Fishery Data Series No. 91-56

Creel Surveys Conducted in Interior Alaska During 1990

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and
Allen E. Bingham

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ABSTRACT

Creel surveys were conducted on six of the major fisheries within the Tanana River drainage, Alaska, during 1990. These fisheries included (1) Piledriver Slough rainbow trout *Oncorhynchus mykiss* and Arctic grayling *Thymallus arcticus* fishery, (2) Harding Lake northern pike *Esox lucius* fishery, (4) Delta Clearwater River Arctic grayling fishery, (4) lower Chena River chinook salmon *Oncorhynchus tshawytscha* fishery, (5) Salcha River chinook salmon fishery, and (6) Chatanika River whitefish *Coregonus pidschian*, *Coregonus sardinella*, *Prosopium cylindraceum* spear fishery. Angler effort, catch-per-unit-effort, harvest-per-unit-effort, catch, and harvest were estimated for the lower Chena River and Salcha River chinook salmon fisheries. The distribution of catches and harvests among anglers along with estimates of angler-effort, catch and harvest were obtained from the remaining four fisheries. Age and length composition of fish harvested, and the proportions of marked fish in the harvest for specific fisheries are reported. Angler demographics and angler opinions concerning the fisheries and their management were recorded for all fisheries.

At the lower Chena River and Salcha River fisheries, the estimated harvest of chinook salmon was 24 (standard error = 8) and 200 (standard error = 40), respectively; harvest-per-unit-effort was 0.015 (standard error = 0.004) and 0.098 fish per angler-hour (standard error = 0.017), respectively.

At the Piledriver Slough Arctic grayling and rainbow trout fishery, 38 percent (standard error = 8) of the anglers caught one or more Arctic grayling and 6 percent (standard error = 2), harvested one or more. The catch and harvest of Arctic grayling was estimated at 10,429 (standard error = 3,735) and 317 (standard error = 91), respectively. The catch and harvest of rainbow trout was estimated to be 7,865 (standard error = 1,988) and 2,366 (standard error = 462), respectively.

At the Harding Lake northern pike fishery, 24 percent (standard error = 16) of the anglers caught one or more northern pike and 3 percent (standard error < 1), harvested one or more. The estimated catch and harvest of northern pike for the period surveyed was 214 (standard error = 147) and 15 (standard error = 0), respectively.

At the Delta Clearwater River Arctic grayling fishery, 57 percent (standard error = 5) of the anglers caught one or more Arctic grayling and 39 percent (standard error = 4), harvested one or more. The estimated catch and harvest of Arctic grayling was 2,861 (standard error = 388) and 1,096 (standard error = 154), respectively.

At the Chatanika River fishery, estimated harvest of all whitefish was 6,501 (standard error = 186). Sixty-three percent (standard error = 2) of the anglers harvested at least one whitefish.

KEY WORDS: creel survey, catch, harvest, catch-per-unit-effort, harvest-per-unit-effort, angler effort, angler demographics, angler questionnaires, angler surveys, age composition, length composition, interior Alaska, Tanana River drainage.

INTRODUCTION

The Arctic-Yukon-Kuskokwim (AYK) Region encompasses an area that covers almost two-thirds of the State of Alaska and includes all of Alaska north of Bristol Bay and the Alaska Range (Figure 1). Within this area, the state's largest river systems (Yukon, Kuskokwim, Colville, and Noatak) are found, along with thousands of lakes, and thousands of miles of streams. These waters support a large number of recreational fisheries for both freshwater and anadromous fish species that include Arctic cisco *Coregonus autumnalis*, Arctic char *Salvelinus alpinus*, Arctic grayling *Thymallus arcticus*, anadromous chinook salmon *Oncorhynchus tshawytscha*, anadromous and land-locked coho salmon *O. kisutch*, anadromous chum salmon *O. keta*, burbot *Lota lota*, Dolly Varden *S. malma*, humpback whitefish *C. pidschian*, lake trout *S. namaycush*, least cisco *C. sardinella*, northern pike *Esox lucius*, rainbow trout *O. mykiss*, round whitefish *Prosopium cylindraceum*, and sheefish *Stenodus leucichthys*.

For sport fishery management purposes, the AYK Region was divided into two areas, the Tanana River drainage (includes all waters within the Tanana River drainage), and the AYK area (includes all waters outside the Tanana River drainage; Figure 1). Even though the AYK Region encompasses a very large area, the majority (approximately 75%) of the recreational angler-effort and harvest occurs near the major population centers (Fairbanks, Delta Junction, and Tok) within the Tanana River drainage (Mills 1979-1990; and see Figure 2).

From 1977 through 1982, harvest of all fish species increased about 19% annually to a peak of about 179,000 in the Tanana River drainage and approximately 275,000 in the AYK Region (Figure 2). From 1983 to 1987, harvest decreased in both the Tanana River drainage and AYK Region. The decrease in harvest that occurred in 1983 was probably the result of the over harvest of the major species in the Tanana River drainage in prior years. Because of this decline, restrictive management regulations were instituted for the major fisheries in the Tanana River drainage in 1987 and 1988. In spite of restrictive regulations, harvest and angler effort increased in 1988. The stocking program in interior Alaska contributed significantly to the sport fishery in 1988. More than 50% of the fish harvested in the interior in 1988 had been stocked (ADFG 1990).

Monitoring of the Tanana River drainage recreational fisheries is important to evaluate the effectiveness of the stocking program, and to assess the consequences of newly-imposed restrictive regulations on indigenous stocks. Conservation of indigenous stocks is desired in interior Alaska, through use of restrictive regulations and by diverting fishing pressure to stocked species. One method of assessing the success of conservation efforts is through the use of creel surveys.

A comprehensive analysis of the creel surveys that were conducted by the Alaska Department of Fish and Game (ADFG) in the AYK Region during 1990 is presented in this report. Many of the same sampling techniques and estimation procedures have been utilized for all the creel surveys. However, there were also many techniques and procedures that were specific to each creel survey. For this reason, a general methods section is first presented that describes the type of creel survey being used, the general sampling techniques and estimation procedures utilized during the creel survey. A separate chapter is then presented for each creel survey. Each chapter contains an introduction,

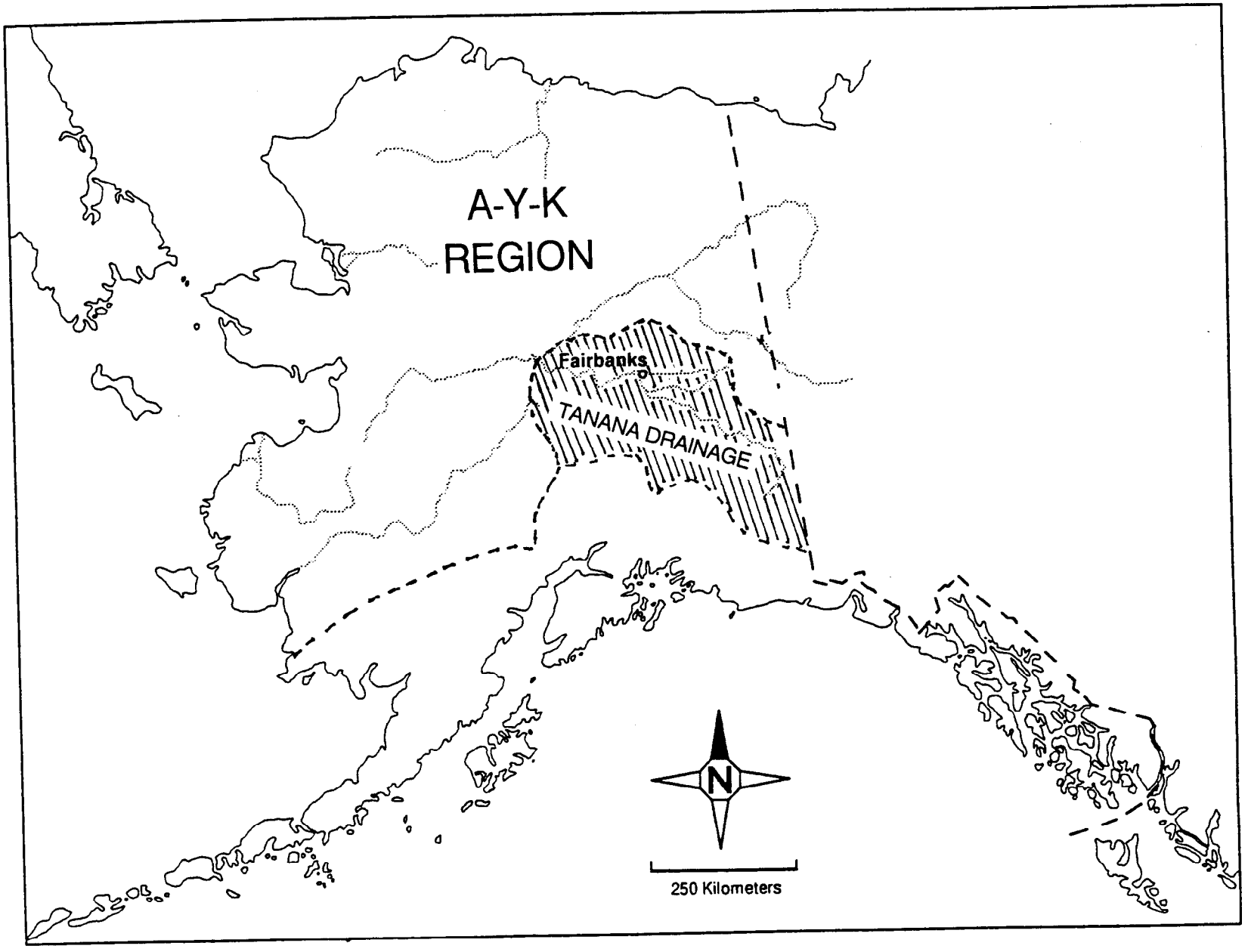

Figure 1. Map of Arctic-Yukon-Kuskokwim (AYK) Region and Tanana River drainage, Alaska.

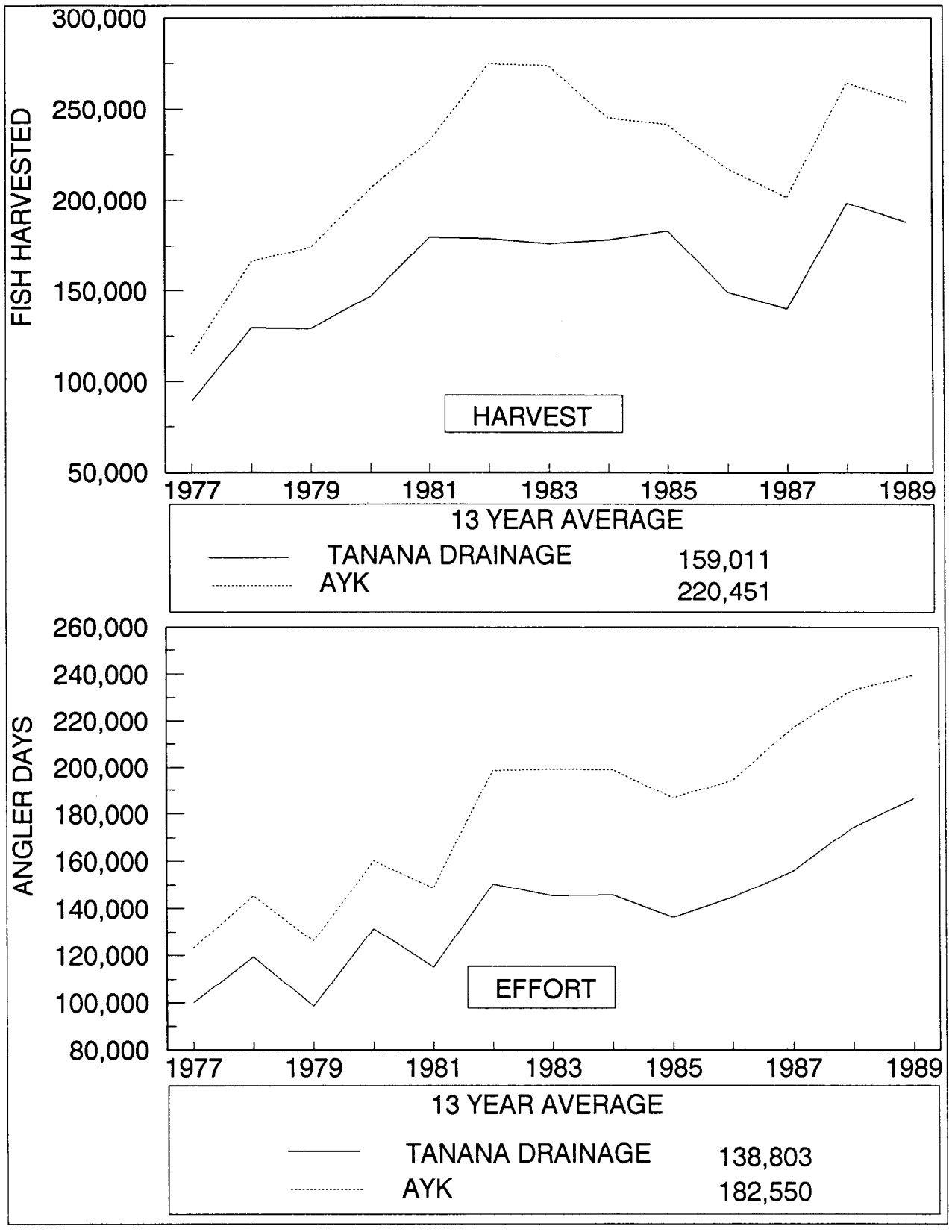

Figure 2. Effort and harvest by recreational anglers in the AYK Region (includes Tanana River drainage) and Tanana River drainage sport fish management areas, 1977-1989.

methods, results, and discussion section that are specific to each creel survey.

Creel surveys were conducted at six of the major fisheries within the Tanana River drainage. The specific objectives of the creel surveys were to provide information concerning the distribution of catch and harvest among the user groups, angler opinions concerning management of a fishery, sport fishery impacts on indigenous stocks, stocked fish contribution to a fishery, and the angler characteristics (e.g., sex and residency). Additional information was obtained that included harvest, catch, angler-effort, catch-per-unit-effort (CPUE), harvest-per-unit-effort (HPUE), and biological data (i.e., length and age compositions of harvested fish).

The long term goals of the creel survey program are to: (1) develop historical data bases to allow monitoring of both the recreational fisheries and the exploited fish populations; (2) develop regulations that reflect the desires of the angling public while ensuring the sustained health of the resource; and (3) estimate the effects of management regulations on the fisheries, fish populations, and recreational angling public.

GENERAL METHODS

Creel surveys conducted in the AYK Region of Alaska during 1990 were direct expansion completed-trip angler interview surveys. Most all of the creel surveys involved the estimation of the distribution of angler catches and harvests, biological characteristics of the harvest, angler demographics and opinion. Additionally, some of the surveys were involved in the estimation of angler effort, catch, harvest, CPUE, and HPUE. Each creel survey, in general, was conducted similarly in terms of sample survey design[1]. The following text describes the study design, data collection, and data analysis procedures which were common to surveys conducted during 1990.

Sections in the individual fishery chapters of this report detail the procedures that were unique to each survey.

General Study Design

On-site direct expansion completed-trip angler interview surveys were conducted on each of the fisheries to estimate the various parameters noted above. Anglers were intercepted at one or more discrete access locations (exit points) during a specified time period. The period to sample at each access point was determined by conducting a random multi-stage stratified sample selection. Strata were defined to more efficiently allocate sampling resources to those time periods or access locations which in general exhibit more angler effort (and hence catch and harvest). The strata in each fishery were defined to increase the relative precision of the estimates (levels of effort are expected to be similar within a stratum) and were based upon historical data (Baker 1988, 1989; Merritt, et al. 1990).

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[1] The procedures for surveying the Chatanika River whitefish spear-fishery were unique, and as such are described fully in the chapter for this fishery.

The multi-stage nature of the creel surveys involved first the random selection of days within each stratum to sample. In general, for most days sampled, all anglers were interviewed as they exited the fishery, and as such these surveys collapsed to a single-stage stratified sample survey. However, during some samples for some surveys, some exiting anglers were not interviewed for one reason or other. These "missed" anglers were counted. For the surveys in which anglers were missed, the "selection" of anglers to interview was treated as the second-stage sampling process.

Counts of fish harvested by all anglers interviewed during the specified time period were expanded upwards for the periods of time for which no samples were made within each stratum[2]. Similarly, effort and catch estimates as measured from the same interviews, were expanded to obtain effort and catch estimates. Estimates of such parameters as distribution of catches and harvests, CPUE, HPUE, biological characteristics of the harvested fish, angler demographics and opinions were obtained by standard weighted mean estimators (e.g., weighting CPUE by sample weights within strata and by stratum weights across strata).

General Data Collection

Creel surveys in the AYK region during 1990 emphasized the collection of catch and harvest information from completed-trip angler interviews. To accomplish this the creel clerk was stationed at a single access site for the duration of the sampled day within each stratum. The creel clerk interviewed all anglers who completed fishing and exited the fishery at the assigned site. If the clerk was unable to interview all anglers, then a count of those completed anglers exiting the area, who were not interviewed, was conducted.

Interviews were conducted for each individual angler and were not group or party interviews. During each interview, the angler's gender (male or female), age class (youth or adult), and type of fishing gear (spinner, bait, flies, etc.) were noted and recorded. The angler was asked the following:

1) the amount of time he or she spent fishing;

2) the number of fish caught by species;

3) the number of fish caught and kept (by species);

4) their residency (resident or non-resident, local or non-local);

5) if they are military; and,

6) if he or she is a tourist.

In addition, the angler was asked to "rate the quality of fishing" (either excellent, good, fair, or poor) he or she experienced this year. They may be asked their opinion regarding specific regulations or proposed management

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[2] Similarly, if anglers were missed, then counts of fish harvested were expanded upwards for the missed anglers (prior to expansion for periods not sampled).

strategies for each fishery[3]. All interview data were recorded on standard ADFG Angler Interview Form (Version 1.1).

Creel clerks recorded the hourly counts of all anglers exiting the fishery on the "Exit Angler Count Form" (see Appendix A1).

An additional goal of the creel surveys was to examine fish harvested for marks (fin clips or tags) and to collect biological information from fish harvested. The creel clerk recorded the following data from sampled harvested fish directly on to coin (scale) envelopes: date, location, species, length (fork length in millimeters), sex, presence of marks (tag color and number, and/or missing fins). This information was transferred from the coin envelope to the standard ADFG Tagging Length Form Version 1.0 mark sense forms in the office during age determination work.

The creel clerk collected at least two scales from each fish sampled from the harvest. The preferred zone for Arctic grayling is an area approximately six scale rows above the lateral line just posterior to the insertion of the dorsal fin. For northern pike a minimum of five scales were collected from an area adjacent to but not on the lateral line, above the pelvic fins as described by Williams (1955). Two scales from each fish were processed by cleaning in a solution of hydrolytic enzyme and then mounted on gum cards. These gum cards were used to make impressions of scales on 20 mil triacetate sheets (30 seconds at 137,895 kPa, at a temperature of 97 degrees C). Ages were determined by counting annuli on the impressions with the aid of a Micron 770 microfiche reader. Determination of age was performed by one reader after each readable set of scales were read once.

General Data Analysis

The data analysis required for each objective will be described in detail in the following text.

Distribution of Angler Catches and Harvests:

The distribution of catches and harvests for each fishery was in general, estimated as described in the following text. The "distribution of catches and harvests" is defined as the fraction p_k of angler-trips in which "k" or more fish were caught or harvested, where "k" can be expressed as k = 1 to k_{max}. If $k_{max} = 10$, then one set of data was analyzed 10 times to obtain all possible fractions p_k in a set. Because there is a set of p_k's for both catch and harvest there are two sets of p_k's. Besides the k_{max} iterations, there was stratification. For each iteration from 1 to k_{max}, there were calculations of each stratum for each fishery and for each species of interest.

As an example, begin with the fraction of angler-trips in which one or more fish were caught. The first step was to code the data prior to calculation. The coding was necessary because not all sampling periods (days) were the same "size"; more anglers fish during some periods than others. Ignoring these differences in "size" would have promoted bias in estimates of angler success when statistics were then averaged across sampling periods within a stratum.

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[3] Some surveys involved these type of questions, whereas some did not.

The coding adjusted for this possible discrepancy. From Sukhatme, et al. (1984: equation 8.58; page 327):

$$y_{khij} = \begin{cases} M_{hi}/\bar{M}_h^* & \text{if catch or harvest made by interviewed angler } j \text{ in stratum } h \text{ on day } i \text{ caught k or more fish;} \\ 0 & \text{otherwise;} \end{cases} \quad (1)$$

where:

M_{hi} = number of secondary units (anglers counted as they complete their fishing trips) on the day i in stratum h that could be sampled (includes both interviewed and "missed" anglers); and

$\bar{M}_h^*$ = the "restricted" mean of the possible number of fishing trips in a stratum was estimated as the mean of the number of anglers completing their trips during a sampling period (restricted to periods in which one or more anglers were counted):

$$= \frac{\sum_{i=1}^{d_h^*} M_{hi}^*}{d_h^*} ; \quad (2)$$

M_{hi}^* = number of anglers counted during each sample for samples with at least one angler counted; and

d_h^* = number of days sampled in each stratum with at least one angler counted.

The angler met the criterion if his or her catch $c_{hij} \geq k$ where k = 1 to kmax; otherwise $y_{khij} = 0$. The data was re-coded for each iteration from 1 to kmax. After coding, the average fraction and its variance were found for each stratum:

$\bar{\bar{y}}_{kh}$ = estimated proportion of anglers in stratum h that catch or harvest at least k fish of the species of interest;

$$= \frac{\sum_{i=1}^{d_h^*} \bar{y}_{khi}}{d_h^*} ; \quad (3)$$

where:

$\bar{y}_{khi}$ = proportion of anglers in each sample that catch or harvest at least k fish;

$$= \frac{\sum_{j=1}^{m_{hi}} y_{khij}}{m_{hi}} . \quad (4)$$

The variance of the estimated proportion was obtained by the usual two-stage equation (see Cochran 1977, equation 10.15, page 278):

$$\hat{V}[\bar{y}_{kh}] = \left\{ (1 - f_{1h}) \frac{s_{1kh}^2}{d_h^*} \right\} + \left\{ \frac{f_{1h}}{d_h^{*2}} \sum_{i=1}^{d_h^*} [(1 - f_{2hi}) \frac{s_{2khi}^2}{m_{hi}}] \right\} ; \quad (5)$$

where: f_{1h} is the primary stage sampling fraction (i.e., d_h / D_h); f_{2hi} is the secondary stage sampling fraction (i.e., m_{hi} / M_{hi}); d_h equals the number of days sampled each stratum; D_h equals the number of primary units (days) that could be sampled in each stratum;

$$s_{1kh}^2 = \frac{\sum_{i=1}^{d_h^*} (\bar{y}_{khi} - \bar{\bar{y}}_{kh})^2}{d_h^* - 1} ; \text{ and} \quad (6)$$

$$s_{2khi}^2 = \frac{\sum_{j=1}^{m_{hi}} (y_{khij} - \bar{y}_{khi})^2}{m_{hi} - 1} . \quad (7)$$

Once the estimated proportion and its variances were calculated for all strata in an iteration, the statistics were combined as weighted averages to estimate one set of statistics (p_k's) of catch or harvest distribution for the entire fishery:

$\hat{p}_k$ = the estimated fraction of completed angler-trips in which anglers caught k or more fish of the species of interest;

$$= \sum_{h=1}^{s} \hat{W}_h \bar{\bar{y}}_{kh} ; \quad (8)$$

$\hat{V}[\hat{p}_k]$ = variance estimate, obtained by treating the stratum weights as constants, rather than as estimates, and as such obtained approximately by (see Kish 1965, equations 2.8.5 and 2.8.7, pages 60 and 61);

$$\approx \sum_{h=1}^{s} \hat{W}_h^2 \hat{V}[\hat{y}_{kh}] \; ; \qquad (9)$$

where:

$\hat{W}_h$ = estimated relative stratum weight of stratum *h* (equivalent to the ratio of the estimated number of angler-trips for the stratum compared to the total number of angler-trips);

$$= \frac{\hat{A}_h}{\hat{A}} \; ; \qquad (10)$$

$\hat{A}_h$ = estimated number of angler-trips in the fishery within stratum *h*;

$$= D_h \bar{M}_h \; ; \qquad (11)$$

$\bar{M}_h$ = unrestricted mean number of anglers counted during all samples;

$$= \frac{\sum_{i=1}^{d_h} M_{hi}}{d_h} \; ; \qquad (12)$$

$\hat{A}$ equals the total number of estimated angler-trips across all strata; M_{hi} equals the unrestricted number of anglers counted during each sample; and s equals the number of sampling strata.

These calculations were repeated for k=2, k=3, ..., and $k=k_{max}$ for the catches. When these calculations were complete, then the whole procedure was repeated for harvested fish.

