Fishery Data Series No. 92-7

# Creel Surveys Conducted in Interior Alaska during 1991

by

**Jerome E. Hallberg**
**and**
**Allen E. Bingham**

March 1992

Alaska Department of Fish and Game

Division of Sport Fish

FISHERY DATA SERIES NO. 92-7

# CREEL SURVEYS CONDUCTED IN INTERIOR ALASKA DURING 1991[1]

By

Jerome E. Hallberg
and
Allen E. Bingham

Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

March 1992

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-7, Job No. R-3-1.

The Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

TABLE OF CONTENTS


| | Page |
|---|---|
| LIST OF TABLES | iii |
| LIST OF FIGURES | iv |
| LIST OF APPENDICES | v |
| ABSTRACT | 1 |
| INTRODUCTION | 2 |
| CHAPTER 1 - UPPER CHENA RIVER ARCTIC GRAYLING FISHERY | 5 |
| Introduction | 5 |
| Methods | 8 |
| Data Collection | 9 |
| Data Analysis | 10 |
| Assumptions | 14 |
| Results | 14 |
| Discussion | 16 |
| CHAPTER 2 - UPPER CHATANIKA RIVER ARCTIC GRAYLING FISHERY | 19 |
| Introduction | 19 |
| Methods | 22 |
| Data Collection | 23 |
| Data Analysis | 24 |
| Assumptions | 24 |
| Results | 24 |
| Discussion | 26 |
| CHAPTER 3 - GEORGE LAKE NORTHERN PIKE FISHERY | 26 |
| Introduction | 26 |
| Methods | 32 |
| Data Collection | 33 |
| Data Analysis | 33 |
| Assumptions | 38 |

TABLE OF CONTENTS (Continued)


| | Page |
|---|---|
| Results | 39 |
| Discussion | 39 |
| CHAPTER 4 - SALCHA RIVER CHINOOK SALMON FISHERY | 43 |
| Introduction | 43 |
| Methods | 45 |
| Data Collection | 46 |
| Data Analysis | 46 |
| Assumptions | 50 |
| Results | 51 |
| Discussion | 54 |
| CHAPTER 5- PILEDRIVER SLOUGH RAINBOW TROUT FISHERY | 54 |
| Introduction | 54 |
| Methods | 56 |
| Data Collection | 57 |
| Data Analysis | 58 |
| Assumptions | 60 |
| Results | 61 |
| Discussion | 65 |
| ACKNOWLEDGEMENTS | 66 |
| LITERATURE CITED | 66 |
| APPENDIX A | 70 |
| APPENDIX B | 72 |

LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | Distribution of angler effort (angler-hours) by area and month for the upper Chena River Arctic grayling fishery, 18 May through 31 July 1991..... | 15 |
| 2. | Demographic profile of anglers interviewed at the upper Chena River, Tanana River drainage, Alaska, 18 May through 31 July 1991..... | 18 |
| 3. | Distribution of angler effort (angler-hours) by area and month for the upper Chatanika River Arctic grayling fishery, 18 May through 31 August 1991..... | 25 |
| 4. | Demographic profile of anglers interviewed at the upper Chatanika River, Tanana River drainage, Alaska, 18 May through 31 August 1991..... | 27 |
| 5. | Age composition estimates for Arctic grayling sampled from the upper Chatanika River, Tanana River drainage, Alaska, 18 May through 31 August 1991..... | 28 |
| 6. | Estimates of the age composition, mean fork length (mm) at age, and Relative Stock Density of northern pike in the harvest from George Lake, Alaska, 25 through 27 May 1991..... | 40 |
| 7. | Estimates of the catch and harvest distribution of northern pike anglers during the 1991 George Lake, Memorial Day weekend fishery..... | 41 |
| 8. | Summary of the angler catch, effort, and harvest estimates for the Salcha River chinook salmon creel survey, 6-28 July, 1991..... | 52 |
| 9. | Estimated proportion of angler-trips by various demographic and terminal gear type categories for the 1991 Salcha River chinook salmon creel survey..... | 53 |
| 10. | Estimates of the catch and harvest distribution of rainbow trout during the creel survey of the 1991 Piledriver Slough-Saturday late day fishery at Eielson Farm Road, 18 May to 27 July 1991 ..... | 62 |
| 11. | Estimated proportion of angler-trips by various demographic, terminal gear type, and opinion on fishing quality categories for the 1991 Piledriver Slough-Saturday creel survey at Eielson Farm Road, 18 May to 27 July 1991..... | 64 |

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | Map of Arctic-Yukon-Kuskokwim (AYK) Region and Tanana River drainage, Alaska | 3 |
| 2. | Effort and harvest by recreational anglers in the AYK Region (includes Tanana River drainage) and Tanana River drainage sport fish management areas, 1977-1990 | 4 |
| 3. | Map of the upper Chena River, Tanana River drainage, Alaska | 6 |
| 4. | Distribution of angler effort by area and time for the upper Chena River Arctic grayling fishery, Tanana River drainage, Alaska, 18 May - 31 July 1990 | 17 |
| 5. | Map of the upper Chatanika River, Tanana River drainage, Alaska | 20 |
| 6. | Distribution of angler effort by area and time for the upper Chatanika River Arctic grayling fishery, Tanana River drainage, Alaska, 18 May - 31 August 1990 | 29 |
| 7. | Map of George Lake, Tanana River drainage, Alaska | 31 |
| 8. | Distribution of northern pike catch and harvest among anglers at George Lake, Tanana River drainage, Alaska, (Memorial day weekend) 1991 | 42 |
| 9. | Map of the Salcha River, Tanana River drainage, Alaska | 44 |
| 10. | Map of Piledriver Slough, Tanana River drainage, Alaska | 55 |
| 11. | Estimate of the proportion of anglers who caught and harvested three or more rainbow trout at Piledriver Slough, Tanana River drainage, Alaska, 1991 | 63 |

## LIST OF APPENDICES


| Appendix | | Page |
|---|---|---|
| A. | Angler interview and biological data files developed for creel surveys conducted in interior Alaska in 1991 | 71 |
| B. | Exit angler count form | 73 |

ABSTRACT

Creel surveys were conducted on five of the major fisheries within the Tanana River drainage, Alaska, during 1991. These fisheries included (1) Upper Chena River Arctic grayling *Thymallus arcticus*, (2) Upper Chatanika River Arctic grayling, (3) George Lake northern pike *Esox lucius*, (4) Salcha River chinook salmon *Oncorhynchus tshawytscha*, and (5) Piledriver Slough rainbow trout *Oncorhynchus mykiss*.

Peak hour (1100 to 2000 hours) angling effort was estimated to be 3,201 angler hours at the upper Chena River Arctic grayling fishery, with 58 percent of the angling effort expended in June. During the month of June, in which harvest was allowed in the areas outside of the designated catch and release area the proportion expended upstream (38 percent) and downstream (44 percent) were each significantly ($\alpha = 0.10$) greater than the proportion of angler effort expended in the designated catch and release area (18 percent). Over the entire survey period, angling effort was not significantly greater for the areas downstream and upstream of the designated catch and release area, with 37 percent and 39 percent reported, respectively.

At the Chatanika River Arctic grayling fishery, peak hour (1100 to 2000 hours) angling effort was estimated to be 3,350 angler hours, with 68 percent of the angling occurring along the Steese Highway from 46 and 67 kilometer.

Eighty-seven percent of the George Lake Memorial Day weekend anglers caught one or more northern pike, and 51 percent harvested one or more northern pike. The estimated harvest of northern pike during the Memorial Day weekend was 128. Age 5 northern pike comprised 27 percent of the harvest. Northern pike harvested ranged in length from 210 to 825 millimeters and averaged 605 millimeters fork length.

At the Salcha River fishery, anglers expended an estimated 7,337 angler hours of effort to catch a total of 362 chinook salmon, of which 308 were harvested. Angling effort was greatest during July.

Thirty-eight percent of the Piledriver Slough rainbow trout anglers caught one or more rainbow trout and 17 percent harvested one or more. Twenty percent of the angler trips resulted in a catch of at least three rainbow trout. Thirty-eight percent of the anglers interviewed rated the quality of fishing as poor.

KEY WORDS: creel survey, catch, harvest, distribution of effort, catch composition, 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 numerous 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 1979-1991; and see Figure 2).

From 1977 through 1982, harvest of all fish species increased about 19% annually to a peak of about 179,000 for the Tanana River drainage. A record harvest for the entire AYK Region of 274,541 fish occurred in 1982 (Figure 2). From 1983 to 1987, harvest trends indicated a general decline 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 total harvest of all sport fish species in the Tanana River drainage dropped by 5% from 1988 to 1989, and more than 31% from 1989 to 1990. During this same period effort levels continued to rise from 1988 to 1989 and then decreased slightly from 1989 to 1990. The stocking program in interior Alaska continued to contribute significantly to the sport harvest. Data obtained from the Statewide Harvest Survey (Mills 1991) indicated that stocked rainbow trout accounted for nearly 50% of all fish harvested in the Tanana River drainage, and that the contribution from all stocked species made up more than 60% of the fish harvested.

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 (ADF&G) in the AYK Region during 1990 is

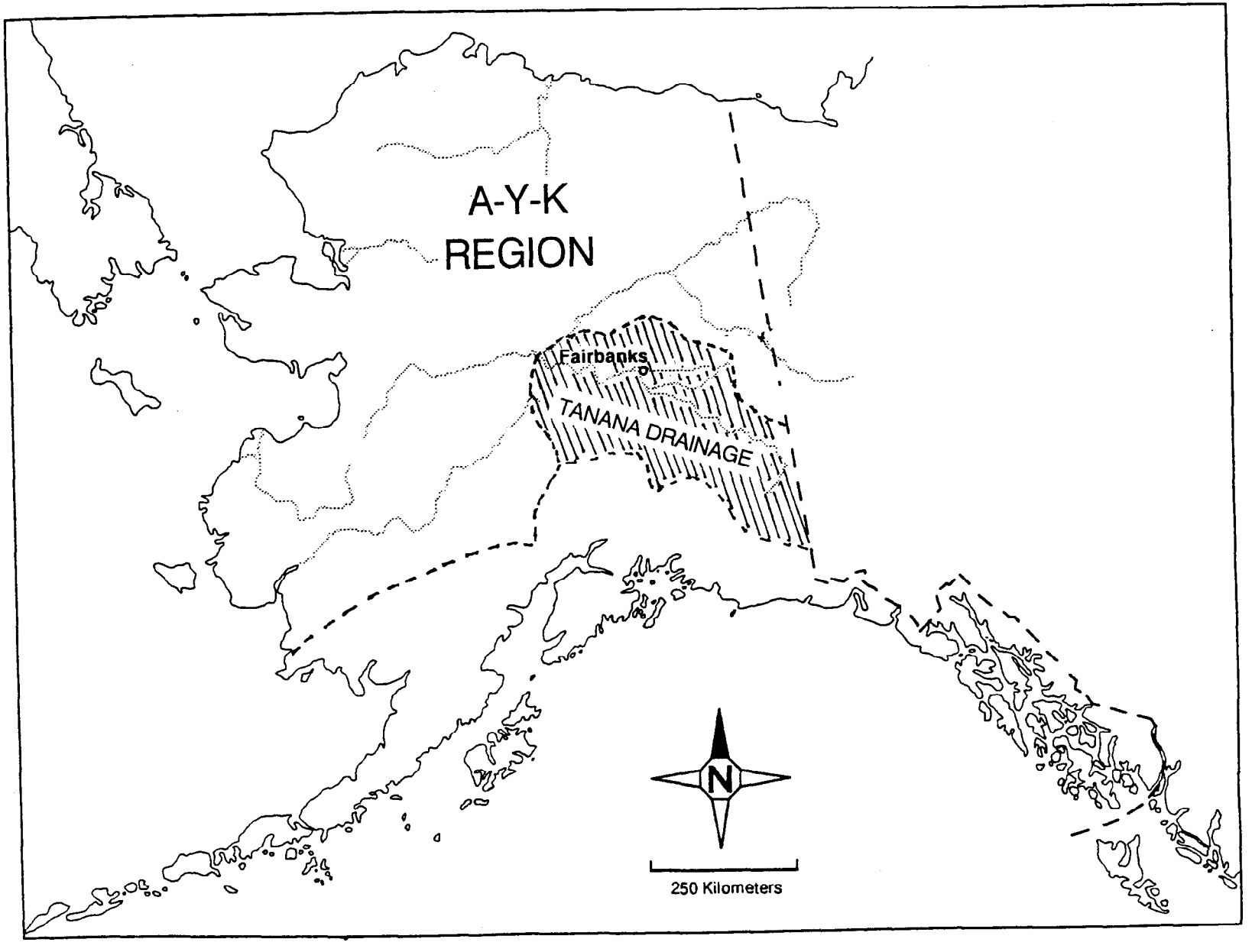


Figure 1. Map of Arctic-Yukon-Kuskokwim (AYK) Region and Tanana River drainage, Alaska.

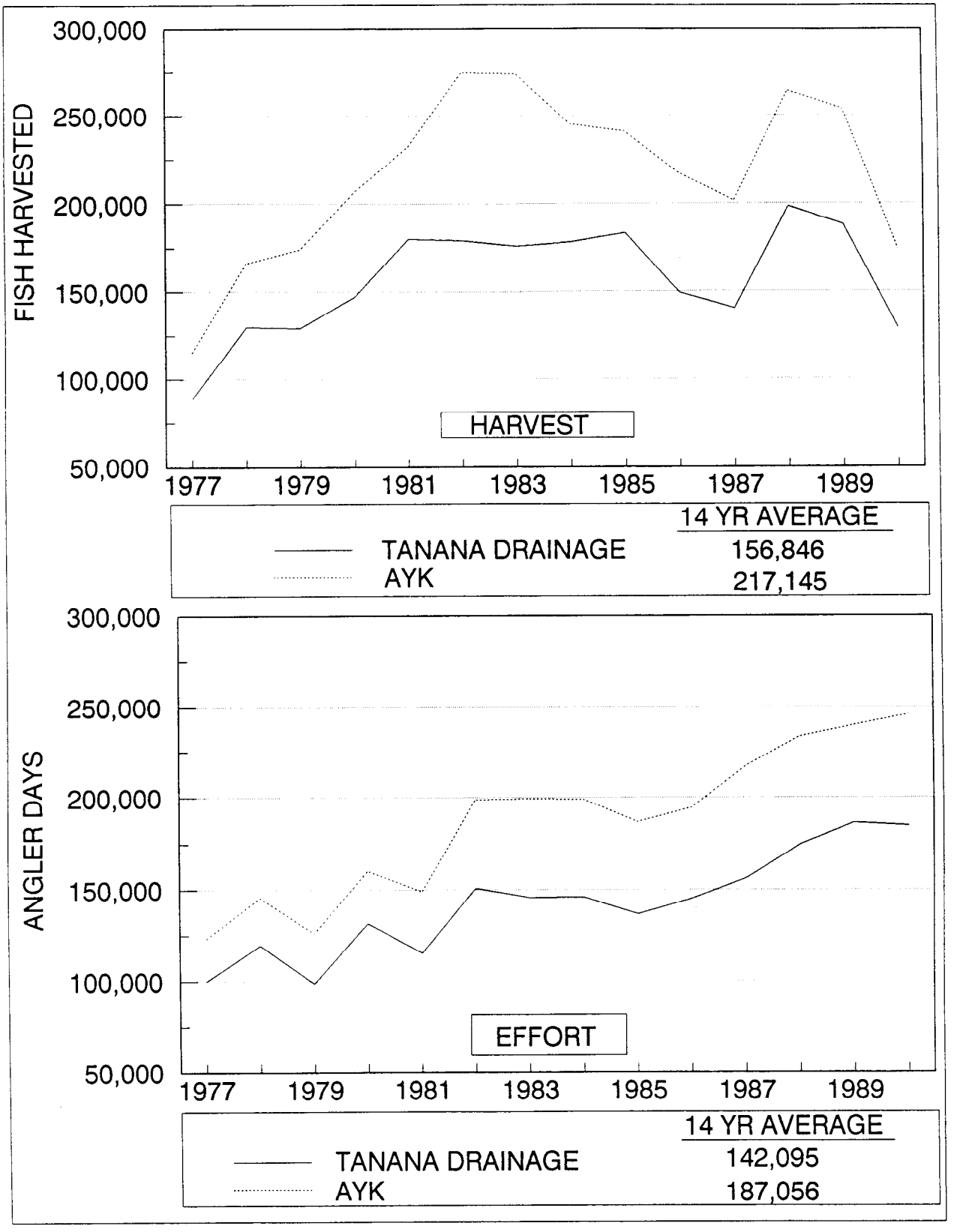


Figure 2. Effort and harvest by recreational anglers in the AYK Region (includes Tanana River drainage) and Tanana River drainage sport fish management areas, 1977-1990.

presented in this report. In addition, this report includes a chapter on the monitoring of the Piledriver Slough sport fisheries that took place during the summer of 1991. The same sampling techniques and estimation procedures have been utilized for many of the creel surveys. However, there were also many techniques and procedures that were specific to each creel survey. For this reason, a separate chapter is presented for each creel survey. Each chapter contains an introduction, methods, results, and discussion section.

Creel surveys were scheduled to be conducted at six of the major fisheries within the Tanana River drainage. However, the Chatanika River whitefish spear fishery was closed by a ADF&G Emergency Order, consequently, the scheduled creel survey for this fishery was cancelled. The specific objectives of the creel surveys were to provide in-season harvest information for the Salcha River chinook salmon and the George Lake Memorial day weekend northern pike fisheries, to identify the distribution of angler effort on the Chena and Chatanika rivers Arctic grayling roadside fisheries, and to provide catch composition and distribution of catches and harvests by anglers on the Piledriver Slough rainbow trout fishery. 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 long-term 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.

## CHAPTER 1 - UPPER CHENA RIVER ARCTIC GRAYLING FISHERY

### Introduction

One of the largest Arctic grayling fisheries in Alaska occurs on the upper Chena River. This fishery attracts a large number of anglers because of its close proximity to Fairbanks and because the majority of the fishery is accessible by road (Figure 3). The upper Chena River fishery occurs mainly within the Chena River State Recreation Area. This is one of the first open-water fisheries during the spring. The early season fishery can harvest large numbers of spawning adults. The fishery continues throughout the open-water period with the majority of angler effort being expended during the months of June, July, and August.

From 1977 to 1984, annual Arctic grayling harvest exceeded 21,000 (Mills 1979-1985). Harvest in the upper Chena River peaked at 41,825 in 1980 and fell to a historic low of 8,008 in 1984. Angler effort during this time remained fairly stable. Harvest has remained fairly constant since 1984. However, the level of harvest from 1984 to 1987 is approximately 30% lower than the 10-year average of 25,000 Arctic grayling from 1977 to 1987 (Mills 1979-1988, Baker 1988).

