

FISHERY DATA SERIES NO. 84

SPORT EFFORT FOR AND HARVEST OF
CHINOOK SALMON IN THE CHIGNIK RIVER,
ALASKA, DURING 1988¹

By

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ABSTRACT

A creel survey was conducted from 2 July through 4 August 1988 to estimate the sport effort for, catch, and harvest of chinook salmon *Oncorhynchus tshawytscha* in the Chignik River, Alaska. Data from these surveys indicated that sport anglers fished an estimated 601 angler-hours and harvested an estimated 233 chinook salmon. An additional 110 chinook salmon were estimated to have been caught and released. Age 1.4 chinook salmon were most abundant in the harvest. The estimated harvest of 233 chinook salmon represents an estimated 4.8 percent exploitation of the inriver escapement and estimated 1.9 percent exploitation of the total chinook salmon return to the Chignik River. Angler characteristic data collected in conjunction with the creel survey indicate that the majority (87 percent) of sport anglers fishing the Chignik River were unguided adult residents of the area. These data also indicate that the majority (66 percent) of anglers fishing the river were successful in catching at least one chinook salmon and that a majority (58 percent) of anglers retained at least one chinook salmon. All anglers who fished the river used single hook spinners.

KEY WORDS: chinook salmon, *Oncorhynchus tshawytscha*, effort, harvest, size, release, age, Chignik River, Alaska Peninsula.

INTRODUCTION

The Chignik River is remotely located on the Alaska Peninsula near Chignik, Alaska (Figure 1). The river supports annual returns of all five species of Pacific salmon *Oncorhynchus spp.* These returns currently support commercial, sport, subsistence, and personal use fisheries.

Within the past several years, concern has been expressed regarding the status of the river's returns of chinook salmon *O. tshawytscha*. These stocks are harvested by a major commercial fishery directed at sockeye salmon *O. nerka* as well as by sport, personal use, and subsistence fisheries. Given the concern for the river's chinook salmon stocks, a preliminary escapement goal of 1,100 chinook salmon (longer than 710 mm) was set by the Alaska Department of Fish and Game in 1988.

Escapements of chinook salmon are monitored annually through a weir on the Chignik River commencing in late May through early August. The weir is located midway between Chignik Lagoon and Chignik Lake. The escapement of chinook salmon from 1963 through 1988 has averaged 2,018 fish (Table 1). Commercial harvests of chinook salmon have also been determined over this period and have averaged 2,093. Harvests by the sport, personal use, and subsistence fisheries have also been estimated and have averaged an estimated 360 fish. Based on these figures, the estimated total return of chinook salmon to the Chignik River over this period has averaged 4,422. Of the various fisheries harvesting these stocks, the marine commercial fishery is the primary user.

The sport fishery for chinook salmon primarily occurs in the reach between the weir and the outlet of Chignik Lake. This is an area where the fish hold until obtaining sexual maturity. After reaching maturity, the fish apparently disperse and spawn both above and below the weir. Only rough estimates of chinook salmon harvest are available historically for this sport fishery; the fishery is not covered in the statewide mail survey. Although the sport fishery harvests comprise a small portion of the historical annual return (1.8%) and escapement (4.5%) to the river, sport harvests have increased in recent years. Given that precise estimates of the sport fishery were unavailable, this lead to concern that in years of weak returns adequate escapements are provided to assure for the continued health of the river's chinook salmon stocks. The Board of Fisheries addressed such concerns in March 1988 by reducing the sport bag limit from five to three chinook salmon (of which only two may be greater than 710 mm in length).

Given these concerns and regulatory actions, a creel survey was initiated on the Chignik River to estimate the sport effort for, harvest and release of chinook salmon; and the age, sex, and length characteristics of the harvest. The findings of this first year study are summarized in this report.