Standard errors were obtained by taking the square root of the variance estimates.

Proportion of Harvested Fish by Category:

The estimation of age composition, relative stock densities, and proportions of marked fish in the harvest of the various surveys was conducted as described in the following text. Since each parameter estimated (i.e., age composition, relative stock densities, and proportion marked) represents a proportion of the same population (i.e., fish harvested) the methods used to obtain the estimates were in general the same regardless of the parameter involved.

Estimates of each proportion for the harvest of fish of each species of interest was calculated according to the following procedures:

$\hat{p}_{uh}$ = estimated proportion of the harvested fish that are category u[4] within sampling stratum h;

$$= \frac{n_{uh}}{n_h}; \qquad (13)$$

where: n_{uh} equals the number of the sampled fish of a particular species harvested within sampling stratum h that are classified as category u; and n_h is the number of fish of a particular species harvested within sampling stratum h that were sub-sampled for the parameter of interest (e.g., age composition).

The estimated proportion by category (across all strata) was then obtained as follows:

$$\hat{p}_u = \sum_{h=1}^{s} \hat{W}_h \hat{p}_{uh} ; \qquad (14)$$

where:

$\hat{W}_h$ = estimated stratum weight (relative size of harvest in stratum h compared to all other strata);

$$= \frac{\hat{H}_h}{\hat{H}} ; \qquad (15)$$

$\hat{H}_h$ = estimated harvest of the species of interest in each sampling stratum[5];

$\hat{H}$ = total harvest of the species of interest in the fishery; and

s equals the number of sampling strata.

The variance of the estimate of p_u was obtained by viewing equation 14, above, as a product of a random variable and a constant, that is treating the weights as constants. Since, we must estimate the size of the harvest in each stratum, then our variance estimates were obtained approximately by (see Kish 1965, equations 2.8.5 and 2.8.7, pages 60 and 61):

$$\hat{V}[\hat{p}_u] \approx \sum_{h=1}^{s} \hat{W}_h^2 \hat{V}[\hat{p}_{uh}] ; \qquad (16)$$

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[4] Where category refers to the different classifications, dependent upon the parameter being estimated (e.g., ages for age composition; tagged for tagging proportion, etc.).

[5] As estimated by procedures noted in later sections of this report.

where:

$\hat{V}[\hat{p}_{uh}]$ = estimated variance of the estimated proportion of category u fish in stratum h, obtained approximately[6] by the standard equation for the variance of a binomial proportion (Cochran 1977, equation 3.8, page 52):

$$\approx \left\{ 1 - \frac{n_h}{\hat{H}_h} \right\} \left\{ \frac{\hat{p}_{uh} (1 - \hat{p}_{uh})}{n_h - 1} \right\} . \qquad (17)$$

Standard errors were obtained by taking the square root of the variance estimates.

Angler Effort, Catch, and Harvest:

The estimation of angler effort, catch, and harvest was an objective for only a few of the fisheries surveyed. However, the estimation of harvest by species was necessary for many of the surveys in order to obtain sample and stratum weights (as noted above for the estimation of proportions of fish harvested by category).

Estimation of angler effort, catch, and harvest of fish by species for each fishery involved the direct expansion of sampled interview data by expansion factors dependent upon the number of anglers "missed" (second-stage units) and sample periods not selected (first-stage units). The following procedures were used in general to estimate effort, catch, and harvest (by species) for all surveys:

$\hat{E}_h$ = estimated angler effort in angler-hours for stratum h;

$$= D_h \bar{\hat{E}}_h \ ; \qquad (18)$$

where:

$\bar{\hat{E}}_h$ = mean effort estimate over all days sampled in stratum h;

$$= \frac{\sum_{i=1}^{d_h} \hat{E}_{hi}}{d_h} \ ; \qquad (19)$$

$\hat{E}_{hi}$ = estimated angler effort exiting the fishery during each sample;

$$= M_{hi} \bar{e}_{hi} \ ; \qquad (20)$$

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6 The variance form is only approximate in that the proportions we are estimating are multinomial rather than binomial.

$\bar{e}_{hi}$ = mean angler effort expended by all exiting anglers interviewed during each sample;

$$= \frac{\sum_{j=1}^{m_{hi}} e_{hij}}{m_{hi}} ; \quad (21)$$

e_{hij} equals the hours of fishing effort expended by each interviewed angler. All other terms are as defined above.

The variance for the estimated angler effort for each stratum was obtained by the two-stage variance equation (following the approach outlined in: Cochran 1977, equation 11.24, page 303):

$$\hat{V}[\hat{E}_h] = \left\{ (1 - f_{1h}) \frac{D_h^2}{d_h} s_{1h}^2 \right\} + \left\{ f_{1h} \frac{D_h^2}{d_h^2} \sum_{i=1}^{d_h} [(1 - f_{2hi}) \frac{M_{hi}^2}{m_{hi}} s_{2hi}^2] \right\}; \quad (22)$$

where:

$$s_{1h}^2 = \frac{\sum_{i=1}^{d_h} (\hat{E}_{hi} - \bar{\hat{E}}_h)^2}{d_h - 1} ; \quad (23)$$

$$s_{2hi}^2 = \frac{\sum_{j=1}^{m_{hi}} (e_{hij} - \bar{e}_{hi})^2}{m_{hi} - 1} ; \text{ and} \quad (24)$$

all other terms were as defined above.

Estimates of catch and harvest by species and their variances were estimated similarly, by substituting the appropriate catch or harvest statistics in place of angler effort in equations 18 through 24, above.

Total angler effort, catch, or harvest across all strata (or select combinations of strata) was obtained by summing the associated stratum estimates. Variances were also obtained by summing the stratum variance estimates, assuming independence (see Kish 1965, equation 2.8.7, page 61). Standard errors were obtained by taking the square root of the variance estimates.

CPUE and HPUE:

Catch per unit effort and harvest per unit effort of anglers participating in the various fisheries surveyed in the AYK Region during 1990 were estimated by the procedures noted below. The estimates obtained by these procedures were reflective of the rates experienced by individual anglers.

To obtain the estimates of CPUE we weighted by sample weights. This weighting procedure ensured that each angler's CPUE information was proportional to the angler effort at the time of the sample. The weighted CPUE for each angler was obtained as follows (using information from anglers interviewed as they exit each fishery):

$$CPUE'_{hij} = w_{hi} \frac{c_{hij}}{e_{hij}} ; \quad (25)$$

where:

$$w_{hi} = \frac{M_{hi}}{\bar{M}^{*}_{h}} ; \quad (26)$$

c_{hij} equals the catch of each interviewed angler. All other terms are as defined above.

The weighted mean CPUE was then estimated for each sample as:

$$\overline{CPUE}'_{hi} = \frac{\sum_{j=1}^{m_{hi}} CPUE'_{hij}}{m_{hi}} ; \quad (27)$$

where: m_{hi} is as defined above.

The stratum estimates of CPUE were obtained as a mean of mean weighted CPUE:

$$\overline{\overline{CPUE}}_{h} = \frac{\sum_{i=1}^{d_h} \overline{CPUE}'_{hi}}{d_h} ; \quad (28)$$

where: d_h is as defined above.

To obtain estimates of mean CPUE across all strata, or select combinations of strata, we weighted the individual stratum estimates of CPUE by the relative size of each stratum in terms of the estimated number of anglers (following the procedures explained in Cochran 1977, Equation 10.45, page 288), as follows:

$$\hat{CPUE} = \sum_{h=1}^{s} \hat{W}_h \, \overline{\overline{CPUE}}_h \; ; \tag{29}$$

where:

$\hat{W}_h$ = estimated relative stratum weight of each stratum (see equation 10).

Harvest per unit effort (HPUE) estimates were obtained similarly by substituting the appropriate harvest statistics into equations 25 to 29.

The variance of the across stratum CPUE estimate was obtained by treating the estimated stratum weights as if they were constants (see Kish 1965, equations 2.8.5 and 2.8.7, pages 60 and 61). Accordingly our variance estimate was only approximate:

$$\hat{V}[\hat{CPUE}] \approx \sum_{h=1}^{s} \hat{W}_h^2 \, \hat{V}[\overline{\overline{CPUE}}_h] \; ; \tag{30}$$

where:

$\hat{V}[\overline{\overline{CPUE}}_h]$ = estimated variance of the stratum estimates of the mean of mean weighted CPUE, obtained by the usual two-stage equation (see Cochran 1977, equation 10.15, page 278):

$$= \left\{ (1 - f_{1h}) \frac{s_{1h}^2}{d_h} \right\} + \left\{ \frac{f_{1h}}{d_h^2} \sum_{i=1}^{d_h} \left[(1 - f_{2hi}) \frac{s_{2hi}^2}{m_{hi}} \right] \right\} \; ; \tag{31}$$

$$s_{1h}^2 = \frac{\sum_{i=1}^{d_h} (\overline{CPUE}_{hi}' - \overline{\overline{CPUE}}_h')^2}{d_h - 1} \; ; \tag{32}$$

$$s_{2hi}^2 = \frac{\sum_{j=1}^{m_{hi}} (CPUE_{hij}' - \overline{CPUE}_{hi}')^2}{m_{hi} - 1} \; ; \text{ and} \tag{33}$$

all other terms are as defined above.

Variance estimates for the estimated HPUE's were obtained similarly by substituting the appropriate harvest statistics into equations 30 through 33. Standard errors were obtained by taking the square root of the variance estimates.

Angler Demographics and Questionnaires:

For each fishery, angler demographics were calculated from angler interviews as proportions of the following: male or female, adult or youth; resident or non-resident; local or non-local; tourist, military, or neither; and terminal gear types. At all fisheries, anglers interviewed were asked to rate the quality of fishing at the particular fishery. The frequency distribution was then calculated for each fishery from the following scale: Excellent = 1, Good = 2, Fair = 3, Poor = 4, and No Opinion = 5. In addition, questions specific to each fishery were asked of anglers interviewed. Number and percent opinions to all these questions were calculated.

Estimates of each proportion associated with each parameter (i.e., various angler demographic categories, rating of the fishery, etc.) were calculated according to the following procedures:

$\hat{p}_{uh}$ = estimated proportion of the anglers that are category u[7] within stratum h;

$$= \frac{\sum_{i=1}^{d_h} w_{hi}\hat{p}_{uhi}}{d_h} ; \qquad (34)$$

where: w_{hi} is as defined previously (equation 26);

$\hat{p}_{uhi}$ = estimated fraction of anglers categorized as "type u" for each sample;

$$= \frac{m_{uhi}}{m'_{hi}} ; \qquad (35)$$

m_{hi} equals the number of anglers interviewed within sample i and stratum h, which can be categorized (i.e., does not include anglers who do not respond to particular question of interest); and m_{uhi} equals the number of anglers categorized as "type u" within each sample.

[7] Where category refers to the different classifications, dependent upon the parameter being estimated.

The variance of the stratum estimate of each proportion (for each parameter) was obtained using a two-stage equation:

$$\hat{V}[\hat{p}_{uh}] = \left\{ (1 - f_{1h}) \frac{s_{1h}^2}{d_h} \right\} + \left\{ \frac{f_{1h}}{d_h^2} \sum_{i=1}^{d_h} (1 - \frac{m'_{hi}}{M_{hi}}) w_{hi} \frac{\hat{p}_{uhi}(1 - \hat{p}_{uhi})}{(m'_{hi} - 1)} \right\} ; \quad (36)$$

where:

$$s_{1h}^2 = \frac{\sum_{i=1}^{d_h} (w_{hi}\hat{p}_{uhi} - \hat{p}_{uh})^2}{d_h - 1} ; \text{ and,} \quad (37)$$

all other terms are as defined previously.

The estimated proportion by category and its variance (across all strata) was obtained by substituting the stratum estimate of the proportion in place of CPUE in equations 29 and 30, above. Standard errors were obtained by taking the square root of the variance estimates.

Assumptions:

The general assumptions necessary for unbiased point and variance estimates of angler effort, catch, harvest, CPUE, HPUE, and catch and harvest distribution obtained by the procedures outlined above are:

1. interviewed anglers accurately reported their hours of fishing effort and the number of fish by species released;

2. no significant fishing effort occurred during the hours not included in the fishing day; and,

3. all anglers participating in the defined fishery exited the fishery through a surveyed access site.

Similarly, the general assumptions necessary for unbiased point and variance estimates of angler demographics and opinion include the following:

1. creel clerks accurately classify anglers and the interviewed anglers accurately report their demographic characteristics and opinions;

2. no significant fishing effort occurred during the hours not included in the fishing day; and

3. all anglers participating in the defined fishery exited the fishery through a surveyed access site.

4. The angler fished with one terminal gear type during their fishing trip.

Since no attempt was made to correct for avidity bias[8], then our estimates of angler demographics and opinion only relate to the proportion of angler-trips not to the proportion of individual anglers. Additionally, the angler opinions obviously relate to only those anglers who participate in the fishery, not potential anglers who do not participate.

CHAPTER 1 - PILEDRIVER SLOUGH RAINBOW TROUT AND ARCTIC GRAYLING FISHERY

Introduction

Piledriver Slough supports a popular fishery for rainbow trout and Arctic grayling. Piledriver Slough is a slough of the Tanana River originating about 48 km southeast of Fairbanks near Eielson Air Force Base (Figure 3). Dike construction associated with the construction of the Moose Creek Flood Control Project blocked the mouth of the Slough in the late 1970's. With the silty waters of the Tanana River blocked, clear spring water began to flow and sightings of Arctic grayling in Piledriver Slough by residents of the area were reported in the early 1980's. In 1983, an estimated 4,148 anglers days of effort were expended to harvest 5,822 Arctic grayling in Piledriver Slough Mills (1984).

During the summer of 1987, the Division of Sport Fish, ADFG, stocked rainbow trout in Piledriver Slough. This was the first stocking of rainbow trout into an open system (not landlocked) in the interior of Alaska. Catchable, sub-catchable, and fingerling-size rainbow trout were stocked in 1987, 1988 and 1989. In 1990, 20,000 catchable-size rainbow trout were stocked into Piledriver Slough.

Anglers are attracted to Piledriver Slough because of its clear spring water appearance and the fact that both Arctic grayling and rainbow trout are available. For these reasons, and because of its close proximity to Fairbanks, North Pole and Eielson Air Force Base, fishing pressure at Piledriver Slough has increased. In 1987, angler effort had risen to 13,257 "days fished" to harvest 4,346 rainbow trout and 4,907 Arctic grayling (Mills 1988). To counter the increasing effort at Piledriver Slough, management regulations were adopted by the Board of Fisheries in 1987 that included:

1) a 12 inch minimum length limit for Arctic grayling; and,

2) a no-bait restriction (only artificial flies and lures can be used).

In 1986, the year prior to the stocking of rainbow trout and the year the new regulations were put into effect, no estimate was available for the amount of angler-effort and harvest of Arctic grayling at Piledriver Slough. However, Mills (1986) estimated that 3,500 angler-days were expended at Piledriver Slough in 1985 to harvest 2,000 Arctic grayling. Angler-effort dramatically

[8] Avidity bias is due to the fact that anglers who fish more often during the survey period have a higher probability of being interviewed than anglers who fish less often.

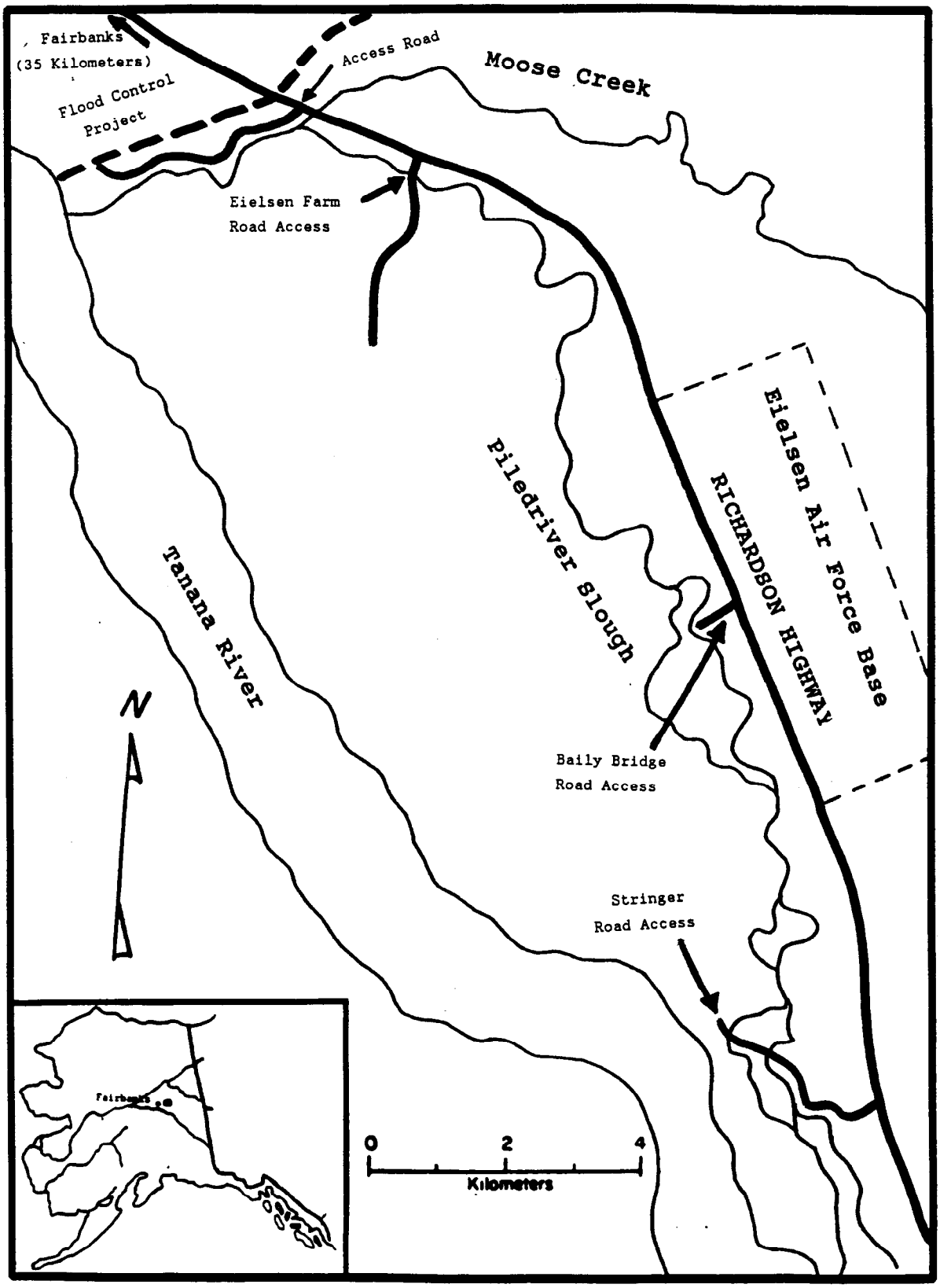

Figure 3. Map of Piledriver Slough, Tanana River drainage, Alaska.

increased from 1985 to 1988. In 1988, anglers spent 24,375 angler-days at Piledriver Slough, and harvested an estimated 12,296 rainbow trout and 8,095 Arctic grayling (Mills 1989). Angler days decreased in 1989 to 22,745 and the harvest of rainbow trout and Arctic grayling was 7,689 and 4,459, respectively (Mills 1990).

The 1990 creel survey at Piledriver Slough was designed to provide managers with data on the catch and harvest composition, as well an idea of the effectiveness of certain sport fishing regulations. In addition, first-hand angler opinions regarding fishery management options were solicited. The specific objectives for the Piledriver Slough creel survey in 1990 are listed below.

1. To provide post-season estimates of the distribution of catches and harvests of Arctic grayling and rainbow trout by angler trip at Piledriver Slough.

2. To provide post-season estimates of the proportion of Arctic grayling and rainbow trout harvested with marks (fin clips and/or tags).

3. To provide post-season estimates of age and length compositions of harvested Arctic grayling and rainbow trout at Piledriver Slough.

4. To estimate the percent demographics of anglers interviewed at Piledriver Slough that are in the following categories:

   a) male/female;
   b) adult/youth;
   c) resident/non-resident;
   d) local/non-local;
   e) tourist/military; and,
   f) terminal fishing gear (spinner/bait/flies/jigs/trolling/spear).

5. To estimate the mean rating by anglers of the quality of fishing at Piledriver Slough.

In addition, the percent response to questions asked of anglers interviewed at Piledriver Slough was estimated. And, angler-effort, catch and harvest were estimated.

Methods

The type of survey used at Piledriver Slough in 1990 was a direct expansion type creel survey. The three major access sites to Piledriver Slough are the Eielson Farm Road, the Bailey Bridge, and Stringer Road (Figure 3). Because these three sites account for the majority of the effort and harvest at Piledriver Slough, all sampling was conducted here.

Study design:

The creel survey at Piledriver Slough in 1990 focused on obtaining estimates of the distribution of catches and harvests of Arctic grayling and rainbow trout by completed angler-trip and estimating the proportion of Arctic

grayling and rainbow trout in the harvest that carried a tag or distinguishing mark.

A stratified two-stage sampling design was utilized with days as the primary units and angler trips as the secondary units. It is thought that the majority of the angler effort and harvest at Piledriver Slough occurs at or near the three areas listed above, and therefore, all sampling was conducted here. Data collected in the 1989 creel survey showed no significant differences in angler success (catch or harvest) within these three areas or between these three areas and other sites, (Merritt, et al. 1990).

The allocation of sampling effort among strata was designed to accomplish the objectives listed above. There are 16 different strata among which the 90 days of available sampling (one technician) were allocated.

Stratification was based on access-site, weekends/holidays versus weekdays (at Eielson Farm Road only), morning versus afternoon, and early versus late in the season. The fishing day was defined as 14 hours long. Mornings were from 0800 to 1500 hours while afternoons were from 1500 to 2200 hours. Early season was defined as nine weeks long, from 1 May to 2 July; late season was six weeks long and ran from 3 July through 12 August. Accordingly a total of 16 strata were defined:

Stratum	Description	Days available for sampling
	EIELSON FARM ROAD	
(1)	weekend/afternoon early season	19
(2)	weekend/morning early season	19
(3)	weekday/afternoon early season	44
(4)	weekday/morning early season	44
(5)	weekend/afternoon late season	13
(6)	weekend/morning late season	13
(7)	weekday/afternoon late season	28
(8)	weekday/morning late season	28
	BAILEY BRIDGE	
(9)	afternoon/early season	63
(10)	morning/early season	63
(11)	afternoon/late season	41
(12)	morning/late season	41
	STRINGER ROAD	
(13)	afternoon/early season	63
(14)	morning/early season	63
(15)	afternoon/late season	41
(16)	morning/late season	41

More sampling effort was placed in those strata with potentially the most angler-trips and subsequently the most catch and harvest. Therefore, every weekend afternoon at Eielson Farm Road was selected for sampling and almost half the mornings; these sample periods represent 57% of the sampling effort. The remaining sampling effort was spread through the other strata to maintain the integrity of the design.

During the sampling period the creel clerk on duty at the designated access site attempted to interview all anglers who completed fishing and exited the area. All anglers leaving the area who could not be interviewed were counted.

Attempts were made to sample all harvested Arctic grayling and rainbow trout encountered during the creel survey. The sample size goal for each species was 125 fish. The sample sizes were obtained by following the procedures outlined in Thompson (1987) for estimating multinomial proportions (i.e., proportions of fish of different categories). For a precision of ± 5 percentage points and an α level of 0.05, Thompson gives the sample size goal of 128. The adjusted sample sizes were obtained by adjusting for the finite population correction (fpc) factor (using the approach suggested by Cochran 1977, equation 4.3, page 76).

Data Analysis:

Estimates of the distribution of angler catches and harvest of both Arctic grayling and rainbow trout in Piledriver Slough during 1990 was obtained by the procedures outlined in equations 1 through 12, above. We set k_{max} equal to 10 fish for the catch and harvest of both species.

The estimates associated with objectives 2 and 3, were calculated according to the procedures outlined in equations 13 through 17, above. The following text defines the various categories associated with the proportional (or percentage) parameters that were estimated.

The different age classes represent the various categories for estimates of age composition. In applying equations 13 through 17 for these estimates, only sampled fish with legible age structures were used for estimation purposes; the terms n_{uh} and n_h did not include unaged samples. Additionally, since site of collection (e.g., Eielson Farm Road) was not recorded with each sampled scale, then estimates were obtained by ignoring the site and weekend versus weekday level of stratification[9].

Relative Stock Densities (RSD's) represented the proportions of harvested fish (by species) that met certain length category criteria (either "stock", "quality", "preferred", "memorable", or "trophy"). The categories and criteria for Arctic grayling were as follows (adapted from English units, to nearest 10 mm size, given by Gabelhouse 1984):

Category	RSD = Percentage of Arctic grayling harvested that are between the following length limits
Stock	150 mm ≤ length < 270 mm
Quality	270 mm ≤ length < 340 mm
Preferred	340 mm ≤ length < 450 mm
Memorable	450 mm ≤ length < 560 mm
Trophy	560 mm ≤ length

[9] That is, only early and late season level of stratification was used in applying equations 13 through 17 to estimate proportions of fish harvested by category.

