Fishery Data Series No. 06-68

Survey of the Chinook Salmon Sport Fishery in the Lower Nushagak River, Alaska, 2001

by

Thomas Cappiello

and

Jason E. Dye

December 2006

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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
milliliter	mL
millimeter	mm

Weights and measures (English)

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

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
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
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
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	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
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.
minute (angular)	'
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
variance	
population	Var
sample	var

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by

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ABSTRACT

A survey of the sport fishery for Chinook salmon on the Nushagak River in Southwest Alaska was conducted from 15 June to 15 July 2001. Index counts of anglers fishing between Black Point and the lower Ekwok land boundary ranged from 28 on 15 July to 365 on 26 June, with an average for the study period of 202. Index counts of anglers fishing the middle reaches of the Nushagak River and lower Mulchatna River from 20 June to 24 July ranged from 8 on 15 and 20 July to 61 on 2 July with an average of 36. Anglers associated with Choggiung Ltd. permitted commercial operations reported harvesting 1,820 and releasing 13,342 Chinook salmon, expending 2,995 angler-trips. The reported number of Chinook that they caught that was less than 20 inches TL was 2,194. Most of the anglers associated with Choggiung Ltd. permitted commercial camps were guided (86%) and used bait (59%). A total of 158 anglers not associated with Choggiung Ltd. permitted commercial operations was interviewed for catch, harvest, and demographic information. Most of the anglers not associated with Choggiung Ltd. permitted commercial camps were adults (94%), males (91%), unguided (82%) and Alaska residents (63%). The primary tackle types used were lures (52%) and bait (46%). Sport-caught Chinook salmon were predominately age 1.4 (47%) followed by age 1.3 (31%) and age 1.5 (9.5%). Overall average mid eye to tail fork length (MEFL) of sport caught Chinook salmon was 742 mm.

During 1991 through 2001, an estimated 0.9% to 3.8% of the Chinook salmon escapement were fish less than 20 inches TL (508 mm TL).

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, Bristol Bay, Nushagak River, Mulchatna River, sport fishery, catch, effort, harvest, rates, creel survey, angler characteristics, age, weight, length comparison, escapement

INTRODUCTION

The Nushagak River drainage hosts the largest Chinook salmon *Oncorhynchus tshawytscha* fishery in the Southwest Alaska Sport Fish Management Area (SWMA; Figure 1). Effort (entire season for all species) in the principle fishery areas of the Nushagak River mainstem averaged approximately 14,000 angler-days from 1996 to 2000 (Howe et al. 2001a-d; Walker et al. 2003). Chinook sport catches (fish kept plus released) in these principle areas have increased from a 1991–1995 average of 14,391 to a 1996–2000 average of 35,911 (Howe et al. 1995, 1996, 2001 a-d; Mills 1992-1994; Walker et al. 2003). The increased catches are likely a function of changing effort and angler characteristics rather than productive runs; inriver sonar estimates averaged higher from 1991–1995 than after 1995 (Appendix A1). The lower 32 km of the Nushagak River has become increasingly congested. Increasing numbers of guide operations and private anglers are using reaches near the confluence of the Mulchatna and Nushagak rivers and reaches from the Iowithla River mouth to near the village of New Stuyahok (Figures 2-4). At the same time use of the Mulchatna River from the Koktuli River mouth to the Stuyahok River mouth has reportedly dispersed or diminished, possibly because gear was restricted to single hooks and no bait in 1992. Inseason restrictions or closures disrupted this fishery in 1996, 1997 and 1999. Reduced daily and annual bag limits may also have been a factor. Increasing and redistributing effort complicates managing Chinook harvests within guideline levels.

Fishery and resource assessment of the Nushagak River comes from several sources and methods. Data on sport fisheries includes the results of the annual Statewide Harvest and Participation Survey (Howe et al. 1995, 1996, 2001 a-d; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003) administered by the Alaska Department of Fish and Game (ADF&G) Sport Fish Division (SF). Regular onsite monitoring of the Nushagak sport fishery is required for timely assessment of the catch, harvest, effort and shifting angler activity. SF operated onsite

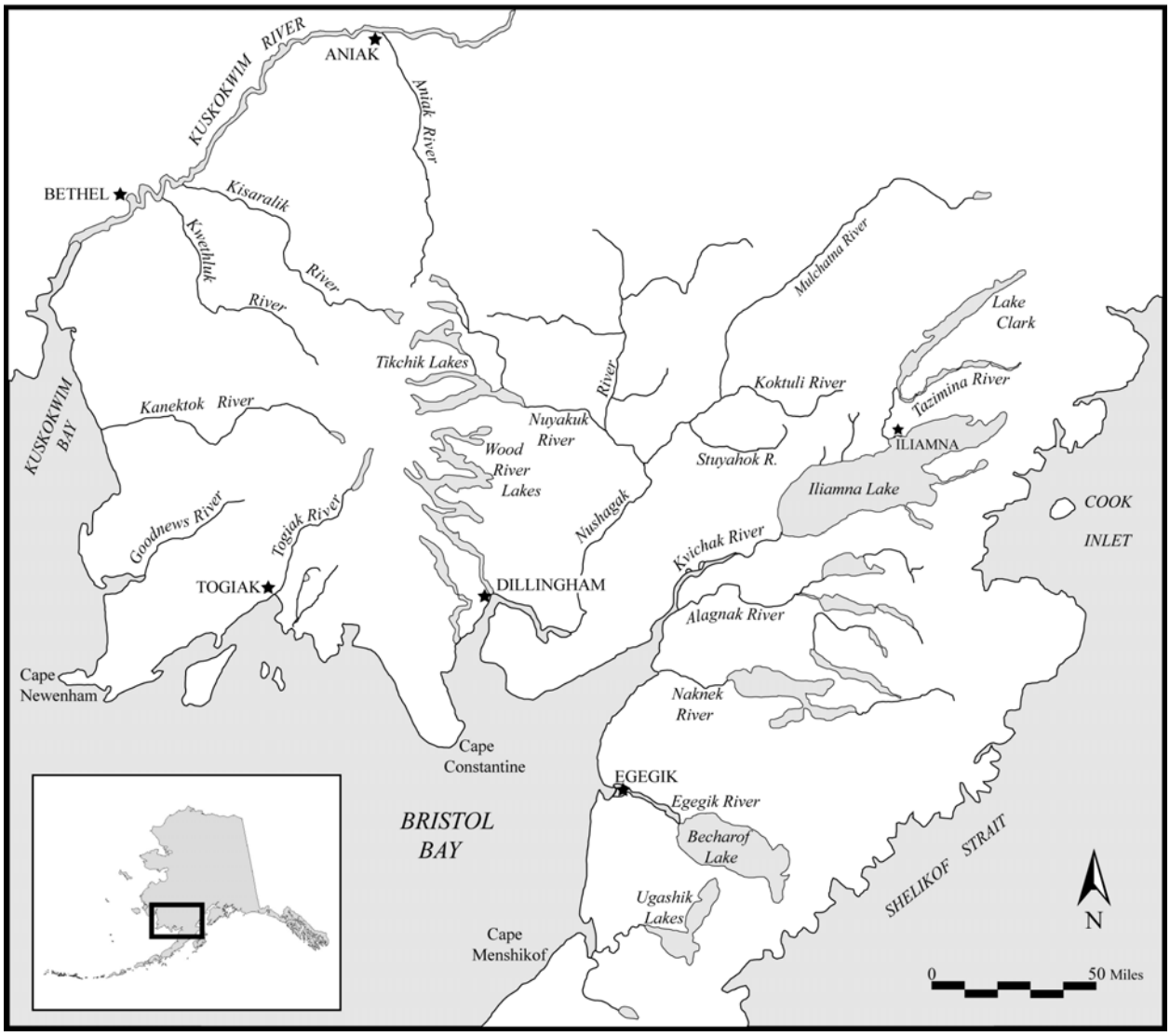

Figure 1.-Popular salmon fisheries in the Southwestern Alaska Sport Fish Management Area.

creel surveys in 1982, 1984, 1986, 1987, 1991, 1994 and 2000 (Dunaway and Bingham 1992; Dunaway and Fleischman 1995; Dye 2005; Minard 1987; Minard and Brookover III 1988; Minard and Morstad 1985). Creel surveys were also initiated in 1997 in the lower reaches of the Nushagak River and middle Mulchatna River but terminated by a closure of the Chinook salmon fishery. Results of the 1997 surveys were briefly summarized in the 1997 Area Management Report (Minard et al. 1998). SF management reports for the SWMA document management of the Nushagak River Chinook salmon sport fishery (Minard and Dunaway 1995; Minard et al. 1998; Dunaway et al. 2000; Dunaway and Sonnichsen 2001).

Data on the commercial and subsistence salmon harvests and escapements into the Nushagak River drainage is compiled primarily by ADF&G Commercial Fisheries Division (CF) and published annually in their Regional Information Report (RIR) series. The main source of inseason and postseason salmon run assessments comes from a side-scan sonar project located 4 km downstream from the village of Portage Creek. Sonar counts are apportioned among

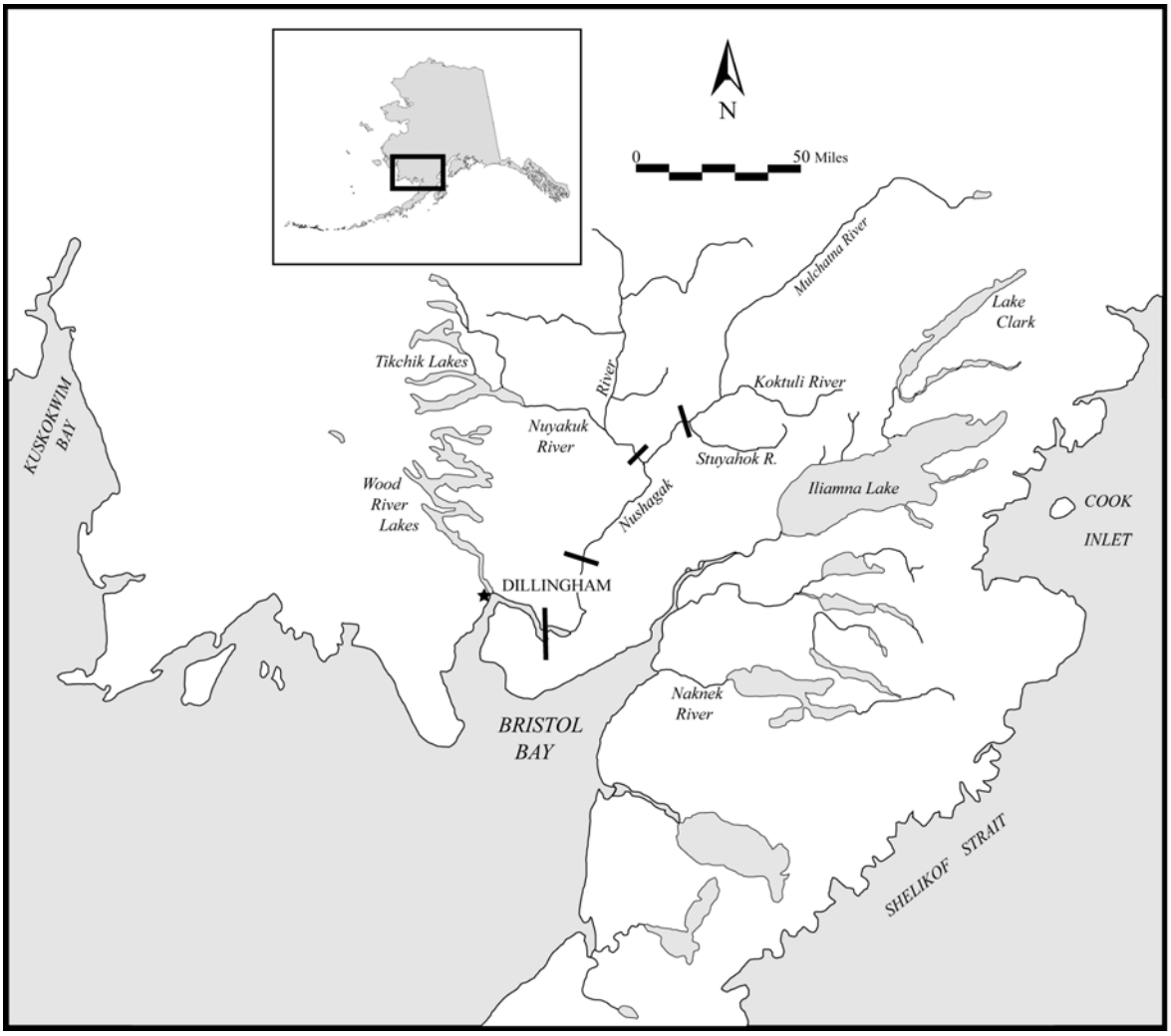

Figure 2.-Study area for the Nushagak River drainage Chinook salmon angler survey.

species based on species proportions in samples collected using gillnets with mesh sizes of 20.6 cm (8.125 in), 15.2 cm (6.0 in) and 13.0 cm (5.125 in) and beach seines; biological data from salmon are also obtained. Aerial surveys of selected Chinook salmon spawning areas in the Nushagak River were routinely conducted from 1967 through 1988 (Appendix B). From 1989 to present, there have been few aerial surveys mainly due to the presence of a sonar program. However, aerial surveys in 1997 proved a valuable alternative for assessing salmon runs when extremely low water may have compromised the accuracy of the sonar counts.

