Fishery Data Series No. 95-33

Harvest of Stocked Chinook Salmon in the Ninilchik River Sport Fishery, 1994

by

Larry E. Marsh

November 1995

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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by

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ABSTRACT

The Ninilchik River sport fishery harvested an estimated 1,389 stocked chinook salmon *Oncorhynchus tshawytscha* in 1994. While the total harvest in 1994 declined from previous years, the percent of the harvest that was hatchery fish (45%) was very similar to that of 1992 and 1993. The total 1994 recreational harvest estimated by the Statewide Harvest Survey was 3,108 chinook salmon. An estimated 5,482 chinook salmon were caught during the 1994 season, with a total effort (inclusive of all species) of 21,827 angler-days. Angler participation and harvest of chinook salmon from the three Lower Kenai Peninsula streams (Anchor River, Deep Creek and Ninilchik River) has increased markedly since 1991. The average total harvest at the Ninilchik River for 1991-1994, years when the fishery harvested stocked chinook salmon, is more than seven times the long-term (1966-1990) historical average of 630 fish. While the initial increase in harvest during 1991 was predominately stocked chinook salmon, the average harvest of non-stocked chinook salmon for 1991-1994 is currently more than three times the 1966-1990 average harvest. Weather and water conditions during 1994 were favorable to obtain an escapement index of 859 chinook salmon from the Ninilchik River.

Key words: Ninilchik River, Kenai Peninsula, chinook salmon, *Oncorhynchus tshawytscha*, 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*. The Ninilchik River is a small river and sport anglers are capable of harvesting a significant portion of the total return. Current regulations control the harvest by limiting the allowable time and area open to fishing. The Ninilchik River, from salt water to approximately 3 km (2 mi) upstream (Figure 2), 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 3-day weekends open to fishing for chinook salmon.

In 1987, 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 dominate age-class (1.3) returning in 1991.

To evaluate the Ninilchik River stocking program, a creel survey and a coded wire tag recovery program directed at the inriver chinook salmon sport fishery has been conducted since 1991 (Boyle and Alexandersdottir 1992; Boyle et al. 1993; Balland et al. 1994). Beginning with the 1994 season, the onsite creel survey was eliminated and harvest of chinook salmon and fishing effort for all species were estimated by the Statewide Harvest Survey (Howe et al. 1995). However, the inriver catch sample program was continued in to recover coded wire tags, provide data to estimate harvest of stocked fish, and to collect biological samples needed to assess the age structure of the recreational harvest.