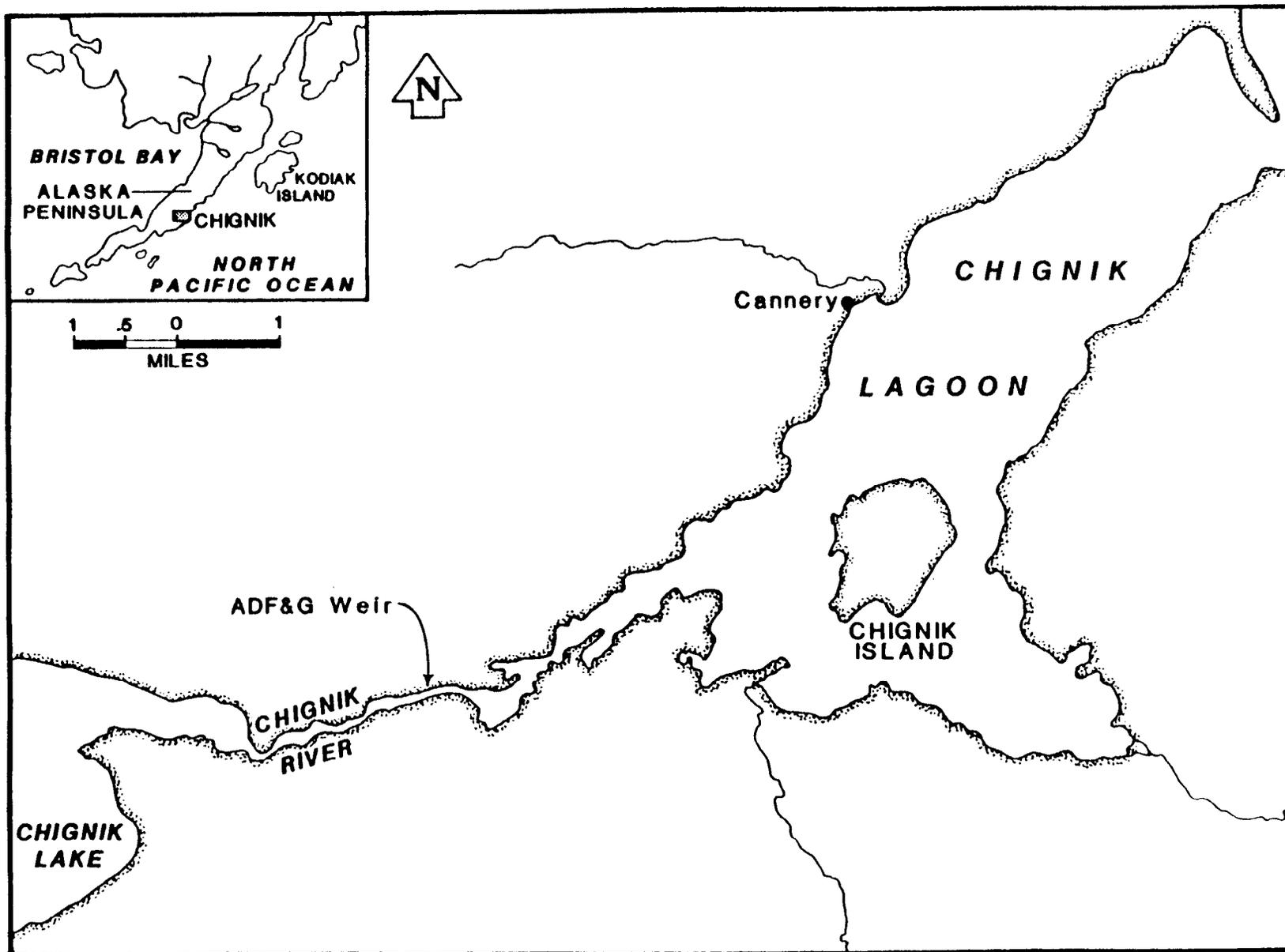


Figure 1. Location of Chignik River, Alaska Peninsula, Alaska.

Table 1. Return statistics for chinook salmon to the Chignik River, 1963-1988.

Year	Esc. ¹	Sport Harvest ²	Personal Use Harvest ²	Subsistence Harvest ³	Commercial Harvest	Total Return
1963	690	50	100	32	1,744	2,616
1964	1,149	50	100	32	1,099	2,430
1965	1,186	50	100	32	1,592	2,960
1966	979	100	100	32	636	1,847
1967	1,868	100	100	32	882	2,982
1968	1,212	100	100	32	674	2,118
1969	687	100	100	32	3,448	4,367
1970	3,181	100	100	32	1,225	4,638
1971	2,475	150	100	32	2,010	4,767
1972	1,818	150	100	32	464	2,564
1973	929	150	100	32	525	1,736
1974	732	150	100	32	255	1,269
1975	1,001	150	100	32	549	1,832
1976	719	200	100	100	763	1,882
1977	847	200	100	50	711	1,908
1978	1,371	200	100	50	1,603	3,324
1979	1,178	200	100	9	1,266	2,753
1980	950	200	100	6	2,325	3,581
1981	1,804	300	100	100	2,694	4,898
1982	2,865	300	100	2	5,236	8,503
1983	2,250	300	100	0	5,488	8,138
1984	7,319	300	100	26	4,318	12,063
1985	3,826	300	100	1	1,919	6,146
1986	4,340	400	100	6	3,037	7,893
1987	2,224	400	NO DATA	NO DATA	2,651	5,275
Mean	1,904	188	100	32	1,885	4,103
1988 ⁴	4,868	233	NO DATA	3	7,300	12,404