Management of the Nushagak River Chinook salmon commercial, subsistence and sport fisheries is governed by the Nushagak-Mulchatna Chinook Salmon Management Plan (5 AAC 06.361, Appendix C) adopted in 1992 and amended in 1995, 1997 and 2001. To meet plan guidelines, current regulations, in part, stipulate an annual bag limit of 4 Chinook salmon and a daily bag limit of 2 Chinook salmon, only 1 of which may be over 28 inches total length (TL) (ADF&G 2001).

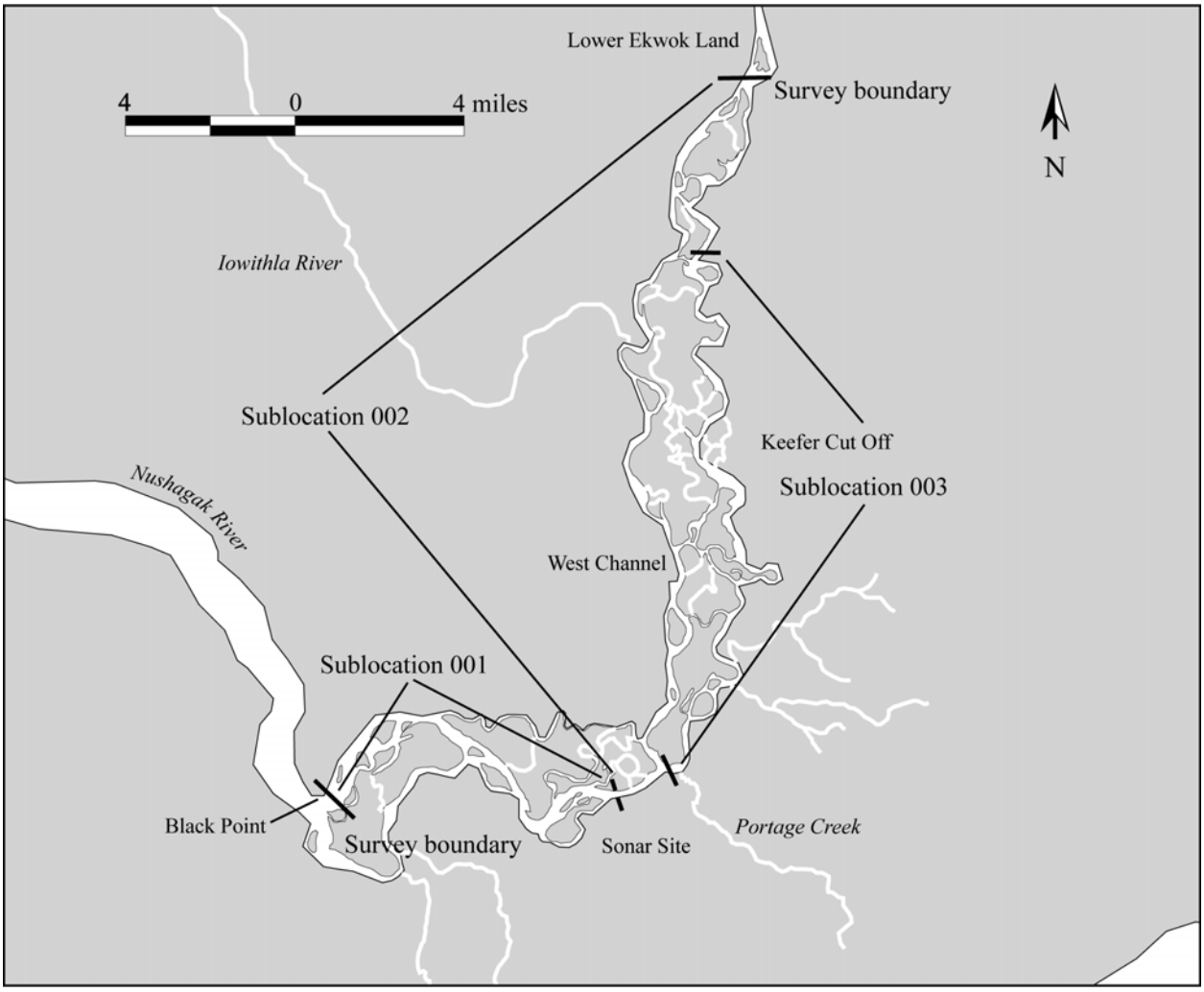

Figure 3.-Nushagak River lower study area sublocations.

A proposal in 2000 to allow a daily bag limit of 10 Chinook salmon less than 20 inches (508 mm) TL was tabled until ADF&G and local tribal agencies could study the potential effects on the spawning populations. Most historical lengths of Chinook salmon have been measured from mid eye to tail fork (MEFL), rather than TL. Assessment of the potential impact of the new regulation requires an accurate model for converting TL to MEFL.

This onsite survey was, in part, designed as an initial assessment of the harvest impacts from the proposed increased bag limit of Chinook less than 20 inches. It was also designed to document the angler distribution in the Nushagak River Chinook salmon fishery. A comprehensive fishery survey of this river by ADF&G alone was cost prohibitive, so cooperation with Choggiung Ltd., the local native corporation, was indispensable. Choggiung Ltd. manages much of the uplands adjoining the Nushagak River and requires all users utilizing their lands, including commercial guide operations, to purchase a permit. Therefore, there are three distinct angler types on the river: commercially permitted, non-commercially permitted, and non-permitted anglers. For this project anglers were divided into two groups: commercially permitted and non-commercially permitted/non-permitted.

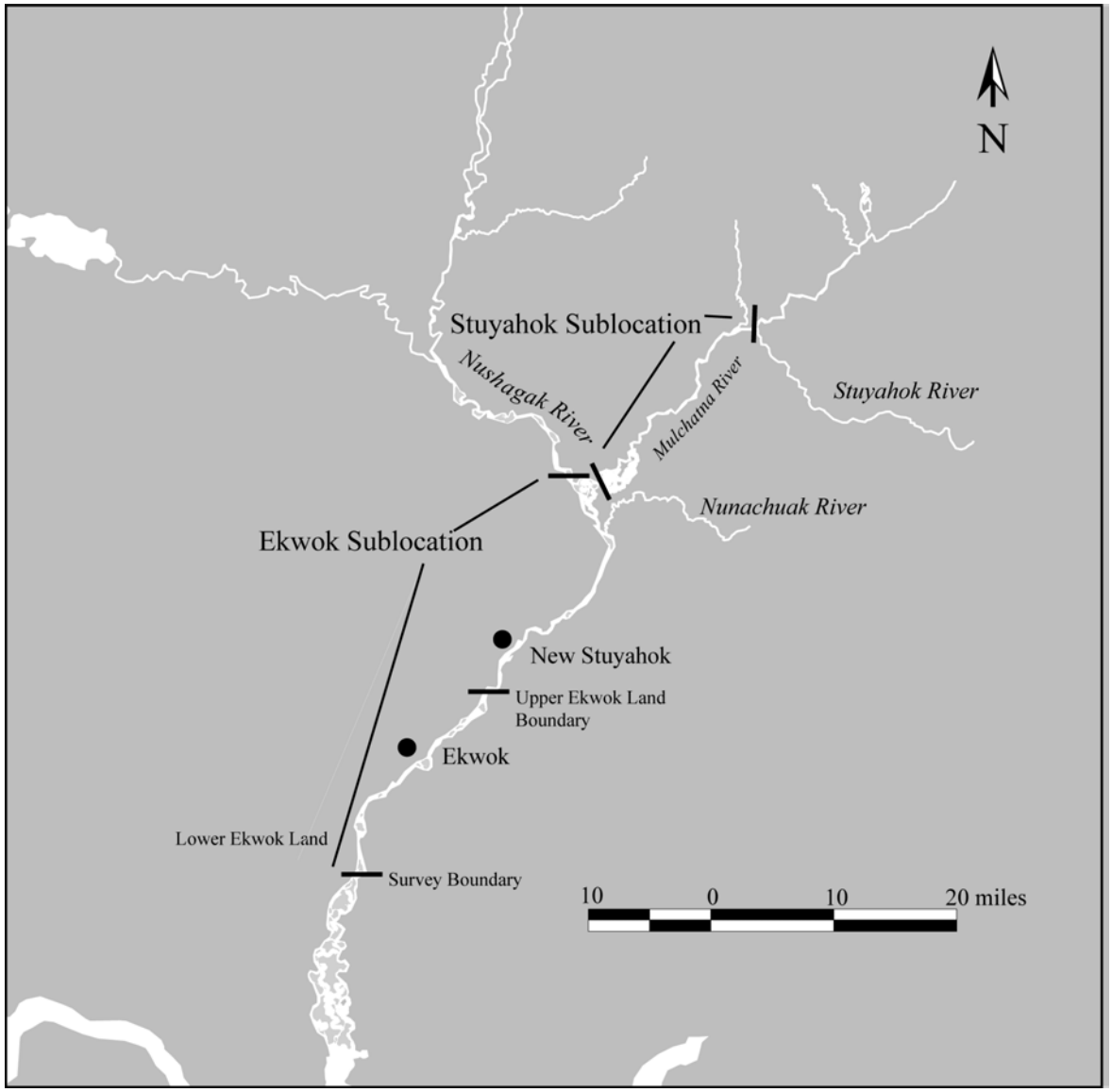

Figure 4.-Nushagak River middle study area sublocations.

This was the second year that ADF&G conducted a survey with Choggiung Ltd. assistance and ADF&G depended on Choggiung Ltd. to collect data for fisheries management purposes.

The objectives for the 2001 survey of the Chinook salmon sport fishery on the Nushagak River near Portage Creek were to:

1) Estimate the relationship between MEFL and the TL of Chinook salmon such that the expected value of MEFL for fish with TL = 508 mm was estimated to within 5 mm of the true value 90% of the time.
2) Estimate the proportion of Chinook salmon less than 508 mm TL that contributed to the annual Nushagak River Chinook salmon escapement estimates during the years 1991 to 2001, such that the estimated proportion was within 2 percentage points of the true value 90% of the time.

3) Census anglers in Choggiung Ltd. permitted commercial operations in the lower Nushagak River as an index of catch, harvest, tackle selection, and other demographics from 16 June through 15 July.
4) Index angler effort in the lower Nushagak River study areas once each sample day from 16 June through 15 July.
5) Conduct aerial surveys indexing the spawning escapement of Chinook salmon in selected tributaries of the Nushagak River.

Tasks for the 2001 study were to:

1) Collect data on the catch and retention rate of Chinook salmon less than 508 mm TL in the lower Nushagak river sport fishery from 16 June through 15 July.

