Fishery Data Series No. 94-25

Contribution of Stocked Chinook Salmon to the Ninilchik River Sport Fishery, 1993

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ABSTRACT

The estimated contribution of stocked chinook salmon *Oncorhynchus tshawytscha* to the Ninilchik River sport harvest was 50% in 1993. An estimated 5,610 chinook salmon were harvested, with 2,782 estimated to be hatchery produced. An estimated 15,054 chinook salmon were caught with a total effort of 51,203 angler-hours. Harvest and effort have increased since stocked chinook salmon began returning to the Ninilchik River in 1991. Although initially most of the increase in harvest was due to stocked chinook salmon, harvest of non-stocked chinook is now quadruple the 1986-1990 average harvest of about 750.

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

INTRODUCTION

The Ninilchik River (Figure 1) is one of three southern Kenai Peninsula rivers that support inriver recreational fisheries for chinook salmon *Oncorhynchus tshawytscha*. Because the Ninilchik River is a small river, sport anglers are 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 for three consecutive 3-day weekends (Saturday, Sunday, and Monday) beginning with the Memorial Day weekend in May. These regulations have been in effect since 1978 with no emergency closures. The other two southern Kenai Peninsula rivers, Anchor River and Deep Creek, are more liberally managed with a total of five weekends open to fishing for chinook salmon.

In 1988, 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. The primary objective of the stocking program was to increase angler effort by 10,000 angler-days while maintaining historic levels of natural spawning. Hatchery-produced chinook salmon smolt from Ninilchik River brood stock have been released into the system annually since 1988 (Table 1), with the first fish returning in 1991. To evaluate the Ninilchik River stocking program, a creel survey and a coded wire tag recovery program of the chinook salmon fishery on the Ninilchik River has been conducted since 1991 (Boyle and Alexandersdottir 1992; Boyle et al. 1993). The objectives of the 1993 study were to:

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

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

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

4. estimate spawning escapement to the Ninilchik River.

METHODS

In 1993, the sport fishery in the Ninilchik River occurred from 29 May through 28 June. From 29 May to 14 June, three 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 an additional 14 days by emergency order 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.

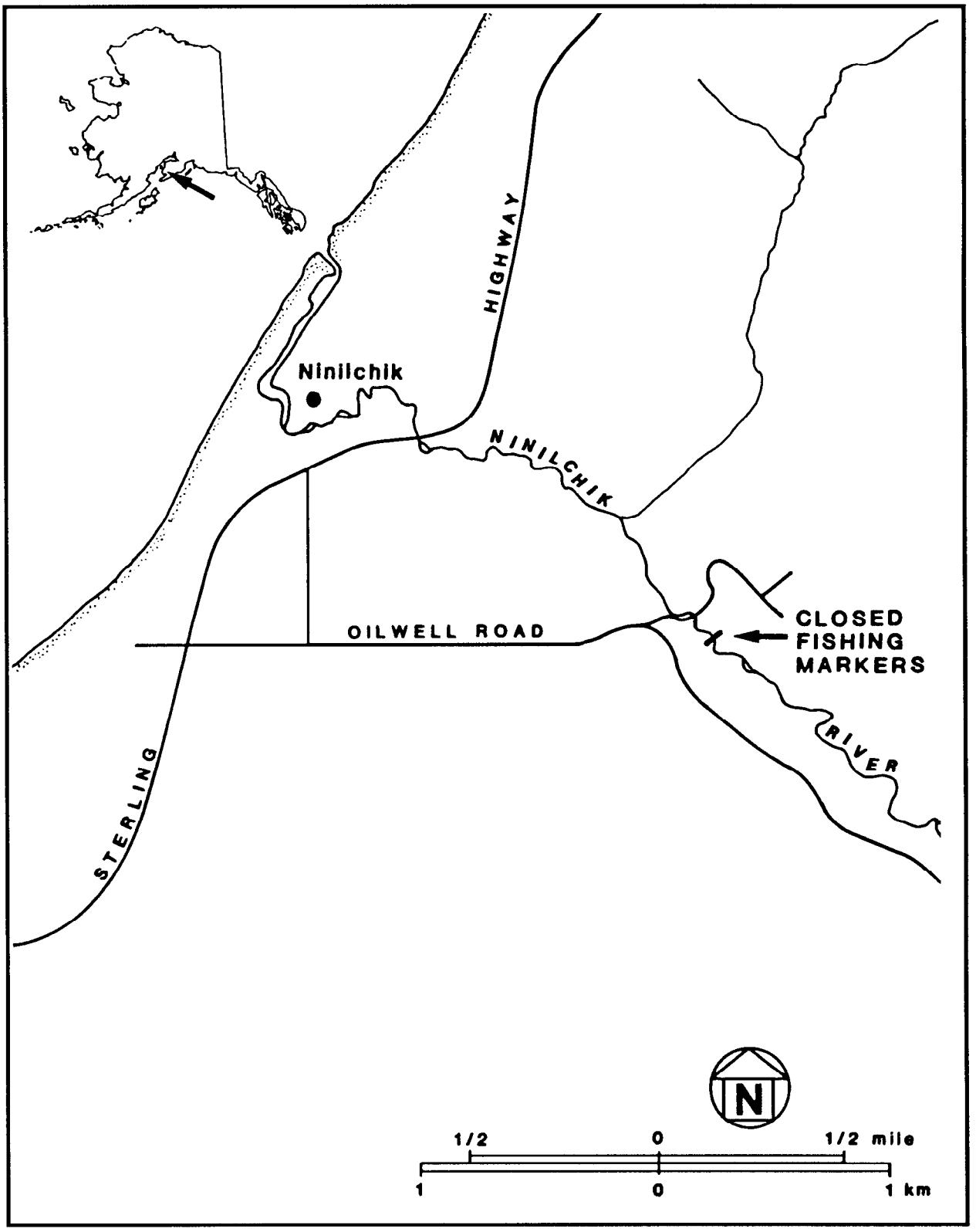

Figure 1. Study area of the Ninilchik River, Alaska.

Table 1. Stocking history of Ninilchik River chinook salmon, 1988-1993.

Year	Release			Returning in Years at Age			
	Total	Marked	% Marked	1.1	1.2	1.3	1.4
1988	247,327	30,809	12.5	1989	1990	1991	1992
1989	199,831	18,772	9.4	1990	1991	1992	1993
1990	215,804	40,319	18.7	1991	1992	1993	1994
1991	87,992	21,074	24.0	1992	1993	1994	1995
1992	132,387	41,335	31.2	1993	1994	1995	1996
1993	184,585	42,960	23.3	1994	1995	1996	1997

Creel Survey

Study Design:

A two-stage roving creel survey was conducted to estimate angler effort (in angler-hours), catch, and harvest of chinook salmon in the Ninilchik River fishery (Bernard et al. *In prep*) from 29 May to 28 June 1993. During each of the three 3-day weekend fisheries in May and June, Saturday and Sunday-Monday were separate strata. The last 2 weeks of the fishery were divided into two additional strata (15-21 June and 22-28 June), for a total of eight strata.