In 1975, the daily bag limit of Arctic grayling in the Tanana River drainage was reduced from ten to five. The possession limit remained at ten fish as it

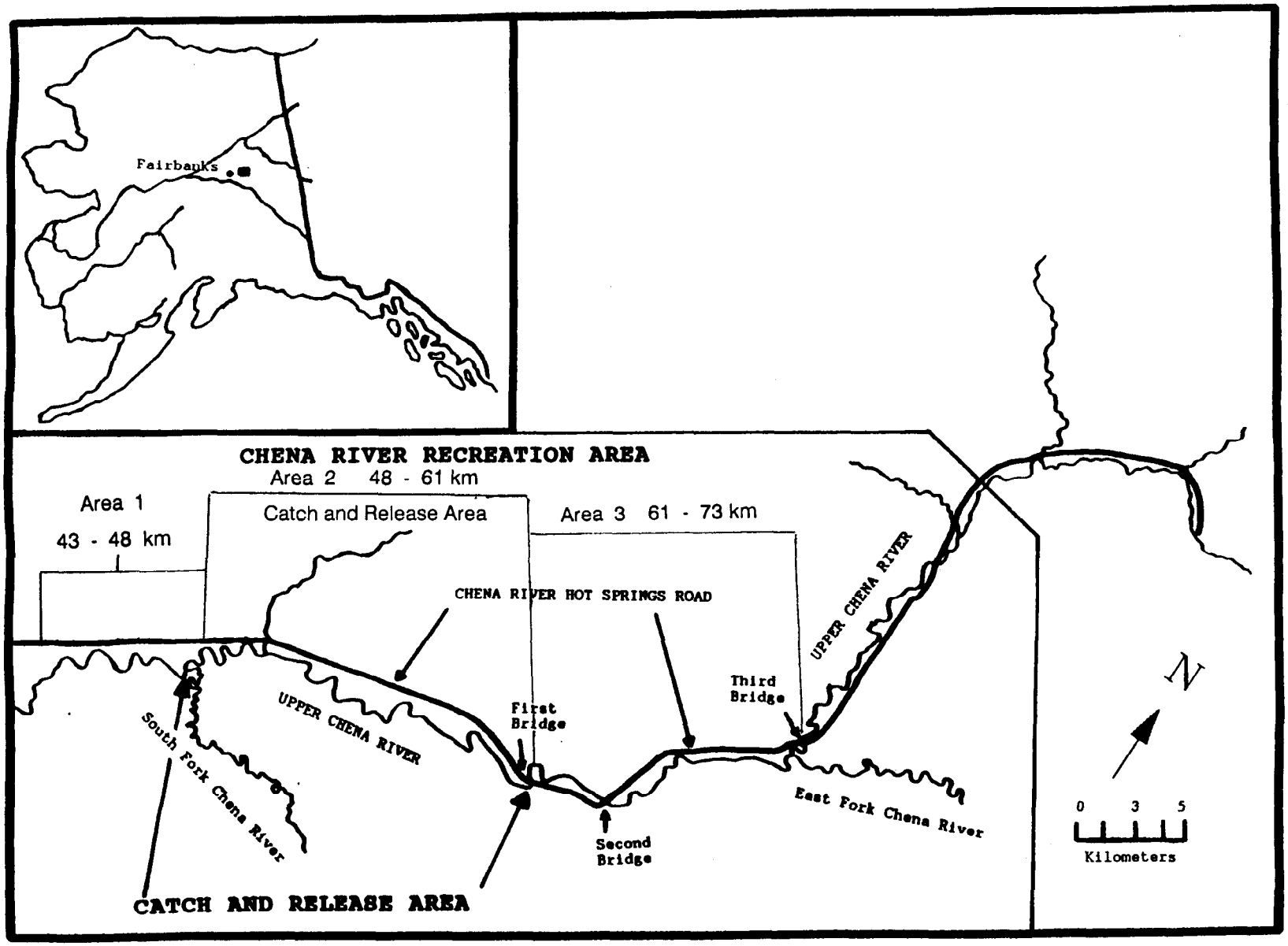


Figure 3. Map of the upper Chena River, Tanana River drainage, Alaska.

had been since 1962. Because these regulations did not prevent the declines in abundance and harvest of Arctic grayling in the upper Chena River, a series of management regulations were implemented in the spring of 1987. The possession limit for Arctic grayling was reduced from ten to five throughout the Tanana River drainage. Three other regulations were implemented in the upper Chena River:

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

2) the banning of bait fishing on the upper Chena River (artificial flies and lures only); and

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

These regulations were put into effect to help sustain the declining stock(s) and still provide adequate angling opportunities.

To provide a diversity of angling opportunities within the Tanana River drainage, a section of upper Chena River from the confluence of the South Fork of the Chena River (river kilometer 128) upstream to the first bridge on the Chena River Hot Springs Road (river kilometer 147) was designated as catch-and-release fishing only in 1988.

With the new regulations in effect, harvest of Arctic grayling from the Chena River in 1987 fell to 2,681 fish (Mills 1988). However, harvest nearly doubled in 1988 to 4,582, followed by a sharp increase in 1989 to 13,737 fish (Mills 1989 and 1990).

Further steps were taken by the Alaska Board of Fisheries in February of 1990 to lower the daily bag and possession limit to two Arctic grayling, 12 inches or greater in length, and to restrict fishing upstream of the Chena River Dam to unbaited single hook artificial lures only. No on-site creel surveys were conducted on upper Chena River Arctic grayling fishery in 1990. However, Mills (1991) reported a total harvest of 4,507 Arctic grayling for the entire Chena River, of which 21% or 945 fish were harvested from the upper Chena River in 1990.

The 1991 creel survey for the upper Chena River Arctic grayling fishery was designed to provide managers with specific data on the distribution of effort by anglers in the upper Chena River Arctic grayling fishery. The specific objective for the upper Chena River creel survey was to:

1. Estimate the distribution of effort by anglers in the upper Chena River Arctic grayling fishery.

In addition to this objective, two additional tasks were completed during this survey. These tasks were primarily directed at collecting ancillary data that may be useful in designing future on-site creel surveys. These tasks were to estimate:

1. the age composition of Arctic grayling harvested in the Chena River sport fishery; and,

2. the percent composition within the following demographic categories for anglers interviewed at the upper Chena River:

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

Methods

The design for the Chena River Arctic grayling creel survey in 1991 was of the roving (Neuhold and Lu 1957) count angler effort type. Angler effort estimates in total and by section were used to estimate the proportion of angler effort by section of the river on a seasonal basis and in total.

The creel survey was conducted from 18 May through 31 July. The survey was originally planned to extend to 2 September. However, in-season regulation changes (i.e., restricting the entire river to catch and release only fishing after 1 July), resulted in a substantive change in the nature of the fishery that superseded the need for the angler effort distribution estimates after 31 July.

The sampling day was defined between the hours of 1100 to 2000. We keyed in on the peak hours of the angling day to estimate distribution of angler effort by section. We anticipated that some sections of the river may have relatively low use. If we were to sample the entire angling day we would run the risk of observing no effort in sections with relatively low effort. We assumed, as such, that the distribution of effort among different sections of the river does not vary substantially throughout the day.

As noted above, the survey was a roving count type of survey. A stratified 2-stage sample design was employed to estimate angler effort. Seasonal strata are defined below. Within each stratum, days to sample represented the first sampling stage. The sampled days were selected at random without replacement from a restricted set of days within each stratum. The "restricted" set of days available for sampling were the days remaining after selecting days for the upper Chatanika River Arctic grayling angler effort survey, as described in the next chapter of this report. This restriction resulted in a unknown bias with the estimates obtained here. Since the proportion of days sampled in either survey for any particular stratum was not large, we expect that the bias was minimal.

Within each sampled day, one of three possible 3-systematic angler counts was scheduled (see Cochran 1977 for definition of systematic sampling). The possible sets of angler counts to conduct represented the second stage sampling units. Each angler count took approximately one hour to conduct, as such the three possible sets of three counts each within the sampling day were: (1) 1100, 1400, and 1700; (2) 1200, 1500, and 1800; and (3) 1300, 1600, and 1900. The selection of which of the three possible count sets to conduct on each sampled day was done randomly.

The fishery was split into weekday strata (Monday through Friday) and weekend-holiday strata (Saturday and Sunday, 27 May, and 4 July). The fishery was further stratified by periods in the season (see below).

The strata breakdowns and numbers of days sampled were as follows:

| Stratum | Total Number of Days in Stratum | Number of Days Sampled |
|---|---|---|
| 1. Period 1-Weekend/Holidays (18-19, 25-27 May) | 5 | 2 |
| 2. Period 1-Weekdays (20-24, 28-31 May) | 9 | 2 |
| 3. Period 2-Weekend/Holidays (1, 2, 8, 9, 15, 16, 22, 23, 29, 30 June) | 10 | 4 |
| 4. Period 2-Weekdays (3-7, 10-14, 17-21, 24-28 June) | 20 | 2 |
| 5. Period 3-Weekend/Holidays (4, 6, 7, 13, 14, 20, 21, 27, 28 July) | 9 | 3 |
| 6. Period 3-Weekdays (1-3, 5, 8-12, 15-19, 22-26, 29-31 July) | 22 | 2 |

Sampling effort among strata was designed to place most of the sampling effort on the days expected to have greater levels of angler effort and hence we expected to estimate the proportional composition of the angler effort among areas most precisely for the strata with the most angler effort.

Data Collection:

The creel clerk made three counts of anglers actively engaged in fishing along a 30 km stretch of the Chena Hot Springs road (43-73 km). This area was split into the following three geographical areas, and counts of anglers were recorded separately for each area:

Area 1. 43-48 km (27-30 mile) below the catch & release area;
Area 2. 48-61 km (30-38 mile) the area within the catch & release area; and,
Area 3. 61-73 km (38-45 mile) the area above the catch & release area.

Note, that during 1991, the entire fishery was closed to the retention of Arctic grayling (i.e., catch and release only) through 31 May 1991, by regulation. During the month of June, Arctic grayling could be retained in Areas 1 and 3, as noted above. After 30 June the entire fishery was again closed to retention of Arctic grayling, by emergency order.

The three roving counts within a sampled day began at the bottom or at the top of 30 km section. This starting point and consequently the direction of the daily counts was randomly selected. Counts took approximately one hour to complete. All angler count data were recorded on standard ADF&G Creel Census-Angler Count Form (Version 1.2). The creel clerk had approximately two hours in which to return to the starting point and begin the next count. During this time the creel clerk conducted interviews with anglers encountered on the return trip.

During the interview process, the creel clerk attempted to collect ancillary data on catch composition and angler demographic information that may be useful in designing future on-site creel surveys. All interview data were recorded on standard ADF&G Angler Interview Form (Version 1.1).

The creel clerk sampled the harvest for: date, location, species, length (fork length in millimeters), sex and presence of marks (tag color and number, and/or missing fins). This information was transferred from the coin envelope to the standard ADF&G Tagging Length Form (Version 1.0) mark sense forms in the office during the age determination work. In addition, at least two scales were taken from the preferred zone. 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. The best 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. Ages were determined by a single reader after one reading.

Data Analysis:

The distribution of angler effort among areas was calculated according to the procedure outlined below. We were primarily interested in the proportion of angler effort (in angler hours) that occurred in the catch and release area of Chena River versus the area outside of the catch and release area, by stratum of the fishery.

The first step in obtaining the proportional estimates was to calculate the angler effort for each area of the fishery for each day sampled:

$\hat{E}_{khi}$ = estimated angler effort for area $k$ within stratum $h$ during sampled day $i$;

$$= H_{hi}\,\bar{x}_{khi}\ ; \qquad (1)$$

where: $\bar{x}_{khi}$ equals the mean angler count in each area during each sampled day, obtained as;

$$\bar{x}_{khi} = \frac{\sum_{j=1}^{r_{hi}} x_{khij}}{r_{hi}}\ ; \qquad (2)$$

$r_{hi}$ equals the number of angler counts conducted during each sampled day (defined previously as 3); $x_{khij}$ equals the number of anglers counted within each area during each individual angler count during each sampled day; and $H_{hi}$ equals the number of hours within each day (set to nine hours as per schedule).

The next step involved estimating the mean angler effort for each area over all days sampled within each stratum:

$$\bar{\hat{E}}_{kh} = \frac{\sum_{i=1}^{d_h} \hat{E}_{khi}}{d_h} ; \quad (3)$$

where: $d_h$ equals the number of days sampled within each stratum.

The estimated angler effort for each area for each stratum was then found by expansion over all days in the stratum, as follows:

$$\hat{E}_{kh} = D_h \bar{\hat{E}}_{kh} ; \quad (4)$$

where: $D_h$ equals the number of days in each stratum.

The estimated proportion of angler effort by area in each stratum was then obtained by the following equation:

$$\hat{p}_{kh} = \frac{\hat{E}_{kh}}{\hat{E}_h} ; \quad (5)$$

where: $\hat{E}_h$ equals the total angler effort over all areas in the fishery within each stratum (obtained as the sum of all estimated angler efforts for each individual area within each stratum).

The variance of the estimated proportion of angler effort for each area within each stratum was approximated by the following equation (as obtained by the Delta method, see Seber 1982, pages 7-9):

$$\hat{V}[\hat{p}_{kh}] \approx \left\{ \frac{\hat{E}_{kh}}{\hat{E}_h} \right\}^2 \left\{ \frac{\hat{V}[\hat{E}_{kh}]}{\hat{E}_{kh}^2} + \frac{\hat{V}[\hat{E}_h]}{\hat{E}_h^2} - \frac{2\,\hat{V}[\hat{E}_{kh}]}{\hat{E}_{kh}\,\hat{E}_h} \right\} ; \quad (6)$$

where: $\hat{V}[\hat{E}_{kh}]$ equals the estimated variance of the angler effort estimate for each area, obtained by the following two stage equation (adapted from Equation 11.24, page 303, in Cochran 1977);

$$\hat{V}[\hat{E}_{kh}] = \left\{ (1 - f_{1h})\, D_h^2 \frac{s_{1kh}^2}{d_h} \right\} + \left\{ f_{1h} \frac{D_h^2}{d_{2h}^2} \sum_{i=1}^{d_{2h}} H_{hi}^2 \frac{s_{2khi}^2}{r_{hi}} \right\} ; \quad (7)$$

where: $d_{2h}$ equals the number of days sampled in which at least two angler counts were conducted; $f_{1h}$ equals the first stage sampling fraction (i.e., $f_{1h} = d_h / D_h$);

$s^2_{1kh}$ = the among day variance for the effort estimate for each area within stratum *h*;

$$= \frac{\sum_{i=1}^{d_h} (\hat{E}_{khi} - \bar{\hat{E}}_{kh})^2}{d_h - 1} ; \quad (8)$$

$s^2_{2khi}$ = the within day variance for the angler effort estimate for each area, obtained from the successive differences formula appropriate for systematic sampling (modified from Equation 7.2.4, page 251, in Wolter 1985);

$$= \frac{\sum_{j=2}^{r_{hi}} (x_{khij} - x_{khi(j-1)})^2}{2(r_{hi} - 1)} ; \text{ and} \quad (9)$$

$\hat{V}[\hat{E}_h]$ equals the estimated variance of the total angler effort estimate over all areas within each stratum, which is obtained by summing the individual variance estimates for all areas within each stratum.

The estimated proportion of angling effort by area across all strata (or combinations of strata) was obtained as follows:

$$\hat{p}_k = \frac{\hat{E}_k}{\hat{E}} ; \quad (10)$$

where: both terms on the right-hand-side of equation 10, are obtained by summing the corresponding stratum estimates.

The variance for the combined stratum estimate was obtained by the equation derived by the Delta method as follows:

$$\hat{V}[\hat{p}_k] \approx \left\{ \frac{\hat{E}_k}{\hat{E}} \right\}^2 \left\{ \frac{\hat{V}[\hat{E}_k]}{\hat{E}_k^2} + \frac{\hat{V}[\hat{E}]}{\hat{E}^2} - \frac{2\,\hat{V}[\hat{E}_k]}{\hat{E}_k\,\hat{E}} \right\} ; \quad (11)$$

where: the variance components are obtained by summing the corresponding stratum variance estimates (as obtained above).

Estimates of angler demographics in terms of the proportion of angler-trips were calculated directly from the sampled data. Angler interviews were conducted to fulfill the requirements necessary to complete the tasks portion

of the study. The collection of interview data was considered secondary and was not to conflict or compete with subsequent counts. Attempts were made to obtain interviews with as many individual anglers as time permitted (on the return trip) between counts. Because some of the (counted) anglers had terminated their fishing trip and exited the area, while others (boaters or floaters) were not available for interviews, only a portion of those anglers counted were subsequently interviewed. However, more angler interviews were obtained on days when more anglers were counted. Accordingly, treating the sampled data as a simple random sample of the fishery involved assuming that our two stage sample design (days the first stage and anglers the second stage) could be ignored in that treating each individual interview equally results in a self-weighting estimation process (i.e., more interviews obtained on days with more angler trips). Accordingly, the proportion of angler-trips by demographic category (e.g., male versus female, resident versus non-resident, etc.), were calculated by the standard equation for a proportion:

$$\hat{p}_u = \text{estimated proportion of the angler-trips that are category } u^1;$$

$$= \frac{n_u}{n'}; \qquad (12)$$

where: $n_u$ equals the number of the interviewed anglers that are classified as category $u$; and $n'$ equals number of interviewed anglers that can be categorized.

The variance of the estimate of $p_u$ was obtained by the standard equation for the variance of a binomial proportion (adapted from Cochran 1977, equation 3.8, page 52):

$$\hat{V}[\hat{p}_u] = \left\{ \frac{\hat{p}_u (1 - \hat{p}_u)}{n' - 1} \right\}. \qquad (13)$$

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

Age composition estimates of the sampled harvest of Arctic grayling were also obtained from equations 12 and 13 above. We assumed that the harvest was sampled proportionally on each day of the survey. Data filenames for this and following analyses are listed in Appendix A.

---

[1] Where category refers to the different classifications, dependent upon the parameter being estimated (e.g., females versus males for sex composition).

Assumptions:

The assumptions necessary for unbiased point and variance estimates of distribution of angler effort obtained by the procedures outlined above were that:

1. the counting process was essentially instantaneous, that is the creel clerk traveled faster than anglers would be expected to enter, leave, or move around the fishery;

2. the distribution of angler effort within each day was similar throughout the day (i.e., measuring during the peak of the day gave an accurate representation of the distribution throughout the day); and,

3. within any strata the distribution of angler effort did not vary appreciably between days (this assumption is necessitated by the restricted random sampling of days as noted above).

Many traditional creel surveys are designed where counts are conducted concurrently with the interviews over a given span of time. During these count/interview samples, some anglers enter and some anglers leave the fishery (non-instantaneous count). The effect of the non-instantaneous nature of the counts would be to bias the point estimate of angler effort in an upward manner, in that anglers with longer trip duration would have a larger probability of being counted than anglers with short trip duration (Robson 1961). This creel survey was designed to obtain counts of all anglers actively fishing, independent of the interview process in an attempt to obtain a more true instantaneous count. Therefore we made the assumption that the creel clerk will travel faster than anglers would be expected to enter or leave, or move around within the fishery. However, given the nature of a roving type count, conducted over a 30 km stretch of road with numerous access points and taking approximately one hour to complete, one would expect the above assumption to undoubtedly be invalid. The degree of this bias is unknown.

The assumptions necessary for unbiased point and variance estimates of proportions of angler-trips by demographic category obtained by the procedures outlined above were that:

1. anglers were interviewed in proportion to their abundance (i.e., an equal proportion of anglers present during any day were interviewed on all sampled days of the fishery); and,

2. anglers accurately reported their demographic characteristics and/or the creel clerk accurately determines the angler's characteristics (as in the case of sex of angler).

