Fishery Data Series No. 92-30

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ABSTRACT

The contribution of hatchery produced chinook salmon *Oncorhynchus tshawytscha* to the sport fishery harvest was estimated in the Ninilchik River for the period 25 May-24 June 1991. A roving creel survey two-stage sample design was used to estimate total harvest as well as catch and effort and the harvest was sampled for adipose finclipped fish for tag recoveries. A total of 5,053 chinook salmon were estimated to be harvested at Ninilchik, of which 3,868 were estimated to be hatchery produced for a contribution rate of 77%. Total harvest surpassed the previous record by three-fold. In addition, a total of 9,719 salmon were caught and total effort was 51,318 angler hours. Escapement was estimated at 827 fish, near the long term average of 830 fish.

KEY WORDS: Ninilchik River, Kenai Peninsula, anadromous, chinook salmon, *Oncorhynchus tshawytscha*, creel survey, stocking, evaluation.

INTRODUCTION

The Ninilchik River (Figure 1) is one of three southern Kenai Peninsula streams that support inriver recreational fisheries for chinook salmon *Oncorhynchus tshawytscha*. The Ninilchik River is a small stream and the sport fishery is capable of harvesting a significant portion of the total return. Harvest is controlled by limiting the allowable time and area open to fishing. The Ninilchik River, from salt water to approximately 3 km (2 mi) upstream, is open to chinook salmon fishing only during the last weekend in May (Saturday, Sunday, and Monday) and the first two weekends in June. These regulations have been in effect since 1978 with no emergency closures. The other two southern Kenai Peninsula streams, Anchor River and Deep Creek, are more liberally managed with a total of five weekends of fishing time.

The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish and Division of Fisheries Rehabilitation, Enhancement and Development (FRED) initiated a stocking program to increase chinook salmon returns to the Ninilchik River with the objective of increasing angler effort by 10,000 days while still maintaining historic levels of natural spawning. Hatchery produced chinook salmon smolt from Ninilchik River brood stock have been released back into the system annually since 1988 (Table 1). The first return of 3-ocean adult chinook salmon from the initial smolt release occurred in 1991. To evaluate this return, a creel survey of the Ninilchik River chinook salmon fishery was conducted during 1991. The survey was used to estimate the contribution of the stocked chinook salmon in the fishery, sport fishing effort, catch (fish landed), harvest (fish retained), and age and size composition of the harvest.

The objectives of this report are to present:

1. estimates of catch and harvest of chinook salmon and angler effort in the Ninilchik River sport fishery;

2. estimates of the contribution of stocked chinook salmon to the Ninilchik River sport fishery;

3. estimates of the age composition of adipose clipped chinook salmon and chinook salmon without adipose clips in the Ninilchik River sport fishery; and

4. estimates of spawning escapement in the Ninilchik River.

METHODS

The sport fishery in the Ninilchik River in 1991 occurred from 25 May through 24 June. From 25 May to 17 June, four 3-day weekend fisheries were prosecuted. Each weekend, the fishery started at midnight Friday night and continued to midnight Monday night. The fishery was extended for an entire week by emergency order during the period 18 June to 24 June in response to a strong return of chinook salmon. Throughout the fishery, a daily bag and possession limit of one chinook salmon over 406 mm (16 in) and a seasonal limit of five chinook salmon was in effect.

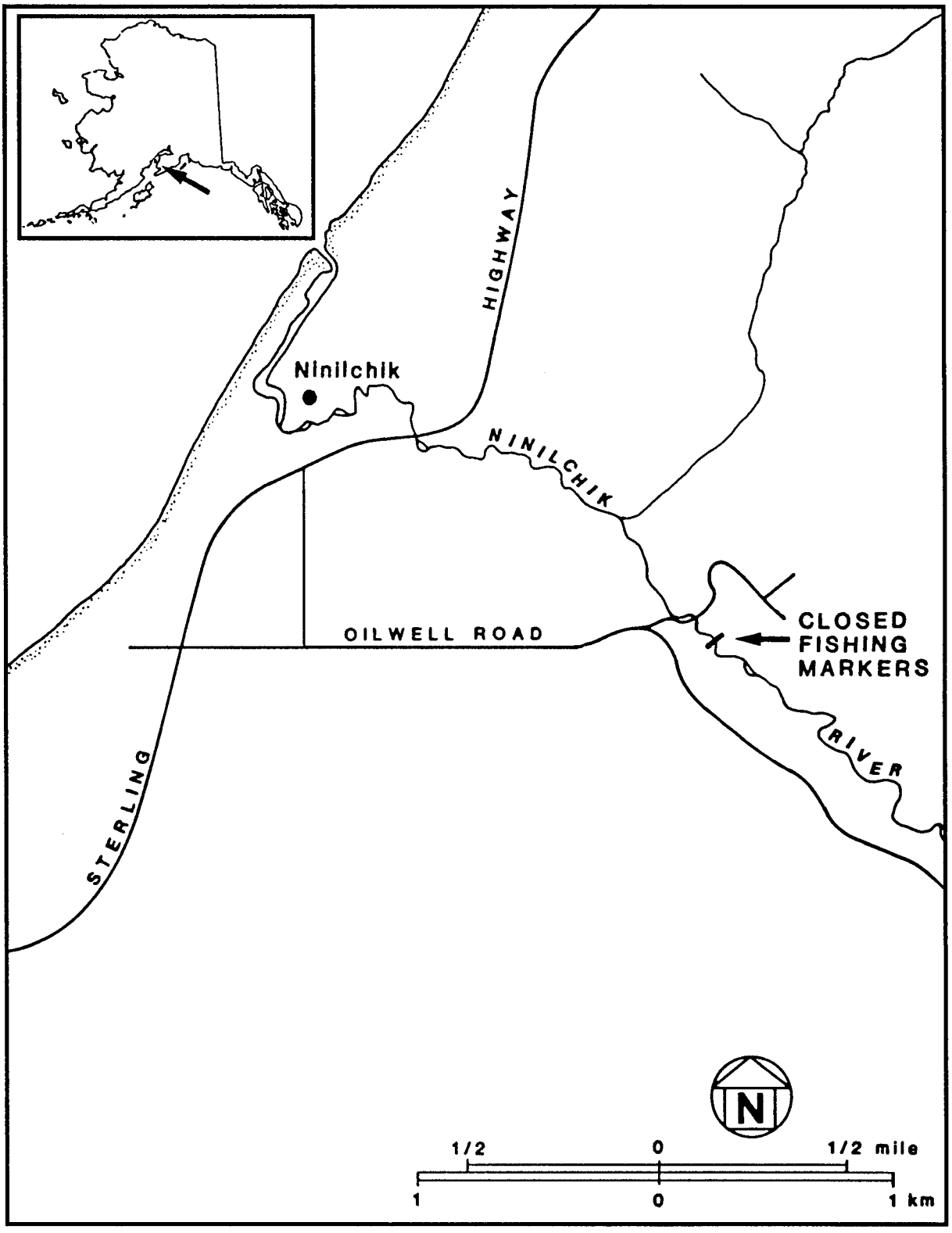

Figure 1. Study area on the Ninilchik River, Alaska.

Table 1. Ninilchik River chinook salmon stocking history, 1988-1990.