In the Saturday strata, two of three possible 8-hour periods were selected randomly for sampling. For the Sunday-Monday strata, three of six possible 8-hour periods were selected for sampling, with the first sampling period chosen at random and every-other period after that sampled. During the last 2 weeks, one 6-hour period was chosen at random during each of the 14 days. Sample periods represented the first sampling stage. Within selected sample periods in each stratum, angler counts were conducted at systematically chosen times to estimate total effort (in angler-hours), and angler interviews were conducted to estimate catch and harvest per unit of effort (CPUE and HPUE). Angler counts and angler interviews represented the second sampling stage.

Three angler counts, made by walking along the shore of the river, were conducted within each 8-hour sample period. Counts took 1 hour to complete, therefore, 5 hours of sampling time were available for angler interviews during sample periods of each weekend. The counts were systematically drawn, with the time for the first count randomly selected in the first 140 minutes of the sample period and the second and third at 140 minute intervals. During the last 2 weeks, two counts were made each period with the first count randomly selected in the first 150 minutes of the period and the second count occurring 150 minutes later.

Because of the low bag limit, interviews were of anglers that finished fishing for the day (completed-trip anglers) to eliminate potential bias in estimates of HPUE. The technician conducted interviews where large numbers of anglers were exiting the fishery and attempted to interview as many completed-trip anglers as possible. Anglers were asked how long they fished, how many chinook salmon they caught, and how many chinook salmon they kept.

Data Analysis:

Angler effort was estimated by multiplying (expanding) the mean count within each sampled period by the number of hours in the sample period. Then jack-knife estimates (Efron 1982) of mean CPUE and HPUE were obtained for all anglers interviewed within each sampled period. Estimates of CPUE and HPUE were multiplied by the estimated angler effort of the sample period to obtain the estimated catch and harvest, respectively, for the sample.

The estimated sample effort, catch, and harvest were averaged over all samples within each stratum and expanded by the number of periods in the stratum. This provided the estimated total effort, catch, and harvest of the stratum. Stratum estimates were considered independent so the estimates and their variances were summed across all strata to calculate total estimates of effort, catch, and harvest.

The jackknife sample mean CPUE (or HPUE) was estimated by:

$$CPUE^{*}_{hij} = \frac{\sum_{\substack{o=1 \\ o \neq j}}^{m_{hi}} c_{hio}}{\sum_{\substack{o=1 \\ o \neq j}}^{m_{hi}} e_{hio}}; \qquad (1)$$

where:

m_{hi} = number of anglers interviewed in period i of stratum h;

c_{hio} = total catch of each interviewed angler o in period i of stratum h; and,

e_{hio} = angler effort (in hours) of each interviewed angler o in period i of stratum h.

The jackknife mean CPUE for sample period i of stratum h was then obtained as:

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

with a bias correction of:

$$\overline{CPUE}^{*+}_{hi} = \left[m_{hi}\left(\overline{CPUE}_{hi} - \overline{CPUE}^{*}_{hi}\right)\right] + \left[\overline{CPUE}^{*}_{hi}\right] \qquad (3)^{1}$$

where:

$$\overline{CPUE}_{hi} = \frac{\sum_{o=1}^{m_{hi}} c_{hio}}{\sum_{o=1}^{m_{hi}} e_{hio}}. \qquad (4)$$

The bias-corrected jackknife mean was then expanded by the estimated angler effort of the sample period to estimate catch in period i of stratum h:

$$\hat{C}_{hi} = \hat{E}_{hi}\overline{CPUE}^{*+}_{hi}, \qquad (5)$$

[1] If the bias correction resulted in a negative value, then the uncorrected version (equation 2) was used.

where:

$\hat{E}_{hi}$ = estimated angler effort (hours) in period i of stratum h

$$= T_{hi}\bar{x}_{hi}\ ; \text{ and} \tag{6}$$

$\bar{x}_{hi}$ = mean angler count in period i of stratum h

$$= \frac{\sum_{q=1}^{r_{hi}} x_{hiq}}{r_{hi}}; \tag{7}$$

where:

T_{hi} = number of hours in sample period i of stratum h;

r_{hi} = total number of angler counts conducted in sample period i of stratum h; and

x_{hiq} = number of anglers counted fishing during count q in sample period i of stratum h.

The harvest of each sample period was estimated similarly by substituting the appropriate harvest statistics into equations 1 through 7.

Mean effort, catch, and harvest (represented by Y in the following equations) of each sampling stratum were estimated by:

$$\bar{\hat{Y}} = \frac{\sum_{i=1}^{Ph} \hat{Y}_{hi}}{P_h}, \tag{8}$$

where:

$\hat{Y}_{hi}$ = estimated sample value of effort (E_{hi} from equation 6), catch or harvest (C_{hi} or H_{hi} from equation 5) in period i of stratum h; and

P_h = number of periods sampled from stratum h.

Effort, catch, and harvest of each stratum were estimated by multiplying these means by the number of sample periods in the stratum:

$$\hat{Y}_h = P_h\bar{\hat{Y}}_h, \tag{9}$$

where:

P_h = total number of possible sample periods of stratum h.

The variance of catch in stratum h was estimated using the two-stage variance equation (Cochran 1977), omitting the finite population correction factor for the second stage units (anglers):

$$\hat{V}\left[\hat{C}_h\right] = \left\{(1 - f_{1h})P_h^2 \frac{S_{1h}^2}{p_h}\right\} + \left\{f_{1h} \frac{P_h^2}{p_h^2} \sum_{i=1}^{p_h} \hat{V}\left[\hat{C}_{hi}\right]\right\} \tag{10}$$

where:

f_{1h} = the sampling fraction for first stage units (periods)

$= p_h/P_h$;

S_{1h}^2 = the among period variance of periods sampled in stratum h or

$$= \frac{\sum_{i=1}^{p_h} \left(\hat{C}_{hi} - \hat{C}_h\right)^2}{p_h - 1}, \tag{11}$$

for randomly selected periods of the Saturday and the last week strata; and

$$= \frac{\sum_{i=2}^{p_h} \left(\hat{C}_{hi} - \hat{C}_{h(i-1)}\right)^2}{2(p_h - 1)} \tag{12}$$

for systematically selected periods of the Sunday-Monday strata.

The within-period variance of periods sampled in stratum h is:

$$\hat{V}\left[\hat{C}_{hi}\right] = \hat{E}_{hi}^2 s_{3hi}^{*2} + \left(\overline{CPUE}_{hi}^{*+}\right)^2 \hat{V}\left[\hat{E}_{hi}\right] - s_{3hi}^{*2} \hat{V}\left[\hat{E}_{hi}\right] \tag{13}$$

where:

$$s_{3hi}^{*2} = \frac{(m_{hi} - 1)}{m_{hi}} \sum_{j=1}^{m_{hi}} \left(CPUE_{hij}^{*} - \overline{CPUE}_{hi}^{*}\right)^2, \text{ and} \tag{14}$$

$$\hat{V}\left[\hat{E}_{hi}\right] = \frac{T_{hi}^2}{r_{hi}} \frac{\sum_{q=2}^{r_{hi}} \left\{x_{hiq} - x_{hi(q-1)}\right\}^2}{2(r_{hi} - 1)}. \tag{15}$$

Variance estimates of effort and harvest were obtained by replacing the appropriate effort and harvest statistics, respectively, for the catch statistics in equations 10 through 15. Note that the final term of the estimated effort variance of equation 10 is given in equation 15. These

estimators assume anglers interviewed when leaving the fishery were representative of all anglers counted in the fishery during the period.

