Fishery Data Series No. 91-24

Seward Peninsula Arctic Grayling Study, 1990

by

Alfred L. DeCicco

August 1991

Alaska Department of Fish and Game

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SEWARD PENINSULA ARCTIC GRAYLING STUDY 1990[1]

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ABSTRACT

Stock status of Arctic grayling *Thymallus arcticus* was investigated in the Niukluk, Fish, Pilgrim and Sinuk rivers of the Seward Peninsula, Alaska during 1990 using mark recapture experiments. The estimated abundance of Arctic grayling greater than 149 millimeters in fork length in a 16 kilometer section of the Niukluk River was 3,739 fish (standard error = 991) or 234 fish per kilometer. Arctic grayling captured in the Niukluk River ranged from 64 to 477 millimeters in fork length with a mean of 344 millimeters and fish of ages 7 and 8 were most frequently represented. The estimated abundance of Arctic grayling greater than 149 millimeters in fork length in 24 kilometers of the Fish River was 2,909 fish (standard error = 371) or 121 fish per kilometer. Arctic grayling captured in the Fish River ranged from 92 to 468 millimeters in fork length with a mean of 369 millimeters and fish of ages 7 and 8 were most frequently represented. The estimated abundance of Arctic grayling greater than 149 millimeters in fork length in a 12 kilometer section of the Pilgrim River was 1,764 fish (standard error = 428) or 147 fish per kilometer. Arctic grayling captured in the Pilgrim River ranged in fork length from 180 to 507 millimeters with a mean of 390 millimeters and fish of ages 6, 7, and 8 were most frequently represented. The estimated abundance of Arctic grayling greater than 249 mm in fork length in a 40 kilometer section of the Sinuk River during 1989 was 1,120 fish (standard error = 264) or 28 fish per kilometer. Arctic grayling captured in the Sinuk River ranged from 260 to 528 millimeters in fork length with a mean of 443 millimeters and fish of ages 6, 7, and 8 were most frequently represented. The majority of Arctic grayling (76, 92, and 66 percent) were in the "preferred" Relative Stock Density category in the Niukluk, Fish and Pilgrim rivers respectively while "memorable" fish made up 50 percent of the Sinuk River Sample. Mean fork length-at-age was greatest in the Sinuk River and least in the Fish and Niukluk rivers.

KEY WORDS: Arctic grayling, *Thymallus arcticus*, electrofishing, population abundance, age composition, length composition, Relative Stock Density, growth, Seward Peninsula, Niukluk River, Sinuk River, Fish River, Pilgrim River.

INTRODUCTION

The Seward Peninsula-Norton Sound area of western Alaska supports the second largest recreational fishery in the Arctic-Yukon-Kuskokwim (AYK) region. From 1980 to 1989, an average of 14,796 freshwater angler-days were fished in this area (Mills 1981-1990, Figure 1). Reported freshwater fish harvests consist primarily of Dolly Varden char *Salvelinus malma*, Arctic grayling *Thymallus arcticus*, pink, coho, chum and chinook salmon *Oncorhynchus spp.*, northern pike *Esox lucius*, whitefish *Coregonus spp.*, and burbot *Lota lota*. From 1980 to 1989, Arctic grayling have accounted for an average of 21% of the harvest of these species, and has averaged 22% over the past two years (Table 1).

The Seward Peninsula is the only area in Alaska outside of Bristol Bay which regularly produces trophy-size Arctic grayling. Of 102 Arctic grayling registered with the Alaska Department of Fish and Game (ADFG) Trophy Fish Program between 1967 and 1990, 25 (25%) were from the Seward Peninsula (ADFG 1990).

Although the Nome area is not connected by road to the state highway system, the Seward Peninsula contains approximately 420 km of gravel roads which are maintained by the State of Alaska Department of Transportation from May through September. These roads originate in Nome and traverse the Seward Peninsula in three general directions: The Beam Road extending to the north, the Teller Road to the west and the Council Road to the east (Figure 2). This road system sets Nome apart from most other rural Alaskan communities and provides angler access to many streams on the Seward Peninsula.

As indicated by harvest statistics (Table 1) fishing pressure can be quite high on accessible streams. Subsistence harvests of Arctic grayling, although not monitored, have raised concern regarding stock status among local anglers and ADFG staff in Nome. The abundance of large-size Arctic grayling appeared to be declining in some streams. These concerns led the Alaska Board of Fisheries in 1988 to reduce the daily bag limit of Arctic grayling on the Seward Peninsula to five per day, five in possession, with only one over 15 in (380 mm).

The first studies conducted by ADFG on the basic life history and angler utilization of fish on the Seward Peninsula began in 1977 and continued through 1979. Nine streams were surveyed for fish presence and 147 Arctic grayling were sampled for age, weight and length. Angler counts were conducted periodically on 15 different streams (Alt 1978, 1979, 1980). Between 1979 and 1984, 88 Arctic grayling from the Fish and Niukluk rivers were sampled for age, length and weight (Alt 1986). During 1988, a project was initiated to survey Arctic grayling stocks on 10 Seward Peninsula rivers and to estimate average catch and harvest-per-unit of effort of Arctic grayling on those streams (Merritt 1989). A total of 887 Arctic grayling were tagged and sampled for length and age on the Nome, Snake, Sinuk, Solomon, Eldorado, Pilgrim, Kuzitrin, Niukluk and Fish rivers and Boston Creek. In addition, 32 anglers were interviewed on Seward Peninsula streams providing data on harvest strategy for Arctic grayling. During 1989, Arctic grayling were sampled on the Niukluk and Sinuk rivers for age at length and size