Results

During the creel survey three angler counts were conducted each day on 15 randomly selected days and angler effort was estimated for three distinct areas along the upper Chena River from 18 May through 31 July 1991 (Table 1). Estimated angler effort for the peak hours of the day during the creel survey

Table 1. Distribution of angler effort (angler-hours) by area and month for the upper Chena River Arctic grayling fishery, 18 May through 31 July 1991. Estimates of angler effort only comprise the fishing effort occurring between the hours of 1100 and 2000.

| Strata Information and Regulation Summary | Days Available For Sampling | Number of Days Sampled | | AREA 1[a] | AREA 2[b] | AREA 3[c] | Totals[d] |
|---|---|---|---|---|---|---|---|
| MAY 18-31 | | | | | | | |
| | 14 | 4 | Effort | 255 | 149 | 149 | 552 |
| (Special regulations in effect, | | | Variance | 6,480 | 645 | 3,358 | 10,483 |
| catch & release only for Arctic | | | Est. Proportion | 0.46 | 0.27 | 0.27 | 0.17 |
| grayling in the entire Chena River). | | | Standard Error | 0.09 | 0.06 | 0.09 | 0.03 |
| JUNE | | | | | | | |
| | 30 | 6 | Effort | 705 | 330 | 825 | 1,860 |
| (Chena River open to the catch and | | | Variance | 43,453 | 5,653 | 31,252 | 80,359 |
| retention of Arctic grayling, EXCEPT | | | Est. Proportion | 0.38 | 0.18 | 0.44 | 0.58 |
| within Area 2. | | | Standard Error | 0.08 | 0.04 | 0.07 | 0.05 |
| JULY | | | | | | | |
| | 31 | 5 | Effort | 216 | 300 | 273 | 789 |
| (Emergency Order in effect, catch & | | | Variance | 4,750 | 14,620 | 3,818 | 23,189 |
| release only for Arctic grayling in the | | | Est. Proportion | 0.27 | 0.38 | 0.35 | 0.25 |
| entire Chena River). | | | Standard Error | 0.08 | 0.10 | 0.08 | 0.04 |
| TOTALS | 75 | 15 | Effort | 1,176 | 779 | 1,247 | 3,201 |
| | | | Variance | 54,683 | 20,918 | 38,429 | 114,030 |
| | | | Est. Proportion | 0.37 | 0.24 | 0.39 | 1.0 |
| | | | Standard Error | 0.05 | 0.04 | 0.05 | |

[a] = 43-48 km (mile 27-30) Chena Hot Springs Road, downstream of the designated catch and release area.
[b] = 48-61 km (mile 30-38) Chena Hot Springs Road. The designated catch and release area.
[c] = 61-73 km (mile 38-45) Chena Hot Springs Road, upstream of the designated catch and release area.
[d] = Totals may not be the sum of the printed estimates due to rounding.

was 3,201 angler hours. The proportion of angler effort was non-significantly (at $\alpha = 0.10$) greater for the areas immediately downstream and upstream (Areas 1 and 3) of the designated catch and release area, with 37% (SE = 5%) and 39% (SE = 5%) reported, respectively. The proportion of angler effort within the designated catch and release area (area 2) was estimated at 24% (SE = 4%).

The highest proportion of angling effort occurred during the month of June with 58% (SE = 5%) followed by July with 25% (SE = 4%), and May 18-31 with 17% (SE = 3%; Figure 4). During the month of June, in which harvest was allowed in the areas outside of the designated catch and release area the proportion expended upstream (38%; SE = 8%) and downstream (44%; SE = 7%) were each significantly ($\alpha = 0.10$) greater than the proportion of angler effort expended in the designated catch and release area (18%; SE = 4%).

The demographic profile of anglers utilizing the upper Chena River Arctic grayling fishery (based on a total of 60 interviews) shows that the majority of anglers were, male (78%; SE = 5%), adult (87%; SE = 4%), resident (77%; SE = 5%), non-military (80%; SE = 5%) (Table 2). Sixty percent of the anglers (SE = 6%) used spinners as their terminal gear type.

Biological data were collected from nine Arctic grayling harvested during the upper Chena River grayling fishery. Mean fork length of the nine fish sampled was 280 mm. Seven grayling (78%, SE = 15%) were found to be age four fish, while one age 5 and one age 12 accounted for the remainder (11%; SE = 11% each).

## Discussion

The upper Chena River Arctic grayling fishery was originally scheduled to run from 18 May through 2 September. The single study objective was to estimate the distribution of angling effort in the fishery. The intent was to assess where the fishing effort was occurring in relation to the designated catch and release area, given the existing regulations. However, the ADF&G, Sport Fish Division closed the entire Chena River and its tributaries to the retention of Arctic grayling on 1 July 1991, by emergency order. A combination of over-harvest, high exploitation rates of large Arctic grayling (beyond that which is sustainable) and poor recruitment were the reasons for the conservation closure.

With the change in the regulations governing the Arctic grayling fishery in the upper Chena River, the focus of our creel survey also changed. Because anglers could not retain any Arctic grayling caught within the Chena River or its tributaries after 1 July 1991, it became equally important to assess the distribution of angler effort before and after the emergency order went into effect, as well as determining the distribution of effort both within and outside the designated catch and release area. The creel survey was terminated on 31 July 1991. In doing so we were able to save the cost of approximately one month creel clerk time, and still compare the distribution of effort in the upper Chena River grayling fishery for one month prior, to one month following, the emergency order going into effect.

From 18-31 May the majority of the angling effort occurred in Area 1, downstream of the designated catch and release area. However, the regulation in effect during this period dictated that the entire Chena River is catch and

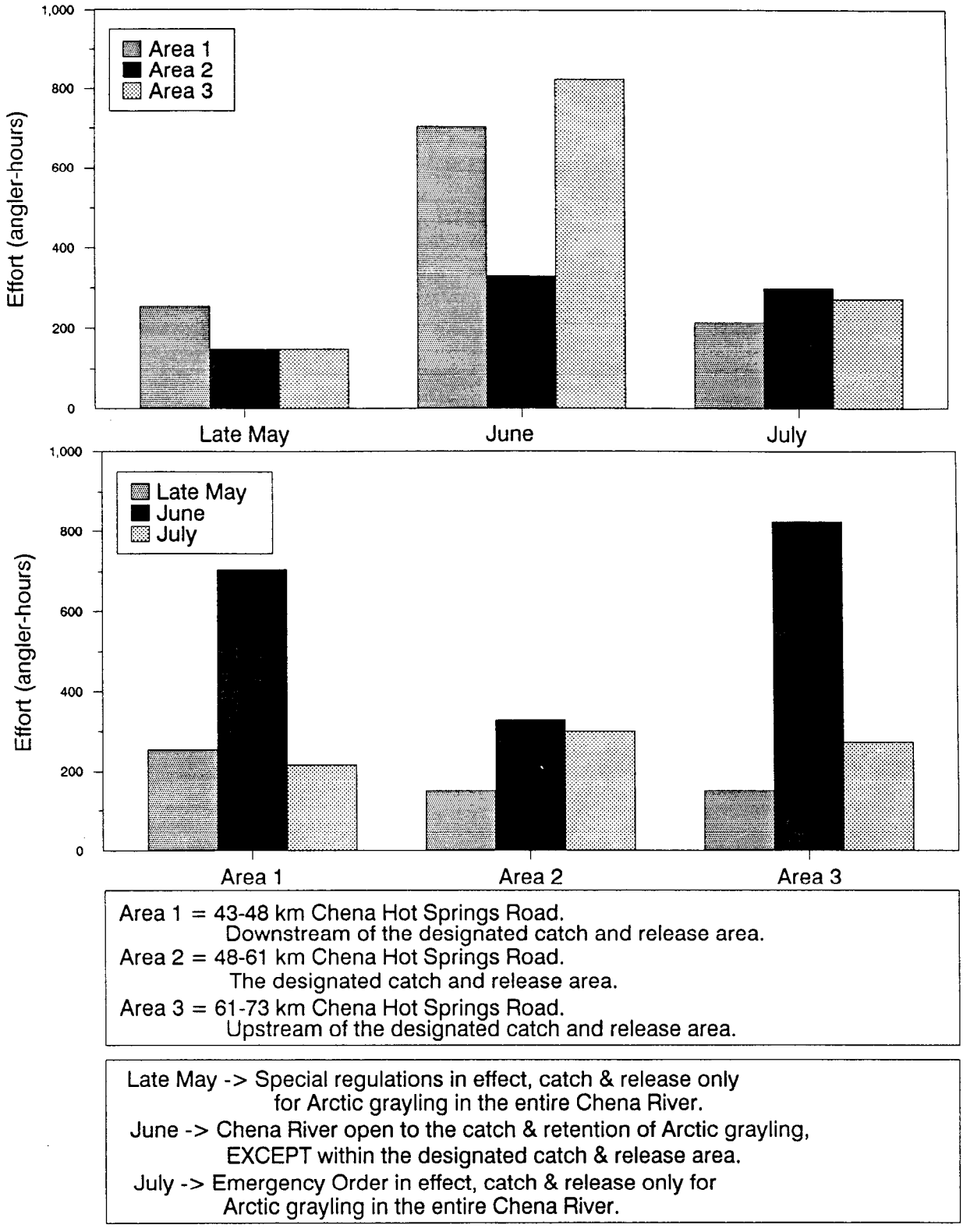


Figure 4. Distribution of angler effort by area and time for the upper Chena River Arctic grayling fishery, Tanana River drainage, Alaska, 18 May - 31 July 1990.

Table 2. Demographic profile of anglers interviewed at the upper Chena River, Tanana River drainage, Alaska, 18 May through 31 July, 1991.

| Angler Characteristic | Number of Anglers | Proportion | SE |
|---|---|---|---|
| Total Number of Interviews | 60 | | |
| Male | 47 | 0.78 | 0.05 |
| Female | 13 | 0.22 | 0.05 |
| Adult | 52 | 0.87 | 0.04 |
| Youth | 8 | 0.13 | 0.04 |
| Resident | 46 | 0.77 | 0.06 |
| Non-Resident | 14 | 0.23 | 0.06 |
| Military | 12 | 0.20 | 0.05 |
| Non-Military | 48 | 0.80 | 0.05 |
| Gear Type: | | | |
| Spin | 36 | 0.60 | 0.06 |
| Flies | 24 | 0.40 | 0.06 |

release only for Arctic grayling. In June, the regulation changed in that the Chena River was open to the catch and retention of Arctic grayling, except for Area 2, the designated catch and release area. The bulk of the effort during this period occurred in areas outside of the designated catch and release area (Figure 4). In July the emergency order went into effect, establishing (once again) a catch and release regulation for Arctic grayling for the entire Chena River (same as was in effect in the 18-31 May period). During this period effort was nearly equal in all three areas.

Estimates of angler effort by time indicate that the majority (58%) of the effort occurred during June, a period when Arctic grayling could be retained. A summary of the proportion of angler effort by area seems to reflect a more even distribution of effort between the three areas, with slightly more effort occurring in the areas above and below the designated catch and release area Table 1).

Determining where anglers fish and just how much time they spend fishing (the distribution of angler effort) within a given fishery is dependent upon many factors. Elements such as fish availability, the regulations in effect, access, accommodations and related facilities (parking or picnic areas), the distance from town, and time of year are just some of the variables that affect angling effort.

The three areas surveyed in 1991 lie within the Chena River State Recreation Area. Managed by the Alaska Department of Natural Resources, Division of Parks, this entire area has received considerable development in recent years.

The size of the three areas along with the total possible access sites available within each area is expected to affect the distribution of anglers (i.e. angler effort). Area 1, while only 5 km long has approximately four access points. Area 2 is 13 km long, and has only four access points, while Area 3 is 11 km in length and has at least seven access points. Both Areas 1 and 3 are much more developed than Area 2. Areas 1 and 3 have overnight camping facilities while Area 2 has none. Consequently, the likelihood of encountering anglers in Area 1 and 3 is expected to be greater than in Area 2, which is the largest of the three areas but has the fewest access locations and the least amount of development. Also, the Chena River within Area 2, (because of its restricted access), has become a very popular float trip.

Anglers who canoe or raft through Area 2 are certainly more likely to be missed by the creel clerk than the more stationary shore angler. For this reason and the fact that Area 2 has the fewest road accessible sites, the estimated effort in Area 2 may be biased low.

## CHAPTER 2 - UPPER CHATANIKA RIVER ARCTIC GRAYLING FISHERY

### Introduction

The Chatanika River presently supports one of the largest Arctic grayling fisheries in the Tanana River drainage. Originating in the foothills of the White Mountains approximately 80 km northeast of Fairbanks, the upper Chatanika River parallels the Steese Highway for approximately 65 km (Figure 5). A State recreation and campground area located at 62 km and a

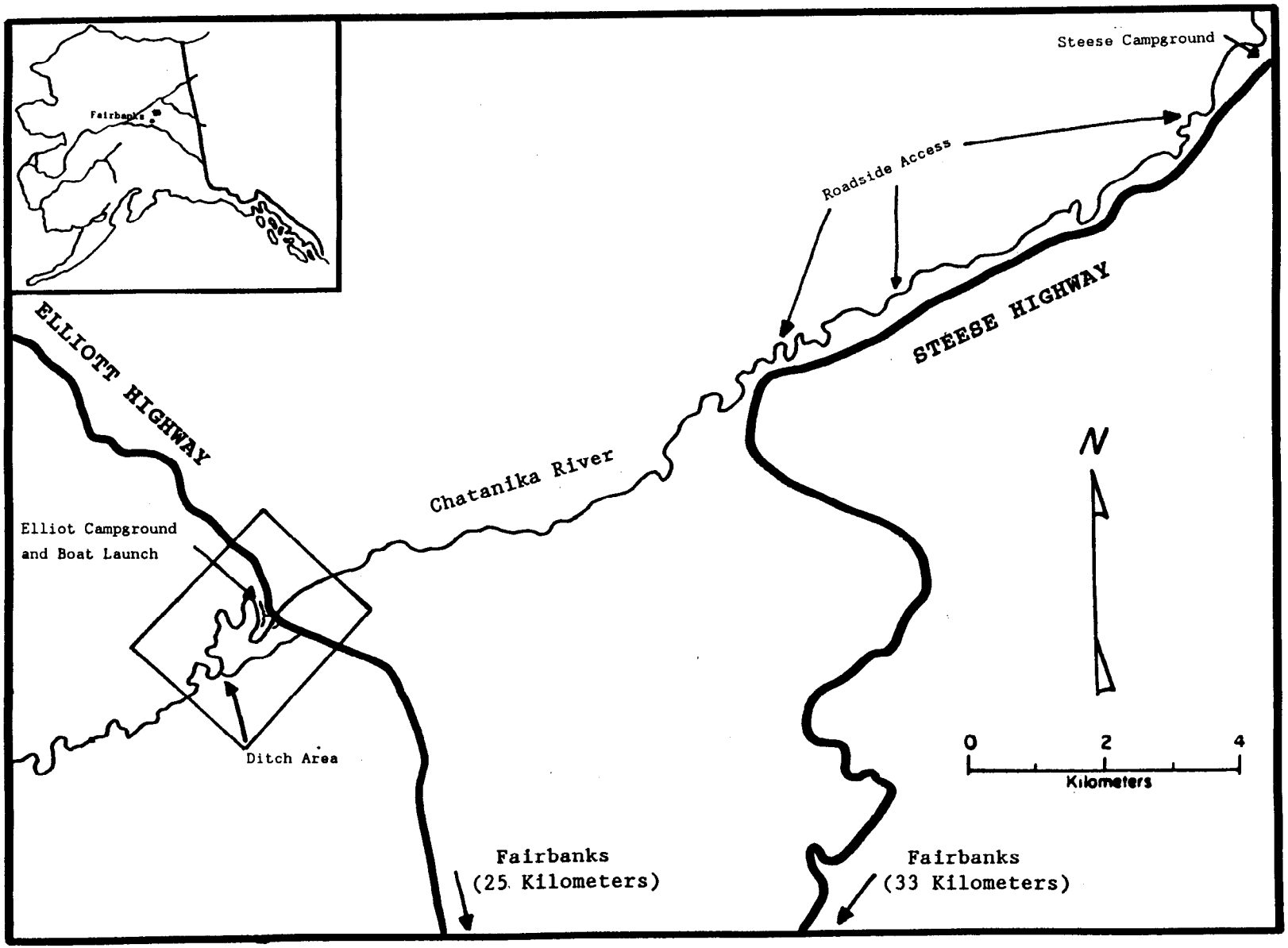


Figure 5. Map of the upper Chatanika River, Tanana River drainage, Alaska.

Bureau of Land Management campground at 97 km, along with many roadside pull-out areas along the Steese highway provide anglers with easy access to the Chatanika River.

Although extensive studies of the Chatanika River Arctic grayling were performed before statehood (Warner 1959), very little creel survey data are available prior to 1977. Arctic grayling catch rates were estimated during summer 1953-1958, ranging from 0.13 fish per hour in 1955 to 0.78 fish per hour in 1954 (Warner 1959). Fishery managers during this period thought that excessive harvest of sub-adult Arctic grayling was causing declines in fish abundance and angler catch rates (Wojcik 1954, 1955). A 305 mm (12 inch) minimum length limit for Arctic grayling was enforced between 1955 and 1958, but was removed in 1959 (Warner 1959).

A creel survey of the 1974 Chatanika River Arctic grayling fishery along the Steese Highway was conducted by Kramer (1975). An estimated 27,250 angler hours were expended with a catch rate of 1.02 Arctic grayling per hour. From 1977 through 1990, harvest of Arctic grayling for the entire Chatanika River was estimated by Mills (1979-1991). Annual harvests during this period ranged from 2,692 fish in 1986 to 9,766 in 1983. Annual harvest averaged 6,215 Arctic grayling during this period, with angling effort for all species averaging 9,045 angler-days.

In addition to harvest data provided by Mills (1988), Baker (1988) conducted a creel survey of Chatanika River (Elliott Highway area) anglers in May and June 1987. Catch rate was estimated at 0.02 Arctic grayling harvested per angler hour.

Precise knowledge of fishery characteristics and the dynamics of Arctic grayling populations in the Chatanika River is of growing importance to fishery managers. Thus, a multi-year study of Arctic grayling populations in the Chatanika River began in 1989. In conjunction with the present on-going research project, the ADF&G initiated a creel survey on the Chatanika River Arctic grayling fishery in 1991. The primary goal of the 1991 creel survey at the Chatanika River was to estimate the distribution of angling effort for Arctic grayling during the open water period (mid-May through August), along that area of the Chatanika River paralleling the Steese Highway from approximately 46 to 111 km.

The specific objective for the 1991 survey of the upper Chatanika River Arctic grayling angler effort survey was to:

1. estimate the distribution of effort by anglers in the upper Chatanika River Arctic grayling fishery.

In addition to this primary study objective, two additional tasks were completed during the survey. These tasks were primarily directed at collecting ancillary data that may be useful in designing future on-site creel surveys. These tasks were to estimate:

1. the age composition of Arctic grayling harvested in the Chatanika River sport fishery; and,

2. the percent composition within the following demographic categories for anglers interviewed at the upper Chatanika River:

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

Methods

The design for the Chatanika River Arctic grayling creel survey in 1991 was of the roving (Neuhold and Lu 1957) count angler effort type. Angler effort estimates in total and by section were used to estimate the proportion of angler effort by section of the river on a seasonal basis and in total. This design was in general the same as used for surveying the upper Chena River Arctic grayling fishery.

The creel census was conducted from 18 May through 31 August. The sampling day was defined between the hours of 1100 to 2000. We keyed in on the peak hours of the angling day, in order to estimate distribution of angler effort by section. We anticipated that some sections of the river may have relatively low use. If we were to sample the entire angling day we would run the risk of observing no effort in sections with relatively low effort. We assumed, as such, that the distribution of effort among different sections of the river does not vary substantially throughout the day.