Size and Age Composition

Chinook salmon were randomly sampled from the harvests of anglers interviewed during the creel survey. Fish were measured from mid-eye to fork of tail to the nearest millimeter, and scales were removed for age determination (Mosher 1969).

The proportion of fish in age class a (p_a) was estimated by:

$$\hat{p}_a = \frac{n_a}{n}; \tag{16}$$

where:

n_a = number of fish sampled in age class a;

n = total number of fish aged;

and the variance was estimated by:

$$\hat{V}\left[\hat{p}_a\right] = \frac{\hat{p}_a\left(1 - \hat{p}_a\right)}{n - 1}. \tag{17}$$

Mean length-at-age and its variance were estimated using equations for normal variates.

Hatchery Contribution

Harvested chinook salmon were examined for adipose finclips, which indicated the presence of a coded wire tag (CWT). With the permission of the angler, the head was removed from fish having a finclip and a numbered headstrap was attached to the head. Heads were sent to the ADF&G Coded Wire Tag Laboratory where tags were removed and decoded.

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

Escapement

An escapement survey of the Ninilchik River was conducted by helicopter in late July when spawning chinook were on redds and water levels were near seasonal lows. The survey covered the Ninilchik River from the Sterling Highway Bridge to the headwaters. Spawning downstream of the bridge was assumed to be insignificant. In prior studies, simultaneous aerial and ground counts over a subsection of the river provided an expansion factor that was applied to aerial counts for the entire river. In 1993, a simultaneous ground count was not conducted, so the 1993 aerial count was not expanded.

RESULTS

Creel Survey

The creel survey was conducted from 29 May through 28 June 1993. A total of 1,167 anglers were interviewed during the creel survey. The mean effort expended by interviewed anglers during each sampled period of the survey ranged from 1.06 hours to 3.49 hours (Table 2). The success rate (percent of interviewed anglers catching or harvesting at least one fish) during each sampled period ranged from 0.0% to 56.5% for the catch, and 0.0% to 47.6% for the harvest. The mean angler count by period ranged from 4 to 398 (Table 3). The estimated mean CPUE by period ranged from 0 to 0.86. The estimated mean HPUE ranged from 0 to 0.57. Total effort by interview period ranged from 24 to 3,181 angler-hours; total catch from 0 to 2,487 fish; and total harvest from 0 to 567 fish.

The estimated total season effort was 51,203 angler-hours, catch was 15,054 chinook salmon, and harvest was 5,610 chinook salmon (Table 4). Sixty-three percent of the chinook salmon catch was released.

For this creel survey design, interviewed anglers were assumed to be representative of the anglers counted during the sample period. If this assumption is violated, estimates of mean CPUE and HPUE, as well as total catch and harvest, are biased. For example, if sample periods are shorter than the range of trip lengths, anglers with long trip lengths do not have the same probability of being interviewed as those with short trip lengths. Our sample periods were longer than most trip lengths. Trip lengths of interviewed anglers ranged from 0.5 hours to 12.0 hours, but the vast majority of trips were less than the minimum period length of 6 hours (Figure 2). Trip length and mean HPUE were not consistently related (Figure 3).

Anglers may have tended to round their reported trip length to the nearest hour rather than the nearest half hour (Figure 2). Although this may bias the estimates, correcting this problem was not possible and bias was probably small.

Size and Age Composition

Scales were collected at random from 192 fish from the sport harvest, of which 66 (34%) had adipose finclips. Most harvested fish were age 1.3 (60.6%) or age 1.4 (35.6%) (Table 5). Fish aged 1.1, 1.2, and 1.5 made up less than 4% of the run. There was no significant difference in mean length-at-age between finclipped fish and fish without finclips aged 1.3 ($t = 0.94$, $df = 126$, $P = 0.35$) and 1.4 ($t = 1.53$, $df = 69$, $P = 0.13$).

Hatchery Contribution

A total of 768 fish (13.7% of the estimated harvest) was examined from the sport harvest for adipose finclips (Appendix A1). Heads were collected from 38 of the 66 fish with adipose clips (Table 6). Coded wire tags were recovered from 34 of the collected heads. Coded wire tags were missing from four of the collected heads (Appendix A2) resulting in a tag loss rate of 10.5%. Of the 34 recovered tags, seven were from the 1989 hatchery smolt release, 26 were from the 1990 release, and one tag was recovered from a 1988 Elmendorf

Table 2. Mean effort (in hours), catch and harvest by period, and standard deviations (SD) of anglers interviewed in the chinook salmon creel survey at the Ninilchik River, 1993.

			Effort		Catch			Harvest		
Date	Period	n	Mean	SD	Mean	SD	% Success[a]	Mean	SD	% Success[a]
29-May	B	59	3.12	2.13	1.39	1.91	55.9	0.56	1.00	44.1
	C	46	2.68	2.18	2.33	4.96	56.5	0.39	0.49	39.1
30-May	B	89	2.30	1.39	0.52	1.49	25.8	0.19	0.42	18.0
31-May	D	29	1.84	1.10	0.14	0.52	6.9	0.07	0.26	6.9
	F	58	3.10	2.57	0.28	0.64	22.4	0.19	0.40	19.0
5-Jun	A	42	2.35	1.60	1.05	2.20	52.4	0.48	0.51	47.6
	C	76	2.90	2.01	1.21	2.19	44.7	0.30	0.46	30.3
6-Jun	B	85	2.88	1.90	1.09	1.87	49.4	0.33	0.47	32.9
7-Jun	D	28	2.55	2.00	0.57	1.10	32.1	0.29	0.46	28.6
	F	45	2.40	1.39	0.24	0.48	22.2	0.18	0.39	17.8
12-Jun	A	68	2.32	1.82	0.68	0.85	48.5	0.43	0.50	42.6
	B	67	2.63	1.92	0.69	1.00	46.3	0.37	0.49	37.3
13-Jun	B	76	3.49	3.13	0.25	0.64	18.4	0.17	0.38	17.1
14-Jun	D	28	2.86	1.30	0.50	0.79	35.7	0.25	0.44	25.0
	F	52	2.20	1.63	0.29	0.50	26.9	0.11	0.32	11.5
15-Jun	A	26	1.83	1.00	0.15	0.46	11.5	0.08	0.27	7.7
16-Jun	B	26	2.85	2.04	0.46	0.65	38.5	0.31	0.47	30.8
17-Jun	C	44	2.22	1.88	0.25	0.49	22.7	0.14	0.35	13.6
18-Jun	D	26	2.27	1.52	0.19	0.40	19.2	0.19	0.40	19.2
19-Jun	E	45	2.53	1.92	0.27	0.58	22.2	0.16	0.37	15.6
20-Jun	F	36	1.88	1.22	0.64	1.02	41.7	0.28	0.45	27.8
21-Jun	G	36	2.14	1.61	0.11	0.32	11.1	0.03	0.17	2.8
22-Jun	A	22	2.59	2.52	0.32	0.65	22.7	0.18	0.39	18.2
23-Jun	B	9	1.94	1.10	0.11	0.33	11.1	0.11	0.33	11.1
24-Jun	C	0								
25-Jun	D	10	1.55	0.76	0.10	0.32	10.0	0.10	0.32	10.0
26-Jun	E	11	1.14	0.71	0.18	0.40	18.2	0.18	0.40	18.2
27-Jun	F	20	2.55	1.36	0.55	0.94	30.0	0.15	0.37	15.0
28-Jun	G	8	1.06	0.82	0.00	0.00	0.0	0.00	0.00	0.0

[a] Percent of interviewed anglers catching or harvesting at least one fish.

