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EFFORT AND CATCH STATISTICS FOR THE  
CHINOOK SALMON (*Oncorhynchus tshawytscha*)  
SPORT FISHERY IN THE  
LOWER NAKNEK RIVER, 1986

By: R. Eric Minard



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P.O. Box 3-2000, Juneau, Alaska 99802

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## ABSTRACT

A roving creel survey was conducted on the lower Naknek River from 28 May through 25 July to estimate sport fishing effort, catch (fish landed), and harvest (fish kept) of chinook salmon (*Oncorhynchus tshawytscha* Walbaum). An estimated 37,532 angler-hours were expended on the lower Naknek River which resulted in 7,263 chinook salmon being caught of which 6,462 (89 percent) were harvested. Seasonal catch rates between guided (0.26 fish per hour) and unguided (0.07 fish per hour) anglers were significantly different ( $P \leq 0.05$ ). Age 1.3 chinook salmon dominated the harvest (47 percent). The major chinook salmon spawning areas were surveyed from fixed wing aircraft and escapement was estimated at 8,510 fish. Age 1.3 fish dominated (48 percent) the spawning escapement. Males comprised 59 percent of the spawning escapement.

KEY WORDS: chinook salmon, *Oncorhynchus tshawytscha*, sport harvest, sport effort, creel survey, escapement, Nushagak River.

## INTRODUCTION

In January 1986, the Alaska Board of Fisheries adopted a new sockeye salmon (*Oncorhynchus nerka* Walbaum) management plan that was intended to protect Kvichak River sockeye salmon stocks from over harvest and provide for the harvest of surplus Naknek River sockeye salmon production. Within the plan, a special sockeye salmon commercial harvest area was created in the lower portion of the Naknek River. Fishing time is offered in this special area only after the escapement goal for Naknek River sockeye salmon is assured and attainment of the escapement goal for Kvichak River sockeye salmon is in jeopardy.

The Naknek River (Figure 1) is also a major producer of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) and supports the area's most intensive chinook salmon sport fishery. Due to the importance of the Naknek River's chinook salmon sport fishery, concern about potentially increased incidental harvest by the commercial fleet due to the new sockeye salmon management plan was voiced by sport fishermen and resource managers. However, information which could improve the management plan by minimizing interception was lacking. Informational needs required to improve the plan included migration timing, entry pattern, daily sport harvest and catch rates, holding areas, and general migratory behavior.

In 1986, the Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) began a program to evaluate these informational needs. A creel survey was conducted on the Naknek River chinook salmon sport fishery to estimate sport fishing effort, catch (fish landed), and harvest (fish retained) and age, sex, and size compositions. These data, in conjunction with estimates of commercial harvest and escapement, provide a more complete picture of the 1986 chinook salmon return to the Naknek River. Specific information regarding the

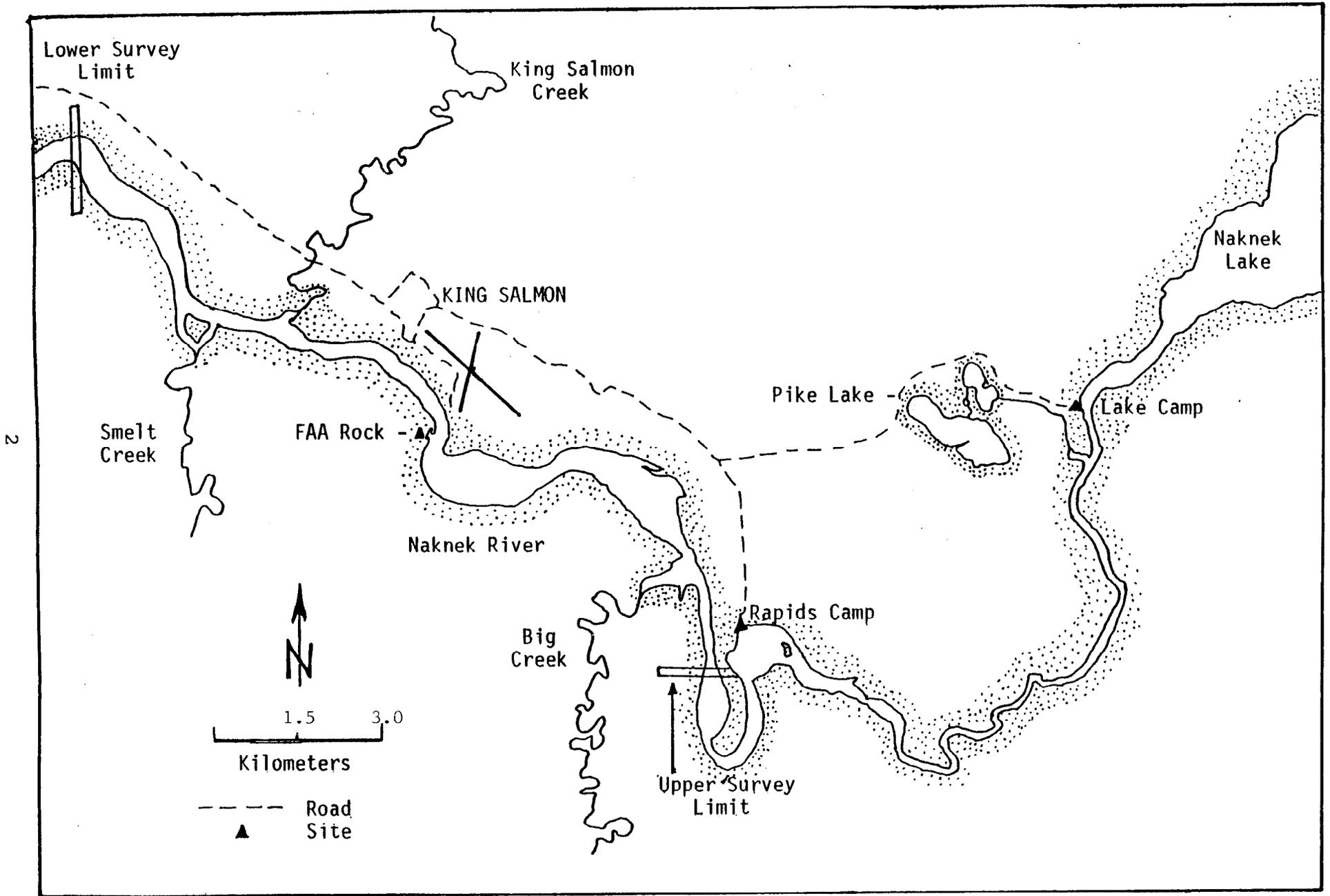


Figure 1. The Naknek River Study Site.

