,948	341	0	16,874
SE	0	461	544	619	169	0	285

Table 17.-Summary of returns by brood year for early-run chinook salmon in the Kenai River, brood years 1979-2001.

Brood Year	Spawning Escapement	Return (0.3,1.2,2.1) Age 4	Return (0.4,1.3,2.2) Age 5	Return (0.5,1.4,2.3) Age 6	Return (1.5,2.4) Age 7	Return (1.6,2.5) Age 8	Estimated Return To Date	Return Per Spawner
					(1986)	(1987)		
1979	Unknown				2,156	0	2,156	
SE					788	0	788	
				(1986)	(1987)	(1988)		
1980	Unknown			9,349	682	53	10,084	
SE				3,399	187	38	3,404	
			(1986)	(1987)	(1988)	(1989)		
1981	Unknown		11,384	14,709	2,237	0	28,331	
SE			4,133	3,417	236	0	5,368	
		(1986)	(1987)	(1988)	(1989)	(1990)		
1982	Unknown	4,191	9,859	14,914	1,706	0	30,670	
SE		1,537	2,312	466	203	0	2,822	
		(1987)	(1988)	(1989)	(1990)	(1991)		
1983	Unknown	393	3,302	12,819	684	0	17,199	
SE		134	281	415	122	0	533	
		(1988)	(1989)	(1990)	(1991)	(1992)		
1984	Unknown	373	2,791	6,409	566	0	10,138	
SE		99	254	282	160	0	424	
		(1989)	(1990)	(1991)	(1992)	(1993)		
1985	Unknown	749	2,851	7,116	537	0	11,253	
SE		137	228	385	146	0	490	
		(1990)	(1991)	(1992)	(1993)	(1994)		
1986	18,682	775	2,451	5,906	731	0	9,863	0.53
SE	9,813	129	306	353	208	0	527	0.28
		(1991)	(1992)	(1993)	(1994)	(1995)		
1987	11,780	801	2,891	12,852	894	0	17,438	1.48
SE	6,001	188	302	596	188	0	719	0.76
		(1992)	(1993)	(1994)	(1995)	(1996)		
1988	5,331	826	5,665	13,173	1,072	0	20,736	3.89
SE	958	179	512	450	318	0	773	0.71
		(1993)	(1994)	(1995)	(1996)	(1997)		
1989	9,449	792	3,741	15,296	499	0	20,328	2.15
SE	655	216	354	727	187	0	858	0.17

-continued-

Table 17.-Page 2 of 2.

Brood Year	Spawning Escapement	Return (0.3,1.2,2.1) Age 4	(0.4,1.3,2.2) Age 5	(0.5,1.4,2.3) Age 6	(1.5,2.4) Age 7	(1.6,2.5) Age 8	Estimated Return To Date	Return Per Spawner
		(1994)	(1995)	(1996)	(1997)	(1998)		
1990	8,494	651	4,482	14,479	159	0	19,771	2.33
SE	351	160	596	674	79	0	917	0.14
		(1995)	(1996)	(1997)	(1998)	(1999)		
1991	8,834	1,072	6,776	9,035	294	0	17,177	1.94
SE	349	316	598	406	97	0	795	0.12
		(1996)	(1997)	(1998)	(1999)	(2000)		
1992	7,610	1,854	5,254	3,824	80	0	11,012	1.45
SE	346	351	379	281	80	0	593	0.10
		(1997)	(1998)	(1999)	(2000)	(2001)		
1993	10,293	637	3,432	9,787	73	0	13,928	1.35
SE	600	156	274	713	73	0	783	0.11
		(1998)	(1999)	(2000)	(2001)	(2002)		
1994	9,947	1,765	13,845	5,865	341		21,816	2.19
SE	499	219	742	452	169		912	0.14
		(1999)	(2000)	(2001)	(2002)	(2003)		
1995	11,310	2,069	5,505	8,948			16,522	1.46
SE	641	391	453	619			861	0.11
		(2000)	(2001)	(2002)	(2003)	(2004)		
1996	16,595	1,159	4,687				5,847	0.35
SE	550	268	544				607	0.04
		(2001)	(2002)	(2003)	(2004)	(2005)		
1997	8,176	2,898					2,898	0.35
SE	723	461					461	0.06
		(2002)	(2003)	(2004)	(2005)	(2006)		
1998	7,760							
SE	266							
		(2003)	(2004)	(2005)	(2006)	(2007)		
1999	17,276							
SE	628							
		(2004)	(2005)	(2006)	(2007)	(2008)		
2000	10,476							
SE	329							
		(2005)	(2006)	(2007)	(2008)	(2009)		
2001	14,075							
SE	367							

Note: Return year is in parentheses above estimate.

Table 18.-Sibling return ratios from early-run chinook salmon of the Kenai River, brood years 1980–1996.

Brood Year	Age 5/ Age4	Age 6/ Age 5	Age 6/ Age4+5	Age 7/ Age 6	Age 7/ Age 5+6	Age 7/ Age4+5+6
1980				0.07		
1981		1.29		0.15	0.09	
1982	2.35	1.51	1.06	0.11	0.07	0.06
1983	8.40	3.88	3.47	0.05	0.04	0.04
1984	7.49	2.30	2.03	0.09	0.06	0.06
1985	3.80	2.50	1.98	0.08	0.05	0.05
1986	3.16	2.41	1.83	0.12	0.09	0.08
1987	3.61	4.45	3.48	0.07	0.06	0.05
1988	6.86	2.33	2.03	0.08	0.06	0.05
1989	4.72	4.09	3.37	0.03	0.03	0.03
1990	6.89	3.23	2.82	0.01	0.01	0.01
1991	6.32	1.33	1.15	0.03	0.02	0.02
1992	2.83	0.73	0.54	0.02	0.01	0.01
1993	5.39	2.85	2.41	0.01	0.01	0.01
1994	7.84	0.42	0.38	0.06	0.02	0.02
1995	2.66	1.63	1.18			
1996	4.04					
Mean	5.09	2.33	1.98	0.07	0.04	0.04
SD	2.54	1.26	1.07	0.05	0.03	0.03
% Coeff. Var.	50%	54%	54%	72%	72%	73%
Maximum	8.40	4.45	3.48	0.15	0.09	0.08
Minimum	2.35	0.42	0.38	0.01	0.01	0.01

Table 19.-Harvest of chinook salmon estimated from the Statewide Harvest Survey above the Soldotna Bridge during the late run.