2) Collect sex, length and weight data, and scale samples from sport harvested Chinook salmon in the lower Nushagak River. Interview non-permitted and privately permitted (Choggiung Ltd.) anglers fishing in the lower Nushagak River study area to collect effort, catch, harvest, tackle choice, and demographic information from 16 June through 15 July.

METHODS

STUDY AREA

This survey of the Nushagak River Chinook salmon recreational fishery occurred on the lower Nushagak River from Black Point to the lower Ekwok land boundary (LELB) at 59º 10' 25" N Lat. 157º 42' 35" W Long. (Figures 2 and 3), defined as the Lower Study Area (LSA). Most of the angling activity occurs in the LSA and is where Choggiung Ltd. concentrates most of their staff and equipment. The LSA was divided into 3 sublocations: (1) from Black Point to the sonar site near Portage Creek (sublocation 001), (2) from sonar site near Portage Creek to LELB using west channel (sublocation 002), and (3) Keefer cutoff just downstream of the confluence of Portage Creek to convergence of the channels using east channel (sublocation 003). Choggiung Ltd. staff also counted anglers from the LELB continuing up the Mulchatna River to the upper boundary of Native lands about 16 km downstream of the Stuyahok River mouth. This area, defined as the Middle Study Area (MSA) (Figure 4), was smaller than the similar study area used in 2000. The MSA was divided into 2 sublocations, from LELB to Mulchatna River mouth (Ekwok sublocation) and from Mulchatna River mouth to the upper boundary of Native lands (Stuyahok sublocation).

DATA COLLECTION

Survey Design

This survey was based on a multistage, stratified sampling design. Anglers were divided into two groups, commercially permitted and non-commercially permitted/non-permitted.

The sampling schedule was stratified by week (Monday through Sunday) and day type (weekend, weekday). From 16 June through 15 July 2001, all weekend days and 3 of 5 weekday days chosen at random were sampled each week (Appendix D). During this study period nearly all anglers are targeting Chinook salmon. The sampling period started at 1000 hours and ended at 1600 hours every sampling day. During each sampling period, Choggiung staff counted active anglers in the LSA, and ADF&G staff interviewed non-commercially permitted/non-permitted anglers. Based on ADF&G and Choggiung Ltd. knowledge, this design covered seasonal,

weekly, and daily peaks in the Chinook salmon sport fishery (Dunaway and Bingham 1992; Dunaway and Fleischman 1995; Minard 1987; Minard and Brookover III 1988; Minard and Morstad 1985; Russell Nelson, Choggiung Ltd., personal communication) and was intended to provide an informational index rather than estimates for the whole fishery.

Angler Effort

Active anglers were defined as individuals fishing or those handling rods and tackle, repositioning a boat, landing a fish, repairing gear, or assisting another angler. An active angler did not include people solely operating boats or engaged in another activity not associated with angling (e.g., someone who put their gear away to eat lunch). Children angling at village beaches were not counted.

On sampling days, Choggiung Ltd. staff counted all active anglers while driving a boat at a constant rate of speed through the LSA. One individual counted in sublocation 001 starting at the downstream boundary. Another individual counted in sublocation 002 starting at the downstream boundary, then counted in sublocation 003 while traveling downstream. At 1000 hours both individuals began their counts which took 1.5–2.5 hours to complete. No stops were made except to record angler counts for each sublocation.

Choggiung staff systematically counted anglers in the MSA, counting 2 consecutive days every 3 days. Staff began counting at 1200 hours at the upstream boundary of the Stuyahok sublocation, then proceeded downstream counting in the Ekwok sublocation. Counts in the MSA were intended as a baseline index to monitor changes in angler distribution.

Angler counts were considered instantaneous and representative of angler effort when conducted. This count regimen would provide an unbiased index of angler effort during the days and time sampled if the distribution of angler effort throughout the sampling day did not vary during the course of the survey.

Angler Interviews: Catch and Harvest Rates and Angler Characteristics

Choggiung Ltd. staff collected angler information from commercial operations (guides and lodges) permitted to operate on Choggiung Ltd. owned lands. Every day, Choggiung Ltd. staff handed out interview cards (Appendix E) to every permitted commercial operation, and received cards completed for the previous day. Because all anglers (or angler-trips) were accounted for by interviewing the operator, a census of the effort (angler-days), catch, harvest, terminal gear used, and angler type was obtained for this group. Each commercially permitted operation reported the total number of guided and unguided anglers who fished that day (including cooks, guides, pilots, etc.), the total Chinook salmon kept and total released, the number of Chinook salmon caught that were less than 508 mm TL, and the number of anglers that used bait.

Nearly all commercially permitted anglers were assumed to have completed their day by 1600 hours. If appreciable numbers of anglers continued to fish during, or began to fish after the operation was sampled, the interview data may not be representative of this group of anglers. Inferences based on interviews from this angler group may not be representative of the whole fishery, but this group was believed to include the majority of all anglers on the lower Nushagak River. Given the study design and interview schedule, if different types of anglers and/or anglers with a different catch or harvest rate fished during hours of the day not covered, then estimates based on these interviews would not represent the fishery in the LSA.

ADF&G interviewed non-commercially permitted/non-permitted anglers to obtain data on catch, harvest and angler characteristics. ADF&G contacted anglers both by roving through the fishery (all three sublocations of the LSA), and by stopping at camps. Staff recorded interview type (complete- or incomplete-day), hours spent fishing at the time of the interview, number of Chinook salmon under and over 508 mm TL that were kept and released, angler type (guided or unguided), fishing from boat or shore, gear type used (bait, lure or fly), male or female, youth or adult, Alaska resident or non-resident, and (if resident) local[1] or non-local.

The proportion of this angler group that was interviewed on a given sample day was unknown. Interviewing as many anglers as possible of this group each day would provide some insight into their characteristics. ADF&G staff coordinated with Choggiung Ltd. staff to identify the permit status of anglers.

Biological Data

Chinook salmon harvested by anglers who were interviewed by ADF&G staff were sampled for age, length, and weight data. When possible, all Chinook salmon retained by an angler were sampled (i.e., no sub-sampling of the creel). The biological sampling design was expected to yield a proportional sample of the harvest through the progression of the fishery (i.e. equal proportion of the harvest). The data were treated as if collected from a simple random sample.

For age information, three scales were removed from the preferred area[2] of each fish and mounted on an adhesive-coated card. Scale cards were heat-pressed on acetate. The impressions were viewed on a microfiche projector and age was determined using procedures in Jearld (1983). A sample size of 120 or more Chinook salmon was needed to attain the desired accuracy and precision, allowing for 15% of the scale samples being unreadable (Thompson 1987). If the sample size would not be obtained from interviewed anglers, ADF&G staff sampled fish caught by anglers associated with Choggiung Ltd. permitted commercial operations.

Salmon were measured for MEFL and TL to the nearest millimeter, and weighed to the nearest 0.1 kg. The desired precision for relating MEFL and TL was expected from a sample size of 30 or more fish with an average TL near 508 mm. When possible the CF staff at the sonar project was assisted in measuring MEFL and TL from Chinook salmon captured during their species apportionment and biological sampling programs.

Aerial Escapement Counts

For each flight the date, surveyor, weather conditions, type of aircraft, and a subjective assessment of survey conditions (Excellent, Good, Fair, or Poor) was recorded. The actual observed number of both live and dead Chinook salmon by stream was recorded on aerial survey maps. At the end of each flight, the number of Chinook salmon observed was tallied by stream.

DATA ANALYSIS

Angler Effort

As noted above, the single daily angler count conducted each day represents an index of angler effort, expressed as angler-days (one angler fishing for any amount of time during a day). Only a

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[1] Alaskan resident living in Dillingham, Aleknagik, Portage Creek, Ekwok, New Stuyahok, or Koliganek; non-locals are all other Alaskan residents.

[2] The left side of the fish approximately two rows above the lateral line and on a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander, A. D. 1940. A study of the development of the scale of Chinook salmon *Oncorhynchus tshawytscha*. Masters Thesis. University of Washington, Seattle.).

summary of the daily counts by study area and sublocation was performed. Relative effort among sublocations and study areas was compared.

Angler Interviews

Angler interview data collected from the commercially permitted operations was summarized separately from the interview data gathered by ADF&G staff.

Catch and Harvest Rates

Daily estimates of catch per unit of effort (CPUE) were calculated as described below, with unit of effort being angler-day:

$$cpue_i = \frac{c_i}{e_i}, \tag{1}$$

where c_i equals the number of fish caught (both kept and released) on the i^{th} day of the survey, and e_i is the number of complete-day anglers who fished in the i^{th} day.

Variance of mean CPUE was estimated by:

$$\hat{V}\left[\overline{cpue_i}\right] = \frac{\sum_{i-1}^{m_i}\left(cpue_i - \overline{cpue_i}\right)^2}{mi(m_i - 1)}, \tag{2}$$

where m_i equals the number of days sampled. The standard error (SE) was estimated as the square root of the variance estimate. Harvest per unit of effort (HPUE) was estimated similarly, replacing harvest (only fish kept) for catch.

Angler Characteristics

The proportion of angler-days by the categories of terminal gear type and angler characteristics was estimated as:

$$\hat{p}_z = \frac{m_z}{m}, \tag{3}$$

where, m_z equals the number of the interviewed anglers whose trips are categorized as z; and m equals the total number of classifiable anglers interviewed. No estimates of the sampling variance were calculated, because these proportions are merely descriptive in nature and cannot be used to make inferences about the fishery.

Assumptions

The assumptions necessary for unbiased point and variance estimates obtained by the above procedures are:

1. Interviewed anglers accurately reported the number of Chinook salmon kept and released, and time fished;
2. Choggiung Ltd. and ADF&G staff accurately classified anglers and the interviewed anglers accurately reported their trip type (guided, unguided) and terminal gear type (use of bait) and other characteristics during their fishing day;

3. Catch rate and duration of fishing trip were independent (necessary for roving interviews collected by ADF&G staff and for completed-day interviews to be representative of the fishery; if appreciable numbers of incomplete-day anglers appeared during the survey, anglers with longer fishing trips may have had a different probability of being intercepted for interview);
4. The daily distribution of angler effort did not vary substantially during the survey schedule (necessary for the single angler count to be an unbiased index of angler effort); and
5. Catchability of the salmon did not vary substantially during the course of the survey (necessary for CPUE to be an unbiased index of fish abundance).

There were no direct ways of evaluating or testing any of the assumptions. For assumptions 1 and 2, anglers were expected to have a good recollection of the total number of fish kept and released, and to accurately report the information requested. In addition, project staff was expected to accurately record data. Assumptions 3 and 4 should be valid if interviews collected at permitted commercial operations resulted in a census of completed-day anglers of this group and this group represented the majority of effort in this fishery.

Biological Data

The relationship between MEFL and TL was estimated using simple linear regression.

$$E\left[MEFL\right] = b_0 + b_1 TL\,, \tag{4}$$

where the estimated regression coefficients b_0 and b_1 were obtained using ordinary least squares.

The expected MEFL corresponding to 508 mm TL was estimated as

$$MEFL_{20} = b_0 + 508 b_1\,, \tag{5}$$

$$\hat{\text{var}}\left[MEFL_{20}\right] = MSE\left[\frac{1}{n_m} + \frac{\left(508 - \overline{TL}\right)^2}{\sum\left(TL - \overline{TL}\right)^2}\right], \tag{6}$$

where n_m is the number of fish measured for both TL and MEFL, and MSE = the mean squared error of the regression.

The proportion of Chinook salmon less than 508 mm TL in the sport harvest was estimated as a binomial proportion:

$$p_{20} = \frac{n_{20}}{n}\,, \tag{7}$$

$$\hat{\text{var}}\left[p_{20}\right] = \frac{p_{20}\left(1 - p_{20}\right)}{n - 1}\,, \tag{8}$$

where n_{20} is the number of Chinook salmon measured which were less than 508 mm TL, and n is the total number of Chinook salmon sampled in the sport harvest which were measured.