The comparable categories and criteria for rainbow trout were (adapted and modified from Gabelhouse 1984):

Category	RSD = Percentage of rainbow trout harvested that are between the following length limits
Stock	180 mm ≤ length < 225 mm
Quality	225 mm ≤ length < 300 mm
Preferred	300 mm ≤ length < 375 mm
Memorable	375 mm ≤ length < 450 mm
Trophy	450 mm ≤ length

The proportion of anglers categorized by the demographic characteristics noted in objective 4, and the proportions of anglers responding to the questions associated with objective 5 were estimated following the procedures outlined in equations 34 through 37.

Results

The Piledriver Slough creel survey began on 1 May and was scheduled to run through the third of September (labor day weekend). Due to unexpected budgetary problems the creel survey was terminated on 12 August 1990. The objectives for the creel survey at Piledriver Slough did not include estimates of angler-effort or the catch and harvest of Arctic grayling and rainbow trout. However, these statistics along with standard errors were obtained relative to meeting other objectives. During the creel survey 76 sampling events were conducted during 15 of the originally planned 16 strata (Table 1). Because the creel survey terminated 22 days early and because of the random selection of sampling periods, no sampling occurred at the Stringer Road, late season, early day stratum. During the creel survey, 812 interviews were acquired from a total of 1,193 anglers (counted) who had completed fishing and exited the fishery during the sampled days at the surveyed locations. Anglers expended an estimated 8,484 hours (SE = 1,117) to catch 10,429 (SE = 3,735) Arctic grayling of which 317 (SE = 91) were harvested. During the same period 7,865 rainbow trout (SE = 1,988) were caught of which 2,366 (SE = 462) were harvested.

Only 38% (SE = 8) of the anglers caught one or more Arctic grayling and 6% (SE = 2) harvested one or more Arctic grayling (Table 2). The distribution of catch and harvest of Arctic grayling among anglers interviewed in 1990 shows the majority of anglers (62%) with zero catches and 94% harvesting zero Arctic grayling (Figure 4). Eleven percent (SE = 4) of the angler-trips resulted in catches greater than the existing bag limit (of five Arctic grayling) while 100% of the trips were comprised of harvests of four or less.

Thirty-four percent (SE = 6) of the anglers caught one or more rainbow trout and 15% (SE = 2) harvested more than one rainbow (Table 3). The distribution of the catch and harvest of rainbow trout among anglers interviewed shows the majority of anglers (66%) with zero catch and (85%) with zero harvest

Table 1. Summary of the angler counts and estimates of angler effort, catch, and harvest, by strata for the Piledriver Slough Arctic grayling fishery, 1 May - 12 August 1990 period.

Strata Information				Sampling Information[e]				Parameter Estimates[f]									
										Arctic grayling				Rainbow trout			
Area[a]	Season[b]	We/Wd[c]	Period[d]	d	D	m	M	E	SE	C	SE	H	SE	C	SE	H	SE
1	1	We	A	9	19	85	112	434	81	189	76	0	0	366	161	188	89
1	1	We	B	18	19	312	503	1,248	50	1,817	159	102	14	366	53	187	32
1	1	Wd	A	4	44	38	46	751	341	1,906	860	73	45	28	16	16	16
1	1	Wd	B	2	44	12	27	984	737	3,608	3,532	44	43	44	43	0	0
			sub-totals	33		447	688	3,417	818	7,520	3,640	219	64	804	176	391	96
1	2	We	A	5	13	34	41	232	27	81	30	0	0	266	68	113	23
1	2	We	B	12	13	221	323	859	49	284	44	19	5	597	79	256	30
1	2	Wd	A	3	28	15	16	263	160	262	250	0	0	722	445	162	95
1	2	Wd	B	3	28	33	47	1,093	550	648	365	0	0	1,321	850	168	160
			sub-totals	23		303	427	2,447	576	1,275	445	19	5	2,906	965	699	191
2	1	Both	A	3	63	9	12	346	171	409	400	0	0	25	25	0	0
2	1	Both	B	2	63	10	10	562	181	662	527	63	62	1,323	1,302	283	279
2	2	Both	A	2	41	1	1	7	70	0	0	0	0	0	0	0	0
2	2	Both	B	2	41	6	10	41	160	41	40	0		1,107	840	328	86
			sub-totals	9		26	33	1,390	304	1,112	663	63	62	2,455	1,549	611	292

-continued-

Table 1. (Page 2 of 2).

Strata Information				Sampling Information[e]				Parameter Estimates[f]									
										Arctic grayling				Rainbow trout			
Area[a]	Season[b]	We/Wd[c]	Period[d]	d	D	m	M	E	SE	C	SE	H	SE	C	SE	H	SE
3	1	Both	A	2	63	2	4	20	218	63	63	0	0	0	0	0	0
3	1	Both	B	4	63	11	17	48	180	189	121	16	15	598	460	268	188
3	2	Both	A	0[g]	41	-	-	-	-	-	-	-	-	-	-	-	-
3	2	Both	B	4	41	23	24	530	273	270	215	0	0	1,102	614	397	218
			sub-totals	10		36	45	1,230	393	522	255	16	15	1,700	768	665	288
TOTALS				76		812	1,193	8,484	1,117	10,429	3,735	317	91	7,865	1,988	2,366	462

[a] 1 = Eielson Farm Road;
2 = Bailey Bridge; and,
3 = Stringer Road.

[b] 1 = Early season May 1 to July 2; and,
2 = Late season 3 July to August 12.

[c] We = Weekend; and,
Wd = Weekday.

[d] A = Early day 0800 to 1500 hours.
B = Late day 1500 to 2200 hours.

[e] d = number of days sampled for angler interviews;
D = total number of days available for sampling;
m = total number of anglers interviewed; and,
M = total number of anglers counted.

[f] E = estimated angler effort in angler-hours;
C = estimated catch;
H = estimated harvest; and,
SE = standard error of the respective effort, catch, and harvest statistic.

[g] The creel survey ended 22 days early, consequently no sampling occured during this stratum.

Table 2. Distribution of Arctic grayling catch and harvest among anglers interviewed at Piledriver Slough, 1990.

Number of Fish	Catch Distribution Prop[a]	Catch Distribution SE	% Dist Catch Among Anglers	Harvest Distribution Prop[a]	Harvest Distribution SE	% Dist Harvest Among Anglers
0	-----	-----	62.31[b]	-----	-----	93.99[b]
1	0.376	0.080	8.95	0.060	0.020	5.19
2	0.287	0.066	7.48	0.008	0.001	0.49
3	0.212	0.063	4.93	0.003	<0.001	0.20
4	0.163	0.049	2.16	0.001	<0.001	0.13
5	0.141	0.045	3.23	0	0	0
6	0.109	0.042	0.21	0	0	0
7	0.107	0.042	1.16	0	0	0
8	0.095	0.041	0.27	0	0	0
9	0.930	0.041	0.00	0	0	0
10 or more	0.093	0.041	9.30	0	0	0

[a] Proportion of angler-trips that caught or harvested at least given number of Arctic grayling.

[b] Percentage of angler-trips that resulted in zero catch and zero harvest of Arctic grayling.

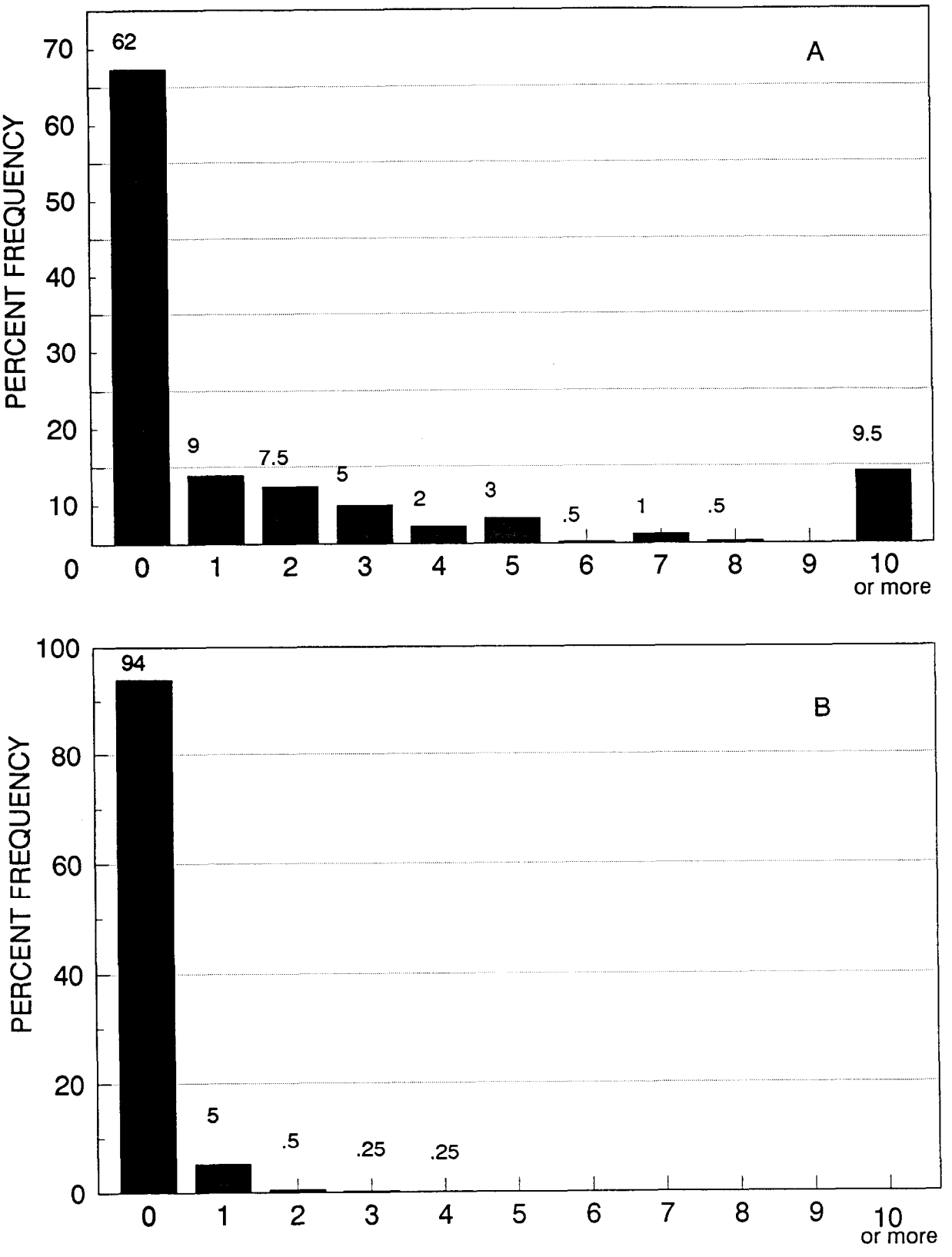

Figure 4. Distribution of Arctic grayling catch (A) and harvest (B) among anglers interviewed at Piledriver Slough, Tanana River drainage, Alaska, 1990.

Table 3. Distribution of rainbow trout catch and harvest among anglers interviewed at Piledriver Slough, 1990.

Number of Fish	Catch Distribution Prop[a]	Catch Distribution SE	% Dist Catch Among Anglers	Harvest Distribution Prop[a]	Harvest Distribution SE	% Dist Harvest Among Anglers
0	-----	-----	66.12[b]	-----	-----	84.97[b]
1	0.338	0.060	6.66	0.150	0.022	2.93
2	0.272	0.055	5.79	0.121	0.020	2.41
3	0.214	0.047	2.84	0.096	0.017	1.68
4	0.185	0.053	2.85	0.080	0.019	1.44
5	0.157	0.043	6.57	0.065	0.016	5.65
6	0.091	0.031	0.56	0.009	0.007	0.20
7	0.085	0.030	1.44	0.007	0.007	0
8	0.071	0.025	1.11	0.007	0.007	0
9	0.060	0.023	0.80	0.007	0.007	0.72
10 or more	0.052	0.017	5.21	0.000	0.000	0

[a] Proportion of angler-trips that caught or harvested at least given number of rainbow trout.

[b] Percentage of angler-trips that resulted in zero catch and zero harvest of rainbow trout.

(Figure 5). Nine percent (SE = 3) of the angler-trips resulted in catches greater than the existing bag limit (of five rainbow trout) while less than 1% (SE = <.01) of the trips resulted in harvests greater than the legal limit.

Of the 76 Arctic grayling encountered during the creel survey in 1990, only 5% (SE = 2) of the harvest sample carried marks (Table 4). Rainbow trout stocked at a catchable size in 1988 comprised 6% (SE = 2) of the total harvest, while 33% (SE = 2) were from the 1989 stocking of catchables (Table 5). The 1990 stocking of catchable size rainbow trout accounted for 60% (SE < 1) of the total estimated harvest for the entire creel census period, and 100% of the late season (3 July - 12 August) harvest.

Biological data were collected from 76 Arctic grayling and 337 rainbow trout in the harvest sample at Piledriver Slough.

Thirty-eight percent (SE = 5) of the Arctic grayling in the harvest were of stock length, and the remaining 62% (SE = 5) were quality length (Table 6). Arctic grayling sampled in the creel at Piledriver slough in 1990 ranged in age from three to seven (Table 6). Estimates of the age composition indicate that Arctic grayling of age 4 were the most dominant accounting for 38% (SE = 6) of the harvest. Ages 5 and 6 accounted for 32% (SE = 6) and 24% (SE = 5) of the harvest, respectively.

Twenty-nine percent (SE = 2) of the rainbow trout in the harvest sample were of stock length, 70% (SE = 2) were of quality length, and 1% (SE = <.01) were of preferred lengths (Table 7). No Arctic grayling in the harvest sample were in the preferred length category and no Arctic grayling or rainbow trout were in the memorable or trophy length categories. Arctic grayling sampled in the harvest ranged in fork length from 220 mm to 320 mm. Rainbow trout ranged from 180 mm to 310 mm fork length.

The majority of the anglers interviewed at Piledriver Slough were male (88%, SE = 8), adult (87%, SE = 9), and residents of the State of Alaska (87%, SE = 9; Table 8). The fishery was also popular for military personnel (48%, SE = 7). Of the anglers interviewed who were residents, 91% (SE = 9) were from the Fairbanks-North Pole area. Only 5% (SE = 1) of all the anglers were tourists. The selection for terminal fishing gear leaned toward spinners with 56% (SE = 78) while 44% (SE = 5) reported using flies. Even though Piledriver Slough is closed to the use of bait, a small proportion (less than 1%) of the anglers interviewed reported using bait.

Forty-one percent (SE = 6) of the anglers interviewed, who expressed an opinion on the quality of fishing, gave the Piledriver Slough fishery a rating of good, where as 33% (SE = 4) rated the fishery as only fair (Table 9). When asked opinions about management regulations, the anglers (who stated an opinion) were highly in favor of stocking rainbow trout (88%, SE = 6), approved of a 12 inch minimum length limit for Arctic grayling (67%, SE = 6), and approved of a no-bait restriction at Piledriver Slough (64%, SE = 7).

Discussion

Because the 1990 creel survey at Piledriver Slough was terminated 22 days early which resulted in zero sampling of one entire strata, the survey is

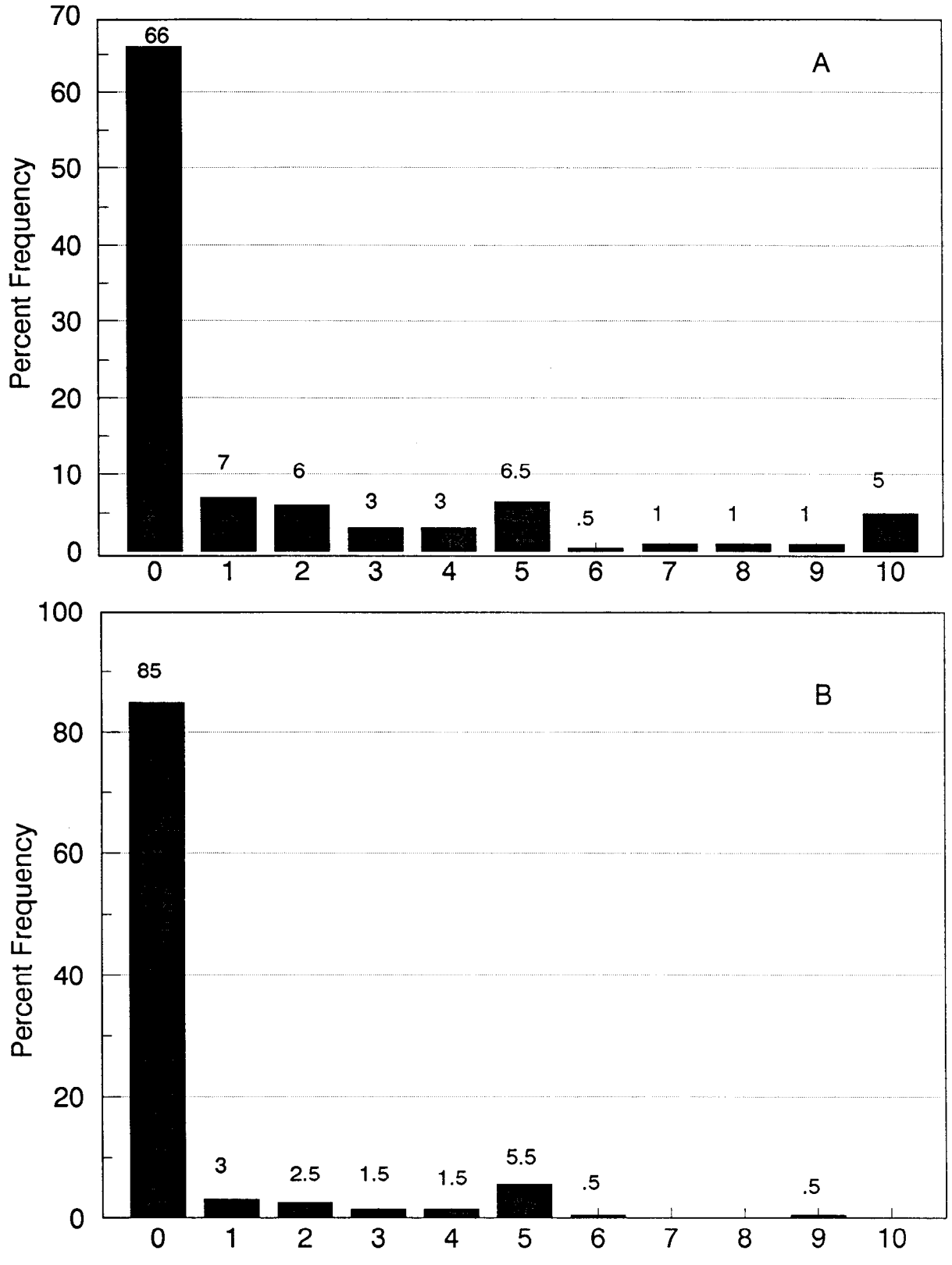

Figure 5. Distribution of rainbow trout catch (A) and harvest (B) among anglers interviewed at Piledriver Slough, Tanana River drainage, Alaska, 1990.

Table 4. Estimate of the Arctic grayling with marks in the harvest by seasonal component at Piledriver Slough, Tanana River drainage, Alaska, 1 May through 12 August, 1990.

Arctic grayling:

Seasonal Component	Category	n	%	SE (%)
1 May - 2 July	Tagged[a]	3	4.76	2.40
	Untagged	60	95.24	2.40
	Subtotal	63		
Estimated harvest = 298				
Weight[b] = 0.940				
FPC[c] = 0.789				
3 July- 12 August	Tagged[a]	1	7.69	3.40
	Untagged	12	92.31	3.40
	Subtotal	13		
Estimated harvest = 19				
Weight[b] = 0.060				
FPC[c] = 0.316				
Entire Season	Tagged[a]	4	4.94[d]	2.27[d]
	Untagged	72	95.06[d]	2.27[d]
	Total	76		
Estimated harvest = 317				

[a] Blue Floy tags, applied in 1990 as part of a Arctic grayling population abundance study.

[b] Stratum weights equal to ratio of estimated harvest for the stratum to the total estimated harvest for the survey.

[c] FPC = finite population correction equal to one minus the sampling fraction, where the sampling fraction equals the ratio of the sample size for the stratum divided by the harvest for the stratum.

[d] Weighted estimates.

Table 5. Estimate of the stocking cohort contribution of the harvest sample of rainbow trout (as determined by the presence of marks or scale analysis), by seasonal component at Piledriver Slough, Tanana River drainage Alaska, 1 May through 12 August, 1990.

Rainbow trout:

Seasonal Component	Cohort	n	%	SE (%)
1 May - 2 July	1988 catchables	6	16.22	6.02
	1989 catchables	31	83.78	6.02
	1990 catchables[a]	0	0.00	0.00
	Subtotal	37		
Estimated harvest = 942				
Weight[b] = 0.3981				
FPC[c] = 0.9607				
3 July - 12 August	1988 catchables	0	0.00	0.00
	1989 catchables	0	0.00	0.00
	1990 catchables[a]	193	100.0	0.00
	Subtotal	193		
Estimated harvest = 1,424				
Weight[b] = 0.6019				
FPC[c] = 0.8645				
Entire Season	1988 catchables	6	6.46[d]	2.40[d]
	1989 catchables	31	33.35[d]	2.40[d]
	1990 catchables[a]	193	60.19[d]	0.00[d]
	Total	230		
Estimated harvest = 2,366				

[a] Stocking of 20,000 catchable size rainbow trout occurred on 28 June, 1990.
[b] Stratum weights equal to ratio of estimated harvest for the stratum to the total estimated harvest for the survey.
[c] FPC = finite population correction equal to one minus the sampling fraction, where the sampling fraction equals the ratio of the sample size for the stratum divided by the harvest for the stratum.
[d] Weighted estimates.

Table 6. Estimates of the contributions of each age class and Relative Stock Density of Arctic grayling in the harvest sample, by seasonal component, from Piledriver Slough, Tanana River drainage, Alaska, 1 May through 12 August, 1990.

Seasonal Component	Age Composition: Age	n	%	SE(%)[a]	Relative Stock Density (RSD): Category	Range[b]	n	%	SE(%)[a]
1 May - 2 July	3	1	1.9	1.74	Small	≤149	--	--	--
	4	20	38.5	6.19	Stock	150-269	25	39.1	5.45
	5	17	32.7	5.97	Quality	270-339	39	60.9	5.45
	6	12	23.1	5.36	Preferred	340-449	--	--	--
	7	2	3.8	2.45	Memorable	450-559	--	--	--
					Trophy	≥560	--	--	--
Sub-total		52	100						
FPC[d]	0.825				Sub-total			64	100
					Harvest Estimate		298		
					Weight[c]		0.940		
					FPC[d]		0.785		
3 July - 12 Sept.	3	--	--	--	Small	≤149	--	--	--
	4	3	25.0	7.92	Stock	150-269	3	25.0	7.92
	5	2	16.7	6.82	Quality	270-339	9	75.0	7.92
	6	5	41.6	9.02	Preferred	340-449	--	--	--
	7	2	16.7	6.82	Memorable	450-559	--	--	--
					Trophy	≥560	--	--	--
Sub-total		12	100						
FPC[d]	0.368				Sub-total		12	100	
					Harvest Estimate		19		
					Weight[c]		0.060		
					FPC[d]		0.368		
Combined[e] Across Both Seasonal Components	3	1	1.8	1.64	Small	≤149	--	--	--
	4	23	37.7	5.84	Stock	150-269	28	38.2	5.14
	5	19	31.7	5.63	Quality	270-339	48	61.8	5.14
	6	17	24.2	5.07	Preferred	340-449	--	--	--
	7	4	4.6	2.34	Memorable	450-559	--	--	--
					Trophy	≥560	--	--	--
Total		64	100.0		Total		76	100	
					Season Harvest Estimate		317		

[a] Standard errors have been adjusted by the square root of the finite population correction factor.

[b] Range is the fork length range of the RSD category in mm.

[c] Stratum weight equal to harvest estimate for seasonal component divided by total season harvest estimate.

[d] FPC is finite population correction factor equal to 1 - (sample size/harvest estimate).

[e] Percent composition and standard errors are weighted means across seasonal components.

Table 7. Relative Stock Density (RSD) of rainbow trout in the harvest sample by seasonal component, at Piledriver Slough, Tanana River drainage, Alaska, 1 May through 12 August, 1990.