Year	SB-MR[a]	MR-SL[a]	SL-KL[a]	Total Above Soldotna Bridge
1996	1,562	491	75	2,128
1997	1,898	517	23	2,438
1998	1,200	334	0	1,534
1999	1,258	310	0	1,568
2000	2,597	549	11	3,157
2001	2,162	421	160	2,743

Note: This table is provided because some fish that are harvested after July 1 (late run) upstream of the Soldotna Bridge may actually be early-run fish.

[a] SB-MR = Soldotna Bridge to Moose River; MR-SL = Moose River to Skilak Lake; SL-KL = Skilak Lake to Kenai Lake.

Table 20.-Historical management actions taken by ADF&G for the early-run chinook salmon fishery of the Kenai River.

Year	BEG and Required Management Actions	Gear Regulations	Inseason Action Taken	Date
1986	None	Bait & trebles allowed	None	
1987	None	Bait & trebles allowed	None	
1988	None	Bait & trebles allowed	None	
1989	<5,300 Closed 5,300-9,000 Restrictions 9,000+ Bait	No bait; trebles allowed	Bait allowed	20-Jun
1990	<5,300 Closed 5,300-9,000 Restrictions 9,000+ Bait	No bait; trebles allowed	C&R, single-hook lures Chinook salmon fishing closed above bridge	7-Jun 1-7 July
1991	<5,300 Closed 5,300-9,000 Restrictions 9,000+ Bait	No bait; trebles allowed	C&R, single-hook lures Retention only below College Hole Closed to chinook fishing above College Hole	6-Jun 28-Jun 1-14 July
1992	<5,300 Closed 5,300-9,000 Restrictions, w/allowance for trophy fishing when C&R 9,000+ Bait	No bait; trebles allowed	Trophy fishing, single-hook lures Closed to chinook fishing at College Hole & above	10-Jun 1-14 July
1993	<5,300 Closed 5,300-9,000 Restrictions, w/allowance for trophy fishing when C&R 9,000+ Bait	No bait; trebles allowed	Bait allowed	26-Jun
1994	<5,300 Closed 5,300-9,000 Restrictions, w/allowance for trophy fishing when C&R 9,000+ Bait	No bait; trebles allowed	Bait allowed	24-Jun
1995	<5,300 Closed 5,300-9,000 Restrictions, w/allowance for trophy fishing when C&R 9,000+ Bait	No bait; trebles allowed	Bait allowed	17-Jun

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Table 20.-Page 2 of 2.

Year	BEG and Required Management Actions	Gear Regulations	Inseason Action Taken	Date
1996	<5,300 Closed	No bait; trebles allowed	Bait allowed	9-Jun
	5,300-9,000 Restrictions,		Fishing allowed on Monday	17-Jun
	w/allowance for trophy fishing when C&R			
	9,000+ Bait		Fishing allowed on Monday	24-Jun
1997	<5,300 Closed	No bait; trebles allowed	Trophy fishing, single-hook lures	17-Jun
	5,300-9,000 Restrictions,		Trophy fishing, single-hook lures above bridge	1-10 July
	w/allowance for trophy fishing when C&R			
	9,000+ Bait			
1998	<5,300 Closed	No bait; trebles allowed	Trophy fishing, single-hook lures	5-Jun
	5,300-9,000 Restrictions,		Trophy fishing, single-hook lures above bridge	1-10 July
	w/allowance for trophy fishing when C&R			
	9,000+ Bait			
1999	7,200–14,400	No bait or trebles allowed	Bait allowed	16-Jun
	no allowance for trophy fishing when C&R			
2000	7,200–14,400	No bait or trebles allowed	Trophy fishing	13-Jun
	w/allowance for trophy fishing when C&R		Rescind restriction	27-Jun
2001	7,200–14,400	No bait or trebles allowed	None	
	w/allowance for trophy fishing when C&R			

Notes: BEG = biological escapement goal; C&R = catch and release.

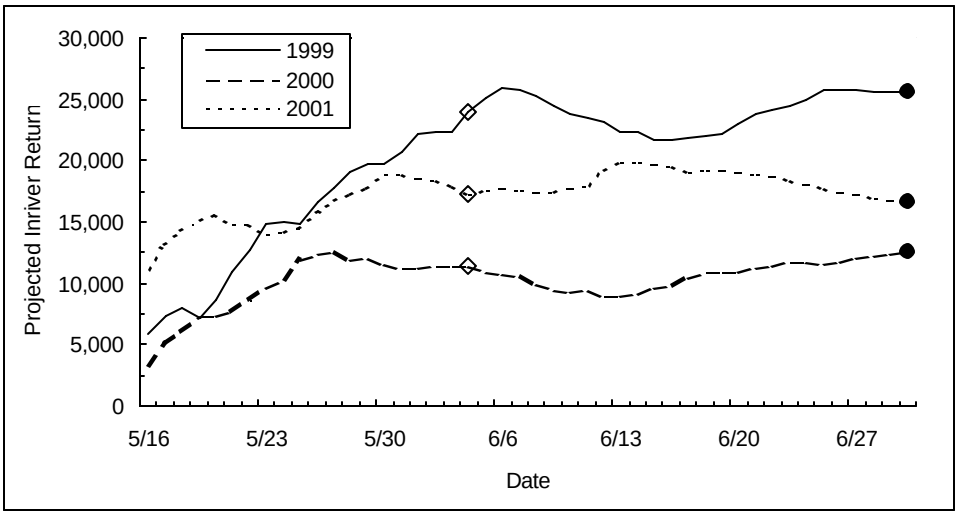

Figure 4.-Projections of inriver return for 1999, 2000, and 2001 using mean run timing (1988-2001) for the early-run chinook salmon return to the Kenai River. Open diamonds mark season projections on 4 June; closed circles mark final postseason estimates of inriver return from sonar.

AGE COMPOSITION OF RETURNS

There appear to be some changes developing in the age at return for this stock. There has been a decline in the number of age-1.5 fish returning (Table 15; Figure 6). Also, the age 6/age 5 sibling ratio has been well below average for 4 of the last 5 brood years, especially in the 1992 and 1994 broods (Table 18). These changes can and have had a large effect on the quality and duration of the early-run sport fishery. The unusually large return of age-5 fish in 1999 is largely what produced the near record return, large harvest, and near record escapement. The paucity of age-6 fish from this same brood the following year (2000) contributed greatly to the poor overall return, poor harvest, and restriction of the fishery on 13 June.