The proportion of harvested Chinook salmon of category (age, length, or weight) *u* was estimated as:

$$\hat{p}_u = \frac{n_u}{n}, \tag{9}$$

where n_u equals the number of sampled Chinook salmon in category *u*; and *n* equals the total number of Chinook salmon sampled. Variance of each proportion was estimated without the finite population correction factor, because we did not have harvest estimates:

$$\hat{V}[\hat{p}_u] = \frac{\hat{p}_u(1-\hat{p}_u)}{n-1}. \tag{10}$$

Mean length- and weight-at-age of harvested Chinook salmon were estimated following standard procedures (Sokal and Rohlf 1981, pp 56, 139). The standard error was estimated as the square root of the variance estimate.

Historical Escapement of Small Chinook Salmon

The annual percent of Chinook salmon less than 508 mm TL in sonar escapement estimates was estimated from historical data provided by CF staff (Appendix F). The estimates were calculated for years 1991 through 2000. For each year, daily counts were summed by week then multiplied by the percent of fish that were less than 508 mm TL (converted from the MEFL point estimate) in the biological samples for that week. The sum of the weekly subtotals was divided by the total sonar estimate for that year then multiplied by 100 to estimate the annual percent.

Aerial Escapement Counts

The actual number of observed Chinook salmon was considered the escapement index. If survey procedures remain consistent and standardized among years, escapement indices can be treated as a relative measure of the abundance of Chinook salmon on the spawning grounds.

RESULTS

ANGLER EFFORT

Choggiung Ltd. staff counted anglers in the LSA on 23 days from 15 June to 15 July. The daily number of anglers ranged from 69 on 15 June to 365 on 26 June (Table 1) and the total for the sampling period was 4,641 anglers. The relative distribution of effort among the sublocations in the LSA was somewhat variable (non-statistical comparison) with approximately 36% of the effort in sublocation 001, 38% in sublocation 002, and 26% in sublocation 003 (Figure 5). Choggiung staff counted anglers in the MSA from 20 June to 24 July. Counts ranged from 8 on 15 July and 21 July to 61 on 2 July (Table 1). On days when anglers were counted in both study areas, effort in the MSA represented from 5% to 38% of the total effort in both study areas combined (Figure 6). The number of anglers remained fairly constant in the MSA (Table 1) and was sustained later in the study period while angler counts waned in the LSA.

ANGLER INTERVIEWS

On every day from 16 June through 12 July Choggiung Ltd. staff conducted interviews, totaling 237 group interviews representing 2,995 completed angler-trips (Table 2). The number of interviews as a fraction of the daily angler counts in the LSA ranged from 8% on 16 June to 85% on 20 June, and the overall average was 47% (Table 3).

Table 1.-Daily counts of anglers in the lower and middle study areas, Nushagak River, 2001**.**

		Lower Study Area				Middle Study Area			
Date	Day	001	002	003	Total	Ekwok	Stuyahok	Total	Grand Total
15-Jun	Fri	24	32	13	69				
16-Jun	Sat	42	10	27	79				
17-Jun	Sun	17	31	45	93				
18-Jun	Mon	18	54	22	94				
19-Jun	Tue								
20-Jun	Wed	45	36	22	103	24	10	34	137
21-Jun	Thu					13	10	23	
22-Jun	Fri	115	44	50	209				
23-Jun	Sat	107	132	97	336	8	8	16	352
24-Jun	Sun	100	117	96	313	34	16	50	363
25-Jun	Mon	90	84	98	272				
26-Jun	Tue	94	154	117	365	18	15	33	398
27-Jun	Wed					30	17	47	
28-Jun	Thu	117	162	73	352				
29-Jun	Fri					41	13	54	
30-Jun	Sat	133	114	95	342	38	18	56	398
1-Jul	Sun	126	81	114	321				
2-Jul	Mon	159	63	89	311	42	19	61	372
3-Jul	Tue					26	18	44	
4-Jul	Wed	53	75	98	226				
5-Jul	Thu					26	16	42	
6-Jul	Fri	85	162	38	285	27	24	51	336
7-Jul	Sat	80	93	30	203				
8-Jul	Sun	96	89	20	205	23	5	28	233
9-Jul	Mon	65	78	18	161	22	36	58	219
10-Jul	Tue								
11-Jul	Wed	42	39	7	88	13	13	26	114
12-Jul	Thu	47	55	7	109	23	30	53	162
13-Jul	Fri								
14-Jul	Sat	32	29	16	77	24	24	48	125
15-Jul	Sun	0	28		28	8	0	8	36
16-Jul	Mon								
17-Jul	Tue					14	21	35	
18-Jul	Wed					7	10	17	
19-Jul	Thu								
20-Jul	Fri					16	3	19	
21-Jul	Sat					4	4	8	
22-Jul	Sun								
23-Jul	Mon					17	1	18	
24-Jul	Tue					26	1	27	
Total		1,687	1,762	1,192	4,641	524	332	856	

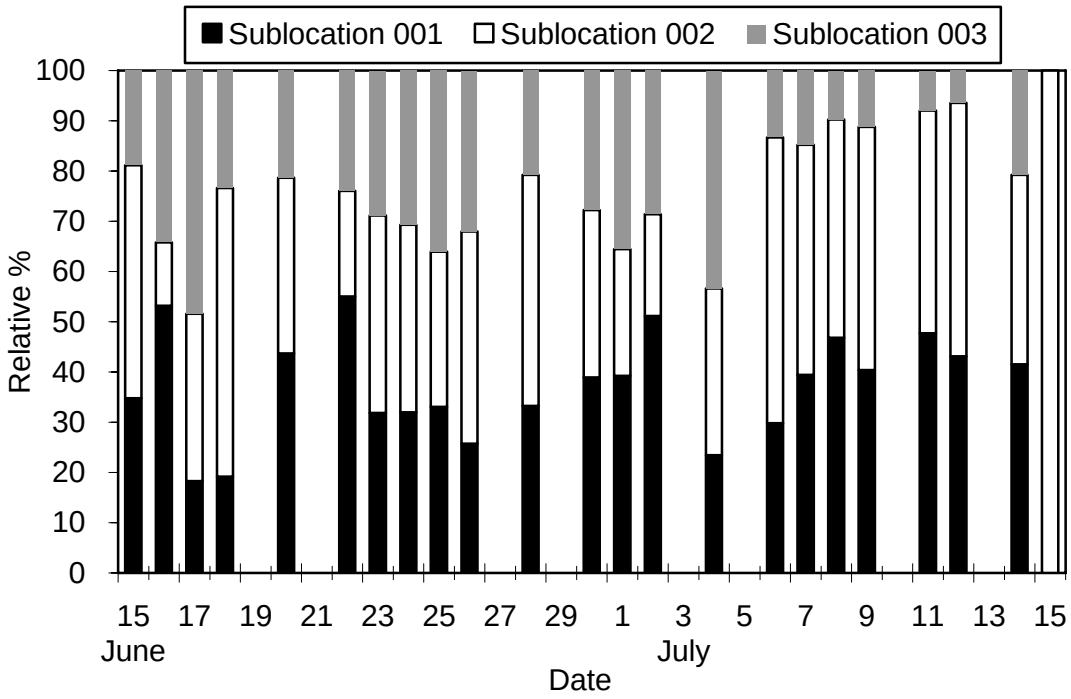

Figure 5.-Relative percent of daily angler counts among sublocations in lower study area, Nushagak River, 2001.

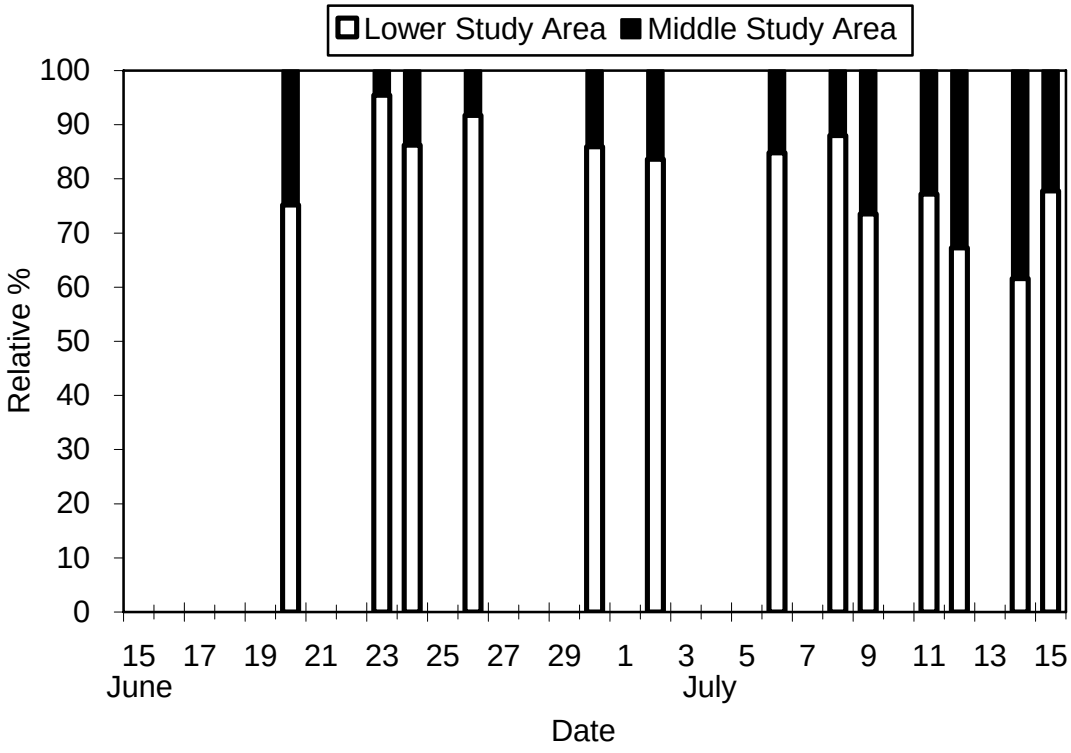

Figure 6.-Relative percent of daily angler counts in lower and middle study areas for days when both areas were counted, Nushagak River, 2001.

Table 2.-Summary of daily angler-group catches of Chinook salmon from Choggiung Ltd. permitted commercial operations, Nushagak River, 2001.

Date	Week	Total Number of Anglers	Percent Guided	Percent Unguided	Percent Using Bait	Total Harvested	Total Released	Total Caught	Total Caught < 508 mm TL	Total Catch per Angler-day	Harvest per Angler-day	Camps Reporting
16-Jun	24	6		100	83	2	6	8		1.3	0.3	1
17-Jun	24	24	17	83	92	5	21	26	5	1.1	0.2	3
18-Jun	25	52	69	31	58	26	73	99	10	1.9	0.5	7
19-Jun	25	72	74	26	49	46	140	186	29	2.6	0.6	9
20-Jun	25	87	94	6	37	61	214	275	28	3.2	0.7	12
21-Jun	25	103	90	10	18	82	215	297	46	2.9	0.8	12
22-Jun	25	118	84	16	9	84	476	560	108	4.7	0.7	12
23-Jun	25	109	72	28	23	57	489	546	117	5.0	0.5	12
24-Jun	25	160	83	18	33	102	855	957	172	6.0	0.6	11
25-Jun	26	135	81	19	44	90	767	857	112	6.3	0.7	9
26-Jun	26	182	79	21	55	100	881	981	223	5.4	0.5	14
27-Jun	26	198	84	16	60	129	1,026	1,155	136	5.8	0.7	14
28-Jun	26	111	91	9	64	57	517	574	71	5.2	0.5	11
29-Jun	26	145	90	10	61	68	589	657	103	4.5	0.5	12
30-Jun	26	230	85	15	64	136	1,014	1,150	144	5.0	0.6	16
1-Jul	26	176	89	11	70	113	740	853	92	4.8	0.6	13
2-Jul	27	157	91	9	65	88	968	1,056	153	6.7	0.6	12
3-Jul	27	179	83	17	71	104	939	1,043	71	5.8	0.6	10
4-Jul	27	126	95	5	77	75	792	867	65	6.9	0.6	8
5-Jul	27	115	90	10	69	70	518	588	51	5.1	0.6	8
6-Jul	27	129	91	9	88	83	555	666	109	5.2	0.6	7
7-Jul	27	66	91	9	91	59	343	402	61	6.1	0.9	4
8-Jul	27	84	93	7	89	68	327	395	89	4.7	0.8	6
9-Jul	28	75	92	8	91	56	367	423	63	5.6	0.7	5
10-Jul	28	66	94	6	82	35	267	302	61	4.6	0.5	4
11-Jul	28	28	100		68	16	186	202	53	7.2	0.6	3
12-Jul	28	22	100		64	8	57	65	22	3.0	0.4	2
Total (Average)		2,955				1,820	13,342	15,190	2,194	(4.7)	(0.6)	237
% (SE)			86	14	59	12	88		14	(0.32)	(0.03)	

Table 3.-Daily number of anglers from Choggiung Ltd. permitted commercial operations and angler interviews from ADF&G relative to number of anglers counted in the lower study area (LSA), Nushagak River, 2001.