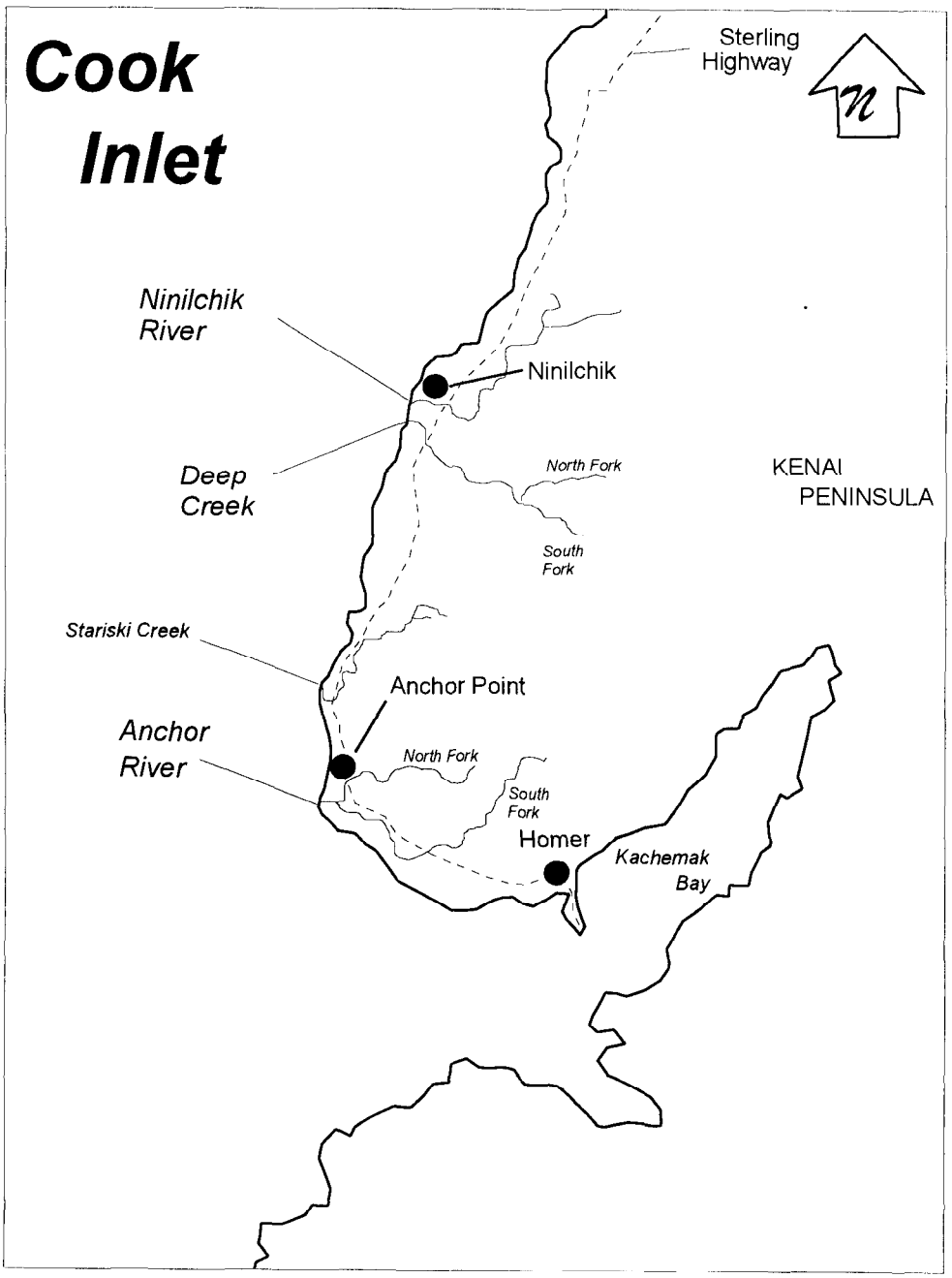

Figure 1.-Lower Kenai Peninsula chinook salmon sport fisheries occur on the Anchor River, Deep Creek, and the Ninilchik River.

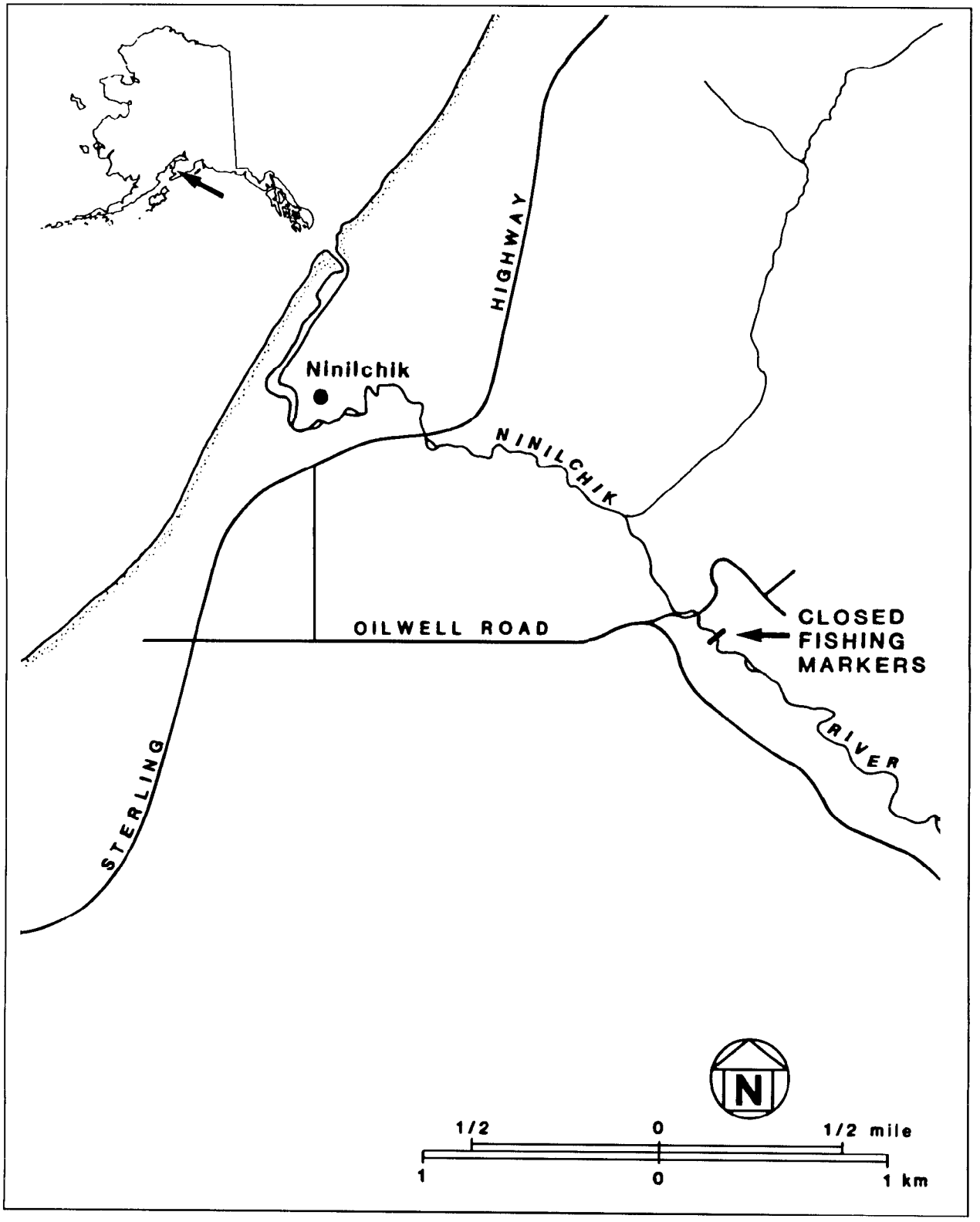

Figure 2.-Study area of the Ninilchik River, Alaska.