Age at maturity and growth have been shown to be partly heritable traits in chinook salmon (Hard et al. 1985; Ricker 1972; Withler et al. 1987; Hankin et al. 1993). Ricker (1981) listed eight possible causes for the decline in age and size experienced by chinook salmon in British Columbia. At most, only five of these causes are likely in the case of Kenai River chinook salmon: (1) marine fisheries harvest some fish that are immature, thereby older-maturing fish are subjected to harvest for more years and are less likely to survive to spawn; (2) a decrease in the overall abundance of a stock results in a decrease in the abundance of older, larger fish; (3) a change in the ocean environment may have reduced growth rate, age at maturity, or both; (4) a slow change in the genetic make-up of a stock could occur because of a tendency to harvest older fish; (7) a change in the type of fishing or regulations governing fishing may have occurred. (Conover and Munch 2002) demonstrated evolutionary effects of size-selective mortality on growth, yield, and population biomass on captive populations of a small marine species. We will continue to track returns at age for early-run chinook salmon and try to discern possible causes for change.

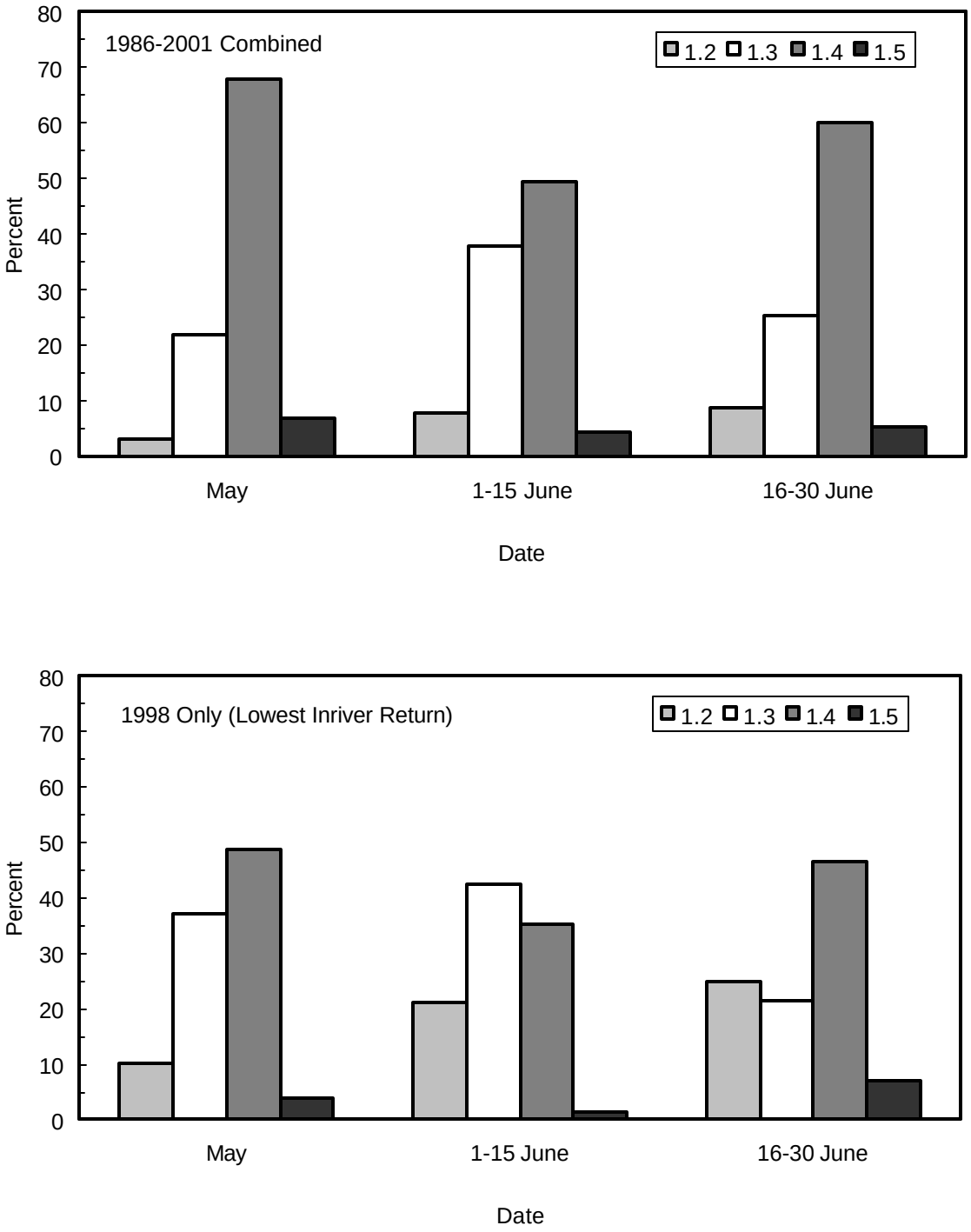

Figure 5.-Age composition (ages 1.2, 1.3, 1.4, and 1.5 only) of inriver return of early-run chinook salmon of the Kenai River, by date. Top panel: 1986-2001 combined. Bottom panel: 1998 only, which was the lowest inriver return during the period 1986-2001.

