

Fishery Data Series No. 01-01

**Surveys of the Chinook and Coho Salmon Sport
Fisheries in the Lower Naknek River, Alaska, 1999**

by

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and

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February 2001

Alaska Department of Fish and Game

Division of Sport Fish



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Weights and measures (metric)		General		Mathematics, statistics, fisheries	
centimeter	cm	All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.	alternate hypothesis	H_A
deciliter	dL	All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	e
gram	g	and	&	catch per unit effort	CPUE
hectare	ha	at	@	coefficient of variation	CV
kilogram	kg	Compass directions:		common test statistics	F, t, χ^2 , etc.
kilometer	km	east	E	confidence interval	C.I.
liter	L	north	N	correlation coefficient	R (multiple)
meter	m	south	S	correlation coefficient	r (simple)
metric ton	mt	west	W	covariance	cov
milliliter	ml	Copyright	©	degree (angular or temperature)	°
millimeter	mm	Corporate suffixes:		degrees of freedom	df
Weights and measures (English)		Company	Co.	divided by	÷ or / (in equations)
cubic feet per second	ft ³ /s	Corporation	Corp.	equals	=
foot	ft	Incorporated	Inc.	expected value	E
gallon	gal	Limited	Ltd.	fork length	FL
inch	in	et alii (and other people)	et al.	greater than	>
mile	mi	et cetera (and so forth)	etc.	greater than or equal to	≥
ounce	oz	exempli gratia (for example)	e.g.,	harvest per unit effort	HPUE
pound	lb	id est (that is)	i.e.,	less than	<
quart	qt	latitude or longitude	lat. or long.	less than or equal to	≤
yard	yd	monetary symbols (U.S.)	\$, ¢	logarithm (natural)	ln
Spell out acre and ton.		months (tables and figures): first three letters	Jan,...,Dec	logarithm (base 10)	log
Time and temperature		number (before a number)	# (e.g., #10)	logarithm (specify base)	log ₂ , etc.
day	d	pounds (after a number)	# (e.g., 10#)	mideye-to-fork	MEF
degrees Celsius	°C	registered trademark	®	minute (angular)	'
degrees Fahrenheit	°F	trademark	™	multiplied by	x
hour (spell out for 24-hour clock)	h	United States (adjective)	U.S.	not significant	NS
minute	min	United States of America (noun)	USA	null hypothesis	H_0
second	s	U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)	percent	%
Spell out year, month, and week.				probability	P
Physics and chemistry				probability of a type I error (rejection of the null hypothesis when true)	α
all atomic symbols				probability of a type II error (acceptance of the null hypothesis when false)	β
alternating current	AC			second (angular)	"
ampere	A			standard deviation	SD
calorie	cal			standard error	SE
direct current	DC			standard length	SL
hertz	Hz			total length	TL
horsepower	hp			variance	Var
hydrogen ion activity	pH				
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

FISHERY DATA SERIES NO. 01-01

**SURVEYS OF THE CHINOOK AND COHO SALMON SPORT FISHERIES
IN THE LOWER NAKNEK RIVER, ALASKA, 1999**

by

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ABSTRACT

Surveys of the sport fishery for chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* were conducted on the lower Naknek River in southwest Alaska during 1999. Anglers were interviewed for information on catch, effort, use of guide services and demographic characteristics. Age, sex, length and weight data were collected from chinook and coho salmon harvested by anglers.

Of 1,081 interviews obtained in the high-use exit area during the chinook salmon fishery, 37% (SE = 1.5%) of angler trips resulted in catches of chinook salmon and 30% (SE = 1.5%) resulted in harvests. The overall catch rate was 0.131 (SE = 0.007) fish/h. Anglers were typically unguided (63%; SE = 1.5%), non-Alaskan residents (62%; SE = 1.5%) and used spin tackle (97%; SE = 0.5%).

Of 371 interviews obtained in the low-use exit area during the chinook salmon fishery, 54% (SE = 2.5%) of angler-trips resulted in catches of chinook salmon and 37% (SE = 2.5%) resulted in harvests. The overall catch rate was 0.227 (SE = 0.016) fish/h. Anglers were typically guided (72%; SE = 2.3%), non-Alaskan residents (88%; SE = 1.7%) and used spin tackle (99%; SE = 0.5%).

Among 852 interviews during the coho salmon survey, 44% (SE = 1.8%) of angler trips resulted in catches of coho salmon and 42% (SE = 1.8%) resulted in harvests. The overall catch rate was 0.194 (SE = 0.016). Anglers were typically unguided (61%; SE = 1.7), non-Alaska residents (75%; SE = 1.5) and used spin tackle (85%; SE = 1.2).

Harvested chinook salmon averaged 745 mm long (29 in) and 8.2 kg (18 lbs), and most were age 1.3 and 1.4 (68%). Harvested coho salmon averaged 592 mm long (23 in) and 3,507 g (8 lbs), and most were age 2.1 (84%)

Key words: chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *O. kisutch*, Naknek River, catch and harvest distributions, harvest contributions, catch rates, angler characteristics, age, length and weight.

INTRODUCTION

The Naknek River is located on the Alaska Peninsula (Figure 1) and near the communities of King Salmon, Naknek and South Naknek. The Naknek River sustains the most effort (>15,000 angler-days annually) of any river in the southwest Alaska management area (Howe et al. 1998). Several factors contribute to the popularity of the Naknek River, including increasingly crowded and restricted fisheries in more populated regions of Alaska, ease of access, and regularly scheduled airline service into King Salmon. Although a variety of sport fish species are available, most angler effort occurs in the lower river and targets chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch*.

Angler effort increased steadily through the late 1970s and early 1980s when it stabilized near 15,000 angler-days (Mills 1979-1994; Howe et al. 1995-1998). Most effort targeting chinook salmon is concentrated on the lower Naknek River from Pauls Creek to Rapids camp (Figure 2). Most coho salmon angling occurs within the same range, though it does extend to the lake outlet later in the season. Harvest of chinook and coho salmon occurs in commercial, subsistence and sport fisheries (Tables 1 and 2). Similar to angler effort, chinook sport harvests peaked in the mid-1980s, but then declined slightly and have stabilized at approximately 3,170 chinook salmon and 2,679 coho salmon (Tables 1 and 2).

Current sport fish regulations affecting chinook salmon angling include: fishing closures in the mouths and lower reaches of King Salmon Creek and Pauls Creek; a daily bag limit of three chinook salmon of which only one may exceed 710 mm (28 in); an annual bag limit of five chinook salmon; guides may not retain fish while guiding; and an open season from 1 May

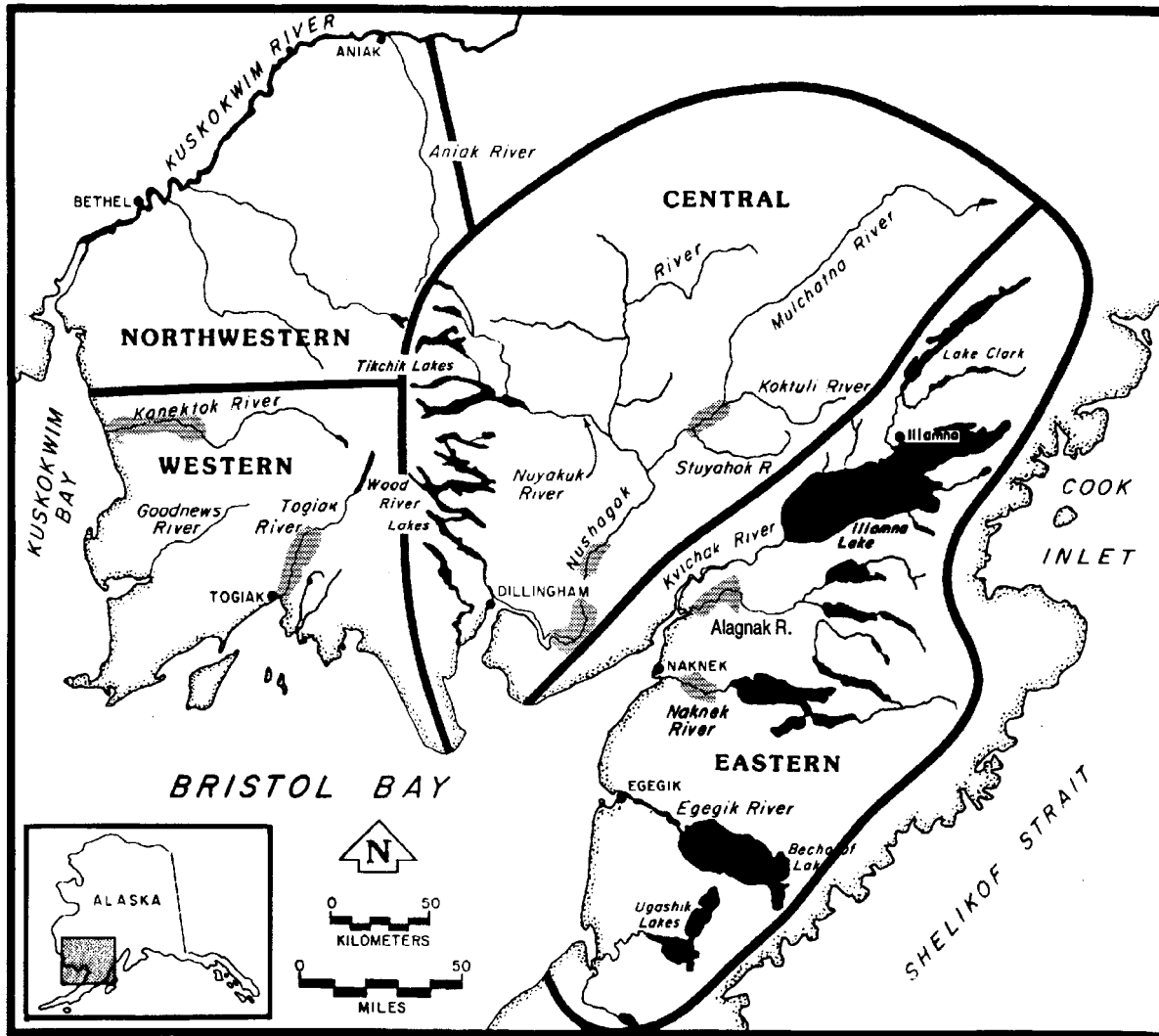


Figure 1.-Popular salmon fisheries in the Southwestern Alaska management area.