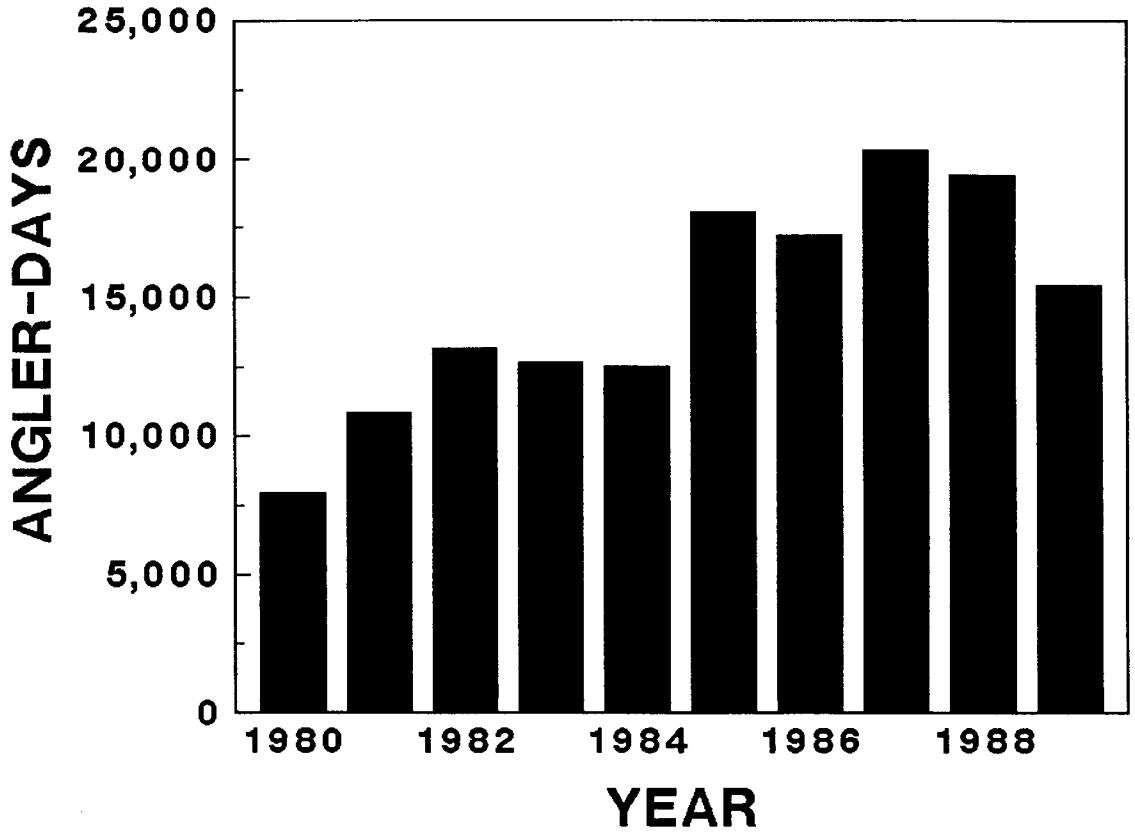


Figure 1. Freshwater sport fishing effort on Seward Peninsula and Norton Sound streams, 1980-1989.Data from Mills (1981-1990).

Table 1. Freshwater sport fish harvests for Seward Peninsula and Norton Sound streams, 1980 to 1989[a].

Year	Days Fished	Salmon all species	Dolly Varden	Arctic Grayling	Northern Pike	Burbot	Whitefish
1980	7,968	10,840	5,811	1,635	284	0	353
1981	10,879	6,564	3,981	2,104	303	0	123
1982	13,198	19,757	6,498	6,225	210	0	597
1983	12,678	10,189	9,779	8,241	798	0	148
1984	12,558	13,881	4,260	2,349	208	13	39
1985	18,141	3,401	5,695	4,501	56	175	70
1986	17,257	9,610	5,381	4,042	699	0	510
1987	20,381	5,415	5,506	4,600	906	0	272
1988	19,456	10,460	4,437	4,873	564	36	655
1989	15,443	8,548	7,003	4,205	648	10	453
Mean	14,796	9,867	5,835	4,278	468	23	322

[a] Data from Alaska statewide sport fish harvest survey (Mills 1981 through 1990).

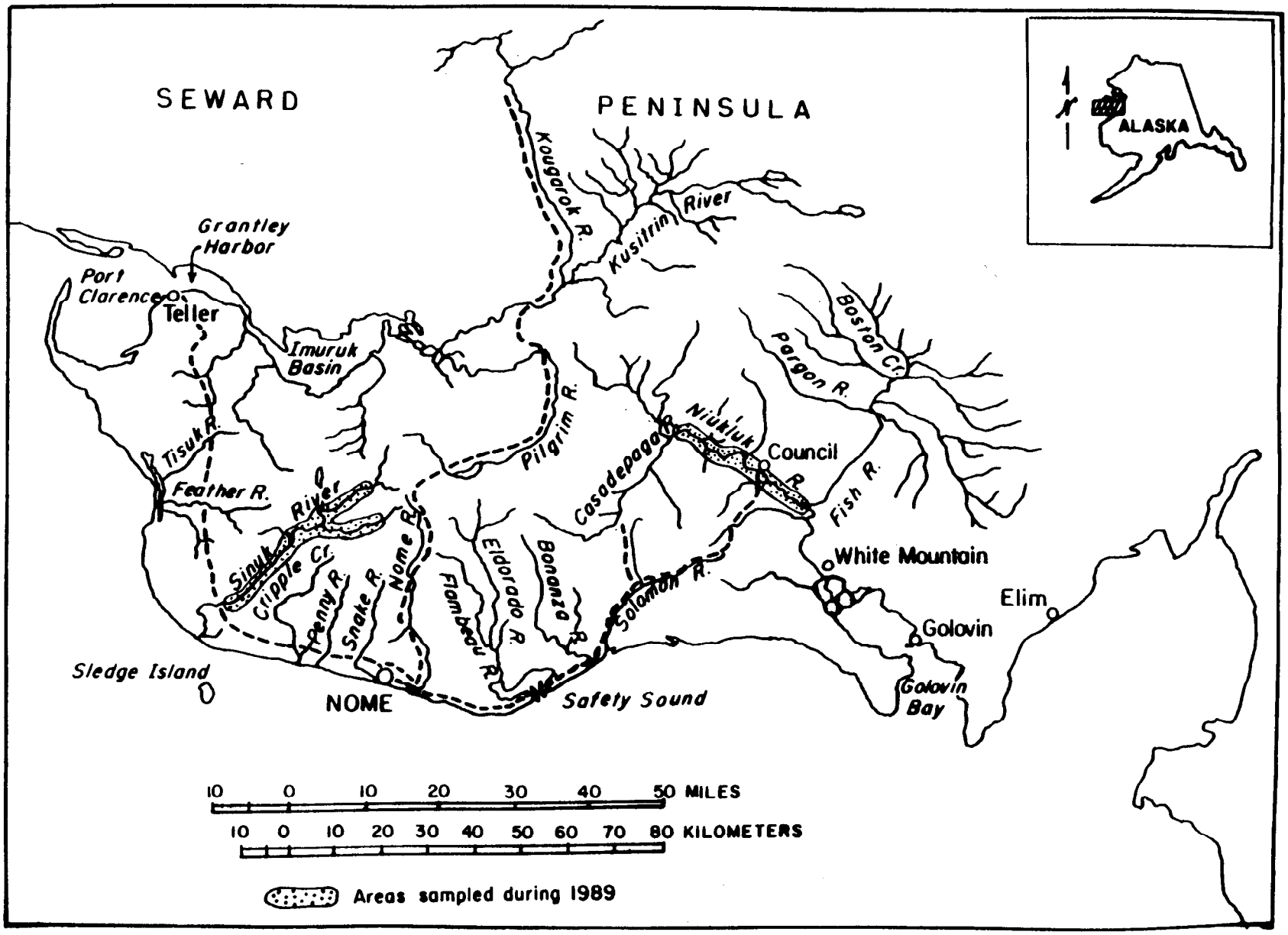


Figure 2. The southern Seward Peninsula showing roads and road accessible waters.

composition estimates and population abundance was estimated for a section of the Niukluk River (DeCicco 1990).