Table 3. Estimated effort (hours), catch and harvest by sample period for the chinook salmon creel survey at the Ninilchik River, 1993.

		Counts		Effort			Catch per Hour		Catch		Harvest per Hour		Harvest	
Date	Period	n	Mean	Total	Var	n[a]	Mean	Var	Total	Var	Mean	Var	Total	Var
29-May	B	3	398	3,181	172,373	59	0.44	0.01	1,410	103,651	0.18	0.00	567	24,933
	C	3	360	2,880	41,520	46	0.86	0.07	2,487	628,387	0.14	0.00	413	10,062
30-May	B	3	288	2,307	197,259	89	0.22	0.00	517	35,056	0.08	0.00	191	3,395
31-May	D	3	83	664	7,003	29	0.08	0.00	50	1,166	0.04	0.00	25	292
	F	3	83	661	4,437	58	0.09	0.00	58	377	0.06	0.00	40	151
5-Jun	A	3	272	2,173	80,693	42	0.44	0.02	964	114,779	0.20	0.00	437	10,041
	C	3	304	2,432	14,640	76	0.42	0.01	1,016	38,128	0.10	0.00	253	2,168
6-Jun	B	3	160	1,283	693	85	0.38	0.00	486	7,683	0.11	0.00	146	525
7-Jun	D	3	33	264	15,883	28	0.23	0.00	60	1,063	0.11	0.00	29	256
	F	3	93	744	3,264	45	0.78	0.06	582	35,566	0.57	0.03	422	18,888
12-Jun	A	2	159	1,268	26,896	68	0.29	0.00	367	6,516	0.18	0.00	231	2,524
	B	3	290	2,317	19,931	67	0.26	0.00	600	14,464	0.14	0.00	326	3,962
13-Jun	B	3	151	1,205	41,045	76	0.07	0.00	85	885	0.05	0.00	58	355
14-Jun	D	3	36	285	4,821	28	0.18	0.00	50	346	0.09	0.00	25	101
	F	3	58	461	4,021	52	0.13	0.00	60	283	0.05	0.00	24	99
15-Jun	A	2	51	303	7,569	26	0.09	0.00	26	252	0.04	0.00	13	83
16-Jun	B	2	92	549	9	26	0.16	0.00	87	716	0.11	0.00	59	341
17-Jun	C	2	79	471	3,969	44	0.11	0.00	53	265	0.06	0.00	29	139
18-Jun	D	2	35	210	17,424	26	0.08	0.00	17	157	0.08	0.00	17	157
19-Jun	E	2	74	444	14,400	45	0.10	0.00	47	364	0.06	0.00	27	133
20-Jun	F	2	65	387	1,089	36	0.34	0.01	131	1,375	0.15	0.00	57	267
21-Jun	G	2	55	327	441	36	0.05	0.00	17	75	0.01	0.00	4	18
22-Jun	A	2	41	246	1,764	22	0.12	0.00	29	227	0.07	0.00	17	78
23-Jun	B	2	13	78	2,304	9	0.06	0.00	5	21	0.06	0.00	5	21
24-Jun	C	2	4	24	576	0	0.00	0.00	0	0	0.00	0.00	0	0
25-Jun	D	2	18	108	2,304	10	0.06	0.00	7	49	0.06	0.00	7	49
26-Jun	E	2	23	138	324	11	0.16	0.01	22	236	0.16	0.01	22	236
27-Jun	F	2	17	102	324	20	0.21	0.01	22	83	0.06	0.00	6	12
28-Jun	G	2	22	132	144	8	0.00	0.00	0	0	0.00	0.00	0	0

[a] Number of anglers interviewed during the period.

Table 4. Estimates of total effort, catch and harvest from the chinook salmon creel survey at the Ninilchik River, 1993.

Stratum Dates	Periods P_h	Periods p_h	Mean	Variance	Total	Variance Components Among	Variance Components Within	Total Variance	Relative Precision
Effort									
29-May	3	2	3,031	45,401	9,092	68,101	320,840	388,941	13
5/30/31	6	3	1,211	674,590	7,264	4,047,541	417,397	4,464,938	57
Total					16,356			4,853,879	26
5-Jun	3	2	2,303	33,454	6,908	50,181	143,000	193,181	12
6/6/07	6	3	763	317,020	4,581	1,902,123	39,680	1,941,802	60
Total					11,489			2,134,983	25
12-Jun	3	2	1,793	550,550	5,378	825,825	70,240	896,065	34
6/13/14	6	3	651	219,344	3,904	1,316,064	99,776	1,415,840	60
Total					9,282			2,311,905	32
6/15/21	28	7	384	13,081	10,764	1,098,828	179,604	1,278,432	21
6/22/28	28	7	118	4,629	3,312	388,800	30,960	419,760	38
Grand Total					51,203			10,998,959	13
Catch									
29-May	3	2	1,948	579,406	5,845	869,109	1,098,058	1,967,166	47
5/30/31	6	3	208	54,387	1,251	326,324	73,199	399,523	99
Total					7,096			2,366,689	42
5-Jun	3	2	990	1,328	2,970	1,991	229,361	231,352	32
6/6/07	6	3	207	45,497	1,243	272,984	18,596	291,580	85
Total					4,213			522,932	34
12-Jun	3	2	484	27,195	1,451	40,792	31,469	72,261	36
6/13/14	6	3	65	341	391	2,045	3,029	5,074	36
Total					1,842			77,335	30
6/15/21	28	7	54	1,773	1,511	148,958	12,812	161,769	52
6/22/28	28	6	14	139	392	14,292	2,877	17,169	66
Grand Total					15,054			3,145,914	23
Harvest									
29-May	3	2	490	11,807	1,470	17,710	52,492	70,203	35
5/30/31	6	3	85	6,938	513	41,629	7,676	49,305	85
Total					1,983			119,508	34
5-Jun	3	2	345	16,972	1,034	25,457	18,313	43,770	40
6/6/07	6	3	77	3,582	460	21,494	2,278	23,772	66
Total					1,494			67,542	34
12-Jun	3	2	278	4,459	835	6,688	9,729	16,418	30
6/13/14	6	3	36	280	215	1,680	1,109	2,789	48
Total					1,050			19,207	26
6/15/21	28	7	29	445	824	37,385	4,548	41,934	49
6/22/28	28	6	9	67	259	6,893	1,850	8,742	71
Grand Total					5,610			256,933	18