through 31 July (ADF&G 1999). The current sport fishing regulation affecting coho anglers is a daily bag limit of five fish with no size limit or annual bag limit (ADF&G 1999).

The Alaska Department of Fish and Game (ADF&G) has used creel surveys extensively throughout southwest Alaska to estimate sport angler effort, catch, harvest and angler demographics. Onsite fishery surveys of the Naknek River have been conducted sporadically by ADF&G since 1967, and the last survey of the sport fishery for chinook and coho salmon was conducted in 1995 (Dunaway and Fleischman 1996). Since 1995, there have been regulation changes, and several new lodges have been built along the Naknek River. These factors were justification for a survey of the chinook and coho salmon sport fisheries.

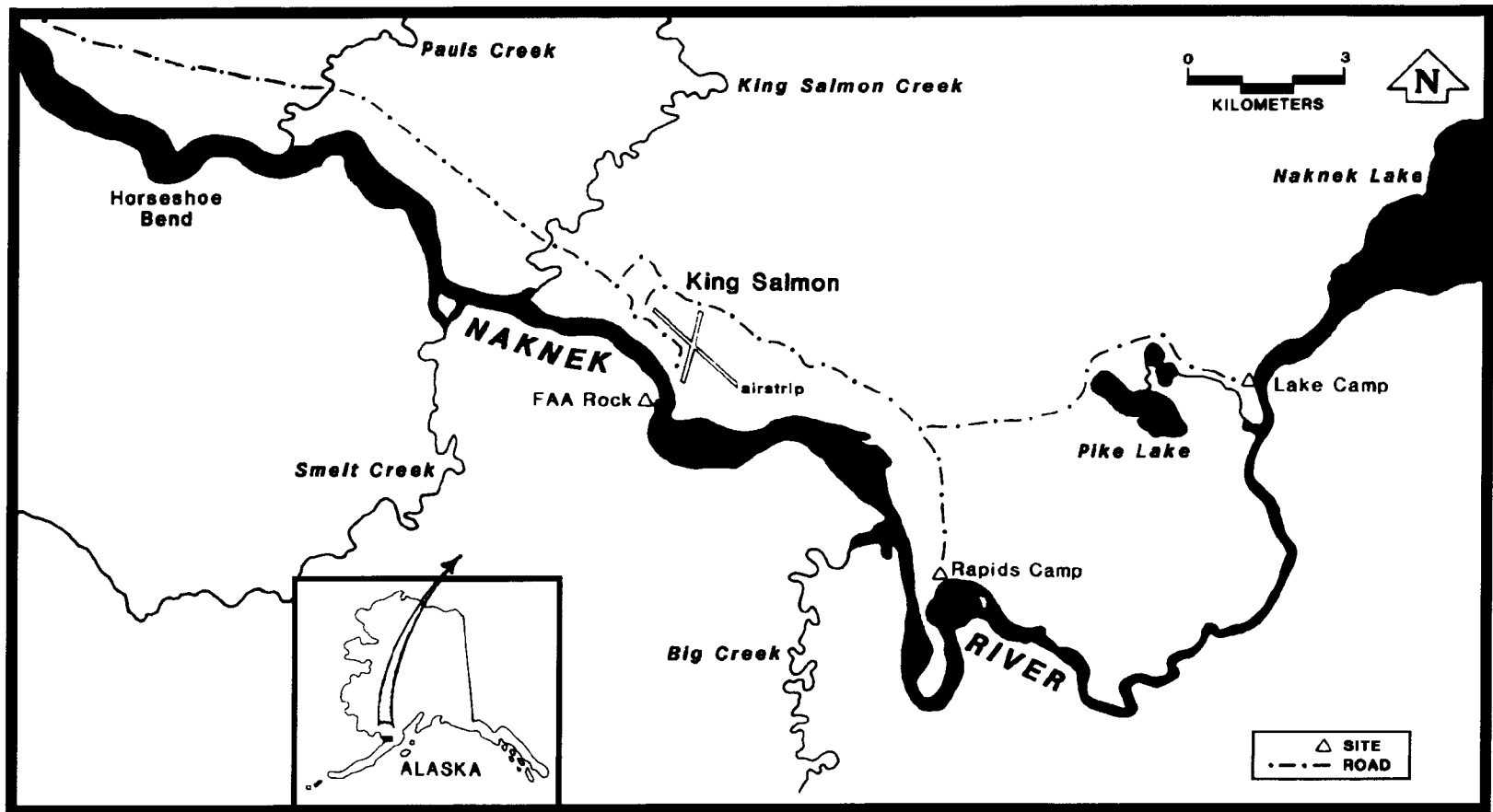


Figure 2.-Naknek River chinook and coho salmon angler survey site.

Table 1.-Commercial, subsistence and sport harvest, and escapement of chinook salmon for the Naknek River, 1970-1998.

Year	Harvest			Total	Escapement Index ^d
	Commercial ^a	Subsistence ^b	Sport ^c		
1970	19,037	300			4,145
1971	10,254	200			2,885
1972	2,262	400			2,791
1973	951	600			2,536
1974	480	1,000			
1975	964	700			3,452
1976	4,064	900			7,131
1977	4,373	1,300	1,005	6,678	
1978	6,930	1,200	2,628	10,758	
1979	10,415	1,200	2,264	13,879	
1980	7,517	1,500	2,729	11,746	
1981	11,048	1,000	2,581	14,629	4,271
1982	12,425	1,100	3,264	16,789	8,610
1983	8,955	1,000	3,545	13,500	7,830
1984	8,972	900	4,524	14,396	4,995
1985	5,697	1,179	5,038	11,914	
1986	3,188	1,295	6,160	10,643	3,917
1987	5,175	1,289	9,069	15,533	4,450
1988	6,538	1,057	5,291	12,886	11,730
1989	6,611	970	3,224	10,805	2,710
1990	5,068	985	2,796	8,849	7,000
1991	3,584	1,152	3,115	7,851	4,391
1992	5,724	1,444	2,633	9,801	2,691
1993	7,477	2,080	2,603	12,160	8,016
1994	6,016	1,843	3,692	11,551	9,678
1995	5,084	1,431	4,153	10,668	4,960
1996	4,195	1,574	2,984	8,753	5,076
1997	2,839	2,764	4,231	9,834	10,453
All Years Avg.	6,280	1,156	3,692	11,601	5,624
1993 to 1997 Avg.	4,782	1,425	3,170	9,377	7,637
1998	2,444	2,433	3,534	7,944	5,505

^a Naknek Kvichak district commercial harvests likely include Naknek, Alagnak, and Kvichak stocks. The harvests reported above for Naknek River stocks are therefore considered maximums. Source: 1971-1978 ADF&G 1991, Appendix Table 6; 1979-1998 ADF&G 2000, Appendix Table 6.

^b Naknek Kvichak District harvests. Harvests are extrapolated for all permits issued, based on returns. Permit and harvest estimates prior to 1989 based on the community where the permit was issued. Estimates from 1989 to the present are based on the area fished. Source: 1971-1978 ADF&G 1991, Appendix Table 46; 1979-1998 ADF&G 2000, Appendix Table 31.

^c Source: SWHS, Mills 1979-1994; Howe et al. 1995-1999. 1996-1998 estimates presented here are revised estimates. Previous reports showed sport harvest estimates from 1970-1976. These estimates were based either on voluntary angler reporting forms given to military anglers or onsite creel surveys (1971 and 1975). They are not directly comparable to the Statewide Harvest Survey estimates for 1977-1998, so are not reported here. The 1970-1976 estimates can be found in Gwartney and Russell 1977.

^d Actual raw counts made from fixed-wing aerial surveys. Source: Glick et al. 2000, Appendix Tables 3-5.

Table 2.-Commercial, subsistence and sport harvest of coho salmon for the Naknek River, 1971-1998.