Naknek River sport fishery is also used to track the evolution of this fishery in comparison to historical performance. Creel surveys on the Naknek River chinook salmon sport fishery were most recently conducted in 1975, 1978, and 1979 (Gwartney, 1976, 1979, 1980).

## METHODS

### Creel Survey

Anglers in 1986 were permitted a daily harvest of five chinook salmon, of which two could be greater than 71 centimeters (28 inches) (ADF&G 1986). No further regulatory restrictions were in effect during 1986.

#### Study Design:

A roving creel survey (Neuhold and Lu 1957) using a stratified, random sampling design was used to count anglers, conduct angler interviews, and sample the sport harvest. Angler counts were used to estimate fishing effort in units of angler-hours. Angler interviews provided estimates of catch rates (fish per angler-hour).

Chinook salmon first enter the Naknek River during early to mid-June and the majority of the run typically migrates through the lower section of river during a 4 week period. The study period was subjectively stratified to reflect changes in chinook salmon abundance.

The study period (28 May through 25 July) was stratified into four sampling periods: period 1 (28 May-13 June); period 2 (14 June-27 June); period 3 (28 June-13 July); and period 4 (14 July-25 July). For the creel survey, the fishing day was defined as 18 hours in duration (0600 to 2400 hrs). Each day was divided into three time strata: period A (0600-1200 hrs); period B (1200-1800 hrs); and period C (1800-2400 hrs).

Angler effort and harvest statistics were compiled separately for each period. Sampling effort was nearly equal across all strata. Specific strata to be sampled were randomly selected.

#### Data Collection:

One angler count was conducted during a randomly selected time during the survey. To conduct an angler count, a boat was driven through the fishery at a near constant speed and all anglers actively fishing were counted. The angler count was completed within 40 to 60 minutes and was considered an instantaneous count (Neuhold and Lu 1957). It was not possible to differentiate between guided and unguided anglers.

Angler interviews were conducted during the remaining time in the period. Most anglers were interviewed as they exited the fishery. However, some anglers were interviewed while they were still fishing. These types of interviews are hereby referred to as complete trips

and incomplete trips, respectively. All interviews were of individual anglers. For each angler interviewed the following information was recorded: the number of hours fished, the number of fish in the angler's possession by species, the number of fish released by species, whether the angler was guided or not guided, and residency.

During the interviews, anglers were also questioned about their preference regarding management of this fishery. At issue was whether the sport fishery should be limited to artificial bait to reduce effectiveness. During the period 27 June through 7 July, anglers were asked if they: (1) preferred fish eggs as bait for chinook salmon; (2) preferred lures for chinook salmon; (3) preferred flies for chinook salmon; or (4) had no preference. After 7 July, the questions was reworded and asked as: "It has been proposed to prohibit fishing with fish eggs in the Naknek River and its tributaries for all species for the entire year. Would you support this proposal, be opposed to it, or have no opinion?"

Harvested chinook salmon encountered during the creel survey were measured for mid-eye to fork-of-tail length to the nearest millimeter and the sex of the fish identified. Three scales were removed from the preferred area<sup>1</sup> and mounted on a gummed card. The fork length of all other species was recorded to the nearest millimeter.

Data Analyses:

The mean number of anglers per count was calculated for each peak and non-peak period by:

$$\bar{X} = (1/N) \sum_{i=1}^4 N_i \bar{x}_i,$$

where;

$\bar{X}$  = the mean number of anglers per count for a period,

$\bar{x}_i$  = the mean number of anglers per count for stratum i,

N = the total number of hours in a period, and

$N_i$  = the total number of hours in stratum i.

The variance of the mean number of anglers per count was calculated as follows (Jessen 1978):

$$\hat{V}(\bar{X}) = (1/N^2) \sum_{i=1}^4 N_i^2 [s_i^2/n_i],$$

<sup>1</sup> The left side of the fish approximately two rows above the lateral line and on the diagonal row downward from the posterior insertion of the dorsal fin (Clutter and Whitesel 1956).

where;

$N$  and  $N_i$  are defined as above, and

$n_i$  = the total number of angler counts in stratum  $i$ , and

$s_i^2$  = the sample variance of  $\bar{x}_i$  for stratum  $i$ .

The total number of angler-hours ( $E_T$ ) in each period was estimated as follows:

$$\hat{E}_T = N\bar{X} = \sum_{i=1}^4 N_i \bar{x}_i.$$

The variance for the estimate of total angler-hours was calculated as follows:

$$\hat{V}(E_T) = N^2 \hat{V}(\bar{X}).$$

The total number of angler-hours for the season was estimated by summing the estimates of total angler-hours for all temporal strata. Because these are independent estimates, the variance is the sum of the individual variances.

Catch per unit effort (CPUE) for species  $i$  during a stratum was estimated by:

$$CPUE_i = \frac{\sum_{j=1}^m c_{ij}}{\sum_{j=1}^m f_j}$$

$m$  = the number of anglers interviewed during the period,

$c_{ij}$  = the catch (either number harvested or total number caught) of species  $i$  by angler  $j$ , and

$f_j$  = the effort (number of hours) expended by angler  $j$ .

The variance of mean effort per angler was estimated using a two-stage sample design with days representing the first-stage sample units and anglers the second-stage sample units (Von Geldern and Tomlinson 1973). On a given sample day, the number of second-stage units available was unknown. The variance of mean effort was estimated as follows (Sukhatme et al. 1984):

$$V(\bar{f}) = [1 - (d/D)] s_B^2/d + \frac{D}{d} \frac{\sum_{k=1}^D s_{Wk}^2/m}{dD},$$

where;

$d$  = the number of days sampled during the period,

$D$  = the number of days in the period,

$s_{Wk}^2$  = the sample variance of effort for anglers interviewed during day  $k$ , and

$s_B^2$  = the between-day variance of angler effort.

The between-day variance,  $s_B^2$ , was estimated as follows:

$$s_B^2 = \left[ \sum_{k=1}^D (\bar{f}_k - \bar{f})^2 \right] / (D-1),$$

where  $\bar{f}_k$  = the mean effort by anglers interviewed during day  $k$ .