As noted above, the survey was a roving count type of survey. A stratified 2 stage sample survey was conducted for estimation of angler effort by section of the fishery and in total. The types of strata are defined below. Within each stratum, days to sample represented the first sampling stage. The sampled days were selected at random without replacement from all available days within each stratum.

Within each sampled day, one of three possible 2-systematic angler counts were scheduled. The possible sets of angler counts to conduct represented the second stage sampling units. Each angler count took approximately 90 minutes to conduct, as such the three possible sets of two counts each within the sampling day were: (1) 1100 and 1530; (2) 1230 and 1700; and (3) 1400 and 1830. The selection of which of the three possible count sets to conduct on each sampled day was done in a random manner.

The fishery was split into weekday strata (Monday through Friday) and weekend-holiday strata (Saturday and Sunday, 27 May, and 4 July). The fishery was further stratified by periods in the season (see below).

The strata breakdowns and numbers of days sampled were as follows:

| Stratum | Total Number of Days in Stratum | Number of Days Sampled |
|---|---|---|
| 1. Period 1-Weekend/Holidays (18-19, 25-27 May) | 5 | 2 |
| 2. Period 1-Weekdays (20-24, 28-31 May) | 9 | 3 |
| 3. Period 2-Weekend/Holidays (1, 2, 8, 9, 15, 16, 22, 23, 29, 30 June) | 10 | 5 |
| 4. Period 2-Weekdays (3-7, 10-14, 17-21, 24-28 June) | 20 | 6 |
| 5. Period 3-Weekend/Holidays (4, 6, 7, 13, 14, 20, 21, 27, 28 July) | 9 | 5 |
| 6. Period 3-Weekdays (1-3, 5, 8-12, 15-19, 22-26, 29-31 July) | 22 | 5 |
| 7. Period 4-Weekend/Holidays (3, 4, 10, 11, 17, 18, 24, 25, 31 August) | 9 | 5 |
| 8. Period 4-Weekdays (1-2, 5-9, 12-16, 19-23, 26-30 August) | 22 | 6 |

Sampling effort among strata was designed to place most of the sampling effort on the days expected to have greater levels of angler effort and hence we expected to estimate the proportional composition of the angler effort among areas most precisely for the strata with the most angler effort.

Data Collection:

The creel clerk made two counts of anglers actively engaged in fishing along a 65 km stretch of the Steese Highway (46-111 km). This area was split into the following three geographical areas, and counts of anglers were recorded separately for each area:

Area 1. 46-67 km (29-42 mile).
Area 2. 67-92 km (42-57 mile).
Area 3. 92-111 km (57-69 mile).

The two roving counts within a sampled day began at the bottom or at the top of 65 km section. This starting point and consequently the direction of the daily counts was randomly selected. Counts took approximately 90 minutes to complete. All angler count data were recorded on standard ADF&G Creel Census-Angler Count Form (Version 1.2). The creel clerk had approximately three hours in which to return to the starting point and begin count number 2. During this time the creel clerk conducted interviews with anglers encountered on the return trip.

During the interview process, the creel clerk attempted to collect ancillary data on catch composition and angler demographic information as noted above. All interview data were recorded on standard ADF&G Angler Interview Form (Version 1.1).

Data Analysis:

The distribution of angler effort among areas was calculated according to the procedures outlined above for the upper Chena River survey (see equations 1-11).

Similarly, estimates of the proportion of angler-trips by demographic category were calculated using equations 12 and 13.

Age composition estimates of the sampled harvest of Arctic grayling were also obtained by using equations 12 and 13. In applying these equations each age group was treated as its own category. We assumed that the harvest was sampled proportionally on each day of the survey.

Assumptions:

The assumptions necessary for unbiased point and variance estimates of distribution of angler effort obtained by the procedures outlined above were the same as those listed for the upper Chena River survey, with the exception that we did not need to assume that distribution of angler effort was similar from day to day within each stratum (since we sampled days at random in this survey). Additionally, we assumed that angler effort exhibits a trend during the day, such that our estimates of the variance of the angler counts would be conservative (i.e., positively biased). This assumption was necessitated by the use of a systematic sample design with only two counts[2]. The variance estimator (see equation 9 above) collapses to the standard sample variance which has been shown to be conservative when a trend in the parameter exists (Wolter 1985).

The assumptions necessary for unbiased point and variance estimates of proportions of angler-trips by demographic category obtained by the procedures outlined above were the same as for the upper Chena River survey. The same set of assumptions also applied to the estimation of age composition (i.e., harvested fish were sampled in proportion to their abundance, and ages were determined accurately).

Results

During the creel survey two angler counts were conducted each day on 37 randomly selected days and angler effort was estimated for three distinct areas along the upper Chatanika River from 18 May through 31 August, 1991 (Table 3). The total estimated peak of day (1100 to 2000 hours) angler effort for the 1991 creel survey was 3,349 angler hours. The proportion of angling effort in area 1 (46-67 km Steese highway), was 68%, (SE = 5%). The estimated proportions for area 2 (67-92 km Steese highway) and area 3 (92-111 km Steese highway) were 18% (SE = 4%) and 14% (SE = 4%) respectively.

---

[2] Ideally, we would have scheduled three systematic counts within each sampled day, however the duration of the count (90 minutes) and the length of the reach covered (65 km) restricted the number of counts that could be conducted within each sampled day.

Table 3. Distribution of angler effort (angler-hours) by area and month for the upper Chatanika River Arctic grayling fishery, 18 May through 31 August 1991. Estimates of angler effort are restricted to the period between the hours of 1100 and 2000.

| STRATUM | Days Available For Sampling | Number of Days Sampled | | AREA 1 46-67 km Steese Highway | AREA 2 67-92 km Steese Highway | AREA 3 92-111 km Steese Highway | Totals[a] |
|---|---|---|---|---|---|---|---|
| MAY 18-31 | 14 | 5 | Effort | 214 | 57 | 0 | 270 |
| | | | Variance | 18,554 | 1,949 | 0 | 20,503 |
| | | | Est. Proportion | 0.79 | 0.21 | 0.00 | 0.08 |
| | | | Standard Error | 0.17 | 0.17 | | 0.04 |
| JUNE | 30 | 11 | Effort | 471 | 231 | 156 | 858 |
| | | | Variance | 19,172 | 4,660 | 3,290 | 27,122 |
| | | | Est. Proportion | 0.55 | 0.27 | 0.18 | 0.26 |
| | | | Standard Error | 0.09 | 0.07 | 0.06 | 0.05 |
| JULY | 31 | 10 | Effort | 1,387 | 208 | 176 | 1,771 |
| | | | Variance | 104,093 | 8,967 | 7,361 | 120,421 |
| | | | Est. Proportion | 0.78 | 0.12 | 0.10 | 0.53 |
| | | | Standard Error | 0.07 | 0.05 | 0.05 | 0.06 |
| AUGUST | 31 | 11 | Effort | 204 | 115 | 131 | 449 |
| | | | Variance | 7,081 | 3,635 | 5,663 | 16,379 |
| | | | Est. Proportion | 0.46 | 0.25 | 0.29 | 0.13 |
| | | | Standard Error | 0.14 | 0.12 | 0.14 | 0.04 |
| TOTALS | 106 | 37 | Effort | 2,277 | 610 | 463 | 3,349 |
| | | | Variance | 148,901 | 19,210 | 16,314 | 184,425 |
| | | | Est. Proportion | 0.68 | 0.18 | 0.14 | 1.00 |
| | | | Standard Error | 0.05 | 0.04 | 0.04 | |

[a] = Totals may not be the sum of the printed estimates due to rounding.

The highest proportion of angling effort (by time stratum) occurred during the month of July 53% (SE = 6%) followed by June with 26% (SE 5%), then August with 13% (SE = 4%) and May 18-31 with 8% (SE = 4%).

The demographic profile of anglers utilizing the upper Chatanika River Arctic grayling fishery (based on a total of 63 interviews) shows that the majority of anglers were male (78%, SE = 5%), adult (90%, SE = 4%), resident (86%, SE = 4%), non-military (79%, SE = 1%) (Table 4). Fifty-five percent of the anglers (SE = 6%), used spinners as their terminal gear type.

Biological data were collected from 29 grayling harvested during the upper Chatanika River grayling fishery (Table 5). Mean fork length of the fish sampled was 280 mm. Ten grayling (34%, SE = 9%) were found to be age five, while eight fish were age 7 (28%, SE = 8%).

Discussion

During the 1991 creel survey of the upper Chatanika River Arctic grayling fishery, the highest estimated proportion of the angling effort by month (July) and for the total season occurred in area 1 (Figure 6). This 21 km stretch of the Steese highway from 46 to 67 km parallels the Chatanika River and is accessible at three popular pullout areas. Also found within this area is a State recreation and campground facility located at 62 km which is a popular spot for angling and serves as a put-in and take-out area for canoers and rafters. Consequently, the likelihood of encountering anglers in this area is greater than in Areas 2 and 3 where access is not as good.

Some of the effort occurring during July in Area 1 is attributable to fishing for salmon. Chinook salmon are available at this time and the Steese Highway bridge crossing the Chatanika River and the nearby campground area is a popular salmon fishing area.

The total estimated peak of the day angling effort for the upper Chatanika River Arctic grayling fishery of 3,349 angler hours is just slightly higher than the 3,201 angler hours estimated for the upper Chena River (also for the peak of the day) in 1991 (see Chapter 1). However, the creel survey on the upper Chatanika River included the month of August, while the upper Chena River survey terminated on July 31. With this in mind and the fact that there were no special regulations on the Chatanika River Arctic grayling fishery (unlike the Chena River where special regulations are in effect), one might view the effort level here to be light. Effort (angler days) as reported in Mills (1987-1990), for the entire Chatanika River for all species has risen 36% from 1986 to 1989. This sharp rise in effort is most likely due to the growth in the Chatanika River whitefish spear fishery during this same period and not necessarily attributable to the growth in the Arctic grayling fishery.

## CHAPTER 3 - GEORGE LAKE NORTHERN PIKE FISHERY

Introduction

The popularity of northern pike as a sport fish in Alaska has increased in recent years. Northern pike are harvested by sport fishermen using hook and line gear and bow and arrow in summer and winter, as well as with spears

Table 4. Demographic profile of anglers interviewed at the upper Chatanika River, Tanana River drainage, Alaska, 18 May through 31 August 1991.

| Angler Characteristic | Number of Anglers | Proportion | SE |
|---|---|---|---|
| Total Number of Interviews | 63 | | |
| Male | 49 | 0.78 | 0.05 |
| Female | 14 | 0.22 | 0.05 |
| Adult | 57 | 0.90 | 0.04 |
| Youth | 6 | 0.10 | 0.04 |
| Resident | 54 | 0.86 | 0.04 |
| Non-Resident | 9 | 0.14 | 0.04 |
| Military | 13 | 0.22 | 0.01 |
| Non-Military | 50 | 0.79 | 0.01 |
| Gear Type: | | | |
| Spin | 35 | 0.55 | 0.06 |
| Flies | 25 | 0.40 | 0.06 |
| Bait | 3 | 0.05 | 0.03 |

Table 5. Age composition estimates for Arctic grayling sampled from the upper Chatanika River, Tanana River drainage, Alaska, 18 May through 31 August 1991.

| Age Class | Number of Fish | Proportion | SE |
|---|---|---|---|
| 4 | 4 | 0.14 | 0.07 |
| 5 | 10 | 0.34 | 0.09 |
| 6 | 3 | 0.10 | 0.06 |
| 7 | 8 | 0.28 | 0.08 |
| 8 | 4 | 0.14 | 0.07 |
| Total | 29 | 1.00 | |

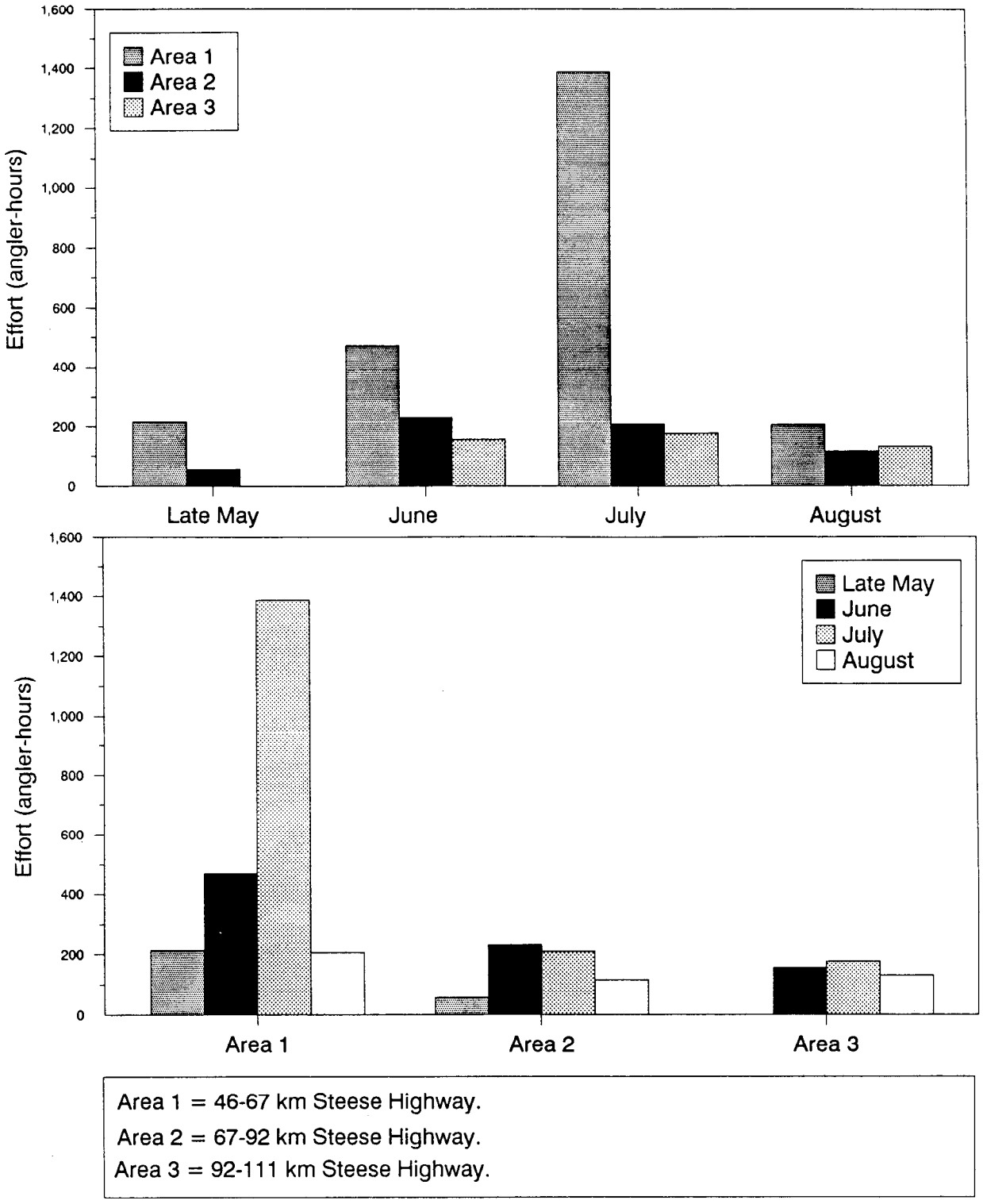


Figure 6. Distribution of angler effort by area and time for the upper Chatanika River Arctic grayling fishery, Tanana River drainage, Alaska, 18 May - 31 August 1990.

during the winter. In the 13-year period from 1977-1989, the estimated statewide harvest of northern pike increased from 11,982 to 21,659 (Mills 1990). In 1990 the statewide harvest of northern pike was 15,985 Mills (1991), a decline of 27% from 1989 and the lowest recorded harvest since 1979. However, northern pike continue to be very popular with interior Alaska anglers, as 77% (12,330) of the 1990 statewide sport harvest of 15,985 northern pike came from the AYK Region. The majority of the AYK harvest, 7,348 (60%), was taken from the easily accessible lakes and rivers in the Tanana River drainage.

George Lake is a semi-remote 1,823 ha lake located approximately 8 km northeast of the Tanana River and the Alaska Highway about 45 km southeast of the town of Delta Junction (Figure 7). The lake is accessible during the open water season by either float-equipped aircraft or boat via the Tanana River and George Creek, the lake's outlet. Snow machines and ski-equipped aircraft provide access in winter.

George Lake is typically ice-free from early June to mid-October, and spawning of northern pike generally coincides with the beginning of the ice-free period and continues for up to two weeks, into mid-June. While anglers at George Lake target northern pike throughout the year, fishing pressure is heaviest from breakup (usually near the end of May) until mid-June (Peckham 1982).

George Lake has consistently ranked second, behind Minto Flats, in annual harvest of northern pike in Tanana drainage lakes. Northern pike fisherman have harvested an average of 1,755 fish annually from George Lake since 1977 (Mills 1979-1991).

The ADF&G initiated studies of northern pike stocks in the major fisheries of the Tanana River drainage in 1985. The overall goals were to accurately estimate the ranges of population abundance, recruitment, and composition over several years. This data, along with estimates of sport harvest and mortality, will permit the development of techniques necessary to balance recreational demands with surplus production in Alaskan northern pike populations. Two major components missing from the northern pike research program is a clear understanding of catch composition, and the distribution of catches and harvests of northern pike by individual anglers. Because most of the northern pike fisheries in interior Alaska are remote and work in these areas is expensive and somewhat impractical, no on-site creel surveys have been conducted in recent years. With this in mind, a creel survey at George Lake during the Memorial Day weekend, (25-27 May 1991) was scheduled. During this short but intense fishing period, we would contact a large number of northern pike anglers, in an attempt to obtain at least a "snap shot" of the fishery.

The specific objectives for the 1991 Memorial Day weekend (25-27 May) survey of the George Lake northern pike fishery were to estimate:

1. the length, age, and sex composition of northern pike harvested at George Lake during the Memorial Day weekend; and

2. the distribution of catches and harvests of northern pike by individual angler-trip at George Lake during the Memorial Day weekend.