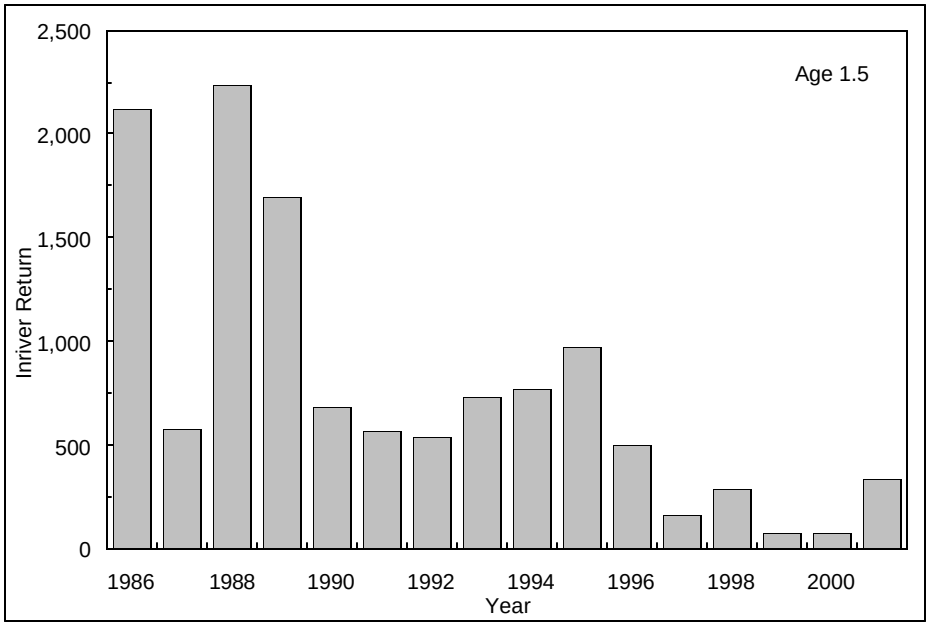

Figure 6.-Inriver return of age-1.5 chinook salmon during the early run, Kenai River, 1986-2001.

BIOLOGICAL ESCAPEMENT GOAL (BEG)

Returns in the range of the original biological escapement goal options of 5,300, 7,300, or 9,000 chinook salmon (McBride et al. 1989) presented to the Board of Fisheries in December 1988 have generally produced well. Because stock-recruit information had not been collected for this stock, these options were based on limited information. Since a BEG of 9,000 chinook salmon was adopted in December 1988, a Ricker model (Ricker 1975) has been fitted to the stock-recruit information collected in the intervening years (Figure 7). However, due to the short time series, poor contrast of returns, and measurement error, we are not certain that this model accurately characterizes the stock-recruit relationship (CTC 1999). The Ricker model continues to have some utility inseason as a diagnostic tool to predict gross magnitude of the return.

Predicting returns based on sibling ratios seemed promising at the outset of this program, and predictions were routinely published in previous reports. However, predictions for recent years were unacceptably different from actual returns. Our current method assumes that the distribution of age classes within brood years is stable, and thus sibling ratios from year to year should be similar. But for the most abundant age groups (ages 4, 5, and 6), ratios ranged from 2.35 to 8.40 for age 5 to age 4, and from 0.73 to 4.45 for age 6 to age 5. These broad fluctuations in sibling ratios suggest that the distribution of age classes within brood years is not similar enough from year to year to be an accurate predictor of return. However, examination of deviations from the average are another useful parameter in assessing the performance of a brood.

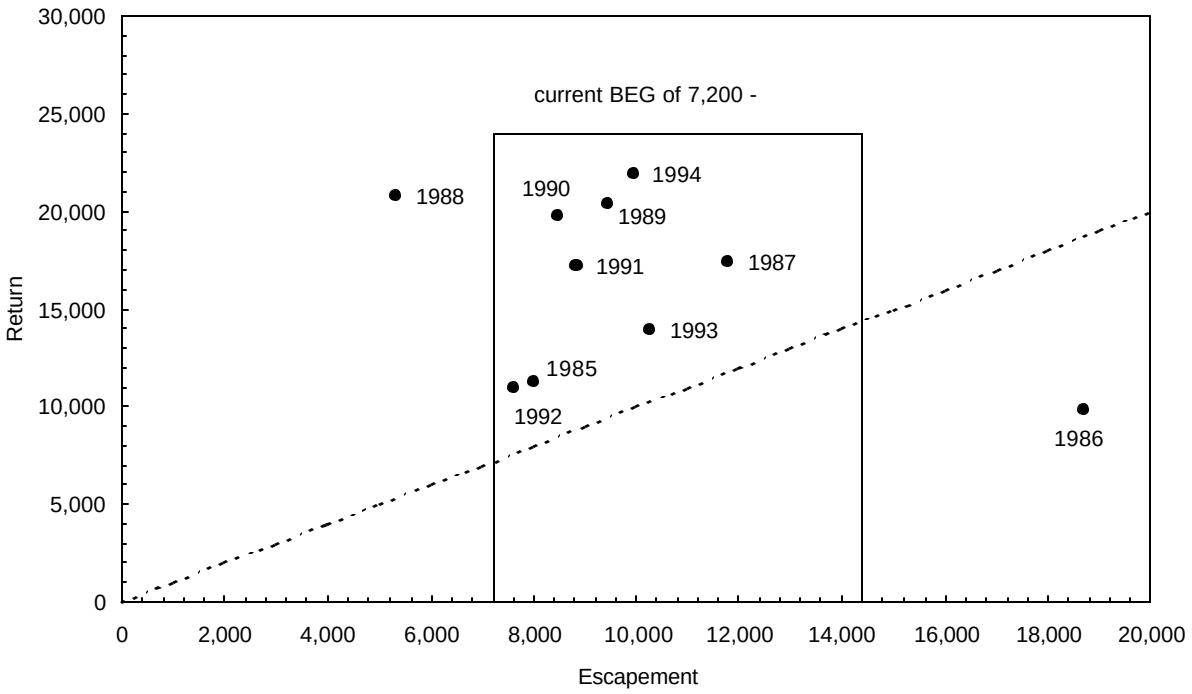

Figure 7.-Return plotted against escapement, line of replacement (dotted line), and BEG range (box) for early-run Kenai River chinook salmon, brood years 1985-1994.

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APPENDIX A. STATISTICAL METHODS

Appendix A1.-Notations used in Appendices A2–A8.

Notation	Definition
a	Age or sex
f	Temporal stratum
y	Brood year
$\hat{p}$	Estimated proportion
n	Sample size for estimating proportions
$\hat{I}$	Estimated inriver return
$\hat{H}$	Estimated inriver sport harvest
$\hat{C}$	Estimated inriver sport catch
S	Subsistence, personal use and educational fishery harvests
$\hat{T}$	Estimated total return
$\hat{M}$	Estimated hook-and-release mortality
$\hat{p}_m$	Estimated hook-and-release mortality rate
$\hat{E}$	Estimated spawning escapement
$\hat{R}_y$	Estimated total return in brood year y
RPS_y	Estimated return per spawner in brood year y
$\hat{r}_{ya}$	Estimated sibling ratio for age a fish in brood year y

Appendix A2.-Estimation of age and sex composition of inriver return.