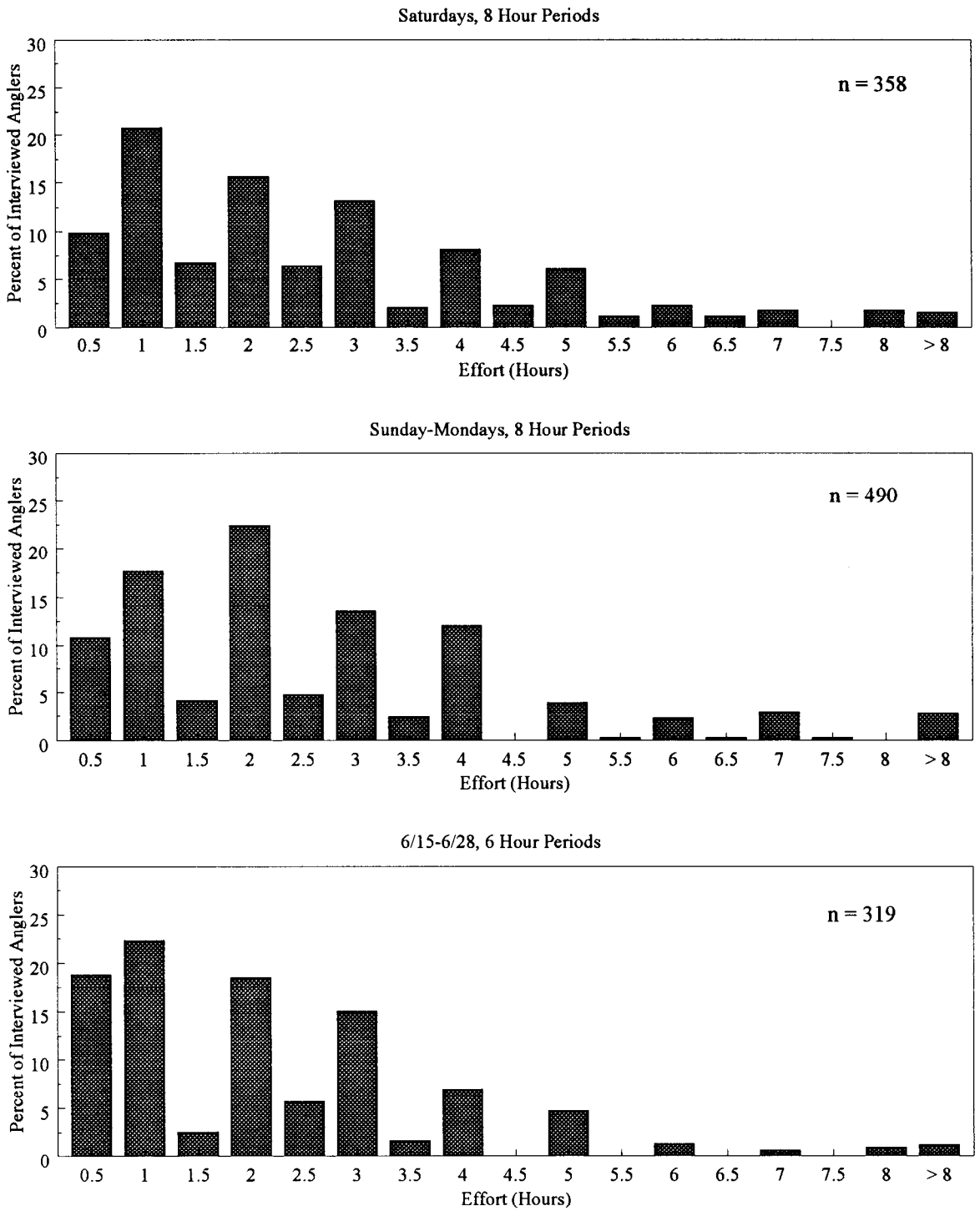

Figure 2. Percent of interviewed anglers expending a given effort (hours) during three strata of the chinook salmon creel survey at the Ninilchik River, 1993.

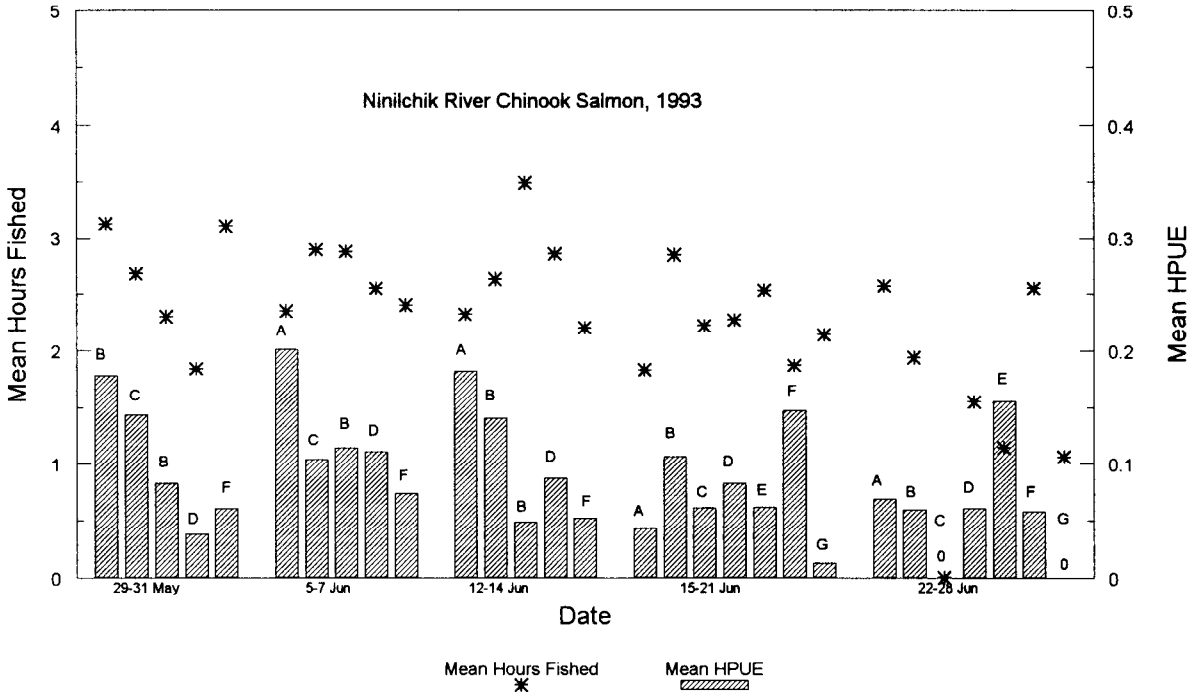

Figure 3. Mean hours fished and HPUE estimated by sample period of the chinook salmon creel survey at the Ninilchik River, 1993.