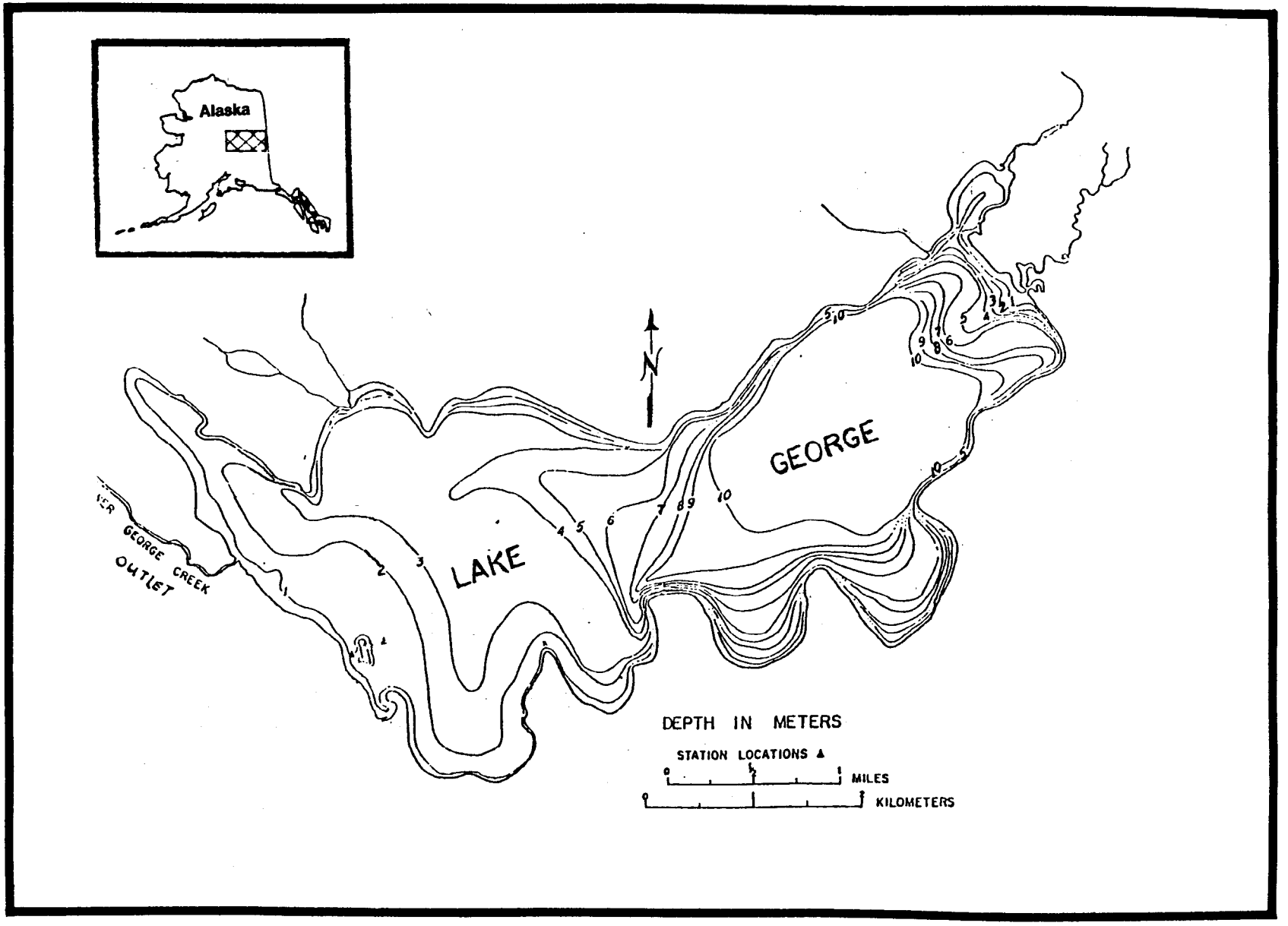


Figure 7. Map of George Lake, Tanana River drainage, Alaska.

Methods

The creel survey at George Lake was a direct expansion single access type survey with information obtained from interviews with individual completed-trip anglers. The sample survey for estimating the catch and harvest distribution was of the stratified two-stage type. Nearly all anglers at George Lake were boat anglers (few anglers accessed the lake by float equipped aircraft).

Anglers began arriving at George Lake on the Friday evening of Memorial Day weekend. Angling parties spread out around the lake at remote campsites. Anglers began fishing for northern pike almost immediately after arriving at the lake. Many of the angling parties remained at the lake for the three day period, during which time many northern pike were caught and released, some were eaten at camp, and others were filleted and placed on ice for the trip home.

Since all boat anglers exited the lake at the outlet to George Creek, the original study design was to station a creel clerk at this location from 1400 to 2100 hours on Saturday, Sunday, and Monday, 25-27 May 1991. The creel clerk would have attempted to stop all angling parties and obtain individual angler interviews. All angling parties unwilling to stop were to be counted.

In an attempt to obtain more information on the catch composition and catch and harvest data on a daily basis, a survey form was distributed to parties located around the lake. This survey form (daily catch diary) requested that the angler voluntarily provide his or her party's daily catch and harvest information. Included in the packet was a tape measure, scale cards, and instructions on how to measure and obtain a scale sample from northern pike. These forms were to be returned to the creel clerk as the fishing parties exited the lake.

As the Memorial Day weekend fishery evolved, it became apparent to the creel clerk that when visiting the respective parties situated around the lake, he could obtain accurate (daily) catch, harvest and effort information from the individual anglers and sample the (daily) harvest of northern pike, before they were filleted or eaten. Also, since there were never more than ten parties on the lake at any one time, the creel clerk felt that he could account for any missed anglers (anglers not interviewed, but counted) on a daily basis. Consequently, we modified the study design to allow the creel clerk the freedom to conduct daily visits with angling parties at their campsites, as opposed to the original design, of waiting at the outlet to conduct the trip interviews. Each day of the weekend represented the strata for this survey. Angling parties represented the first stage units, while individual anglers in each party represented the second stage sample units.

All northern pike age, sex, and size information collected from direct angler interviews during the sample survey and from voluntary survey returns were treated as one "simple random" sample of the fishery. The precision of the resultant estimates depended upon the sampling fraction realized. The sampling fraction was estimated by the number of fish actually sampled and the estimated harvest as obtained from the creel survey.

The size categories used for describing the length composition of the harvest was the Relative Stock Density (RSD) categories defined by Gabelhouse (1984).

Data Collection:

The creel clerk made daily visits to all angling parties (campsites) between 1800 - 2400 hours. The time of the visits corresponded with when the respective parties would stop fishing and had returned to their campsites. During the visits, interviews were obtained from individual anglers who had completed fishing for the day. The creel clerk would distribute the daily catch diaries to as many parties as required. During each interview, the following information was collected from individual anglers:

1) the amount of time he or she spent fishing;
2) the number of northern pike caught that day; and,
3) the number of northern pike harvested that day.

All interview data were recorded on standard ADF&G Angler Interview forms (Version 1.1). Creel clerks recorded the hourly counts of anglers exiting the fishery of the "Exit Angler Count Form" (see Appendix B).

The creel clerk recorded the following data from a sample of harvested fish: date, location, species, length (fork length in millimeters), sex and presence of marks (tag color and number, and/or missing fins). This information was transferred from the coin envelope to the standard ADF&G Tagging Length Form (Version 1.0) mark sense forms in the office during the age determination work.

The creel clerk collected at least five scales from each fish sampled from the harvest. The preferred zone for northern pike is 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.

Data Analysis:

The estimation of age composition by sex, and RSD categories in the harvest of the 1991 George Lake Memorial Day weekend northern pike fishery was conducted as described in the following text. Since each parameter to be estimated (i.e., age composition by sex and RSD categories) represented a proportion of the same population (i.e., fish harvested) the methods used to obtain the estimates were the same regardless of the parameter involved.

Estimates of each proportion for the harvest of northern pike were calculated by using equation 12 as presented in chapter one of this report substituting number of fish for angler-trips and using age, sex or RSD as categories. The variance of this estimated proportion was obtained in a similar manner to equation 13, however a finite population correction factor was applied using the estimated harvest. Accordingly the variance was calculated as:

$$\hat{V}[\hat{p}_u] = \left\{ 1 - \frac{n'}{\hat{H}} \right\} \left\{ \frac{\hat{p}_u (1 - \hat{p}_u)}{n' - 1} \right\} . \qquad (14)$$

where: $\hat{H}$ equals the estimated harvest of northern pike during the Memorial Day weekend, as obtained by equations 15-17, below.

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

RSDs represent the proportions of harvested fish that met certain length category criteria (either "stock", "quality", "preferred", "memorable", or "trophy"). The categories and criteria for northern pike were 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 |

As noted above, an estimate of the daily harvest and total harvest of northern pike was needed to track the success of the harvest sampling program, and to obtain precise estimates of the proportional estimates noted above. The procedures outlined below were used to obtain the daily and total harvest estimates.

Estimation of harvest of northern pike for each day in the fishery involved the direct expansion of sampled interview data by expansion factors dependent upon the number of parties missed (first-stage units). The following procedures were used to estimate harvest:

$\hat{H}_i$ = estimated harvest for day $i$;

$$= B_i \bar{H}_i \ ; \qquad (15)$$

where: $B_i$ equals the number of parties counted on each day (including both stopped and non-stopped parties);

$\bar{H}_i$ = mean harvest over all parties sampled during each day;

$$= \frac{\sum_{j=1}^{b_i} H_{ij}}{b_i} ; \qquad (16)$$

$b_i$ equals the number of parties interviewed during day $i$; and $H_{ij}$ is the harvest by interviewed party $j$ during day $i$; which included harvest by all anglers within each party (sum of harvest over all individuals in the party).

The variance of the harvest estimate was obtained by the following equation:

$$\hat{V}[\hat{H}_i] = (1 - f_{1i}) \frac{B_i^2}{b_i} \frac{\sum_{j=1}^{b_i} (H_{ij} - \bar{H}_i)^2}{b_i - 1} ; \qquad (17)$$

where: $f_{1i}$ equals the sampling fraction for the first stage units (i.e., $f_{1i} = b_i / B_i$).

The total harvest estimate and its variance were calculated by summing the individual daily estimates.

The distribution of catches and harvests for the fishery were estimated as described in the following text. The catch and harvest distribution of anglers were estimated from the angler interviews obtained from the sample survey described above. The catch and harvest distribution were defined as the proportion of angler-trips that resulted in catch or harvest of *k or more* fish for $k = 1$ to $k_{max}$. Additionally, we defined the catch or harvest distribution for $k = 0$ to be the proportion of angler-trips that resulted in catch or harvest of 0 fish. We set $k_{max}$ equal to 10 fish for the catch and harvest of all northern pike.

The first step was to code the data prior to calculation. The coding was necessary because not all sampling units (parties) were the same size; more anglers are in some parties than others. Ignoring these differences in size would have promoted bias in estimates of angler success when statistics were averaged across parties within a day. The coding adjusted for this discrepancy. From Sukhatme, et al. (1984: equation 8.58; page 327):

$$y_{kijo} = \begin{cases} M_{ij}/\bar{M}_i^* & \text{if harvest made by interviewed angler o within party } j \text{ on day } i \text{ caught k or more fish (or zero fish if k = 0);} \\ 0 & \text{otherwise;} \end{cases} \qquad (18)^3$$

where: $M_{ij}$ is the number of anglers in each party stopped and interviewed;

$\bar{M}_i^*$ = the restricted mean of the number of anglers within parties in each day, restricted to those parties with at least one angler per party[4];

$$= \frac{\sum_{j=1}^{b_i^*} M_{ij}}{b_i^*}; \text{ and} \qquad (19)$$

$b_i^*$ was the restricted number of parties stopped and interviewed within each day, restricted to those parties with at least one angler per party.

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

$\bar{y}_{ki}$ = proportion of angler-trips in day $i$ that harvested 0 or at least k fish;

$$= \frac{\sum_{j=1}^{b_i^*} \bar{y}_{kij}}{b_i^*}; \qquad (20)^5$$

---

[3] Including data from only individuals who reported fishing.

[4] That is not including parties who did not fish.

[5] Including data from only parties with at least one individual who reported fishing.

$\bar{y}_{kij}$ = proportion of angler-trips within each party on day $i$ that harvested 0 or at least k fish;

$$= \frac{\sum_{o=1}^{m_{ij}} y_{kijo}}{m_{ij}} \text{ ; and} \qquad (21)$$

$m_{ij}$ equaled the number of anglers interviewed within each party[6].

The variance of the estimated proportion was obtained by the usual one-stage equation[7] (derived from Equation 9A.2, page 249, in Cochran 1977):

$$\hat{\bar{V}}[\bar{y}_{ki}] = (1 - f_{1i}) \frac{\sum_{j=1}^{b_i} (\bar{y}_{kij} - \bar{\bar{y}}_{ki})^2}{b_i (b_i - 1)} \text{ ;} \qquad (22)$$

where: all other terms were as defined above.

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

$\hat{p}_k$ = the estimated fraction of completed angler-trips in which anglers harvested either 0 or at least k northern pike;

$$= \sum_{i=1}^{d} \hat{W}_i \hat{\bar{y}}_{ki} \text{ ;} \qquad (23)$$

$\hat{V}[\hat{p}_k]$ = 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);

$$\approx \sum_{i=1}^{d} \hat{W}_i^2 \hat{\bar{V}}[\bar{y}_{ki}] \text{ ;} \qquad (24)$$

---

[6] Including only individuals that reported fishing (note that all individuals within each party should be interviewed).

[7] No second stage variance component was needed for this estimation, since all anglers within a party were interviewed.

where:

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

$$= \frac{\hat{M}_i}{\hat{M}} ; \quad (25)$$

$\hat{M}$ equals the total estimated number of angler-trips participating in the fishery (equal to the sum of estimated angler-trips across all days);

$\hat{M}_i$ = estimated number of angler-trips participating in the fishery within day *i*;

$$= B_i \bar{m}_i ; \quad (26)$$

$\bar{m}_i$ = mean number of angler-trips within day *i*;

$$= \frac{\sum_{j=1}^{b_i} m_{ij}}{b_i} ; \text{ and,} \quad (27)$$

all other terms were as defined above.

Standard errors were obtained by taking the square root of the variance estimates. The distribution of angler catches, their variances, and standard errors were obtained similarly by substituting the appropriate catch statistics into equations 18-27, above.

Assumptions:

The assumptions necessary for unbiased point and variance estimates of the proportions of northern pike harvested by category (e.g., age composition), included the following:

1. a large proportion of the harvest was sampled (necessitated by the non-random sampling procedures as outlined above);

2. anglers and creel clerks accurately collect and record the necessary information (e.g., length of fish); and,

3. ages are accurately determined during the aging procedures in the lab.

The assumptions necessary for unbiased point and variance estimates of distribution of angler catch and harvest obtained by the procedures outlined above were that:

1. missed angler parties did not have different catch or harvest characteristics than the interviewed angler parties; and,

2. interviewed anglers accurately reported their catch and harvest.

Results

The first initial interviews with angling parties were obtained on Friday evening, 24 May. Similar interviews were obtained during the afternoon and evenings of Saturday, 25 May and Sunday, 26 May. On Monday, 27 May, only a few angling parties remained on George Lake. Interviews with the remaining parties, revealed that (due to inclement weather and the fact the weekend was coming to a close), no angling for northern pike occurred on this day.

The total harvest of northern pike for the period surveyed was estimated to be 128 fish (SE = 10; Table 6). The predominant age class of harvested northern pike was ages 5-7, comprising 70% of the harvest (Table 6). Northern pike sampled in the creel ranged from 210 mm to 825 mm with an average of 605 mm (SE = 12). The predominant RSD category of the harvested northern pike was quality, comprising 54% (SE = 7%), followed by the preferred category with 28% (SE = 5%). No northern pike in the memorable or trophy categories were sampled (Table 6).

Most northern pike encountered in the angler's creel had been gutted and placed on ice. Consequently, sexes were obtained from only 26 of the 74 sampled northern pike (16 males and 10 females) sampled during the survey. Males ranged in age from 5 to 9 years, and in length from 550 mm to 787 mm with an average 619 mm. Females ranged in age from 4 to 11 years, and in length from 560 mm to 730 with an average of 669 mm in fork length.

A total of 132 angler-trips were estimated from the 106 completed-trip angler interviews obtained during the survey (Table 7). Of these, 27 were conducted on the Friday, 24 May, with 49 and 30 interviews obtained on 26 and 27 May.

Eighty-seven percent (SE = 10%) of the anglers caught one or more northern pike and 51% (SE = 5%) harvested one or more northern pike (Table 7). The distribution of the catch and harvest of northern pike among anglers interviewed in 1991 showed a wide range of pike catches, (from one to more than 11), with 49% of the anglers harvesting zero pike, and no angler harvesting more than the daily bag limit of five northern pike (Figure 8).

Discussion

Since most of the northern pike waters within the Tanana River drainage are not road accessible, conducting creel surveys here is expensive and logistically difficult. The 1991 creel survey at George Lake was an attempt to obtain a "snap shot" of a semi-remote northern pike fishery, with hopes of identifying the level of angler participation (angler-trips), catch and harvest distribution and catch composition.

Angling parties began arriving at George Lake on the late afternoon/early evening of Friday (24 May). Angling parties consisted of anywhere from two individuals to as high as twenty. Most parties remained at the lake for a period of one to three nights while at least two parties fished the lake for only an afternoon. The maximum number of angling parties at George Lake at any one time during the Memorial Day weekend was ten. The weather remained

Table 6. Estimates of the age composition, mean fork length (mm) at age, and Relative Stock Density of northern pike in the harvest from George Lake, Alaska, 25 through 27 May 1991.

| | Age Composition | | | Fork Length | | Relative Stock Density (RSD) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | n | % | SE(%) | Mean | SE[a] | Category | Range[b] | n | % | SE(%) |
| 3 | 2 | 3 | 2 | 444 | 2 | Small | ≤ 289 | 1 | 1 | 1 |
| 4 | 8 | 11 | 3 | 527 | 5 | Stock | 290- 529 | 12 | 16 | 4 |
| 5 | 20 | 27 | 5 | 534 | 12 | Quality | 530- 659 | 40 | 54 | 7 |
| 6 | 18 | 24 | 5 | 608 | 6 | Preferred | 660- 859 | 21 | 29 | 5 |
| 7 | 14 | 19 | 4 | 662 | 5 | Memorable | 860-1079 | -- | -- | -- |
| 8 | 5 | 7 | 3 | 681 | 4 | Trophy | ≥1080 | -- | -- | -- |
| 9 | 3 | 4 | 2 | 800 | 2 | | | | | |
| 10 | 1 | 1 | 1 | 712 | - | Total | | 74 | 100 | |
| 11 | 3 | 4 | 2 | 767 | 4 | Harvest estimate | | 128 | | |
| | | | | | | FPC[c] | | 0.421 | | |
| Total | 74 | | | 605 | 12 | | | | | |

[a] Standard error of the mean fork length.
[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 7. Estimates of the catch and harvest distribution of northern pike anglers during the 1991 George Lake, Memorial Day weekend fishery.

| | Percentage of angler-trips[a] that caught or harvested the noted number of northern pike | | | |
|---|---|---|---|---|
| Parameter[b] | % Caught | SE | % Harvested | SE |
| 1 or more fish | 87 | 10 | 51 | 5 |
| 2 or more fish | 75 | 8 | 25 | 2 |
| 3 or more fish | 60 | 5 | 12 | 2 |
| 4 or more fish | 43 | 2 | 7 | 2 |
| 5 or more fish | 32 | 2 | 3 | 1 |
| 6 or more fish | 27 | 2 | 0 | 0 |
| 7 or more fish | 24 | 2 | 0 | 0 |
| 8 or more fish | 16 | 2 | 0 | 0 |
| 9 or more fish | 12 | 1 | 0 | 0 |
| 10 or more fish | 11 | 2 | 0 | 0 |
| 0 fish | 13 | 2 | 49 | 7 |
| 1 fish | 12 | 2 | 27 | 6 |
| 2 fish | 15 | 3 | 13 | 2 |
| 3 fish | 17 | 4 | 6 | 1 |
| 4 fish | 11 | 1 | 4 | 1 |
| 5 fish | 5 | 1 | 3 | 1 |
| 6 fish | 4 | 1 | 0 | 0 |
| 7 fish | 8 | 1 | 0 | 0 |
| 8 fish | 4 | 1 | 0 | 0 |
| 9 fish | 1 | < 0.5 | 0 | 0 |
| 10 fish | 2 | 1 | 0 | 0 |
| 11 or more | 9 | 1 | 0 | 0 |

[a] The total number of estimated angler-trips for the survey equaled 132.