Category	Range[a]	n	%	SE (%)[b]
Early season 1 May - 2 July				
Stock	180-224	49	34.0	3.65
Quality	225-299	93	64.6	3.68
Preferred	300-374	2	1.4	0.90
Memorable	375-449	0	0	---
Trophy	450-above	0	0	---
Sub-total		144	100	
Harvest Estimate	942			
Weight[c]	0.398			
FPC[d]	0.847			
Late season 3 July - 12 August				
Stock	180-224	49	25.4	2.92
Quality	225-299	143	74.1	2.93
Preferred	300-374	1	0.5	0.48
Memorable	375-449	0	0	---
Trophy	450-above	0	0	---
Sub-total		193	100	
Harvest Estimate	1,424			
Weight[c]	0.602			
FPC[d]	0.602			
Entire season 1 May - 12 August[e]				
Stock	180-224	98	28.8	2.28
Quality	225-299	236	70.3	2.30
Preferred	300-374	3	0.9	0.46
Memorable	375-449	0	0	---
Trophy	450-above	0	0	---
Total		337	100	
Season Harvest Estimate	2,366			

[a] Range is the fork length range of the RSD category in mm.
[b] Standard errors have been adjusted by the square root of the finite population correction factor.
[c] Stratum weight equal to harvest estimate for seasonal component divided by total season harvest estimate
[d] FPC is finite population correction factor equal to 1 - (sample size/ harvest estimate).
[e] Percent composition and standard errors are weighted means across seasonal components.

Table 8. Demographic profile of anglers interviewed at Piledriver Slough, Tanana River drainage, Alaska, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] Prop	Angler Characteristic	n[a]	Prop[b]	SE[c] Prop
Total Number of Interviews	812	--	--	Local[d]	734	0.910	0.086
				Non-local	69	0.090	0.023
Male	699	0.884	0.079	Tourist	45	0.050	0.014
Female	113	0.116	0.020	Non-Tourist	765	0.950	0.096
Adult	699	0.870	0.091	Gear Type:			
Youth	111	0.130	0.021	Spinners	485	0.562	0.068
				Bait	2	<.010	0.003
Resident	702	0.870	0.085	Jigs		0	0
Non-Resident	108	0.130	0.022	Flies	309	0.437	0.051
Military	356	0.480	0.070				
Non-Military	454	0.520	0.052				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard error of the weighted proportion.

[d] Local and non-local includes Alaska residents only. Local category are anglers from the Fairbanks-North Pole area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 9. Opinions of anglers interviewed at Piledriver Slough, Tanana River drainage, Alaska, 1990.

Question	Opinion	n	Prop[a]	SE[b] Prop
1. How would you rate the quality of fishing at Piledriver Slough this year?	Excellent (1)	15	0.02	0.007
	Good (2)	197	0.41	0.063
	Fair (3)	222	0.33	0.035
	Poor (4)	111	0.09	0.007
	No Opinion (5)	131	0.15	0.024
	Total	676	100	
	Mean	2.78		
2. What is your opinion of stocking rainbow trout in Piledriver Slough?	Approve	547	0.88	0.060
	Disapprove	8	0.01	0.002
	No Opinion	97	0.11	0.018
	Total	652	100	
3. What is your opinion of a 12 inch minimum length limit for Arctic grayling in Piledriver Slough?	Approve	390	0.67	0.061
	Disapprove	48	0.06	0.018
	No Opinion	213	0.27	0.035
	Total	651	100	
4. What is your opinion of restricting the use of bait in Piledriver Slough (only artificial flies and lures may be used)?	Approve	360	0.64	0.065
	Disapprove	74	0.11	0.017
	No Opinion	216	0.25	0.035
	Total	650	100	

[a] Proportions are weighted proportions, weighted by individual sample weights.

[b] Standard error of the weighted proportion.

considered to be incomplete, although minimal additional data would have been collected.

Data collected during the 1990 creel survey at Piledriver Slough suggests that a substantial portion of the Arctic grayling fishery can be characterized as catch and release. This practice is thought to be largely voluntary, but is driven in part by the 12 inch minimum length limit regulation. Anglers reported catching more than 10,000 Arctic grayling, but harvested slightly more than 300. The data also shows that the majority of the total catches (85%) and the total harvests (94%) of Arctic grayling occurred in the early season (May and June), prior to the 1990 stocking of 20,000 catchable size rainbow trout, which took place on 28 June.

The large proportion of Arctic grayling in the catch during the early season may be a function of the fact that only a few rainbow trout survived the winter and were available to the anglers, or that the larger legal size (12" and greater) Arctic grayling are migrating into Piledriver Slough and may be more concentrated in preparation to their spawning.

Anglers released three quarters of the estimated catch of rainbow trout (7,865 rainbows caught, 1,988 harvested). The bulk of the rainbow trout catches (65%) and harvests (60%) took place during the late season (July and August) after the rainbow trout were stocked.

Arctic grayling sampled in the harvest ranged in fork length from 220 mm to 321 mm, indicating some violation of the 12 inch minimum length regulation.

CHAPTER 2 HARDING LAKE NORTHERN PIKE FISHERY

Introduction

Harding Lake is a large (1,000 ha) land-locked lake, accessible from the Richardson Highway, located approximately 77 km southeast of Fairbanks (Figure 6). The lake contains resident populations of northern pike, burbot, and whitefish.

Recent enhancement efforts have resulted in the introduction of Arctic char, rainbow trout, Arctic grayling, lake trout, and kokanee (land-locked sockeye salmon). Lake trout were first stocked in the mid 1960's and a few of those fish still remain in Harding Lake today. The enhancement program is designed to divert angling pressure away from wild stocks by providing diverse and alternative sport fishing opportunities at places like Harding lake. A goal of ADFG is to develop Harding Lake into a major recreational fishery, providing recreational and economic benefit to the residents of the entire area.

Fishing for northern pike has become increasingly popular with Interior anglers. Mills (1989) reported a total of 3,256 days of effort to harvest more than 2,000 northern pike from Harding Lake in 1988. Effort increased in 1989 to 4,935 days of effort with a harvest of 1,764 northern pike, thus making Harding Lake the largest northern pike fishery in interior Alaska for the second consecutive year (Mills 1990). For this reason and the fact that our enhancement efforts are expected to attract yet more anglers to the lake,

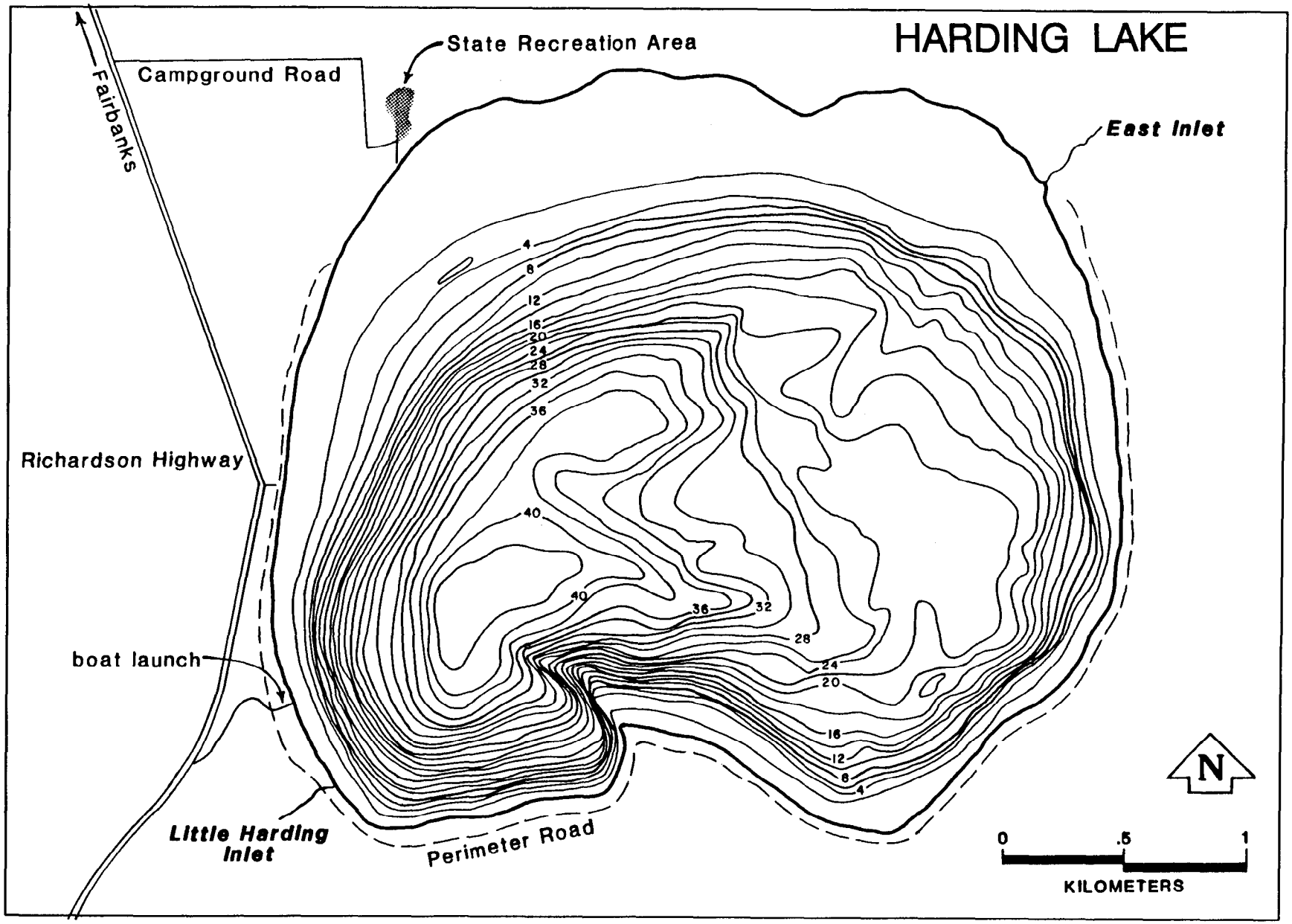

Figure 6. Map of Harding Lake, Tanana River drainage, Alaska.

it becomes imperative that we closely monitor the northern pike sport fishery at Harding Lake.

ADFG has initiated a research project to estimate northern pike population abundance in Harding Lake. In concert with this on-going research ADFG conducted an intensive creel survey for the period of mid-May to mid-June, a time when most of the northern pike fishing is thought to occur.

Specific objectives of the 1990 Harding Lake northern pike creel survey are listed below:

1. to provide post-season estimates of the distribution of catches and harvests of northern pike by angler trip at Harding Lake;

2. to provide estimates of percent age and length compositions for northern pike harvested from Harding Lake;

3. to estimate the percent angler demographics of anglers interviewed at Harding Lake that are in the following categories:

   a) male/female;
   b) adult/youth;
   c) resident/non-resident;
   d) local/non-local;
   e) tourist/military; and,
   f) terminal gear used; (spinner/bait/flies/jigs/trolling/spear).

4. to estimate the mean rating by anglers of the quality of fishing at Harding Lake.

In addition, the percent response to questions asked of anglers interviewed at Harding Lake was estimated. The fishery at Harding Lake (for all species) was monitored throughout the summer after the end of the formal creel survey, on an extremely reduced schedule. The objective of the spot check creel survey is to alert the fishery manager of any new fishery that may develop as the result of the on-going enhancement efforts at Harding Lake.

Methods

The type of survey used at Harding Lake in 1990 was a direct expansion type creel survey. Because the majority of the anglers fishing Harding Lake gain access at the Harding State Recreation area (Figure 6), all surveys were conducted at this location. During the survey the creel clerk would attempt to interview all individual anglers who had completed fishing and were exiting the area. If anglers were not interviewed, then non-interviewed anglers (exiting) were counted.

Study Design:

The design for the spring 1990 Harding Lake northern pike creel survey was a stratified two-stage sampling program, with days as the primary units and anglers as the secondary units.

The sampling strata and number of days in each stratum for the Harding Lake creel survey in 1990 are listed below.

Stratum	Total Number of Days in Stratum
Early day 0800 to 1300 hours	31
weekdays/late-day 1300 to 2200 hour	20
weekends-holidays/late-day 1300 to 2200 hours	11

Sampling effort among the three strata was designed to place most of the effort on the days with proportionally the most angler-trips and subsequently the most catch and harvest. Therefore, every weekend-holiday/late-day strata was censused. Since the total of 11 weekend-holiday/late day stratum days were censused, only seven remaining samples were allocated to fully utilize a single creel clerk's allotted time. We expected a minimal amount of angler effort during the morning stratum, as such we scheduled only three samples during this stratum. The remaining four of 20 weekday/late-day stratum days were selected at random without replacement.

Attempts were made to sample all northern pike harvested during sampled periods. All fish were examined for tags or fin clip markings and were measured to the nearest mm fork length (FL). In addition, a scale sample was collected and each fish was sexed (if possible). All data along with the date and location was recorded on scale envelopes. The number of northern pike to sample for the estimation of age composition or RSD was set at approximately 32 fish[10].

Data Analysis:

Estimates of the distribution of angler catches and harvest of northern pike in Harding Lake during 1990 were obtained by the procedures outlined in equations 1 through 12, above. We set k_{max} equal to 10 fish for angler catches and harvests of northern pike.

The estimates of proportions of harvested fish by category (objective 2), were calculated according to the procedures outlined in equations 13 through 17, above. The following text defines the various categories associated with the proportional (or percentage) parameters estimated.

The different age classes represented the various categories for estimates associated with objective 2. In applying equations 13 through 17 for these estimates, only sampled fish with legible age structures were used for estimation purposes, accordingly the terms n_{uh} and n_h did not include unaged samples. Additionally, since period of day was not recorded along with the age and size data, then estimates were obtained by ignoring the various levels of stratification.

RSD's represented the proportions of harvested fish (by species) that met certain length category criteria (either stock, quality, preferred, memorable,

[10] Obtained using the table from Thompson (1987), with $\alpha = 0.05$, a precision level of ±20%, and applying a finite population correction factor as per Cochran (1977) with an anticipated harvest of 6,000 fish.

or trophy). The categories and criteria for northern pike were defined as follows (adapted from English units, to nearest 10 mm size, given by Gabelhouse 1984):

Category	RSD = Percentage of northern pike harvested that are between the following length limits
Stock	290 mm ≤ length < 530 mm
Quality	530 mm ≤ length < 660 mm
Preferred	660 mm ≤ length < 860 mm
Memorable	860 mm ≤ length < 1,080 mm
Trophy	1,080 mm ≤ length

The proportion of anglers categorized by the demographic characteristics noted in objective 3, and the proportions of anglers responding to the questions associated with objective 4 were estimated following the procedures outlined in equations 34 through 37.

Results

The Harding Lake northern pike fishery began on 18 May when the winter ice began moving off-shore allowing pike to move into the shallows in preparation for spawning. Sampling occurred during all scheduled (strata) periods (18 May through 17 June), and all anglers who had completed fishing and exited the State recreation/boat launch area were interviewed (Table 10).

A total of 223 anglers were interviewed during this period (Table 10). Anglers expended a total of 815 hours (SE = 184) to catch 214 (SE = 147) northern pike. A total of 15 northern pike (SE = 0) were estimated to have been harvested during this period.

Only 23% (SE = 16) of the anglers caught one or more northern pike and only 3% (SE = <.01) harvested one or more pike (Table 11). The distribution of catch and harvest of northern pike among anglers interviewed in 1990 shows the majority of anglers (76%) with zero catches and 97% harvesting zero pike (Figure 7). About 1% (SE < 1) of the angler-trips resulted in catches greater than the existing bag limit of five northern pike.

The predominant age class of the harvested northern pike was age 6, comprising 56% (SE = 13) of the harvest (Table 12). Northern pike sampled in the creel ranged in length from 280 mm to 638 mm. The predominant RSD category of the harvested northern pike was quality, comprising 73% (SE = 7) of the harvest. No northern pike in the preferred, memorable, or trophy category were sampled.

The majority of anglers interviewed were male (89%, SE = 23), adult (88%, SE = 18), and local residents (94%, SE = 18; Table 13). Tourists comprised only 6% (SE = 6) of the anglers interviewed. All anglers (100%, SE = 23) used spinners for terminal gear.

The majority (55%, SE = 11) of anglers interviewed in 1990 were fishing Harding Lake for the first time (Table 14). Thirty-seven percent (SE = 12)

Table 10. Summary of the angler count data and estimates of angler effort, catch and harvest, by stratum for the Harding Lake northern pike fishery, 18 May through 17 June, 1990.

Strata Information		Sampling Information[c]				Parameter Estimates[d]					
We/Wd[a]	Period[b]	d	D	m	M	E	SE	C	SE	H	SE
Both	A	3	31	11	11	230	182	155	147	0	0
We	B	11	11	202	202	489	0	59	0	15	0
Wd	B	4	20	10	10	96	25	0	0	0	0
TOTALS		18	62	223	223	815	184	214	147	15	0

[a] Both = no weekend/weekday stratification;
We = weekend; and,
Wd = weekday.

[b] A = early day 0800 to 1300 hours; and,
B = late day 1300 to 2200 hours.

[c] d = number of days sampled for angler interviews;
D = total number of days available for sampling;
m = total number of anglers interviewed; and,
M = total number of anglers counted.

[d] E = estimated angler effort in angler-hours.
C = estimated catch of northern pike;
H = estimated harvest of northern pike; and,
SE = standard error of the respective angler effort, catch and harvest statistics.

Table 11. Distribution of northern pike catch and harvest among anglers interviewed at Harding lake, 18 May through 17 June, 1990.

Catch	Catch Distribution Prop[a]	Catch Distribution SE	% Dist Catch Among Anglers	Harvest Distribution Prop[a]	Harvest Distribution SE	% Dist Harvest Among Anglers
0	-----	-----	76.48[b]	-----	-----	96.99[b]
1	0.235	0.161	10.93	0.030	0.000	1.91
2	0.125	0.080	5.01	0.010	0.000	1.09
3	0.075	0.053	0.82	0.000	0.000	0.00
4	0.067	0.053	0.00	0.000	0.000	0.00
5	0.067	0.053	5.65	0.000	0.000	0.00
6	0.010	0.000	0.82	0.000	0.000	0.00
7	0.002	0.000	0.27	0.000	0.000	0.00
8	0.000	0.000	0.00	0.000	0.000	0.00
9	0.000	0.000	0.00	0.000	0.000	0.00
10 or more	0.000	0.000	0.00	0.000	0.000	0.00

[a] Proportion of angler-trips that caught or harvested at least given number of northern pike.

[b] Percentage of angler-trips that resulted in zero catch and zero harvest.

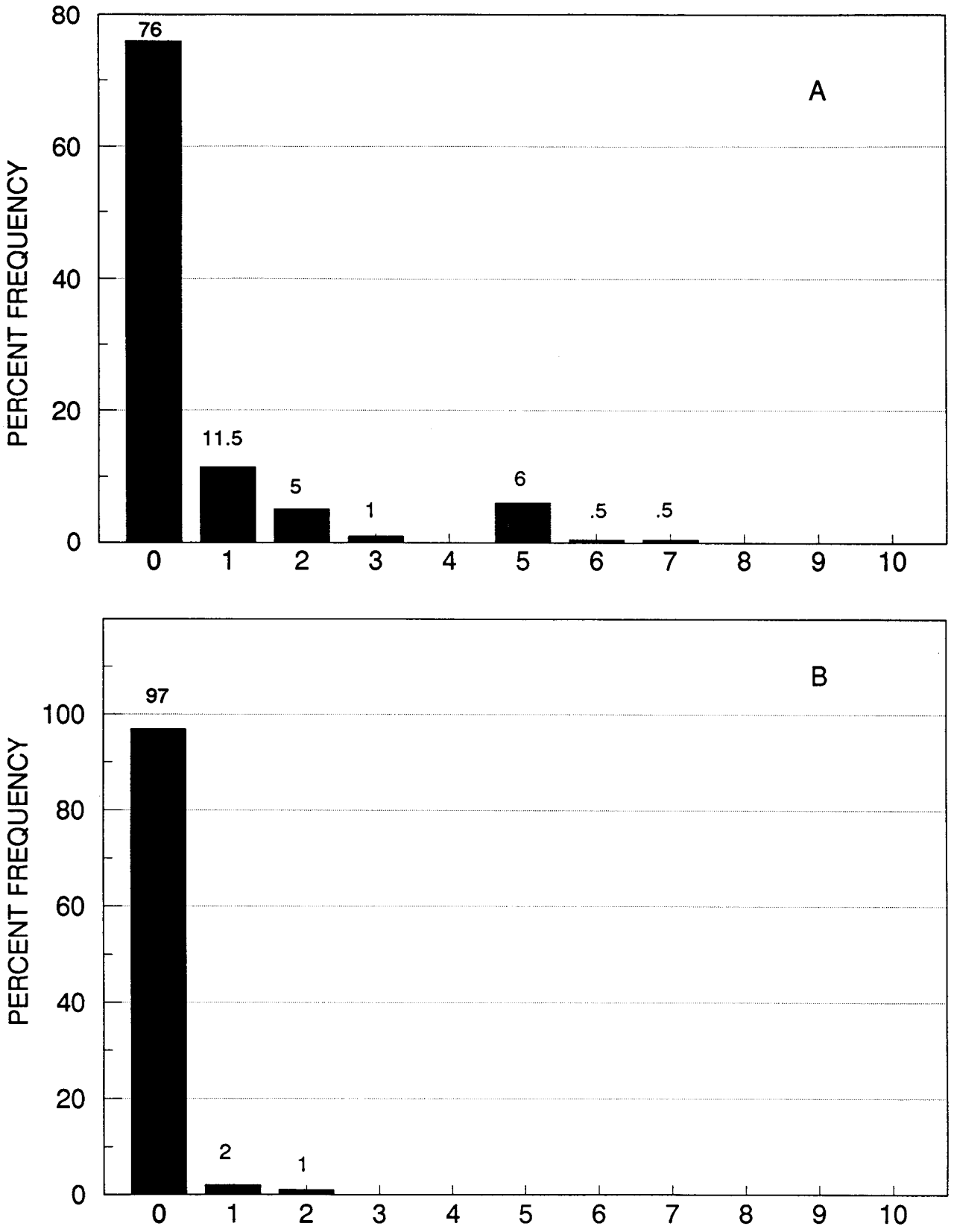

Figure 7. Distribution of northern pike catch (A) and harvest (B) among anglers interviewed at Harding Lake, Tanana River drainage, Alaska, 1990.

Table 12. Estimates of the contributions of each age class and relative stock density of northern pike in the harvest from Harding Lake, Alaska, 18 May through 17 June, 1990.

Seasonal Component	Age Composition				Relative Stock Density (RSD)				
	Age	n	%	SE(%)[a]	Category	Range[b]	n	%	SE(%)[a]
	3	1	11.1	8.54	Small	≤ 289	1	9.1	4.70
	4	--	--	--	Stock	290- 529	2	18.2	6.30
	5	1	11.1	8.54	Quality	530- 659	8	72.7	7.27
	6	5	55.6	13.50	Preferred	660- 859	--	--	--
	7	2	22.2	11.30	Memorable	860-1079	--	--	--
					Trophy	≥1080	--	--	--
Total		9	100						
FPC[c]	0.40				Total		11	100	
					Harvest Estimate		15		
					FPC[c]		0.266		

[a] Standard errors have been adjusted by the square root of the finite population correction factor.

[b] Range is the fork length range of the RSD category in mm.

[c] FPC = finite population correction factor; equal to 1 - (sample size/harvest estimate).

Table 13. Demographic profile of anglers interviewed at the Harding Lake State recreation area and boat launch, Tanana River drainage, Alaska, 18 May through 17 June, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] Prop	Angler Characteristic	n[a]	Prop	SE[c] Prop
Total Number of Interviews	223	--	--	Local[d]	219	0.94	0.178
				Non-local	4	0.06	0.057
Male	184	0.89	0.233	Tourist	2	0.06	0.057
Female	39	0.11	<0.001	Non-Tourist	221	0.94	0.178
Adult	197	0.88	0.178	Gear Type:			
Youth	26	0.12	0.057	Spinners	221	1.00	0.233
				Bait	0	0	0
Resident	220	0.94	0.178	Jigs	0	0	0
Non-Resident	3	0.06	0.057	Flies	0	0	0
Military	66	0.38	0.147				
Non-Military	157	0.62	0.089				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard errors of the weighted proportion.

[d] Local and non-local includes Alaska residents only. Local category are anglers from the Fairbanks-North Pole area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 14. Opinions of anglers interviewed at Harding Lake, Tanana River drainage, Alaska, 18 May through 17 June, 1990.