Table 5. Age composition and mean length-at-age of chinook salmon sampled at the Ninilchik River, 1993.

	Age					
	1.1	1.2	1.3	1.4	1.5	Total
Random Sample:						
No adipose finclip						
Percent	2.4	1.2	58.7	37.1	0.6	100
SE percent	1.19	0.84	3.82	3.75	0.6	
Number aged	4	2	98	62	1	167
Mean length	388	640	768	843	930	786
SE mean length	9.46	30	4.28	6.74		6.78
Minimum	360	610	650	670	930	360
Maximum	400	670	880	950	930	950
Adipose finclip						
Percent			76.2	23.8		100
SE percent			9.52	9.52		
Number aged	0	0	16[a]	5[b]	0	21
Mean length			762	802		772
SE mean length			8.74	14.63		9.76
Minimum			680	750		680
Maximum			830	830		830
Total random sample						
Percent	2.1	1.1	60.6	35.6	0.5	100
SE percent	1.06	0.75	3.57	3.5	0.53	
Number aged	4	2	114[a]	67	1	188
Mean length	388	640	768	840	930	785
SE mean length	9.46	30	3.88	6.44		6.13
Minimum	360	610	650	670	930	360
Maximum	400	670	880	950	930	950
All adipose-clipped fish (including nonrandom samples):						
Percent			79.1	20.9		100
SE percent			6.28	6.28		
Number aged	0	0	34[c]	9[b]	0	43
Mean length			760	811		772
SE			9.46	10.6		8.39
Minimum			640	750		640
Maximum			880	850		880

[a] One not measured.
[b] One age-1.4 adipose-clipped fish was released at Crooked Creek.
[c] Four not measured.

Table 6. Coded wire tags recovered from chinook salmon each weekend from the Ninilchik River, 1993.

Date	Number Examined	Finclips Observed	n[b]	Year Released[a] 1989	Year Released[a] 1990	No Tag
5/29-31	216	26	14	2	10	2
6/05-07	246	23	12[c]	1	9	1
6/12-14	213	10	5	2	3	0
6/15-21	90	7	7	2	4	1
6/22-28	3	0	0	0	0	0
Total	768	66	38[c]	7	26	4

[a] Tag codes 311830 (1989) and 311735 (1990).

[b] Number of heads collected.

[c] One recovery was from a 1988 Elmendorf Hatchery smolt released into Crooked Creek Hatchery.

Hatchery smolt released into Crooked Creek (Table 6). No tags were recovered from the 1991 or 1992 releases.

Estimated hatchery contribution was 2,782 fish and accounted for 50% of the total harvest (Table 7). Age-1.4 fish from the 1989 release accounted for 903 fish and age-1.3 fish from the 1990 release accounted for 1,879 fish. Total contribution of hatchery fish to each fishing period ranged from 0% to 64%.

Escapement

A ground survey, conducted on 9 June to determine if the fishery should be extended, enumerated 1,300 chinook salmon above the fishery (Table 8). The aerial survey conducted by helicopter on 22 July enumerated 800 chinook salmon. Water conditions during the survey were poor to fair due to the dark tannic coloration of the river, so only fish near the surface were visible. The water level was low.

DISCUSSION

1993 Evaluation

During 1993, the fishing season for chinook salmon at the Ninilchik River was extended by emergency order due to large estimates of catch, harvest, and hatchery contribution. The 9 June ground survey enumerated 1,300 chinook upstream of the fishery, further supporting the extension, because historically, less than 900 chinook spawn in the Ninilchik River. If the creel survey is eliminated in the future, fishery extensions could be based on estimates of escapement from ground surveys conducted inseason.

Catch and harvest of chinook salmon from the Ninilchik River increased slightly in 1993, relative to 1991 and 1992, but effort measured in angler-hours decreased to the 1991 level (Figure 4). Angler-hours may have decreased due to higher angler success rate in 1993, rather than due to fewer anglers participating in the fishery. The maximum mean angler count in 1992 was 303 compared to 398 in 1993, and the maximum success rate for harvest was 35.7% in 1992 compared to 47.6% in 1993 (Boyle et al. 1993). Thus, effort measured by angler-days may have actually increased in 1993. A greater proportion of effort, catch, and harvest occurred during the regular season rather than during the extended season in 1993, as compared to 1991 and 1992.

Some scales taken in 1992 and 1993 from chinook salmon containing coded wire tags appeared to have two freshwater checks, but based on the known release date of the fish and the number of ocean checks on the scale, the freshwater age was incorrect by as much as 3 years. Similar scale patterns were observed on scales of hatchery-reared chinook salmon from the Kasilof River (S. Hammarstrom, Alaska Department of Fish and Game, Soldotna, personal communication), but never on scales of river-reared chinook salmon of other Kenai Peninsula rivers. Therefore, we believe that the extra freshwater checks are an artifact of hatchery rearing, and all scale-sampled chinook were assumed to have a freshwater age of 1.

No coded wire tags were recovered from the 1991 or 1992 smolt release groups, although a small number of age-1.1 and age-1.2 chinook salmon were sampled.

Table 7. Estimated contribution (C) and standard error (SE) of stocked chinook salmon to the Ninilchik River sport fishery, 1993.

Date	Total Harvest	Age 1.4 1989 Release[a] C	Age 1.4 1989 Release[a] SE	Age 1.3 1990 Release[a] C	Age 1.3 1990 Release[a] SE	Total[b]	Percent
5/29-31	1,983	363	254	913	279	1,276	64
6/05-07	1,494	135	135	612	187	747	50
6/12-14	1,050	210	141	158	83	368	35
6/15-21	824	195	141	196	104	391	48
6/22-28	259	0	0	0	0	0	0
Total	5,610	903	350	1,879	361	2,782	50

[a] Tag codes 311830 (1989) and 311735 (1990).

[b] Estimated total hatchery contribution to the harvest.

Table 8. Historical harvest and escapement of chinook salmon, Ninilchik River, 1966-1993.

Year	Harvest[a]	Escapement[b]	Exploitation
1966		670	
1967		360	
1968		450	
1969		760	
1970		No Data	
1971		No Data	
1972		1,360	
1973		640	
1974		510	
1975		830	
1976		1,180	
1977	1,168	1,400	0.45
1978	1,445	990	0.59
1979	1,493	1,390	0.52
1980 [c]	723	720	0.50
1981 [c]	1,523	830	0.65
1982	1,240	1,430	0.46
1983	871	710	0.55
1984	648	600	0.52
1985	983	650	0.60
1986	420	790	0.35
1987	1,112	600	0.65
1988	795	1,080	0.42
1989	744	400	0.65
1990	693	840	0.45
Mean 1986-1990	753	742	0.50
1991	5,053	827	0.86
1992	4,896	No Data	No Data
1993	5,610	1,300[d]	0.81

[a] Harvest estimates for 1977-1990 from Mills (1979-1991); 1991 estimate from Boyle and Alexandersdottir (1992); 1992 estimate from Boyle et al. (1993); 1993 estimate from creel survey, this report.

[b] Nelson 1993.