The mean harvest and variances of a species were estimated identically to effort by substituting the corresponding harvest or catch quantities for effort ( $f$ ).

The variance of  $CPUE_i$  was calculated using the approximation for the variance of the quotient of two random variables (Jessen 1978):

$$\hat{V}(CPUE_i) = (\bar{c}_i / \bar{f}_i)^2 (s_c^2 / \bar{c}^2 + s_f^2 / \bar{f}^2 - 2rs_c s_f / \bar{c}\bar{f})$$

where;

$\bar{c}_i$  = the mean catch of species  $i$  by anglers interviewed during a period,

$\bar{f}_i$  = the mean number of hours fished by anglers interviewed during a period,

$s_c^2$  = the two-stage variance estimate for  $\bar{c}_i$ ,

$s_f^2$  = the two-stage variance estimate for  $\bar{f}_i$ , and

$r$  = the correlation between the  $c_{ij}$  and  $f_j$ .

The catch (or harvest) of species  $i$  was estimated by:

$$C_i = E_T CPUE_i.$$

The variance of the catch was estimated using Goodman's (1960) formula for the variance of the product of two independent random variables, which is:

$$\hat{V}(C_i) = [E_T^2 V(CPUE_i)] + [CPUE_i^2 V(E_T)] - [V(E_T) V(CPUE_i)].$$

Total catch and its variance were estimated for each stratum and summed to estimate the total season catch. The same procedures were followed in estimating total harvest of each species.

The assumptions necessary for these analyses were:

1. Interviewed anglers were representative of the total angler population and anglers were interviewed in proportion to their abundance.
2. No significant fishing effort occurred between 2400 hours and 0600 hours.
3. The catch and effort are normally distributed random variables.
4. Catch rate and duration of fishing trip are independent (DiConstanzo 1956).

The age composition of chinook salmon harvested by the sport fishery was calculated from all legible scales collected during the creel survey. The proportional age composition of the chinook salmon harvest was estimated. Letting  $p_h$  equal the estimated proportion of age group  $h$ , the variance of  $p_h$  was estimated using the normal approximation to the binomial (Schaeffer et al. 1979):

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

where  $n_T$  is the number of chinook salmon scales read.

Mean length at age by sex and its variance were estimated using standard normal procedures. Mean length (mm) and weight (kg) were calculated by age group for all chinook salmon sampled.

### Escapement

The magnitude of the spawning escapement was estimated from aerial counts. Aerial surveys were conducted from fixed wing aircraft. Four major spawning locations were surveyed: Big Creek, Pauls Creek, King Salmon Creek, and the mainstem Naknek River. Only the largest (peak) count for each area were recorded. These counts were expanded for missed sections of the river. To do this, it was necessary to assume that spawner distribution for unsurveyed sections was similar to surveyed sections. No accounting was made for fish that had already spawned and left the system or fish that had not yet arrived.

Spawned-out carcasses were sampled for age, sex, and length data as previously described.

## RESULTS

The creel survey on the lower Naknek River was conducted during the period 28 May to 25 July.

### Effort

Mean angler counts were 1.7, 29.9, 79.6, and 30.1 for periods one through four, respectively (Appendix Table 1 and Table 1). Total effort was estimated to be 37,532 angler-hours. Most of the fishing effort (22,971 angler-hours or 61%) occurred during period three. Interviewed anglers who had completed their fishing trip (N = 942) averaged 5.1 hours per trip. Variability in this estimate was high (standard error = 1.25).

### Catch Rate

Catch rates for chinook salmon were similar during periods one, three, and four; but declined substantially during period two (Appendix Table 2 and Table 2). The pattern for harvest rates was similar. Catch rates for other species were low.

### Catch and Harvest

An estimated 7,263 chinook salmon were caught (landed) of which 6,462 (89%) were harvested (Table 3). The largest catch and harvest occurred during period three (28 June - 13 July). The estimated catch and harvest of chum salmon was 239 and 209 (87%) respectively.

Although guided and unguided effort and catch could not be estimated separately, estimates of catch and harvest rates were possible (Table 4). Daily catch rates of guided and unguided anglers were compared with a sign test (Conover 1980). Guided anglers caught and harvested chinook salmon at a significantly greater rate ( $P \leq 0.05$ ) than did unguided anglers.

### Gear Preference

Interviewed anglers on the Naknek River (N = 479) preferred fishing with artificial lures (43%) over fish eggs (35%) or flies (4%) (Table 5). This response was consistent between anglers of different residency. Interviewed anglers (N = 344) also consistently opposed (56%) a regulatory proposal that would ban the use of fish eggs as bait on the Naknek River and its tributaries (Table 6).

### Escapement Estimation

A total of 4,460 chinook salmon were observed during aerial surveys (Table 7). The largest number of fish were observed in the mainstem Naknek River (2,781). However, due to the large amount of area unavailable to the survey, it is presumed that Big Creek supported a larger escapement.

### Size, Sex, and Age Sampling

Nearly 70% of the chinook salmon sampled in the sport harvest (N = 673) were males (Table 8). Age 1.3 fish were most common (47%); followed by age 1.4 fish (22%) and age 1.2 fish (20%). The Naknek

Table 1. Estimated effort (angler-hours) by sampling period for the lower Naknek River sport fishery, 1986.

Sampling Period <sup>1</sup>	Number of Interviews	Number of Days Possible	Number of Days Sampled	Anglers Per Count	Estimated Effort			
					Ang-Hrs	Std Err	95 % CI	Rel Pre <sup>2</sup>
1	31	17	8	1.7	525	138	255 - 795	51.4%
2	252	14	8	29.9	7,532	1,727	4,147 - 10,917	44.9%
3	692	16	13	79.6	22,971	2,073	18,907 - 27,035	17.7%
4	335	12	8	30.1	6,504	972	4,600 - 8,408	29.3%
Total	1,310	59	37	55.4	37,532	2,871	31,905 - 43,160	15.0%

<sup>1</sup> Period 1 - 5/28-6/13; Period 2 - 6/14-6/27;  
Period 3 - 6/28-7/13; Period 4 - 7/14-7/25

<sup>2</sup> Relative precision at  $\alpha = 0.05$ .