Question	Opinion	n	Prop[a]	SE[b] Prop
1. How would you rate the quality of fishing at Harding Lake this year?	Excellent (1)	6	0.093	0.080
	Good (2)	14	0.092	0.053
	Fair (3)	38	0.180	0.059
	Poor (4)	160	0.620	0.060
	No Opinion (5)	1	0.013	0.012
	Total	219	1.00	
	Mean	3.61		
2. How often do you fish here?	First Time	124	0.552	0.110
	1-2 times/year	17	0.370	0.122
	1-2 times/month	16	0.043	0.000
	1-2 times/week	12	0.033	0.001
	> 2 times/week	0	0	0
	Total	169	1.00	
3. What species do you normally catch at Harding Lake?	Grayling	0	0	0
	Pike	70	0.394	0.163
	Rainbow Trout	0	0	0
	Lake Trout	0	0	0
	Arctic Char	1	0.002	0.000
	Burbot	1	0.002	0.000
	Other	0	0	0
	No Opinion	147	0.599	.079
	Total	219	1.00	
4. What species do you prefer to catch at Harding Lake?	Grayling	0	0	0
	Pike	24	0.124	0.035
	Rainbow Trout	0	0	0
	Lake Trout	1	0.002	0.000
	Arctic Char	0	0	0
	Burbot	1	0.013	0.012
	Other	0	0	0
	No Opinion	195	0.859	0.236
	Total	221	1.00	

[a] Proportions are weighted proportions, weighted by sample and stratum weights.

[b] Standard errors of the weighted proportions.

said they fished at Harding Lake once or twice a year. Sixty-two percent (SE = 6) of all anglers interviewed rated the quality of fishing at Harding lake as poor. Sixty percent (SE = 8) of the anglers interviewed had no opinion when asked "what species do you normally catch at Harding Lake". Of those anglers voicing an opinion regarding the species they normally target at Harding Lake, 97% (70 anglers) said they normally catch northern pike. One angler interviewed indicated that he normally caught burbot while another angler reported Arctic char. When asked what species the angler would prefer to catch at Harding Lake, the majority of the anglers (86%, SE = 24) had no opinion. Of the 26 anglers expressing an opinion, 24 responded that they would prefer to fish for northern pike, one said they would prefer to catch lake trout, and one wanted to catch burbot (Table 14).

Sampling of the anglers' creel at Harding Lake continued on a much reduced schedule from 18 June to 1 August 1990 A creel clerk was stationed at the Harding Lake recreation/boat launch area on weekend days from approximately 1500 hours to 2200 hours. Interviews were conducted with anglers who had completed fishing and were exiting the area. The creel clerk reported that during the 12 (weekend afternoon) sampling periods a total of 80 such interviews were obtained. Sixty-eight anglers reported zero catches, eight reported catches of one northern pike with two of these being released and six being harvested. Two anglers reported to have caught and retained two pike each and two other anglers caught and harvested three northern pike each. The total observed (minimum) harvest of northern pike during this period was 16. No other species of fish were encountered in the creel during this time.

Discussion

A substantial portion of the northern pike fishery at Harding Lake in 1990 could be characterized as catch-and-release, with nearly 93% of the fish caught (214) being released (199). Merritt, et al. (1990) reported that in 1989, 46% of the catch of 1,237 were released (572).

The daily bag limit (harvest) for northern pike in Harding Lake in 1990 was "5 northern pike of which only one may be over 30 inches". No violation of the daily bag limit was encountered during the 1990 creel survey. In fact no angler interviewed harvested more than two pike. Reduction in the daily bag limit for northern pike at Harding Lake from five down to two fish would appear to have little affect on the harvest. Similarly, since no anglers harvested more than two northern pike, a relaxing of the current bag limit would have little immediate impact on the harvest.

The harvest estimate of 15 northern pike during the intensive creel survey (18 May through 17 June) represents a substantial reduction from estimated harvest for the entire year during 1989. Mills (1990) reported a harvest of 1,764 northern pike from Harding Lake for the year 1989. Whereas, Merritt, et al. (1990) reported an estimated harvest of 665 (SE = 316) for the 2 June through 24 August 1989 period. During, the 2-30 June 1989 period the estimated harvest was 136 northern pike (SE = 102). During our spot check of the fishery from 18 June through 1 August 1990, we observed 16 additional northern pike harvested. Accordingly, we assume that substantially more fish were harvested during 1990 than the minimum estimate of 31 northern pike.

CHAPTER 3 - DELTA CLEARWATER RIVER ARCTIC GRAYLING FISHERY

Introduction

The Delta Clearwater River provides a popular Arctic grayling sport fishery. The river is located approximately 13 km northeast of Delta Junction. The main channel of the river is approximately 32 km long. The river drains an area of about 1,000 km^2. Public access to the river is available at the State of Alaska Clearwater Campground at river kilometer 13 and at the U.S. Army facility on Clearwater lake (Figure 8).

Fishing begins on the Delta Clearwater River in mid to late May when the larger Arctic grayling begin to migrate to their summer feeding areas in the upper part of the river. From 1977 to 1989, an average of 6,265 angler-days were expended annually to harvest an average of 4,993 Arctic grayling (Mills 1979-1990). In 1986, angler effort peaked at 10,137 angler days. However, in 1986, harvest dropped to its lowest level (2,343 fish) since 1977 (Mills 1979-1988). Because of concern for the fishery and the decline in harvest, emergency regulations were set forth on the Delta Clearwater River to protect the Arctic grayling stock(s) in 1987. These emergency regulations became permanent regulations in 1988. The regulations implemented were:

1) a 12 inch minimum length limit for Arctic grayling;

2) a no-bait restriction (only artificial flies and lures may be used); and,

3) catch and release Arctic grayling fishing from 1 April to the first Saturday of June each year.

To examine the effects of these new regulations, an on-site creel survey was initiated on the Delta Clearwater River in 1986. Point estimates of angler-effort, catch and harvest were obtained from 1986 to 1988 (Clark and Ridder 1987, Baker 1988 and 1989) To be more cost-effective, angler counts were dropped from the on-site creel survey in 1989, consequently no estimate of effort or harvest were obtained, however estimates of CPUE and HPUE were reported (Merritt, et al. 1990).

The long term goals of this creel survey are to: (1) develop a historical database to allow the monitoring of both the recreational fishery and the exploited fish populations; (2) develop management regulations that reflect the desires of the angling public while ensuring the sustained health of the fish populations; and (3) evaluate the effect of management regulations and enhancement programs on the fishery. Specific objectives for the Delta Clearwater River creel survey in 1990 are listed below.

1. To provide post-season estimates of the distribution of catches and harvests of Arctic grayling by angler trip at the Delta Clearwater River.

2. To provide estimates of the proportion of fish harvested with marks (fin clips and/or tags).

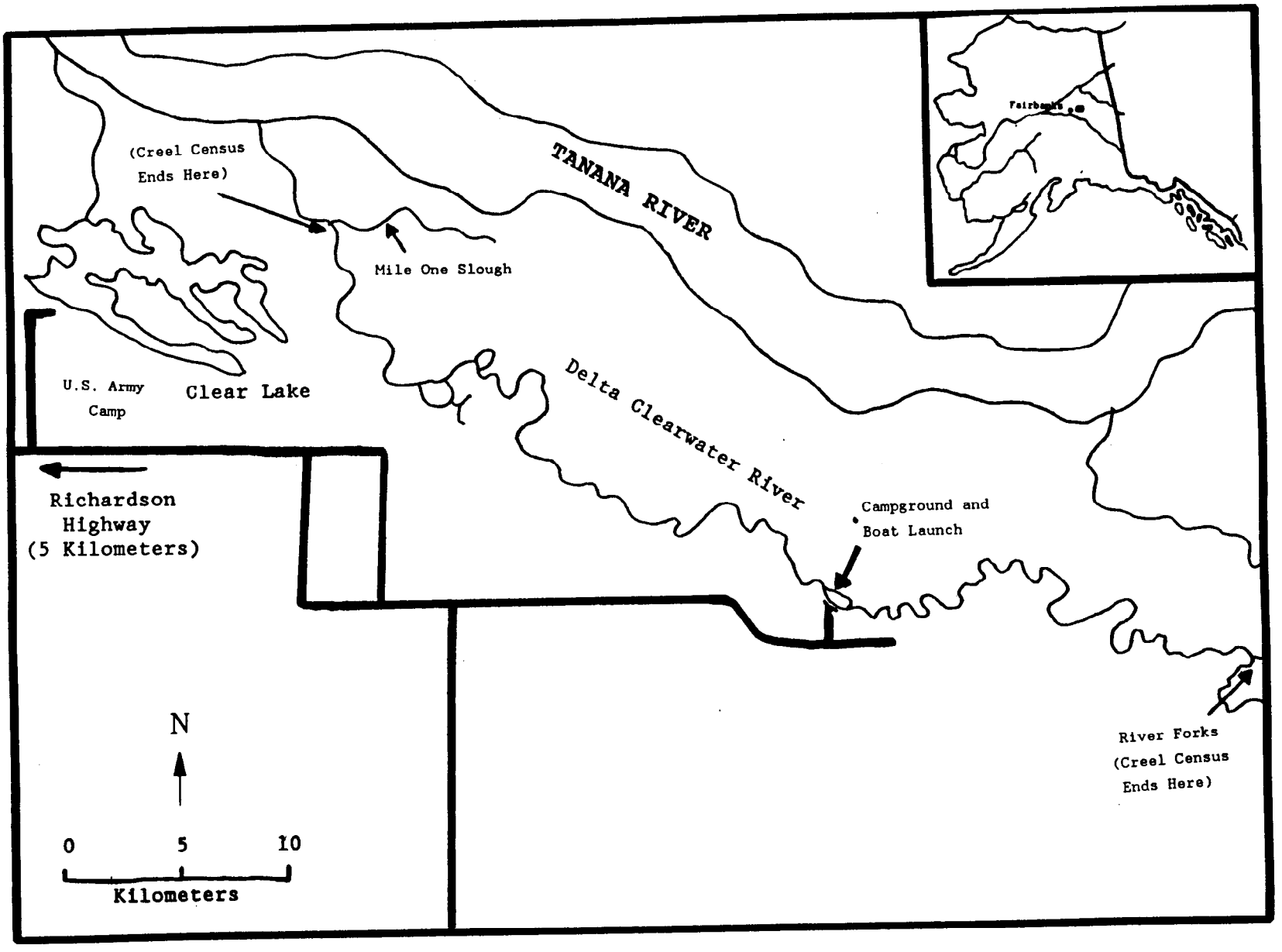

Figure 8. Map of the Delta Clearwater River, Tanana River drainage, Alaska.

3. To provide post-season estimates of percent age and length compositions for Arctic grayling at the Delta Clearwater River.

4. To estimate the percent angler demographics of anglers interviewed at the Delta Clearwater that are in the following categories:

   a) male/female;
   b) adult/youth;
   b) resident/non-resident;
   c) local/non-local;
   d) tourist/non-tourist;
   e) military/non-military; and,
   f) terminal fishing gear (spinner/bait/flies/jigs/trolling/spear).

5. To estimate the mean rating by anglers of the quality of fishing at the Delta Clearwater River.

In addition, the percent response to questions asked of anglers interviewed was estimated. Angler-effort, catch and harvest were also estimated.

Methods

The survey used at the Delta Clearwater River in 1990 was a direct expansion type creel survey. Since the majority of the anglers fishing the Delta Clearwater River gain access to the river at the State of Alaska Clearwater River campground (Figure 8), all surveys were conducted at this location.

Study Design:

The study design for the 1990 Delta Clearwater River creel survey was a stratified two-stage sampling program, with days as the primary units and anglers as the secondary units. The creel clerk interviewed all anglers who completed fishing and exited the area.

The creel survey at the Delta Clearwater River was run from 1 June through 12 August. Ten strata were defined as follows:

Stratum	Description	Days available for sampling
	June	
(1)	early day 0800 to 1500 hours	30
(2)	weekday late 1500 to 2200 hour	21
(3)	weekends-holidays late 1500 to 2200 hours	9
	July	
(4)	weekday early 0800 to 1500 hours	21
(5)	weekday late 1500 to 2200 hour	21
(6)	weekends-holidays early 0800 to 1500 hours	10
(7)	weekends-holidays late 1500 to 2200 hours	10
	August	
(8)	early day 0800 to 1500 hours	12
(9)	weekday late 1500 to 2200 hours	8
(10)	weekends-holidays late 1500 to 2200 hours.	4

Evaluation of the 1989 Delta Clearwater River creel survey data (Merritt et al. 1990) indicated that more fishing effort occurred in July than in June or August. Consequently, the month of July was stratified into four periods (as noted above), while only three were defined within June and August.

Sampling effort among the strata was designed to place most of the effort on the days with proportionally the most angler-trips and subsequently the most catch and harvest. Therefore, nearly every weekend-holiday late strata day was surveyed. Sampling during the remaining strata was allocated to fully utilize a single creel clerks allotted time. We expected the minimal amount of angler effort during the morning weekday stratum, and as such, we scheduled only three samples each month to this stratum. Three sampling periods were scheduled for the early weekend day stratum for July only, with the remaining weekday/late-day stratum days allocated nearly equally for each of the three months. All scheduled sampling periods were selected at random without replacement.

Attempts were made to sample all Arctic grayling harvested by anglers exiting the fishery during the sampled periods. All fish were examined for tags or fin clip markings and were measured to the nearest mm. In addition, a scale sample was collected and each fish was sexed (if possible). All data along with the date and location was recorded on scale envelopes. The number of Arctic grayling to sample for meeting the objective criteria for the estimation of RSD was set at approximately 393 fish[11].

Data Analysis:

Estimates of the distribution of angler catches and harvest of Arctic grayling in the Delta Clearwater River during 1990 were obtained by the procedures outlined in equations 1 through 12, above. We set k_{max} equal to 10 fish for Arctic grayling caught or harvested.

The estimates associated with objective 3 were calculated according to the procedures outlined in equations 13 through 17, above. The following text defines the various categories associated with the proportional parameters estimated.

The different age classes represent the various categories for estimates associated with objective 3(a). In applying equations 13 through 17 for these estimates, only sampled fish with legible age structures were used for estimation purposes; the terms n_{uh} and n_h did not include unaged samples. Additionally, because time of day was not recorded with the length and age data, the estimates were obtained by ignoring the time of day and weekend versus weekday level of stratification[12].

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[11] Again obtained using the table from Thompson (1987), with $\alpha = 0.05$, a precision level of ±5%, and applying a finite population correction factor as per Cochran (1977) with an anticipated harvest of 1,700 fish (approximately equal to the number harvested reported by Mills 1989).

[12] That is, only seasonal level of stratification was used in applying equations 13 through 17 to estimate proportions of fish harvested by category.

RSD's represented the proportions of harvested fish (by species) that met certain length category criteria (either stock, quality, preferred, memorable, or trophy). The categories and criteria for Arctic grayling were as given in a previous chapter of this report (i.e., Chapter 1 - Piledriver Slough Rainbow Trout and Arctic Grayling Fishery).

The proportion of anglers categorized by the demographic characteristics noted in objective 4, and the proportions of anglers responding to the questions associated with objective 5 were estimated following the procedures outlined in equations 34 through 37.

Results

The Delta Clearwater Arctic grayling creel survey was originally scheduled to run from 1 June to 31 August 1990. Due to unexpected budgetary problems, the creel survey was terminated nineteen days early, on 12 August. The objectives for the creel survey at the Delta Clearwater River did not include estimating angler-effort, or the catch, and harvest of Arctic grayling. However, these statistics along with standard errors were obtained ancillary to other objectives and are summarized by strata in (Table 15).

During the creel survey, a total of 406 anglers were interviewed (Table 15). The number of angler interviews for June and July were nearly equal with 187 and 179 anglers contacted respectively. Due to the shortened creel survey only 40 anglers were interviewed during the first 12 days of August. Anglers during this period expended 2,703 (SE = 224) hours of effort to catch 2,861 (SE = 388) Arctic grayling, of which 1,096 (SE = 154) were harvested.

Fifty-seven percent (SE = 5) of the anglers at the Delta Clearwater River caught one or more Arctic grayling, and 39% (SE = 4) harvested one or more Arctic grayling (Table 16). The percent distribution of catch and harvest of Arctic grayling among anglers interviewed in 1990 shows 43% of the anglers with zero catches and the majority of anglers (61%) harvesting zero Arctic grayling (Figure 9).

Biological data were collected from 412 Arctic grayling harvested during the creel survey. Harvested Arctic grayling ranged in age from 3 to 14 years (Table 17). Age 7 was the predominant age class accounting for 24% (SE = 2) of the harvest.

Ten of the 412 Arctic grayling examined during the creel survey at the Delta Clearwater River in 1990 carried Floy internal anchor tags. Seven of the 10 Arctic grayling were tagged in the Delta Clearwater River in 1988, one individual was tagged in the Goodpaster River in 1988, and two were tagged in the Goodpaster River in 1989.

The predominant RSD category of the harvested Arctic grayling was preferred, comprising 50% (SE = 2) of the harvest (Table 17). Forty-eight percent (SE = 2) of the harvest was of the quality category, 2% (SE = .05) were stock category, and no fish in the memorable or trophy length categories. Arctic grayling ranged in length from 240 mm to 440 mm fork length, with an average of 340 mm.

Table 15. Summary of the angler count data and estimates of angler effort, catch and harvest, by stratum for the Delta Clearwater River, Arctic grayling fishery, 1 June through 12 August, 1990.

Strata Information			Sampling Information[c]				Parameter Estimates[d]					
Month	We/Wd[a]	Period[b]	d	D	m	M	E	SE	C	SE	H	SE
June	Both	A	5	30	42	42	525	102	852	245	390	113
June	Wd	B	3	21	18	18	315	112	343	270	56	52
June	We/Holiday	B	7	9	127	127	398	29	471	30	262	15
	sub-total		15	60	187	187	1,238	155	1,666	365	708	125
July	Wd	A	3	21	15	15	213	75	133	65	56	52
July	Wd	B	3	21	14	14	294	15	434	102	56	42
July	We/Holiday	A	2	10	23	23	261	140	135	40	85	58
July	We/Holiday	B	7	10	127	127	538	31	397	41	144	15
	sub-total		15	62	179	179	1,306	162	1,099	134	341	90
Aug 1-12	Both	A	1	12	2	2	6	0	0	0	0	0
Aug 1-12	Wd	B	0	8	0	0	0	0	0	0	0	0
Aug 1-12	We/Holiday	B	4	4	38	38	153	0	96	0	47	0
	sub-total		5	24	40	40	159	0	96	0	47	0
TOTALS			40	146	406	406	2,703	224	2,861	388	1,096	154

[a] Both = no weekday/weekend stratification
We = Weekend
Wd = Weekday

[b] A = Early day 0800 to 1500 hours
B = Late day 1500 to 2200 hours

[c] d = number of days sampled for angler interviews.
D = total number of days available for sampling.
m = total number of anglers interviewed.
M = total number of anglers counted.

[d] E = estimated angler effort in angler-hours
C = estimated catch of Arctic grayling
H = estimated harvest of Arctic grayling
SE = standard error of the respective effort, catch and harvest statistics.

Table 16. Distribution of Arctic grayling catch and harvest among anglers interviewed at the Delta Clearwater River, 1 June through 12 August, 1990.

Catch	Catch Distribution Prop[a]	SE Prop	% Dist Catch Among Anglers	Harvest Distribution Prop[a]	SE Prop	% Dist Harvest Among Anglers
0	-----	-----	42.54[b]	-----	-----	60.55[b]
1	0.575	0.052	10.12	0.394	0.044	14.23
2	0.473	0.048	9.17	0.252	0.040	8.62
3	0.382	0.050	8.40	0.166	0.034	5.65
4	0.298	0.048	6.64	0.110	0.023	4.76
5	0.233	0.050	9.56	0.062	0.013	5.48
6	0.137	0.034	2.82	0.007	0.004	0.63
7	0.109	0.029	1.81	0.009	0.000	0.00
8	0.091	0.027	2.06	0.009	0.000	0.00
9	0.070	0.022	1.61	0.009	0.000	0.09
10 or more	0.054	0.015	5.44	0.000	0.000	0.00

[a] Proportion of angler-trips that caught or harvested at least given number of Arctic grayling.

[b] Percentage of angler-trips that resulted in zero catch and zero harvest.

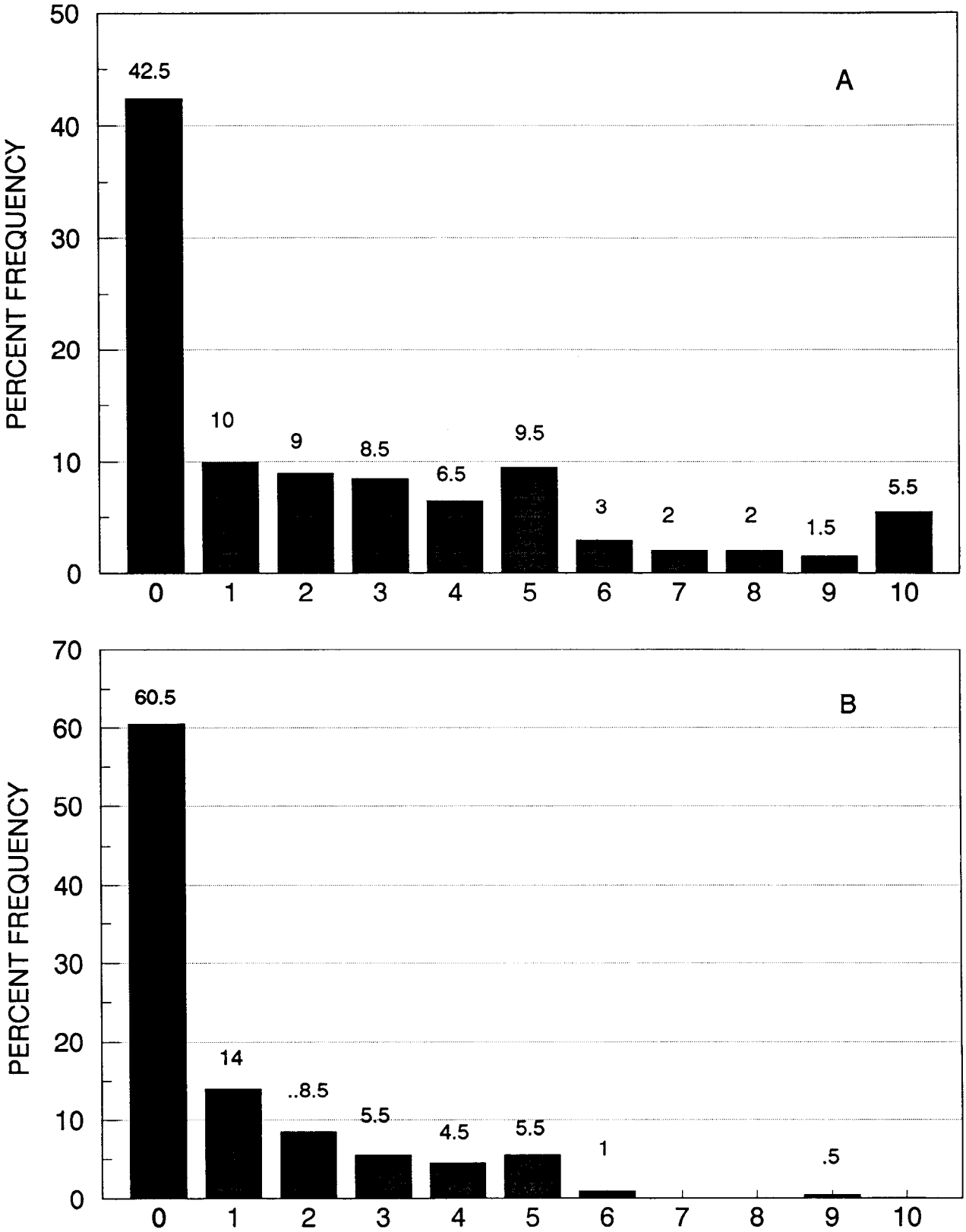

Figure 9. Distribution of Arctic grayling catch (A) and harvest (B) among anglers interviewed at Delta Clearwater River, Tanana River drainage, Alaska, 1990.

Table 17. Estimates of the contributions of each age class and relative stock density of Arctic grayling in the harvest sample, by seasonal component, from Delta Clearwater River, Tanana River drainage, Alaska, 1 June through 12 August, 1990.