Release				Returning in years at age		
Year	Number	No. marked	% marked	1.1	1.2	1.3
1988	247,327	30,809	12.46	1989	1990	1991
1989	199,831	18,772	9.39	1990	1991	1992
1990	215,804	40,319	18.68	1991	1992	1993

Creel Survey

Study Design:

The creel survey was designed as a two-stage roving creel survey, with periods within strata representing the first stage and counts and angler interviews representing the second stage. Total catch, harvest and effort (in angler-hours) were estimated for each period, and the period means expanded over all periods within a stratum. Strata totals were considered independent estimates and so the totals and their variances could be summed over all strata for the overall total estimate.

During each of the four weekend fisheries in May and June, two strata were defined. Saturday was treated as one stratum and Sunday and Monday were combined into the second stratum. The last week of the fishery, from 18 June to 24 June, was treated as one stratum. This resulted in nine total strata.

During the weekend fisheries, there were potentially six 4-hour periods in the Saturday strata and six 8-hour periods in the Sunday-Monday strata. Three periods were systematically chosen for sampling in each of the strata by randomly choosing the first period to be sampled and then choosing every other period. During the last week (18 to 24 June), periods were 6 hours in length and five were randomly chosen for sampling.

In any sample period chosen, anglers were counted to estimate total effort (in angler-hours), and completed-trip anglers were interviewed for estimation of catch per unit of effort (CPUE) and harvest per unit of effort (HPUE).

Counts took 1 hour to complete. In the Saturday strata, only a single count was randomly made and the remaining 3 hours were spent interviewing anglers. In the Sunday-Monday strata, three angler counts were made within each 8-hour sample period, leaving 5 hours of sampling time for angler interviews. These counts were systematically drawn, with the first count randomly selected in the first 140 minutes (2 hours and 20 minutes) of the period and the second and third at 140 minute intervals. During the last week, two counts were made each period. These counts were also systematically selected with the first randomly selected in the first 3 hours and the second 3 hours later.

Because of the low bag limit in effect, interviews were of completed anglers only to eliminate potential bias in estimates of HPUE. Samplers attempted to interview as many completed-trip anglers as possible and interviews were conducted where large numbers of people were exiting the fishery.

Data Analysis:

Angler counts were used to estimate mean number of anglers fishing in a period such that:

$$\bar{x}_i = \frac{\sum_{j=1}^{r_i} x_{ij}}{r_i} \qquad (1)$$

where,

x_{ij} = angler count j in period i,

r_i = number of angler counts in period i,

$\bar{x}_i$ = mean angler count in period i.

Angler counts were systematically drawn within a period and the variance of the mean angler count was estimated by:

$$\mathrm{Var}(\bar{x}_i) = \frac{\sum_{j=2}^{r_i} (x_{ij} - x_{i(j-1)})^2}{2\, r_i\, (r_i - 1)} . \qquad (2)$$

In the Saturday strata only one count was made and therefore this count estimates the mean period angler count with a variance of zero.

Effort for period i was estimated by:

$$\hat{E}_{hi} = L_h \bar{x}_i \qquad (3)$$

where,

$\hat{E}_{hi}$ = effort for period i in angler-hours,

L_h = length of period in hours in stratum h,

and the variance was estimated by:

$$\mathrm{Var}(\hat{E}_{hi}) = L_h^2\, \mathrm{Var}(\bar{x}_i). \qquad (4)$$

The mean effort for stratum h was estimated by:

$$\bar{E}_h = \frac{\sum_{i=1}^{p} \hat{E}_{hi}}{p} \qquad (5)$$

where,

$\bar{E}_h$ = mean effort for stratum h,

p = number of periods sampled in stratum h.

Periods were systematically drawn within a stratum for the weekend strata and the variance of the mean period effort was estimated by:

$$S_{Eh1}^2 = \frac{\sum_{p=2}^{p} (\hat{E}_{hi} - \hat{E}_{h(i-1)})^2}{2(p-1)} . \quad (6)$$

In the last week of the fishery, periods were randomly drawn and the variance of the mean period effort was then estimated by:

$$S_{Eh1}^2 = \frac{\sum_{p=1}^{p} (\hat{E}_{hi} - \hat{E}_h)^2}{(p-1)} . \quad (7)$$

Total effort for the strata h was estimated by:

$$\hat{E}_h = P \bar{E}_h \quad (8)$$

where,

$\hat{E}_h$ = total effort for stratum h,

P = total number of periods in stratum.

The variance of total effort for the stratum was estimated by:

$$Var(E_h) = (1-f) P^2 \frac{S_{Eh1}^2}{p} + P \frac{\sum_{i=1}^{p} Var(\hat{E}_{hi})}{p} . \quad (9)$$

Catch and harvest per unit of effort was estimated for each sample period from angler interviews using jackknife methods in order to minimize the bias of these ratio estimators (Efron 1982).

A total of m_{hi} estimates of CPUE were made, one for each angler by removing that angler, so that

$$CPUE_{hij}^{*} = \frac{\sum_{lnej\ l \neq j}^{m_{hi}} c_{hil}}{\sum_{lnej\ l \neq j}^{m_{hi}} e_{hil}} \quad (10)$$

where,

$CPUE^{*}_{hij}$ = jackknifed estimate for angler j,

$\sum_{\ell \neq j}^{m_{hi}} c_{hil}$ = catches for all anglers interviewed in period i except angler j,

$\sum_{\ell \neq j}^{m_{hi}} e_{hil}$ = hours fished for all anglers interviewed in period i except angler j,

m_{hi} = number of anglers interviewed in period i.

The jackknife estimate of mean CPUE for period i was the mean of the above estimates:

$$\overline{CPUE}^{*}_{hi} = \frac{\sum_{j=1}^{m_{hi}} CPUE^{*}_{hij}}{m_{hi}} \qquad (11)$$

and the bias corrected mean was:

$$\overline{CPUE}^{**}_{hi} = (m_{hi}\ (\overline{CPUE}_{hi} - \overline{CPUE}^{*}_{hi})) + \overline{CPUE}^{*}_{hi} \qquad (12)$$

where,

$\overline{CPUE}_{hi}$ = the standard estimate of CPUE, or the sum of all catches over the sum of all hours fished in a period.

The variance of the jackknife estimate of CPUE was estimated by:

$$Var(\overline{CPUE}^{**}_{hi}) = \frac{(m_{hi} - 1)}{m_{hi}} \sum_{j=1}^{m_{hi}} (CPUE^{*}_{hij} - \overline{CPUE}^{*}_{hi})^2 \qquad (13)$$

The estimate of HPUE was made as for CPUE, substituting angler harvest for angler catch in equations (10) through (13) above.

Catch for the sample period was then estimated as the product of effort and CPUE by:

$$\hat{C}_{hi} = \hat{E}_{hi}\ \overline{CPUE}^{**}_{hi} \qquad (14)$$

and the variance by:

$$Var(\hat{C}_{hi}) = Var(\hat{E}_{hi}) * \overline{CPUE}^{**}_{hi}{}^2 + Var(\overline{CPUE}^{**}_{hi}) * \hat{E}_{hi}{}^2 - Var(\overline{CPUE}^{**}_{hi}) * Var(\hat{E}_{hi}). \qquad (15)$$

Harvest for sample period i was estimated using equations (14) through (15).

Total catch and harvest for stratum h was estimated using equations (6) through (9) above for effort, substituting estimated sample period catch (C_{hi}) or harvest (H_{hi}) for sample period effort (E_{hi}).