Year	Harvest			Total
	Commercial ^a	Subsistence ^b	Sport ^c	
1971	89	100		
1972	402	100		
1973	255	500		
1974	916	200		
1975	43	200		
1976	1,195	600		
1977	2,883	300	297	3,480
1978	913	300	646	1,859
1979	12,355	1,200	300	13,855
1980	7,802	800	818	9,420
1981	1,229	1,100	1,156	3,485
1982	10,586	1,000	1,676	13,262
1983	7,282	900	1,385	9,567
1984	3,209	600	2,332	6,141
1985	10,474	1,103	1,281	12,858
1986	5,824	650	1,942	8,416
1987	5,274	1,106	2,579	8,959
1988	29,988	813	3,341	34,142
1989	22,668	1,927	3,092	27,687
1990	16,091	726	2,179	18,996
1991	17,527	1,056	4,475	23,058
1992	18,553	1,152	1,579	21,284
1993	1,779	2,025	1,034	4,838
1994	5,877	1,807	1,940	9,624
1995	981	1,791	1,788	4,560
1996	3,601	1,482	4,754	9,837
1997	718	1,457	3,879	6,054
All Years Avg.	6,982	926	2,023	11,971
1993 to 1997 Avg.	2,591	1,712	2,679	6,469
1998	1,587	1,592	2,547	5,726

^a Commercial harvests are for the Naknek/Kvichak District and therefore include stocks destined for the Kvichak, Alagnak, and Naknek Rivers. Source: 1971-1978 ADF&G 1991, Appendix Table 46; 1979-1998 ADF&G 2000, Appendix Table 9.

^b Naknek/Kvichak District total. Subsistence harvests are extrapolated for all permits issued, based on returns. Estimates prior to 1989 are based on the community where the permit was issued; estimates from 1989 to the present are based on the area fished. Estimates prior to 1985 are rounded to the nearest 100 fish. Source: 1971-1978 ADF&G 1991, Appendix Table 9; 1979-1998 ADF&G 2000, Appendix Table 31.

^c Sources: SWHS, Mills 1979-1995; Howe et al. 1995-1999.

The objectives of the 1999 fisheries survey on the lower Naknek River were:

1. To estimate the distribution of catch and harvest success by angler-day among anglers in the lower Naknek River chinook and coho salmon sport fisheries;
2. To estimate the contributions to the harvests of each fish in anglers' daily bags for both fisheries;
3. To estimate the weekly and overall catch per unit effort (CPUE) for both fisheries;
4. To estimate the percentage of angler-trips by angler type (residency status, guided or unguided) and terminal tackle type (flies or lures) for both fisheries;
5. To estimate the age, length and sex compositions of chinook and coho salmon harvested for both fisheries; and
6. To index by aerial survey the spawning escapement of chinook and coho salmon in Pauls, King Salmon and Big creeks and the mainstem of the Naknek River.

METHODS

A survey of the chinook and coho salmon sport fisheries was conducted on the lower Naknek River at two locations. The first, located between King Salmon Creek and FAA rock, was termed the high-use area; the second, which was defined as the low-use area, was located between Big Creek and Rapids Camp (Figure 2). The chinook salmon survey occurred from 5 June through 31 July 1999 and the coho salmon survey occurred from 1 through 31 August 1999. During each sample day, a technician interviewed anglers and collected biological data from chinook and coho salmon retained by interviewed anglers. Additionally, an aerial survey was performed to index escapement.

CREEL SURVEY

Data Collection

Sampling was stratified by temporal component (variable time spans), day-type (weekday and weekends) and location (high- and low-use exit areas). Four days per week were sampled: Saturday, Sunday, and two weekdays. Weekdays were randomly selected without replacement from all paired combinations of weekdays (other than Tuesday and Thursday). The weekend of 4 July was sampled as a 3-day weekend. The Tuesday/Thursday combination was excluded to accommodate personnel scheduling, and therefore the resulting sample was not truly random. However, the departure from randomness was not expected to affect the accuracy of the estimates.

During the chinook salmon survey, the sampling day was 17 hours (0630-2330) and was divided into four 4.00 h sampling periods with two 0.50 h breaks for travel between high- and low-use areas. During the coho salmon survey, the sampling day was 16.00 hours (0630-2230), to account for decreased daylight, and was divided into four 3.75 h sample periods with two 0.50 h breaks for travel between high- and low-use areas.

The location-period combinations sampled within a day were systematically alternated within the weekday and weekend strata (Appendix A1). Ideally, the entire fishing-day would be covered at each location to obtain unbiased estimates, since anglers exiting the fishery early in the day are

on average more likely to be successful (Bernard et al. 1998). By alternating the location-period combinations, relatively unbiased estimates were expected.

To conduct interviews, a technician traveled (roved) throughout the fishery via motorboat. Interviews consisted of obtaining information about catch, harvest, effort (time duration), angler-type (guided, unguided, residency and gender) and terminal tackle from anglers encountered in the fishery. Only anglers who had suspended fishing for the day (completed trip) were interviewed. Technicians attempted to distribute their interview effort uniformly among all angling groups and throughout the survey area and to interview nearly all anglers exiting the fishery. Those anglers not interviewed were recorded as missed angler interviews. Completed-trip anglers who exited the fishery more than once during the day were asked to report their effort, catch and harvest for the entire day.

Information from angler interviews was used to estimate: (1) the distribution of catches and harvests of chinook and coho salmon by angler-day, (2) the contribution to total harvest of each fish in anglers' daily bags, (3) mean catch rate of interviewed anglers, and (4) the percentage of angler-trips by tackle type and angler type.

Data Analysis

Distributions of Angler Catches and Harvests

The proportions p_g and their variances of angler-days in which g or more fish were caught were calculated for each stratum h as:

$$\hat{p}_{gh} = \frac{\sum_{i=1}^{d_h} y_{ghi}}{m_h}, \quad (1)$$

$$\hat{V}[\hat{p}_{gh}] = \frac{\hat{p}_{gh}(1 - \hat{p}_{gh})}{m_h - 1}, \quad (2)$$

where y_{ghi} was the number of interviewed anglers on day i , within stratum h , whose catch or harvest puts them into category g , and m_h was the number of anglers interviewed within each stratum:

$$m_h = \sum_{i=1}^{d_h} m_{hi}, \quad (3)$$

where m_{hi} was the number of anglers interviewed each day within each stratum, and d_h was the number of days sampled within each stratum.

Overall estimates were calculated as the weighted means of individual stratum estimates:

$$\hat{p}_g = \sum_{h=1}^L \hat{W}_h \hat{p}_{gh}, \quad (4)$$

$$\hat{V}[\hat{p}_g] \approx \sum_{h=1}^L \hat{W}_h^2 \hat{V}[\hat{p}_{gh}], \quad (5)$$

where the weights were the proportions of total estimated angler trips in each stratum:

$$\hat{W}_h = \frac{\tilde{M}_h}{\sum_{h=1}^L \tilde{M}_h}, \quad (6)$$

$$\tilde{M}_h = D_h \tilde{M}_h = D_h \frac{\sum_{i=1}^{d_h} \tilde{M}_{hi}}{d_h} = D_h \frac{\sum_{i=1}^{d_h} Q_{hi} \tilde{M}_{hi}}{d_h} \approx D_h \frac{\sum_{i=1}^{d_h} Q_{hi} \frac{\sum_{j=1}^{q_h} \tilde{M}_{hij}}{q_{hi}}}{d_h}, \quad (7)$$

and where \tilde{M}_{hij} was the approximate number of angler-trips for period j within day i for each stratum (i.e., the count of all anglers observed by the technician regardless of whether or not they were interviewed), Q_{hi} was the number of sampling periods within each day (equal to four), q_{hi} was the number of sampling periods sampled within each day within each stratum, and D_h was the number of days available for sampling within each stratum.

Contributions to Total Harvest

The contribution to total harvest by each fish in anglers' daily bags was calculated as follows:

$$\hat{s}_g = \frac{\hat{p}_g}{\sum_{g=1}^{g_{\max}} \hat{p}_g}, \quad (8)$$

where \hat{p}_g was calculated as in equation (1) and g_{\max} was the largest observed number of fish in any angler's daily bag. The variance of \hat{S}_g was obtained by a bootstrap procedure (see Bernard et al. 1998; sect. 4.1).

Overall estimates of harvest contributions were calculated as weighted means of individual stratum estimates:

$$\hat{s}_g = \sum_{h=1}^L \hat{W}_h \hat{s}_{gh}, \quad (9)$$

where the weights were calculated following equation (6).

Catch Rate

Catch per unit effort (CPUE) was estimated for each stratum h as follows:

$$\overline{\text{cpue}}_h = \frac{\sum_{i=1}^{m_h} \text{cpue}_{hi}}{m_h}, \quad (10)$$

$$\hat{V}[\overline{cpue}_h] = \frac{\sum_{i=1}^{m_h} (cpue_{hi} - \overline{cpue}_h)^2}{m_h(m_h - 1)}, \quad (11)$$

where:

$$cpue_{hi} = \frac{c_{hi}}{e_{hi}}, \quad (12)$$

and where c_{hi} was the number of fish caught (both kept and released), and e_{hi} was the number of hours fished by angler i .