This project is a continuation of the work begun in 1988 by Merritt (1989). Long term goals of the project are to:

1) define sustainable yield for Arctic grayling stocks in Seward Peninsula drainages, and

2) achieve sustainable yield sport fisheries for Arctic grayling populations through regulation.

Project objectives in 1990 were to estimate:

1) the abundance of Arctic grayling greater than 149 mm in fork length in a 16 km section of the Niukluk River downstream from Council;

2) age and length composition of Arctic grayling greater than 149 mm in a 16 km section of the Niukluk River downstream from Council;

3) the abundance of Arctic grayling greater than 149 mm in fork length in a 24 km section of the Fish River upstream from its confluence with the Niukluk River;

4) age and length composition of Arctic grayling greater than 149 mm in a 24 km section of the Fish River upstream from its confluence with the Niukluk River;

5) the abundance of Arctic grayling greater than 149 mm in fork length in a 16 km section of the Pilgrim River downstream of the Beam Road bridge;

6) age and length composition of Arctic grayling greater than 149 mm in a 16 km section of the Pilgrim River downstream of the Beam Road bridge; and,

7) the mean length-at-age of Arctic grayling in the Sinuk River.

METHODS

Sampling Gear and Techniques

Sampling of Arctic grayling on the Niukluk, Fish and Pilgrim rivers (Figures 3 and 4) was performed using a pulse-DC electrofishing system mounted on a 5.4 m long river boat. Input voltage (240 VAC) was provided by a 2,900 W single-phase Kawasaki Model GA 3200-A gas powered generator. A variable voltage pulsator (Coffelt Manufacturing Model VVP 3C) was used to generate output current. Six anodes were constructed of 9.5 mm diameter twisted steel cable 1.5 m long inside 19 mm diameter flexible conduit and attached equidistantly to the 3.5 m cross member of a 3.5 m long retractable "T-boom" attached to a platform on the bow of the boat. The aluminum hull of the river boat was used as the cathode. Output voltages varied between 180 and 240 VDC and amperage varied from 1.8 to 4 A. The pulse rate was held around 80 Hz.

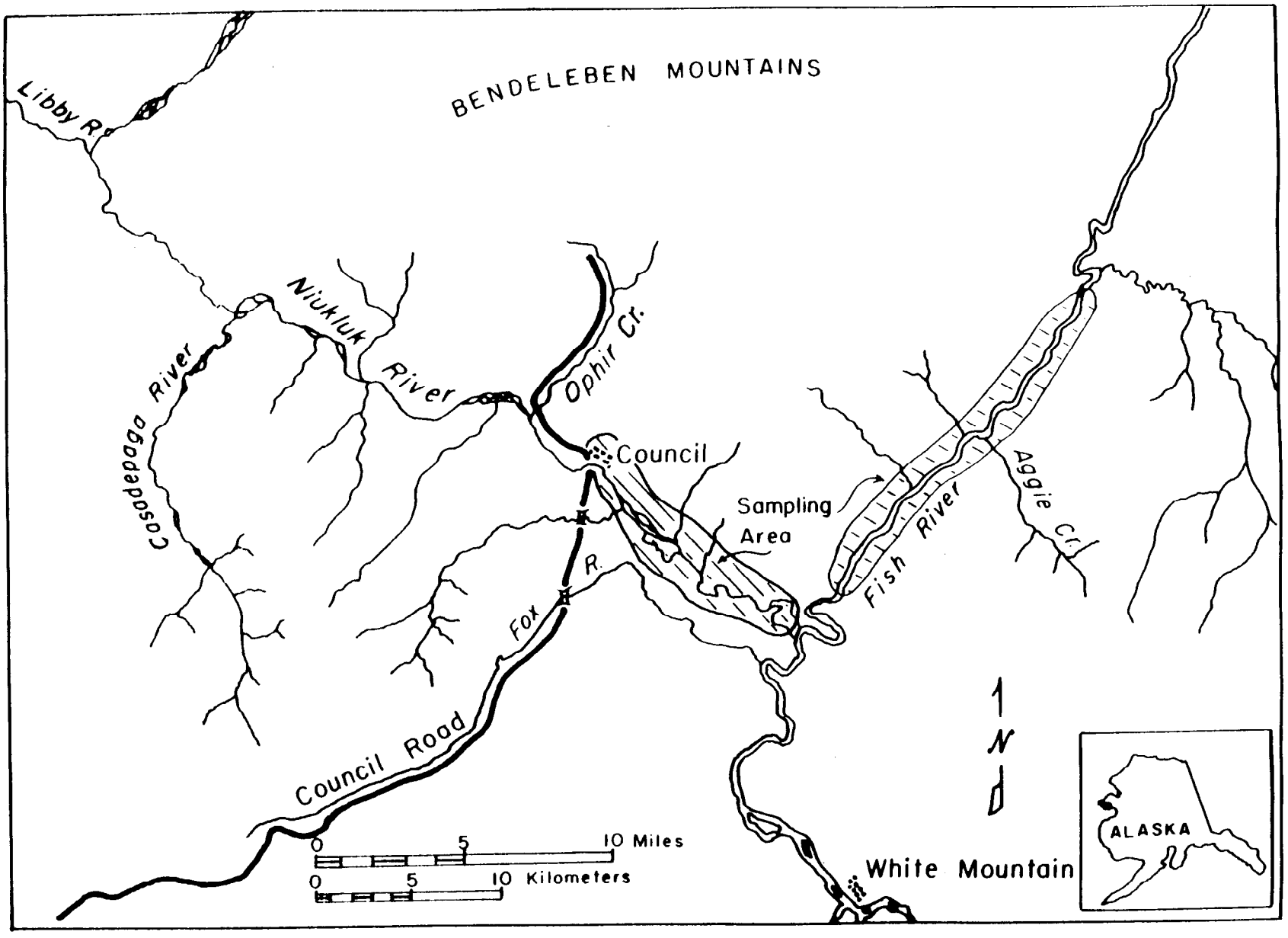


Figure 3. The Niukluk and Fish rivers with areas sampled during 1990, Seward Peninsula, Alaska.