The assumption necessary for this estimator is that anglers interviewed exiting the fishery are representative of all anglers in the fishery during the period.

Age Composition and Mean Length at Age

Chinook salmon were measured and scales removed for aging. The proportion of fish in an age class (p_i) was estimated by:

$$\hat{p}_i = \frac{n_i}{n} \qquad (16)$$

where,

n_i = number of fish sampled in age class i,

n = total number of fish sampled,

and the variance was estimated by:

$$\widehat{Var}(\hat{p}_i) = \frac{\hat{p}_i (1-\hat{p}_i)}{n-1} . \qquad (17)$$

Mean lengths at age and the variance were estimated using equations for normal variates.

Hatchery Contributions

Harvested salmon were examined for adipose finclips. If a finclipped fish was observed, then the head was removed with the permission of the angler and a numbered headstrap attached. The heads were sent to the ADF&G Coded Wire Tag Laboratory where the tags were removed and decoded.

Hatchery contributions were estimated using equations derived by Clark and Bernard (1987). Variance of the contribution estimate was derived from bootstrapping (Efron 1982). Sample size for the bootstrapping was 2,000.

Escapement

Methods:

Escapement surveys were conducted in late July after fish began to spawn and water levels were near seasonal lows. Spawning occurs throughout the stream from the Sterling Highway bridge to the headwaters. Although some spawning occurs downstream from the bridge, it is assumed to be insignificant.

Escapement estimates were generated from both ground and aerial surveys. Ground counts for a predetermined area were compared to counts conducted from a helicopter over the same area on the same day. The remainder of the stream was then surveyed from the air, again on the same day, and the counts expanded. This method attempts to account for fish missed during the aerial survey. Since the survey is only done once, this method does not account for fish unavailable to either survey (fish which have not yet entered the survey area or fish which have died and have exited the survey area). Therefore, this method provides an estimate of escapement which has a negative bias of unknown magnitude.

Each ground surveyor recorded the number of live chinook salmon and the number of carcasses observed in the predescribed area. The surveyors in the helicopter also made an independent count recording similar information in both the index area and over the remainder of the stream.

Expanded estimates of chinook salmon escapement, $\hat{N}$, were calculated from ground and aerial counts as follows:

$$\hat{N}_{(i)} = g_{(i)} + [(g_{(i)}/a_{(i)})(r_{(i)})], \quad (18)$$

where: i = stratum (live or dead),
g = number of fish observed from the ground,
a = number of fish observed from the air,
r = number of fish observed from the air in other than the index area.

In most cases, ground survey counts are greater than aerial survey counts and the above method is utilized. On occasion however, an aerial count of the area exceeds the ground count. If the latter case arises, the escapement is estimated by summing only the aerial counts and the ground survey counts are ignored.

RESULTS

Creel Survey

The creel survey on the Ninilchik River was conducted from 25 May through 27 May, 1 June through 3 June, 8 June through 10 June, 15 June through 17 June, 19 June through 22 June, and 24 June; a total of 744 anglers were interviewed. The mean hours fished by these anglers ranged from 1.23 hours during the A period on 15 June to 3.99 hours during the B period on 8 June. The success rate or percent of anglers catching one or more fish ranged from 9.5% to 71.4% while 4.7% to 54.8% of the anglers kept at least one fish (Table 2). The mean angler count ranged from 24 during the D period on 17 June to 382 during the D period on 25 May (Table 3) and total effort ranged from 189 angler hours during the D period on 17 June to 1,528 during the D period on 25 May (Table 3). The estimated mean CPUE ranged from 0.039 during the A period on 9 June to 1.23 during the A period on 15 June, and total catch from 12 during the D period on 3 June to 779 salmon during the A period on 15 June (Table 3). The estimated mean HPUE ranged from 0.012 during the

Table 2. Summary of hours fished, fish caught and harvested for anglers interviewed in the creel survey, Ninilchik River, 1991.

Date	Period	Number Sampled	Hours Fished		Fish Caught			Fish Harvested		
			Mean	SD	Mean	SD	Success Rate[a]	Mean	SD	Success Rate[a]
5/25	B	21	2.05	1.25	0.71	1.35	38.10	0.24	0.44	23.81
	D	11	2.77	1.27	0.80	0.92	63.64	0.30	0.48	36.36
	F	11	2.68	1.10	0.70	1.06	45.45	0.27	0.47	27.27
5/26	A	10	2.00	0.53	0.30	0.48	30.00	0.30	0.48	30.00
	C	6	2.25	1.86	0.33	0.52	33.33	0.33	0.52	33.33
5/27	E	14	2.18	1.07	0.64	0.63	57.14	0.43	0.51	42.86
6/1	A	14	2.14	1.32	0.14	0.36	14.29	0.14	0.36	14.29
	C	20	3.45	1.20	0.70	0.86	50.00	0.40	0.50	40.00
	E	18	2.67	0.91	0.33	0.69	22.22	0.06	0.24	5.56
6/2	B	51	2.93	1.13	0.27	0.57	21.57	0.18	0.39	17.65
6/3	D	18	3.03	1.14	0.11	0.32	11.11	0.11	0.32	11.11
	F	27	2.78	1.12	0.23	0.43	25.93	0.12	0.33	14.81
6/8	B	15	3.73	1.31	0.47	0.64	40.00	0.27	0.46	26.67
	D	45	3.99	1.84	0.58	0.81	42.22	0.29	0.46	28.89
	F	31	3.32	1.29	0.52	0.77	38.71	0.23	0.43	22.58
6/9	A	21	2.43	0.76	0.10	0.30	9.52	0.05	0.22	4.76
	C	31	3.03	1.06	0.32	0.54	29.03	0.06	0.25	6.45
6/10	E	23	2.70	0.89	0.39	0.58	34.78	0.13	0.34	13.04
6/15	A	28	1.23	0.69	1.54	2.01	71.43	0.64	0.87	50.00
	C	29	2.78	1.01	1.03	1.50	44.83	0.31	0.54	27.59
	E	14	2.71	0.93	0.57	0.65	50.00	0.29	0.47	28.57
6/16	B	32	2.67	1.16	0.59	1.04	37.50	0.16	0.45	12.50
6/17	D	20	2.47	0.95	0.30	0.47	30.00	0.20	0.41	20.00
	F	25	2.86	1.02	0.68	0.90	48.00	0.48	0.59	44.00
6/19	A	31	1.97	1.13	0.65	0.66	54.84	0.55	0.51	54.84
6/20	B	48	3.15	2.18	0.38	0.71	31.25	0.21	0.41	20.83
6/21	C	41	2.07	1.06	0.17	0.38	17.07	0.12	0.33	12.20
6/22	D	49	2.60	1.14	0.26	0.49	26.53	0.10	0.31	10.20
6/24	F	40	2.45	1.10	0.38	0.70	27.50	0.20	0.46	17.50

[a] Percentage of interviewed anglers with one or more fish.

Table 3. Estimated effort, catch and harvest by sample period for Ninilchik River creel survey, 1991.