Overall CPUE was estimated as the weighted mean of individual stratum estimates:

$$\overline{cpue} = \sum_{h=1}^L \hat{W}_h \overline{cpue}_h, \quad (13)$$

where the weights were calculated as in equation (6).

Percentage of Angler-Trips by Terminal Tackle and Angler Type

Estimates of the proportion of angler-trips by angler type (local versus nonlocal, resident versus nonresident, etc.) and by terminal tackle use (lures versus flies) were estimated as simple binomial proportions. The proportion of angler trips by angler type that were type u was estimated as:

$$\hat{p}_u = \frac{n_u}{n}, \quad (14)$$

where n_u equals the number of anglers that were type u ; and n equals the total number of anglers interviewed.

The variance of the estimated proportion of angler types was estimated by the standard equation for the variance of a binomial proportion (Cochran 1977, equation 3.8, page 52, omitting the finite population correction factor):

$$\hat{V}[\hat{p}_u] = \frac{\hat{p}_u(1 - \hat{p}_u)}{n - 1}. \quad (15)$$

Assumptions

The assumptions necessary for unbiased point and variance estimates for the various parameters obtained by the procedures outlined above included the following:

1. Interviewed anglers accurately reported the number of fish by species released;
2. Interviewed anglers were representative of the total angler population;
3. No significant fishing effort occurred during the hours not included in the sampling day; and,
4. No significant fishing effort occurred in areas not covered by the survey.

BIOLOGICAL DATA

Sport harvested chinook and coho salmon encountered during angler interviews were sampled for age, sex, length and weight data. When possible, all chinook and coho salmon retained by interviewed anglers were sampled (i.e., no subsampling of the creel). The sampling design was expected to yield an equal proportional sample of the harvest through the progression of the fishery. The resultant data were treated as if collected from a simple random sample.

Harvested chinook and coho salmon were measured to the nearest millimeter for mid-eye to fork-of-tail length, weighed to the nearest 0.25 kg for chinook and 10 g for coho salmon and sexed based on external characteristics. In addition, three scales were removed from the preferred area¹ and mounted on an adhesive-coated card. Standard age determination procedures were used (see Jerald 1983 for a general description of the principles used). The European system of age designation was used, where the number of freshwater winter annuli precedes the decimal and the number of marine winter annuli follows. Total age of the brood year is the sum of the two numerals plus one.

Estimates of sex and age composition were calculated for chinook and coho salmon utilizing equations 14 and 15 where n_u equals the number of fish of age u ; and n equals total number of fish for which age or sex was determined. Mean length-at-age and weight-at-age of harvested chinook or coho salmon was estimated, following standard procedures (Sokal and Rohlf 1981, Boxes 4.2 and 7.1, pages 56 and 139).

To investigate if harvest composition was affected by the recently promulgated regulation of an annual bag limit of five chinook salmon, the proportions of harvested chinook salmon $<$ and \geq 710 mm total length in 1999 were compared to those during 1990, 1991 and 1995. The proportion of fish $<$ and \geq 645 mm mid-eye to fork-of-tail length (this length was used to duplicate the approximate mid-eye to fork-of-tail length of a fish measuring 710 mm total length) was determined. A chi-square contingency table was used to compare 1990, 1991 and 1995 proportions with each other and then between these years' proportions and 1999 proportions.

ESCAPEMENT SURVEY

Aerial surveys were conducted for Pauls, King Salmon and Big creeks and the mainstem of the Naknek River to count chinook and coho salmon on or near spawning grounds. Chinook salmon survey flights were conducted during early August and September. Coho salmon survey flights were to occur between mid to late September, but were cancelled due to inclement weather.

Counts of live and dead chinook salmon were made from fixed-wing aircraft by an observer wearing polarized sunglasses. The actual observed number of chinook salmon (both live and dead) was recorded by stream.

Expansions of raw counts to account for stream life, missed fish, missed sections of the stream or visibility were not made since the technical basis for expansion is dubious. The actual observed number of chinook salmon was considered the escapement index. Escapement indices are considered to be minimum escapement estimates. By using standardized survey procedures among years, escapement indices can be treated as a relative measure of the abundance of salmon

¹ The left side of the fish approximately two rows above the lateral line and on a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Scarnecchia 1979 and Welander 1940).

on the spawning grounds. The Naknek River drainage is presently managed for a minimal escapement index of 5,000 chinook salmon (Dunaway and Jaenicke 2000).

RESULTS

CHINOOK SALMON

Catch and Harvest

The distributions of catch and harvest were significantly different, based on non-overlapping 90% confidence intervals, between high- and low-use exit areas for several different proportions (Tables 3 and 4). Therefore, data from both areas were not pooled. Additionally, separate analyses and results allowed for comparability to previous surveys, as high-use exit area survey boundaries were similar among surveys.

Anglers from the high-use exit area caught chinook salmon during 37.1% (SE = 1.5%) of angler-trips and kept chinook salmon during 29.8% (SE = 1.5%) of angler-trips. Anglers caught and harvested several other fish species (Appendix A2). Fewer angler-trips resulted in multiple fish capture (11.4%; SE = 1.0%) or harvest (1.5%; SE = 0.4%).

Anglers from the low-use exit area caught chinook salmon during 53.7% (SE = 2.5%) of angler-trips and kept chinook salmon during 37.4% (SE = 2.5%) of angler-trips. Fewer angler-trips resulted in multiple fish capture (22.4%; SE = 2.2%) or harvest (2.4%; SE = 0.8%).

The contributions to daily bags of harvested fish were similar for anglers using both exit areas. Typically, the first fish kept accounted for most of the total harvest for both the high- (95.7%, SE = 0.9%) and low-use (94.2%; SE = 1.8%) exit areas (Table 5).

Among 1,452 interviews, catch rates were significantly different between high- and low-use exit areas. Due to differences, data from each exit area were analyzed and are presented separately (Table 6). Among 1,081 interviews obtained in the high-use exit area, CPUE ranged from 0.012 to 0.175 across all temporal components and overall CPUE was 0.131 (SE = 0.007). Among 371 interviews obtained in the low-use exit area, CPUE ranged from 0.000 to 0.307 across all temporal components and overall CPUE was 0.227 (SE = 0.016).

In the high-use exit area, catch rate of guided anglers (0.176; SE = 0.012; n = 397) was greater than unguided anglers (0.107; SE = 0.008; n = 679). In the low-use exit area, catch rates of guided anglers (0.266; SE = 0.019; n = 269) was also greater than unguided anglers (0.138; SE = 0.029; n = 102).

As a result, catch rates of guided anglers were significantly greater than catch rates of unguided anglers, regardless of exit area. CPUE of guided anglers in exit areas combined ranged from 0.003 to 0.256 across all temporal components and 0.216 overall (SE = 0.011; Table 7). CPUE of unguided anglers in exit areas combined ranged from 0.011 to 0.149 across all temporal

Table 3.-Estimated proportion of angler-trips, by exit location, which resulted in catches of zero, one or more, and up to seven or more chinook salmon, lower Naknek River, 5 June–31 July 1999.

Catches	High-Use Exit Location				Low-Use Exit Location			
	Proportion	SE	90% CI		Proportion	SE	90% CI	
			Lower	Upper			Lower	Upper
0	0.629	0.015	0.605	0.654	0.463	0.025	0.423	0.504
1+	0.371	0.015	0.346	0.395	0.537	0.025	0.496	0.577
2+	0.114	0.010	0.097	0.131	0.224	0.022	0.189	0.260
3+	0.028	0.005	0.020	0.037	0.103	0.017	0.076	0.131
4+	0.006	0.002	0.002	0.010	0.051	0.013	0.030	0.072
5+	0.003	0.001	0.001	0.005	0.013	0.007	0.002	0.024
6+	0.003	0.001	0.001	0.005	0.006	0.004	0.000	0.013
7+	0.001	0.001	0.000	0.001	0.004	0.004	0.000	0.010

Table 4.-Estimated proportion of angler-trips, by exit location, which resulted in harvests of zero, one or more, and up to three chinook salmon, lower Naknek River, 5 June–31 July 1999.

Harvest	High-Use Exit Location				Low-Use Exit Location			
	Proportion	SE	90% CI		Proportion	SE	90% CI	
			Lower	Upper			Lower	Upper
0	0.702	0.015	0.678	0.726	0.626	0.025	0.585	0.668
1+	0.298	0.015	0.274	0.322	0.374	0.025	0.332	0.415
2+	0.015	0.004	0.009	0.021	0.024	0.008	0.011	0.036
3	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.004

components and 0.109 overall (SE = 0.008; Table 7). CPUE of guided anglers was higher than unguided anglers for all temporal components, except the first (Figure 3).

Angler Characteristics

Angler characteristics were also partitioned by exit area. In the high-use exit area, 1,081 interviews were obtained of which 37.2% (SE = 1.5%) were guided anglers, 62.3% (SE = 1.5%) were non-Alaskan residents, and 10.9% (SE = 0.9%) were non-U.S. residents (Table 8). In the low-use exit area, 371 interviews were obtained of which 72.5% (SE = 2.3%) were guided anglers, 88.4% (SE = 1.7%) were non-Alaskan residents, and 2.7% (SE = 0.8%) were non-U.S.