Table 2. Estimated catch and harvest rates (fish per angler-hour) by species and time period for the lower Naknek River sport fishery, 1986.

Species	Sampling Period <sup>1</sup>	Catch		Harvest	
		Fish/Hr	Std Err	Fish/Hr	Std Err
Chinook	1	0.2478	0.0229	0.1999	0.0180
Salmon	2	0.1193	0.0027	0.1095	0.0027
	3	0.2060	0.0007	0.1783	0.0008
	4	0.2314	0.0014	0.1737	0.0019
Sockeye Salmon	1	0.0000	0.0000	0.0000	0.0000
	2	0.0010	0.0000	0.0000	0.0000
	3	0.0000	0.0000	0.0000	0.0000
	4	0.0000	0.0000	0.0000	0.0000
Chum Salmon	1	0.0236	0.0000	0.0236	0.0000
	2	0.0010	0.0000	0.0010	0.0000
	3	0.0049	0.0000	0.0043	0.0000
	4	0.0163	0.0003	0.0139	0.0003
Pink Salmon	1	0.0000	0.0000	0.0000	0.0000
	2	0.0000	0.0000	0.0000	0.0000
	3	0.0000	0.0000	0.0000	0.0000
	4	0.0024	0.0001	0.0018	0.0001
Coho Salmon	1	0.0000	0.0000	0.0000	0.0000
	2	0.0000	0.0000	0.0000	0.0000
	3	0.0009	0.0000	0.0009	0.0000
	4	0.0018	0.0001	0.0018	0.0001
Rainbow Trout	1	0.0118	0.0027	0.0000	0.0000
	2	0.0159	0.0005	0.0099	0.0005
	3	0.0040	0.0001	0.0012	0.0000
	4	0.0121	0.0002	0.0048	0.0001
Dolly Varden	1	0.0000	0.0000	0.0000	0.0000
	2	0.0000	0.0000	0.0000	0.0000
	3	0.0000	0.0000	0.0000	0.0000
	4	0.0006	0.0000	0.0006	0.0000
Arctic Grayling	1	0.0000	0.0000	0.0000	0.0000
	2	0.0020	0.0002	0.0020	0.0002
	3	0.0000	0.0000	0.0000	0.0000
	4	0.0000	0.0000	0.0000	0.0000

<sup>1</sup> Period 1 - 5/28-6/13; Period 2 - 6/14-6/27;  
Period 3 - 6/28-7/13; Period 4 - 7/14-7/25.

Table 3. Estimated total catch and harvest by species in the lower Naknek River sport fishery, 1986.

Species	Sampling Period <sup>1</sup>	Catch				Harvest				Percent Harvest
		Number	Std Err	95 % CI	Rel Pre <sup>2</sup>	Number	Std Err	95 % CI	Rel Pre <sup>2</sup>	
Chinook	1	130	36	0-0	54.3%	105	29	0-0	54.3%	80.8%
Salmon	2	898	207	59-201	45.2%	831	192	59-201	45.2%	92.5%
	3	4,732	427	492-1,304	17.7%	4,272	386	492-1,304	17.7%	90.3%
	4	1,503	225	3,894-5,570	29.3%	1,254	187	3,894-5,570	29.3%	83.4%
<b>Total</b>		<b>7,263</b>	<b>527</b>	<b>1,062-1,944</b>	<b>14.2%</b>	<b>6,462</b>	<b>471</b>	<b>1,062-1,944</b>	<b>14.3%</b>	<b>89.0%</b>
Sockeye	1	0	0	0-0		0	0	0-0		
Salmon	2	8	2	5-11	42.4%	0	0	0-0		0.0%
	3	0	0	0-0		0	0	0-0		
	4	0	0	0-0		0	0	0-0		
<b>Total</b>		<b>8</b>	<b>2</b>	<b>5-11</b>	<b>42.4%</b>	<b>0</b>	<b>0</b>	<b>0-0</b>		<b>0.0%</b>
Chum	1	12	4	5-19	57.5%	12	4	5-19	57.5%	100.0%
Salmon	2	8	2	5-11	42.4%	8	2	5-11	42.4%	100.0%
	3	113	10	93-133	17.8%	99	9	81-117	17.9%	87.6%
	4	106	16	75-137	29.5%	90	14	63-117	29.6%	84.9%
<b>Total</b>		<b>239</b>	<b>19</b>	<b>201-277</b>	<b>15.9%</b>	<b>209</b>	<b>17</b>	<b>176-242</b>	<b>15.7%</b>	<b>87.4%</b>
Pink	1	0	0	0-0		0	0	0-0		
Salmon	2	0	0	0-0		0	0	0-0		
	3	0	0	0-0		0	0	0-0		
	4	16	2	11-21	30.0%	12	2	8-16	31.0%	75.0%
<b>Total</b>		<b>16</b>	<b>2</b>	<b>11-21</b>	<b>30.0%</b>	<b>12</b>	<b>2</b>	<b>8-16</b>	<b>31.0%</b>	<b>75.0%</b>
Coho	1	0	0	0-0		0	0	0-0		
Salmon	2	0	0	0-0		0	0	0-0		
	3	21	2	17-25	18.0%	21	2	17-25	18.0%	100.0%
	4	12	2	8-16	30.1%	12	2	8-16	30.1%	100.0%
<b>Total</b>		<b>33</b>	<b>3</b>	<b>28-38</b>	<b>15.8%</b>	<b>33</b>	<b>3</b>	<b>28-38</b>	<b>15.8%</b>	<b>100.0%</b>

-Continued-

Table 3. Estimated total catch and harvest by species in the lower Naknek River sport fishery, 1986  
(Continued).