		Counts		Effort		Number	Catch per hour		Catch		Harvest per hour		Harvest	
Date	Period	N	Mean	Total	Variance	Interv.	Mean	Variance	Total	Variance	Mean	Variance	Total	Variance
5/25	B	1	117	468	0	21	0.3469	0.0202	162	4,431	0.1167	0.0019	55	407
	D	1	382	1,528	0	11	0.2567	0.0104	392	24,296	0.1009	0.0020	154	4,753
	F	1	168	672	0	11	0.2774	0.0091	186	4,118	0.1013	0.0027	68	1,229
5/26	A	3	77	616	73,067	10	0.1518	0.0053	93	3,298	0.1518	0.0053	93	3,298
	C	3	97	776	65,547	5	0.1264	0.0133	98	8,188	0.1264	0.0133	98	8,188
5/27	E	3	53	424	2155	14	0.2905	0.0072	123	1,468	0.1945	0.0041	82	816
6/1	A	1	139	556	0	14	0.0688	0.0018	38	571	0.0688	0.0018	38	571
	C	1	200	800	0	20	0.2046	0.0023	164	1,451	0.1171	0.0007	94	460
	E	1	198	792	0	18	0.1258	0.0034	100	2,154	0.0211	0.0004	17	274
6/2	B	3	120	960	603	51	0.0944	0.0006	91	550	0.0606	0.0003	58	261
6/3	D	3	39	315	15,669	18	0.0369	0.0006	12	73	0.0369	0.0006	12	73
	F	3	107	853	16,155	27	0.2134	0.0176	182	13,273	0.0402	0.0005	34	367
6/8	B	1	133	532	0	15	0.1264	0.0016	67	441	0.0723	0.0009	38	243
	D	1	299	1,196	0	45	0.1452	0.0007	174	1,052	0.0726	0.0002	87	357
	F	1	122	488	0	31	0.1557	0.0015	76	367	0.0678	0.0005	33	125
6/9	A	3	55	437	6,363	21	0.0393	0.0007	17	144	0.0197	0.0004	9	74
	C	3	137	1,093	20,789	31	0.1072	0.0008	117	1,219	0.0214	0.0002	23	262
6/10	E	3	108	867	14,955	23	0.1456	0.0018	126	1,651	0.0481	0.0007	42	567
6/15	A	1	158	632	0	28	1.2333	0.1115	779	44,553	0.5122	0.0249	324	9,960
	C	1	205	820	0	29	0.3763	0.0070	309	4,709	0.1128	0.0011	93	707
	E	1	291	1,164	0	14	0.2124	0.0030	247	4,007	0.1057	0.0020	123	2,678
6/16	B	3	104	832	1,579	32	0.2246	0.0036	187	2,547	0.0594	0.0008	49	545
6/17	D	3	24	189	1,627	20	0.1219	0.0015	23	77	0.0800	0.0015	15	60
	F	3	95	757	3,605	25	0.2400	0.0027	182	1,748	0.1688	0.0012	128	811
6/19	A	2	170	1,023	8,649	31	0.3241	0.0050	332	6,101	0.2751	0.0033	281	4,060
6/20	B	2	90	537	81	49	0.1249	0.0009	67	269	0.0656	0.0003	35	97
6/21	C	2	62	372	3,600	41	0.0822	0.0008	31	133	0.0588	0.0006	22	94
6/22	D	2	167	1,002	144	51	0.1037	0.0007	104	736	0.0369	0.0003	37	267
6/24	F	2	59	354	4,356	40	0.1516	0.0024	54	389	0.0806	0.0010	29	153

A period on 9 June to 0.512 during the A period on 15 June, and total harvest from 9 fish during the A period on 9 June to 324 during the A period on 15 June (Table 3).

An important assumption of the creel survey design is that interviewed anglers were representative of the anglers counted during the sample period. If this assumption is violated, then estimates of mean CPUE and HPUE as well as total catch and harvest will be biased. There is reason to believe this may have happened in some sample periods at Ninilchik in 1991. The trip lengths, or hours fished, of anglers interviewed at Ninilchik ranged from 0.5 to 8 hours, with one trip being 12 hours. If sample periods were shorter than the range of trip lengths, then anglers with long trip lengths did not have the same probability of being interviewed as those with short trip lengths. An examination of the distribution of trip lengths for the anglers interviewed during A, B, and C periods shows that the distribution of trip lengths during A period on 15 June were much shorter than during other sample periods: 10 out of 28 anglers interviewed during the A period on 15 June had only fished 0.5 hours (Figure 2).

Estimates of mean CPUE and HPUE will be biased if the mean CPUE and HPUE of anglers with short trip length were different than the remaining anglers. On 15 June, 74% of the anglers were successful (Table 2). Of the 10 anglers who only fished 0.5 hours, 8, or 80%, had been successful while only 40% of the anglers fishing 1 or more hours had been successful (Figure 3). During this sample period, anglers of short trip duration were twice as successful as anglers of longer trip duration. Similar trends in differential success as a function of trip duration were not evident during A period samplings on either 1 or 19 June (Figure 3).

These factors suggest that the estimates of CPUE and HPUE for the A period sampled on 15 June were biased. The mean hours fished, 1.23 hours, was the lowest of any sample period (Table 2) and the percent of anglers with fish was the highest (Table 2). The high success rate of anglers fishing only 0.5 hours contributed to the highest CPUE and HPUE of all periods sampled (Table 3, Figure 4). It appears that on this Saturday, some anglers were immediately successful, left the fishery, and were interviewed. During the remaining periods sampled on that same day, success rates were not similarly high (Tables 2 & 3). This high success rate estimated during the 15 June A period was probably not representative of the remaining anglers fishing during that period. For these reasons, the A period on 15 June was not included in the estimate of total catch and harvest. As the estimate of total effort only involves the angler count, the A period on 15 June was not excluded for this estimate.

The result of excluding this sample period is that the mean catch for 15 June decreases from 445 salmon per period to 278 per period and estimated total catch for that weekend decreases from 3,454 to 2,450 fish. The mean harvest for 15 June decreases from 180 fish to 108 fish and harvest for the weekend from 1,463 to 1,031 fish (Table 4).

The estimate of total catch was 9,718 (SE = 1,404) fish with a harvest of 5,053 (SE = 1,146) fish and total effort was 51,318 (SE = 6,544) angler-hours (Table 5).