[b] Two types of parameters were estimated for catch and harvest; the first set describes the proportion of angler-trips that caught or harvested at least the noted number of fish (e.g. "2 or more fish" = caught at least 2 fish and possibly more); the second set describes the proportion of trips that caught or harvested only the noted number (e.g., "2 fish" = caught only two fish).

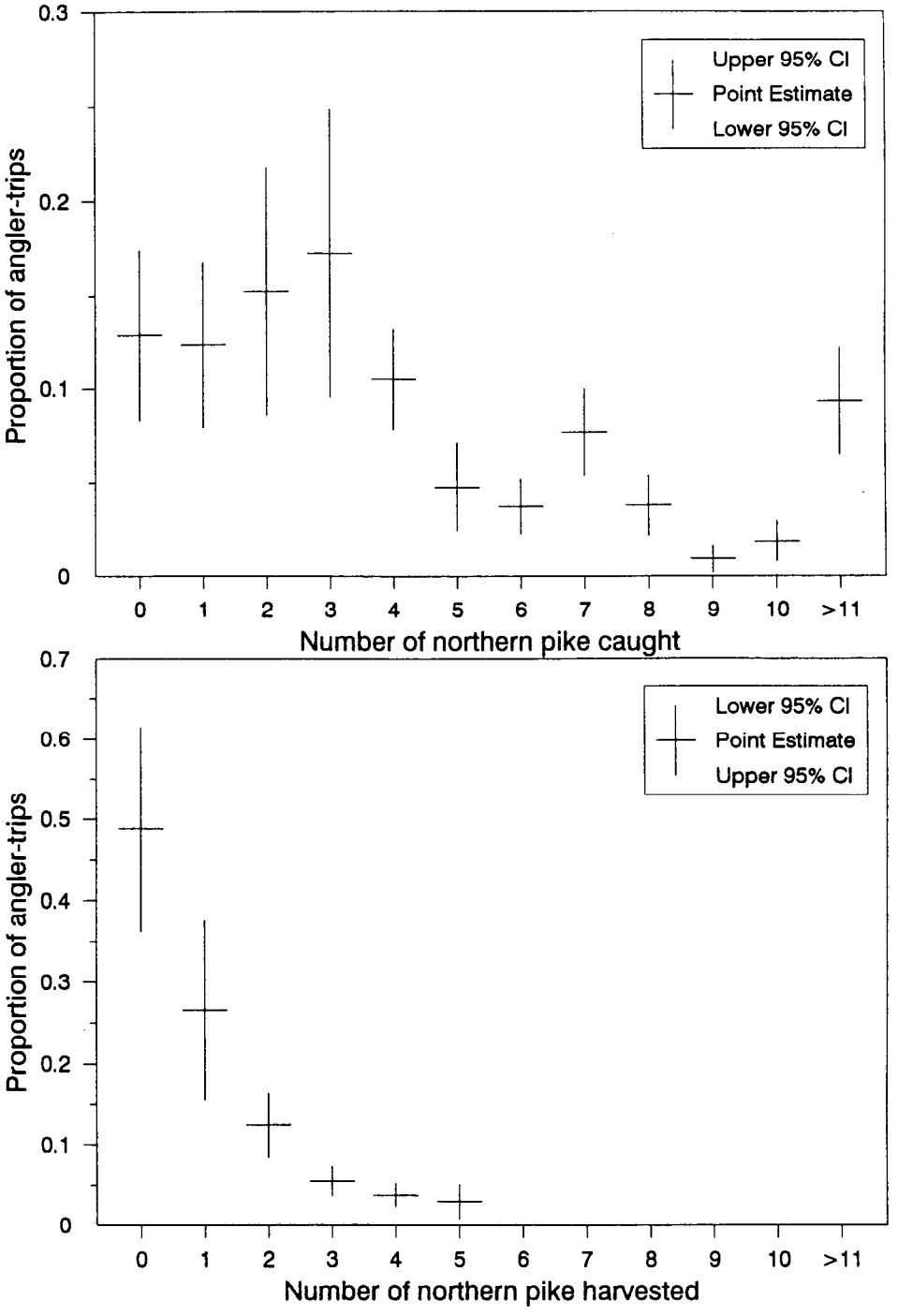


Figure 8. Distribution of northern pike catch and harvest among anglers at George Lake, Tanana River drainage, Alaska, (Memorial day weekend) 1991.

sunny and warm through the weekend, however the wind began blowing on Sunday evening (26 May) and continued through Monday, forcing most of the anglers off the lake.

The 14 year average of northern pike harvested from George Lake as reported in Mills (1979-1991) was 1,755 fish. Peckham (1980), through the use of an angler questionnaire given to anglers who fished George Lake during the years from 1976 through 1979, estimated the average annual harvest of northern pike to be 1,805. Peckham (1979) stated that the fishing pressure at George Lake is heaviest from breakup (usually near the first of June) until mid-July, and reported that 67% of all anglers who fished George Lake in 1978 did so during this period, and harvested 62%, or 352 of the total estimated annual take of 568 northern pike.

Harvest of northern pike from George Lake in 1988 and 1989 was 882 and 945 fish, respectively (Mills 1989-1990). Abundance estimates for all northern pike larger than 299 mm for George Lake in 1989 and 1990 was 25,466 and 11,568, respectively, Pearse (1991). However, the calculated exploitation rates of 3 and 8% for 1988 and 1989, respectively, remain well below the recommended limit for exploitation of 15% in interior Alaska lakes (Pearse 1991).

If the documented harvest for the Memorial Day weekend in 1991 of 128 northern pike was similar for the years 1989/1990 this would represent approximately 15% of the total annual take. George Lake is typically ice-free from late-May to mid-October, and spawning of northern pike generally coincides with the beginning of the ice-free periods and continues for up to two weeks, into early-June (Pearse 1991). If in the future, harvest increases to a level that is not sustainable, a closure to the retention of northern pike during this period would result in a significant reduction in harvest and ultimately a greater savings to the entire population by allowing pike to spawn unmolested by sport anglers.

## CHAPTER 4 - SALCHA RIVER CHINOOK SALMON FISHERY

### Introduction

The Salcha River is located about 67 km southeast of Fairbanks on the Richardson Highway (Figure 9). The Salcha River supports a popular chinook salmon recreational fishery that occurs 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). From 1977 to 1990, the chinook salmon harvest from the Salcha River has ranged from 62 to 808 fish annually, averaging 468 (Mills 1979-1991). Until 1987, salmon fishing was allowed in the lower 29 km of the river. However, chinook salmon are known to spawn in this lower portion of the river. For this reason, the Alaska 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. In order to ensure that the recreational harvest does not exceed the allocated range, and because the Yukon River salmon stocks are being fully utilized by all user groups, it is imperative that we monitor the sport harvest on the Salcha River.

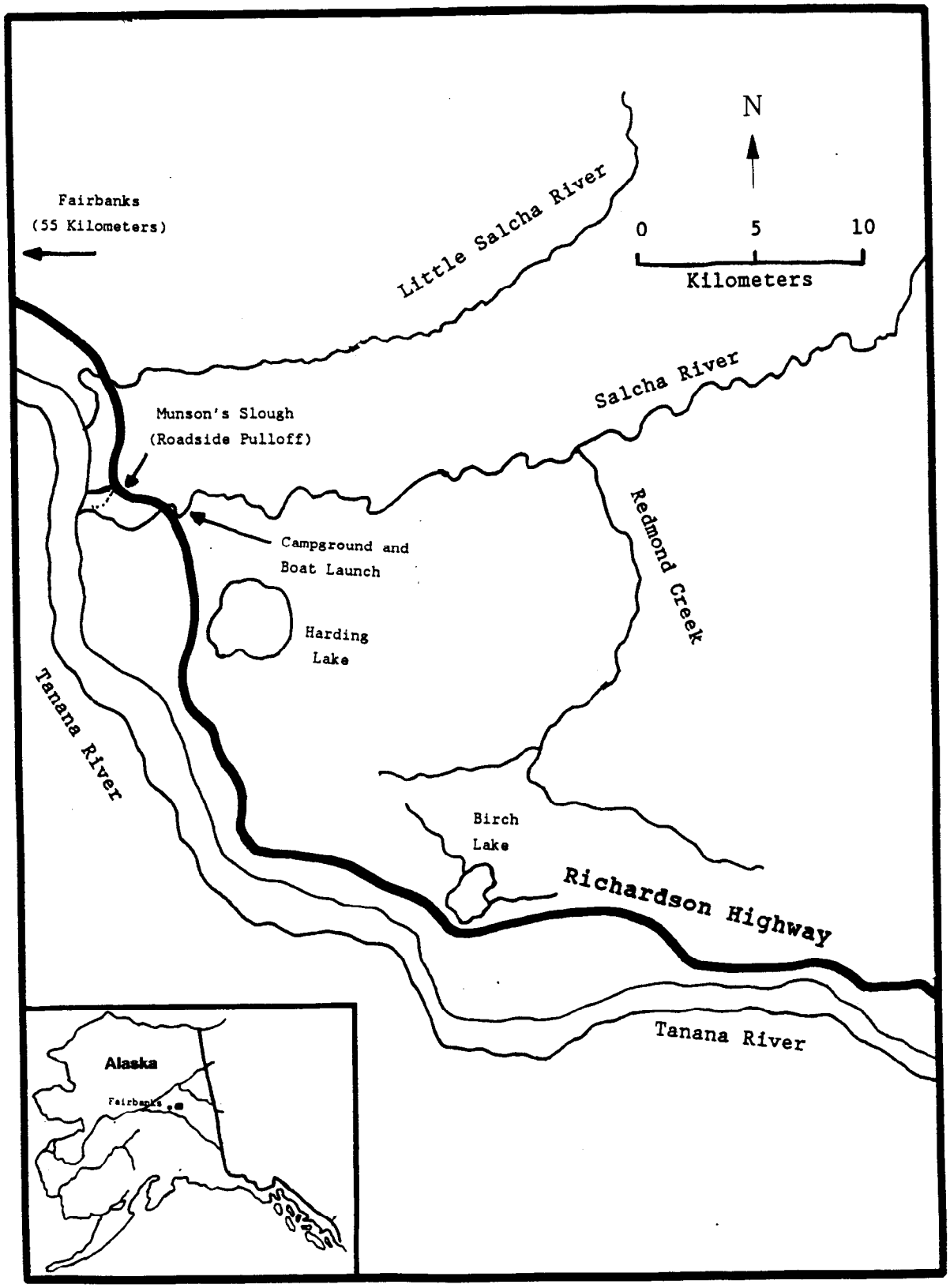


Figure 9. Map of the Salcha River, Tanana River drainage, Alaska.

The specific objectives of the Salcha River creel survey in 1991 were to estimate:

1. angler effort for, and catch and harvest of chinook salmon at the Salcha River fishery;

2. the percent composition of angler demographics for anglers interviewed at the Salcha River:

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

Methods

The design for the Salcha River chinook salmon creel survey in 1991 was of the single access direct expansion type. Estimates of angler effort for, and catch and harvest of chinook salmon were estimated from the information obtained from interviews of completed-trip anglers.

The creel survey was conducted from 6 July through 28 July. The fishing and sampling day was defined between the hours of 1000 to 0200 (i.e., overlapping calendar days). This definition of the angling day was designed to encompass the majority of anglers exiting the fishery. Some angler effort and presumably some catch and harvest was missed between the hours of 0200 and 1000. Comparatively, the proportion missed was likely small.

As noted above, the survey was a direct expansion completed-trip type of survey. A stratified 2-stage sample survey was conducted for estimation of angler effort, catch and harvest. The types of strata are defined below. Within each stratum, days to sample represented the first sampling stage. The sampled days were selected at random without replacement from all available days within each stratum. The selection of days to sample was not conducted independently between the early versus late day levels of stratification. Due to having one technician, only an early day or late day stratum could be sampled during any given day. For this reason, days to be sampled were selected from the most "important" strata first. This constrained the potential days for sampling in the least important strata and possibly led to biased estimates. The degree of this bias was minimized by restricting the bias to the strata with the relatively smaller variances.

Within each sampled day, anglers exiting the fishery at the surveyed location represented the second stage sampling units. The fishery was separated into type of day and time of day strata as follows:

| Stratum | Total Number of Days in Stratum | Number of Days Sampled |
|---|---|---|
| 1. Weekday early 1000 to 1800 hours | 15 | 2 |
| 2. Weekday late 1800 to 0200 hours | 15 | 5 |
| 3. Weekends-holidays early 1000 to 1800 hours | 8 | 4 |
| 4. Weekends-holidays late 1800 to 0200 hours | 8 | 4 |

The weekends-holidays included all Saturdays and Sundays, whereas the weekday strata consisted of Mondays-Fridays. The late day strata days were selected prior to choosing the early day strata days.

Sampling effort among strata was designed to place most of the effort on the days with proportionally larger variances observed during the 1990 survey (Hallberg and Bingham 1991).

Data Collection:

The creel survey at the Salcha River in 1991 emphasized the collection of catch, harvest, and effort information from completed-trip angler interviews. The creel clerk attempted to interview all anglers who completed fishing and exited the Salcha River at the Munson Slough parking area. All non-interviewed exiting anglers were counted.

During each interview, the following information was collected from individual anglers:

1) the amount of time he or she spent fishing;
2) the number of chinook salmon caught;
3) the number of chinook salmon harvested;
3) angler gender (male/female);
4) age class (youth/adult);
5) resident or non-resident;
6) military or non-military; and,
8) type of terminal fishing gear used (e.g., spinner, bait, etc.).

All interview data were recorded on standard ADF&G Angler Interview form (Version 1.1). Creel clerks recorded the hourly counts of anglers exiting the fishery of the "Exit Angler Count Form" (Appendix B).

Data Analysis:

Estimation of angler effort for, and catch and harvest of chinook salmon for each stratum in the fishery (and in total) involved the direct expansion of sampled interview data by expansion factors dependent upon the number of anglers "missed" (second-stage units) and days not selected (first-stage units). The following procedures were used to estimate effort, catch and harvest:

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

$$= D_h \bar{\hat{E}}_h \; ; \tag{28}$$

where: $D_h$ equaled the number of possible days within each stratum available for sampling;

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

$$= \frac{\sum_{i=1}^{d_h} \hat{E}_{hi}}{d_h} \; ; \tag{29}$$

$\hat{E}_{hi}$ = estimated effort exiting the fishery during day $i$ within stratum $h$;

$$= M_{hi} \bar{e}_{hi} \; ; \tag{30}$$

$M_{hi}$ equaled the number of anglers counted exiting the fishery during sampled day $i$ within stratum $h$ (including both interviewed and "missed" anglers);

$\bar{e}_{hi}$ = mean effort by all exiting anglers interviewed during day sampled $i$ within stratum $h$;

$$= \frac{\sum_{j=1}^{m_{hi}} e_{hij}}{m_{hi}} \; ; \tag{31}$$

$m_{hi}$ equals the number of exiting anglers interviewed during day $i$ within stratum $h$; and $e_{hij}$ is the effort expended by interviewed angler $j$ during day $i$ within stratum $h$.

The variance for the estimated effort for stratum $h$ was obtained by the two-stage variance equation (Cochran 1977, equation 11.24, page 303):

$$\hat{V}[\hat{E}_h] = \left\{ (1 - f_{1h}) \, D_h^2 \, \frac{S_{1h}^2}{d_h} \right\} + \left\{ f_{1h} \frac{D_h^2}{d_{2h}^2} \sum_{i=1}^{d_{2h}} \left[ (1 - f_{2hi}) \, M_{hi}^2 \, \frac{s_{2hi}^2}{m_{hi}} \right] \right\} \; ; \tag{32}$$

where: $f_{1h}$ and $f_{2hi}$ equaled the first and second stage sampling fractions, respectively (i.e., $f_{1h} = d_h / D_h$, and $f_{2hi} = m_{hi} / M_{hi}$); $d_{2h}$ equaled the number of days sampled in which the second stage variance term could be estimated (i.e., number of days with either all anglers that exited were interviewed or at least two exiting anglers were interviewed);

$$s^2_{1h} = \frac{\sum_{i=1}^{d_h} (\hat{E}_{hi} - \bar{\hat{E}}_h)^2}{d_h - 1} \quad ; \text{ and} \tag{33}$$

$$s^2_{2hi} = \frac{\sum_{j=1}^{m_{hi}} (e_{hij} - \bar{e}_{hi})^2}{m_{hi} - 1} \quad . \tag{34}$$

Total effort across all strata (or select combinations of strata) and the associated variances were obtained by summing the respective stratum estimates (assuming independence). Standard errors were obtained by taking the square root of the variance estimates. Similarly, estimates of catches and harvests of chinook salmon were obtained by substituting the appropriate catch and harvest statistics into equations 28-34, above.

Estimates of the proportion of angler-trips by demographic or gear type categories were estimated as described below. Each proportion associated with each parameter (e.g., various angler demographic categories) was calculated as follows:

$\hat{p}_{uh}$ = estimated proportion of the "angler-trips"[8] that are category $u$[9] within stratum $h$, which is weighted by the relative size of each first stage units (i.e., number of anglers counted);

$$= \frac{\sum_{i=1}^{d^*_h} w_{hi} \hat{p}_{uhi}}{d^*_h} \quad ; \tag{35}$$

where:

$$w_{hi} = \frac{M_{hi}}{\bar{M}^*_h} \quad ; \tag{36}$$

---

[8] Angler-trip as used here is defined as one trip on and then off the river, as measured from counts and interviews of anglers exiting the river at the surveyed location.

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

$\hat{p}_{uhi}$ = estimated fraction of angler-trips categorized as "type u" (dependent upon parameter being estimated) within each day;

$$= \frac{m_{uhi}}{m'_{hi}} ; \qquad (37)$$

$d^*_h$ = restricted number of days sampled, including only days in which at least one angler exited and was interviewed during each day involved;

$m_{uhi}$ = number of anglers categorized as "type u" within each sampled day;

$m'_{hi}$ = number of anglers interviewed within each day, which could be categorized (i.e., does not include anglers who do not respond to particular question of interest);

$\bar{M}^*_h$ equaled the restricted mean number of anglers counted within each stratum, restricted to days with at least one angler counted exiting the fishery, obtained as;

$$\bar{M}^*_h = \frac{\sum_{i=1}^{d^*_h} M_{hi}}{d^*_h} ; \qquad (38)$$

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

$$\hat{V}[\hat{p}_{uh}] = \left\{(1-f_{1h}) \frac{s^2_{1h}}{d^*_h}\right\} + \left\{\frac{f_{1h}}{d^{*2}_h} \sum_{i=1}^{d^*_h} (1-f_{2hi})\, w^2_{hi} \frac{s^2_{2hi}}{m'_{hi}}\right\} ; \qquad (39)$$

$$s^2_{1h} = \frac{\sum_{i=1}^{d^*_h} (w_{hi}\hat{p}_{uhi} - \hat{p}_{uh})^2}{d^*_h - 1} ; \qquad (40)$$

$$s^2_{2hi} = \frac{\hat{p}_{uhi}\,(1 - \hat{p}_{uhi})}{m'_{hi} - 1} ; \qquad (41)$$

and all other terms were as defined above.