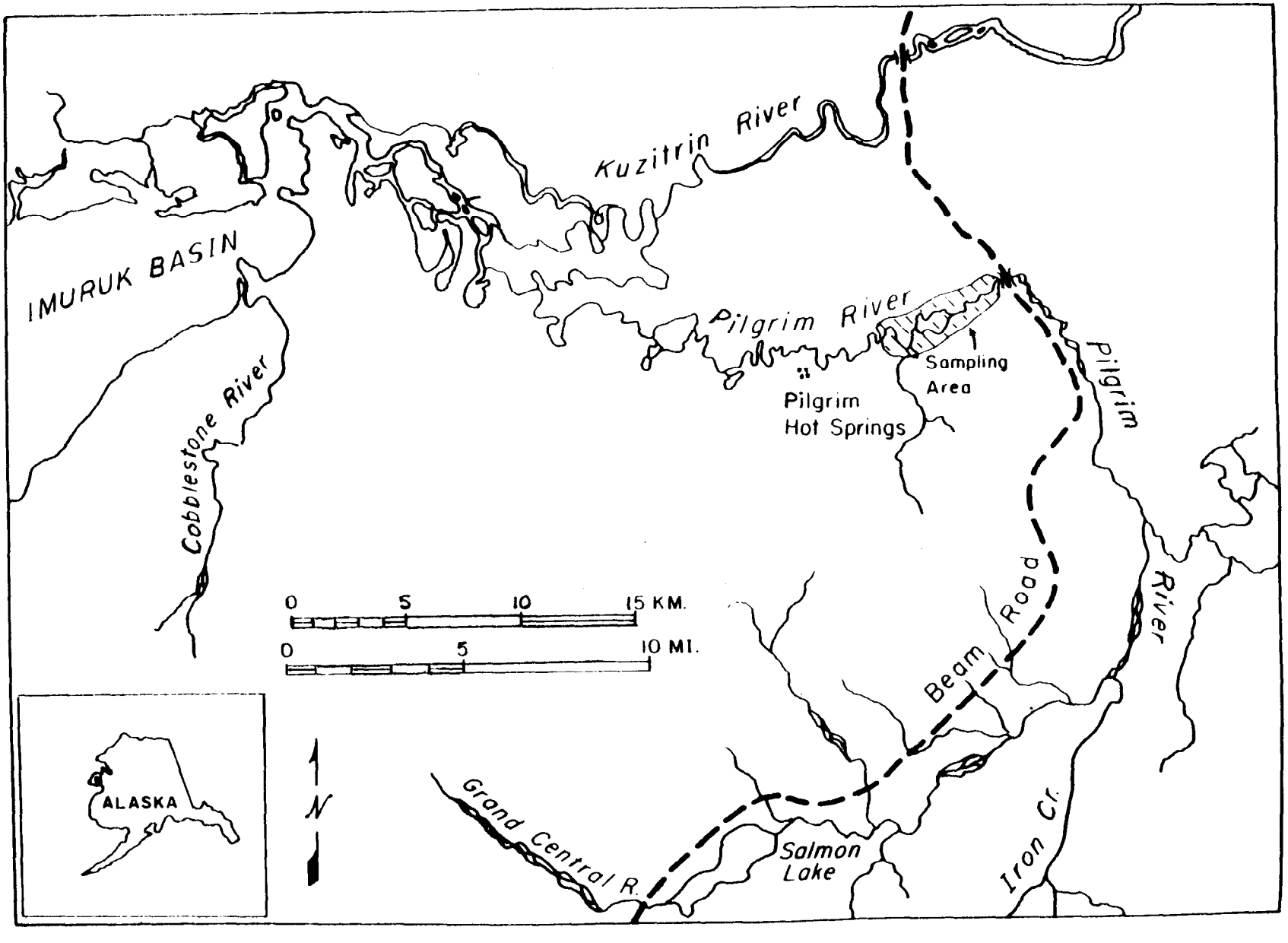


Figure 4. The Pilgrim River with area sampled during 1990, Seward Peninsula, Alaska.

Water temperatures were measured to the nearest degree Celsius and water conductivity was measured in micro-mhos/cm with a YSI Model 33 S-C-T meter.

Sampling was conducted along the banks of each river. The electrofishing boat was directed downstream along each bank at a speed slightly above that of the current in order to maintain steerage of the vessel. All Arctic grayling seen were collected when possible by two technicians with dip nets located on the boat's bow platform which was equipped with a safety rail. Captured fish were immediately placed in one of two 0.6 m diameter black plastic water-filled tubs. Fish were sampled after 20-30 had been captured or after a river subsection had been fully traversed. Each electrofishing run was timed and the catch of Arctic grayling per minute of electrofishing was calculated for each run using standard normal procedures. Fish were also sampled using hook and line in all rivers, and using a 30 m x 2 m 6.5 mm mesh beach seine and a 15 m x 2 m x 12 mm mesh beach seine in tandem on the Pilgrim and Niukluk rivers.

Arctic grayling from a 40 km section of the Sinuk River (Figure 5) were sampled with hook and line during five days in early August. Access to the headwaters of the river was gained using a Bell Jet Ranger helicopter under contract to the Bureau of Land Management (BLM). The river was floated using a 3.7 m Avon Redshank inflatable raft and oars.

Each Arctic grayling was measured to the nearest mm in fork length (FL). Fish over 150 mm FL were tagged with individually numbered Floy FD-67 internal anchor tags which were inserted such that the "T" anchor locked between the base of adjacent dorsal fin rays (Appendix A1). Each fish was also marked with a partial fin clip where 5-8 mm of the extreme tip of the fin was removed (Appendix A1). Scales were taken for aging from the left side of the fish approximately midway between the dorsal fin and the lateral line down from the posterior insertion of the dorsal fin.

Data were recorded on standard ADFG Tagging-Length forms (version 1). Scales were cleaned with detergent and water, mounted on gummed cards and acetate impressions were made (30 seconds at 7,000 kg/cm^2, at 100° C). Ages were determined by counting annuli from the acetate impressions using a microfiche reader. All scale impressions were read twice by the same reader. If readings were not the same, the scale was read a third time. When two readings agreed, this was taken to be the age of the fish. If the reader could not age the fish with three readings, the age sample was discarded. Less than 1% of age samples were discarded in this manner. Regenerated scales were not aged.

Population Abundance Estimates

A modified Petersen mark-recapture experiment (Chapman 1951) was used to estimate the abundance of Arctic grayling greater than 149 mm FL in the lower 16 km of the Niukluk River, in a 24 km section of the Fish River upstream from its confluence with the Niukluk River (Figure 3) and in a 12 km section of the Pilgrim River downstream from the Beam Road bridge (Figure 4).