Species	Sampling Period <sup>1</sup>	Catch				Harvest				Percent Harvest
		Number	Std Err	95 % CI	Rel Pre <sup>2</sup>	Number	Std Err	95 % CI	Rel Pre <sup>2</sup>	
Rainbow	1	6	2	2-10	70.1%	0	0	0-0		0.0%
Trout	2	120	28	66-174	45.3%	75	18	41-109	45.8%	62.5%
	3	92	8	75-109	18.0%	28	3	23-33	18.3%	30.4%
	4	79	12	56-102	29.4%	31	5	22-40	30.1%	39.2%
Total		297	31	236-358	20.7%	134	18	98-170	26.8%	45.1%
Dolly	1	0	0	0-0		0	0	0-0		
Varden	2	0	0	0-0		0	0	0-0		
	3	0	0	0-0		0	0	0-0		
	4	4	1	3-5	34.6%	3	1	2-4	46.2%	75.0%
Total		4	1	3-5	34.6%	3	1	2-4	46.2%	75.0%
Arctic	1	0	0	0-0		0	0	0-0		
Grayling	2	15	4	8-22	47.5%	15	4	8-22	47.5%	100.0%
	3	0	0	0-0		0	0	0-0		
	4	0	0	0-0		0	0	0-0		
Total		15	4	8-22	47.5%	15	4	8-22	47.5%	100.0%

<sup>1</sup> Period 1 - 5/28-6/13; Period 2 - 6/14-6/27;  
Period 3 - 6/28-7/13; Period 4 - 7/14-7/25.

<sup>2</sup> Relative precision.

Table 4. Comparative catch and harvest rates (fish per angler-hour) of chinook salmon by guided and unguided fishermen in the lower Naknek River sport fishery, 1986.

Sampling Period <sup>1</sup>	No. Interviews		Catch		Harvest	
	Guided	Unguided	Guided	Unguided	Guided	Unguided
1	3	28	1.7778	0.0660	1.3330	0.0660
2	53	199	0.2443	0.0840	0.2262	0.0777
3	162	523	0.2668	0.1858	0.2349	0.1693
4	138	197	0.2430	0.2232	0.2211	0.1728
Total <sup>2</sup>	356	947	0.2623	0.0660	0.2340	0.1514

<sup>1</sup> Period 1 - 5/28-6/13; Period 2 - 6/14-6/27;  
Period 3 - 6/28-7/13; Period 4 - 7/14-7/25.

<sup>2</sup> Seasonal catch and harvest rates between guided and unguided anglers are significantly different  $P = 0.05$ .

Table 5. Response to questions concerning the use of bait in the lower Naknek River sport fishery, 1986.

Residence	Number Interviewed	Preference			No Preference
		Fish Eggs	Lures	Flies	
Bristol Bay Non-Military	66	23%	41%	4%	32%
Bristol Bay Military	28	28%	64%	4%	4%
Other	385	38%	42%	4%	16%
<b>Total</b>	<b>479</b>	<b>35%</b>	<b>43%</b>	<b>4%</b>	<b>18%</b>

Table 6. Response to a proposal to prohibit sport fishing with fish eggs in the Naknek River drainage, 1986.

Residence	Number Interviewed	Support	Oppose	No Opinion
Bristol Bay Non-Military	41	36%	46%	17%
Bristol Bay Military	48	12%	50%	38%
Other	255	19%	59%	22%
<b>Total</b>	<b>344</b>	<b>20%</b>	<b>56%</b>	<b>24%</b>

Table 7. Escapement estimates of chinook salmon from aerial surveys in the Naknek River drainage, 1986.

Survey Dates	Location	Chinook Salmon		Percent
		Observed	Expanded <sup>1</sup>	
August 8	Big Creek	1,504	5,840	68.6%
August 11	Pauls Creek	73	236	2.8%
August 11	King Salmon Creek	102	284	3.3%
August 19	Naknek River	1,781	1,990	23.4%
Drainage Total		3,460	8,350	100.0%

<sup>1</sup> Expansion is for missed sections of the river only and does not account for fish which had already spawned or for fish which had yet to enter the spawning grounds.

Table 8. Sex, age, and length (mm) compositions of chinook salmon sampled from the lower Naknek River sport harvest, 1986.

	Age Class						Total
	1.1	1.2	1.3	2.2	1.4	1.5	
<u>Male</u>	192	1,248	2,228	19	624	144	4,455
Percent	3.0%	19.3%	34.5%	0.3%	9.7%	2.2%	68.9%
Avg Length	375	510	713	604	829	903	663
Std Error	8.9	6.6	8.9	76.5	17.5	15.6	8.2
Sample Size	20	130	232	2	65	15	464
<u>Female</u>	0	29	835	0	816	326	2,007
Percent	0.0%	0.4%	12.9%	0.0%	12.6%	5.1%	31.1%
Avg Length		615	819		864	878	844
Std Error		79.9	5.8		5.0	8.6	4.4
Sample Size		3	87		85	34	209
<u>Both Sexes</u>	192	1,277	3,063	19	1,440	470	6,462
Percent	3.0%	19.8%	47.4%	0.3%	22.3%	7.3%	100.0%
Avg Length	375	513	742	604	849	886	654
Std Error	8.9	6.8	7.2	76.5	8.2	7.8	8.9
Sample Size	20	133	319	2	150	49	673

River is unique in Alaska in that the sport harvest contains a large component of age 1.2 fish (McBride and Wilcock 1983), commonly referred to as "jacks." The composition of the escapement (Table 9) was similar to that observed in the sport harvest.

## DISCUSSION

### Historical Performance

The 1986 Naknek River sport harvest of chinook salmon (6,462 fish) is the largest on record (Table 10). The magnitude of the sport harvest has steadily increased since 1975. Conversely, commercial harvests have steadily declined in recent years. This is the first year that the sport fishery represents the largest source of removal of chinook salmon in the Naknek River.

The magnitude of the chinook salmon escapement for the Naknek River during 1986 was similar to the 20 year average (Table 10). Although escapement levels appear adequate compared to previous years, rigorous analysis of escapement requirements is not possible with the present data base.

### In-River Commercial Harvest

The special commercial harvest area was first opened on 9 July and was fished for 11 consecutive days until 19 July. The total chinook salmon harvest within this special harvest area was estimated at only 291 fish, while an additional 1,162,173 sockeye salmon were harvested (Table 11) .

It is anticipated that the special in-river harvest area will again be used in 1987, with an adjustment to the starting date to allow for earlier use of the area. There is little question that an earlier opening of the special harvest area maximizes the potential for increased interception of Naknek River chinook salmon stocks. Migratory timing analysis of sport CPUE data (Mundy 1982) shows that most of the run was beyond the special harvest area prior to the first opening (Figure 2). Sport CPUE did not decline during the time the special harvest area was in use.

### Recommendations

Naknek River stocks appear to be in satisfactory condition, but are in a declining phase since the record returns of the early 1980s. With increases in angler effort expected, consideration should be given to a more conservative management policy for these stocks.