Date	LSA Counts	Number of Choggiung Anglers	% of LSA Counts	Number of ADF&G Interviews	% of LSA Counts	Total as % of LSA Counts
15-Jun	69					
16-Jun	79	6	8	[b]		
17-Jun	93	24	26	[b]		
18-Jun	94	52	55	[b]		
19-Jun		72				
20-Jun	103	87	84	1	1	85
21-Jun		103				
22-Jun	209	118	56	19	9	66
23-Jun	336	109	32	14	4	37
24-Jun	313	160	51	18	6	57
25-Jun	272	135	50	7	3	52
26-Jun	365	182	50	19	5	55
27-Jun		198				
28-Jun	352	111	32	14	4	36
29-Jun		145				
30-Jun	342	230	67	[b]		
1-Jul	321	176	55	9	3	58
2-Jul	311	157	50	11	4	54
3-Jul		179				
4-Jul	226	126	56	10	4	60
5-Jul		115				
6-Jul	285	129	45	8	3	48
7-Jul	203	66	33	9	4	37
8-Jul	205	84	41	6	3	44
9-Jul	161	75	47	5	3	50
10-Jul		66				
11-Jul	88	28	32	5	6	38
12-Jul	109	22	20	3	3	23
Total	4,536	2,955	47 [a]	158	4 [a]	

[a] Total percent calculated only for days with counts.

[b] Regularly scheduled interview day, interviews not conducted.

ADF&G staff interviewed 158 anglers from 19 June through 12 July. Interviews did not occur on 6 of the scheduled days: 16–18, 30 June, and 14, 15 July. The number of interviews per day ranged from 1 on 20 June to 19 on 22 and 26 June (Table 3). The number of interviews as a fraction of the daily angler counts in the LSA ranged from 1% to 9%, and the average was 4% (Table 3).

Catch and Harvest Rates

Anglers from commercially permitted operations reported harvesting 1,820 Chinook salmon and releasing 13,342 (Table 2). The number of Chinook salmon caught (kept plus released) that were less than 508 mm TL was estimated at 2,194 or 14% of the total catch. Comments from some camps indicated that catches of salmon less than 508 mm TL were too high to keep accurate count.

CPUE of anglers associated with commercially permitted operations ranged from 1.1 per angler-day on 17 June to 7.2 on 11 July and the average was 4.7 (SE = 0.32, Table 2). Catch rates increased at the beginning of the study period, when sonar estimates indicated the Chinook run was building, but remained steady as sonar estimates diminished (Figure 7). HPUE ranged from 0.2 per angler-day on 17 June to 0.9 on 7 July and the average was 0.6. Harvest rates remained remarkably constant throughout the study period, and appeared independent of run strength (Figure 8).

The 158 anglers interviewed by ADF&G harvested 78 Chinook salmon over and 0 under 508 mm TL (Table 4). These anglers released approximately 27 Chinook salmon over and 66 under 508 mm TL. Recorded interview information was incomplete for 4 Chinook salmon over and 15 under 508 mm TL, and 2 of unknown size, so are not included in this summary. CPUE and HPUE were not assessed for ADF&G-interviewed anglers due to the low number of completed-trip interviews.

Angler Characteristics

Of the anglers from commercially permitted operations 86% were guided and 59% used bait (Table 2). Of the anglers interviewed by ADF&G staff, 91% were males, 94% were adults, 82% were unguided, and 63% were Alaska residents of whom 34% were locals (Table 5). Terminal tackle included bait (52%), lures (46%), and flies (1%). About 90% of interviewed anglers fished from a boat.

BIOLOGICAL DATA

Biological data were collected from 159 Chinook salmon. Data that were not within realistic biological boundaries were removed. Inadvertently, the sample included both harvested fish and an unknown but presumably small number of fish that were released. Sex was not noted for the released fish. Out of 159 scale samples, 33 were unreadable or regenerated (Table 6). Of the 126 fish with readable scales, 9.5% were age 1.5 (SE = 2.6%), 46.8% age 1.4 (SE = 4.5%), 31.0% age 1.3 (SE = 4.1%), 8.7% age 1.2 (SE = 2.5%), and 4.0% age 1.1 (SE = 1.7%). Because of discrepancies in the data, length-at-age comparisons were only available for 44 fish (Table 6).

Average MEFL of the sampled Chinook salmon was 742 mm (SE = 13; n = 155) and ranged from 295 mm to 980 mm (Figure 9). Average weight was 7.3 kg (SE = 0.3; n = 107) and ranged from 0.8 to 20 kg.

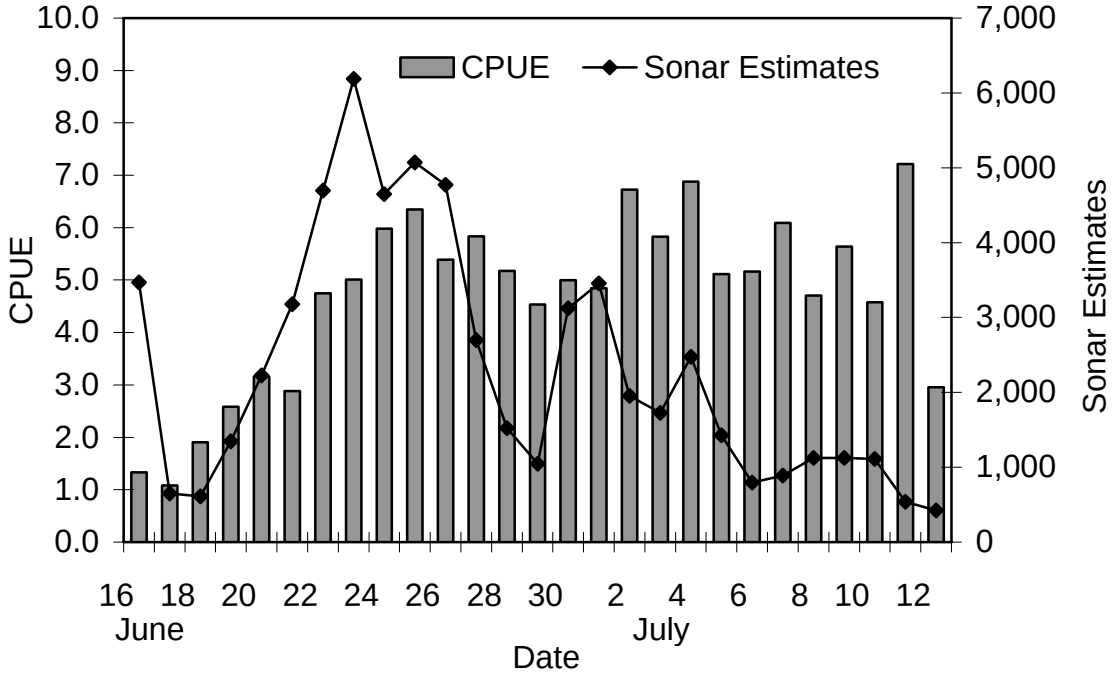

Figure 7.-Daily catch per unit effort (angler-day) of Chinook salmon by anglers associated with Choggiung Ltd. permitted commercial operations, compared to sonar estimates, Nushagak River, 2001.

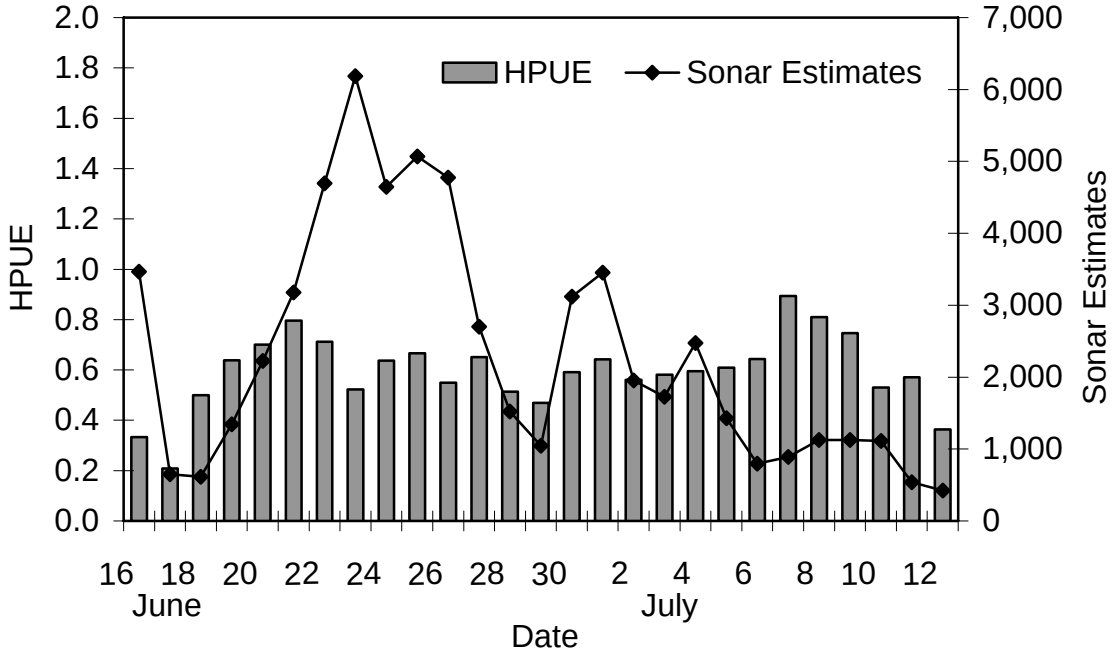

Figure 8.-Daily harvest per unit effort (angler-day) of Chinook salmon by anglers associated with Choggiung Ltd. permitted commercial operations, compared to sonar estimates, Nushagak River, 2001.

Table 4.-Summary of catch and harvest of Chinook salmon by interviewed non-commercially permitted/non-permitted anglers, Nushagak River, 2001.

Date	Number of Interviews	Harvested > 508 mm TL	Released > 508 mm TL	Harvested < 508 mm TL	Released < 508 mm TL	Total Catch
20-Jun	1	1	2	0	0	3
21-Jun						
22-Jun	19	10	5	0	5	20
23-Jun	14	6	9	0	3	18
24-Jun	18	6	0	0	11	17
25-Jun	7	2	1	0	1	4
26-Jun	19	1	0	0	15	16
27-Jun						
28-Jun	14	11	0	0	10	21
29-Jun						
30-Jun						
1-Jul	9	4	1	0	1	6
2-Jul	11	10	4	0	8	22
3-Jul						
4-Jul	10	6	1	0	5	12
5-Jul						
6-Jul	8	5	2	0	2	9
7-Jul	9	6	1	0	1	8
8-Jul	6	2	0	0	1	3
9-Jul	5	1	0	0	2	3
10-Jul						
11-Jul	5	4	0	0	1	5
12-Jul	3	3	1	0	0	4
Total	158	78	27	0	66	171

Note: This summary does not include 4 Chinook salmon over (large) and 15 under (small) 508 mm TL, and 2 of unknown size that did not have complete information.