Table 1.-Stocking history of Ninilchik River chinook salmon, 1988-1994.

Release Year	Number Released	Number Marked[a]	Marked %	Return year at age 0.1	0.2	0.3	0.4
1988	247,327	30,809	12%	1989	1990	1991	1992
1989	199,831	18,772	9%	1990	1991	1992	1993
1990	215,804	40,319	19%	1991	1992	1993	1994
1991	87,992	21,074	24%	1992	1993	1994	1995
1992	132,387	41,335	31%	1993	1994	1995	1996
1993	184,585	42,960	23%	1994	1995	1996	1997
1994	201,513	45,535	23%	1995	1996	1997	1998
Total	1,269,439	240,804					

[a] Marked indicates fish was coded-wire tagged and adipose finclipped.

Objectives of the 1994 study were to:

1. estimate the harvest of stocked chinook salmon by the Ninilchik River sport fishery;
2. estimate the age composition of adipose-clipped chinook salmon and chinook salmon without adipose clips in the Ninilchik River sport fishery; and
3. estimate spawning escapement to the Ninilchik River.

METHODS

From 29 May to 14 June, 1994, three 3-day weekend fisheries were prosecuted at the Ninilchik River. Each weekend, the fishery started at midnight Friday and continued through midnight Monday. The fishery was extended from 15 June through 27 June by emergency order in response to a strong return of chinook salmon. During the course of 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.

STUDY DESIGN

Two different approaches were used to evaluate whether using a nonstratified estimate of harvest by the sport fishery (i.e., the SWHS) would provide an unbiased estimate of hatchery contribution to the total harvest. The initial analysis utilized chi-squared tests to determine if the proportion of marked fish recovered in the fishery during each year the onsite creel survey was conducted, 1991-1993, changed significantly over time. The second approach was to compare the estimates of harvest of stocked fish in 1991-1993 using the stratified creel survey and catch sample design with estimates generated by pooling the data each year. Pooling the catch sampling data and estimating harvest of stocked fish based on a total estimate of harvest from the creel survey ignores the stratified design. If the contribution estimates of the release groups were not different, then changes in the harvest and/or the proportion of marked fish observed during the temporal strata would be too small to seriously bias contribution estimates generated using a nonstratified design.

Harvest of Stocked Chinook Salmon

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.

The harvest of hatchery-produced chinook salmon in the Ninilchik River sport harvest and its variance were estimated using procedures outlined in Clark and Bernard (1987) and Bernard and Clark (*in prep*).

Size and Age Composition

Chinook salmon were randomly sampled from the harvest of anglers contacted during the coded wire tag recovery efforts. 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 (Cochran 1977):

$$\hat{p}_a = \frac{n_a}{n}; \quad (1)$$

where:

n_a = number of fish sampled in age class a,

n = total number of fish aged,

and the variance was estimated by:

$$\hat{V}[\hat{p}_a] = \frac{\hat{p}_a(1 - \hat{p}_a)}{n - 1}. \quad (2)$$

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

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. Simultaneous aerial and ground counts over a subsection of the river were conducted to provide an expansion factor which was applied to the aerial counts for the entire river.

RESULTS

HARVEST OF STOCKED CHINOOK SALMON

There were no significant differences in the proportion of finclipped chinook salmon recovered (Table 2) among temporal strata during the entire fishery (i.e., including extensions of the fishery by Emergency Order) during any of the years studied (1991: $\chi^2 = 2.92$, df = 4, P = 0.57; 1992: $\chi^2 = 2.90$, df = 4, P = 0.58; 1993: $\chi^2 = 7.92$, df = 4, P = 0.09; 1994: $\chi^2 = 1.42$, df = 4, P = 0.84). There was also no difference in the proportion of marked fish recovered among strata during the typical three 3-day weekend fishery except in 1993 (1991: $\chi^2 = 1.20$, df = 2, P = 0.55; 1992: $\chi^2 = 2.85$, df = 2, P = 0.24; 1993: $\chi^2 = 7.43$, df = 2, P = 0.02; 1994: $\chi^2 = 1.10$, df = 2, P = 0.58). Even though the proportion of marked fish observed in 1993 was different, the proportions did not differ dramatically among weekends. In addition, contribution estimates of harvest for years 1991-1993 did not differ between stratified and pooled designs as the estimates were within one standard error of each other (Table 3). Therefore, based on these results, using the SWHS to estimate total sport harvest will probably not bias the estimates of contribution.

A total of 474 chinook salmon (15% of the estimated harvest) was examined from the sport harvest for adipose finclips (Table 4; Appendix A1). Heads were collected from 56 of the 59 fish with adipose clips. Coded wire tags were recovered from 43 of the collected heads. Coded wire tags were missing from 13 of the collected heads (Appendix A2) resulting in a tag loss rate of 23%. Of the 43 recovered tags, 28 were from the 1990 hatchery smolt release, two were from the 1991 release, 12 were from the 1992 release, and one was from the 1993 release.

Estimated hatchery contribution was 1,389 fish and accounted for 45% of the total harvest (Table 5). The majority of the contribution was age-1.4 fish from the 1990 release (1,035 fish), followed by age-1.2 fish from the 1992 release (266 fish).