The proportion at age or by sex in stratum t ($\hat{p}_{at}$) was estimated directly from age or sex composition data as:

$$\hat{p}_{at} = \frac{n_{at}}{n_t}, \tag{A2.1}$$

with variance (Cochran 1977):

$$\hat{V}(\hat{p}_{at}) = \frac{\hat{p}_{at}(1-\hat{p}_{at})}{(n_t - 1)}, \tag{A2.2}$$

where n_t is the number of scales for which age was determined from stratum t.

If age/sex composition did not differ significantly (P<0.05) among strata, the proportion of chinook salmon in age/sex group a during the entire run, and its variance, was estimated by pooling data across strata (equations A2.1 and A2.2 ignoring stratum subscripts t).

Inriver return in each age/sex group in each stratum was estimated by:

$$\hat{I}_{at} = \hat{I}_t \hat{p}_{at}, \tag{A2.3}$$

with variance (Goodman 1960):

$$\hat{V}(\hat{I}_{at}) = \hat{I}_t^2 \hat{V}(\hat{p}_{at}) + \hat{p}_{at}^2 \hat{V}(\hat{I}_t) - \hat{V}(\hat{p}_{at})\hat{V}(\hat{I}_t), \tag{A2.4}$$

where:

$\hat{I}_t$ and $\hat{V}(\hat{I}_t)$ = estimated inriver return and its variance during temporal stratum t.

If age/sex composition differed (P<0.05) among strata, a weighted proportion was calculated:

$$\hat{p}_a = \frac{\sum_t W_t \hat{p}_{at}}{\sum_t W_t}, \tag{A2.5}$$

where the weights W_t were estimates of inriver return by stratum. Variance of the weighted proportion was estimated with a parametric bootstrap procedure (Efron and Tibshirani 1993).

Appendix A3.-Estimation of total return and total return at age or by sex.

Total return was estimated from inriver return and subsistence, personal use, and educational fishery harvests:

$$\hat{T} = \hat{I} + S, \tag{A3.1}$$

with variance:

$$\hat{V}\left(\hat{T}\right) = \hat{V}\left(\hat{I}\right), \tag{A3.2}$$

because subsistence, personal use, and educational harvests were considered measured without error.

Total return at age or by sex was estimated from the age and sex compositions of the inriver return applied to the total return:

$$\hat{T}_a = \hat{p}_a \hat{T}, \tag{A3.3}$$

with variance (Goodman 1960):

$$\hat{V}\left(\hat{T}_a\right) = \hat{T}^2 \hat{V}(\hat{p}_a) + \hat{p}_a^2 \hat{V}\left(\hat{T}\right) - \hat{V}(\hat{p}_a)\hat{V}\left(\hat{T}\right). \tag{A3.4}$$

Appendix A4.-Estimation of age and sex composition of inriver sport harvest.

Inriver sport harvest at age or by sex was estimated by substituting the inriver sport harvest downstream of the Soldotna Bridge for the inriver return ($\hat{I}$) and substituting the age or sex composition of the inriver sport harvest for the age or sex composition of the inriver return in equations A2.1 through A2.4.

Total harvest ($\hat{H}$) was the sum of harvest downstream of the Soldotna Bridge and harvest upstream of the Soldotna Bridge. Total harvest at age or by sex was estimated from the age and sex compositions of the harvest downstream of the bridge applied to the total harvest, using equations A3.3 and A3.4, where $\hat{H}$ is substituted for $\hat{T}$.

Appendix A5.-Estimation of hook-and-release mortality.

Hook-and-release mortality was estimated by:

$$\hat{M} = \hat{p}_m\left(\hat{C} - \hat{H}\right), \tag{A5.1}$$

with variance:

$$\hat{V}\left(\hat{M}\right) = \hat{p}_m^2\left[\hat{V}\left(\hat{C}\right) + \hat{V}\left(\hat{H}\right)\right] + \left[\hat{C} - \hat{H}\right]^2\hat{V}\left(\hat{p}_m\right) - \left[\hat{V}\left(\hat{C}\right) + \hat{V}\left(\hat{H}\right)\right]\hat{V}\left(\hat{p}_m\right). \tag{A5.2}$$

where $\hat{p}_m$ = 0.088 and $\hat{V}(\hat{p}_m)$ = 0.000625 for 1990 (Bendock and Alexandersdottir 1991), and $\hat{p}_m$ = 0.040 and $\hat{V}(\hat{p}_m)$ = 0.000400 for 1991 (Bendock and Alexandersdottir 1992). Because hook-and-release mortality was not measured in other years, we averaged the 1990 and 1991 estimates, so that $\hat{p}_m$ = 0.064 and $\hat{V}(\hat{p}_m)$ = 0.001665 for all other years. Mortality differed by sex and size in 1991 (Bendock and Alexandersdottir 1992), but size and sex composition of releases were not measured in other years. Thus, hook-and-release estimates are probably biased because of the higher mortality for small males and the tendency of anglers to release smaller fish.

Mortalities at age or by sex were estimated from the age or sex compositions of the inriver return:

$$\hat{M}_a = \hat{p}_a\hat{M}, \tag{A5.3}$$

with variance:

$$\hat{V}\left(\hat{M}_a\right) = \hat{M}^2\hat{V}\left(\hat{p}_a\right) + \hat{p}_a^2\hat{V}\left(\hat{M}\right) - \hat{V}\left(\hat{p}_a\right)\hat{V}\left(\hat{M}\right). \tag{A5.4}$$

Appendix A6.-Estimation of spawning escapement and escapement at age or by sex.

Spawning escapement was estimated by subtracting sport harvest and hook-and-release mortality from the inriver return:

$$\hat{E} = \hat{I} - \hat{H} - \hat{M}, \tag{A6.1}$$

with variance:

$$\hat{V}\left(\hat{E}\right) = \hat{V}\left(\hat{I}\right) + \hat{V}\left(\hat{H}\right) + V\left(\hat{M}\right). \tag{A6.2}$$

Escapement at age or by sex was also estimated by subtraction:

$$\hat{E}_a = \hat{I}_a - \hat{H}_a - \hat{M}_a, \tag{A6.3}$$

with variance:

$$\hat{V}\left(\hat{E}_a\right) = \hat{V}\left(\hat{I}_a\right) + \hat{V}\left(\hat{H}_a\right) + V\left(\hat{M}_a\right). \tag{A6.4}$$

If estimated harvest in the sport fishery was greater than estimated inriver return, spawning escapement for that age class was set to zero, and spawning escapement by age class did not sum to total escapement.