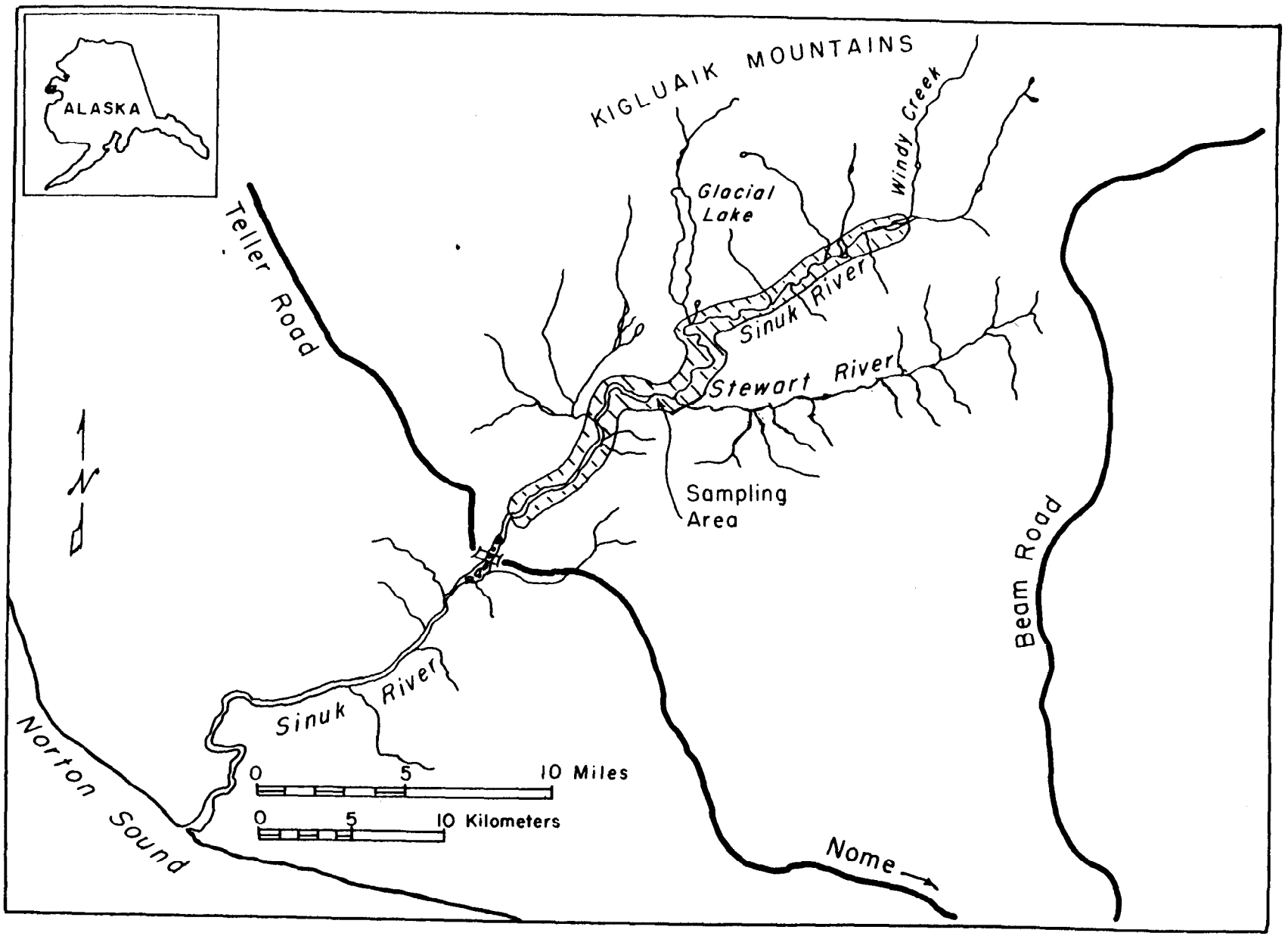


Figure 5. The Sinuk River with area sampled during 1990, Seward Peninsula, Alaska.

Sampling for the two-event population estimates was performed in each of the river sections. The entire length of each river section was sampled during both the mark and recapture events.

The assumptions necessary for the accurate estimation of abundance in a closed population are (from Seber 1982):

1. there is neither mortality nor recruitment between sampling events (closed population);

2. fish have an equal capture probability in the first event or the second event, or marked fish mix completely with unmarked fish during the second sampling event;

3. marking does not affect capture probability in the second event;

4. marks are not lost between events; and,

5. marked fish can be recognized from unmarked fish.

Assumption 1 could not be tested directly. It was assumed that neither mortality nor recruitment occurred because both events were close together in time. Assumptions 2 and 3 were tested with two Kolmogorov-Smirnov two-sample tests (Conover 1980). The first test compared the cumulative length distribution of fish marked in the first sampling event (mark event) with those marked fish recaptured during the second sampling event (recapture event). The cumulative length distribution of fish captured during the marking event were compared with that of fish captured during the recapture event in a second test (Seber 1982). If the results of the first test showed that the samples were different ($p < 0.05$), size selectivity between samples was indicated. If the results of the second test showed that the samples were different ($p < 0.05$), recruitment was indicated. Possible actions as a consequence of data analysis are presented in Appendix A2. All fish were released within the reach of the river in which they were captured. To meet conditions of assumption 4, all fish were double marked with a floy tag and an appropriate partial fin clip (Appendix A1). Partial fin clips were chosen so as to not duplicate those used on a given river in previous years. Assumption 5 was met by the close examination of all fish and by the presence of the double mark.

Population abundance and the approximate variance of the estimate were calculated with the following formulas (Seber 1982):

$$\hat{N} = \frac{(C+1)(M+1)}{(R+1)} - 1 \qquad (1)$$

$$\hat{V}[N] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \qquad (2)$$

where:

M = the number marked during the first period;

C = the number captured during the second period;

R = the number captured during the second period with marks from the first period;

$\hat{N}$ = the estimated abundance of Arctic grayling during the first sampling event, and

V = the approximate variance of the abundance estimate.

A modified Petersen estimator was originally chosen to estimate the abundance of Arctic grayling greater than 149 mm FL in the Sinuk River, with the marking event taking place in 1989 and the recapture event in 1990. The Petersen estimator is valid for multi-year experiments if either mortality or recruitment (but not both) occurs between sampling events (Seber 1982). It was assumed that some mortality occurred during the one year interval between the sampling events and that mortality rates were similar between marked and unmarked fish. To evaluate growth recruitment between the marking event and the subsequent recapture event, a nonparametric method was used (Robson and Flick 1965). Although the second Kolmogorov-Smirnov test indicated that the first and second samples were not significantly different, the Robson and Flick test suggested that there was some growth recruitment. The abundance estimate for 1989 was calculated for Arctic grayling 250 mm in fork length and greater in accordance with Seber (1982) while adjusting for growth recruitment as follows:

$$\hat{N} = (m+1)(\bar{u}_r) - 1 \text{ and,} \quad (3)$$

$$\hat{V}[N] = (m+1)^2 \, V[\bar{u}_r]; \quad (4)$$

where:

N = estimated abundance

m = number of marked fish

$\bar{u}_r$ = average number of fish in a size class for which there was no significant growth recruitment.