ADF&G staff measured 55 Chinook salmon for both MEFL (mean = 482 mm) and TL (mean = 550 mm). The estimated regression coefficients were b_0 = 15 and b_1 = 0.85 (Figure 10). At TL = 508 mm, the expected value of MEFL is 447 mm (SE = 3.3; 90% CI = 442–452 mm). Using MEFL = 447 mm as a cutoff, an estimated 8.0% of the Chinook sampled by ADF&G staff were less than 508 mm TL (Figure 9).[1]

[1] During analysis of the original length data it became apparent that there was an improbable number of observations (18) which had zeroes in the tens digit for both MEFL and TL measurements. Given 18 such pairs out of 55 total, the probability of this happening is infinitesimally small (10^{-22}). We concluded that these 18 observations had been misrecorded on the data forms by transposing the last 2 digits. We

Table 5.-Characteristics of interviewed non-commercially permitted/non-permitted anglers, lower Nushagak River, 2001.

Characteristic	Numer of Anglers	Percent
Angler Type		
Guided	28	18
Unguided	126	82
Not Recorded	4	
Alaska Residency		
Resident	99	63
Local	54	34
Non-local	45	66
Non-resident	59	37
Sex		
Male	144	91
Female	14	9
Not Recorded	28	
Youth/Adult		
Youth	9	6
Adult	149	94
Tackle Type		
Bait	82	52
Lure	73	46
Fly	2	1
Not Recorded	1	
Type of Interview		
Complete	8	5
Incomplete	144	95
Not recorded	6	
Total Interviews	158	

HISTORICAL ESCAPEMENT OF SMALL CHINOOK SALMON

From 1991 to 2000 the estimated annual proportion of Chinook salmon less than 508 mm TL in the escapement ranged from 0.9% in 1993 to 3.8% in 2000 (Appendix F1). The average for those years was 1.7%.

subsequently re-transposed the digits and used the corrected data for the results shown above. The original data yielded different regression coefficients ($b_0 = 58$, $b_1 = 0.76$), but almost the same expected MEFL of 445 mm at TL of 508 mm.

Table 6.-Age composition and mean length-at-age of sport caught Chinook salmon from the Nushagak River, 2001.

	Age Group					Total	
	1.1	1.2	1.3	1.4	1.5	Readable	Unreadable
Percent	4.0	8.7	31.0	46.8	9.5	100	21
SE	1.7	2.5	4.1	4.5	2.6		
Sample size	5	11	39	59	12	126	33
Mean Length (mm)	360	463	671	816	851	742	
SE	33	26	46	22	22	13	
Sample size	3	5	11	21	4	44	

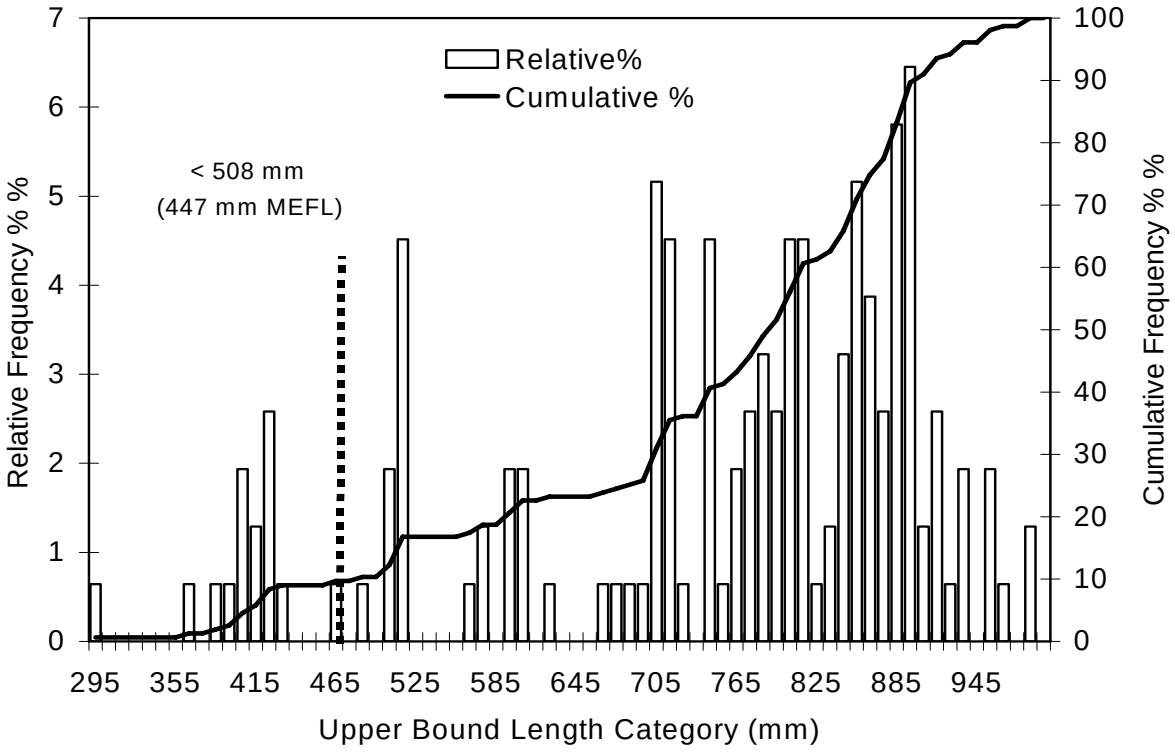

Figure 9.-Length (MEFL) frequency and cumulative length frequency of sport caught Chinook salmon from lower Nushagak River, 2001.

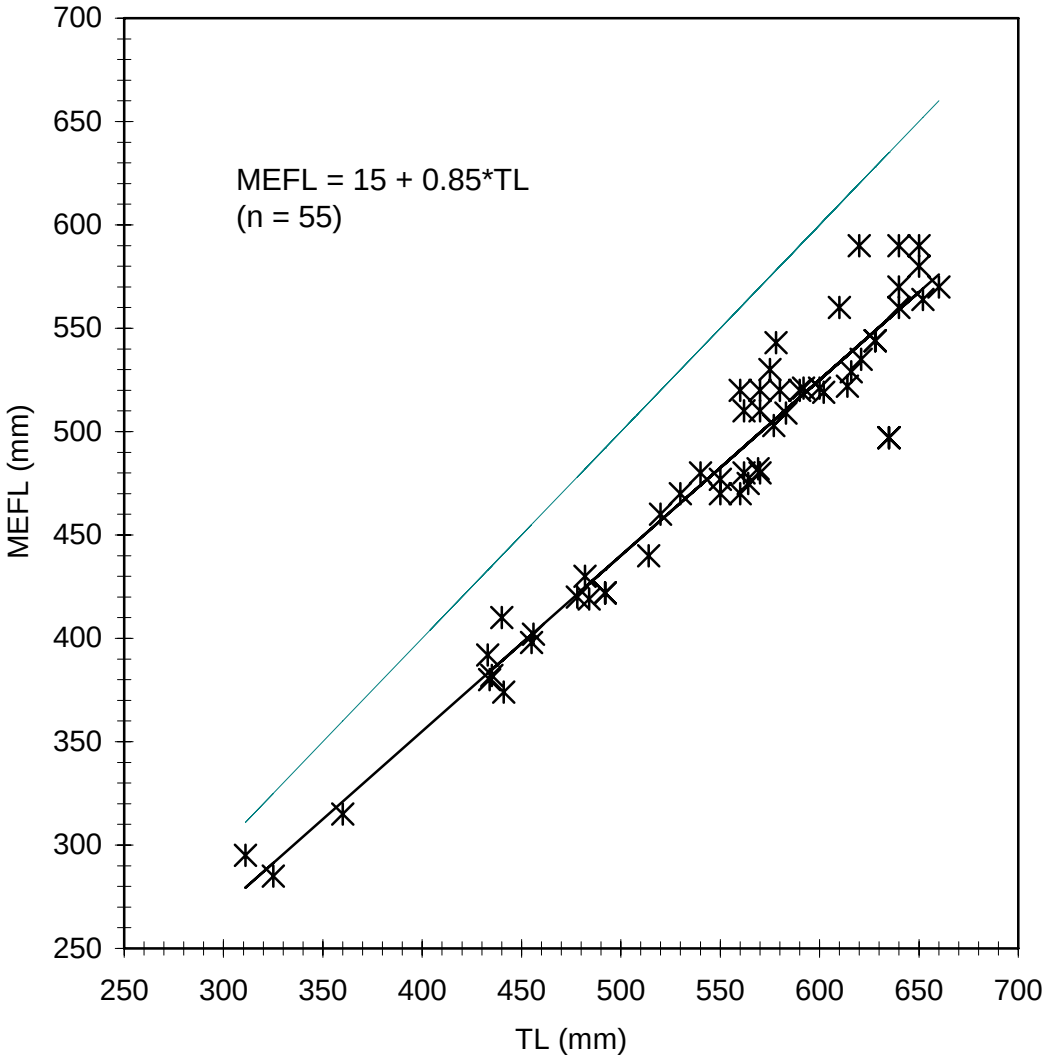

Figure 10.-Relationship between mid eye to tail fork length (MEFL) and total length (TL) of sport caught Chinook salmon, Nushagak River, 2001. The estimated regression line and the 1:1 line (MEFL=TL) are shown.

AERIAL ESCAPEMENT COUNTS

Escapement counts by aerial surveys took place from 10 to 14 August 2001. Survey conditions were deemed good to fair but the surveys took place after peak spawning, thus counts should not be considered as an index. A total of 3,833 live Chinook salmon were counted in the Nushagak River and Mulchatna River drainages (Appendix B). The Koktuli River accounted for 52% of the spawning escapement in the areas surveyed.

DISCUSSION

Past study designs for onsite creel surveys of Nushagak sport fisheries have reflected the primary informational needs of management. A number of differences in the design of this survey preclude comparisons with results from surveys prior to 2000. These differences include changes

in study area boundaries and sampling schedules, division of anglers into 2 groups, reporting of effort in terms of angler-days rather than angler-hours, and the cooperation with Choggiung Ltd. staff to collect data. The main impetus for such changes was to streamline the project by reducing labor costs while collecting timely information useful for management and evaluation of present and proposed regulations. Rather than an expansion design to estimate elements of the whole fishery, it was an index-focused design to monitor harvest and catch rates, effort distribution and trends, and angler characteristics.

Angler counts in the LSA during this study were similar in trend and cumulative magnitude when compared to the same period in 2000. Although boundary and count-schedule differences complicate comparisons for the MSA, trends and magnitude of effort in this area in 2001 also appear similar to 2000. However, the number of angler-trips in the Choggiung Ltd. permitted commercial operations was down approximately 29% from last year with 2,995 reported angler-trips in 2001 compared with 4,208 in 2000. Reasons for this decline are unknown, but a number of lodges mentioned their bookings were down, and Choggiung Ltd. indicated use was less in 2001. The reduction possibly reflects the downturn in national and global economies.

Commercially permitted anglers harvested 26% fewer Chinook in 2001 than in 2000, but released 24% more. The increase in catches with a decrease in effort was probably due to a stronger run. The sonar estimate of Chinook salmon for 2001 indicated that the escapement was about 84% higher than in 2000 (Weiland et al. 2002). Unlike catch rates, harvest rates are mostly controlled by certain logistical and regulatory constraints, which may also explain the uniformity of harvest rate during the study period. Anglers are predisposed to harvest a certain number with a regulatory seasonal limit of 4, and some anglers merely catch-and-release despite bag limits. Most of the information (95%) was from incomplete-trip interviews and does not necessarily reflect the success of this angler group.

This study was not designed to combine information from the different angling groups to make inferences for all anglers. Because ADF&G staff typically interviewed unguided anglers rather than all anglers, the characteristics resulting from those interviews are not directly comparable with years prior to 2000. Most of the characteristics of non-commercially permitted/non-permitted anglers were similar to those in 2000. The biggest differences were in percents of Alaska residents (63% in 2001; 49% in 2000), locals (34% in 2001; 25% in 2000) and unguided (82% in 2001, 100% in 2000).