Regulatory steps will be necessary in the near future to ensure overall exploitation is not excessive. Available options include, but are not limited to: reduction in bag and possession limits, changes in seasons, institution of an annual harvest limit, and area closures.

Table 9. Sex, age, and length (mm) composition of chinook salmon sampled from the Big Creek escapement, 1986.

	Age Class						Total
	1.1	1.2	1.3	2.2	1.4	1.5	
<u>Male</u>							
Percent	2.0%	15.9%	26.9%	0.2%	12.6%	1.6%	59.2%
Avg Length	384	550	811	429	921	916	751
Std Error	762.0	11.0	6.4	0.0	7.0	13.0	9.2
Sample Size	13	101	171	1	80	10	376
<u>Female</u>							
Percent	0.0%	0.5%	21.4%	0.0%	16.4%	3.0%	40.8%
Avg Length		615	804		873	881	837
Std Error		79.9	7.0		5.0	10.6	4.8
Sample Size		3	136		104	19	259
<u>Both Sexes</u>							
Percent	2.0%	15.9%	48.3%	0.2%	29.0%	4.6%	100.0%
Avg Length	384	550	808	429	894	893	786
Std Error	762.0	11.0	4.7	0.0	4.5	8.8	6.0
Sample Size	13	101	307	1	184	29	635

Table 10. Harvest and escapement of chinook salmon returns to the Naknek River, 1967-1986.

Year	Harvest				Escapement Index <sup>4</sup>	Total Return	% Exploitation by the Sport Fishery
	Commercial <sup>1</sup>	Subsistence <sup>2</sup>	Sport <sup>3</sup>	Total			
1967	3,705	500	1,579	5,784	2,218	8,002	20%
1968	6,398	500	2,203	9,101	7,120	16,221	14%
1969	19,016	400	4,631	24,047	8,922	32,969	14%
1970	19,037	300	2,730	22,067	4,361	26,428	10%
1971	10,254	200	2,417	12,871	2,866	15,737	15%
1972	2,262	400	1,668	4,330	2,791	7,121	23%
1973	951	600	1,000	2,551	2,625	5,176	19%
1974	480	1,000	1,700	3,180	2,575	5,755	30%
1975	964	700	427	2,091	3,704	5,795	7%
1976	4,064	900	800	5,764	9,150	14,914	5%
1977	4,373	1,300	1,005	6,678	10,800	17,478	6%
1978	6,930	1,200	2,406	10,536	9,075	19,611	12%
1979	10,415	1,200	2,669	14,284	7,150	21,434	12%
1980	7,517	1,500	2,729	11,746			
1981	11,048	1,000	2,581	14,629	8,920	23,549	11%
1982	12,425	1,100	3,264	16,789	17,000	33,789	10%
1983	9,942	1,000	3,545	14,487	13,400	27,887	13%
1984	9,198	900	4,524	14,622	12,400	27,022	17%
1985	5,891	979	5,038	11,908	4,100	16,008	31%
1986	3,552	1,000	6,462	11,014	8,350	19,364	33%
20 Year Average	7,421	834	2,669	10,924	7,238	18,119	15%

<sup>1</sup> Commercial catches estimated from sales receipts. These catches are composed of mixed stocks. The actual number of Naknek River origin fish is unknown.

<sup>2</sup> Subsistence catches estimated from permits.

<sup>3</sup> Sport harvest was estimated by "informal" creel survey for 1967, 1968, 1969, 1973, 1974, and 1976. The precision of these estimates cannot be estimated. Sport harvest was estimated "formally" for 1970, 1971, 1972, 1975, and 1986. The precision of these estimates can be estimated. The sport harvest was estimated by statewide survey 1977-1985.

<sup>4</sup> Escapement was estimated by fixed wing aerial surveys. Estimates are believed to be conservative.

Table 11. Preliminary commercial catch estimates from the Naknek River in-river harvest area, 1986.

Date	Commercial Harvest				Total
	Sockeye	Chinook	Pink	Chum	
July 9	132,722	13	9	29	132,773
10	306,578	37		54	306,669
11	315,398	44		115	315,557
12	130,507	46		113	130,666
13	91,775	38		53	91,866
14	52,796	19		25	52,840
15	17,847	8		6	17,861
16	16,535	14	3	21	16,573
17	50,327	37	1	28	50,393
18	32,953	29	40	226	33,248
19	14,735	6	3	47	14,791
<b>Total</b>	<b>1,162,173</b>	<b>291</b>	<b>56</b>	<b>717</b>	<b>1,163,237</b>