Table 2.-Number (n) of harvested chinook salmon observed in the Ninilchik River sport fishery and proportion (p) of those fish with an adipose finclip, 1991-1994.

Temporal	1991		1992		1993		1994	
Stratum[a]	n	p	n	p	n	p	n	p
1	41	0.12	150	0.06	216	0.12	125	0.11
2	128	0.11	246	0.08	246	0.09	151	0.12
3	132	0.08	203	0.11	213	0.05	117	0.15
4	247	0.13	208	0.08	90	0.08	49	0.12
5	26	0.12	135	0.09	3	0.00	32	0.09

[a] Strata 1 - 3 were the regular three 3-day weekends, stratum 4 was an extended 3-day weekend in 1991 and 1992 and an extended 7-day week in 1993 and 1994, and stratum 5 was an extension of 6 days in 1991 and 7 days in all other years.

Table 3.-Estimated harvest ($\hat{H}$) and associated standard error (SE) of three release groups to the Ninilchik River sport fishery in 1991-1993, estimated by summing stratified estimates and by pooling the creel and the catch sample data.

	Recovery Year					
	1991		1992		1993	
	$\hat{H}$	SE	$\hat{H}$	SE	$\hat{H}$	SE
First three weekends						
1988						
Stratify	1,246	448	1,314	291		
Pooled	988	278	1,340	300		
1989						
Stratify			468	171	708	320
Pooled			462	182	679	298
1990						
Stratify	47	34	94	56	1,683	346
Pooled	83	57	100	58	1,502	298
Total fishery						
1988						
Stratify	3,575	1,345	1,880	336		
Pooled	2,580	727	1,871	346		
1989						
Stratify			789	212	903	350
Pooled			789	226	945	343
1990						
Stratify	293	97	120	64	1,879	361
Pooled	612	223	122	62	1,764	328

Table 4.-Coded wire tags recovered each weekend from chinook salmon during the recreational fishery at the Ninilchik River, 1994.

Date	Number Examined	Finclips Observed	n[b]	Year Released[a] 1990	1991	1992	1993	No Tag
5/28-30	125	14	14	11	0	1	0	2
6/04-06	151	18	16	10	0	5	0	1
6/11-13	117	18	17	5	2	3	0	7
6/14-20	49	6	6	1	0	3	1	1
6/21-27	32	3	3	1	0	0	0	2
Total	474	59	56	28	2	12	1	13

[a] Tag codes 311735 (1990), 311934 (1991), 312104 (1992), and 312159 (1993).

[b] Number of heads collected.

Table 5.-Estimated harvest ($\hat{H}$) and standard error (SE) of stocked chinook salmon to the Ninilchik River sport fishery, 1994.

Release Year	Tag Code	Proportion Marked	Age	$\hat{H}$	SE	Percent[a]
1990	311735	0.1868	0.4	1,035	208	33
1991	311934	0.2395	0.3	58	40	2
1992	312104	0.3122	0.2	266	78	9
1993	312159	0.2327	0.1	30	30	1
Total				1,389	228[b]	45

[a] Percent of total sport harvest of 3,108 (Howe et al. 1995).

[b] Conservative estimate based on the square root of the sum of variances among release groups that does not include negative covariances.

SIZE AND AGE COMPOSITION

Scales were collected at random from 160 fish from the sport harvest, of which 56 (35%) had adipose finclips. Most harvested fish were age 1.4 (59%) or age 1.3 (24%) (Table 6). Fish aged 1.2 comprised 16% of the harvest while fish aged 1.1 made up less than 1% of the harvested return. There was no significant difference in mean length-at-age between finclipped fish and fish with adipose fins for fish aged 1.2 ($t = 0.06$, $df = 20$, $P = 0.95$) and fish aged 1.3 ($t = -0.35$, $df = 28$, $P = 0.73$). However, there was a significant difference in mean length-at-age between clipped fish and nonclipped fish aged 1.4 ($t = 2.77$, $df = 74$, $P = 0.007$).

ESCAPEMENT

The aerial survey conducted by helicopter on 30 July on the Ninilchik River resulted in an estimate of 859 chinook salmon (Table 7). Water conditions during the survey were good to fair. The water level was low allowing for a more complete assessment of the fish in the river. However, due to the dark tannic coloration of the river, only fish near the surface were visible in some of the deeper pools.

DISCUSSION

1994 EVALUATION

During 1994, the fishing season for chinook salmon at the Ninilchik River was extended by emergency order from 14 June through 27 June to continuous fishing (23 total season days). Survey observations by staff prior to the fishery extension indicated that the overall harvest appeared similar to that experienced during the previous seasons and that the numbers of fish which had migrated above the fishery were nearly sufficient to meet escapement needs.

Scales taken in 1994 from chinook salmon containing coded wire tags appeared to have similar freshwater growth annuli and winter checks as the non-clipped fish sampled in the sport harvest. However, based upon the known release date of the hatchery fish, the number of winter checks on the scale would be less than 1, as these fish are released as "0 check" smolts. Similar scale patterns have been observed on scales of hatchery-reared chinook salmon from the Kasilof River (S. Hammarstrom, Alaska Department of Fish and Game, Soldotna, personal communication), whereby the scale patterns appeared identical to the growth patterns of river-reared chinook salmon of other Kenai Peninsula rivers. Therefore, the freshwater checks are probably an artifact of hatchery rearing or smolting stress which may occur when the fish enter saltwater. As a result of the similarities in scale patterns between the finclipped and non-clipped fish and the inability to separate the hatchery-reared fish from river-reared fish, all chinook salmon which were non-clipped were assumed to have a freshwater age of 1 (Table 6) and all known clipped fish were aged as 0 (Table 1, Table 5, and Table 8). When samples were combined to assess total production all sampled fish were assumed to have a freshwater age of 1 (Table 6, Figure 3).