¹ Expanded to include age 1.1 and age 1.2 chinook which are not counted as they pass through the weir gates.

² These components of the fishery were not quantified. These data are guesses by the commercial fishery manager.

³ Average harvest during the years 1976 to 1986 (32 fish) was used as the estimate for the years 1963 to 1975.

⁴ 1988 data are preliminary, with exception of the sport harvest.

METHODS

Creel Survey

The chinook salmon immigration to the Chignik River during 1988 commenced during late June and continued through early August. The sport fishery primarily occurred in a 2.7 km section of the river (above the weir) where chinook salmon hold prior to spawning. Access was by way of boat from Chignik Lagoon or Chignik Lake with most fishing having occurred from boats. The sport fishing season for chinook salmon was open all year in 1988 and anglers were permitted a daily bag limit of three chinook salmon of which only two fish could be longer than 710 mm (ADF&G 1988). Sport fishing was not permitted within 100 m of the weir by regulation.

Study Design:

A roving creel survey was conducted on the Chignik River from 2 July through 15 August 1988 to estimate sport effort for (in angler-hours), harvest, and release of chinook salmon. The creel survey followed a stratified random sampling design. Angler counts were used to determine effort and angler interviews were used to determine catch and harvest rates.

Angler effort, and catch and harvest rates were estimated irrespective of weekends and holidays. The fishing day was considered to be 17 hours in duration (0600-2300 hours) and was stratified into three time periods: A) 0600-1159 hours; B) 1200-1659 hours; and C) 1700-2300 hours. Days to be sampled within each period were randomly selected without replacement from those available. Sampling effort was allocated approximately equally across time periods. Sampling occurred during a randomly selected 2.5-hour sampling period in each selected sampling unit.

The major assumptions necessary for the creel survey are:

1. Angler counts made during the same day and on consecutive days are independent.
2. No significant fishing effort occurs during the hours 2300-0600.
3. Interviewed anglers are representative of the total angler population.
4. The number of anglers interviewed during a day is proportional to the effort on that day.
5. Fishing effort does not influence catch per unit effort.
6. Angler efforts and catches are normally distributed random variables.

Data Collection:

During a selected sample period, a starting time was randomly selected within the randomly selected 2.5-hour survey period to count the number of anglers. Angler counts were conducted by boating the length of the fishing area as quickly as possible and counting the number of people actively engaged in fishing. Approximately 30 minutes was required to conduct an angler count. All counts were considered instantaneous (Neuhold and Lu 1957).

The remaining time in the 2.5-hour survey period was spent conducting angler interviews. Only anglers who had completed fishing were interviewed. The following information was recorded during each interview:

1. number of fish released by species,
2. number of fish retained by species,
3. total hours fished (to the nearest 1/4 hour); and
4. selected information regarding angler characteristics and demographics.

Data Analyses:

Angler effort was calculated using a stratified random sample design (Scheaffer et al. 1979). Effort and its variance was estimated over all periods as:

$$\hat{E} = \sum_{k=1}^P N_k \bar{Y}_k, \quad [1]$$

and

$$\hat{V}(E) = \sum_{k=1}^P [N_k^2 (s_k^2 / m_k)], \quad [2]$$

where;

$$s_k^2 = \left[\sum_{i=1}^W \sum_{j=1}^{d_i} (y_{ijk} - \bar{Y}_k)^2 \right] / (m_k - 1). \quad [3]$$

Notations used in the above equations and subsequent equations for the roving creel survey are described in Tables 2 and 3.