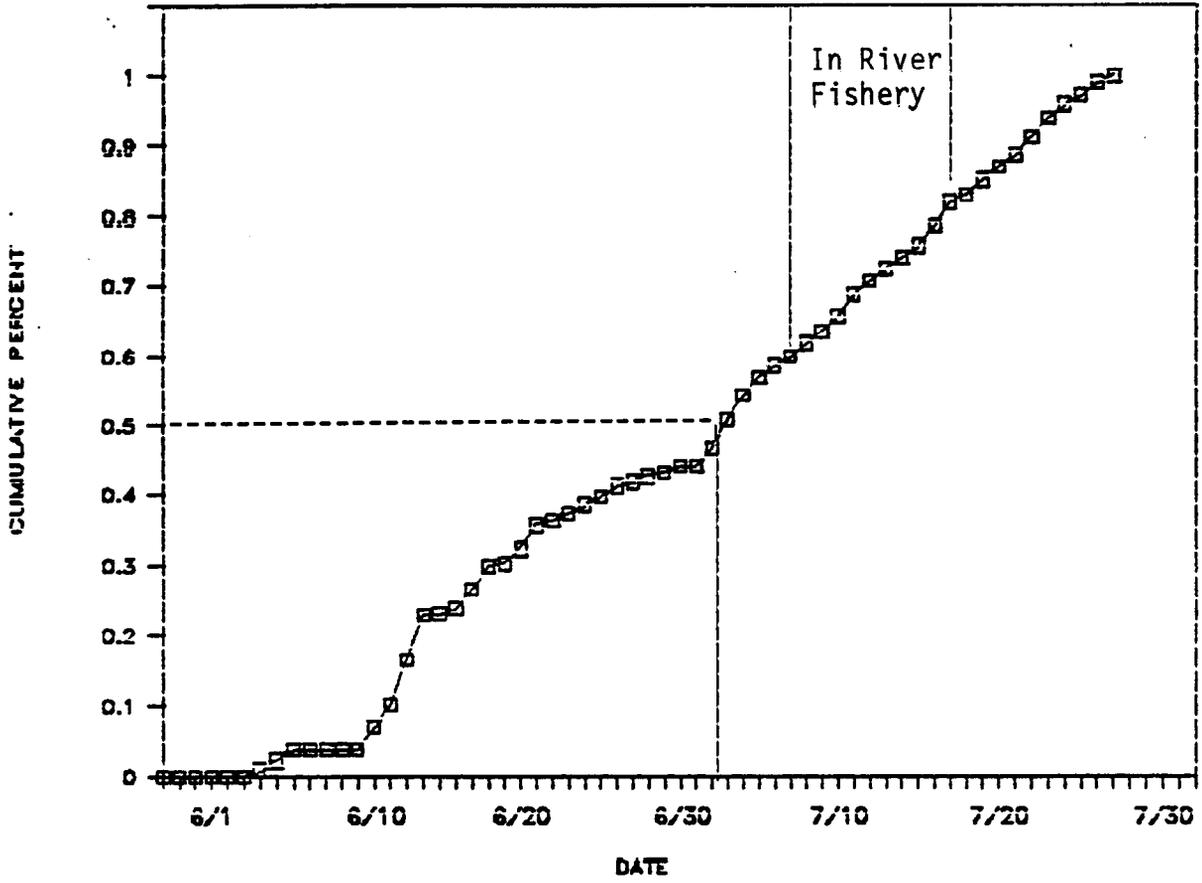


Figure 2. Cumulative catch per angler hour expressed as percent for the Naknek River chinook salmon sport fishery, 1986.

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APPENDIX TABLES

Appendix Table 1. Angler counts for the lower Naknek River sport fishery, 1986.

Date	Wd/ We <sup>1</sup>	Period			Date	Wd/ We <sup>1</sup>	Period		
		A	B	C			A	B	C
5/28	Wd			4	7/02	Wd	74		
5/29	Wd	0			7/02	We			
5/30	Wd				7/04	We	41		
5/31	We	2			7/05	Wd	60		64
6/01	We	4	1		7/06	Wd		98	68
6/02	Wd	1			7/07	Wd			87
6/03	Wd				7/08	Wd			
6/04	Wd				7/09	Wd	148		
6/05	Wd		3	0	7/10	We		56	
6/06	Wd				7/11	We			
6/07	We			0	7/12	Wd	11		
6/08	We		2	0	7/13	Wd		107	50
6/09	Wd				7/14	Wd		85	
6/10	Wd				7/15	Wd	11		
6/11	Wd				7/16	Wd	10		
6/12	Wd				7/17	We			
6/13	Wd			3	7/18	We			34
6/14	We				7/19	Wd		64	0
6/15	We		31		7/20	Wd			5
6/16	Wd		16		7/21	Wd			
6/17	Wd		21		7/22	Wd			
6/18	Wd				7/23	Wd			
6/19	Wd	6			7/24	We		59	
6/20	Wd				7/25	We	3		
6/21	We	60			7/26	Wd			
6/22	We			25	7/27	Wd			
6/23	Wd				7/28	Wd			
6/24	Wd				7/29	Wd			
6/25	Wd			16					
6/26	Wd								
6/27	Wd	70		24					
6/28	We		140						
6/29	We	82		83					
6/30	Wd	58	77						
7/01	Wd		129						

<sup>1</sup> Wd = Weekday; We = Weekend/Holiday.

Appendix Table 2. Summary of daily angler effort and catch rates (CPUE) for chinook, sockeye, chum, and pink salmon from angler interviews in the lower Naknek River sport fishery, 1986.

Date	Wd/ We <sup>1</sup>	Sample Size	Effort		Chinook			Sockeye			Chum			Pink		
			Mean	Std Err	Mean	Std Err	CPUE	Mean	Std Err	CPUE	Mean	Std Err	CPUE	Mean	Std Err	CPUE
5/28	Wd	3	2.750	0.0000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
5/31	We	4	1.750	0.1443	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
6/01	We	8	2.000	0.3536	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
6/03	Wd	2	2.750	0.0000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
6/05	Wd	3	3.167	0.3333	0.667	0.3333	0.211	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/07	We	3	2.500	0.5000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
6/09	Wd	3	3.333	0.6667	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
6/13	Wd	5	4.200	0.7349	3.800	1.1136	0.905	0.000	0.0000	0.000	0.400	0.2450	0.095	0.000	0.0000	0.000
6/15	We	26	4.346	0.3172	0.077	0.0533	0.018	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/16	Wd	8	3.250	0.3536	0.375	0.3750	0.115	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/17	Wd	8	3.689	0.7482	1.500	0.7559	0.407	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/19	Wd	15	1.933	0.2922	0.133	0.0909	0.069	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/21	We	8	3.438	0.5361	1.625	0.7055	0.473	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/22	We	38	4.276	0.3529	0.342	0.1017	0.080	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/25	Wd	63	3.746	0.2983	0.619	0.1207	0.165	0.016	0.0159	0.004	0.016	0.0159	0.004	0.000	0.0000	0.000
6/27	Wd	86	4.451	0.3450	0.419	0.0928	0.094	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/28	We	48	5.344	0.4177	0.667	0.1819	0.125	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/29	We	111	5.270	0.2837	0.306	0.0611	0.058	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
6/30	Wd	29	3.578	0.2302	0.483	0.1067	0.135	0.000	0.0000	0.000	0.034	0.0345	0.010	0.000	0.0000	0.000
7/01	Wd	36	5.021	0.3849	0.056	0.0387	0.011	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
7/02	Wd	32	4.016	0.2699	1.438	0.2577	0.358	0.000	0.0000	0.000	0.063	0.0435	0.016	0.000	0.0000	0.000
7/04	We	32	3.109	0.3035	1.563	0.2287	0.503	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
7/05	We	73	3.793	0.3204	1.397	0.3039	0.368	0.000	0.0000	0.000	0.014	0.0137	0.004	0.000	0.0000	0.000
7/06	We	96	4.787	0.2186	1.135	0.1551	0.237	0.000	0.0000	0.000	0.073	0.0450	0.015	0.000	0.0000	0.000
7/07	Wd	41	4.280	0.4597	0.683	0.1691	0.160	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
7/09	Wd	4	3.000	0.0000	0.750	0.4787	0.250	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
7/10	Wd	46	4.870	0.3167	1.522	0.2462	0.313	0.000	0.0000	0.000	0.022	0.0217	0.004	0.000	0.0000	0.000
7/12	We	28	2.205	0.1612	0.607	0.1948	0.275	0.000	0.0000	0.000	0.071	0.0714	0.032	0.000	0.0000	0.000
7/13	We	116	5.858	0.2684	1.388	0.1312	0.237	0.000	0.0000	0.000	0.017	0.0121	0.003	0.000	0.0000	0.000
7/14	Wd	63	4.389	0.1645	0.952	0.1788	0.217	0.000	0.0000	0.000	0.063	0.0384	0.014	0.000	0.0000	0.000
7/15	Wd	22	2.848	0.2952	0.682	0.2220	0.239	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
7/16	Wd	18	2.528	0.3227	1.056	0.3379	0.418	0.000	0.0000	0.000	0.111	0.0762	0.044	0.000	0.0000	0.000
7/18	Wd	41	7.732	0.4348	1.244	0.2414	0.161	0.000	0.0000	0.000	0.098	0.0766	0.013	0.000	0.0000	0.000
7/20	We	58	5.767	0.3154	1.500	0.2337	0.260	0.000	0.0000	0.000	0.207	0.1471	0.036	0.017	0.0172	0.003
7/21	Wd	71	5.478	0.3439	1.282	0.1762	0.234	0.000	0.0000	0.000	0.042	0.0313	0.008	0.000	0.0000	0.000
7/24	Wd	41	4.390	0.2881	1.244	0.1807	0.283	0.000	0.0000	0.000	0.049	0.0488	0.011	0.024	0.0244	0.006
7/25	Wd	21	2.381	0.1823	0.429	0.2634	0.180	0.000	0.0000	0.000	0.000	0.0000	0.000	0.095	0.0656	0.040
7/27	We	69	3.862	0.2375	0.594	0.1311	0.154	0.000	0.0000	0.000	0.014	0.0145	0.004	0.014	0.0145	0.004
7/31	Wd	4	2.750	0.1443	0.500	0.5000	0.182	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000
8/09	We	11	1.773	0.2967	0.727	0.3042	0.410	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000