Coded wire tags were recovered from smolt release groups for years 1990-1993 (Table 5). Contribution to the harvest by the 1991 release group was quite small. This magnitude of contribution may indicate a recruitment failure for this release year as the 1.3 age-class component to the Ninilchik River is typically a major year-class. Historically, this age-class has comprised approximately 30% of the return. Contributions to the sampled harvest by non-clipped fish in this age class (1.3) of 27% approximates the historical average for this age-class

Table 6.-Age composition and mean length-at-age of chinook salmon sampled at the Ninilchik River, 1994.

	Age					
	1.1	1.2	1.3	1.4	1.5	Total
No adipose finclip						
Percent		12	33	56		100
SE percent		4	5	5		
Number aged		10	28	48		86
Mean length		634	756	844		791
SE mean length		19	9	7		9
Minimum		545	645	745		545
Maximum		711	817	964		964
Adipose finclip						
Percent	2	24	10	64		100
SE percent	2	6	4	7		
Number aged	1	12	5	32		50
Mean length	375	632	748	814		755
SE mean length		18	15	8		15
Minimum	375	505	715	696		375
Maximum	375	760	792	891		891
Total						
Percent	1	16	24	59		100
SE percent	1	3	4	4		
Number aged	1	22	33	80		136[a]
Mean length	375	633	755	832		778
SE mean length		13	8	6		8
Minimum	375	505	645	696		375
Maximum	375	760	817	964		964

[a] 160 chinook sampled excluding regenerated and illegible scales.

Table 7.- Lower Kenai Peninsula chinook salmon escapement surveys, 1994.

	Live	Dead	Total
Anchor River, 7/30/94			
Ground Index	119	31	150
Aerial			
Index	98	20	118
Remainder	635	84	719
Expanded	771	130	901
Total	890	161	1,051
Deep Creek, 7/30/94			
Ground Index	81	8	89
Aerial			
Index	32	8	40
Remainder	312	12	324
Expanded	790	12	802
Total	871	20	891
Ninilchik River, 7/30/94			
Ground Index	102	159	261
Aerial			
Index	68	16	84
Remainder	127	41	168
Expanded	191	407	598
Total	293	566	859

Table 8.-Estimated harvest of hatchery-stocked chinook salmon at the Ninilchik River, 1991-1994.

Return Year	Release Year[a] 1988	1989	1990	1991	1992	1993	Percent Contribution	Return Year Total
1991	3,575 (0.3)		293 (0.1)				77%	3,868
1992	1,880 (0.4)	789 (0.3)	120 (0.2)				57%	2,789
1993		903 (0.4)	1,879 (0.3)				50%	2,782
1994			1,035 (0.4)	58 (0.3)	266 (0.2)	30 (0.1)	45%	1,389
Release Year Total	5,455	1,692	3,327	58	266	30		

[a] Age class in parentheses.