Appendix A7.-Estimation of return by brood year and return per spawner.

Brood year returns were estimated by summing total return at age for those ages comprising the same brood year y:

$$\hat{R}_y = \sum_{a=1}^{j} \hat{T}_{ya}\,, \tag{A7.1}$$

with variance:

$$\hat{V}\left(\hat{R}_y\right) = \sum_{a=1}^{j} \hat{V}\left(\hat{T}_{ya}\right). \tag{A7.2}$$

Return per spawner was then estimated for brood year y as:

$$RPS_y = \frac{\hat{R}_y}{\hat{E}_y}, \tag{A7.3}$$

with variance (Lindgren 1976):

$$\hat{V}\left(RPS_y\right) = RPS_y^2 \left\{ \frac{\hat{V}\left(\hat{R}_y\right)}{\hat{R}_y^2} + \frac{\hat{V}\left(\hat{E}_y\right)}{\hat{E}_y^2} \right\}. \tag{A7.4}$$

Appendix A8.-Estimation of sibling ratios.

Sibling ratios were estimated by:

$$\hat{r}_{ya} = \frac{\hat{T}_{ya}}{\hat{T}_{y(a-1)}} \text{ or } \frac{\hat{T}_{ya}}{\sum_{j=4}^{a-1} \hat{T}_{yj}}, \tag{A8.1}$$

with variance (Lindgren 1976):

$$\hat{V}\left(\hat{r}_{ya}\right) = \hat{r}_{ya}^2 \left\{ \frac{\hat{V}\left(\hat{T}_{ya}\right)}{\hat{T}_{ya}^2} + \frac{\hat{V}\left(\hat{T}_{y(a-1)}\right)}{\hat{T}_{y(a-1)}^2} \right\} \text{ or } \hat{r}_{ya}^2 \left\{ \frac{\hat{V}\left(\hat{T}_{ya}\right)}{\hat{T}_{ya}^2} + \frac{\sum_{j=4}^{a-1} \hat{V}\left(\hat{T}_{yj}\right)}{\left[\sum_{j=4}^{a-1} \hat{T}_{yj}\right]^2} \right\}. \tag{A8.2}$$

For example, the sibling ratio of 6-year-old fish in the 1993 brood year could be expressed in terms of the abundance of 6-year-old fish relative to 5-year-old fish in the same brood year or in terms of the abundance of 6-year-old fish relative to 4- and 5-year old fish in the same brood year:

$$\hat{r}_{1993,6} = \frac{\hat{T}_{93,6}}{\hat{T}_{93,5}} \text{or} \frac{\hat{T}_{93,6}}{\hat{T}_{93,4} + \hat{T}_{93,5}}.$$

APPENDIX B. HISTORICAL DAILY AND CUMULATIVE INRIVER RETURN ESTIMATED BY SONAR

Appendix B1.-Daily and cumulative inriver returns of chinook salmon estimated by sonar during the early run, Kenai River, 1988-2001.

	1988 Estimate		1989 Estimate		1990 Estimate		1991 Estimate		1992 Estimate		1993 Estimate	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
5/07												
5/08												
5/09												
5/10												
5/11												
5/12												
5/13												
5/14												
5/15												
5/16	188	188	180	180	78	78	30	30	54	54	85	85
5/17	415	603	319	499	57	135	12	42	48	102	91	176
5/18	259	862	264	763	93	228	65	107	88	190	66	242
5/19	260	1,122	180	943	136	364	55	162	40	230	69	311
5/20	406	1,528	147	1,090	93	457	68	230	78	308	165	476
5/21	184	1,712	245	1,335	69	526	51	281	90	398	117	593
5/22	182	1,894	164	1,499	75	601	111	392	108	506	155	748
5/23	231	2,125	186	1,685	63	664	66	458	150	656	141	889
5/24	288	2,413	279	1,964	51	715	66	524	126	782	150	1,039
5/25	351	2,764	300	2,264	76	791	57	581	79	861	168	1,207
5/26	393	3,157	270	2,534	70	861	81	662	93	954	150	1,357
5/27	387	3,544	419	2,953	87	948	81	743	66	1,020	322	1,679
5/28	483	4,027	357	3,310	61	1,009	78	821	78	1,098	488	2,167
5/29	713	4,740	269	3,579	144	1,153	51	872	45	1,143	340	2,507
5/30	333	5,073	164	3,743	138	1,291	51	923	111	1,254	266	2,773
5/31	501	5,574	157	3,900	173	1,464	69	992	114	1,368	185	2,958
6/01	556	6,130	258	4,158	153	1,617	150	1,142	106	1,474	389	3,347
6/02	545	6,675	194	4,352	303	1,920	240	1,382	107	1,581	324	3,671
6/03	598	7,273	233	4,585	235	2,155	362	1,744	232	1,813	255	3,926
6/04	755	8,028	246	4,831	177	2,332	177	1,921	190	2,003	276	4,202
6/05	782	8,810	280	5,111	192	2,524	316	2,237	166	2,169	327	4,529
6/06	493	9,303	384	5,495	156	2,680	290	2,527	319	2,488	198	4,727
6/07	506	9,809	545	6,040	304	2,984	215	2,742	515	3,003	297	5,024
6/08	771	10,580	890	6,930	415	3,399	244	2,986	375	3,378	378	5,402
6/09	569	11,149	912	7,842	330	3,729	447	3,433	486	3,864	453	5,855
6/10	333	11,482	913	8,755	270	3,999	281	3,714	264	4,128	549	6,404
6/11	320	11,802	710	9,465	453	4,452	335	4,049	234	4,362	600	7,004
6/12	302	12,104	577	10,042	569	5,021	388	4,437	394	4,756	951	7,955
6/13	188	12,292	599	10,641	444	5,465	360	4,797	236	4,992	812	8,767
6/14	289	12,581	458	11,099	330	5,795	272	5,069	174	5,166	406	9,173
6/15	510	13,091	335	11,434	651	6,446	432	5,501	312	5,478	617	9,790
6/16	808	13,899	397	11,831	486	6,932	610	6,111	239	5,717	567	10,357
6/17	535	14,434	514	12,345	277	7,209	335	6,446	339	6,056	606	10,963
6/18	533	14,967	464	12,809	238	7,447	494	6,940	320	6,376	425	11,388
6/19	200	15,167	295	13,104	332	7,779	440	7,380	390	6,766	504	11,892
6/20	175	15,342	498	13,602	369	8,148	317	7,697	548	7,314	621	12,513
6/21	373	15,715	520	14,122	256	8,404	454	8,151	372	7,686	399	12,912
6/22	312	16,027	614	14,736	265	8,669	438	8,589	297	7,983	608	13,520
6/23	375	16,402	547	15,283	240	8,909	398	8,987	213	8,196	720	14,240
6/24	674	17,076	564	15,847	322	9,231	250	9,237	337	8,533	808	15,048
6/25	582	17,658	374	16,221	258	9,489	225	9,462	362	8,895	1,050	16,098
6/26	436	18,094	369	16,590	322	9,811	271	9,733	330	9,225	1,156	17,254
6/27	549	18,643	309	16,899	231	10,042	340	10,073	291	9,516	797	18,051
6/28	827	19,470	425	17,324	236	10,278	330	10,403	253	9,769	732	18,783
6/29	495	19,965	376	17,700	208	10,486	258	10,661	121	9,890	657	19,440
6/30	915	20,880	292	17,992	193	10,679	270	10,931	197	10,087	481	19,921
TOTAL		20,880		17,992		10,679		10,931		10,087		19,921