<sup>1</sup> Wd = Weekday; We = Weekend/Holiday.

Appendix Table 3. Summary of daily angler effort and catch rates (CPUE) for coho salmon, rainbow trout, Dolly Varden, and Arctic grayling from angler interviews in the lower Naknek River sport fishery, 1986.

Date	Wd/ We <sup>1</sup>	Sample Size	Effort		Coho			Rainbow Trout			Dolly Varden			Arctic Grayling		
			Mean	Std Err	Mean	Std Err	CPUE	Mean	Std Err	CPUE	Mean	Std Err	CPUE	Mean	Std Err	CPUE
5/28	Wd	3	2.750	0.000	0.000	0.0000	0.000	0.333	0.3333	0.121	0.000	0.0000	0.000	0.000	0.0000	0.000
5/31	We	4	1.750	0.144	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/01	We	8	2.000	0.354	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/03	Wd	2	2.750	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/05	Wd	3	3.167	0.333	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/07	We	3	2.500	0.500	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/09	Wd	3	3.333	0.667	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/13	Wd	5	4.200	0.735	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/15	We	26	4.346	0.317	0.000	0.0000	0.000	0.115	0.0846	0.027	0.000	0.0000	0.000	0.077	0.0769	0.018
6/16	Wd	8	3.250	0.354	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/17	Wd	8	3.689	0.748	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/19	Wd	15	1.933	0.292	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/21	We	8	3.438	0.536	0.000	0.0000	0.000	0.250	0.2500	0.073	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/22	We	38	4.276	0.353	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/25	Wd	63	3.746	0.298	0.000	0.0000	0.000	0.079	0.0411	0.021	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/27	Wd	86	4.451	0.345	0.000	0.0000	0.000	0.070	0.0431	0.016	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/28	We	48	5.344	0.418	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/29	We	111	5.270	0.284	0.009	0.0090	0.002	0.018	0.0180	0.003	0.000	0.0000	0.000	0.0000	0.000	0.0000
6/30	Wd	29	3.578	0.230	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/01	Wd	36	5.021	0.385	0.000	0.0000	0.000	0.111	0.0531	0.022	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/02	Wd	32	4.016	0.270	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/04	We	32	3.109	0.303	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/05	We	73	3.793	0.320	0.000	0.0000	0.000	0.082	0.0822	0.022	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/06	We	96	4.787	0.219	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/07	Wd	41	4.280	0.460	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/09	Wd	4	3.000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/10	Wd	46	4.870	0.317	0.043	0.0304	0.009	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/12	We	28	2.205	0.161	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/13	We	116	5.858	0.268	0.000	0.0000	0.000	0.009	0.0086	0.001	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/14	Wd	63	4.389	0.165	0.000	0.0000	0.000	0.032	0.0223	0.007	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/15	Wd	22	2.848	0.295	0.000	0.0000	0.000	0.045	0.0455	0.016	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/16	Wd	18	2.528	0.323	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/18	Wd	41	7.732	0.435	0.000	0.0000	0.000	0.098	0.0766	0.013	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/20	We	58	5.767	0.315	0.000	0.0000	0.000	0.172	0.1157	0.030	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/21	Wd	71	5.478	0.344	0.000	0.0000	0.000	0.028	0.0198	0.005	0.014	0.0141	0.003	0.000	0.0000	0.000
7/24	Wd	41	4.390	0.288	0.073	0.0540	0.017	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/25	Wd	21	2.381	0.182	0.000	0.0000	0.000	0.048	0.0476	0.020	0.000	0.0000	0.000	0.0000	0.000	0.0000
7/27	We	69	3.862	0.237	0.000	0.0000	0.000	0.014	0.0145	0.004	0.000	0.0000	0.000	0.014	0.0145	0.004
7/31	Wd	4	2.750	0.144	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000
8/09	We	11	1.773	0.297	0.000	0.0000	0.000	0.000	0.0000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.0000

<sup>1</sup> Wd = Weekday; We = Weekend/Holiday.