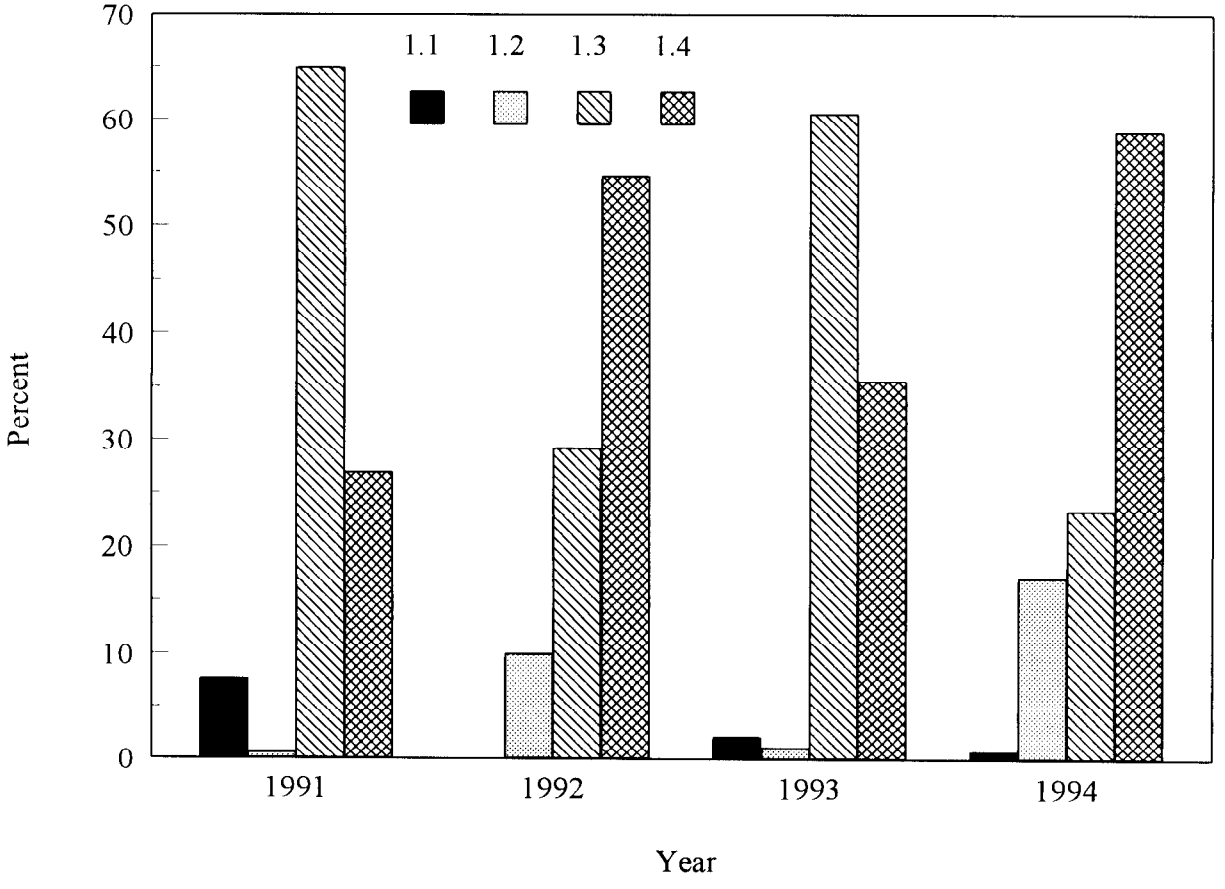

Figure 3.-Age composition of chinook salmon harvested by the Ninilchik River sport fishery, 1991-1994.

component sampled in the recreational harvest at the three lower peninsula streams, Anchor River, Deep Creek and Ninilchik River (Hammarstrom 1977).

Coded wire tag loss from chinook salmon returning to the Ninilchik River in 1994 was approximately 23%. This was an increase from the level observed in 1993 (10%) and was similar to the 1991-1992 average of 20% tag loss for finclipped chinook salmon returning to the Ninilchik River.

STOCKING PROGRAM GOALS AND OBJECTIVES

The goals of the Ninilchik River stocking program were debated and subsequently modified prior to the 1994 season. The goals currently are three-fold:

1. to maintain the present quantity and quality of natural chinook salmon production in the Ninilchik River by ensuring that a minimum of 830 chinook salmon spawn in the Ninilchik River annually; and by ensuring that the historical age and sex compositions are not significantly altered by stocking;
2. to stock 50,000 chinook salmon smolt of Ninilchik River origin annually into the Ninilchik River in order to produce an additional 1,500 returning adult chinook salmon, which are available for harvest in the Deep Creek marine and the Ninilchik River recreational fisheries; and,
3. to provide additional angler-days of chinook salmon fishing opportunity annually at the Ninilchik River 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 830 chinook salmon (Table 9). However, a better method of estimating escapement is needed. The aerial survey provides an index number that is biased low. The survey is conducted only one time and there is no method to account for fish which may not be observed during that time. Fish which have not yet entered the system or those fish that have died and were flushed out of the river would not be counted. Additionally, high or murky water during some years have completely eliminated any reliable counts. A weir or sonar would provide more reliable, accurate counts of escapement as well as allow for more prudent inseason management decisions. Further evaluation of the contribution of hatchery stocked chinook salmon to the spawning population could also be conducted using a weir structure or possibly by subsampling the spawning escapement while employing a sonar counter.

Evaluating the effects of the stocking program on the historical age and sex compositions of naturally-produced chinook salmon is not possible because historical age, length, and sex compositions are not available for escapements of chinook salmon to the Ninilchik River. Although historical age, length and sex databases do exist for the recreational harvest, using these data to evaluate the effects of the stocking program is problematic because of possible biases due to angler selectivity towards larger fish and the inability to distinguish hatchery-produced from naturally-produced fish.

Historical age, length, and sex compositions are not available for escapements of chinook salmon to the Ninilchik River. However, historical age, length and sex databases do exist for the

Table 9.-Historical harvest and escapement of chinook salmon, Ninilchik River, 1966-1994.

Year	Harvest[a]	Escapement[b]	Exploitation
1966	200	670	0.23
1967	120	360	0.25
1968	210	450	0.32
1969	130	760	0.15
1970	280	No Data	
1971	140	No Data	
1972	170	1,360	0.11
1973	300	640	0.32
1974	350	510	0.41
1975	540	830	0.39
1976	630	1,180	0.35
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]	1,370	830	0.62
1982	1,080	1,430	0.43
1983	810	710	0.53
1984	540	600	0.47
1985	870	650	0.57
1986	370	790	0.32
1987	1,090	600	0.64
1988	740	1,080	0.41
1989	520	400	0.57
1990	590	840	0.41
Mean 1966-1990	630	830	0.40
1991	5,053	827	0.86
1992	4,896	No Data	No Data
1993	5,610	1,300[d]	0.81
1994	3,108	859	0.78
Mean 1991-1994	4,667	995	0.82

[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 Balland et al. (1994); 1994 estimate from Howe et al. 1995.

[b] Nelson 1994.