The estimated proportion by category and its variance (across all strata) was obtained by the following procedures. The individual stratum estimates of proportions by category were weighted by the relative size of each stratum in terms of the estimated number of angler-trips (following the procedures explained in Cochran 1977, Equation 10.45, page 288), as follows:

$$\hat{p}_u = \sum_{h=1}^{s} \hat{W}_h \hat{p}_{uh}; \quad (42)$$

where:

$$\hat{W}_h = \frac{\hat{M}_h}{\hat{M}} . \quad (43)$$

$\hat{M}$ equals the total estimated number of angler-trips participating in the fishery (equal to the sum of angler-trips across all strata);

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

$$= D_h \bar{M}_h \text{ ; and} \quad (44)$$

$$\bar{M}_h = \frac{\sum_{i=1}^{d_h} M_{hi}}{d_h} . \quad (45)$$

The variance of the across stratum proportional estimate by category 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:

$$\hat{V}[\hat{p}_u] \approx \sum_{h=1}^{s} \hat{W}_h^2 \hat{V}[\hat{p}_{uh}] ; \quad (46)$$

where: all terms were as defined 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, obtained by the procedures outlined above were:

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;

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

4. all counted individuals that were not interviewed were properly classified as an angler (i.e., missed anglers truelly have been fishing).

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

1. creel clerks accurately classify anglers and the interviewed anglers accurately report their demographic characteristics and the gear type used during the trip;

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.

Since no attempt was made to correct for avidity bias[10], then our estimates of angler demographics and opinion only relate to the proportion of angler-trips not to the proportion of individual anglers.

Results

The 1991 creel survey began on 6 July and was terminated on 28 July. All eight weekend days during this period and 46% of the weekdays (seven of a possible 15 days) were sampled (Table 8). A total of 698 anglers who had completed their fishing trip and were exiting the fishery at the Munson Slough parking area were interviewed. A total of 7,337 (SE = 1,039) angler hours were expanded to catch an estimated 362 (SE = 70) chinook salmon of which 308 (SE = 61) were harvested.

The majority of the anglers interviewed at the Salcha River were male (90%; SE = 13%), adult (93%; SE = 14%), and residents of the State of Alaska (97%; SE = 15%) (Table 9). Fifty-seven percent (SE = 9%) were military personnel. Nearly all anglers 94% (SE = 14%) used spinners or artificial lures as their terminal gear type.

The creel technician collected age and length data from all chinook salmon encountered during the creel survey for future reference and comparison, even though it was not a study objective or a task. From a total of 64 chinook salmon sampled during the 1991 Salcha River creel survey, 10 were age 3, 35 were age 4, 16 were age 5, and three were age 6. Chinook salmon in the sample ranged from 490 to 990 mm (mid-eye to fork of tail) in length. The mean length of all chinook salmon sampled was 756 mm.

---

[10] 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.

Table 8. Summary of the angler catch, effort, and harvest estimates for the Salcha River chinook salmon creel survey, 6-28 July, 1991.

| Strata | | D[a] | d[b] | m[c] | Angler Effort (hours) Estimate | SE | Catch Estimate | SE | Harvest Estimate | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| Weekend | Early | 8 | 4 | 115 | 831 | 319 | 46 | 24 | 34 | 17 |
| | Late | 8 | 4 | 225 | 1,631 | 411 | 60 | 25 | 40 | 12 |
| Weekday | Early | 15 | 2 | 73 | 1,815 | 265 | 90 | 14 | 83 | 21 |
| | Late | 15 | 5 | 285 | 3,059 | 860 | 165 | 60 | 152 | 54 |
| Total | | 23 | 15 | 698 | 7,337[d] | 1,039 | 362[d] | 70 | 308[d] | 61 |

[a] Number of days available for sampling.
[b] Number of days sampled.
[c] Number of anglers interviewed.
[d] Totals may not agree due to rounding.

Table 9. Estimated proportion of angler-trips by various demographic and terminal gear type categories for the 1991 Salcha River chinook salmon creel survey.

| Angler Characteristic | n[a] | Proportion[b] | SE[c] |
|---|---|---|---|
| Male | 618 | 0.90 | 0.13 |
| Female | 80 | 0.10 | 0.02 |
| Youth | 43 | 0.07 | 0.01 |
| Adult | 654 | 0.93 | 0.14 |
| Resident | 683 | 0.97 | 0.15 |
| Non-resident | 14 | 0.03 | 0.01 |
| Military | 414 | 0.57 | 0.10 |
| Non-Military | 284 | 0.43 | 0.05 |
| Spin | 651 | 0.94 | 0.14 |
| Bait | 2 | <0.01 | < 0.01 |
| Spin and Bait | 42 | 0.05 | 0.01 |
| Fly | 2 | <0.01 | < 0.01 |

[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 stratum weights.

[c] Standard error of the weighted proportion.

## Discussion

Although point estimates for catch and harvest of chinook salmon from the Salcha River, and angler effort in 1991 increased by 32%, 35%, and 21%, respectively, from 1990 (Hallberg and Bingham 1991), the difference was not significant (at $\alpha = 0.05$).

The lack of a significant difference was in spite of changes which were made in how the survey was conducted in 1991. During the 1991 creel survey the angling-day and sampling-day was defined between the hours of 1000 to 0200 (i.e., overlapping calender days). The survey in 1990 was conducted during the hours of 0800 to 2400 (Hallberg and Bingham 1991). Examination of the frequency of angler interviews by hour of interviewing in 1990 indicated that anglers were likely to be still exiting the fishery well past the 2400 hour each "night" and, that very few anglers exited the fishery prior to 1000. As such we adapted the definition of the angling day to encompass the majority of anglers exiting the fishery.

Salmon were available when the creel survey began on 6 July and seemed to remain accessible to the anglers until late July. The harvest of 308 chinook salmon in the Salcha River in 1991 was the largest since 1986 when an estimated 526 chinook salmon were taken (Clark and Ridder 1987). However, this harvest falls well below the 14 year average of 468 chinook salmon, as reported in Mills (1979-1990) and is within the sport harvest guideline range of 300 to 700 chinook salmon imposed by the Board of Fisheries in 1987.

# CHAPTER 5 - PILEDRIVER SLOUGH RAINBOW TROUT FISHERY

## Introduction

In 1976, Piledriver Slough, located southeast of Fairbanks, Alaska near Eielson Air Force Base, was blocked off from the Tanana River by the Army Corps of Engineers as part of the construction of the Moose Creek Dam Flood Control Project (Figure 10). As a result, Piledriver Slough became a clear-water stream fed primarily from run-off and ground-water instead of the Tanana River. Within a year after the blockages were installed, Piledriver Slough, which empties into the Tanana River via Moose Creek, became inhabited by most fish species indigenous to interior Alaska. A sport fishery for Arctic grayling was established and by 1983, an estimated 4,148 anglers days of effort were expended to harvest 5,822 Arctic grayling from in Piledriver Slough (Mills 1984).

Increasing sport fishing pressure and over-harvest of indigenous fish populations during the early and mid-1980's resulted in more restrictive regulations and reduced fishing opportunities in some areas of interior Alaska. As fishing and harvest pressure increased, stocking of hatchery fish became a popular management option for meeting the demand for recreational fishing opportunities. Results from angler opinion surveys conducted by Holmes (1987) indicated that about 80% of the respondents approved of stocking fish as a means to improve fishing. In addition to this general approval of stocking as a management tool, the ADF&G received increasingly frequent requests from anglers seeking opportunities to fish for rainbow trout in Fairbanks area road-side streams. With the objective of diverting a portion

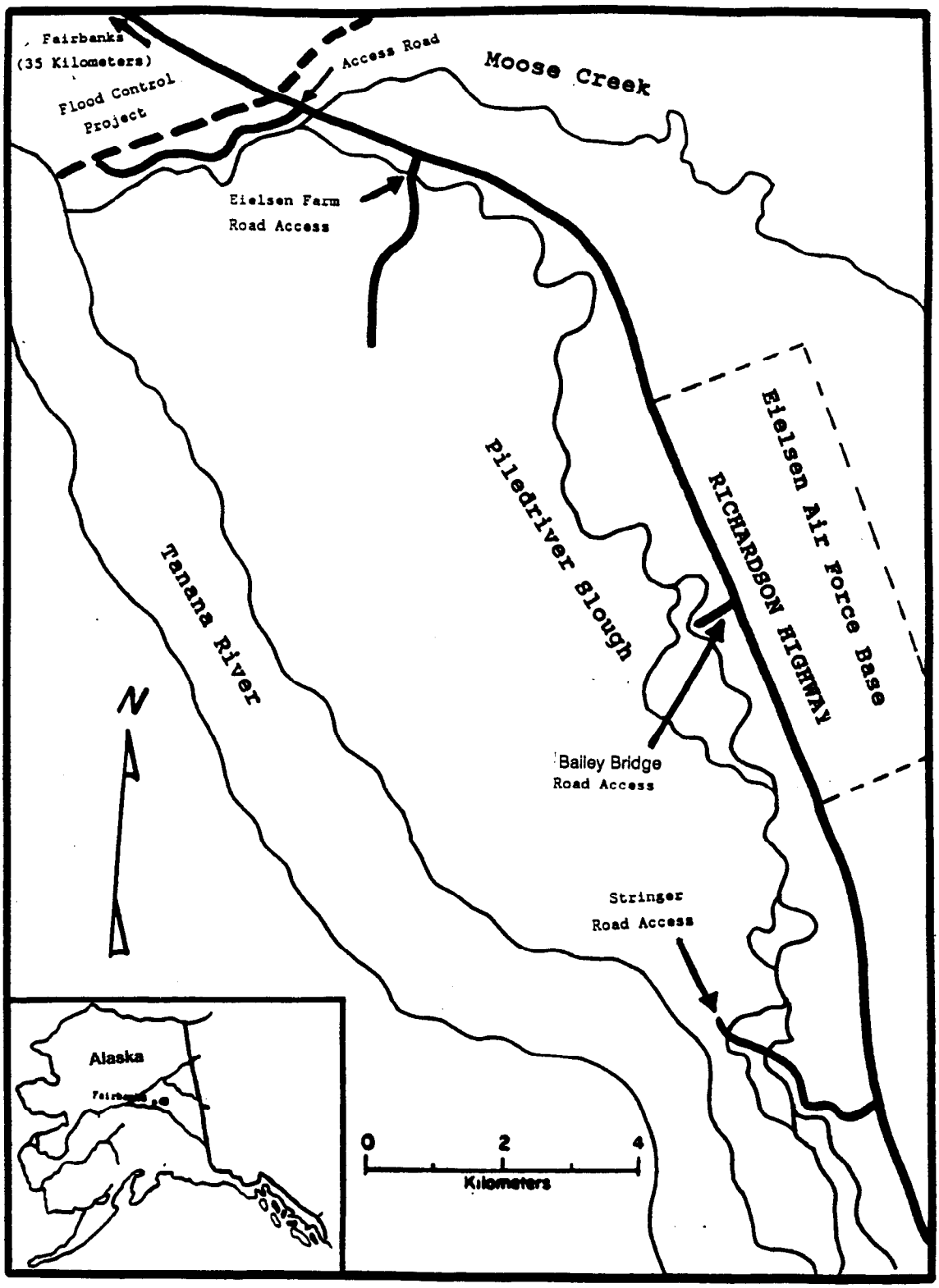


Figure 10. Map of Piledriver Slough, Tanana River drainage, Alaska.

of the increasing recreational fishing pressure away from various wild stock species in the area and in an attempt to provide a diversity of sport fishing opportunity, the Sport Fish Division initiated the stocking of rainbow trout into Piledriver Slough in the spring of 1987.

Rainbow trout were stocked into Piledriver Slough at different densities, several locations, and three sizes (fingerlings, subcatchables, and catchables) for the next four years. After initiation of the stocking program, Piledriver Slough quickly became one of the most popular sport fishing locations in interior Alaska. In 1990 the stocking program was evaluated using estimates of effort and harvest from Statewide Harvest Surveys and creel surveys, and data collected during field sampling (Timmons 1991). Based on creel survey questionnaires, anglers gave the quality of fishing moderate ratings, but overwhelmingly approved of the stocking program. A high proportion of the stocked catchable rainbow trout were harvested and only rainbow trout stocked as catchables contributed significantly to the fishery. The number of catchable rainbow trout stocked was related positively to effort expended (days fished). Timmons (1991) reported that an average "success" rate of about 40% was maintained for three to four weeks after stocking in 1990, where success was defined as a catch of at least three rainbow trout for anglers fishing at least one hour.

In 1991, 20,000 catchable-sized rainbow trout were stocked in Piledriver Slough. Stockings took place on three occasions, approximately four weeks apart, in May, June, and July. Monitoring of the Piledriver Slough fishery was to be conducted from May through September. The goal of this project was to expose trends in angler success that might be used to better schedule the release of rainbow trout. The specific objectives for monitoring the Piledriver Slough sport fisheries in 1991 were to estimate:

1. the proportion of anglers (of those who fished on Saturdays between 1400 and 2200 hours at the Eielson Farm Road) who caught at least three rainbow trout.;

2. the proportion of anglers (of those who fished on Saturdays between 1400 and 2200 hours at the Eielson Farm Road) who rated the quality of fishing as excellent, good, fair, poor, or who had no opinion; caught at least three rainbow trout;

3. the proportion of anglers (of those who fished on Saturdays between 1400 and 2200 hours at the Eielson Farm Road) who were in the following categories:

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

Methods

The design for the Piledriver Slough rainbow trout creel survey in 1991 was of the single access direct expansion type. The proportion of angler-trips exiting the Eielson Farm Road access location during Saturdays between 1400

and 2200 hours were estimated from the information obtained in interviews of completed-trip anglers. Additionally, demographics and opinions of anglers regarding the quality of the fishery were obtained from the completed-trip interviews.

The Piledriver Slough fishery can be accessed from a number of other access locations (e.g., Bailey Bridge and the culvert on Stringer Road). A comprehensive creel survey conducted in 1990 (Hallberg and Bingham 1991) indicated that approximately 70% of the angler-trips exited at the Eielson Farm Road access. The number of anglers leaving the fishery, and the number of anglers interviewed during the weekend days were at least double the number for any other sampling period, although no distinction was evident between the average sample sizes for Saturday and for Sunday afternoons. Sampling during 1991 occurred on Saturday afternoons from 1400 to 2200 hours at Eielson Farm Road, and the estimates of proportions only pertain to this sampling period.

The sampling program was not stratified. Each day selected for sampling (i.e., non-random selection of all Saturdays) represented first stage sampling units in a 2-stage design. We assumed that the proportions of angler-trips do not vary substantially from day to day. We did however assume that these proportions changed as the season progressed. We treated the days sampled as if they were systematically chosen (non-randomly).

Completed-trip anglers represented our second stage sampling units. All anglers exiting the fishery at the sampled access location during each sample period were either interviewed or counted. Total counts of exiting anglers were used to weight proportions across days as noted below.

Data Collection:

As noted above, on each Saturday afternoon from 1400 to 2200 hours (starting on 18 May and continuing until 27 July), a creel technician was stationed at the Eielson Farm Road. As anglers returned to their vehicles upon completion of fishing for the day, the technician interviewed each angler.

During each interview, the following information was collected from individual anglers:

1. the amount of time he or she spent fishing;
2. the number of fish caught by species;
3. the number of fish harvested by species;
4. angler gender (male/female);
5. age class (youth/adult);
6. resident or non-resident;
7. military or non-military; and
8. opinion of the angler as to the quality of fishing (excellent, good, fair, poor, or no opinion).

Each interview was recorded on a separate Angler Interview mark-sense form (version 1.1). Anglers who were not interviewed were counted, and counts were recorded by the hour (Appendix B).

When not engaged in interviewing anglers, the technician measured harvested Arctic grayling and rainbow trout for length. Scales for aging were not taken.

Data Analysis:

Although the primary objective of this survey was to estimate the proportion of anglers who caught at least three rainbow trout, we also estimated the proportions of anglers who caught 0 rainbow trout, 1 or more, 2 or more, ..., to 10 or more. Similarly, the proportions of anglers that harvested 0 rainbow trout, 1 or more, etc. were also estimated. These proportions are termed the catch and harvest distributions. The catch and harvest distribution of anglers was estimated from the angler interviews obtained from the sample survey described above.

The first step was to code the data prior to calculation. The coding was necessary because not all sampling periods were the same "size"; more anglers were in some sampled days than others. Ignoring these differences in "size" would have promoted bias in estimates of catch and harvest distributions when statistics were averaged across days. The coding adjusted for this discrepancy. From Sukhatme, et al. (1984: equation 8.58; page 327):

$$y_{kio} = \begin{cases} M_i/\bar{M}^* & \text{if catch made by interviewed angler } o \text{ within day } i \text{ caught k or more fish (or zero fish if k = 0);} \\ 0 & \text{otherwise;} \end{cases} \quad (47)$$

where: $M_i$ is the number of anglers counted exiting the fishery on each sampled day at Eielson Farm Road between 1400 and 2200 hours;

$\bar{M}^*$ = the restricted mean of the number of anglers across all sampled days, restricted to days with at least one angler counted;

$$= \frac{\sum_{j=1}^{d^*} M_i}{d^*} \text{ ; and} \quad (48)$$

$d^*$ was the restricted number of days sampled, restricted to those days with at least one angler counted.

The angler met the criterion if their catch $c_{io} \geq k$ where $k = 1$ to 10 or $c_{io} = 0$ for $k = 0$; otherwise $y_{kio} = 0$. The data was re-coded for each iteration from 0 to 10. After coding, the average fraction and its variance were found for the survey:

$\hat{p}_k$ = proportion of angler-trips for the survey that caught 0 or at least k fish;

$$= \frac{\sum_{j=1}^{d^*} \bar{y}_{ki}}{d^*} ; \quad (49)$$

$\bar{y}_{ki}$ = weighted proportion of angler-trips within each day that harvested 0 or at least k fish;

$$= \frac{\sum_{o=1}^{m_i} y_{kio}}{m_i} ; \text{ and} \quad (50)$$

$m_i$ equaled the number of anglers interviewed within each day.

The variance of the estimated proportion was obtained by a two-stage equation (see Cochran 1977):

$$\hat{V}[\hat{p}_k] = \left\{ (1 - f_1) \frac{s_{1k}^2}{d} \right\} + \left\{ \frac{f_1}{d_2^2} \sum_{i=1}^{d_2} (1 - f_{2i}) \frac{s_{2ki}^2}{m_i} \right\} ; \quad (51)$$

where: $f_1$ equals the sampling fraction for the first stage units (i.e., $f_1 = d / D$); $d$ = total number of days sampled; $D$ equals the number of days in the survey (equal to 71); $d_2$ equals the number of days sampled in which at least two anglers were interviewed; $f_{2i}$ equals the sampling fraction for anglers (i.e., $f_{2i} = m_i / M_i$);

$s_{1k}^2$ = the among day variance for the catch distribution estimate, obtained by the formula proposed by Wolter (1985, modified from Equation 7.2.4, page 251) appropriate for systematic sampling;

$$= \frac{\sum_{i=2}^{d} (\bar{y}_{ki} - \bar{y}_{k(i-1)})^2}{2 \ (d - 1)} ; \text{ and} \quad (52)$$

$$s^2_{2hi} = \frac{\sum_{j=1}^{m_i} (y_{kio} - \bar{y}_{ki})^2}{m_i - 1} . \qquad (53)$$

Standard errors were obtained by taking the square root of the variance estimates. The distribution of angler harvests, their variances, and standard errors were obtained similarly by substituting the appropriate harvest statistics into equations 47-53, above.