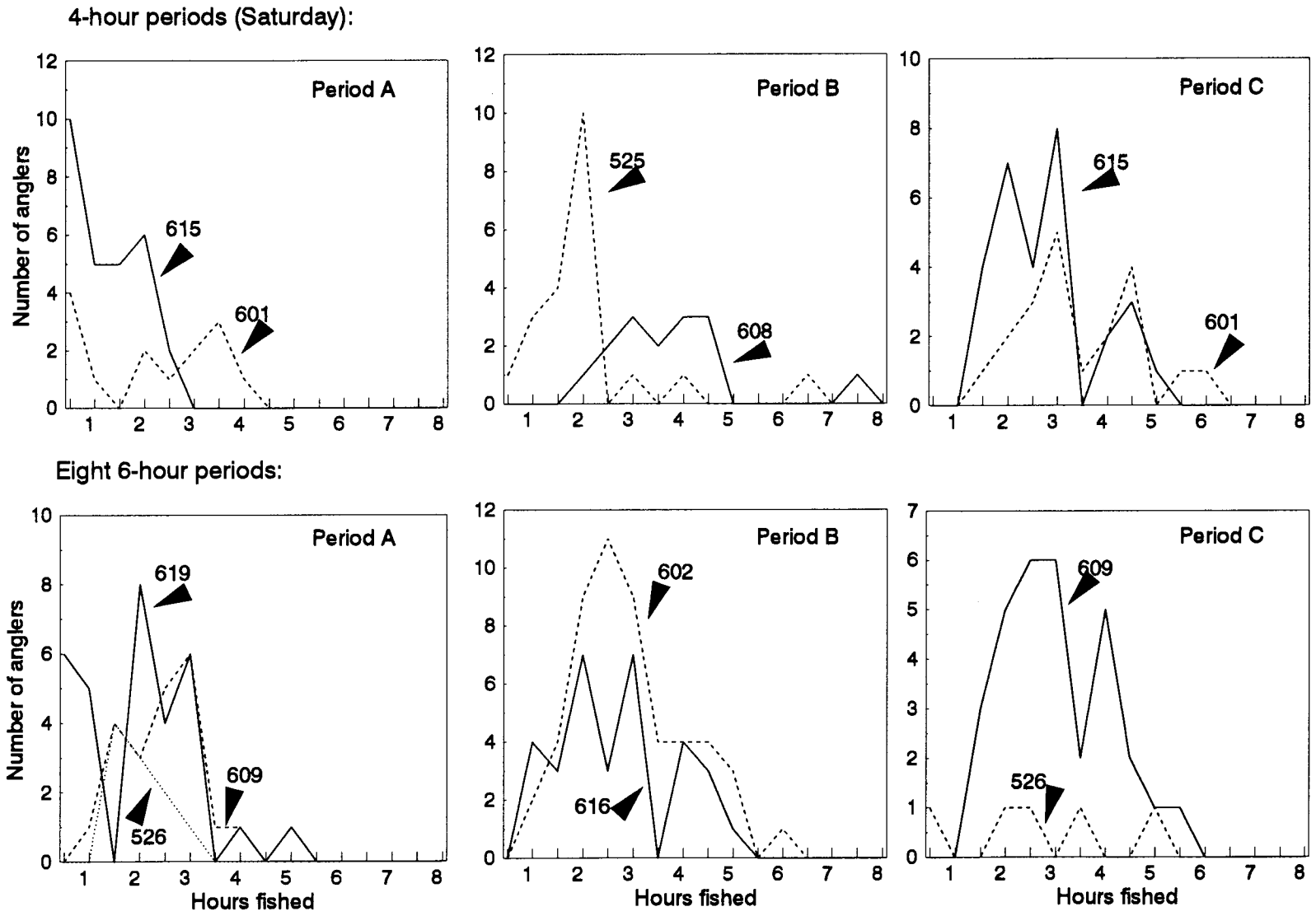

Figure 2. Distribution of hours fished in A, B, and C periods for anglers interviewed in Ninilchik River chinook salmon creel survey, 1991.

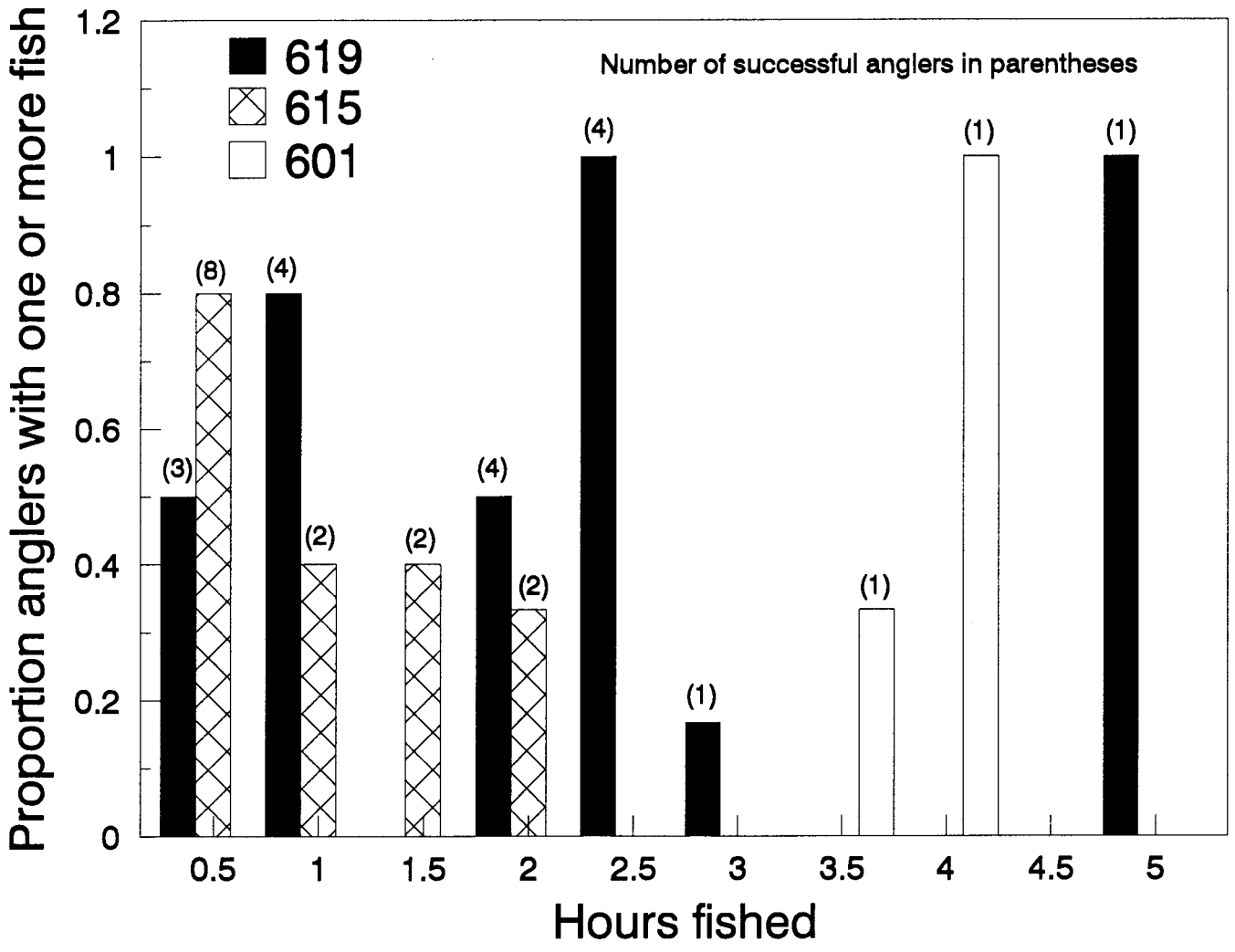

Figure 3. Proportion of successful anglers by hours fished for anglers interviewed during A-period on 1, 15, and 19 June in the Ninilchik River chinook salmon creel survey, 1991.