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	1994 Estimate		1995 Estimate		1996 Estimate		1997 Estimate		1998 Estimate[a]	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
5/07									6	6
5/08									18	24
5/09									3	27
5/10									3	30
5/11									12	42
5/12									12	54
5/13									27	81
5/14									43	124
5/15									63	187
5/16	238	238	98	98	60	60	114	114	48	235
5/17	342	580	99	197	91	151	99	213	45	280
5/18	260	840	78	275	63	214	93	306	57	337
5/19	302	1,142	149	424	96	310	165	471	36	373
5/20	369	1,511	228	652	177	487	84	555	54	427
5/21	327	1,838	465	1,117	165	652	129	684	33	460
5/22	246	2,084	265	1,382	156	808	114	798	15	475
5/23	212	2,296	286	1,668	159	967	162	960	12	487
5/24	303	2,599	265	1,933	159	1,126	138	1,098	33	520
5/25	170	2,769	198	2,131	153	1,279	165	1,263	81	601
5/26	150	2,919	189	2,320	240	1,519	220	1,483	43	644
5/27	267	3,186	165	2,485	204	1,723	325	1,808	60	704
5/28	258	3,444	159	2,644	330	2,053	317	2,125	63	767
5/29	347	3,791	222	2,866	512	2,565	288	2,413	63	830
5/30	321	4,112	351	3,217	348	2,913	350	2,763	129	959
5/31	369	4,481	282	3,499	474	3,387	318	3,081	93	1,052
6/01	321	4,802	357	3,856	603	3,990	213	3,294	111	1,163
6/02	266	5,068	369	4,225	740	4,730	241	3,535	189	1,352
6/03	298	5,366	549	4,774	873	5,603	376	3,911	192	1,544
6/04	304	5,670	693	5,467	1,051	6,654	324	4,235	186	1,730
6/05	351	6,021	429	5,896	943	7,597	427	4,662	162	1,892
6/06	198	6,219	807	6,703	741	8,338	327	4,989	150	2,042
6/07	384	6,603	843	7,546	772	9,110	591	5,580	283	2,325
6/08	306	6,909	999	8,545	918	10,028	441	6,021	300	2,625
6/09	462	7,371	789	9,334	1,140	11,168	391	6,412	234	2,859
6/10	432	7,803	876	10,210	684	11,852	527	6,939	162	3,021
6/11	423	8,226	774	10,984	882	12,734	512	7,451	408	3,429
6/12	329	8,555	417	11,401	864	13,598	537	7,988	779	4,208
6/13	376	8,931	492	11,893	1,071	14,669	681	8,669	510	4,718
6/14	514	9,445	691	12,584	1,111	15,780	424	9,093	630	5,348
6/15	306	9,751	636	13,220	1,116	16,896	318	9,411	585	5,933
6/16	453	10,204	648	13,868	420	17,316	348	9,759	455	6,388
6/17	315	10,519	750	14,618	495	17,811	405	10,164	414	6,802
6/18	435	10,954	808	15,426	697	18,508	315	10,479	252	7,054
6/19	636	11,590	419	15,845	657	19,165	399	10,878	303	7,357
6/20	402	11,992	594	16,439	315	19,480	408	11,286	168	7,525
6/21	570	12,562	438	16,877	351	19,831	252	11,538	183	7,708
6/22	366	12,928	375	17,252	396	20,227	390	11,928	165	7,873
6/23	550	13,478	178	17,430	401	20,628	225	12,153	156	8,029
6/24	696	14,174	450	17,880	573	21,201	285	12,438	183	8,212
6/25	734	14,908	429	18,309	684	21,885	332	12,770	138	8,350
6/26	597	15,505	334	18,643	504	22,389	381	13,151	135	8,485
6/27	639	16,144	946	19,589	228	22,617	363	13,514	123	8,608
6/28	681	16,825	696	20,285	303	22,920	297	13,811	189	8,797
6/29	929	17,754	984	21,269	234	23,154	570	14,381	222	9,019
6/30	649	18,403	615	21,884	351	23,505	582	14,963	165	9,184
TOTAL		18,403		21,884		23,505		14,963		9,184