Seasonal Component	Age Composition: Age	n	%	SE(%)[a]	Relative Stock Density (RSD): Category	Range[b]	n	%	SE(%)[a]
1-30 June	3	--	--	--	Small	≤149	--	--	--
	4	18	7.7	1.42	Stock	150-269	1	0.4	.31
	5	43	18.3	2.07	Quality	270-339	106	40.9	2.44
	6	31	13.2	1.81	Preferred	340-449	152	58.7	2.44
	7	68	28.9	2.42	Memorable	450-559	--	--	--
	8	33	14.0	1.86	Trophy	≥560	--	--	--
	9	20	8.5	1.49					
	10	16	6.8	1.35	Sub-total		259	100	
	11	2	0.9	0.49	Harvest Estimate		708		
	12	3	1.3	0.60	Weight[c]		0.645985		
	13	1	0.4	0.35	FPC[d]		0.634181		
	14	--	--	--					
Sub-total		235	100						
FPC[d]		0.668079							
1-31 July	3	3	2.8	1.24	Small	≤149	--	--	--
	4	21	19.3	2.98	Stock	150-269	4	3.4	1.30
	5	25	22.9	3.18	Quality	270-339	69	59.0	3.51
	6	24	22.0	3.13	Preferred	340-449	44	37.6	3.45
	7	17	15.6	2.74	Memorable	450-559	--	--	--
	8	8	7.4	1.97	Trophy	≥560	--	--	--
	9	2	1.8	1.02					
	10	5	4.6	1.58	Sub-total		117	100	
	11	1	0.9	0.72	Harvest Estimate		285		
	12	--	--	--	Weight[c]		0.260036		
	13	2	1.8	1.02	FPC[d]		0.589474		
	14	1	0.9	0.72					
Sub-total		109	100						
FPC[d]		0.617544							
1-31 Aug.	3	4	11.1	4.28	Small	≤149	--	--	--
	4	8	22.2	5.67	Stock	150-269	2	5.5	3.12
	5	11	30.5	6.28	Quality	270-339	23	63.9	6.55
	6	5	13.9	4.71	Preferred	340-449	11	30.6	6.28
	7	4	11.1	4.28	Memorable	450-559	--	--	--
	8	2	5.6	3.12	Trophy	≥560	--	--	--
	9	1	2.8	2.24					
	10	1	2.8	2.24	Sub-total		36	100	
	11	--	--	--	Harvest Estimate		103		
	12	--	--	--	Weight[c]		0.093978		
	13	--	--	--	FPC[d]		0.650485		
	14	--	--	--					
Sub-total		36	100						
FPC[d]		0.650485							

- continued -

Table 17. (page 2 of 2).

Seasonal Component	Age Composition: Age	n	%	SE(%)[a]	Relative Stock Density (RSD): Category	Range[b]	n	%	SE(%)[a]
Combined[e] Across All Seasonal Components	3	7	1.8	0.52	Small	≤149	--	--	--
	4	47	12.1	1.31	Stock	150-269	7	1.7	0.48
	5	79	20.7	1.68	Quality	270-339	198	47.8	1.92
	6	60	15.6	1.49	Preferred	340-449	207	50.5	1.91
	7	89	23.8	1.77	Memorable	450-559	--	--	--
	8	43	11.5	1.34	Trophy	≥560	--	--	--
	9	23	6.2	1.02					
	10	22	5.9	0.98	Total		412	100	
	11	3	0.3	0.37	Season Harvest Estimate		1,096		
	12	3	0.5	0.39					
	13	3	0.5	0.35					
	14	1	1.1	0.19					
	Total	380	100						

[a] Standard errors have been adjusted by the square root of the finite population correction factor.

[b] Range is the fork length range of the RSD category in mm.

[c] Stratum weight equal to harvest estimate for seasonal component divided by total season harvest estimate.

[d] FPC is finite population correction factor equal to 1 - (sample size/harvest estimate).

[e] Percent composition and standard errors are weighted means across seasonal components.

The majority of the anglers interviewed were male (73%, SE = 5), adult (91%, SE = 7), and were residents of the State of Alaska (72%, SE = 8; Table 18). Local Delta Junction people accounted for only 17%, (SE = 2). Tourists and military personnel, respectively, made up 23% (SE = 4) and 3% (SE = 1) of the anglers interviewed. Most of the anglers interviewed used flies (55%, SE = 6) or spinners (37%, SE = 5)) as their terminal gear.

Of the 289 anglers who had an opinion, 30% (SE = 4) rated the fishery good, 28% (SE = 4) rated the fishery excellent, 18% (SE = 4) rated it fair, and 2% (SE = 1) rated it poor (Table 19). The majority of the anglers interviewed approved of the current management regulations, with 91% (SE = 7), approving of a 12 inch minimum length limit for Arctic grayling, 87% (SE = 7), approving of a no-bait restriction at the Delta Clearwater River, and 91% (SE = 7), approving of catch-and-release fishing only until the first Saturday in June.

Discussion

Since 1986, when the on site creel surveys began, angler effort has remained similar between 1986 (5,481 hour with SE = 645), 1987 (4,476 hours with SE = 533), and 1988 (4,433 hours with SE = 362; Clark and Ridder 1987; Baker 1988, 1989). However, estimated harvest of Arctic grayling was greater in 1988 (3,330 fish with SE = 360) compared to 1987 (1,838 fish with SE = 450) and 1986 (1,701 fish with SE = 634). No estimates of effort, catch or harvest were available for 1989. This year's estimate of angler effort (2,703 angler-hours) was lower than the years 1986 through 1988. The estimated 1,096 Arctic grayling harvested in 1990, (while also lower) was somewhat closer to the harvests documented in 1986 and 1987. Harvest of Arctic grayling in the Delta Clearwater River as reported in the Statewide Harvest Survey for the years 1986-1989 was 2,419 and the 13-year average from 1977-1989 was 4,993 (Mills 1990).

The Relative Stock Densities (RSD) for Arctic grayling shows that less than 2% (SE = .05) of the Arctic grayling harvested were of the stock category (Table 17). Stock category for Arctic grayling includes fish between 150 mm and 269 mm total length, which is about equal to the fork length of a 12 inch (305 mm) Arctic grayling, the legal minimum length limit. This would illustrate that while some illegal, undersize Arctic grayling harvest is occurring, the frequency of such violation appears to be low.

The data also suggests that many fisherman are participating in catch and release fishing in that anglers reported 2,861 catches of Arctic grayling, but harvested only 38% (1,096).

The distribution of Arctic grayling harvests by anglers indicates that the frequency of harvest decreases with increasing number of fish, however more anglers harvest the bag limit (five per day) than those harvesting four fish per day (Figure 9). The distribution of Arctic grayling harvests by anglers indicate that some illegal harvesting (less than 1% of all anglers interviewed) is occurring. The most Arctic grayling harvested by any angler interviewed was nine.

Table 18. Demographic profile of anglers interviewed at the Delta Clearwater River, Tanana River drainage, Alaska, 1 June through 12 August, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] Prop	Angler Characteristic	n[a]	Prop[b]	SE[c] Prop
Total Number of Interviews	406	--	--	Local[d]	78	0.83	0.024
				Non-local	325	0.17	0.072
Male	291	0.73	0.046	Tourist	64	0.27	0.043
Female	115	0.27	0.035	Non-tourist	332	0.73	0.081
Adult	357	0.91	0.074	Gear Type:			
Youth	49	0.09	0.014	Spinners	161	0.37	0.050
				Jigs	46	0.08	0.031
Resident	317	0.72	0.075	Flies	199	0.55	0.058
Non-Resident	89	0.28	0.049				
Military	21	0.03	0.010				
Non-Military	385	0.97	0.073				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard error of the weighted proportion.

[d] Local and non-local category includes Alaska residents only. Local category are anglers from the Delta Junction area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 19. Opinions of anglers interviewed at the Delta Clearwater River, Tanana River drainage, Alaska, 1 June through 12 August, 1990.

Question	Opinion	n	Prop[a]	SE[a] Prop
1. How would you rate the quality of Arctic grayling fishing at the Delta Clearwater River this year?	Excellent (1)	93	0.283	0.041
	Good (2)	119	0.297	0.043
	Fair (3)	67	0.184	0.040
	Poor (4)	10	0.020	0.011
	No opinion	71	0.214	0.043
	Total	360		
	Mean	1.97		
2. What is your opinion of a 12 inch minimum length limit for Arctic grayling in the Delta Clearwater River?	Approve	340	0.914	0.070
	Disapprove	17	0.063	0.026
	No Opinion	13	0.021	<0.001
	Total	370		
3. What is your opinion of restricting the use of bait in the Delta Clearwater River (Only artificial flies and lures may be used?)	Approve	312	0.871	0.070
	Disapprove	38	0.087	0.027
	No Opinion	19	0.041	0.005
	Total	369		
4. What is your opinion of catch and release fishing only for Arctic grayling in the Delta Clearwater River until the first Saturday in June?	Approve	343	0.911	0.069
	Disapprove	13	0.056	0.026
	No Opinion	13	0.031	0.000
	Total	369		

[a] Percentages are calculated for anglers with opinions only and do not take into account anglers in the no-opinion category.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard error of the weighted proportion.

CHAPTER 4 - LOWER CHENA RIVER CHINOOK SALMON FISHERY

Introduction

Sport fishing for chinook salmon on The Chena River is allowed from the Moose Creek Dam Flood Control Project (river kilometer 72), downstream to its confluence with the Tanana River (Figure 10). Within this area the Chena River flows directly through the city of Fairbanks and the Fort Wainwright Army facility, thus allowing for public access to the fishery at several locations.

Prior to 1984 the area open to salmon fishing in the Chena River extended from the mouth of the Chena River upstream to the confluence of the Little Chena River at river kilometer 39. In 1984, through a Board of Fisheries regulatory action, an additional 33 km, from the confluence of the little Chena River upstream to the Moose Creek Dam site, were opened to sport fishing. Annual sport harvest has been estimated by the statewide postal survey beginning in 1977 (Mills 1979-1990).

The lower Chena River creel program began in 1987, when a significant increase in fishing effort was observed. In 1987, the objectives of the creel survey were to estimate CPUE and HPUE. These objectives were expanded in 1988 and 1989 to include angler effort, catch and harvest estimates. In February of 1990 the Alaska Board of Fisheries established a guideline harvest range for the Chena River recreational chinook salmon fishery of 300-600 fish. In order to ensure that the recreational harvest does not exceed the allocated range, and because Yukon River salmon stocks are being fully utilized by all user groups, it is imperative that we closely monitor the sport harvest on the lower Chena River.

The specific objectives of the lower Chena River creel survey in 1990 were to:

1) estimate angler-effort, CPUE, HPUE, catch, and harvest for chinook salmon at the lower Chena River;

2) estimate the percent composition of angler demographics for the lower Chena River that include:

   a) male/female;
   b) adult/youth;
   c) resident/non-resident;
   e) local/ non-local;
   d) military/non-military;
   f) tourist/non-tourist; and
   g) terminal fishing gear (spinner/bait/flies); and,

3) estimate the mean rating by anglers of the quality of fishing.

In addition, percent response (opinions) to questions asked anglers at the lower Chena River was estimated.

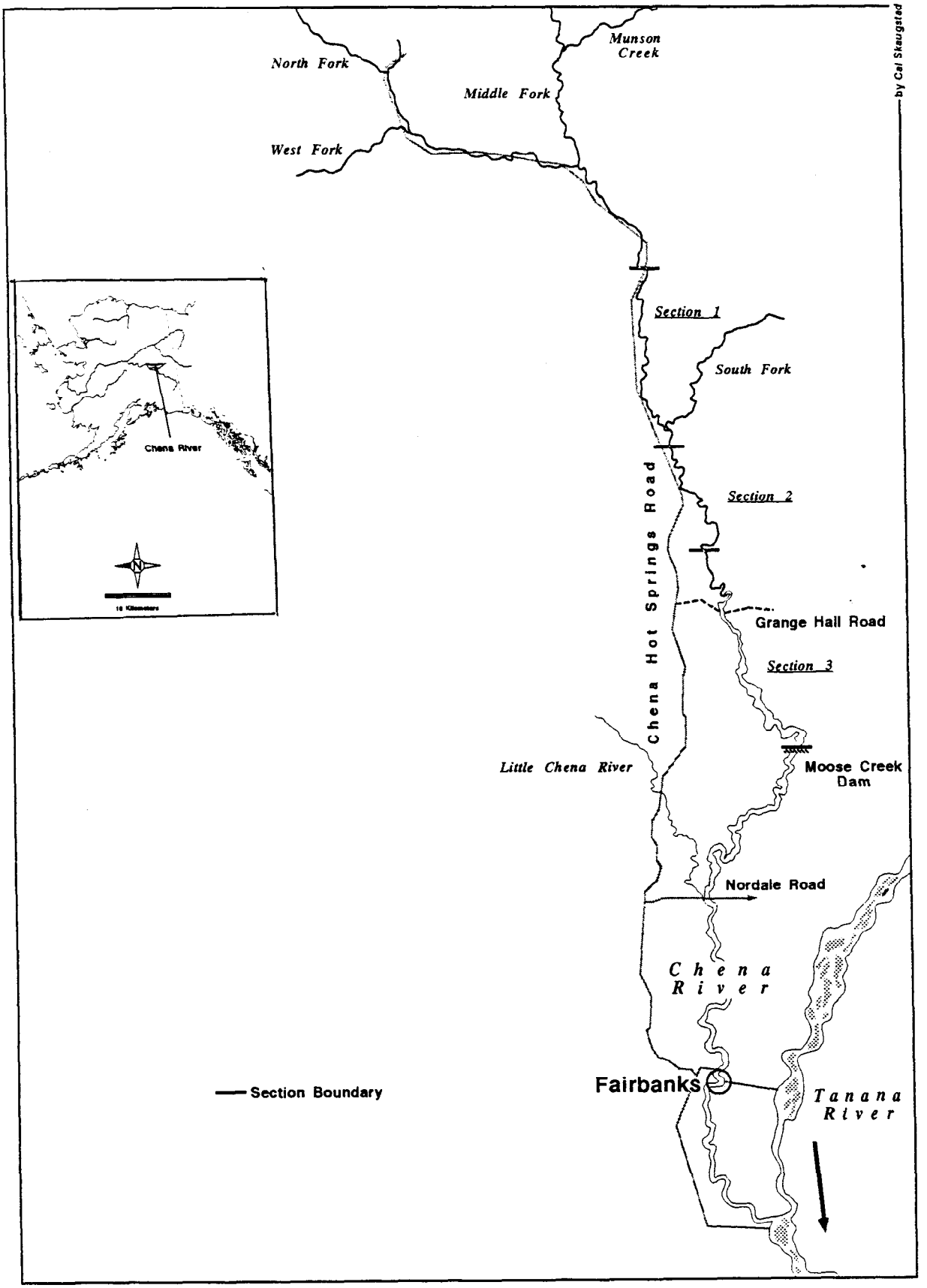

Figure 10. Map of the lower Chena River, Tanana River drainage, Alaska.

Methods

A direct expansion type survey was used to monitor the lower Chena River chinook salmon fishery in 1990. Estimates of effort, catch, harvest, CPUE, and HPUE were estimated from information obtained from interviews of completed-trip anglers. Since the majority of the anglers fishing for chinook salmon in the Chena River use the boat launching area at Nordale road to gain access to the river (Figure 10), all surveys were conducted at this location.

Study Design:

The creel clerk attempted to interview all anglers who had completed fishing and were exiting the Nordale Road boat launch area. If all anglers were not interviewed, then non-interviewed anglers exiting the fishery were counted.

The creel survey was conducted from 7 July through 29 July. The fishery was separated into the following strata:

Stratum	Total Number of Days in Stratum
weekday early 0800 to 1500 hours	15
weekday late 1300 to 2200 hour	15
weekends-holidays early 0800 to 1500 hours	8
weekends-holidays late 1300 to 2200 hours	8

Sampling effort among strata was designed to place most of the effort on the days with proportionally the most angler-trips and subsequently the most catch and harvest. Sampling did not begin until 7 July due to the fact that chinook salmon did not begin entering the lower Chena river until this time. After 7 July, every weekend-holiday was surveyed, with five sampling periods scheduled for the late day, and three during the early day. Sampling during the remaining weekday early/weekday late strata was similarly designed with more effort allotted for the late day than the early. All scheduled sampling periods were selected at random without replacement and sampling was designed to fully utilize a single creel clerk's allotted time.

Data Analysis:

Estimates of angler effort, catch and harvest of chinook salmon by anglers exiting from the lower Chena River at the Nordale Bridge access location during 1990 were calculated according to the procedures outlined in equations 18 through 24, above.

Estimates of CPUE and HPUE for the chinook salmon fishery by anglers exiting from the lower Chena River at the Nordale Bridge access location during 1990 were calculated according to the procedures outlined in equations 25 through 33, above.

The proportion (and/or percentage) of anglers categorized by the demographic characteristics noted in objective 2, and the proportions of anglers responding to the questions associated with objectives 3 and 4 were estimated following the procedures outlined in equations 34 through 37, above.

Results

Sampling occurred on all scheduled sampling periods during this time. However, due to the fact that the chinook salmon did not arrive to the lower Chena River until the second week in July and had completed their migration through the fishery by 28 July, the total number of available sample periods was less than originally scheduled. Sampling occurred on all eight weekend days and 60% of the weekdays (nine of a possible 15 days) during this time (Table 20). A total of 228 anglers who had completed their fishing trip and were exiting the fishery at the Nordale Road boat launch were interviewed. Total angler effort was estimated at 1,699 hours (SE = 188). Total catch was estimated to be 33 (SE = 9) chinook salmon. Total harvest was estimated at 24 (SE = 8) chinook salmon, with 46% of the harvest occurring during the weekend/early day strata.

Mean CPUE for the fishery was estimated at 0.02 fish per hour (SE = 0.01). Mean HPUE for the fishery was estimated at 0.02 fish per hour (SE = < 0.01; Table 20).

The majority of the 228 anglers interviewed at the Nordale Road boat launch area were male (84%, SE = 7), adult (86%, SE = 9), and local residents (96%, SE = 9). Non-residents and tourists accounted for only 3% (SE = 1) respectively, while 26% (SE = 9) were military. Spinners were the preferred terminal angling gear (98%, SE = 8; Table 21).

Of the 218 anglers who were asked to rate the quality of fishing for chinook salmon in the lower Chena River chinook salmon, 75% (SE = 8) rated the fishing poor (Table 22). Twenty percent (SE = 4) rated it fair, 5% (SE = 2) rated it good, and no angler said the fishing was excellent. All anglers (100%) responding, knew the bag limit. One hundred and eighteen or 74% of all the anglers interviewed fished for chinook salmon in the lower Chena River and exited at the Nordale Road boat launch at least two or more times (Table 22).

Discussion

The 1990 harvest estimate of 24 chinook salmon from the lower Chena River resembles those harvests that occurred from 1977 to 1985, as reported in the Statewide Harvest Reports (Mills 1979-1986) which showed an average annual harvest of 22 chinook salmon for this period. Harvest levels increased in 1986 and 1987 to 212 and 195, respectively, and then fell to 0 in 1988 and 0 in 1989 when no chinook salmon greater the 16 inches were reported (Mills 1989-1990.

In 1989, 4,938 angler-hours were expended to catch 1,077 chinook salmon, of which 685 were harvested (Merritt, et al. 1990). Anglers rated the 1990 chinook salmon fishery on the lower Chena River substantially worse than in 1989 when 50% (SE = 5) said fishing was excellent. At a harvest rate of .015 HPUE, an angler fishing the lower Chena river in 1990 would need to spend approximately 66 hours fishing to harvest one chinook salmon.

This estimate should be considered a minimum estimate as fishing does occur at other locations and certainly not all anglers enter or exit the lower Chena

Table 20. Summary of the angler count data and estimates of angler effort, catch, harvest, CPUE and HPUE for the lower Chena River chinook salmon creel survey, 7-29 July, 1990.

Strata Information		Sampling Information[a]				Parameter Estimates[b]									
		d	D	M	m	E	SE	C	SE	H	SE	CPUE	SE	HPUE	SE
7-29 July	Weekday early 0800 to 1500 hours	3	15	4	4	28	14	0	0	0	0	0	0	0	0
	Weekday late 1300 to 2200 hours	6	15	109	105	872	104	15	6	7	4	0.232	0.01	.007	0.001
	Weekend-holidays early 0800 to 1500 hours	3	8	20	20	247	107	11	6	11	6	0.065	0.03	0.065	0.03
	Weekend-holiday late 1300 to 2200 hours	5	8	110	99	553	114	7	5	6	4	0.014	0.01	.012	0.01
Totals		17	46	243	228	1,699	188	33	9	24	8	0.023	0.007	.015	0.004

[a] d = number of days sampled.
D = total number of days available for sampling.
M = total number of anglers counted exiting the fishery.
m = total number of exiting anglers interviewed.

[b] E = estimated angler effort in angler-hours.
C = estimated catch of chinook salmon.
H = estimated harvest of chinook salmon.
SE = standard error of the respective angler-effort, catch and harvest statistics.
CPUE = estimated catch per unit of effort.
HPUE = estimated harvest per unit of effort.

Table 21. Demographic profile of anglers interviewed at the lower Chena River, Tanana River drainage, Alaska, 7-29 July, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] prop	Angler Characteristic	n[a]	Prop[b]	SE[c] Prop
Total Number of Interviews	228	--	-	Local[d]	219	0.96	0.087
				Non-local	9	0.04	0.011
Male	189	0.84	0.065	Tourist	8	0.03	0.011
Female	39	0.16	0.024	Non-tourist	222	0.97	.093
Adult	188	0.86	0.086	Gear Type:			
Youth	40	0.17	0.016	Spinners	222	0.98	0.084
				Bait	4	0.01	0.009
Resident	220	0.97	0.085	Flies	1	<.01	0.003
Non-Resident	8	0.03	0.011				
Military	56	0.26	0.092				
Non-military	174	0.74	0.080				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard error of the weighted proportions.

[d] Local and non-local includes Alaska residents only. Local category are anglers from the Fairbanks-North Pole area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 22. Opinions of anglers interviewed at the lower Chena River, Tanana River drainage, Alaska, 7-29 July, 1990.

Question	Opinion	n	Prop[a]	SE[b] Prop
1. How would you rate the quality of fishing for chinook salmon in the lower Chena River this year?	Excellent (1)	0	0	0
	Good (2)	12	0.05	0.022
	Fair (3)	42	0.20	0.043
	Poor (4)	164	0.75	0.079
	Total	218		
	Mean	3.64		
2. What is the bag limit for chinook salmon in the lower Chena River?	One	136	1.00	0.181
	Three	0	0	0
	Other	0	0	0
	Total	136		
3. How many times have you fished for chinook salmon in the Chena River this season that you exited the river at this location.	One	38	0.26	0.059
	Two	57	0.33	0.061
	Three	12	0.05	0.025
	Four	49	0.36	0.052
	Total	156		

[a] Proportions are weighted proportions, weighted by sample and stratum weights.

[b] Standard error of the weighted proportions.

River at the Nordale Road boat launch area. However, chinook harvest throughout the lower Chena River in 1990 was considered to be below average, and the harvest of 24 chinook salmon is well below the guideline harvest range of 300-600 as set by the Board of Fisheries in 1990.

CHAPTER 5 - SALCHA RIVER CHINOOK SALMON FISHERY

Introduction

The Salcha River is located about 67 km southeast of Fairbanks on the Richardson Highway (Figure 11). The Salcha River supports a popular chinook and chum salmon recreational fishery that occurs annually during the month of July. The chinook salmon run in the Salcha River is the largest documented run in the middle Yukon River drainage (Barton 1985). Chum salmon migrate up the Salcha River in late July, and while not as important to recreational anglers, chum salmon provide additional angling opportunities. Annual sport harvest of chinook and chum salmon has been estimated by the statewide postal survey beginning in 1978 (Mills 1980-1990). Sport harvest estimates from on-site creel surveys began in 1985. Until 1987, fishing was allowed in the lower 23 km of the river. However, chinook salmon were found to be spawning in part of this section. For this reason, the Board of Fisheries in 1988 restricted the area open to salmon fishing to the lower 8 km of the Salcha River. The Board of Fisheries, also in 1988, established a guideline harvest range for the Salcha River recreational chinook salmon fishery of 300-700 fish. To ensure that the recreational harvest does not exceed the allocated range, and because Yukon River salmon stocks are being fully utilized, (Andersen 1990) by all user groups, it is imperative that we monitor the sport harvest on the Salcha River.

Specific objectives of the Salcha River creel survey in 1990 were to:

1. estimate angler-effort, CPUE, HPUE, catch and harvest of chinook salmon at the Salcha River chinook salmon fishery;

2. estimate the percent composition of angler demographics for the Salcha River that include;

    a) male/female;
    b) adult/youth;
    c) resident/non-resident;
    d) local/non-local;
    e) tourist/non-tourist;
    d) military/non-military; and
    f) terminal fishing gear (spinner/bait/flies/); and,

3. estimate the rating by anglers of the quality of fishing.

In addition, the percent response (opinions) to questions asked anglers at the Salcha River was estimated.