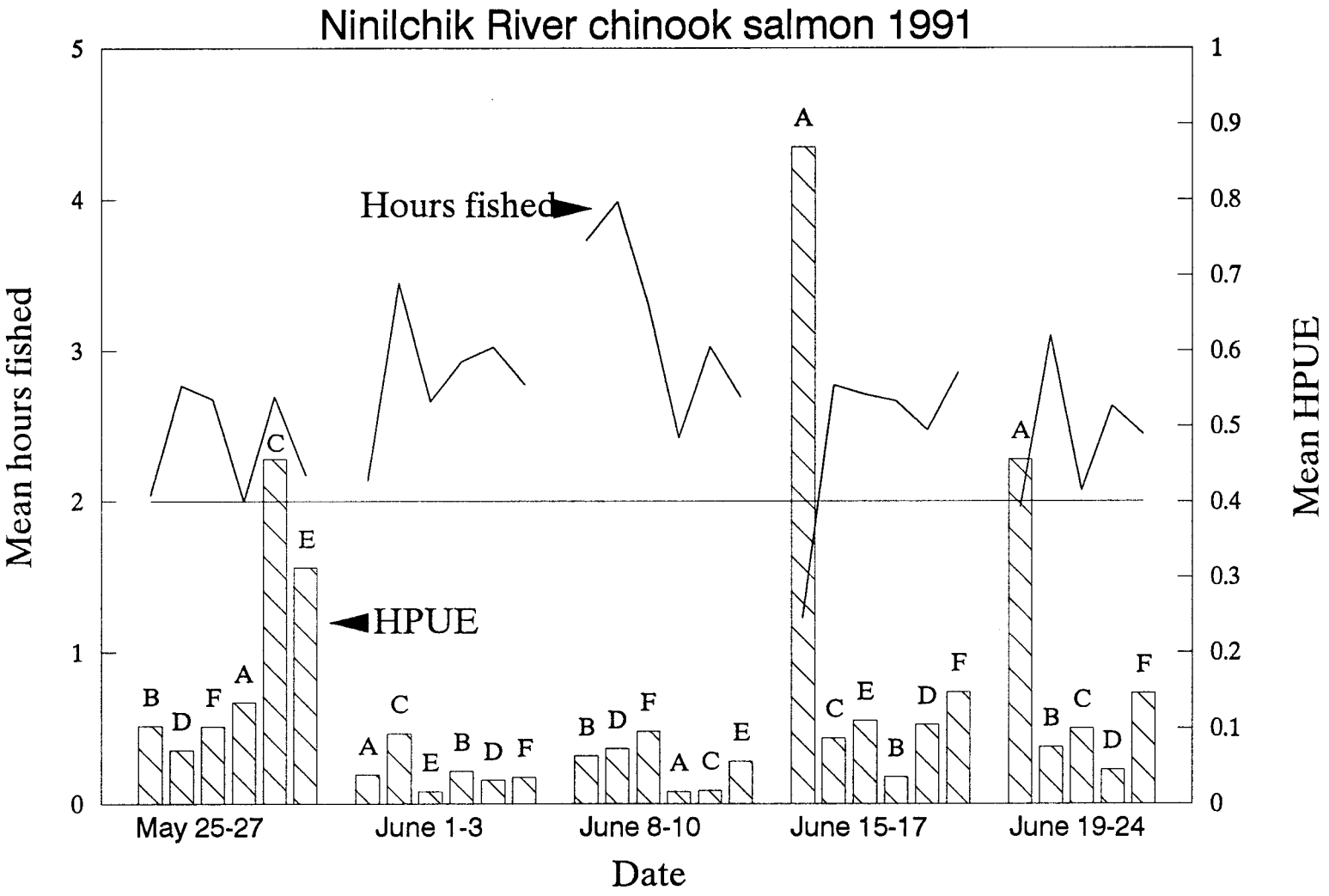

Figure 4. Mean hours fished and HPUE estimated by sample period in Ninilchik River chinook salmon creel survey, 1991.

Table 4. Estimates of total catch and harvest for the weekend of 15-17 June with and without the A period on 15 June, for Ninilchik River chinook salmon fishery, 1991.

Stratum Dates	Periods Ph	Periods ph	Mean	Variance	Total	Variance components Among	Variance components Within	Total Variance	Relative Precision
Catch									
June 15 A period included:									
June 15	6	3	445	56,374	2,670	338,246	106,539	444,785	49.0
June 16 - 17	6	3	131	13,002	784	78,015	8,743	86,758	73.7
Total					3,454			531,543	41.4
June 15 A period excluded:									
June 15	6	2	278	1,883	1,667	22,593	26,149	48,742	26.0
June 16 - 17	6	3	131	13,002	783	78,015	8,743	86,758	73.7
Total					2,450			135,500	29.4
Harvest									
June 15 A period included:									
June 15	6	3	180	13,595	1,078	81,571	26,691	108,261	59.8
June 16 - 17	6	3	64	3,468	385	20,805	2,833	23,639	78.3
Total					1,463			131,900	48.6
June 15 A period excluded:									
June 15	6	3	108	464	646	5,566	10,155	15,721	38.0
June 16 - 17	6	3	64	3,468	385	20,805	2,833	23,639	78.3
Total					1,031			39,360	37.7

Table 5. Estimates of total catch, harvest and effort for Ninilchik River chinook salmon creel survey, 1991.

Stratum Dates	Periods Ph	Periods ph	Mean	Variance	Total	Variance components Among	Variance components Within	Total Variance	Relative Precision
Catch									
May 25	6	3	250	25,295	1,496	151,768	74,818	226,586	62.4
May 26 - 27	6	3	105	163	629	975	25,909	26,884	51.1
Total					2,125			253,470	46.4
June 1	6	3	101	960	603	29,760	8,353	38,113	63.4
June 2 - 3	6	3	95	8,827	569	52,961	27,792	80,753	98.0
Total					1,172			118,866	57.7
June 8	6	3	106	5,214	634	31,282	3,721	35,003	57.9
June 9 - 10	6	3	87	2,520	521	15,120	6,028	21,148	54.7
Total					1,155			56,151	40.2
June 15	6	2	278	1,883	1,667	22,593	26,149	48,742	26.0
June 16 - 17	6	3	131	13,002	783	78,015	8,743	86,758	73.7
Total					2,450			135,500	29.4
June 19 - 24	24	5	117	15,043	2,816	1,371,888	36,611	1,408,499	82.6
Grand total					9,718			1,972,486	28.3
Harvest									
May 25	6	3	94	4,805	564	28,827	13,378	42,206	71.4
May 26 - 27	6	3	91	66	548	396	24,605	25,001	56.5
Total					1,112			67,207	45.7
June 1	6	3	50	2,250	298	13,498	2,610	16,109	83.7
June 2 - 3	6	3	35	671	208	4,025	1,402	5,428	69.4
Total					506			21,537	56.9
June 8	6	3	53	1,305	317	7,830	1,450	9,280	59.6
June 9 - 10	6	3	24	138	147	830	1,806	2,636	68.2
Total					464			11,916	46.1
June 15	6	2	108	464	646	5,566	10,155	15,721	38.0
June 16 - 17	6	3	64	3,468	385	20,805	2,833	23,639	78.3
Total					1,031			39,360	37.7
June 19 - 24	24	5	81	12,617	1,940	1,150,627	22,417	1,173,043	109.4
Grand total					5,053			1,313,063	44.5

-continued-

Table 5. (Page 2 of 2).