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	1999 Estimate		2000 Estimate		2001 Estimate	
Date	Daily	Cum	Daily	Cum	Daily	Cum
5/07						
5/08						
5/09						
5/10						
5/11						
5/12						
5/13						
5/14						
5/15						
5/16	33	33	18	18	62	62
5/17	63	96	49	67	111	173
5/18	66	162	54	121	117	290
5/19	39	201	84	205	133	423
5/20	116	317	64	269	156	579
5/21	186	503	84	353	101	680
5/22	192	695	123	476	128	808
5/23	243	938	132	608	81	889
5/24	159	1,097	147	755	147	1,036
5/25	141	1,238	234	989	175	1,211
5/26	330	1.568	186	1.175	278	1.489
5/27	342	1,910	177	1,352	314	1,803
5/28	402	2,312	84	1,436	291	2,094
5/29	378	2.690	204	1.640	323	2.417
5/30	273	2,963	105	1,745	440	2,857
5/31	459	3,422	117	1,862	276	3,133
6/01	633	4,055	192	2,054	259	3,392
6/02	444	4,499	250	2,303	316	3,708
6/03	540	5,039	282	2,585	328	4,036
6/04	924	5,963	266	2,851	255	4,291
6/05	876	6,839	139	2,990	519	4,810
6/06	807	7,646	186	3,176	433	5,243
6/07	672	8,318	237	3,413	427	5,670
6/08	609	8.927	108	3.521	486	6.156
6/09	504	9,431	135	3,656	590	6,746
6/10	439	9,870	207	3,863	639	7,385
6/11	596	10.466	315	4.178	576	7.961
6/12	723	11,189	165	4,343	1,355	9,316
6/13	393	11,582	337	4,680	939	10,255
6/14	610	12.192	309	4.989	647	10.902
6/15	436	12,628	571	5,560	600	11,502
6/16	696	13,324	441	6,001	499	12,001
6/17	807	14.131	765	6.766	364	12.365
6/18	742	14,873	591	7,357	607	12,972
6/19	771	15,644	348	7,705	558	13,530
6/20	1.247	16.891	319	8.024	418	13.948
6/21	1,192	18,083	522	8,546	417	14,365
6/22	819	18,902	456	9,002	346	14,711
6/23	935	19.837	462	9.464	272	14.983
6/24	1,151	20,988	408	9,872	240	15,223
6/25	1,292	22,280	186	10,058	213	15,436
6/26	731	23.011	359	10.418	203	15.639
6/27	678	23,689	615	11,033	220	15,859
6/28	537	24,226	489	11,522	224	16,083
6/29	753	24.979	516	12.038	190	16.273
6/30	687	25,666	441	12,479	403	16,676
TOTAL		25,666		12,479		16,676

[a] 1998 estimate was derived with a right-bank threshold of 40 m instead of the usual 25 m threshold (see also Bosch and Burwen 2000).

APPENDIX C. HISTORICAL ESTIMATES OF HOOK-AND-RELEASE MORTALITY BY AGE

Appendix C1.-Historical age composition of chinook salmon mortalities due to hook and release during the early run, 1986–1998.

	Ages										
	0.3	0.4	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	All
1986											
Inriver Return %	0.00	0.00	15.5	42.0	34.5	7.8	0.00	0.00	0.00	0.15	100
Inriver Return % SE	0.00	0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	37	102	84	19	0	0	0	0	242
Hook-&-Release SE	0	0	25	68	55	13	0	0	0	0	161
1987											
Inriver Return %	0.00	0.00	1.5	38.4	57.3	2.2	0.00	0.00	0.10	0.41	100
Inriver Return % SE	0.00	0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	5	118	175	7	0	0	0	1	306
Hook-&-Release SE	0	0	3	80	119	5	0	0	0	1	208
1988											
Inriver Return %	0.00	0.00	1.8	15.8	71.3	10.7	0.26	0.00	0.13	0.00	100
Inriver Return % SE	0.00	0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	6	54	243	36	1	0	0	0	340
Hook-&-Release SE	0	0	4	36	161	24	1	0	0	0	225
1989											
Inriver Return %	0.00	0.00	4.1	15.5	71.0	9.4	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	0.8	1.4	1.7	1.1	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	6	23	105	14	0	0	0	0	149
Hook-&-Release SE	0	0	4	16	73	10	0	0	0	0	103
1990											
Inriver Return %	0.00	0.00	7.2	26.6	59.8	6.4	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	1.20	2.04	2.26	1.13	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	27	101	226	24	0	0	0	0	378
Hook-&-Release SE	0	0	9	32	69	8	0	0	0	0	115
1991											
Inriver Return %	0.00	0.00	7.3	22.4	65.1	5.2	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	1.7	2.7	3.1	1.5	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	11	34	99	8	0	0	0	0	152
Hook-&-Release SE	0	0	6	18	51	4	0	0	0	0	78
1992											
Inriver Return %	0.00	0.00	8.1	28.5	58.1	5.3	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	1.7	2.9	3.2	1.4	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	19	67	137	12	0	0	0	0	236
Hook-&-Release SE	0	0	13	43	88	8	0	0	0	0	152

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	Ages										
	0.3	0.4	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	All
1993											
Inriver Return %	0.00	0.00	3.95	27.96	63.22	3.65	0.00	0.30	0.91	0.00	100
Inriver Return % SE	0.00	0.00	1.08	2.48	2.66	1.04	0.00	0.30	0.52	0.00	
Hook-&-Release Mortality	0	0	11	80	181	10	0	1	3	0	286
Hook-&-Release SE	0	0	8	52	118	7	0	1	2	0	186
1994											
Inriver Return %	0.00	0.00	3.5	20.0	70.7	4.2	0.00	0.22	0.66	0.66	100
Inriver Return % SE	0.00	0.00	0.9	1.9	2.1	0.9	0.00	0.22	0.38	0.38	
Hook-&-Release Mortality	0	0	10	57	202	12	0	1	2	2	285
Hook-&-Release SE	0	0	7	37	131	8	0	1	1	1	185
1995											
Inriver Return %	0.00	0.00	4.89	20.44	69.78	4.44	0.00	0.00	0.00	0.44	100
Inriver Return % SE	0.00	0.00	4.89	20.44	69.78	4.44	0.00	0.00	0.00	0.44	
Hook-&-Release Mortality	0	0	17	73	249	16	0	0	0	2	357
Hook-&-Release SE	0	0	12	48	161	11	0	0	0	2	231
1996											
Inriver Return %	0.00	0.00	7.9	28.7	61.3	2.1	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	1.5	2.5	2.7	0.8	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	23	82	176	6	0	0	0	0	287
Hook-&-Release SE	0	0	15	54	115	4	0	0	0	0	188
1997											
Inriver Return %	0.00	0.00	4.2	34.8	59.9	1.1	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	1.0	2.5	2.5	0.5	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	15	122	210	4	0	0	0	0	350
Hook-&-Release SE	0	0	10	81	139	3	0	0	0	0	233
1998											
Inriver Return %	0.00	0.00	18.9	36.8	41.1	3.2	0.00	0.00	0.00	0.00	100
Inriver Return % SE	0.00	0.00	2.3	2.9	2.9	1.0	0.00	0.00	0.00	0.00	
Hook-&-Release Mortality	0	0	48	94	104	8	0	0	0	0	254
Hook-&-Release SE	0	0	31	61	68	6	0	0	0	0	164