The value of $\bar{u}_r$ and its variance were calculated using the simple average of values of u_r and the squared deviations from the mean.

Age Composition

Samples of Arctic grayling for age composition were collected in conjunction with the abundance estimate on the Niukluk, Fish and Pilgrim rivers and during the length-at-age sampling on the Sinuk River. The multinomial proportion (Cochran 1967) of fish in each age category was estimated as:

$$\hat{p}_i = \frac{n_i}{n} \tag{5}$$

where:

n_i = the number in the sample from group i;

n = the sample size; and,

$\hat{p}_i$ = the estimated fraction of the population that is made up of group i.

The unbiased variance of this proportion was estimated as:

$$\hat{V}[p_i] = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}; \tag{6}$$

Abundance of Arctic grayling by age was estimated as follows:

$$\hat{N}_i = \hat{p}_i(\hat{N}); \tag{7}$$

where:

$\hat{N}_i$ = estimated number of fish in age category i;

$\hat{p}_i$ = estimated proportion of fish in age category i; and,

$\hat{N}$ = estimated abundance of Arctic grayling.

Variances for Equation 7 are from Goodman (1960):

$$\hat{V}[N_i] = (\hat{p}_i^2\hat{V}[N])+(\hat{N}^2\hat{V}[p_i])-(\hat{V}[p_i]\hat{V}[N]); \tag{8}$$

Length Composition

Length measurements of Arctic grayling in the Niukluk, Fish, Pilgrim and Sinuk rivers were partitioned into Relative Stock Density (RSD) categories (Gabelhouse 1984). The RSD categories for Arctic grayling are: "stock" (150

to 269 mm FL); "quality" (270 to 339 mm FL); "preferred" (340 to 449 mm FL); "memorable" (450 to 559 mm FL); and "trophy" (greater than 559 mm FL). Estimates of the proportion of fish in each RSD category followed the same procedures used for age composition (equations 5 and 6). Abundance estimates by RSD category were calculated using equations 7 and 8.

Mean Length-at-Age

Mean length-at-age was estimated by the arithmetic mean length of all fish assigned the same age. Simple averages and squared deviations from the mean were used to calculate means and variances of the means.

RESULTS

Population Abundance Estimates

Abundance estimates for Arctic grayling in the Niukluk, Fish, Pilgrim, and Sinuk rivers were germane to 1990 for all but the Sinuk River. An abundance estimate germane to 1989 was calculated for the Sinuk River.

Niukluk River:

The marking run was conducted using electrofishing gear during three days on the Niukluk River (Figure 3). After 14 days, a recapture run was conducted with electrofishing and hook and line in combination. A like number of fish were examined as were initially marked, however an insufficient number of fish were recaptured to calculate an abundance estimate. Consequently, these two events were combined as a mark event and an additional recapture event was conducted 13 days later using beach seining as the capture method. Adequate numbers of fish were examined and recaptured during this event to calculate an abundance estimate for Arctic grayling 150 mm and greater in fork length.

In the 16 km section of the Niukluk River downstream from Council (Figure 3), the estimated abundance of Arctic grayling greater than 149 mm in FL was 3,739 fish (SE = 911 fish, CV = 24.4%). A total of 219 Arctic grayling greater than 149 FL were marked during the two marking runs (6 to 8 July and 24 to 26 July). During the recapture event (8 to 10 August) 237 Arctic grayling greater than 149 mm FL were examined of which 13 had marks or tags from the marking event(s). Only one fish had shed its tag.

Kolmogorov-Smirnov two sample tests of the cumulative length distributions of Arctic grayling >149 mm FL marked versus those recaptured during the recapture event (test 1) failed to detect significant differences between samples, however a similar test of the cumulative length distributions of those fish marked versus those examined in the recapture event (test 2) did detect significant differences (test 1: $D = 0.27$, $p = 0.26$, $n_1 = 219$, $n_2 = 13$; test 2: $D = 0.21$, $p < 0.01$, $n_1 = 237$, $n_2 = 219$, Figure 6). Therefore a single unstratified abundance estimate was calculated for Arctic grayling greater than 149 mm FL and only fish from the second sampling event were used for age and length composition estimates (Appendix A2).