Stratum Dates	Periods Ph	Periods ph	Mean	Variance	Total	Variance components Among	Variance components Within	Total Variance	Relative Precision
Effort									
May 25	6	3	889	464,084	5,336	2,784,504	0	2,784,504	61.3
May 26 - 27	6	3	605	37,376	3,632	224,256	281,536	505,792	38.4
Total					8,968			3,290,296	39.6
June 1	6	3	716	14,900	4,296	89,400	0	89,400	13.6
June 2 - 3	6	3	709	176,654	4,256	1,059,925	64,853	1,124,779	48.8
Total					8,552			1,214,179	25.3
June 8	6	3	738	235,540	4,432	1,413,240	0	1,413,240	52.6
June 9 - 10	6	3	799	120,428	4,795	722,571	84,213	806,784	36.7
Total					9,227			2,220,024	31.7
June 15	6	2	872	38,420	5,232	230,520	0	230,520	18.0
June 16 - 17	6	3	593	183,911	3,557	1,103,467	13,621	1,117,088	58.2
Total					8,789			1,827,104	27.9
June 19 - 24	24	5	658	380,160	15,782	10,041,421	80,784	34,751,335	73.2
Grand total					51,318			42,823,442	25.0

Size and Age Composition

Scales were collected from 171 fish from the sport harvest, of which 51 were from adipose finclipped fish. Age-1.3 fish were the most abundant age group in the sample (65%) (Table 6). Among adipose finclipped fish, only age-1.3 and -1.1 fish were represented. Fish that had not been adipose finclipped were comprised of these age classes along with age-1.2 and -1.4 fish (Table 6).

Mean lengths from the sampled fish were: age 1.1, 344 mm; age 1.2, 630 mm; age 1.3, 768 mm; and age 1.4, 849 mm (Table 6). There were no significant differences in mean length at age for clipped and unclipped fish.

Hatchery Contribution

There were 574 fish examined from the sport harvest for adipose finclips (Appendix A). The heads from 55 fish were collected from the 65 adipose finclipped fish observed. There were only 43 tags in the collected heads, tag loss was high at approximately 22%. Of the 43 recovered tags, 31 were from the 1988 hatchery smolt release, 11 were from the 1990 release, and 1 tag was from a 1988 Crooked Creek smolt release (Table 7). There were no tags recovered from the 1989 hatchery smolt releases, nor is it likely that any of the clipped fish missing tags were from the 1989 release (Appendix B).

Estimates of contribution were computed by stratum (Table 8). The estimated hatchery contribution to the harvest was 3,868 fish, or 77% of the total harvest. Age-1.3 fish from the 1988 hatchery smolt release accounted for 3,575 fish while 293 age-1.1 fish were from the 1990 smolt release (Table 8). Total contribution of hatchery fish ranged from 48% to 75% during the first four strata and increased to 93% during the last stratum.

Escapement

Surveys were conducted on 27 July 1991. Water conditions during the survey were poor to fair due to the dark tannic coloration, so that only fish near the surface could be seen. The water level was considered low. The ground survey of the index area enumerated 232 live and 130 dead chinook salmon. The remainder of the stream had an estimated 349 live and 116 dead chinook salmon for a total escapement of 827 fish (Table 9). The historic Ninilchik River chinook salmon spawning escapement averaged 830 fish (Table 10). The 1991 escapement of 827 fish is almost exactly the historic average, even though the established 9-day fishery was extended an additional 10 days.

DISCUSSION

The large estimates of total catch, harvest, and hatchery contribution from the creel survey were used as justification to extend the chinook salmon fishing season on the Ninilchik River during 1991. The season extensions were the first since the three 3-day fishing regulations were adopted in 1978. An emergency order (EO) was issued on 15 June extending the fishery a fourth weekend (15-17 June) and a second EO on 18 June extended the fishery for 7 consecutive days (18-24 June).

Table 6. Age composition and mean length at age for chinook salmon sampled in the Ninilchik River fishery, 1991.

	Age Group				
	1.1	1.2	1.3	1.4	Total
With adipose fin:					
Percent	1.8	0.6	40.9	26.9	70.2
Mean Length	337	630	773	849	790
SE	23.13		7.21	9.18	9.36
Sample Size	3	1	70	46	120
Minimum	298	630	559	710	298
Maximum	378	630	988	975	988
Without adipose fin:					
Percent	5.8		24.0		29.8
Mean Length	346		761		680
SE	5.39		5.55		23.75
Sample Size	10		41		51
Minimum	320		652		320
Maximum	375		835		835
All Combined:					
Percent	7.6	0.6	64.9	26.9	100.0
Mean Length	344	630	768	849	757
SE	6.21		5.00	9.18	10.37
Sample Size	13	1	111	46	171
Minimum	298	630	559	710	298
Maximum	378	630	988	975	988

Table 7. Summary of coded wire tag recoveries from the Ninilchik River chinook salmon sport fishery, 1991.

Date	Fish Examined	Finclips Observed	Heads Collected	Tag Codes		No Tag
				31-17-35 (1990)	31-17-62 (1988)	
May 25-27	41	5	4	0	3	1
June 1-3	128	14	14	0	8	6
June 8-10	132	10	8	2	5	1
June 15-17	247	33	27[a]	9	13	4
June 19-24	26	3	2	0	2	0
Total	574	65	55	11	31	12

[a] One recovery was from a 1988 Crooked Creek smolt release.

Table 8. Contribution of hatchery produced chinook salmon to the Ninilchik River sport fishery, 1991.

Stratum	Total Harvest	31-17-35 (1990) Contribution	SE	31-17-62 (1988) Contribution	SE	Total hatchery	% Contribution
May 25-27	1,112	0	0	816	427	816	74
June 1-3	506	0	0	254	109	254	50
June 8-10	464	47	34	176	81	223	48
June 15-17	1,031	246	90	532	169	778	75
June 19-24	1,940	0	0	1,797	1,257	1,797	93
Total	5,053	293	97	3,575	1,345	3,868	77

Table 9. Results of spawning escapement surveys for chinook salmon, Ninilchik River, 1991.

	Survey Area		Remainder of River		
	Live	Dead	Live	Dead	Total
Ground Survey	232	130			362
Aerial Survey	173	85	260	76	
Expanded Estimates			349	116	465
Total Escapement Estimate					827

Table 10. Historic harvest and escapement of chinook salmon, Ninilchik River, 1961-1991.

Year	Harvest[a]	Escapement[a]	Exploitation
1966	200	670	23
1967	120	360	25
1968	210	450	32
1969	130	760	15
1970	280	...	...
1971	140	...	...
1972	170	1,360	11
1973	300	640	32
1974	350	510	41
1975	540	830	39
1976	630	1,180	35
1977	910	1,400	39
1978	1,130	990	53
1979	700	1,390	33
1980[b]	480	720	40
1981[b]	1,300	830	61
1982	1,070	1,430	43
1983	1,160	710	62
1984	440	600	42
1985	600	650	48
1986	550	790	41
1987	1,090	600	64
1988	740	1,080	41
1989	740	400	65
1990	690	840	45
Mean[c]	620	830	40
1991	5,053	827	86

[a] Numbers rounded to nearest 10.

[b] Escapement counts considered minimal due to high turbid water during escapement surveys.

[c] Excludes all 1970 and 1971 data.

The estimated 1991 harvest of 5,053 chinook salmon from the Ninilchik River was a record (Mills 1979-1991) (Figure 5). However, harvest of natural fish during the historic limits of the fishery (last weekend in May and the first two weekends of June) (789 fish) was within historic levels (Figure 5). The additional contribution of stocked fish to the harvest during this time frame (1,293 fish or 62% of the total) provided for a record harvest of 2,082 fish. The additional harvest realized during the 10 days of extended fishing totaled an additional 2,971 fish of which 87% (2,575) were stocked fish. This additional fishing resulted in a high level of exploitation (86%) in comparison to historic performance (1966-1990 average exploitation = 40%). Despite the high exploitation, the historic level of natural spawning was maintained.