Rates of catch of chinook salmon (fish caught per angler-hour) were estimated using a two-stage random sample design with a finite number of primary sample units (days) and an unknown number of secondary sample units (anglers). Only completed-trip interviews were used to estimate harvest rates. Catch rates were estimated as:

$$\hat{CPUE} = \bar{c} / \bar{f} = \left[\sum_{i=1}^D \sum_{k=1}^{m_i} c_{ik} \right] / \left[\sum_{i=1}^D \sum_{k=1}^{m_i} f_{ik} \right]. \quad [4]$$

The variance of CPUE was approximated using the formula for the quotient of the mean of two random variables (Jessen 1978), which is:

$$V(\hat{CPUE}) \approx \left[\frac{\hat{c}}{\bar{c}} \right]^2 \left[\frac{s_c^2}{c} + \frac{s_f^2}{f} - (2rs_c s_f / \bar{c}\bar{f}) \right]. \quad [5]$$

Table 2. Definitions for the notation used in the equations for calculating angler effort in the roving creel survey.

Notation	Definition
<u>Angler Effort Equations</u>	
\hat{E}	the estimate of effort in angler-hours.
N_k	the total number of hours of possible fishing time during period k .
\bar{Y}_k	the mean angler count for period k .
P	the number of daily periods.
m_k	the number of angler counts conducted during period k .
W	the number of weeks in the fishing period.
d_i	the number of days randomly selected for conducting an angler count during a specific weekly component i .
\bar{Y}_k	the mean angler count for period k over all weeks.
y_{ijk}	an angler count made during week i , day j , and period k .

Table 3. Definitions for the notation used in the equations for calculating rates of catch and harvest and subsequent catch and harvest in the roving creel survey.

Notation	Definition
\hat{C}	the estimate of catch ¹ during a specific weekly component.
\bar{c}	the mean catch ¹ per angler by all anglers interviewed during a specific weekly component.
\bar{c}_i	the mean catch ¹ per angler by all anglers interviewed on day i during a specific weekly component.
c_{ik}	the catch ¹ by angler k interviewed on day i during a specific weekly component.
D	the number of days the fishery was open during a specific weekly component.
d	the number of days on which angler interviews were conducted during a specific weekly component.
\bar{f}	the mean number of hours fished by all anglers interviewed during a specific weekly component.
f_{ik}	the number of hours spent fishing by angler k interviewed on day i during a specific weekly component.
m_i	the number of anglers interviewed on day i during a specific weekly component.
r	the correlation between the c_{ik} and f_{ik} for anglers interviewed during a specific weekly component.
s^2	the sample variance for the mean angler count during a specific weekly component (\bar{x}).
s_c^2	the two-stage estimate of variance for the mean catch by anglers interviewed during a specific weekly component (\bar{c}).
s_f^2	the two-stage estimate of variance for the mean effort by anglers interviewed during a specific weekly component (\bar{f}).

-continued-

Table 3. Definitions for the notation used in the equations for calculating rates of catch and harvest and subsequent catch and harvest in the roving creel survey (continued).

Notation	Definition
s_i^2	the sample variance for the mean catch by anglers interviewed on day i of a specific weekly component (\bar{c}_i).

¹ Catch or harvest

The two-stage variance estimate for \bar{c} was (Sukhatme et al. 1984, Von Geldern and Tomlinson 1973):

$$s_c^2 = [1 - (d/D)] s_B^2/d + \left[\sum_{i=1}^D (s_i^2/m_i) \right] / (dD), \quad [6]$$

where;

$$s_B^2 = \left[\sum_{i=1}^D (\bar{c}_i - \bar{c})^2 \right] / (d-1). \quad [7]$$

The variance for \bar{f} was estimated identically as for \bar{c} by substituting the necessary quantities for effort into equations 7 and 8.

Total catch was estimated as:

$$\hat{C} = \hat{E} \hat{CPUE}. \quad [8]$$

The variance of this estimate was calculated using the formula for the product of two independent random variables (Goodman 1960):

$$V(\hat{C}) = [\hat{E}^2 V(\hat{CPUE})] + [\hat{CPUE}^2 V(\hat{E})] - [V(\hat{E}) V(\hat{CPUE})]. \quad [9]$$

Mean harvest rates and associated variances were estimated following the above procedures with the exception that only fish harvested by interviewed anglers were used.