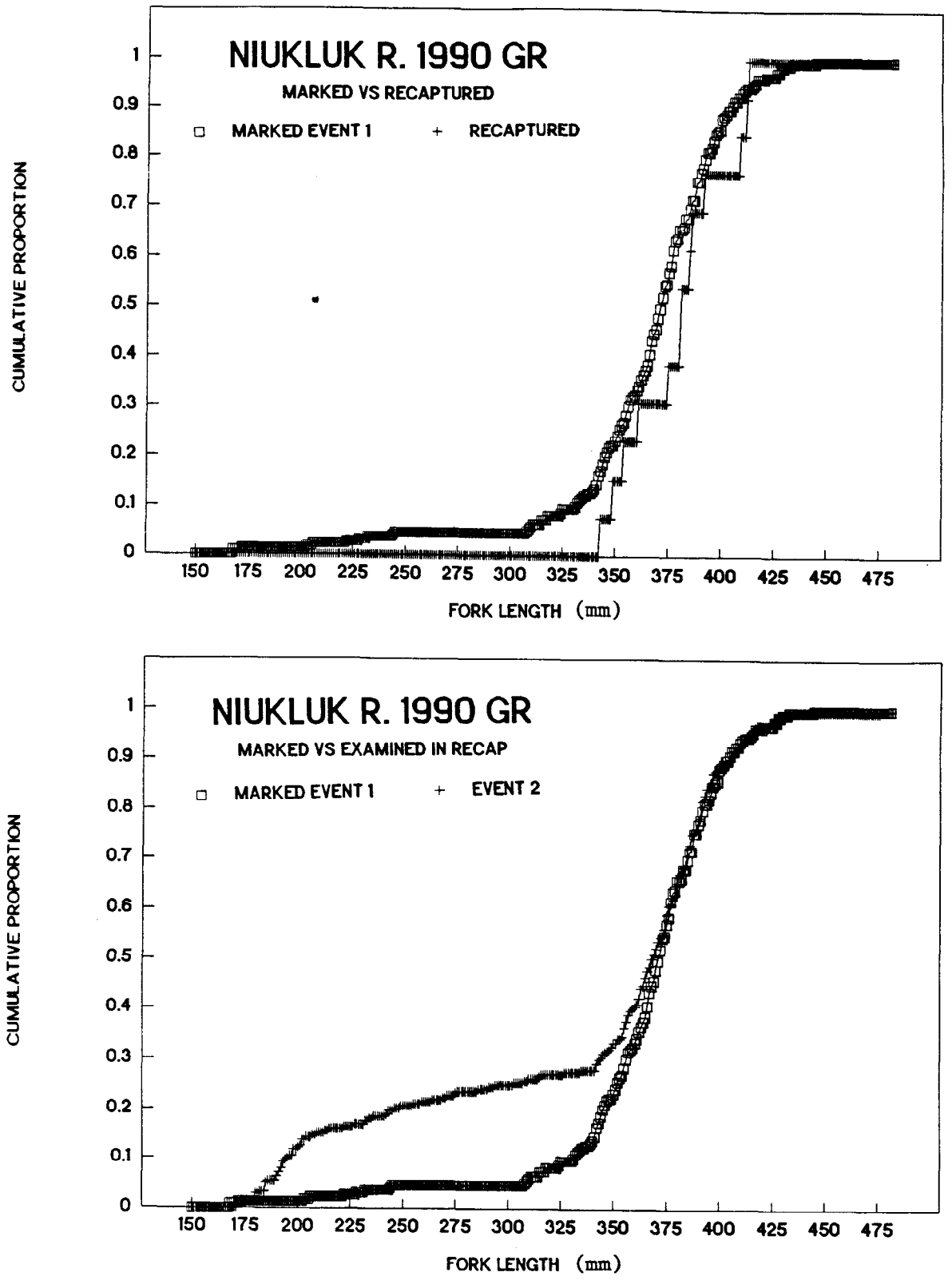


Figure 6. Cumulative length distribution plots, Kolmogorov -Smirnov test 1 (top) and test 2 (bottom), of Arctic grayling ≥ 150 mm FL sampled from the Niukluk River during 1990, Seward Peninsula, Alaska.

During 400 minutes of electrofishing, 105 Arctic grayling were captured or 0.26 fish per minute of fishing. Electrofishing catches by run ranged from 0.00 fish per minute to 0.45 fish per minute. Water temperatures in the Niukluk River ranged from 11.5° C to 15° C and conductivities ranged from 112 to 190 micromhos/cm (Appendix A3). Clear water in the Niukluk River reduced the effectiveness of electrofishing. Arctic grayling were often observed swimming around the approaching boat thus avoiding the electrical field.

Contingency table analysis was used to compare the sizes of Arctic grayling captured using electrofishing, beach seine and hook and line. The size distributions of catches were significantly different ($\chi^2 = 98.93$, df = 10, $p < 0.01$). Most of the difference was in fish of less than 300 mm FL. For Arctic grayling greater than 299 mm FL no significant differences were detected between the three capture methods ($\chi^2 = 9.32$, df = 4, $p > 0.95$).

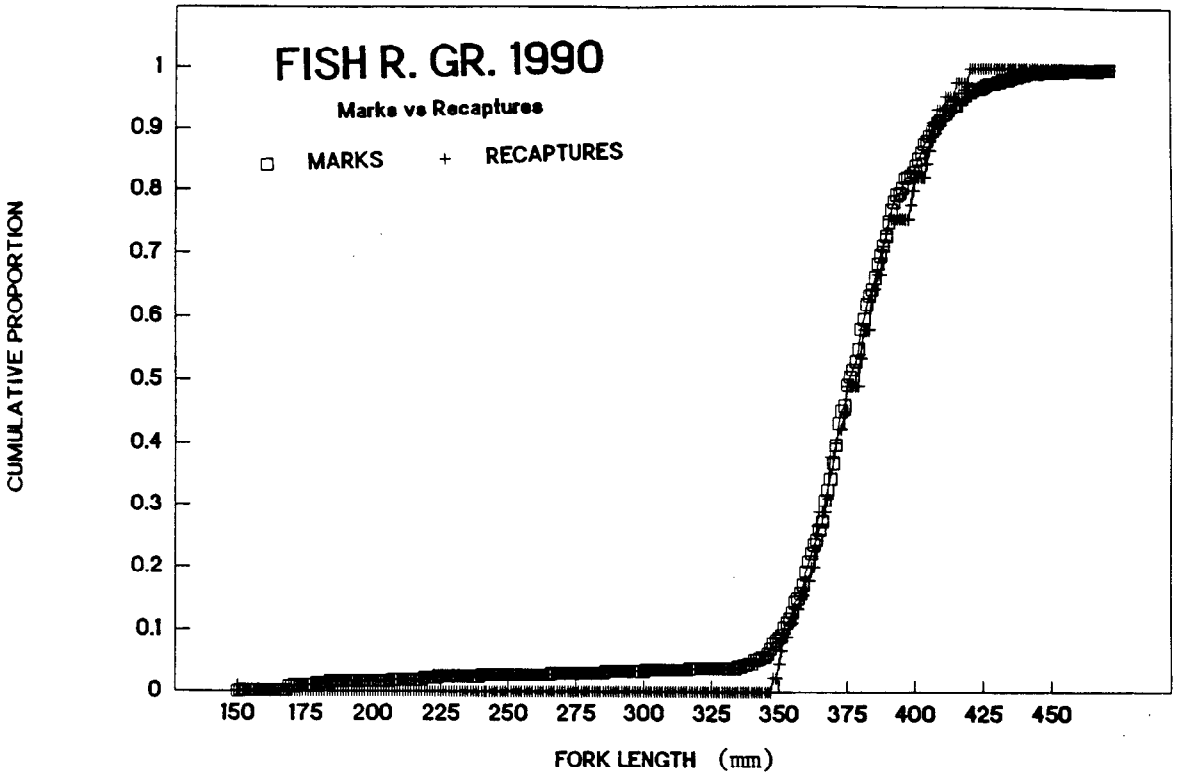
Fish River:

Both the mark and recapture runs on the Fish River (Figure 3) were conducted during four day periods in July with a five day hiatus between events. A combination of electrofishing and hook and line was used to sample Arctic grayling. The two capture methods complimented each other well on this river and good coverage of the river section was obtained during both events under varying water conditions. When water was low and clear, electrofishing was only moderately successful but hook and line was very effective. When water was high and turbid, electrofishing was very successful but hook and line capture rates were low. Like numbers of fish were examined during both events and an adequate number of marked fish were recaptured to calculate an abundance estimate for Arctic grayling 150 mm and greater in fork length.

In the 24 km section of the Fish River upstream from its confluence with the Niukluk River (Figure 3), the estimated abundance of Arctic grayling greater than 149 mm in fork length was 2,909 fish (SE = 371 fish, CV = 12.7%). A total of 375 Arctic grayling greater than 149 mm FL were marked during the first event (10 to 13 July). During the recapture event (20 to 22 July) 355 Arctic grayling greater than 149 mm FL were examined of which 45 had tags from the marking event. No tag loss was detected.