Table 5.-Estimated proportion of chinook salmon harvest, by exit location, due to the first, second, and third fish in all anglers' daily creels, lower Naknek River, 5 June–31 July 1999.

Harvest	High-Use Exit Location				Low-Use Exit Location			
	Proportion	SE	90% CI		Proportion	SE	90% CI	
			Lower	Upper			Lower	Upper
1	0.957	0.009	0.943	0.972	0.942	0.018	0.912	0.971
2	0.043	0.009	0.028	0.057	0.056	0.018	0.027	0.085
3	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.006

Table 6.-Catch per unit of effort, by temporal component and exit location, for the chinook salmon sport fishery of the lower Naknek River, 5 June–31 July 1999.

Temporal Component	Date	Sample Size	CPUE ^a	90% Confidence Interval		
				SE	Lower	Upper
High-use Exit Area						
1	5-21 June	70	0.012	0.006	0.002	0.022
2	22-30 June	177	0.092	0.016	0.065	0.119
3	01-07 July	298	0.175	0.017	0.146	0.203
4	08-14 July	187	0.159	0.019	0.128	0.190
5	15-21 July	129	0.174	0.021	0.139	0.210
6	22-31 July	220	0.105	0.013	0.084	0.125
Entire Season		1,081	0.131	0.007	0.119	0.143
Low-use Exit Area						
1	5-21 June	29	0.000	0.000	0.000	0.000
2	22-30 June	66	0.131	0.028	0.085	0.178
3	01-07 July	99	0.298	0.041	0.231	0.366
4	08-14 July	45	0.222	0.041	0.155	0.289
5	15-21 July	61	0.265	0.048	0.186	0.345
6	22-31 July	71	0.307	0.035	0.250	0.364
Entire Season		371	0.227	0.016	0.201	0.253

^a Number of fish caught per angler-hour of effort.

Table 7.-Catch per unit of effort, by temporal component and angler type, for the chinook salmon sport fishery of the lower Naknek River, 5 June–31 July 1999.

Temporal Component	Date	Sample		90% Confidence Interval		
		Size	CPUE ^a	SE	Lower	Upper
Guided Anglers						
1	5-21 June	36	0.003	0.003	0.000	0.008
2	22-30 June	66	0.158	0.026	0.115	0.201
3	01-07 July	212	0.256	0.024	0.217	0.295
4	08-14 July	115	0.201	0.025	0.160	0.242
5	15-21 July	104	0.253	0.032	0.200	0.306
6	22-31 July	133	0.230	0.021	0.195	0.265
Entire Season		666	0.216	0.011	0.198	0.234
Unguided Anglers						
1	5-21 June	63	0.011	0.006	0.001	0.021
2	22-30 June	174	0.080	0.017	0.052	0.108
3	01-07 July	185	0.149	0.021	0.114	0.184
4	08-14 July	117	0.139	0.021	0.104	0.174
5	15-21 July	86	0.146	0.025	0.105	0.187
6	22-31 July	156	0.101	0.016	0.075	0.127
Entire Season		781	0.109	0.008	0.096	0.122

^a Number of fish caught per angler-hour of effort.

residents (Table 8). Both exit areas had similar percents by gender (over 80% male) and tackle type (over 95% spin fishing gear).

Biological Composition

Among 356 chinook salmon, males comprised 59.9% (SE = 2.9%) of the harvest (Table 9). Among 294 fish for which age could be determined, the predominant age groups were 1.4 (46.6%; SE = 2.9%) and 1.3 (21.1%; SE = 2.4%). Average length of 356 fish was 745 mm (SE = 8.5; 29 in) and average weight of 351 fish was 8.2 kg (SE = 0.4; 18 lbs).

The proportion of harvested fish < and ≥ 710 mm total length during 1990, 1991 and 1995 were found not to be significantly different ($p = 0.1118$), therefore data were pooled. The 1999 data had a greater proportion (75.9 %) of fish ≥ 710 mm total length harvested than the pooled years (64.6%). Comparing 1999 data with pooled data, a significant difference was observed ($p = 0.00003$).

Aerial Surveys

Aerial surveys were conducted 2 August for Pauls, King Salmon and Big creeks and 8 September for the mainstem of the Naknek River (Table 10). In Pauls Creek, 221 chinook salmon (65% > 10-year mean) were observed, and 847 (67% > 10-year mean) were observed in King Salmon Creek. Only 20% of fish were paired in both creeks. For the survey of Big Creek, 2,250 fish (27% > 10-year mean) were observed. Most fish were pooled together in the upper and lower

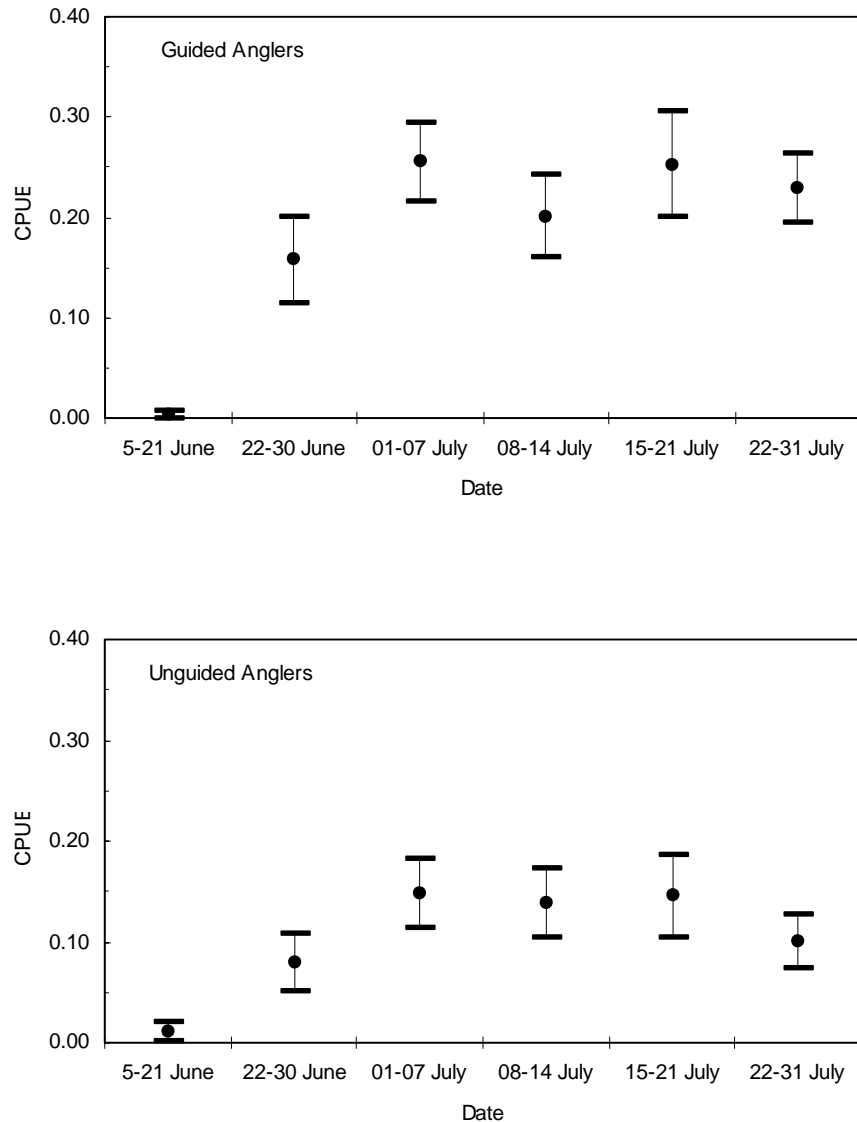


Figure 3.-Catch per unit of effort (numbers of chinook salmon per angler-hour) by date and angler type during the sport fishery, lower Naknek River, 1 June–31 July 1999.

reaches of the stream and very few fish were paired. The mainstem of the Naknek was surveyed about 3 weeks later than usual due to poor weather and water conditions. During the survey, 1,200 fish (67% < 10-year mean) were observed.

COHO SALMON

Catch and Harvest

There was only one significant difference (based on non-overlapping 90% confidence intervals) in catch and harvest distributions between high- and low-use exit areas during one temporal component, therefore data were not partitioned. About 44% (SE = 1.8%) of all angler-trips

Table 8.-Angler characteristics, by exit area, during the chinook salmon sport fishery of the lower Naknek River, 5 June–31 July 1999.