Modifications to the sample design should to be made prior to the planned 1992 creel survey. Sample periods should be no shorter than 8 hours because of longer trip duration.

It is not clear if the virtual lack of age-1.2 fish in the harvest, both natural and hatchery fish, indicate production failures. For fish greater than 406 mm (16 inches), the daily bag limit is only one fish with a seasonal limit of 5 fish. However, the bag limit for chinook salmon under 406 mm is 10 per day with no seasonal limit. Since age-1.2 fish are the youngest fish above the 406 mm delineation (630 mm mean length), anglers are more likely to release 2-ocean fish in hopes of catching a larger fish, yet retain fish under 406 mm which are entirely age 1.1 (337 mm mean length).

The hatchery contribution of 38% of the harvest was a very encouraging beginning to this new enhancement program. Future contributions could be higher as 4-ocean hatchery fish begin contributing to this fishery in 1992.

ACKNOWLEDGEMENTS

There are numerous Sport Fish and FRED Division staff members of Region II we wish to thank for their help with this new project. Bob Och and his staff at Crooked Creek hatchery collected the chinook salmon eggs while Gary Wall and the Fort Richardson hatchery staff hatched, reared, and released the smolt. Larry Larson provided the use of his Polycorder along with clear instructions of its use. Gary Kyle provided a trailer for living quarters for the sampling crew as well as a vehicle. Dave Nelson and Nick Dudiak shared their long knowledge of this fishery and were very supportive of the project. Finally, special thanks to Jean Hulbert and Carla Milburn for their enthusiasm while working an intense, irregular sampling schedule.

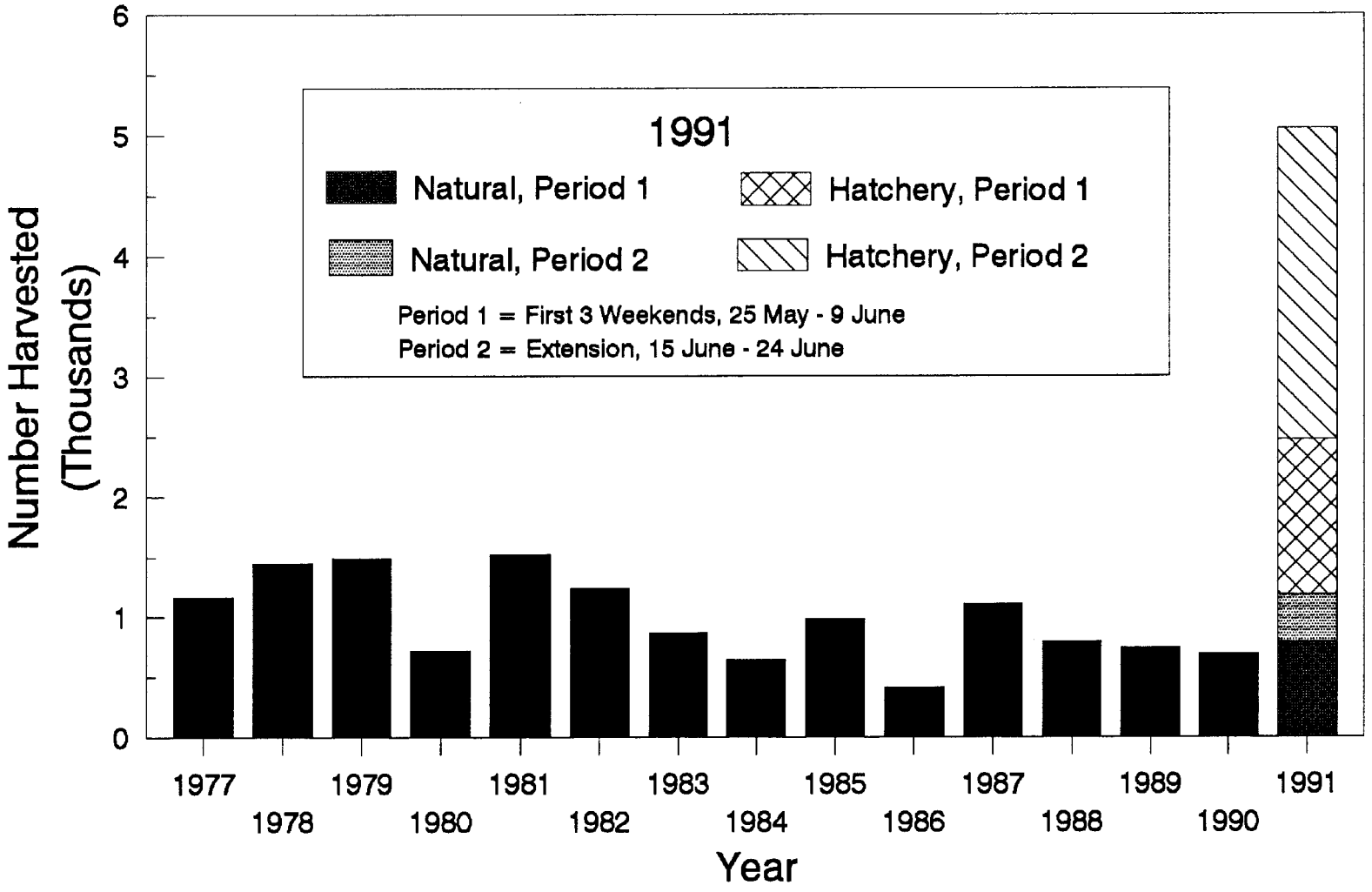

Figure 5. Total estimated harvest of chinook salmon in Ninilchik River, 1977-1991.

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APPENDIX A

Appendix A. Coded wire tag recoveries from chinook salmon, Ninilchik River, 1991.

Date	Number Examined	Adipose Finclips Observed	Heads Collected	Tag Codes		No Tag
				31-17-35	31-17-62	
May 25	18	4	3	-	3	-
26	10	0	0	-	-	-
27	13	1	1	-	-	1
June 1	52	3	3	-	2	1
2	48	7	7	-	3	4
3	28	4	4	-	3	1
8	62	7	5	1	3	1
9	40	2	2	-	2	-
10	30	1	1	1	-	-
15	83	8	8[a]	3	2	2
16	91	12	8	1	6	1
17	73	13	11	5	5	1
19	3	1	1	-	1	-
20	7	1	1	-	1	-
21	8	1	0	-	-	-
22	5	0	0	-	-	-
23	3	0	0	-	-	-
24	0	-	-	-	-	-

[a] One recovery was from a 1988 Crooked Creek smolt release.

APPENDIX B

Appendix B. Summary of adipose finclipped fish which did not contain a tag, Ninilchik River, 1991.

Head Number	Mid-Eye To Fork Length	Age	Recovery Date
53004	770	1.3	5/27/91
53103	745	1.3	6/01/91
53105	739	1.3	6/02/91
53106	746	N.R.[a]	6/02/91
53109	792	1.3	6/02/91
53111	825	N.R.	6/02/91
53115	775	1.3	6/03/91
53119	835	N.R.	6/08/91
53128	351	1.1	6/15/91
53129	803	1.3	6/15/91
53137	743	N.R.	6/16/91
53153	360	N.R.	6/17/91

[a] Not readable.