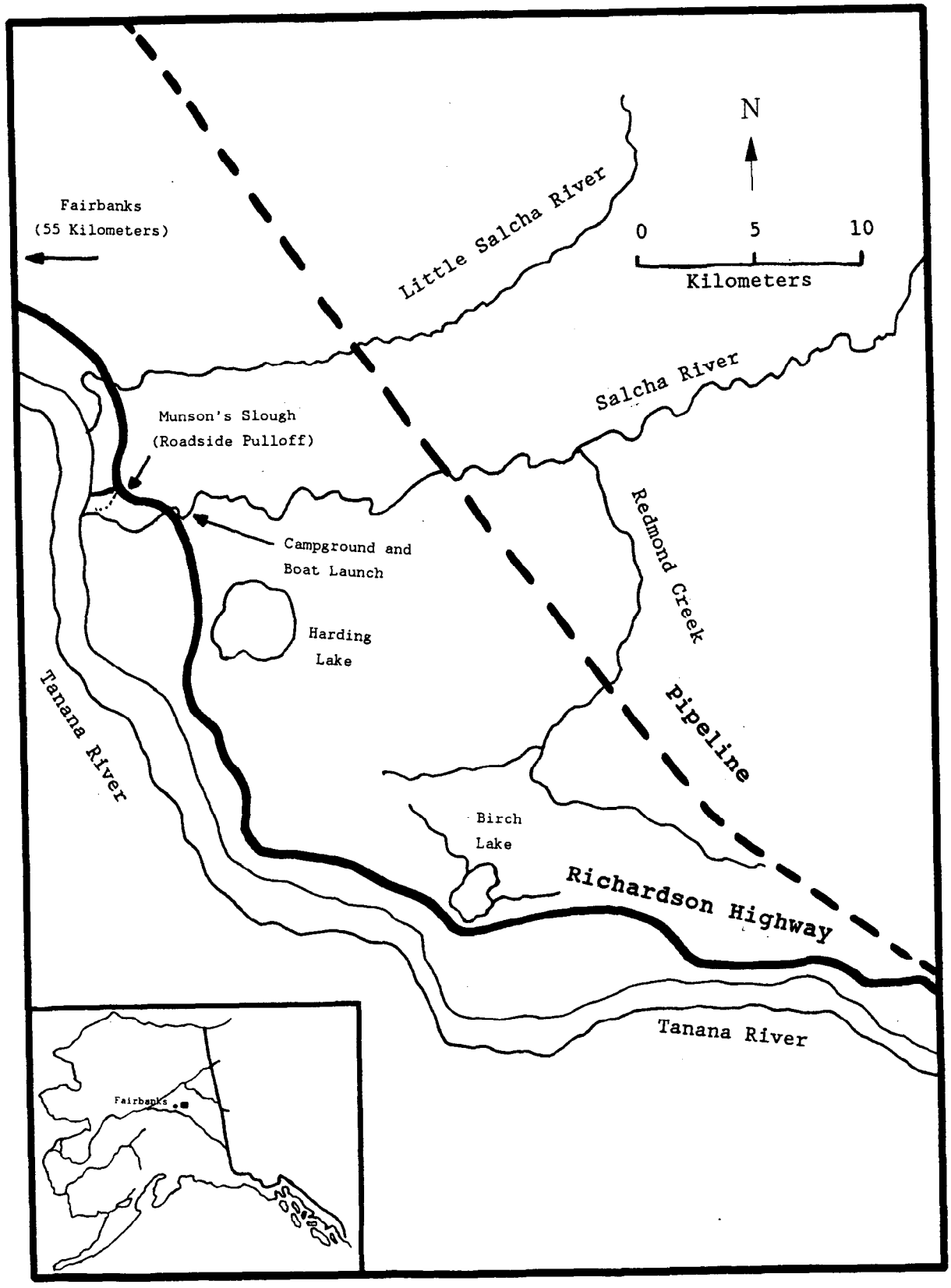

Figure 11. Map of the Salcha River, Tanana River drainage, Alaska.

Methods

The design for the Salcha River chinook salmon fishery in 1990 was a direct expansion type survey. Estimates of effort, catch, harvest, CPUE, and HPUE were estimated from information obtained from interviews of completed-trip anglers. Because the majority of the anglers fishing for chinook salmon in the Salcha River use the Munson Slough parking area to gain access to the river (Figure 11), all surveys were conducted at this location. During the survey the creel clerk would attempt to interview all individual anglers who had completed fishing and were exiting the area.

Study Design:

The creel clerk attempted to interview all anglers who had completed fishing and were exiting the Salcha River at the Munson Slough parking area. If all exiting anglers were not interviewed, then non-interviewed exiting anglers were counted.

The creel survey was conducted from 7 July through 29 July. The fishery was separated into the following strata:

Stratum	Total Number of Days in Stratum
weekday early 0800 to 1500 hours	15
weekday late 1500 to 2200 hours	15
weekends-holidays early 0800 to 1500 hours	8
weekends-holidays late 1500 to 2200 hours	8

Sampling effort among strata was designed to place most of the effort on the days with proportionally the most angler-trips, and subsequently the most catch and harvest. Chinook salmon did not arrive at the Salcha River until the second week in July, hence no sampling occurred prior to 7 July. Beginning on 7 July, every weekend-holiday was surveyed, with five sampling periods scheduled for the late day, and three during the early day. Sampling during the remaining weekday early/weekday late strata was similarly designed with more effort allotted for the late day than the early day. All scheduled sampling periods were selected at random without replacement and sampling was designed to fully utilize a single creel clerk's allotted time.

Data Analysis:

Estimates of angler effort, and catch and harvest of chinook salmon by anglers exiting the Salcha River at the Munson Slough parking area-access location during 1990, were calculated according to the procedures outlined in equations 18 through 24, above.

Estimates of CPUE and HPUE for the chinook salmon fishery by anglers exiting the Salcha River at the Munson Slough parking area-access location during 1990, were calculated according to the procedures outlined in equations 25 through 33, above.

The proportion (and/or percentage) of anglers categorized by the demographic characteristics noted in objective 2, and the proportions of anglers responding to the questions associated with objectives 3 were estimated following the procedures outlined in equations 34 through 37, above.

Results

Sampling occurred on all scheduled sampling periods during this time. However due to the fact that the chinook salmon did not arrive to the Salcha River until the second week in July and had completely migrated through the fishery by 28 July, the total number of available sampling periods was less than originally scheduled. All eight weekend days during this period and forty percent of the weekdays (six of a possible 15 days) were sampled (Table 23). A total of 568 anglers who had completed their fishing trip and were exiting the fishery at the Munson Slough parking area were interviewed. A total of 5,796 (SE = 949) angler-hours were expended to catch an estimated 249 (SE = 54) chinook salmon of which 200 (SE = 40) were harvested.

Mean CPUE of chinook salmon at the Salcha River fishery was 0.10 (SE = 0.018). Mean HPUE was estimated at 0.09 (SE = 0.017; Table 23).

The majority of anglers interviewed at the Salcha River were, male (90%, SE = 15), adult (93%, SE = 15), and residents of the State of Alaska (76%, SE = 11) (Table 24). Thirty-seven percent (SE = 6) of the anglers were military personnel and 24% (SE = 6) were non-residents. Of the anglers who were military or residents, 86% (SE = 13) were local people from the Fairbanks-North Pole area. Only 9% (SE = 3) of all the anglers interviewed were tourists. Nearly all anglers 98% (SE = 15) used spinners as their terminal gear type.

Fifty-one percent (SE = 9) of all anglers interviewed rated the 1990 chinook salmon fishery at the Salcha River as fair (Table 25). Five percent (SE = 2) rated the fishing excellent. All but one of 542 anglers knew the correct bag limit for chinook salmon in the Salcha river.

Discussion

Anglers at the Salcha River produced a larger catch and harvest, experienced higher CPUE and HPUE, and in general, rated the quality of fishing here higher than the lower Chena River. Anglers at the Salcha River in 1990 needed to expend approximately 10 hours of fishing to harvest one chinook salmon. By contrast, the same angler fishing the lower Chena River chinook salmon fishery in 1990, would have to spend more than 66 hours to achieve the same results.

The harvest of 200 chinook salmon in the Salcha River in 1990 was the largest since 1986 when an estimated 526 chinook salmon were taken (Clark and Ridder 1987). However, this harvest falls well below the 13 year average of 461 chinook salmon, as reported in Mills (1979-1990) and is well below the sport harvest guideline range of 300 to 700 chinook salmon imposed by the Board of Fisheries in 1987.

Table 23. Summary of angler count data and estimates of angler effort, catch, harvest, CPUE and HPUE for the Salcha River chinook salmon creel survey, 7-29 July, 1990.

Strata Information		Sampling Information[a]				Parameter Estimates[b]									
		d	D	M	m	E	SE	C	SE	H	SE	CPUE	SE	HPUE	SE
7-29 July	Weekday early 0800 to 1500 hours	2	15	26	26	679	255	7	7	7	7	0.010	0.01	0.010	0.01
	Weekday late 1300 to 2200 hours	4	15	282	252	3,207	879	164	39	155	38	0.139	0.03	0.138	0.03
	Weekend-holidays early 0800 to 1500 hours	3	8	77	77	755	137	59	37	19	6	0.114	0.08	0.072	0.05
	Weekend-holiday late 1300 to 2200 hours	5	8	226	213	1,155	209	19	7	19	7	0.044	0.02	0.044	0.02
Totals		14	46	611	568	5,796	949	249	54	200	40	0.104	0.018	0.098	0.017

[a] d = number of days sampled
D = total number of days available for sampling
M = total number of anglers counted exiting the fishery
m = total number of exiting anglers interviewed

[b] E = estimated angler effort in angler-hours.
C = estimated catch of chinook salmon.
H = estimated harvest of chinook salmon.
SE = standard error for the respective angler effort, catch, harvest, CPUE and HPUE statistics.
CPUE = catch per unit of effort.
HPUE = harvest per unit of effort.

Table 24. Demographic profile of anglers interviewed at the Salcha River, Tanana River drainage, Alaska, 7-29 July, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] Prop	Angler Characteristic	n[a]	Prop[b]	SE[c] Prop
Total Number of Interviews	568	--	--	Local[d]	477	0.86	0.134
				Non-local	84	0.14	0.048
Male	507	0.90	0.145	Tourist	46	0.09	0.031
Female	61	0.10	0.018	Non-tourist	522	0.91	0.140
Adult	529	0.93	0.150	Gear Type:			
Youth	35	0.07	0.016	Spinners	529	0.98	0.154
				Bait	7	0.02	0.014
Resident	426	0.76	0.109	Flies	2	<0.01	<0.001
Non-Resident	135	0.24	0.064				
Military	219	0.37	0.062				
Non-military	349	0.63	0.104				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by sample and stratum weights.

[c] Standard error of the weighted proportions.

[d] Local and non-local includes Alaska residents only. Local category are anglers from the Fairbanks-North Pole area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 25. Opinions of anglers interviewed at the Salcha River, Tanana River drainage, Alaska, 7-29 July, 1990.

Question	Opinion	n	Prop[a]	SE[b] Prop
1. How would you rate the quality of fishing for chinook salmon in the Salcha River this year?	Excellent (1)	26	0.05	0.015
	Good (2)	89	0.18	0.048
	Fair (3)	266	0.51	0.094
	Poor (4)	149	0.26	0.038
	Total	530		
	Mean	3.01		
2. What is the bag limit for chinook salmon in the Salcha River?	One	542	0.999	0.163
	Three	1	<0.001	<0.001
	Other	0	0	0
	Total	543		

[a] Proportions are weighted proportions, weighted by sample and stratum weights.

[b] Standard error of the weighted proportions.

CHAPTER 6 - CHATANIKA RIVER WHITEFISH SPEAR FISHERY

Introduction

The Chatanika River supports a large fall spawning run of least cisco, humpback whitefish, and round whitefish. Because of its proximity to Fairbanks (Figure 12) and the large size of this spawning run, a fall whitefish spear fishery has developed at the Chatanika River. In 1987, this fishery accounted for over 90% of the whitefish harvest in the Tanana River drainage and over 75% of the Statewide whitefish harvest (Mills 1988). Most of the whitefish harvested during the Chatanika River spear fishery are least cisco and humpback whitefish. A few round whitefish are harvested along with incidental spearing of sheefish, Arctic grayling, burbot, and longnose suckers *Catostomus Catostomus*.

The whitefish spear fishery in the Tanana River drainage began in 1969. Historically, whitefish were pursued by recreational anglers with conventional rod and reel. However, because of the difficulty of catching whitefish on rod and reel, these users began to seek other means of harvesting whitefish. The result was the establishment of a spear fishing season for whitefish within the Tanana River drainage. The spear fishery on the Chatanika River developed rather slowly. A creel survey in 1970 estimated a harvest of 400 whitefish (Hallberg 1985). Estimates of harvest from 1972-1977 averaged around 2,000 whitefish. In 1986, the estimated harvest of whitefish was 19,686 fish, with estimated exploitation rates of 23% and 17% for least cisco and humpback whitefish, respectively (Clark and Ridder 1987; Hallberg and Holmes 1987). In 1987, an on-site creel survey estimated harvest at 28,591 whitefish, with exploitation rates estimated to be 43% for least cisco and 17% for humpback whitefish (Hallberg 1988; Baker 1988). This made the Chatanika River the fastest growing recreational fishery in the Tanana River drainage. Because of the high exploitation rates in 1986 and 1987, a 15 whitefish daily bag and possession limit was instituted in 1988. Prior to 1988, there was no bag and possession limit for whitefish in the Tanana River drainage. Harvest of whitefish from the Chatanika River in 1988 was substantially reduced (about 8,000 reported in Mills 1989) by the imposition of possession limits. In 1989 the harvest of whitefish nearly doubled to 15,542 (Mills 1990).

Concern over this rapidly expanding fishery and potential effects on the stock status of whitefish prompted ADFG to initiate an in-depth research project in 1986 that has continued through 1990. The goal of this research was to estimate population abundance, harvest levels, species composition of the runs, and exploitation rates of whitefish in the spear fishery. Part of this research was a creel survey that provided information on angler-effort, harvest, and HPUE. Since 1988, age and length composition data for the harvest have been obtained during mark-recapture experiments conducted prior to the creel survey. It was found that composition data did not significantly differ between that observed during mark-recapture experiments and in the creel survey.

The specific objectives of the 1990 creel survey at the Chatanika River whitefish spear fishery were to:

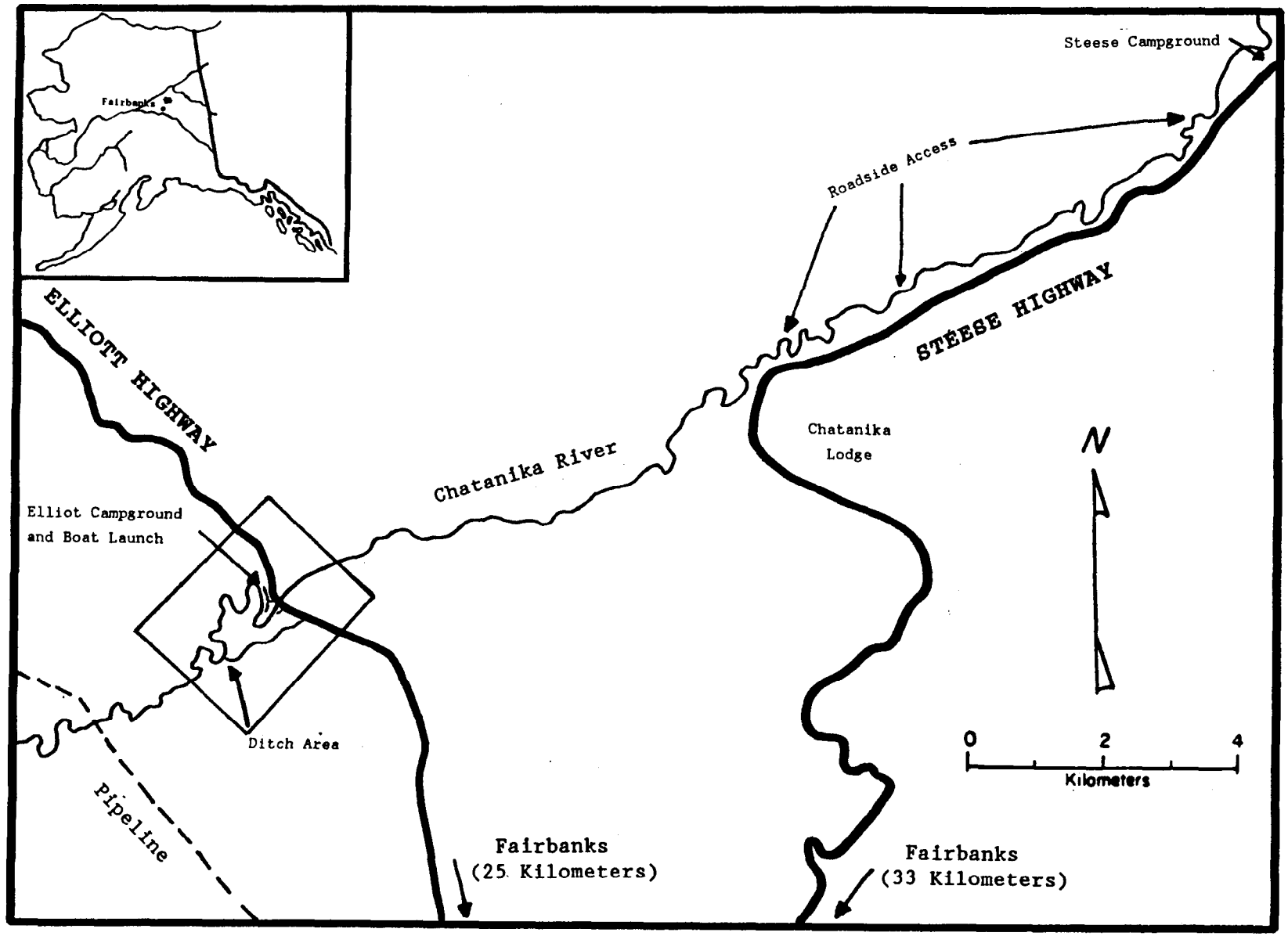

Figure 12. Map of the Elliott Campground, Olnes Pond and Steese Highway areas, Chatanika River, Tanana River drainage, Alaska.

1. provide post-season estimates of the distribution of harvest of least cisco and humpback whitefish by angler trip in the Chatanika River whitefish spear fishery;

2. provide post-season estimates of the proportion of least cisco and humpback whitefish harvested with tags or fin clips;

3. provide post season estimates of length composition (LC_i in proportions of the harvest) of humpback whitefish and least cisco harvested from the Chatanika River whitefish spear fishery;

4. estimate the percent composition within the following demographic categories of anglers interviewed at the Chatanika River;

   a) male/female;
   b) adult/youth;
   c) resident/non-resident;
   d) local/non-local;
   e) tourist/non-tourist;
   e) military/non-military; and,

5. estimate the mean rating by anglers of the quality of fishing at the Chatanika River.

In addition, the percent response to questions asked of anglers interviewed at the Chatanika River was estimated. And, angler effort and harvest were estimated. Least cisco and humpback whitefish in the harvest were examined for tags, in conjunction with the whitefish population abundance project.

Methods

The creel survey in 1990 was conducted at the entrance of the lower Chatanika State recreation and boat launch area and at the entrance of the Olnes Pond campground area, both located near the Elliott Highway bridge crossing of the Chatanika River (Figure 12). Because most anglers enter and exit the fishery from these two sites, all surveys were conducted here. Creel clerks were stationed at each site, and would attempt to stop all exiting automobiles and obtain interviews from individual anglers who had completed fishing and were exiting the area. All automobiles failing to stop were counted.

Study Design:

The 1990 survey of the Chatanika River whitefish spear fishery consisted of a three-stage stratified sampling design. The season was stratified by season (early season = 14-25 September; and late season = 26 September-10 October); and by type of day during the early season ("weekends" = Friday and Saturday nights[13]; and "weekdays" = Sunday-Thursday nights). During the early season all weekends were sampled (i.e., censused), whereas we arbitrarily sampled each Wednesday and Thursday for the early season weekday stratum. During the late season stratum all days were sampled (censused). Two access locations[14]

[13] Nights = 2000 hours to 0200 hours the next day.

[14] The campground and Olnes Pond sites.

represented an additional level of stratification (resulting in a total of six strata). Within all strata, days represent our first sampling stage.

During each sampled day, the creel clerks stopped cars and trucks exiting the fishery at each site. Any car and truck not stopped was counted. As such, vehicles represent the second stage units within our three-stage sample survey. The anglers within each vehicle were interviewed, any anglers within each vehicle sampled who were not interviewed were counted. Anglers interviewed within each vehicle represent the third stage units. Counts of vehicles stopped and not stopped, and numbers of anglers counted and interviewed within each sampled vehicle were recorded on the "People/Car Count Form" (see Appendix A2).

Information gathered from each interviewed angler was not identified as to car-party. Accordingly, we could not analyze the data as a three-stage stratified design. As such, we used the information on the people/car count form to estimate the number of anglers exiting the fishery during each sampled day, and treated the interviewed anglers as if they were sampled at random from all exiting anglers within each day[15].

Data Analysis:

Estimates of the distribution of angler harvest of whitefish in the Chatanika River during 1990 were obtained by the procedures outlined in equations 1 through 12, above. We set k_{max} equal to 16 fish for angler catches and harvests of whitefish. In applying equations 1-12, we had to estimate the number of anglers exiting the fishery as noted above. The following procedures were used to estimate the number of anglers exiting the fishery during each sampled day within each stratum (as used in equations 1, 2, 11, and 12):

$$\hat{M}_{hi} = \frac{C_{hi}}{c_{hi}} \hat{R}_{hi}\, a_{hi} \; ; \qquad (38)$$

where: C_{hi} equals the number of cars exiting the fishery during each sampled day within each stratum; c_{hi} equals the number of cars stopped during each day; a_{hi} equals the number of anglers interviewed[16] during each day;

$$\hat{R}_{hi} = \frac{\sum_{j=1}^{c_{hi}} M_{hij}}{\sum_{j=1}^{c_{hi}} m_{hij}} \; ; \qquad (39)$$

---

15 Two-stage design with days as primary units and anglers as secondary units.

16 According to the mark-sense interview data.

M_{hij} equals the number of anglers within the jth stopped car (both interviewed and not interviewed); and m_{hij} equals the number of anglers interviewed within each stopped car[17].

The estimates of proportions of harvested fish by category (objectives 2 and 3), were calculated according to the procedures outlined in equations 13 through 17, above. The term defined in equation 38, above was also used in applying these procedures. Length categories were set at 10 mm increments (fork length) starting at 200 mm. These categories were designed to agree with the categories used in a separate population study being conducted at the same time.

The proportion of anglers categorized by the demographic characteristics noted in objective 4, and the proportions of anglers responding to the questions associated with objective 5 were estimated following the procedures outlined in equations 34 through 37. The term defined in equation 38, above was used in applying these procedures.

Since we had to estimate the number of anglers exiting the fishery, we assume that our variance estimates are negatively biased due to this extra component of variability that was not incorporated into our analysis procedures. Additionally, because days were not selected at random within the early season-weekday strata, both our point and variance estimates are assumed to be biased to an unknown degree within these strata. Finally, because days were not selected independently for each site (for the strata that were not censused at the daily level), our estimates for the two sites are not independent, and as such the variances are not additive. However, since we censused the fishery (on a daily basis) for the remaining four strata (i.e., early-season weekends and late season at each of the two sites), our overall estimates are assumed to be minimally biased.

Results

The harvest survey began 14 September and continued through 10 October, at which time the fishery was closed by emergency order. The estimated abundance of humpback whitefish in the Chatanika River in 1990 was less than 9,000 fish, approximately half of what it was in 1989 and only 25% of the 1988 estimate. Consequently, the emergency order closing the whitefish sport fishery was necessary to prevent further depletion of the humpback whitefish population and to provide for conservation of the spawning stock in the Chatanika River.

A creel survey of the whitefish spear fishery was conducted from 14-25 September with sampling occurring on randomly selected days during this time. From 26 September until the fishery closed on 10 October the fishery was censused; sampling occurred during all identified strata (100% coverage). The objectives for the 1990 creel survey for the Chatanika River whitefish spear fishery did not include estimates of angler effort or the harvest of least cisco, humpback and round whitefish. However, these statistics along with standard errors were obtained relative to meeting other objectives (Table 26).

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[17] According to the data from the People/Car Count Form.

Table 26. Summary of the angler count and estimates of angler effort, and harvest, by strata for the Chatanika River (Elliott highway) whitefish spear fishery, 14 September to 10 October, 1990.

Strata Information			Sampling[b] Information				Parameter Estimates[c]									
									LCI		HWF		RWF		All Whitefish	
Area	Season	We/Wd[a]	d	D	m	$\hat{M}$	E	SE	H	SE	H	SE	H	SE	H	SE
Campground	Sept 14-25	We	4	4	93	132	276	7	157	16	4	1	6	4	167	16
Campground	Sept 14-25	Wd	8	2	20	25	170	10	68	38	17	7	24	22	109	13
Campground	Sept 26-Oct 10	Both	15	15	444	676	1,542	18	1,311	60	209	16	21	7	1,541	65
sub-total			27	21	557	833	1,988	22	1,536	73	230	18	51	23	1,817	68
Olnes Pond	Sept 14-25	We	4	3	62	93	246	42	277	50	25	7	13	7	315	60
Olnes Pond	Sept 14-25	Wd	8	2	16	26	217	98	206	125	6	5	0	0	212	130
Olnes Pond	Sept 26-Oct 10	Both	15	15	615	924	2,443	22	3,377	84	696	27	84	10	4,157	98
sub-total			27	20	693	1043	2,906	109	3,860	159	727	30	97	12	4,684	173
TOTALS					1,250	1,876	4,894	111	5,396	175	957	34	148	26	6,501	186

[a] We = Weekend
Wd = Weekday

[b] d = number of days sampled for angler interviews.
D = total number of days available for sampling.
m = total number of anglers interviewed.
$\hat{M}$ = estimated number of anglers counted exiting the fishery.