Characteristic	High-Use Exit Area			Low-Use Exit Area		
	Angler Trips	Percent	SE	Angler Trips	Percent	SE
ANGLER TYPE						
Guided	402	37.2	1.5	269	72.5	2.3
Unguided	679	62.8	1.5	102	27.5	2.3
Unknown	5	0.5	0.2	0	0.0	0.0
RESIDENCY						
Alaskan Residents	407	37.7	1.5	43	11.6	1.7
Local Alaskan Residents ^a	275	25.4	1.3	20	5.4	1.2
Nonlocal Alaskan Residents ^b	132	12.2	1.0	23	6.2	1.3
Non-Alaskan Residents	674	62.3	1.5	328	88.4	1.7
U.S. Resident	556	51.4	1.5	318	85.7	1.8
Non-U.S. Resident	118	10.9	0.9	10	2.7	0.8
GENDER						
Male	924	85.5	1.1	307	82.7	2.0
Female	157	14.5	1.1	63	17.0	2.0
TACKLE TYPE						
Lures	1,051	97.2	0.5	368	99.2	0.5
Fly	12	1.1	0.3	0	0.0	0.0
Lures and Fly	6	0.6	0.2	0	0.0	0.0
Unknown	12	1.1	0.3	3	0.8	0.5
TOTAL ANGLER TRIPS	1,081			371		

^a Alaskan resident living in Naknek, South Naknek, or the King Salmon area.

^b All other Alaskan residents.

resulted in catches of one or more coho salmon, and only 4.4% (SE = 0.8%) anglers captured three or more fish (Table 11). Similar proportions were observed for the harvest distributions (Table 12). Anglers caught and harvested several other fish species (Appendix A3).

For angler trips during which fish were harvested, most harvested fish were the first fish of the bag (77.5%, SE = 1.8%) and only 13.4% (SE = 1.2%) of harvested fish were the second contribution to the bag (Table 13). The remaining 9% of harvest was comprised of the third, fourth, and fifth harvested fish.

Among 852 interviews collected during the lower Naknek River coho salmon survey, the overall CPUE was 0.194 (SE = 0.016) fish/h and ranged from 0.077 to 0.278 fish/h across all temporal components (Table 14).

Table 9.-Mean lengths (millimeters) and weights (kilograms) of chinook salmon, by sex and age group, from the lower Naknek River sport harvest, 5 June–31 July 1999.

	Unknown	Age Group							Total	
		1.1	1.2	1.3	1.4	1.5	2.2	2.3		2.4
Females										
Percent				7	24	5		1	2	38
SE				1	3	1		1	1	3
Sample size				19	70	16		2	6	113
Mean length	836			817	837	865		791	832	837
SE	12			13	8	15		14	22	5
Sample size	23			18	70	16		2	6	135
Mean weight	9.6			9.3	10.9	10.5		7.4	10.3	10.4
SE	0.5			0.4	1.3	0.6		0.2	1.6	0.7
Sample size	23			18	70	16		2	2	135
Males										
Percent		1	12	14	22	3	5	1	1	60
SE		1	2	2	2	1	1	1	1	3
Sample size		3	36	42	66	8	14	4	3	176
Mean length	689	378	502	717	812	856	458	635	793	689
SE	31	18	12	20	12	28	13	124	22	12
Sample size	40	3	35	42	66	8	14	4	3	215
Mean weight	8.6	1.3	2.3	6.8	9.3	10.9	1.8	5.8	8.3	6.9
SE	1.8	0.3	0.2	0.6	0.5	1.2	0.1	2.7	0.4	0.4
Sample size	39	2	35	42	64	7	14	4	3	210
Unknown										
Percent			1	0	0	0				2
SE			1	0	0	0				1
Sample size			2	1	1	1				5
Mean length	680		578	640	832	803				685
SE			8							45
Sample size	1		2	1	1	1				6
Mean weight	4.5		2.9	5.0	9.0	8.3				5.4
SE			0.1							1.1
Sample size	1		2	1	1	1				6
All Samples										
Percent		1	13	21	47	9	5	2	3	100
SE		1	2	2	3	2	1	1	1	0
Sample size		3	38	62	137	25	14	6	9	294
Mean length	742	378	506	745	825	859	458	687	819	745
SE	21	18	12	16	7	13	13	85	17	9
Sample size	64	3	37	61	137	25	14	6	9	356
Mean weight	8.9	1.3	2.3	7.5	10.1	10.5	1.8	6.3	9.6	8.2
SE	1.2	0.3	0.2	0.4	0.7	0.5	0.1	1.7	1.1	0.4
Sample size	63	2	37	61	135	24	14	6	9	351

Table 10.-Aerial escapement counts for chinook salmon in the Naknek River and drainage, 1970-1999.

Year	Mainstream		King Salmon		Total
	Naknek	Pauls Creek	Creek	Big Creek	
1970	3,060		260	825	4,145
1971	1,639	52	704	490	2,885
1972	351	156	1,224	1,060	2,791
1973	1,315		115	1,106	2,536
1974		91	495	860	
1975	2,250	144	279	779	3,452
1976	5,950	31	180	970	7,131
1977	4,830		1,860		
1978					
1979					
1980	300	17		30	
1981	2,890		591	790	4,271
1982	5,360	340	980	1,930	8,610
1983	2,860	290	460	4,220	7,830
1984	790	400	385	3,420	4,995
1985	590				
1986	2,200	73	102	1,542	3,917
1987	2,800	7	290	1,353	4,450
1988	7,380	150	600	3,600	11,730
1989	1,700	50	100	860	2,710
1990	4,500	150	350	2,000	7,000
1991	1,655	121	275	2,340	4,391
1992	1,550	88	158	895	2,691
1993	5,520	86	700	1,710	8,016
1994	5,970	203	974	2,531	9,678
1995	2,790	26	239	1,905	4,960
1996	2,965	157	312	1,576	5,010
1997	7,520	248	902	1,783	10,453
1998	2,150	210	1,060	2,085	5,505
1970-98					
Average	3,111	140	544	1,626	5,422 ^a
Percent	57%	3%	10%	30%	
1999	1,200	221	847	2,250	4,518
Percent	27%	5%	6%	31%	

Source: Glick et al 2000, Appendix Tables 3-5.

^a Calculated as the sum of the averages.

Table 11.-Estimated proportion of angler-trips which resulted in catches of zero, one or more, and up to seven or more coho salmon, lower Naknek River, 1-31 August 1999.

Catches	Proportion	SE	90% CI	
			Lower	Upper
0	0.557	0.018	0.527	0.586
1+	0.443	0.018	0.414	0.473
2+	0.123	0.012	0.103	0.143
3+	0.044	0.008	0.032	0.057
4+	0.027	0.006	0.017	0.037
5+	0.015	0.005	0.007	0.023
6+	0.001	0.001	0.000	0.003
7+	0.001	0.001	0.000	0.002

Table 12.-Estimated proportion of angler-trips which resulted in harvests of zero, one or more, and up to five coho salmon, lower Naknek River, 1-31 August 1999.

Catches	Proportion	SE	90% Confidence Interval	
			Lower	Upper
0	0.579	0.018	0.550	0.608
1+	0.421	0.018	0.392	0.450
2+	0.092	0.011	0.075	0.110
3+	0.037	0.007	0.025	0.049
4+	0.023	0.006	0.013	0.033
5	0.013	0.005	0.006	0.021

Table 13.-Estimated proportion of coho salmon harvest due to the first through fifth fish in all anglers' daily creels, lower Naknek River, 1-31 August 1999.

Catches	Proportion	SE	90% Confidence Interval	
			Lower	Upper
1	0.775	0.018	0.746	0.804
2	0.134	0.012	0.114	0.153
3	0.048	0.006	0.037	0.058
4	0.028	0.005	0.019	0.037
5	0.016	0.004	0.009	0.023

Table 14.-Catch per unit of effort, by temporal component, for the coho salmon sport fishery of the lower Naknek River, 1–31 August 1999.

Temporal Component	Date	Sample Size	CPUE ^a	SE	90% Confidence Interval	
					Lower	Upper
7	1-7 August	140	0.077	0.022	0.041	0.112
8	8-14 August	193	0.141	0.026	0.098	0.184
9	15-21 August	249	0.217	0.036	0.158	0.277
10	22-31 August	270	0.278	0.025	0.237	0.319
Overall		852	0.194	0.016	0.169	0.220

^a Number of fish caught per angler-hour of effort.

Angler Characteristics

Among 852 interviews, 39.3% (SE = 1.7%) of the anglers were guided, 74.6% (SE = 1.5%) were non-Alaska residents, and 6.1% (SE = 0.8%) were nonresidents of the United States (Table 15). Male anglers accounted for 88.5% (SE = 1.1%) of all interviews. Most anglers used spin fishing gear (85.1%; SE = 1.2%).

Biological Composition

Among 270 coho salmon, males comprised 59.6% (SE = 3.2%) of the harvest (Table 16). Among 235 fish for which age could be determined, the predominant age group was 2.1 (84.3%; SE = 2.4%). Overall average length of 271 fish was 592 mm (SE = 2.6; 23 in) and overall average weight of 270 fish was 3,507 g (SE = 49; 8 lbs).