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

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

recreational harvest. Applying these data to the evaluation of the affects of the stocking program on the age and sex composition of the escapement is problematic, with possible biases due to angler selectivity, generally towards larger fish. The use of such information with its possible limitations would, however, provide a means to weigh the significance of any possible alterations in the age composition of the escapement should this project be continued for an extended timeframe. Age compositions of harvests for 1991-1994 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 and 1994 (Figure 3). However, the harvests from 1991-1994 were predominantly age 1.3 and 1.4, which generally parallels the historical age composition of the recreational fishery.

Increased Harvest of Chinook Salmon

During previous seasons, the stocking program at the Ninilchik River increased the total harvest of chinook salmon to over seven times the 1966-1990 average (Table 9). Although most of the initial increase was due to the harvest of stocked chinook salmon, the contribution of stocked chinook salmon decreased from 77% in 1991 (Boyle and Alexandersdottir 1992) to only 45% in 1994 (Table 8). Non-stocked fish comprised a large proportion of the harvest with greater absolute numbers of non-stocked fish being harvested during each succeeding year (1991-1993) before declining in 1994. The stocking program provided nearly 1,400 additional chinook salmon to the harvest during 1994 while the harvest of non-stocked chinook salmon was approximately 1,700 fish. This level of harvest of non-stocked fish is nearly triple the historical 1966-1990 average of 630 fish (Table 9).

Programmatic changes made to the Ninilchik River stocking program in 1994 should reduce possible genetic changes to the chinook salmon stocks and allow for a larger proportionate harvest of stocked fish. These changes include marking 100% of all chinook salmon smolts stocked in the Ninilchik River. Future returns with all stocked fish marked will enable fishery managers to target hatchery fish, allowing more stocked fish to be harvested. Increased harvest rates of hatchery stocks in concert with 100% marking will also provide the means to further reduce hatchery stocks from comprising a large proportion of the spawning escapement.

In conjunction with marking all stocked smolt, stocking levels were decreased from about 247,000 in 1988 to about 200,000 smolt in 1994 (Table 1). All future smolt releases will be confined to the intertidal area of the Ninilchik River. The released smolt will be held in covered net-pens near the mouth of the river for an extended time to allow for acclimation and imprinting. Previously, the smolt were released at various locations in the river with the more recent stocking releases upstream of the mouth of the river approximately 4 to 4.5 miles. The altered stocking regime will minimize possible competitive interaction for space and food between naturally-produced smolt and stocked smolt before outmigration as well as reducing the possibility of disease transferal between stocks. Hopefully, the location of the stocking will also increase the probability that the returning hatchery fish will be harvested by increasing the time these fish spend in the area open to fishing. However, the current management strategies will need to be further refined to allow for a differential harvest of the returning stocked chinook salmon while allowing for an adequate spawning escapement of naturally-produced fish.

Increased Fishing Opportunity for Chinook Salmon

The stocking program has served to increase the amount of available opportunity for recreational anglers to fish for chinook salmon at the Ninilchik River. The fishery has been extended for

increasingly longer periods since hatchery-produced fish began returning to the Ninilchik River. The fishery was extended by 9 days in 1991, 10 days in 1992, and 14 days in both 1993 and 1994.

Total effort at the Ninilchik River averaged 22,437 angler-days during 1991-1994, an increase of nearly 10,000 angler-days over the previous 5-year average of 12,760 angler-days (Mills 1987-1994; Howe et al. 1995) (Table 9, Figure 4). Most of this increase can be directly attributed to the stocking program in light of the fact that overall effort on the Kenai Peninsula has increased by less than 10% per year over the past 10 years.

This increase in effort is not benign and without associated impacts upon the fishery resources of the Ninilchik River. The recent past has been marked by a growing awareness among fishery professionals as well as the angling public that unrestricted growth of recreational fisheries can result in degraded and lost fish habitat. The Ninilchik River has not remained unscathed or unaffected by the increased levels of angler traffic along its shorelines. The past several fishing seasons have also been noteworthy for the trails and trampled riparian vegetation as much as for the number of chinook salmon in anglers' creels. While major alterations of the Ninilchik River's aquatic habitat as a response to increased angler participation have not been documented, continued high levels of traffic or increased levels of fishing effort may change that assessment.