Biological Data

A portion of the chinook salmon harvested by the sport fishery was randomly sampled for age, sex, and length information. Three scales were collected on the left side of each fish approximately two rows above the lateral line and on the diagonal row downward from the posterior insertion of the dorsal fin as described in Clutter and Whitesel (1956). Scales were mounted on adhesive-coated cards and impressions were made in cellulose acetate. Age determinations were made by examination of scales using a microfiche reader. Ages were designated using the European method (Koo 1962) where the first number refers to the number of years of freshwater residence after emergence and the second number refers to the number of years of marine residence. Fish lengths were measured from the middle of the eye to fork of the tail to the nearest 0.5 cm.

The proportional age composition of the sampled portion of the sport harvest was estimated for each fishery. Letting p_h equal the estimated proportion of age group h in the sample, the variance of p_h was estimated using the normal approximation to the binomial (Scheaffer et al. 1979):

$$V(\hat{p}_h) = \hat{p}_h(1-\hat{p}_h)/(n_T-1), \quad [10]$$

where n_T is the total number of legible scales collected from coho salmon or rainbow trout during the fishery. Mean length at age by sex and its variance were estimated using standard normal procedures.

RESULTS AND DISCUSSION

Creel Survey

An estimated 601 angler-hours of effort were expended by sport anglers fishing for chinook salmon on the Chignik River from 2 July through 4 August 1988 (Table 4). Most of the effort (82%) was expended in time periods B and C. Counts of anglers by date and time period are summarized in Appendix Table 1. The mean catch and harvest rates of chinook salmon were 0.571 and 0.387 fish per angler-hour, respectively (Table 5). Daily summary statistics of angler interviews are presented in Appendix Table 2. The estimated catch and harvest of chinook salmon was 343 and 233 fish, respectively (Table 6). Based on this, an estimated 110 chinook salmon were caught and released in this fishery. This level of harvest represents an estimated exploitation rate by sport anglers of 1.9% of the total return and 4.8% of the inriver escapement.

A summary of angler characteristic and demographic data collected in conjunction with the creel survey is presented in Table 7. These data indicate that a majority (87%) of sport anglers fishing the Chignik River were unguided adult residents of the area. These data also indicate that the majority (66%) of anglers fishing the river were successful in catching at least one chinook salmon and that a majority (58%) of the anglers retained at least one chinook salmon. All anglers who fished the river used single hook spinners. All of the observed chinook salmon harvest came from the river tidal area above Chignik Weir and 91.4% of the fish surveyed during angler interviews were caught by anglers that passed through the weir boat gate.

Biological Data

Chinook salmon aged 1.4, 1.3, and 1.2 comprised 75.9%, 12.1% and 8.6% of the sport fishery harvest, respectively (Table 8). Males and females were nearly equally abundant (46.6% males, 53.4% females). In the numerically dominant 1.4 age class, males averaged 912 mm while females averaged 905 mm (Table 9). Mean lengths by sex of the other age groups are presented in Table 9.

RECOMMENDATIONS

1. Given the magnitude of the sport harvest in relation to the total return and escapement of chinook salmon in the Chignik River during 1988, the current length of the sport fishing season and current daily bag and

Table 4. Estimated number of angler-hours of effort, by period, for the sport fishery for chinook salmon on the Chignik River, 1988.

	PERIOD			All Periods
	A	B	C	
Number of Counts	17	20	18	55
Estimated Effort	111	245	245	601
Standard Error	63	69	96	134
Relative Precision ¹	111%	55%	77%	44%

¹ $\alpha = 0.05$

Table 5. Estimated sport harvest rate (HPUE) and catch rate (CPUE) of chinook salmon in the Chignik River, 1988.

Number of Interviews	HARVEST		CATCH	
	HPUE	SE	CPUE	SE
49	0.387	0.0675	0.571	0.1046

Table 6. Estimated number of chinook salmon caught, harvested, and released in the Chignik River, 1988.

	Estimate	Standard Error	95% Confidence Interval	Relative Precision ¹
CATCH	343	98	151 - 535	56%
HARVEST	233	65	105 - 361	55%

¹ $\alpha = 0.05$

Table 7. Summary of angler characteristic and demographic data collected from sport anglers fishing for chinook salmon in Chignik River, 1988.

Angler Demographics		Fishing Gear	
Females	- 14.5%	Residents	- 87.3%
Males	- 85.5%	Tourists	- 0.0%
Adults	- 92.7%	Non-local	- 38.2%
Youth	- 7.3%	Military	- 0.0%
Nonresidents	- 12.7%	Unguided	-100.0%
Angler Success and Harvest Data		Type of Lure	
Successful anglers	- 65.5%	Bait	- 0.0%
Unsuccessful anglers	- 34.5%	Spinners	- 100.0%
Anglers that retained fish	- 58.2%	Flies	- 0.0%
Anglers that released fish	- 23.6%		
Fish retained	- 68.4%		
Fish released	- 31.6%		

Table 8. Age composition of chinook salmon sampled from the Chignik River sport harvest, 1988.