DISCUSSION

CHINOOK SALMON

Although equal sampling effort (time) was allotted for each exit area, only 25% of 1,452 interviews were obtained from the low-use exit. Other differences between anglers utilizing the two exit areas were observed. Significant differences in catch and harvest distributions, harvest contributions and catch rates for most temporal components and for the entire season were observed. These differences probably occurred as a result of the use of guiding services, because anglers from both exit areas fished the same portions of the river. Guided anglers comprised 73% of interviews in the low-use exit area, whereas guided anglers comprised only 37% of interviews in the high-use exit area. Guided anglers had better catch rates than unguided anglers. Most anglers utilizing the low-use exit area stayed at lodges, which provide guided services.

The 1999 chinook salmon fishing season was late by all indications (our data and anecdotal accounts). The first chinook salmon capture encountered in the survey occurred 20 June. A comparison with previous surveys of catch rates by temporal component indicates that chinook salmon run timing was delayed by about 7 to 10 days (Table 17). Late run timing occurred throughout Bristol Bay and may have been the result of a late break-up and cooler water. Many

Table 15.-Angler characteristics during the coho salmon sport fishery of the lower Naknek River, 1–31 August 1999.

Characteristic	Angler Trips	Percent	SE
ANGLER TYPE			
Guided	335	39.3	1.7
Unguided	517	60.7	1.7
RESIDENCY			
Alaskan Residents	213	25.0	1.5
Local Alaskan Residents ^a	182	21.4	1.4
Nonlocal Alaskan Residents ^b	32	3.8	0.7
Non-Alaskan Residents	636	74.6	1.5
U.S. Resident	584	68.5	1.6
Non-U.S. Resident	52	6.1	0.8
GENDER			
Male	754	88.5	1.1
Female	93	10.9	1.1
Unknown	5	0.6	0.3
TACKLE TYPE			
Spin	725	85.1	1.2
Fly	35	4.1	0.7
Spin and Fly	70	8.2	0.9
Unknown	22	2.6	0.5
Total Angler Trips	852		

^a Alaskan resident living in Naknek, South Naknek, or the King Salmon area.

^b All other Alaskan residents.

interviewed anglers expressed concern that the run was depressed in 1999 but catch rate data from previous surveys do not support this notion (Table 17), although comparisons are tenuous because methodologies were not exactly the same and statistical tests cannot be performed.

The average weight and length of sport harvested chinook salmon was about 20 mm and 0.6 kg greater than in 1991 and 1995, and about 30 mm and 1.1 kg greater than in 1990 (Coggins 1992; Dunaway and Bingham 1991; Dunaway and Fleischman 1996). This may indicate that angler behavior has changed to harvesting larger fish because an annual bag limit of five chinook salmon was promulgated in 1998 (Dunaway and Jaenicke 2000). Anglers may have decided to fill their limited annual bags with fish greater than 710 mm (> 28 inches) only, whereas before this regulation, an angler may have harvested any fish because each harvest only affected a daily bag limit. In support of this conclusion, it was found that a significantly greater proportion of harvested fish were ≥ 710 mm total length during the postregulation year (1999) than preregulation years (1990, 1991 and 1995). But, additional postregulation surveys are needed to

Table 16.-Mean lengths (millimeters) and weights (grams) of coho salmon, by sex and age group, from the lower Naknek River sport harvest, 1–31 August 1999.

	Unknown	Age Group					TOTAL
		1.1	1.2	2.1	2.2	3.1	
Females							
Percent		1		32	2	5	40
SE		1		3	1	1	3
Sample size		3		76	4	12	95
Mean length	601	590		597	572	590	596
SE	6	33		3	9	7	3
Sample size	15	3		76	4	12	110
Mean weight	3,460	3,233		3,499	3,000	3,242	3,440
SE	142	567		66	274	123	54
Sample size	15	3		76	4	12	110
Males							
Percent		3	0	52		5	60
SE		1	0	3		1	3
Sample size		6	1	122		11	140
Mean length	592	577	515	591		584	589
SE	10	26		5		16	4
Sample size	20	6	1	122		11	160
Mean weight	3,548	3,383	2,000	3,579		3,505	3,552
SE	239	450		84		282	75
Sample size	20	6	1	121		11	159
Unknown							
Percent							
SE							
Sample size							
Mean length	593						593
SE							
Sample size	1						1
Mean weight	3,700						3,700
SE							
Sample size	1						1
All Samples							
Percent		4	0	84	2	10	100
SE		1	0	2	1	2	0
Sample size		9	1	198	4	23	235
Mean length	596	581	515	593	572	587	592
SE	6	19		3	9	9	3
Sample size	36	9	1	198	4	23	271
Mean weight	3,515	3,333	2,000	3,548	3,000	3,367	3,507
SE	144	334		57	274	148	49
Sample size	36	9	1	197	4	23	270

Table 17.-Comparison of catch rates and angler characteristics for four surveys of the chinook salmon sport fishery of the lower Naknek River.

Statistic	1991 ^a		1992 ^a		1995 ^a		1999 ^b	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Total Interviews	1,490		2,030		1,430		1,081	1,081
Completed-trip Interviews	914		2,030		1,430		1,081	1,081
Catch Rate	0.12	0.007	not estimated		0.17	0.007	0.13	0.007
Catch and Harvest Distributions^c								
<u>Catch</u>								
0	70	4	not estimated		51.9	3.2	62.9	1.5
1+	30	3			48.1	3.2	37.1	1.5
2+	4	1			18.7	1.5	11.4	1
3+	1	<1			7.8	0.8	2.8	0.5
4+	<1	<1			2.8	0.5	0.6	0.2
5+	<1	<1			1.6	0.3	0.3	0.1
<u>Harvest</u>								
0	71	4	not estimated		54.5	3	70.2	1.5
1+	29	3			45.5	3	29.8	1.5
2+	3	<1			15	1	1.5	0.4
3	<1	<1			4.9	0.7	0	0
Angler Characteristics^c								
<u>Angler Type</u>								
Guided	24.3	1.4	41.7	1.1	38	1	37.2	1.5
Unguided	75.7	1.4	58.3	1.1	62	1	63	2
<u>Residency</u>								
Alaskan Residents	34.1	1.6	28.9	1.0	25.8	1.1	37.7	1.5
Non-Alaskan Residents	65.9	1.6	71.1	1.0	72.3	1.1	62.3	1.5
Non-U.S. Residents					17.2	1.0	10.9	0.9
<u>Gender</u>								
Male					87.0	0.9	85.5	1.1
Female					13.0	0.9	14.5	1.1
<u>Tackle Type</u>								
Spin	99.7	0.2	97.8	0.3	97.8	0.4	97.2	0.5
Fly	0.3	0.2	2.2	0.3	2.2	0.3	1.1	0.3
Spin and Fly	0.0	0.0					0.6	0.2

^a Dunaway and Fleischman 1996.

^b For comparisons between years, only data from the high-use exit location were used from 1999.

^c Percentage of angler trips.

determine if this is a real trend. Although harvest behavior may have been influenced, it can not be concluded that there is a detrimental effect on the population, because among all anglers, fewer fish are likely to be harvested.

The overall escapement index was less than the 10-year average by approximately 1,500 fish (Table 10). Although Pauls, King Salmon and Big creeks had greater index counts than the 10-year average, their sum total negligibly affected the overall escapement index. The survey of the mainstem Naknek River is the most probable cause for a less than average index count as 2,432 fewer individuals than average were counted. The escapement index of 4,512 fish was less than the goal of 5,000 fish. However, a conclusion of a shortfall in chinook salmon spawner numbers is not supported because of a very late survey on the mainstem and visual vagaries of these surveys.

For comparisons with previous surveys, only the results from the high-use exit area are useful because its boundaries are similar to the previous surveys. Although surveys were similar, methodologies were not replicated and direct statistical comparisons are not valid, therefore comparisons should be viewed cautiously. The average catch rate during 1999 was slightly greater than in 1991, but less than 1995 (Table 18). A similar pattern exists for the catch and harvest distributions. The proportion of guided anglers has remained near 40% during the last three surveys. Residency, gender and gear type have also remained similar. There was a smaller proportion (10.9% versus 17.2%) of non-U.S. resident anglers.

COHO SALMON

Similar to the chinook salmon survey, only 22% of all interviews were obtained in the low-use exit area. Of those anglers interviewed, 63% were guided and they fished the same portions of the river as anglers utilizing the high-use exit area. Unlike the chinook salmon survey, differences in catch and harvest distributions, harvest contributions and catch rates did not exist beyond a couple of instances. Differences either did not exist or may not have occurred because of fewer samples and/or greater variance.

The 1999 coho salmon run was poor throughout Bristol Bay, and resulted in an emergency order which reduced the daily bag limit from five to one fish on August 23, the beginning of the tenth temporal component (*Dunaway In prep*). Catch rates were depressed during temporal periods 7 and 8; however, catch rates did increase during temporal components 9 and 10. Harvest contributions of multiple fish also increased through temporal component 9 (Table 19). Unfortunately for anglers interested in harvesting coho salmon, as catch rates finally increased the bag limit was reduced, and the increase in proportions of multiple fish harvest, occurring before the emergency order, ceased.