Estimates of the proportion of angler-trips by demographic or opinion categories were estimated as described in Chapter 4 for the Salcha River survey. Each proportion associated with each parameter (e.g., various angler demographic categories) and its variance was calculated according to equations 35-39 and 41. In applying these equations the entire survey was treated as one stratum (i.e., no *h* subscript needed). Equation 40 was replaced by the following calculation appropriate to systematic sampling:

$$s^2_{1k} = \frac{\sum_{i=2}^{d^*} (w_i \hat{p}_{ui} - \hat{p}_{u(i-1)})^2}{2 \ (d^* - 1)} ; \qquad (54)$$

where: all terms were as defined in Chapter 4.

Assumptions:

The assumptions necessary for unbiased point and variance estimates of distribution of angler catch and harvest obtained by the procedures outlined above were that:

1. missed anglers did not have different characteristics than the interviewed angler parties;

2. interviewed anglers accurately reported their catch;

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

4. all counted individuals that were not interviewed were properly classified as an angler (i.e., missed anglers truelly have been fishing).

The general assumptions necessary for unbiased point and variance estimates of angler demographics and opinion proportions include the first assumption above as well as:

3. creel clerks accurately classified anglers and the interviewed anglers accurately reported their demographic characteristics during the trip.

All estimates apply only to the fishery defined by the anglers who exited the fishery at the Eielson Farm Road location, during Saturdays between 1400 and 2200 hours.

Results

Rainbow trout were released into Piledriver in 1991 in the following lots;

6,568 fish averaging 57 g on 17 May;
6,525 fish averaging 64 g on 11 June; and,
12,050 fish averaging 88 g on 15 July 1991.

Only catchable-sized rainbow trout were stocked in 1991; no fingerlings or sub-catchable size fish were released. During each stocking event, rainbow trout were released in three different, road accessible locations along the length of Piledriver Slough. Attempts were made to notify anglers (through press releases in the local newspaper and the ADF&G's recorded fishing hot-line telephone service) of the dates and the approximate numbers of rainbow trout scheduled to be released.

The sport fishery at the Eielson Farm Road on Piledriver Slough was monitored from 1400 to 2200 hours, for 11 consecutive Saturdays, from 18 May to 27 July. It was anticipated that the fishery here would be monitored from 18 May through August. However, due to unexpected budgetary problems coupled with the fact that relative size of rainbow trout at the time of stocking was smaller than anticipated (which may have discouraging angler participation) the creel survey was terminated on 27 July 1991.

During the 11 (Saturdays) sampling events 260 angler-trips were observed from which 193 angler interviews were obtained.

Thirty-eight percent (SE = 7) of the anglers caught one or more rainbow trout and 17% (SE = 4) harvested more than one rainbow (Table 10). Twenty percent (SE = 4) of the observed angler-trips resulted in a catch of three or more rainbow trout. The distribution of the catch and harvest of rainbow trout among anglers interviewed showed the majority of anglers (62%) with zero catch and (83%) with zero harvest. Thirteen percent (SE = 3) of the angler-trips resulted in catches greater than the existing bag limit (of five rainbow trout) while no angler-trips resulted in harvests greater than the legal limit. Angler success (rainbow trout catches and harvests) were greater on the 20th and 27th of July than on the previous nine Saturdays (Figure 11).

The majority of the anglers interviewed at Piledriver Slough were male (90%, SE = 9), adult (85%, SE = 11), and residents of the State of Alaska (75%, SE = 10; Table 11). The fishery was also popular for military personnel (38%, SE = 5). The majority of anglers (65%; SE = 8) selected spinners for terminal fishing gear while 35% (SE = 6) reported using flies.

Thirty percent (SE = 3) of the anglers interviewed, who expressed an opinion on the quality of fishing on Piledriver Slough (at the Eielson Farm Road), rated the fishing here as poor, whereas 26% (SE = 4) rated the fishing as only fair, 25% (SE = 4) rated the fishing as good and only 9% (SE = 4) said fishing was excellent (Table 11).

Table 10. Estimates of the catch and harvest distribution of rainbow trout during the creel survey of the 1991 Piledriver Slough-Saturday late day fishery at Eielson Farm Road, 18 May to 27 July 1991. The total number of observed angler-trips for the survey was 260, and the number of anglers interviewed was 193.

| Parameter[a] | Percentage of angler-trips that caught or harvested the noted number of rainbow trout | | | |
|---|---|---|---|---|
| | Caught (%) | SE (%) | Harvested (%) | SE (%) |
| 1 or more fish | 38 | 7 | 17 | 4 |
| 2 or more fish | 28 | 7 | 12 | 2 |
| 3 or more fish | 20 | 5 | 8 | 2 |
| 4 or more fish | 16 | 4 | 6 | 2 |
| 5 or more fish | 15 | 4 | 5 | 2 |
| 6 or more fish | 13 | 3 | 0 | 0 |
| 7 or more fish | 11 | 3 | 0 | 0 |
| 8 or more fish | 10 | 3 | 0 | 0 |
| 9 or more fish | 9 | 2 | 0 | 0 |
| 10 or more fish | 8 | 2 | 0 | 0 |
| 11 or more fish | 7 | <0.5 | 0 | 0 |
| 0 fish | 62 | 6 | 83 | 9 |
| 1 fish | 11 | 2 | 5 | 2 |
| 2 fish | 8 | 2 | 4 | 2 |
| 3 fish | 4 | 1 | 1 | 1 |
| 4 fish | 2 | 1 | 1 | 1 |
| 5 fish | 2 | 1 | 5 | 2 |
| 6 fish | 2 | 1 | 0 | 0 |
| 7 fish | 1 | 1 | 0 | 0 |
| 8 fish | <0.5 | <0.5 | 0 | 0 |
| 9 fish | 1 | 1 | 0 | 0 |
| 10 fish | 1 | <0.5 | 0 | 0 |

[a] Two types of parameters were estimated for catch and harvest; the first set describes the proportion of angler-trips that caught or harvested at least the noted number of fish (e.g. "2 or more fish" = caught at least 2 fish and possibly more); the second set describes the proportion of trips that caught or harvested only the noted number (e.g., "2 fish" = caught only two fish).

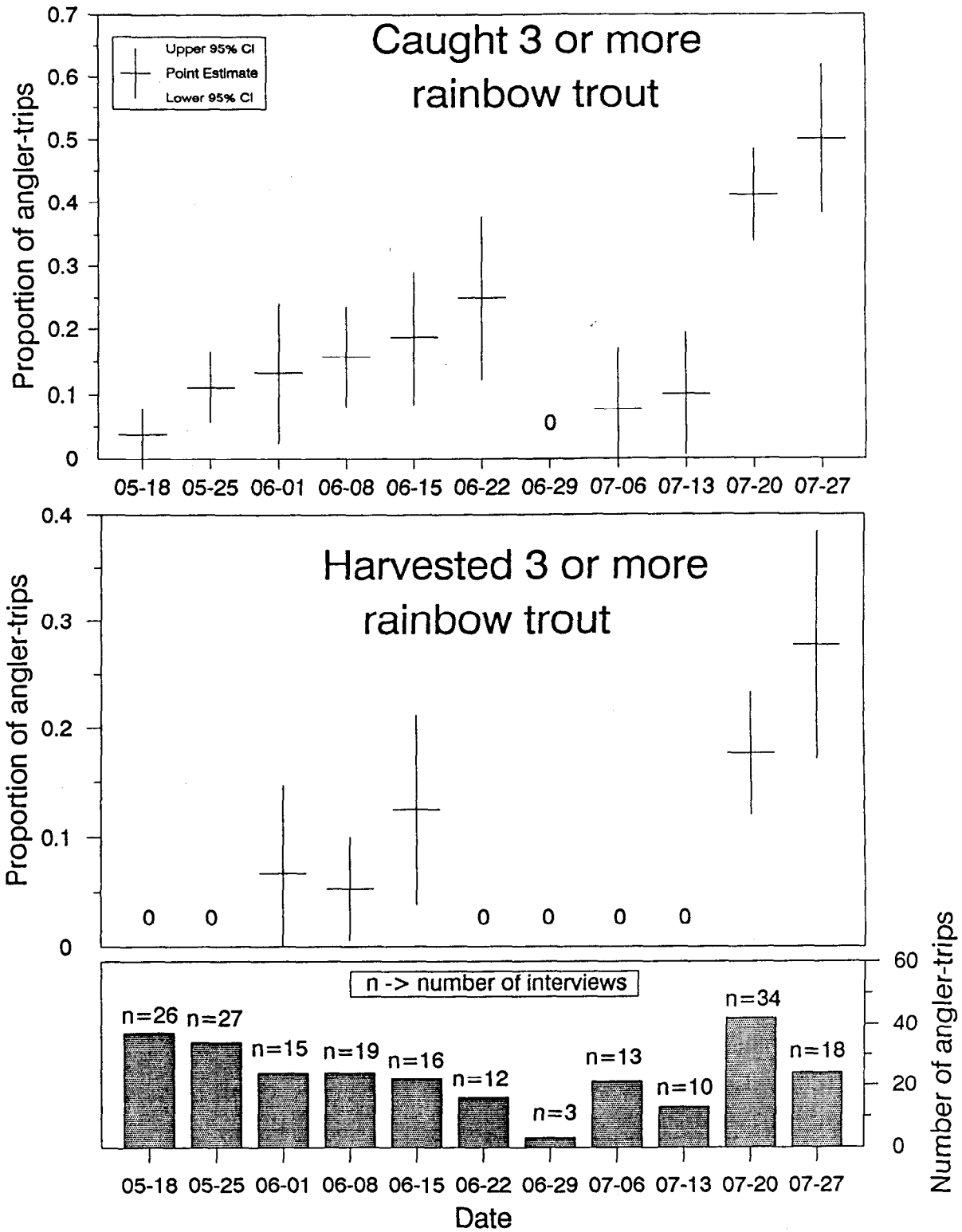


Figure 11. Estimate of the proportion of anglers who caught and harvested three or more rainbow trout at Piledriver Slough, Tanana River drainage, Alaska, 1991.

Table 11. Estimated proportion of angler-trips by various demographic, terminal gear type, and opinion on fishing quality categories for the 1991 Piledriver Slough-Saturday creel survey at Eielson Farm Road, 18 May to 27 July 1991.

| | n[a] | Proportion[b] | SE[c] |
|---|---|---|---|
| Male | 173 | 0.90 | 0.09 |
| Female | 20 | 0.10 | 0.03 |
| Youth | 29 | 0.15 | 0.02 |
| Adult | 161 | 0.85 | 0.11 |
| Resident | 143 | 0.75 | 0.10 |
| Non-resident | 48 | 0.25 | 0.05 |
| Military | 74 | 0.38 | 0.05 |
| Non-Military | 119 | 0.62 | 0.10 |
| Spin | 117 | 0.65 | 0.08 |
| Fly | 63 | 0.35 | 0.06 |
| Opinion on Fishing Quality: | | | |
| Excellent | 17 | 0.09 | 0.04 |
| Good | 47 | 0.25 | 0.05 |
| Fair | 49 | 0.26 | 0.04 |
| Poor | 58 | 0.30 | 0.03 |
| No Opinion | 19 | 0.10 | 0.03 |

[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 stratum weights.

[c] Standard error of the weighted proportion.

## Discussion

By distributing catchable-sized rainbow trout along the course of the stream on three different dates (roughly a month apart) and advertising the event to the public, the ADF&G had hoped to increase angler awareness and angler participation in the fishery. It is not known at this time whether increased advertising influenced the total catch, effort and harvest of rainbow trout at Piledriver Slough in 1991. However, it appears that the popularity of the fishery and the distribution of catches in the fishery did not respond as anticipated.

For the first time in the five years that rainbow trout have been released into Piledriver Slough, the majority (30%) of anglers rated the fishery as poor. The proportion of anglers who rated the fishery as excellent and good was the lowest (34%) in the past five years. Beginning in 1986, 95% of those anglers interviewed rated the fishery as excellent or good (Clark and Ridder 1987). Ratings fell to 63% in 1987, to 58% in 1988 (Baker 1988-1989), and to 37% in 1989 (Merritt, et al. 1990). Hallberg and Bingham (1991) reported that only 43% of the anglers interviewed in 1990 rated the fishery as excellent or good.

Possible reasons for the anglers' response may stem from the fact the size of the catchable trout put into Piledriver Slough in 1991 were much smaller than what has been stocked historically. Timmons (1991) pointed out that rainbow trout stocked as catchables since 1987 ranged in weight from 65 to 154 g, and averaged 106 g. Rainbow trout released in 1991 averaged less than 70 g. While the length of the rainbow trout stocked into Piledriver Slough in 1991 is not available at this time, ADF&G staff who were in attendance at the time of stocking commented on how small the fish appeared.

However, after the 15 July 1991 stocking, which consisted of the most fish (12,050) of the largest size (averaging 88 g) of all three stocking events, a marked increase in both the catch and effort of rainbow trout was observed (Figure 11).

Timmons (1991) recommended that to reduce the potential spread of rainbow trout (at least those capable of reproducing themselves) into other nearby river systems, sterile fish be stocked into Piledriver Slough. Consequently, the ADF&G in 1991, for the first time ever, stocked triploid (sterile) rainbow trout into Piledriver Slough. It is not known at this time, but it may be possible these "triploid" fish do not grow or perform similar to "normal rainbow trout". Since this was a first time event, new or different hatchery techniques may be developed that could improve the performance of the triploid strain of rainbow trout.

The estimated proportion of anglers who caught at least three rainbow trout while fishing near the Eielson Farm Road in 1991 was 0.20, nearly the same as that reported by Hallberg and Bingham (1991) for the entire Piledriver Slough in 1991 (0.21).

Data collected during the 1991 creel survey at Piledriver Slough suggested that the rainbow trout fishery is strongly characterized as catch and release. Also, no violation of the daily bag limit for rainbow trout was observed.

## ACKNOWLEDGEMENTS

We wish to thank the creel technicians Pat Houghton, Mark Zeller, and Richard Barnes for collecting the survey data and suggesting improvements in procedures. We wish to thank Renata Riffe for her efforts in scale mounting preparations and with the aging of northern pike scales and, Bob Clark for providing the initial age determination of Arctic grayling, and also to David Bernard and Saree Timmons for helping design the Piledriver Slough survey. Sara Case is thanked for typing the report. Donna Buchholz and Gail Heineman, of Research and Technical Services, assisted in the processing of the mark-sense data and in archiving all data associated with the project. Special thanks go to our peer reviewer, Scott Meyer, whose constructive criticisms and suggested edits substantially improved this document. Thanks to the U.S. Fish and Wildlife Service for the funding of this project through the Federal Aid in Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-7, Job No. R-3-1.

## LITERATURE CITED

Baker, T. T. 1988. Creel censuses in Interior Alaska in 1987. Alaska Department of Fish and Game, Fishery Data Series No. 64, Juneau.

_____. 1989. Creel censuses in Interior Alaska in 1988. Alaska Department of Fish and Game, Fishery Data Series No. 95, Juneau.

Barton, L. H. 1985. A catalog of Yukon River spawning salmon escapement surveys. Alaska Department of Fish and Game, Technical Data Report No. 121, Juneau.

Clark, R. A. and W. P. Ridder. 1987. Tanana drainage creel census and harvest surveys, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 12, Juneau.

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

Gabelhouse, D. W. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Hallberg, J. E., and A. E. Bingham. 1991. Creel surveys conducted in Interior Alaska during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-56, Anchorage.

Holmes, R. A. 1987. Profiles and regulatory preferences of Tanana River drainage sport fishermen. Alaska Department of Fish and Game, Fishery Manuscript No. 53, Juneau.

Kish, L. 1965. Survey sampling. John Wiley and Sons, New York.

Kramer, M. J. 1975. Inventory and cataloging of interior Alaska waters - Fairbanks district. Alaska Department of Fish and Game. Federal Aid in Sport Fish Restoration, Annual Report of Progress, 1974-1975, Project F-9-7, 16 (G-I-G): 145-181.

Merritt, M., A. E. Bingham and N. Morton. 1990. Creel surveys conducted in interior Alaska during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-54, Anchorage.

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

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

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

_____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 20 (SW-I-A).

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

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

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

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

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

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

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

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

_____. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series 90-44, Anchorage.

_____. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series 91-58, Anchorage.

Neuhold, J. M., and K. H. Lu. 1957. Creel census method. Utah State Department of Fish and Game Publication 8, Salt Lake City.

Pearse, G. A. 1991. Stock assessment of the northern pike populations in George, Volkmar, and T Lakes, 1990 and 1991, and a historical review of research conducted since 1985. Alaska Department of Fish and Game. Fishery Data Series No. 91-63, Anchorage.

Peckham, R. D. 1979. Evaluation of Interior Alaska waters and sport fish with emphasis on managed waters - Delta District. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1978-1979, Project F-9-11, 20(G-III-I): 87-114.

_____. 1980. Evaluation of Interior Alaska waters and sport fish with emphasis on managed waters - Delta District. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1979-1980, Project F-9-12, 21(G-III-I): 1-25.

_____. 1982. Evaluation of Interior Alaska waters and sport fish with emphasis on managed waters - Delta District. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1981-1982, Project F-9-14, 23(G-III-I): 1-28.

Robson, D. S. 1961. On the statistical theory of a roving creel census of fishermen. Biometrics 17:415-437.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. Charles Griffen and Company, London, Great Britain.

Sukhatme, P. V., B. V. Sukhatme, S. Sukhatme, and C. Asok. 1984. Sampling theory of surveys with applications, third edition. Iowa State University Press, Ames.

Timmons, L. S. 1991. Evaluation of the rainbow trout stocking program for Piledriver Slough. Alaska Department of Fish and Game, Fishery Data Series, No. 91-25, Anchorage.

Warner, G. 1959. Catch distribution, age and size composition sport fish in Fairbanks area. U.S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-8, Work Plan A, Job 3c, 8(3): 7 pp.

Williams, J. E. 1955. Determination of age from the scales of northern pike (*Esox lucius L.*) Ph. D. Thesis, University of Michigan, Ann Arbor.

Wojcik, F. J. 1954. Game fish investigations of Alaska. U.S. Fish and Wildlife Service and Alaska Game Commission. Federal Aid in Fish Restoration, Work Plan 5, Job 1.

_____. 1955. Life history and management of the grayling in interior Alaska. M.S. Thesis, University of Alaska - Fairbanks.

Wolter, K. M. 1985. Introduction to variance estimation. Springer-Verlag, New York.

# APPENDIX A

Appendix A. Angler interview, angler count, and biological data files developed for creel surveys in interior Alaska in 1991[a].

| | |
|---|---|
| U0010CA1.DTA | Upper Chena River Arctic grayling, creel survey angler count data. |
| U0010IA1.DTA | Upper Chena River Arctic grayling fishery, creel survey angler interview data. |
| U0010LA1.DTA | Upper Chena River Arctic grayling, creel survey tagging length data. |
| U0040CA1.DTA | Chatanika River Arctic grayling, creel survey angler count data. |
| U0040IA1.DTA | Chatanika River Arctic grayling fishery, creel survey angler interview data. |
| U0040LN1.DTA | Chatanika River Arctic grayling fishery, creel survey tagging length data. |
| U0110IA1.DTA | George Lake northern pike fishery, creel survey angler interview data. |
| U0110LC1.DTA | George Lake northern pike fishery, creel survey tagging length data. |
| U0050IA1.DTA | Salcha River chinook salmon fishery, creel survey angler interview data. |
| U3190IA1.DTA | Piledriver Slough rainbow trout fishery, creel survey angler interview data. |

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

# APPENDIX B

Appendix B. 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 | _____ |