Age-1.3 and -1.4 Chinook salmon usually predominate the sport harvest in the lower Nushagak River. The age composition of sport-caught Chinook salmon in 2001 was within the range of historical age compositions with the exception of age 1.1. Age-1.1 fish were either absent or rare in previous years. The percent of this age group (4%) in this study was the highest recorded and was probably due to sampling bias, rather than scale misinterpretation. As a major objective of this study, assessing the sport-caught component less than 508 mm TL may have led to smaller fish being noticed more often and sampled more often by ADF&G staff. As mentioned previously, a few released fish were sampled and these were more likely to be small. Overall mean length and weight in 2001 were on the low end of historical ranges.

The point estimate of MEFL (447 mm) when TL = 508 mm was within the range of what Pahlke (1989) found from length comparisons of Chinook salmon in Southeast Alaska. At TL = 508, MEFL = 451 mm using Pahlke's regression coefficients from spawning Chinook salmon and MEFL = 441 mm using parameters from ocean-caught fish.

The reported catch of Chinook salmon less than 508 mm TL by commercially permitted anglers is approximate. Anglers or their guides did not measure each fish and often commented they could not keep accurate count, particularly when catch rates were high. How many of these fish were harvested remains unknown, but it was probably very few. We believe anglers are more inclined to keep large fish when there is a seasonal limit. Again, sampling bias may have inflated the percent less than 508 mm TL (9%) of fish sampled by ADF&G staff in this study; only 0.8% of the sport-harvested Chinook salmon sampled in 2000 were less than 447 mm MEFL.

Compositions of Chinook salmon less than 508 mm TL in the historical escapements should be viewed as minimums because they primarily derive from samples collected by variable-mesh gillnet with minimum mesh size of 13 cm. Small fish may be underrepresented in this gear type. Very few samples collected by beach seine, which tends to catch smaller fish, are included in the analysis. As indicated by angler harvest, reported catches, and biological samples, the proportion of Chinook salmon less than 508 mm TL in the run was low in 2001, and variable but also presumably low from year to year. This indicates that since sonar has been used, the total annual estimates of Nushagak Chinook salmon escapements and all related spawner-recruit analyses have not been substantially influenced by the small fish component of the run.

RECOMMENDATIONS

Water and weather conditions and anecdotal information pertaining to fishing conditions and angler sentiments should be recorded. Weather conditions could affect the presence of fly-in guided anglers which in turn could affect the catch/harvest rates of non-commercially permitted/non-permitted anglers. Water and weather conditions will also affect catchability of salmon.

By using similar methods in the future, information will be more comparable and thus more useful for monitoring changes in the fishery. Periodic surveys of the Nushagak River Chinook salmon fishery should continue to ensure effective management of this important sport fishery.

ACKNOWLEDGMENTS

This project would not have been possible without the hard work of ADF&G field technician Larry Boyer and Choggiung Ltd. staff Russell Nelson, Don LeClair, Bill Wiley and Gabe Andrews. Steve Fleischman assisted with the data analysis and Margie Nussbaum processed and archived the raw data. We thank the angling public, guides, and lodge operators for their patience and support during this survey.

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APPENDIX A. CHINOOK SALMON COMMERCIAL, SUBSISTENCE, AND SPORT HARVEST, PLUS ESCAPEMENT AND TOTAL RUN FOR THE NUSHAGAK DRAINAGE, 1966-2001

Appendix A1.-Chinook salmon commercial, subsistence, and sport harvest, escapement and total run for the Nushagak drainage, 1986-2000.

		Harvests Below Sonar					Harvests Above Sonar		Spawning Escapement	
Year	Total Run	Commercial Harvest[a]	Commercial Subsistence Removals[b]	Subsistence Harvest[c]	Sport Harvest[d]	Inriver Sonar estimate	Subsistence Harvest[e]	Sport Harvest[f]	Sonar Estimate[g]	Aerial Survey Estimate[h]
1986	117,478	65,783	798	6,834	628	43,434	4,725	4,162	34,547	
1987	139,814	45,983	318	7,919	1,286	84,309	3,139	3,173	77,997	
1988	80,184	16,648	528	4,911	1,192	56,905	4,037	1,626	51,242	
1989	102,872	17,637	632	4,898	1,404	78,302	2,217	2,210	73,875	
1990	86,990	14,812	1,197	6,228	797	63,955	3,325	2,689	57,941	
1991	134,740	19,718	1,971	6,907	1,793	104,351	3,127	3,758	97,466	
1992	140,850	47,563	907	7,688	1,844	82,848	2,499	2,911	77,438	
1993	175,614	62,976	1,867	10,552	2,408	97,812	2,919	3,492	91,401	
1994	229,583	119,480	1,126	8,587	4,436	95,954	3,775	6,191	85,989	
1995	177,801	79,942	1,327	8,672	2,238	85,622	2,420	2,713	80,489	
1996	136,812	72,011	730	9,598	2,346	52,127	3,055	3,045	46,027	
1997	156,096	64,294	544	8,328	931	40,705	3,192	2,567		82,000
1998	234,107	108,486	805	5,682	1,640	117,495	4,440	4,188	108,868	
1999	79,973	10,893	927	4,888	934	62,331	2,477	3,304	56,551	
1986-1999 Average	142,351	53,302	977	7,264	1,705	76,154	3,239	3,287	72,295	
1995-1999 Average	156,958	67,125	866	7,434	1,617	71,656	3,117	3,163	72,984	
2000	75,172	12,055	1,052	4,302	1,389	56,374	2,132	4,628	49,615	

[a] Total Nushagak District commercial harvest. Source: Weiland et al. 2001, Appendix Table 6.

[b] Nushagak Bay Commercial Harvest from Subsistence Division Subsistence Database. Source: ADF&G Subsistence Division, Subsistence Database from Charles Utermohle, Program Coordinator, Subsistence Division, Region II, Anchorage, November 20, 2000.

[c] Includes Nushagak Bay and Igushik. Source: ADF&G Subsistence Division, Subsistence Database from Charles Utermohle, Program Coordinator, Subsistence Division, Region II, Anchorage, November 20, 2000. Data for 2000 provided by James Fall, Subsistence Division, Region II, Anchorage.

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[d] 1986-1996 is 50% of Nushagak River System sport harvest. 1997-1999 is 50% of Nushagak River Black Point to Iowithla. Source: Howe et al. 1995-1996, 2001 a-d; Mills 1987-1994; and Walker et al. 2003.

[e] Includes Ekwok area, Iowithla River, Klutuk River, Koliganek area, New Stuyahok area, Portage Creek area, Kokwok area, Mulchatna River, and Nushagak watershed site unknown. Source: ADF&G Subsistence Division, Subsistence Database from Charles Utermohle, Program Coordinator, Subsistence Division, Region II, Anchorage, 2000. Data for 2000 provided by James Fall, Subsistence Division, Region II, Anchorage.

[f] 1977-1996 is 50% of Nushagak River System Sport Harvest, plus Mulchatna River System, Tikchik/Nuyakuk, and Koktuli River harvest reported in Howe et al. 1995 and 1996 and Mills 1979-1980, 1981a-b, 1982-1994. 1997-2000 is 50% of Nushagak River Black Point to Iowithla, Nushagak upstream of Iowithla, Mulchatna River System, Tikchik/Nuyakuk and Koktuli River from Howe et al. 1995-1996, 2001 a-d, and Walker et al. 2003

[g] 1986-1996, and 1998-99 estimates are sonar estimates minus subsistence and sport harvest above sonar.

[h] Source: Weiland et al. 2001.

APPENDIX B. HISTORICAL AERIAL SURVEY COUNTS OF CHINOOK SALMON IN THE NUSHAGAK RIVER DRAINAGE

Appendix B1.-Historical aerial escapement counts of Chinook salmon in selected streams in the Wood, Nushagak and Mulchatna rivers drainages, 1967 to 2001.

	Wood R.	Nushakgak and Mulchatna drainages								
Year	Muklung River	Iowithla River	Kokwok River	Klutispak River	King Salmon River	Stuyahok River	Koktuli River	Nushagak River[a]	Mulchatna River[b]	Total
1967	350	200				2,500	3,300			6,000
1968	750[c]	850		310	1,000	2,470	4,220	970	510	10,330
1969	520	580	90[c]	90	670	1,220	1,600	910[c]	680[d]	5,840
1970	590	700	110[c]	320	1,060	1,900	1,500	1,180[c]	880[d]	7,650
1971	280	390	80[c]							470
1972	150	170		280	900	610	1,450	690[c]	510[d]	4,610
1973				380	1,470	1,220	950			4,020
1974	1,010[c]	860	60[c]	440	2,000	2,300	3,920	2,340	2,160	14,080
1975	660	1,040	270	670	2,900	2,530	4,080	2,320[c]	1,710[d]	15,520
1976	840[c]	1,110	560	1,180	3,510	3,750	6,710	1,760	2,580	21,160
1977	940[c]	840	310	650	1,420	2,700	4,630	820	1,980	13,350
1978	1,170[c]	1,700	520	1,940	4,450	4,400	6,730	5,850	2,280	27,870
1979	950[c]	1,350	170	1,040	2,150	3,570	6,260	2,880	1,730	19,150
1980	1,600	2,310[d]	70	970	4,500	7,200	10,620	5,300[c]	3,920[d]	34,890
1981	2,260	2,630	70	1,650	2,950	5,980	9,960	4,960[c]	3,670[d]	31,870
1982	790	2,520	90	350	8,390	3,640	6,780	4,380[c]	3,240[d]	29,390
1983	1,830[c]	2,430	350	2,090	5,990	2,910	8,060	6,330	4,260	32,420
1984	1,300[c]	1,080	110	770	1,780	2,010	2,860	2,800	1,060	12,470
1985	1,250	1,610	60	1,950	4,460	2,690	4,940	3,420[c]	2,390[d]	21,520
1986	230	270		170	380	520	290	380[c]	260[d]	2,270
1987	160	140		340	570	280	440	390[c]	270[d]	2,430
1988	430	550		780	1,380	2,040	2,580	1,800	710	9,840
1989						190[c]	240[c]			430
1990	60	120		340	900	830	3,390	630	800	7,010
1995[e]	210	170	75	630	3,150	660	2,230			6,915
1997[f]	1,240	640		1,190	8,900	1,460	6,220	21,818	1,496	41,724
1998	150[g]	[g]	150[g]	2,620	5,510	550[g]	720	8,390	180[g]	18,120
1999	95	450	145	1,545	6,825	645	2,075	6,467		18,152
2000[h]										
2001[i]	265	138	93	60	387	430	1,985	580	160	3,833
Average	744	956	178	875	2,985	2,186	3,884	3,640	1,628	16,331

[a] Nushagak River from the outlet of the Nuyakuk River to outlet of King Salmon River (to Big Bend in 1997).

[b] Mulchatna River from outlet of Mosquito Creek to outlet of Koktuli River (to outlet of Stuyahok River in 1997)

[c] Minimal estimate - very poor survey conditions.

[d] These numbers are proportional estimates rather than aerial live counts; estimates are based on the mean proportion of fish counted in these areas during year in which aerial coverage was complete.

[e] No surveys were conducted from 1991 through 1994, or in 1996.

[f] Survey conditions in 1997 excellent, water very clear and very low.

[g] Surveys conducted 8/11/98, well past peak of spawning; Iowithla River not surveyed. Remaining surveys conducted 7/29/98, before peak of spawning.

[h] No surveys were conducted.

[i] Surveys conducted 8/10 through 8/14/2001, far past peak of spawning and are a poor indication of abundance. Mulchatna River count includes Mosquito Creek counts for 2001.

APPENDIX C. NUSHAGAK-MULCHATNA CHINOOK SALMON MANAGEMENT PLAN

Appendix C1.-Nushagak-Mulchatna Chinook salmon management plan.