[c] Escapement counts considered minimal due to high turbid water during escapement survey.

[d] Minimum escapement based on ground count conducted 9 June 1993.

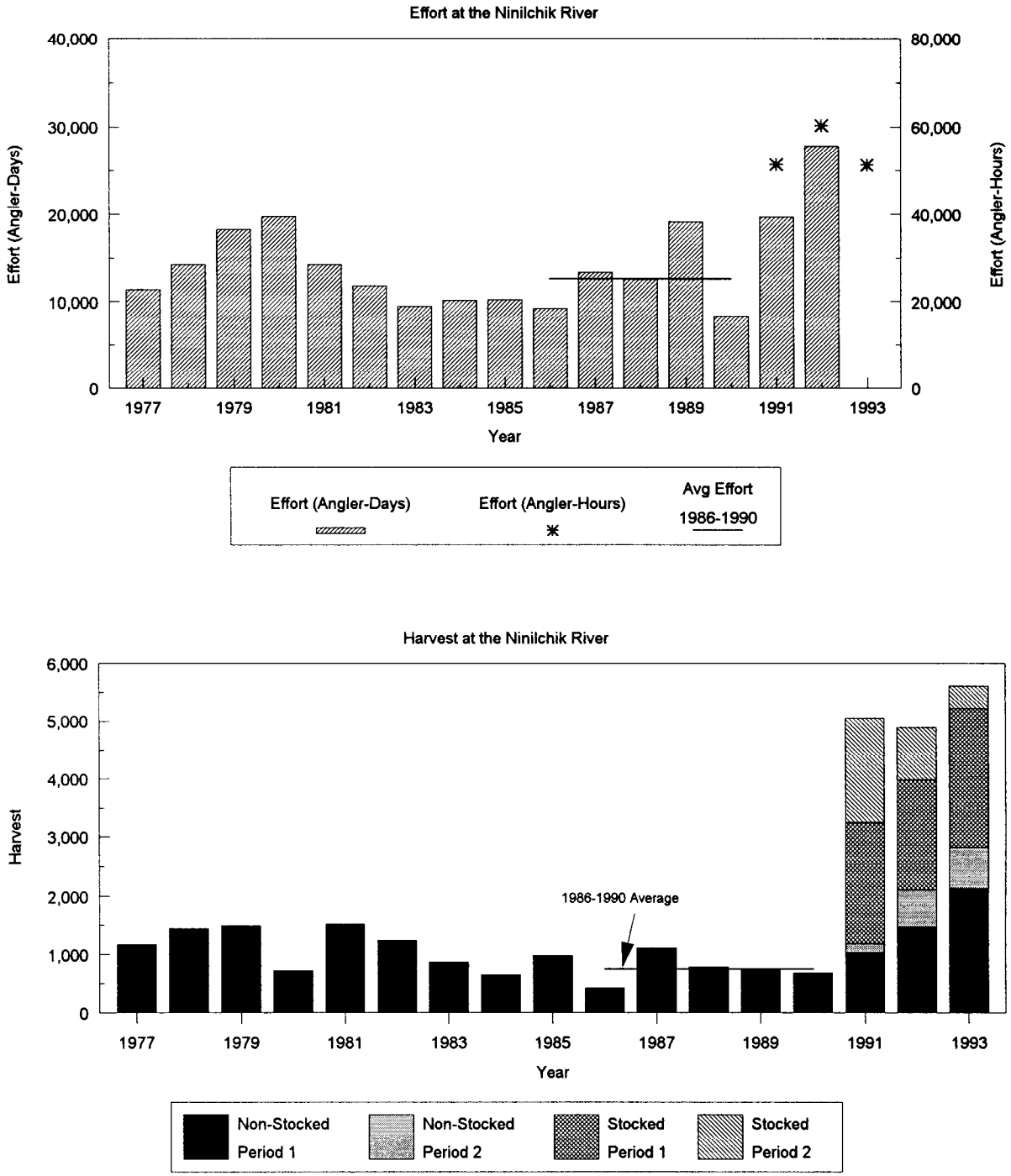

Figure 4. Effort and harvest of chinook salmon at the Ninilchik River, 1977-1993. Estimates for 1977-1992 angler-days and 1977-1990 harvest from Mills (1979-1993); 1991-1993 estimates of harvest and angler-hours from creel surveys. Period 1 is regular fishery; Period 2 is fishery extension.

Recruitment from these age classes may be poor, or perhaps anglers chose to release smaller fish in anticipation of catching larger (and therefore older) fish. Anglers are allowed to harvest only five chinook salmon larger than 16 inches from Kenai Peninsula rivers during the season, so release of small chinook salmon is common.

Retention of coded wire tags from chinook salmon returning to the Ninilchik River improved in 1993. Tag loss in 1991 and 1992 was about 20%, whereas tag loss in 1993 was only 10%.

Stocking Program Goals and Objectives

The goals of the Ninilchik River stocking program are three-fold:

1. to maintain the present quantity and quality of natural chinook salmon production in the Ninilchik River by insuring that a minimum of 860 chinook salmon spawn in the Ninilchik River annually; and by insuring that the historical age and sex compositions are not significantly altered by stocking;

2. to produce through supplemental hatchery production an addition of approximately 6,000 returning chinook salmon, of which 4,200 are available for harvest annually in the Deep Creek Marine and the Ninilchik River fisheries; and

3. to provide 10,000 angler-days of additional chinook salmon fishing opportunity annually at the Ninilchik River during weekdays by providing extended fishing opportunity for chinook salmon during June.

Natural Chinook Salmon Production:

The stocking program at the Ninilchik River has met the objective of maintaining a minimum escapement of 860 chinook salmon (Table 8). However, a better method of estimating escapement is needed. High or murky water could preclude reliable counts by aerial or ground surveys. A weir or sonar would be more reliable, provide accurate counts of escapement, and allow for timely inseason management decisions.

Historical age, length, and sex compositions are not available for escapements of chinook salmon to the Ninilchik River. Without these data, evaluating the affects of the stocking program on the age and sex composition of the escapement is not possible. Age compositions of harvests for 1991-1993 have been variable, with high returns of age-1.3 chinook salmon in 1991 and 1993, and a high return of age-1.4 chinook in 1992 (Figure 5). However, harvests from 1991-1993 were predominantly age 1.3 and 1.4, with few chinook salmon of other ages.