[c] E = estimated angler effort in angler-hours.
H = estimated Harvest of fish.
SE = standard error of the respective effort and harvest statistics.
HWF = humpback whitefish.
LCI = least cisco.
RWF = round whitefish.

During the creel survey 1,250 interviews were obtained from a total of 1,876 (estimated) anglers who had completed their fishing trip and were exiting the fishery at one of two areas. Anglers expended a total of 4,894 (SE = 111) hours of spear fishing to harvest a total of 5,396 (SE = 175) least cisco, 957 (SE = 34) humpback whitefish and 148 (SE = 26) round whitefish.

Sixty-three percent (SE = 15) of all anglers harvested at least one or more whitefish (Table 27). The distribution of whitefish harvests among anglers interviewed shows that 37% of the anglers harvested zero whitefish (Figure 13).

A total of 3,510 least cisco, and 682 humpback whitefish were examined in the creel. Blue colored, Floy internal anchor tags (marks) were observed on 10% (SE = 0.38) least cisco and 16% (SE = 0.83) of the humpback whitefish (Tables 28 and 29).

Least cisco encountered in the creel averaged 328 mm fork length and ranged in length from 210 mm to 397 mm (Figure 14). Eighty-five percent of the harvest was between 290 mm and 350 mm. Humpback whitefish ranged in length from 290 mm to 506 mm, and averaged 412 mm fork length (Figure 15). More than 80% of the humpback whitefish were between 290 mm and 350 mm fork length.

Of the 1,250 anglers interviewed at the Chatanika River, the typical angler was male (86%, SE = 2), adult (95%, SE = 2), a resident of Alaska (100%), non-military (82%, SE = 3), and was from the local Fairbanks-North Pole area (97%; SE = 1, Table 30). One angler interviewed was found to be a tourist.

Forty-four percent (SE = 1) of the anglers rated the 1990 spear fishery as poor, and an equal percentage (44%, SE = 1) gave it a rating of fair (Table 31). Only 11% (SE = 1), rated the fishing as good and 1% (SE < 1) thought it was excellent. The majority of the anglers (86%, SE = 2) reported that they use whitefish for personal consumption while 10% (SE < 1) indicated that they used the fish for bait. Spear fishermen prefer the existing bag limit (78%, SE = 2) as a way of preventing overfishing. Only 3% (SE < 1) selected a harvest quota on whitefish as a way of preventing overfishing.

Discussion

The majority (55%) of the angler interviews were obtained at the Olnes Pond area, and 59% of the angling effort and 72% of the harvest of all whitefish occurred there.

Three percent of the anglers achieved the legal bag limit of 15 whitefish, and less than 50% of all anglers interviewed harvested five or fewer whitefish. Some anglers interviewed (less than 1%) had harvested more than the legal bag limit. The effect of bag limits (imposed beginning in the fall of 1988) was a temporary reduction in harvest. Harvest is once again increasing because anglers have responded to the bag limit restriction by taking more fishing trips.

By Alaska sport fishing regulation, harvested (dead) whitefish can legally be used as bait. However, only 10% responded that they do indeed use their whitefish catch for this purpose, while 86% indicated that their whitefish catch went for personal consumption.

Table 27. Distribution of whitefish harvest among anglers interviewed at the Chatanika River, 14 September through 10 October, 1990.

Catch	Prop[a]	SE Prop	% Dist Harvest Among Anglers
0	-----	-----	36.74[b]
1	0.632	0.015	13.05
2	0.501	0.015	10.45
3	0.397	0.010	7.22
4	0.325	0.011	5.61
5	0.269	0.010	4.93
6	0.219	0.010	4.16
7	0.178	0.008	2.91
8	0.149	0.007	2.18
9	0.127	0.007	2.33
10	0.103	0.005	2.77
11	0.076	0.004	1.15
12	0.064	0.003	0.91
13	0.055	0.003	1.42
14	0.041	0.003	1.32
15	0.027	0.002	2.54
16 or more	0.002	<0.001	0.25

[a] Proportion of angler-trips that caught or harvested at least given number of whitefish.

[b] Percentage of angler trips that resulted in zero harvest.

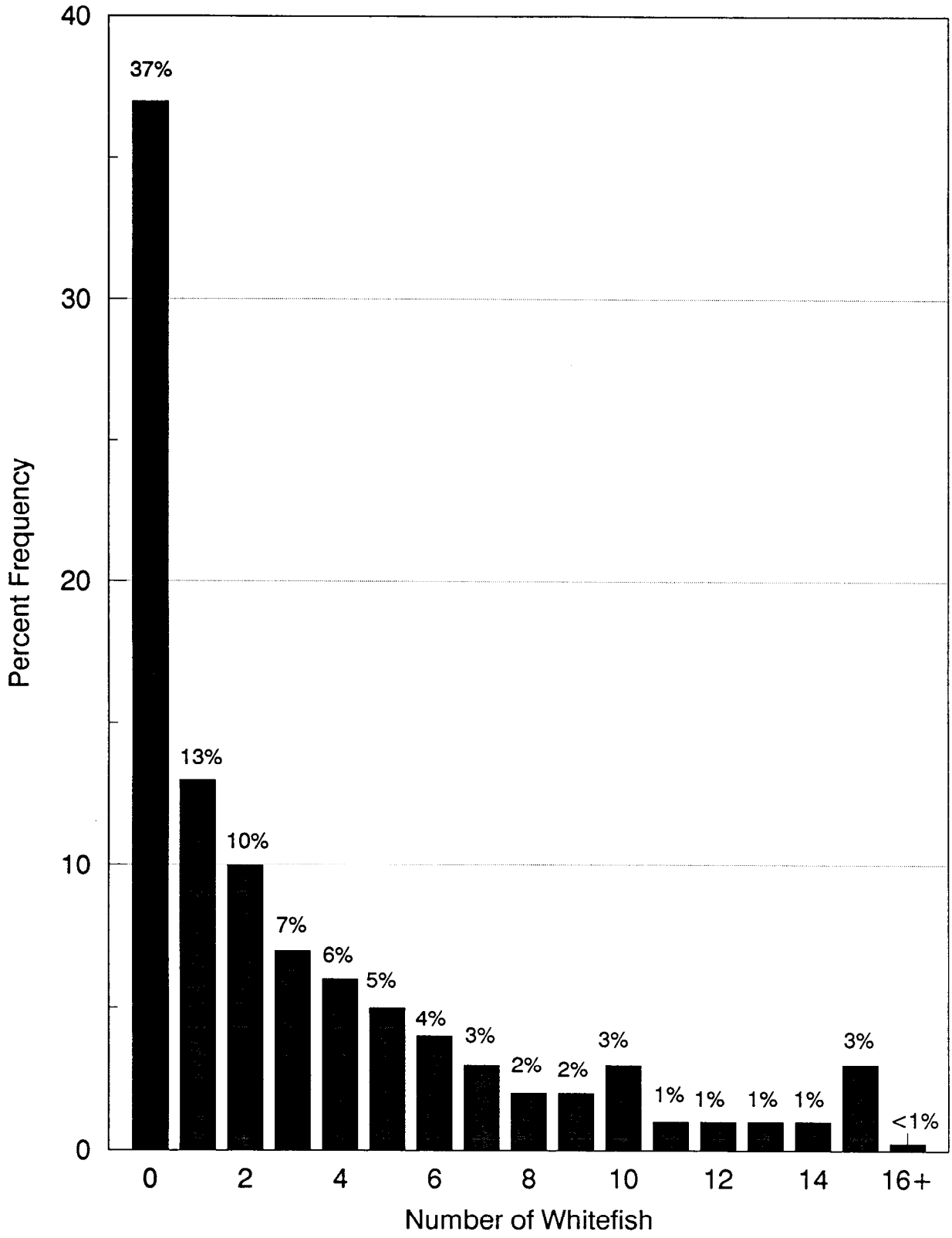

Figure 13. Distribution of whitefish harvest among anglers interviewed at the Chatanika River, Tanana River drainage, Alaska, 1990.

Table 28. Estimate of the least cisco with marks in the harvest by strata for the Chatanika River (Elliott highway), whitefish spear fishery, 14 September through 12 October, 1990.

Strata Information Area	Season	We/Wd	Category	n	%	SE
Campground	Sept 14-25	Weekend	Tagged	7	6.54	1.36
			Untagged	100	93.46	1.36
Estimated Harvest	= 157		Sub-total	107		
Weight[a]	= 0.0291					
FPC[b]	= 0.3185					
Campground	Sept 14-25	Weekday	Tagged	7	38.89	10.14
			Untagged	11	61.11	10.14
Estimated Harvest	= 68		Sub-total	18		
Weight[a]	= 0.0126					
FPC[b]	= 0.7353					
Campground	Sept 26-Oct 12	Both	Tagged	72	8.12	0.52
			Untagged	815	91.88	0.52
Estimated Harvest	= 1,311		Sub-total	887		
Weight[a]	= 0.2430					
FPC[b]	= 0.3234					
Olnes Pond	Sept 14-25	Weekend	Tagged	17	11.97	1.91
			Untagged	125	88.03	1.91
Estimated Harvest	= 277		Sub-total	142		
Weight[a]	= 0.0513					
FPC[b]	= 0.4874					
Olnes Pond	Sept 14-25	Weekday	Tagged	6	18.18	6.25
			Untagged	27	81.82	6.25
Estimated Harvest	= 206		Sub-total	33		
Weight[a]	= 0.0382					
FPC[b]	= 0.8398					
Olnes Pond	Sept 26-Oct 12	Both	Tagged	213	9.17	0.33
			Untagged	2,110	90.83	0.33
Estimated Harvest	= 3,377		Sub-total	2,323		
Weight[a]	= 0.6258					
FPC[b]	= 0.3121					
Combined	Sept 14-Oct 12		Total Tagged	322	9.70	0.38
			Total Untagged	3,188	90.30	0.38
Estimated Harvest	= 5,396		Total	3,510		

[a] Stratum weights equal to ratio of estimated harvest for the stratum to the total estimated harvest for the survey.

[b] FPC = finite population correction equal to one minus the sampling fraction, where the sampling fraction equals the ratio of the sample size for the stratum divided by the harvest for the stratum.

Table 29. Estimate of the humpback whitefish with marks in the harvest by strata for the Chatanika River (Elliott highway), whitefish spear fishery, 14 September through 12 October, 1990.

Strata information Area	Season	We/Wd	Category	n	%	SE
Campground	Sept 14-25	Weekend	Tagged	2	50.00	0.00
			Untagged	2	50.00	0.00
Estimated Harvest	= 4		Sub-total	4		
Weight[a]	= 0.0042					
FPC[b]	= 0.0000					
Campground	Sept 14-25	Weekday	Tagged	1	25.00	21.86
			Untagged	3	75.00	21.86
Estimated Harvest	= 17		Sub-total	4		
Weight[a]	= 0.0261					
FPC[b]	= 0.7647					
Campground	Sept 26-Oct 1 2	Both	Tagged	23	14.02	1.26
			Untagged	141	85.98	1.26
Estimated Harvest	= 209		Sub-total	164		
Weight[a]	= 0.2184					
FPC[b]	= 0.2153					
Olnes Pond	Sept 14-25	Weekend	Tagged	4	28.57	8.31
			Untagged	10	71.43	8.31
Estimated Harvest	= 25		Sub-total	14		
Weight[a]	= 0.0216					
FPC[b]	= 0.4400					
Olnes Pond	Sept 14-25	Weekday	Tagged	0	00.00	0.00
			Untagged	1	100.00	0.00
Estimated Harvest	= 6		Sub-total	1		
Weight[a]	= 0.0063					
FPC[b]	= 0.8333					
Olnes Pond	Sept 26-Oct 1 2	Both	Tagged	78	15.76	0.88
			Untagged	417	84.24	0.88
Estimated Harvest	= 696		Sub-total	495		
Weight[a]	= 0.7273					
FPC[b]	= 0.2888					
Combined	Sept 14-Oct 1 2		Total Tagged	108	15.92	0.83
			Total Untagged	574	84.08	0.83
Estimated Harvest	= 957		Total	682		

[a] Stratum weights equal to ratio of estimated harvest for the stratum to the total estimated harvest for the survey.

[b] FPC = finite population correction equal to one minus the sampling fraction, where the sampling fraction equals the ratio of the sample size for the stratum divided by the harvest for the stratum.

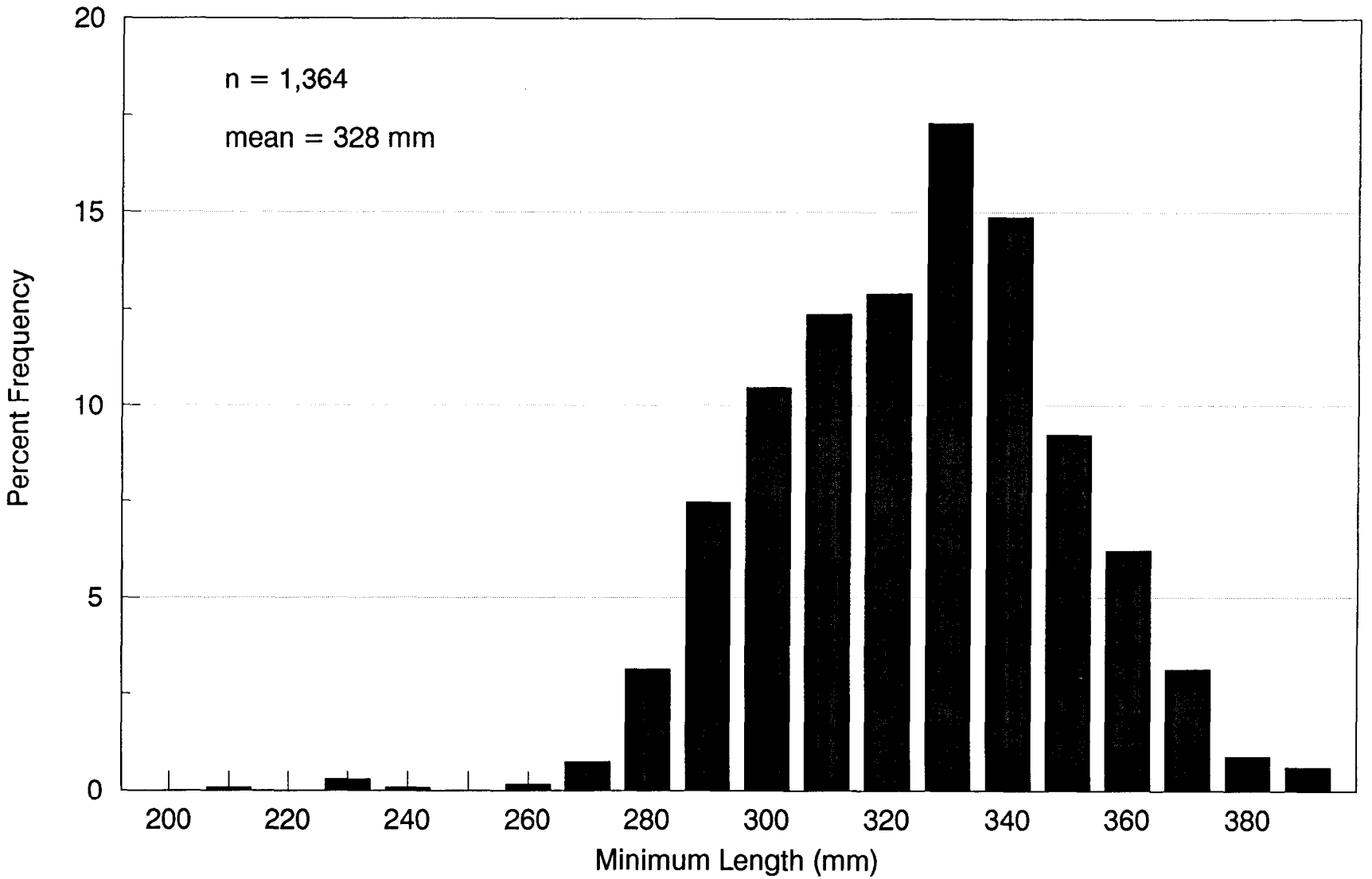

Figure 14. Length composition of least cisco harvested from the Chatanika River, 1990.

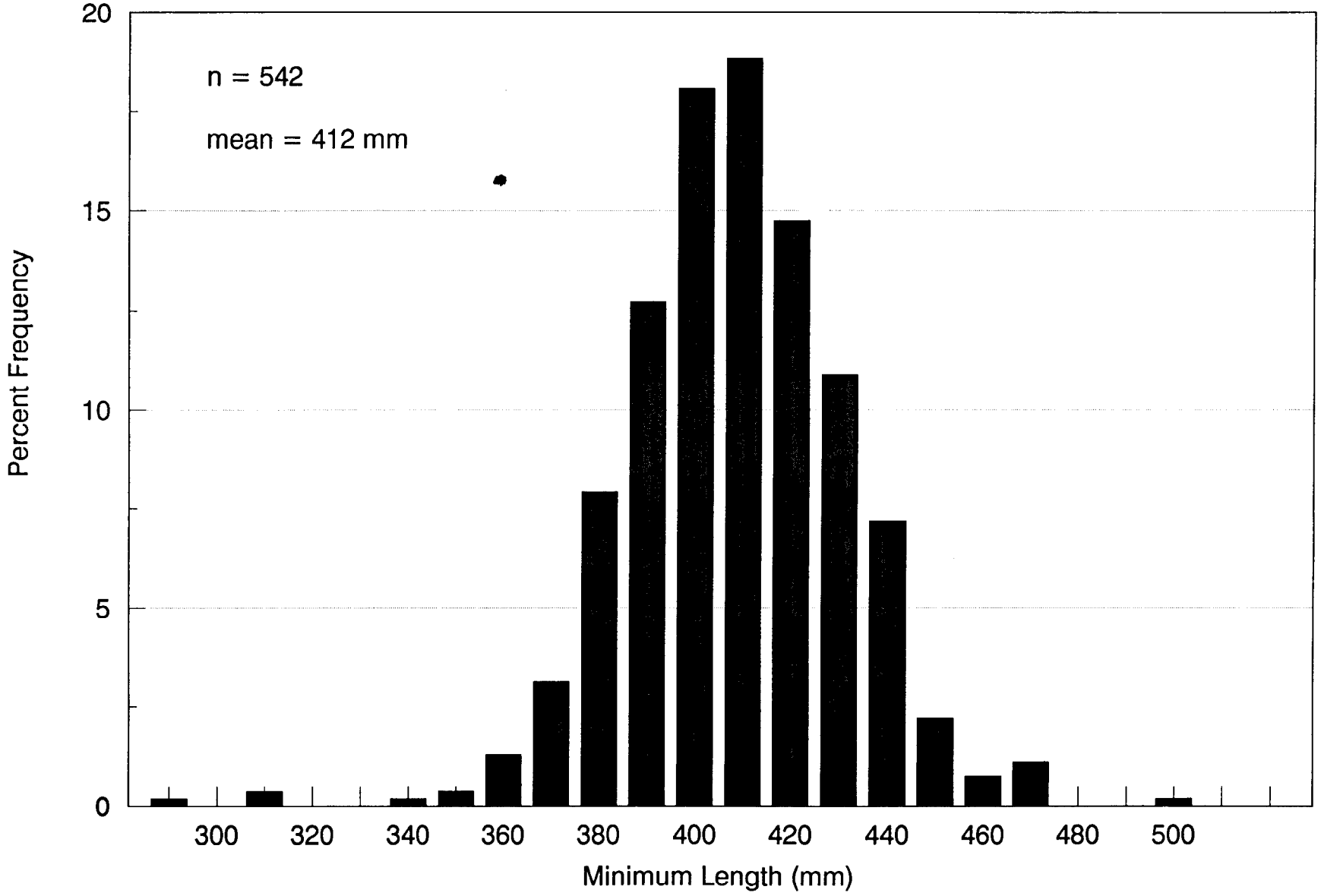

Figure 15. Length composition of humpback whitefish harvested from the Chatanika River, 1990.

Table 30. Demographic profile of anglers interviewed at the Chatanika River whitefish spear-fishery, Tanana River drainage, Alaska, 1990.

Angler Characteristic	n[a]	Prop[b]	SE[c] Prop	Angler Characteristic	n[a]	Prop[b]	SE[c] Prop
Total Number of Interviews	1,250	--	--	Local[d]	1,216	0.97	0.012
				Non-Local	22	0.03	0.009
Male	1,064	0.86	0.018	Tourist	1	0.01	0.000
Female	176	0.14	0.006	Non-Tourist	1,249	0.99	0.009
Adult	1,176	0.95	0.020				
Youth	64	0.05	0.002				
Resident	1,240	1.00	0.019				
Non-Resident	0	.00	.000				
Military	221	0.18	0.012				
Non-Military	1,029	0.82	0.031				

[a] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[b] Proportions are weighted proportions, weighted by individual sample weights.

[c] Standard errors of the weighted proportion.

[d] Local and non-local category includes Alaska residents only. Local category are anglers from the Fairbanks area. The sum of anglers in the local and non-local categories does not always equal anglers in the resident category because of nonresponses.

Table 31. Opinions of anglers interviewed at the Chatanika River whitefish spear-fishery, Tanana River drainage, Alaska, 1990.

Question	Opinion	n	Prop[a]	SE[b] Prop
1. How would you rate the quality of spear fishing at the Chatanika River this year?	Excellent (1)	6	0.004	0.001
	Good (2)	131	0.105	0.011
	Fair (3)	532	0.436	0.012
	Poor (4)	559	0.445	0.011
	No opinion	14	0.009	0.001
	Total	1,242		
	Mean	3.33		
2. Was the purpose of your catch for?	Personal consumption	976	0.864	0.023
	Bait	123	0.102	0.007
	Other	44	0.033	0.003
	Total	1,143		
3. Which of the following regulations would you prefer as measures to prevent overfishing?	Existing bag limit	968	0.776	0.020
	Shorter season	2	0.001	0.000
	Harvest quota	30	0.025	0.003
	Area restrictions	1	0.003	0.003
	No opinion	232	0.192	0.008
	Total	1,233		

[a] Proportions are weighted proportions, weighted by sample and stratum weights.

[b] Standard error of the weighted proportions.

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APPENDIX A

Appendix A1. Exit angler count form.

1990 REGION III SPORT FISH CREEL SURVEY - EXIT ANGLER COUNT FORM

FORM NUMBER (Assigned by keypuncher): _____

Site: _____ Date(YY MM DD): ___ ___ ___

Technician: _____ Hours surveyed (HH MM): ___ ___ to ___ ___

Hours from to	Number of Anglers Counted Exiting Fishery at Site during indicated hours
midnight (0000) - 0059	_____
0100 - 0159	_____
0200 - 0259	_____
0300 - 0359	_____
0400 - 0459	_____
0500 - 0559	_____
0600 - 0659	_____
0700 - 0759	_____
0800 - 0859	_____
0900 - 0959	_____
1000 - 1059	_____
1100 - 1159	_____
1200 - 1259	_____
1300 - 1359	_____
1400 - 1459	_____
1500 - 1559	_____
1600 - 1659	_____
1700 - 1759	_____
1800 - 1859	_____
1900 - 1959	_____
2000 - 2059	_____
2100 - 2159	_____
2200 - 2259	_____
2300 - 2359	_____

Appendix A2. People/car count form.

PEOPLE/CAR COUNT

LOCATION: ____________________

DATE: ____________________

CAR NO.	STOPPED (Y/N)	# PEOPLE IN CAR	# FISHED	# INTERVIEWED ON MARK-SENSE

APPENDIX B

Appendix B. Angler interview and biological data files developed for creel surveys conducted in Interior Alaska in 1990.[a]

U3190IAO.DTA	Piledriver Slough creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting Piledriver Slough.
U1890IBO.DTA	Harding Lake creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting Harding Lake.
U0060IAO.DTA	Delta Clearwater River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Delta Clearwater River.
U0020IAO.DTA	Lower Chena River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Lower Chena River.
U0050IAO.DTA	Salcha River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Salcha River.
U0040IAO.DTA	Chatanika River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Chatanika River at the campground.
U004AIAO.DTA	Chatanika River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Chatanika River at Olnes Pond.
U3190LHO.DTA	Piledriver Slough Arctic grayling tagging length data.
U3190LJO.DTA	Piledriver Slough rainbow trout tagging length data.
U1890LJO.DTA	Harding Lake northern pike tagging length data.
U0060LDO.DTA	Delta Clearwater River Arctic grayling tagging length data.
U0040LEO.DTA	Chatanika River humpback whitefish tagging length data.
U0040LFO.DTA	Chatanika River least cisco tagging length data.

[a] These data files are archived with Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Unit, 333 Raspberry Rd, Anchorage, Alaska 99518-1519.