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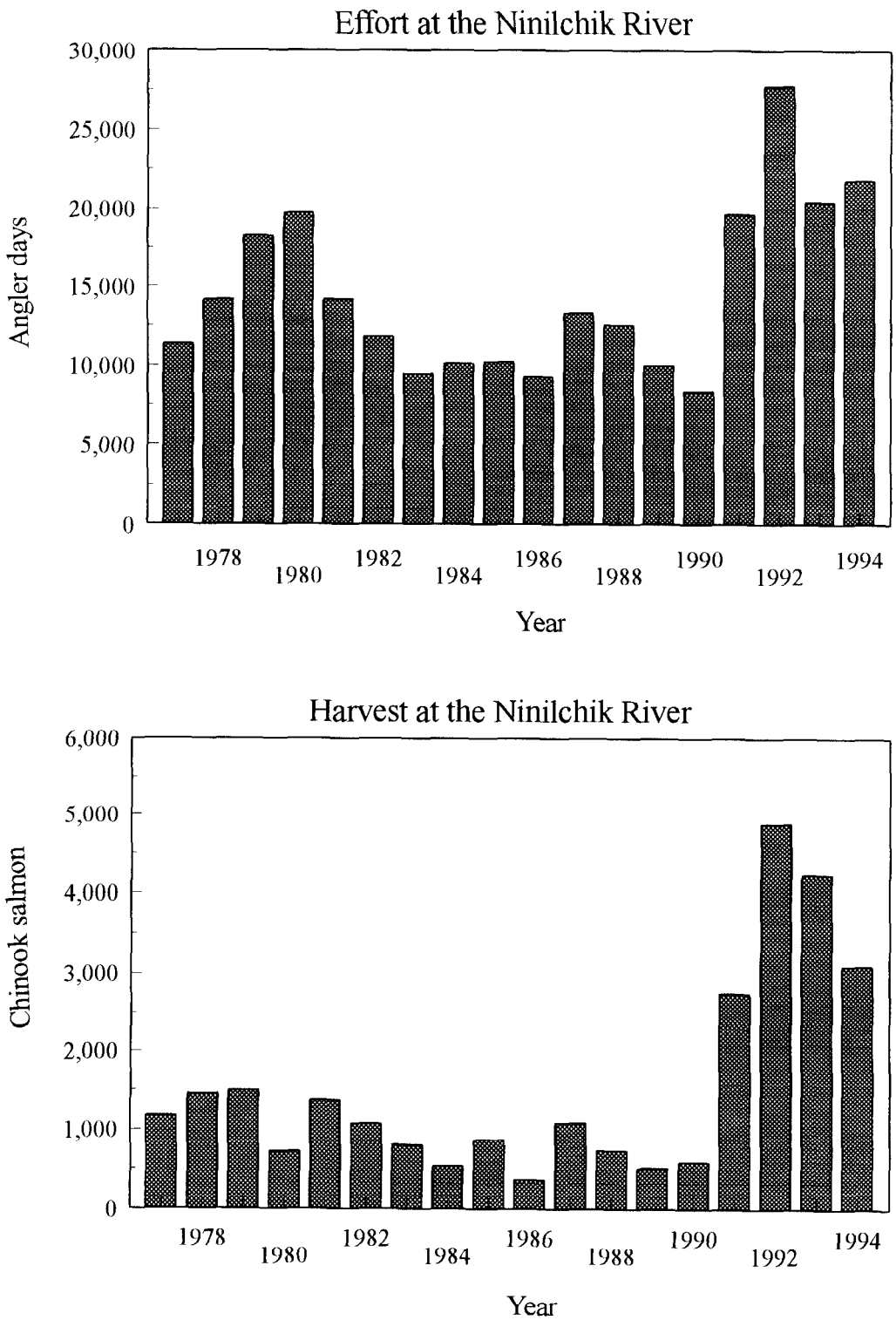

Figure 4.-Historical harvest of chinook salmon and sport fishing effort at the Ninilchik River, 1977-1994.

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APPENDIX A SUMMARY OF ADIPOSE-CLIPPED CHINOOK SALMON SAMPLED AT THE NINILCHIK RIVER, 1994

Appendix A1.-Coded wire tag recoveries from chinook salmon, Ninilchik River, 1994.

Date	Number Examined	Finclips Observed	n[b]	Year Released[a] 1990	1991	1992	1993	No Tag
1st weekend								
5/28	74	8	8	5		1		2
5/29	22	4	4	4				
5/30	29	2	2	2				
2nd Weekend								
6/04	73	8	8	5		3		
6/05	44	4	3	1		1		1
6/06	34	6	5	4		1		
3rd Weekend								
6/11	71	12	12	3	2	3		4
6/12	24	3	2	1				1
6/13	22	3	3	1				2
Extended Fishery								
6/14	7	0	0					
6/15	7	0	0					
6/16	4	1	1				1	
6/17	2	1	1			1		
6/18	6	1	1					1
6/19	8	0	0					
6/20	15	3	3	1		2		
6/21	8	0	0					
6/22	11	1	1	1				
6/23	2	0	0					
6/24	3	1	1					1
6/25	6	0	0					
6/26	1	0	0					
6/27	1	1	1					1
Total	474	59	56	28	2	12	1	13

[a] Tag codes 311735 (1990), 311934 (1991), 312104 (1992), and 312159 (1993).

[b] Number of heads collected.

Appendix A2.-Summary of adipose finclipped fish which did not contain a tag, Ninilchik River, 1994.

Head Number	Mid-Eye to Fork Length (mm)	Age	Clip Status	Recovery Date
26962	840	0.4	Good	5/28/94
26966	823	0.4	Good	5/28/94
26989	781	RG[a]	Good	6/05/94
26348	767	NA[b]	Good	6/11/94
26349	800	NA	Good	6/11/94
26350	752	NA	Good	6/11/94
26957	759	NA	Good	6/11/94
26959	709	RG	Good	6/12/94
26333	715	0.3	Good	6/13/94
26334	831	0.4	Good	6/13/94
26342	845	0.4	Good	6/18/94
26336	769	0.3	Good	6/24/94
26337	720	0.3	Good	6/27/94

[a] Regenerated scale, could not be aged.

[b] Missing scales.