5 AAC 06.361. NUSHAGAK-MULCHATNA CHINOOK SALMON MANAGEMENT PLAN.

(a) The purpose of this management plan is to ensure biological spawning escapement requirements of chinook salmon into the Nushagak-Mulchatna river systems. It is the intent of the Alaska Board of Fisheries (board) that Nushagak-Mulchatna chinook salmon be harvested in the fisheries that have historically harvested them. This management plan provides guidelines to the department in an effort to preclude allocation conflicts between the various users of this resource. The department shall manage Nushagak-Mulchatna chinook salmon stocks in a conservative manner consistent with sustained yield principles and the subsistence priority.

(b) The department shall manage the commercial fishery in the Nushagak District as follows:

(1) to achieve an inriver goal of 75,000 chinook salmon present in the Nushagak River upstream from the department sonar counter; the inriver goal provides for

(A) a biological escapement requirement of 65,000 fish;

(B) reasonable opportunity for subsistence harvest of chinook salmon; and

(C) a chinook salmon sport fishery guideline harvest level of 5,000 fish;

(2) in order to maintain a natural representation of age classes in the escapement, the department shall attempt to schedule commercial openings to provide pulses of fish into the river that have not been subject to harvest by commercial gear.

(c) If the total inriver chinook salmon return in the Nushagak River is projected to exceed 75,000 fish, the guideline harvest level described in (b)(1)(C) of this section does not apply.

(d) If the spawning escapement of chinook salmon in the Nushagak River is projected to be more than 40,000 and the projected inriver return is less than 75,000 fish, the commissioner

(1) shall close, by emergency order, the directed chinook salmon commercial fishery in the Nushagak District; during a closure under this paragraph, the use of a commercial gillnet with webbing larger than five and one-half inches in another commercial salmon fishery is prohibited; and

(2) if the projected inriver return of chinook salmon in the Nushagak River is less than 55,000 fish, and to ensure that projected spawning escapement does not fall below 40,000 fish, shall establish, by emergency order, fishing periods to restrict the chinook salmon sport fishery in the Nushagak River during which any, or a combination, of the following restrictions may be applied:

(A) reduction of bag and possession limits;

(i) from two to one fish; and

(ii) if necessary, from one fish to non-retention of chinook salmon; if a non-retention fishery for chinook salmon is established under this paragraph, the use of bait will be prohibited [for all species of fish] until the end of the chinook salmon season;

(B) a seasonal limit of up to four fish;

(C) prohibition of the use of bait;

(D) reductions in the time or area for fishing;

(E) a closure of the chinook salmon sport fishery.

(e) If the spawning escapement of chinook salmon in the Nushagak River is projected to be less than 40,000 fish, the commissioner

(1) shall close, by emergency order, the sockeye salmon commercial fishery in the Nushagak District until the projected sockeye salmon escapement into the Wood River exceeds 100,000 fish;

(2) shall close, by emergency order, the sport fishery in the Nushagak River to the taking of chinook salmon; and

(3) shall establish, by emergency order, fishing periods during which the time or area is reduced for the inriver chinook salmon subsistence fishery in the Nushagak River.

APPENDIX D. NUSHAGAK RIVER CREEL SURVEY SAMPLING SCHEDULE

Appendix D1.-Preseason Nushagak River creel survey sampling schedule, 2001.

Date	Sampled
16-Jun	X
17-Jun	X
18-Jun	X
19-Jun	
20-Jun	X
21-Jun	
22-Jun	X
23-Jun	X
24-Jun	X
25-Jun	X
26-Jun	X
27-Jun	
28-Jun	X
29-Jun	
30-Jun	X
1-Jul	X
2-Jul	X
3-Jul	
4-Jul	X
5-Jul	
6-Jul	X
7-Jul	X
8-Jul	X
9-Jul	X
10-Jul	
11-Jul	X
12-Jul	X
13-Jul	
14-Jul	X
15-Jul	X

APPENDIX E. INTERVIEW CARDS PROVIDED TO CHOGGIUNG LTD. PERMITTED COMMERCIAL OPERATIONS FOR SUMMARIZING DAILY ANGLER-TRIP INFORMATION

Appendix E1.-Interview cards provided to Choggiung Ltd. permitted commercial operations for summarizing daily angler-trip information.

Lower Area Camp Daily Tally

Camp:_____ Date:_____

Number Guided Anglers[1]	Unguided Anglers	Number who used bait	Kings Kept	Kings Released	Total Kings Caught	Kings Caught <20"[2]	Notes
totals below							

[1] Guided anglers include all camp employees and guides who fished for any time during a day.

[2] Total number of king salmon caught that are less than 20 inches in length.

REMEMBER, KING SALMON TO BE RELEASE MAY NOT BE REMOVED FROM THE WATER

APPENDIX F. WEEKLY SONAR ESTIMATES AND BIOLOGICAL SAMPLES, 1991 TO 2001

Appendix F1.-Weekly sonar estimates and number of Chinook salmon less than 508 mm TL in samples collected at the Nushagak River sonar project from 1991 to 2001.

Year	Week	Number < 508 mm TL in Samples	Total Number Sampled	% in Samples	Sonar Count	Estimated Number < 508 mm TL
1991	23	0	19	0.0	628	0
	24	0	80	0.0	6,685	0
	25	6	282	2.1	13,717	292
	26	14	495	2.8	60,756	1,718
	27	11	377	2.9	10,219	298
	28	9	475	1.9	4,341	82
	29	1	30	3.3	5,005	167
	30	0	12	0.0	2,121	0
	31	0	5	0.0	650	0
	32	0	1	0.0	132	0
	33	0	0	0.0	89	0
1991 Total		41	1,776	2.5	104,351	2,557
1992	23	0	0	0.0	124	0
	24	2	1,316	0.2	4,952	8
	25	8	1,352	0.6	12,315	73
	26	11	1,019	1.1	31,593	341
	27	40	1,210	3.3	18,245	603
	28	18	183	9.8	12,502	1,230
	29	0	114	0.0	3,071	0
	30	0	0	0.0	46	0
1992 Total		79	5,194	2.7	82,848	2,254
1993	23	0	0	0.0	8,476	0
	24	1	561	0.2	6,952	12
	25	1	605	0.2	21,104	35
	26	6	682	0.9	33,744	297
	27	8	461	1.7	18,185	316
	28	15	504	3.0	6,225	185
	29	2	190	1.1	2,361	25
	30	0	12	0.0	439	0
	31	0	3	0.0	114	0
	32	0	2	0.0	212	0
1993 Total		33	3,020	0.9	97,812	870
1994	23	0	0	0.0	374	0
	24	0	260	0.0	8,196	0
	25	1	411	0.2	38,480	94
	26	4	846	0.5	15,870	75
	27	6	181	3.3	16,917	561
	28	5	269	1.9	10,261	191
	29	2	104	1.9	3,544	68
	30	0	28	0.0	2,158	0
	31	0	18	0.0	154	0
1994 Total		18	2,117	1.0	95,954	988

-continued-

Appendix F1.-Page 2 of 3.

Year	Week	Number < 508 mm TL in Samples	Total Number Sampled	% in Samples	Sonar Count	Estimated Number < 508 mm TL
1995	23	0	0	0.0	212	0
	24	0	138	0.0	6,938	0
	25	1	725	0.1	8,009	11
	26	1	412	0.2	46,194	112
	27	11	806	1.4	11,842	162
	28	10	154	6.5	9,485	616
	29	0	21	0.0	1,383	0
	30	0	6	0.0	985	0
	31	0	7	0.0	173	0
	32	0	2	0.0	310	0
	33	0	0	0.0	84	0
	34	0	0	0.0	7	0
1995 Total		23	2,271	1.1	85,622	901
1996	23	0	193	0.0	962	0
	24	0	229	0.0	5,987	0
	25	11	440	2.5	25,417	635
	26	11	334	3.3	9,400	310
	27	2	179	1.1	3,424	38
	28	1	35	2.9	3,583	102
	29	0	24	0.0	2,221	0
	30	0	1	0.0	513	0
	31	0	4	0.0	501	0
	32	0	1	0.0	115	0
	33	0	0	0.0	4	0
1996 Total		25	1,440	2.1	52,127	1,086
1997	23	0	0	0.0	111	0
	24	1	287	0.3	7,547	26
	25	1	202	0.5	9,929	49
	26	0	17	0.0	9,748	0
	27	0	0	0.0	6,243	0
	28	0	0	0.0	4,149	0
	29	0	0	0.0	2,355	0
	30	0	0	0.0	581	0
	31	0	0	0.0	42	0
	32	0	0	0.0		0
1997 Total		2	506	0.2	40,705	75
1998	23	0	0	0.0	368	0
	24	0	27	0.0	2,980	0
	25	1	142	0.7	32,668	230
	26	2	536	0.4	24,239	90
	27	2	367	0.5	22,453	122
	28	4	242	1.7	23,092	382
	29	2	149	1.3	3,517	47
	30	0	21	0.0	2,713	0
	31	1	7	14.3	4,325	618
	32	0	2	0.0	1,101	0
	33	0	2	0.0	35	0
	34		0	0.0	4	0
1998 Total		12	1,495	1.3	117,495	1,490

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Year	Week	Number < 508 mm TL in Samples	Total Number Sampled	% in Samples	Sonar Count	Estimated Number < 508 mm TL
1999	23	0	0	0.0	8	0
	24	0	1	0.0	960	0
	25	0	41	0.0	1,320	0
	26	0	183	0.0	15,723	0
	27	13	654	2.0	27,448	546
	28	3	568	0.5	6,702	35
	29	3	238	1.3	6,067	76
	30	0	23	0.0	3,449	0
	31	0	10	0.0	443	0
	32	0	0	0.0	146	0
	33	0	0	0.0	39	0
	34	0	0	0.0	26	0
1999 Total		19	1,718	1.1	62,331	657
2000	23	0	0	0.0		0
	24	1	3	33.3	3,221	1,074
	25	1	46	2.2	11,372	247
	26	2	152	1.3	21,820	287
	27	1	183	0.5	11,147	61
	28	0	145	0.0	4,138	0
	29	0	46	0.0	2,079	0
	30	0	25	0.0	733	0
	31	1	4	25.0	1,862	466
	34	0	0	0.0		0
2000 Total		6	604	3.8	56,372	2,134
2001	24	0	125	0.0	24,629	0
	25	0	142	0.0	18,896	0
	26	2	143	1.4	22,880	320
	27	3	135	2.2	12,722	283
	28	3	71	4.2	5,093	215
	29	2	43	4.7	8,999	419
	30	0	17	0.0	2,681	0
	31	0	1	0.0	1,447	0
	32	0	0		1,019	0
	33	0	0		465	0
2001 Total		10	677	1.3	98,831	1,236

Source: Sonar estimates and biological data provided by, Lowell Fair and Fred West, ADF&G Commercial Fisheries Division.

APPENDIX G. DATA FILES AND COMPUTER PROGRAMS USED TO PRODUCE THIS REPORT

Appendix G1.-Data files and computer programs used to produce this report.

t-000300b012001.dta	Nushagak River Chinook salmon biological data.
t-000300b022001.dta	Nushagak River Chinook salmon total and mid eye to tail fork lengths.
t-000300i012001.dta	ADF&G angler interviews from 20 to 28 June.
t-000300i022001.dta	ADF&G angler interviews from 28 June to 12 July.
t-000301c012001.dta	Nushagak River angler counts, sublocation 001.
t-000302c022001.dta	Nushagak River angler counts, sublocation 002.
t-000303c032001.dta	Nushagak River angler counts, sublocation 003.
anglerinterviews.xls	Excel file with angler interview data and analysis.
anglercounts.xls	Excel file with angler counts data and analysis.
NushAWL01.xls	Biological data analysis and summary.
NushChinMEFvsTL01.xls	Excel file with regression analysis of MEF and TL
NushKingLeng91-00.xls	Historical biological data from Chinook salmon
NushKingLeng-01.xls	sampled at Nushagak River sonar site and analysis (Commercial Fisheries Division data).
NushChinookEsc.xls	Excel file of historical Nushagak River sonar counts (Commercial Fisheries Division data).