Sex	Age Group				Total ¹
	1.2	1.3	1.4	1.5	
Female					
Sample Size	0	0	30	1	31
Percent	0.0	0.0	51.7	1.7	53.4
Male					
Sample Size	5	7	14	1	27
Percent	8.6	12.1	24.2	1.7	46.6
Sexes Combined					
Sample Size	5	7	44	2	58
Percent	8.6	12.1	75.9	3.4	100.0
Standard Error	3.7	4.3	5.7	4.2	

¹ Of 67 fish sampled, 9 (13.4%) had unreadable scales.

Table 9. Mean length (mm) of chinook salmon in the Chignik River sport harvest, 1988.¹

Sex	Age Group ²			
	1.2	1.3	1.4	1.5
Female				
Mean Length	---	---	905	944
Standard Error	---	---	7	0
Sample Size	0	0	30	1
Male				
Mean Length	651	779	912	935
Standard Error	11	7	17	0
Sample Size	5	17	14	1

¹ Mid-eye to fork-of-tail length.

² Of the 67 fish sampled, 9 (13.4%) had unreadable scales.

possession limits appear adequate to protect the long-term health of the chinook salmon return to the Chignik River.

2. Careful monitoring of the chinook salmon return will be important to assure adequate escapement in years of weak or low returns. To achieve escapement goals in future years, the inriver sport harvest should be monitored at Chignik weir. Within the next 5 years, a complete creel survey should be conducted to examine any possible changes in the chinook salmon sport fishery.
3. The feasibility of reducing the incidental chinook salmon harvest in the commercial fishery should be investigated. This study should be conducted as soon as feasible to avoid possible over-exploitation of the chinook population during low cycles in the population size.

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APPENDIX

Appendix Table 1. Counts of anglers fishing the Chignik River for chinook salmon, 1988.

Date	Count by Period ¹		
	A	B	C
7/02		3	0
7/03		0	
7/04			3
7/05			
7/06	0	5	0
7/07			
7/08	0	0	0
7/09		3	0
7/10	0		6
7/11	0	0	3
7/12	0	1	
7/13	0	1	0
7/14			
7/15			
7/16		1	
7/17	0	0	0
7/18			
7/19	0	4	1
7/20	3	2	0
7/21			
7/22	0		0
7/23	4	4	
7/24	0		0
7/25			
7/26		0	3
7/27	0	4	
7/28	0	0	5
7/29			
7/30	0	0	
7/31	0	0	0
8/01		0	0
8/02			
8/03			
8/04	2	0	0

¹ Period A: 0600-1159 hrs, Period B: 1200-1659 hrs, and Period C: 1700-2300 hrs.

Appendix Table 2. Daily summary statistics for sport anglers fishing the Chignik River for chinook salmon, 1988.

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS	Mean	SE	Mean	SE	HPUE	Mean	SE	CPUE
7/02	We	4	4.9	0.31	1.00	0.408	0.203	1.75	0.854	0.354
7/06	Wd	2	1.5	0.50	0.00	0.000	0.000	3.00	2.000	2.000
7/10	We	8	1.5	0.65	1.13	0.295	0.735	1.25	0.366	0.816
7/11	Wd	7	2.0	0.00	0.86	0.404	0.429	1.00	0.378	0.500
7/13	Wd	2	1.3	0.25	1.00	0.000	0.800	1.00	0.000	0.800
7/19	Wd	6	3.9	0.65	1.33	0.333	0.340	2.00	0.856	0.511
7/20	Wd	2	3.0	0.00	1.50	0.500	0.500	1.50	0.500	0.500
7/26	Wd	6	2.8	0.97	1.33	0.422	0.471	2.17	0.703	0.765
7/27	Wd	4	3.0	0.00	0.25	0.250	0.083	0.25	0.250	0.083
7/28	Wd	6	0.5	0.00	0.17	0.167	0.333	0.17	0.167	0.333
8/04	Wd	2	3.0	0.00	2.00	1.000	0.667	3.00	0.000	1.000