Increased Harvest of Chinook Salmon:

The stocking program at the Ninilchik River has increased the total harvest of chinook salmon to over seven times the 1986-1990 average (Figure 4). Although initially most of the increase was due to harvest of stocked chinook salmon, the contribution of stocked chinook salmon decreased from 77% in 1991 (Boyle

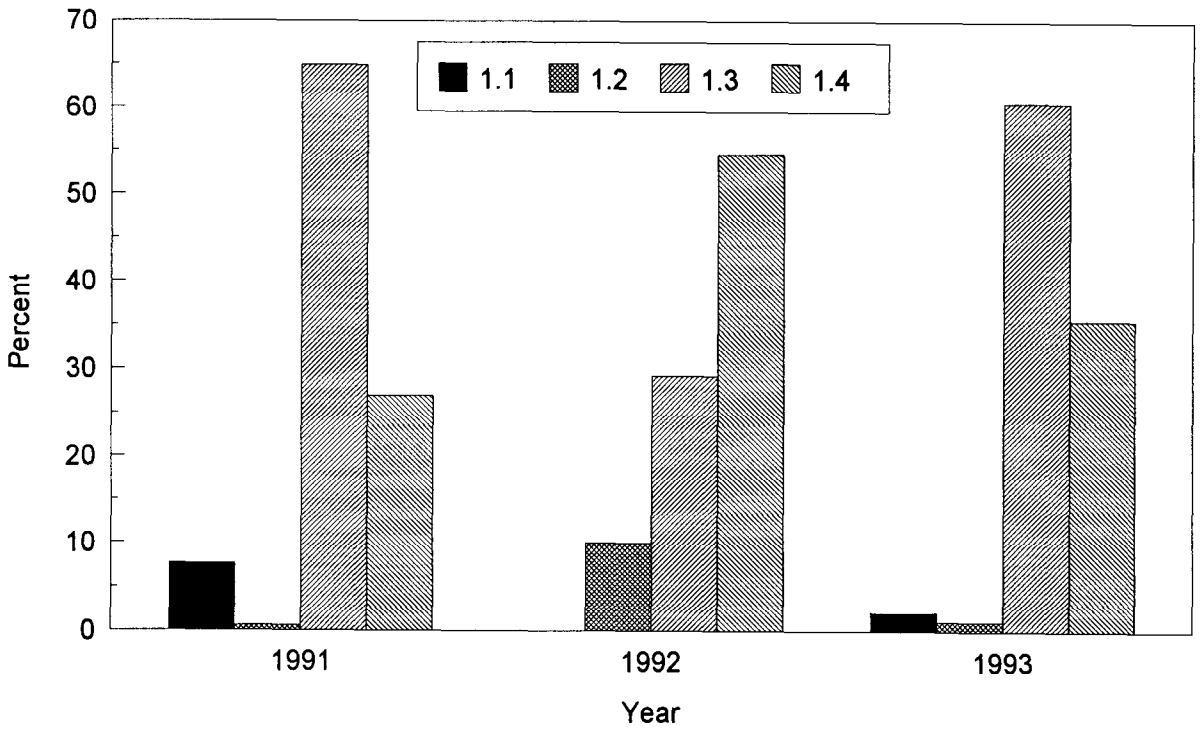

Figure 5. Age composition of chinook salmon harvested from the Ninilchik River, 1991-1993.

and Alexandersdottir 1992) to only 50% in 1993. Thus, the stocking program has provided about 2,700 additional chinook salmon, but harvest of nonstocked chinook salmon quadrupled, from an average of 750 fish from 1986-1990 to nearly 3,000 in 1993. This was partly due to extensions of the fishery, and nonstocked fish composed a greater proportion of the harvest during the extension with each succeeding year (Figure 4).

Increased Fishing Opportunity for Chinook Salmon:

The stocking program has increased the opportunity to fish for chinook salmon at the Ninilchik River. The fishery has been extended for increasingly longer periods since hatchery-produced chinook began returning to the Ninilchik River. The fishery was extended by 9 days in 1991, 10 days in 1992, and 14 days in 1993.

Total effort at the Ninilchik River averaged 23,728 angler-days during 1991-1992, an increase of more than 10,000 angler-days over the previous 5-year average of 12,516 angler-days (Mills 1987-1991) (Figure 4). Most of this increase was due to the stocking program because overall effort on the Kenai Peninsula increased by less than 10% per year over the past 10 years. If sustained, the current fishing effort would satisfy the program goal of increasing angler effort by 10,000 angler-days.

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LITERATURE CITED

Bernard, D. R., A. Bingham, and M. Alexandersdottir. *In prep.* The mechanics of conducting onsite creel surveys in Alaska. Alaska Department of Fish and Game, Special Publication.

Boyle, L. and M. Alexandersdottir. 1992. Contribution of stocked chinook salmon to the Ninilchik River sport fishery, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-30, Anchorage.

Boyle, L., S. Sonnichsen, and D. T. Balland. 1993. Contribution of stocked chinook salmon to the Ninilchik River sport fishery, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-21, Anchorage.

Clark J. E. and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 261, Juneau.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley and Sons, New York.

Efron, B. 1982. The jackknife, the bootstrap and other resampling plans. Society for Industrial and Applied Mathematics, CBMS-NSF Monograph 38, Philadelphia, Pennsylvania.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-1-A), Juneau.

_____. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-1-A), Juneau.

_____. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

_____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

_____. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-1-A), Juneau.

_____. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-1-A), Juneau.

_____. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-1-A), Juneau.

_____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-1-A), Juneau.

_____. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2), Juneau.

_____. 1987. Alaska statewide sport fisheries harvest report 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

_____. 1988. Alaska statewide sport fisheries harvest report 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

_____. 1989. Alaska statewide sport fisheries harvest report 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

_____. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

_____. 1991. Harvest and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

_____. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game. Fishery Data Series No. 92-40, Anchorage.

_____. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game. Fishery Data Series No. 92-42, Anchorage.

Mosher, K. H. 1969. Identification of pacific salmon and steelhead trout by scale characteristics. U.S. Fish and Wildlife Service Circular 317. Washington, D.C.

Nelson, D. 1993. Area management report for the recreational fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Division of Sport Fish, Soldotna.

APPENDIX A

Summary of Adipose-Clipped Chinook Salmon Sampled at the Ninilchik River, 1993

Appendix A1. Coded wire tag recoveries from chinook salmon, Ninilchik River, 1993.

Date	Number Examined	Adipose Finclips Observed	Heads Collected	Year Released[a] 1989	1990	No Tag
May 29	124	13	6		5	1
30	40	4	3		3	
31	52	9	5	2	2	1
June 5	127	12	6[b]		5	
6	67	3	0			
7	52	8	6	1	4	1
12	144	8	4	2	2	
13	45	2	1		1	
14	24	0	0			
15	20	2	2		1	1
16	24	3	3	1	2	
17	19	1	1		1	
18	7	1	1	1		
19	3	0	0			
20	13	0	0			
21	4	0	0			
22	0	0	0			
23	0	0	0			
24	0	0	0			
25	0	0	0			
26	2	0	0			
27	1	0	0			
28	0	0	0			
Total	768	66	38[b]	7	26	4

[a] Tag Codes 311830 (1989) and 311735 (1990).

[b] One recovery was from a 1988 Elmendorf Hatchery smolt released into Crooked Creek.

Appendix A2. Summary of adipose finclipped fish which did not contain a tag, Ninilchik River, 1993.

Head Number	Mid-Eye to Fork Length (mm)	Age	Clip Status	Recovery Date
64404	760	1.3	Good	5/29/93
64411	760	1.3	Good	5/31/93
64425	NA	NA	unknown[a]	6/06/93
64427	760	1.3	Good	6/07/93
64436	780	1.3	Good	6/15/93

[a] Head volunteered by angler.