During 1999, only 2.7% of angler trips resulted in catches of four or more coho salmon, and only 2.3% of angler trips resulted in harvest of four or more fish. Among angler trips that harvested coho salmon, the fourth and fifth fish occurred in only 4.4% of daily bags. Some anglers and guides suggested a reduction in the daily bag from five to three coho salmon. As proposed, the reduction would affect only a small proportion of angler trips as indicated by the 1999 data. However, this was an unusual year in which catch rates were depressed and the daily bag limit was reduced during the tenth temporal component. Since it is unknown if this affected normal angler harvest behavior, it is difficult to speculate how a reduction in bag limit would affect

Table 18.-Comparison of catch per unit effort in the chinook salmon sport fishery, by temporal component, for four surveys, lower Naknek River.

Temporal Component	Date	1990 ^a			1991		1995		1999 ^b	
		CPUE	SE	SE	CPUE	SE	CPUE	SE	CPUE	SE
1	1-21 June	0.077			0.024	0.007	0.092	0.017	0.012	0.006
2	22-30 June	0.189			0.091	0.009	0.161	0.015	0.092	0.016
3	01-07 July	0.124			0.116	0.012	0.136	0.014	0.175	0.017
4	08-14 July	0.143			0.132	0.019	0.234	0.018	0.159	0.019
5	15-21 July	0.108			0.154	0.023	0.155	0.015	0.174	0.021
6	22-31 July	0.072			0.159	0.019	0.184	0.021	0.105	0.013
Entire Season		0.127			0.117	0.007	0.170	0.007	0.131	0.007

^a Estimates of SE are not available for 1990.

^b 1999 estimates are for high-use exit area.

Table 19.-Estimated proportion of angler-trips, by temporal component, which resulted in harvests of one to five coho salmon, lower Naknek River, 1–31 August 1999.

Temporal Component	Harvest									
	1 Fish		2 Fish		3 Fish		4 Fish		5 Fish	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
7	0.893	0.042	0.107	0.042	0.000	0.000	0.000	0.000	0.000	0.000
8	0.755	0.055	0.126	0.026	0.072	0.021	0.036	0.018	0.011	0.009
9	0.564	0.036	0.237	0.019	0.096	0.015	0.062	0.013	0.041	0.012
10	0.951	0.012	0.037	0.010	0.010	0.004	0.002	0.002	0.000	0.000
Overall	0.775	0.018	0.134	0.012	0.048	0.006	0.028	0.005	0.016	0.004

anglers. Based on previous surveys, a reduction of the daily bag limit from five to three coho salmon would affect about 10% of all angler trips and about 16% of the anglers who harvest fish (Table 20; Coggins 1992; Dunaway and Fleischman 1996).

For comparisons with previous surveys, only the results from the high-use exit area are useful because its boundaries were similar to the previous surveys. Although surveys were similar, methodologies were not replicated and direct statistical comparisons are not valid; therefore, comparisons should be viewed cautiously. Catch and harvest distributions have remained similar among surveys for zero and one or more fish, but during 1999 about half as many angler-trips resulted in catches of two or more fish (Table 20). Compared to previous surveys, catch rates

Table 20.-Comparison of catch rates and angler characteristics from three surveys of the coho salmon sport fishery of the lower Naknek River.

Statistic	1991 ^a		1995 ^a		1999 ^b	
	Estimate	SE	Estimate	SE	Estimate	SE
Total Interviews	1,145		597		667	
Completed-trip Interviews	666		597		667	
Catch Rate	0.22		0.19		0.18	0.02
Catch and Harvest Distributions^c						
<u>Catch</u>						
0	60	4	56.7	2.8	58.0	2.1
1+	40	2	43.3	2.8	42.0	2.1
2+	25	2	26.0	2.3	12.2	1.4
3+	14	2	16.8	1.9	4.0	0.9
4+	10	2	12.5	1.7	2.5	0.7
5+	5	1	8.4	1.4	1.4	0.5
<u>Harvest</u>						
0	61	4	57.4	3.2	60.2	2.0
1+	39	3	42.6	3.2	39.8	2.0
2+	24	3	25.6	2.5	9.1	1.2
3+	14	2	16.1	2.0	3.3	0.8
4+	9	2	12.2	1.7	2.0	0.6
5	4	1	8.0	1.4	1.3	0.5
Angler Characteristics^c						
<u>Angler Type</u>						
Guided	21.8	1.6	36.0	2.0	32.8	1.8
Unguided	78.2	1.6	64.0	2.0	67.2	1.2
<u>Residency</u>						
Alaskan Residents	26.3	1.7	26.8	1.8	28.8	1.8
Non-Alaskan Residents	73.7	1.7	73.2	1.8	71.2	1.8
Non-U.S. Residents	N/A		14.4	1.4	7.5	1.0
<u>Gender</u>						
Male	N/A		86.6	1.4	88.3	1.2
Female	N/A		13.4	1.4	11.2	1.2
<u>Tackle Type</u>						
Spin	98.9	0.4	96.8	0.7	85.2	1.4
Fly	1.1	0.4	0.8	0.4	3.3	0.7
Spin and Fly	0.0		0.5	0.3	8.7	1.1

^a Dunaway and Fleischman 1996.

^b 1999 data are from the high-use exit location only.

^c Percentage of angler trips.

Table 21.-Comparison of catch per unit effort (number of fish caught per angler-hour of effort) from three surveys of the coho salmon sport fishery of the lower Naknek River.

Temporal Component	Date	1991 ^a		1995 ^a		1999 ^b	
		CPUE	SE	CPUE	SE	CPUE	SE
6	22-31 July	0.037	0.008	0.016	0.005		
7	1-7 August	0.526	0.065	0.292	0.037	0.086	0.026
8	8-14 August	0.300	0.029	0.507	0.072	0.152	0.023
9	15-21 August	0.324	0.031	0.203	0.037	0.219	0.045
10	22-31 August	0.197	0.019	0.297	0.045	0.235	0.031
Overall		0.222	0.012	0.186	0.016	0.184	0.019

^a Dunaway and Fleischman 1996.

^b Start date for 1999 was 1 August; only estimates from the high-use exit area were used for comparisons to previous surveys.

were depressed and the peak catch rates were later (Table 21). The differences in catch distributions are probably due to the poor coho salmon run and the enactment of the emergency order reducing the bag limit. Although catch rates had increased and catch-and-release fishing was possible, many anglers ceased fishing or switched to other species when their bag limit of one fish was reached, resulting in lower proportions of multiple fish catch distributions than previous surveys.

Consistent with previous surveys, most anglers were unguided, non-Alaskan residents and male (Table 20). The proportion of anglers utilizing only fly-fishing gear or fly and spin gear increased from about 1% to 12%. The biological composition of harvested fish was nearly identical to surveys performed in 1991 and 1995 (Coggins 1992; Dunaway and Fleischman 1996).

It is advisable to continue periodic surveys so that this important sport fishery will be well monitored. By standardizing methods, we will have statistically comparable figures to monitor use and its change over time. With greater understanding of the fishery and its participants, the department will be more prepared to face management issues in the future.

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APPENDIX A

Appendix A1.-A sampling schedule for the lower Naknek River creel survey during June 1999 is presented to demonstrate alternation of sampling between high and low use exit locations.

Temporal Component	Date	Day of Week	Period and Time				
			A 0630-1030 hours	B 1100-1500 hours	C 1500-1900 hours	D 1930-2330 hours	
1	5-Jun	Sat	Low	High	Low	High	
	6-Jun	Sun	High	Low	High	Low	
	7-Jun	Mon	Low	High	Low	High	
	8-Jun	Tues					
	9-Jun	Wed	High	Low	High	Low	
	10-Jun	Thurs					
	11-Jun	Fri					
	12-Jun	Sat	High	Low	High	Low	
	13-Jun	Sun	Low	High	Low	High	
	14-Jun	Mon					
	15-Jun	Tues					
	16-Jun	Wed	Low	High	Low	High	
	17-Jun	Thurs					
	18-Jun	Fri	High	Low	High	Low	
	19-Jun	Sat	Low	High	Low	High	
	20-Jun	Sun	High	Low	High	Low	
	21-Jun	Mon					
	2	22-Jun	Tues				
		23-Jun	Wed	Low	High	Low	High
		24-Jun	Thurs	High	Low	High	Low
25-Jun		Fri					
26-Jun		Sat	High	Low	High	Low	
27-Jun		Sun	Low	High	Low	High	
28-Jun		Mon					
29-Jun		Tues					
30-Jun	Wed	Low	High	Low	High		

Appendix A2.-Numbers of fish of all species kept and released by anglers during the chinook salmon survey on the lower Naknek River, 5 June-31 July 1999.

Species	Kept	Released
Chinook Salmon	488	423
Rainbow Trout	5	179
Red Salmon	63	15
Chum Salmon	24	22
Arctic Grayling	1	24
Pink Salmon	0	2
Coho Salmon	2	0

Appendix A3.-Numbers of fish of all species kept and released by anglers during the coho salmon survey on the lower Naknek River, 1-31 August 1999.

Species	Kept	Released
Coho Salmon	472	66
Rainbow Trout	4	162
Red Salmon	29	108
Chinook Salmon	0	86
Chum Salmon	13	68
Arctic Grayling	1	66
Dolly Varden	9	23
Pink Salmon	2	3
Northern Pike	1	0