Kolmogorov-Smirnov two sample tests of the cumulative length distributions of Arctic grayling greater than 149 mm FL marked versus those recaptured during the recapture event (test 1) and of those captured during the mark event versus those examined in the recapture event (test 2) failed to detect significant differences (test 1: D = 0.07, $p = 0.98$, $n_1 = 373$, $n_2 = 45$; test 2: D = 0.09, $p = 0.08$, $n_1 = 373$, $n_2 = 354$, Figure 7). Therefore a single unstratified abundance estimate was calculated for Arctic grayling greater than 149 mm FL, and both samples were combined for age and length composition estimates (Appendix A2).

During 841 minutes of electrofishing, 388 Arctic grayling were captured or 0.46 fish per minute of fishing. Electrofishing catches by run ranged from 0.00 fish per minute to 1.23 fish per minute. Water temperatures in the Fish River ranged from 11° C to 15.5° C and conductivities ranged from 90 to 155 micromhos/cm (Appendix A3). Clear water in the Fish River during part of the



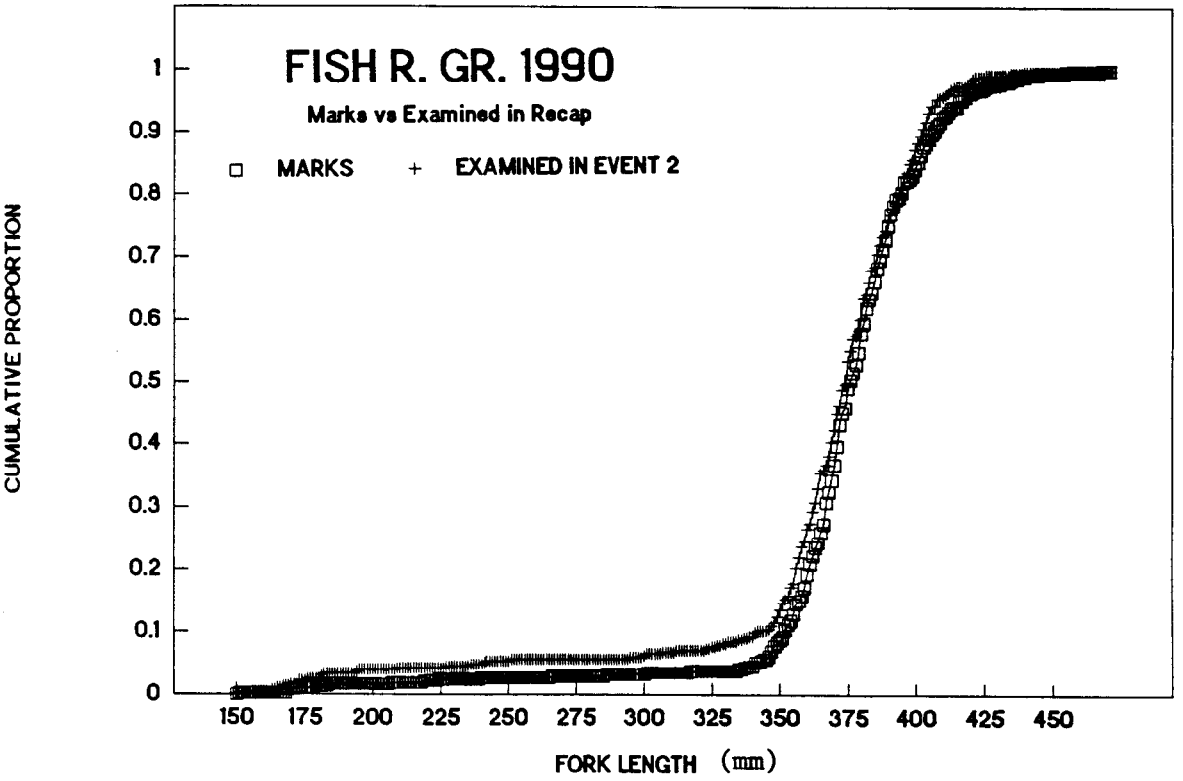


Figure 7. Cumulative length distribution plots, Kolmogorov -Smirnov test 1 (top) and test 2 (bottom), of Arctic grayling ≥ 150 mm FL sampled from the Fish River during 1990, Seward Peninsula, Alaska.

sampling reduced the effectiveness of electrofishing. Catch rates were higher during 108 minutes (90 fish captured) of electrofishing under high, turbid water conditions in the recapture event than under clear water conditions in the same section of the river during the mark event, (111 minutes and 47 fish captured). During 138 minutes of electrofishing under clear water conditions in one section of the river, 24 Arctic grayling were captured and an additional 140 were observed but not captured or stunned because they avoided the boat and the electrical field.

Contingency table analysis detected significant differences between the size distribution (fish grouped in 50 mm fork length increments) of Arctic grayling captured in the Fish River by electrofishing and hook and line ($\chi^2 = 17.85$, df = 6, $p < 0.01$). However, when fish smaller than 200 mm FL were eliminated from the sample, contingency table analysis failed to detect a difference in the size distributions between the two capture methods ($\chi^2 = 3.65$, df = 5, $p > 0.95$).

Pilgrim River:

The mark run on the Pilgrim River (Figure 4) was conducted during a three day period in August using electrofishing, beach seine and hook and line. Electrofishing success was poor and most of the sample was captured with the combination of beach seine and hook and line. The recapture event was conducted during a three day period after a four day hiatus. Beach seine and hook and line were used in combination to capture fish. Fishing success was lower than during the mark event, but enough fish were examined and recaptured to calculate an abundance estimate for Arctic grayling 150 mm and greater in fork length.

In the 12 km section of the Pilgrim River downstream from the Beam Road bridge (Figure 4), the estimated abundance of Arctic grayling greater than 149 mm in fork length was 1,764 fish (SE = 428 fish, CV = 24.2%). A total of 224 Arctic grayling greater than 149 mm FL were marked during the first event (14 to 17 August). During the recapture event (21 to 24 August) 101 Arctic grayling were examined of which 12 had tags from the marking event. No tag loss was detected.

Kolmogorov-Smirnov two sample tests of the cumulative length distributions of Arctic grayling greater than 149 mm FL marked versus those recaptured during the recapture event (test 1) failed to detect significant differences, however, a similar test of the cumulative length distributions of Arctic grayling marked in first event and of those examined in the second event (test 2) did detect significant differences (test 1: $D = 0.34$, $p = 0.11$, $n_1 = 224$, $n_2 = 12$; test 2: $D = 0.20$, $p = <0.01$, $n_1 = 224$, $n_2 = 101$, Figure 8). Therefore a single unstratified abundance estimate was calculated for Arctic grayling greater than 149 mm FL and only the fish from the second sample were used to estimate age and length composition (Appendix A2).

During one 90 minute pass through the section along alternating banks with the electrofishing boat only 11 Arctic grayling were captured while nine seine hauls averaged 5.2 Arctic grayling per haul. Therefore, after the first attempt at electrofishing, this method was abandoned in favor of a combination

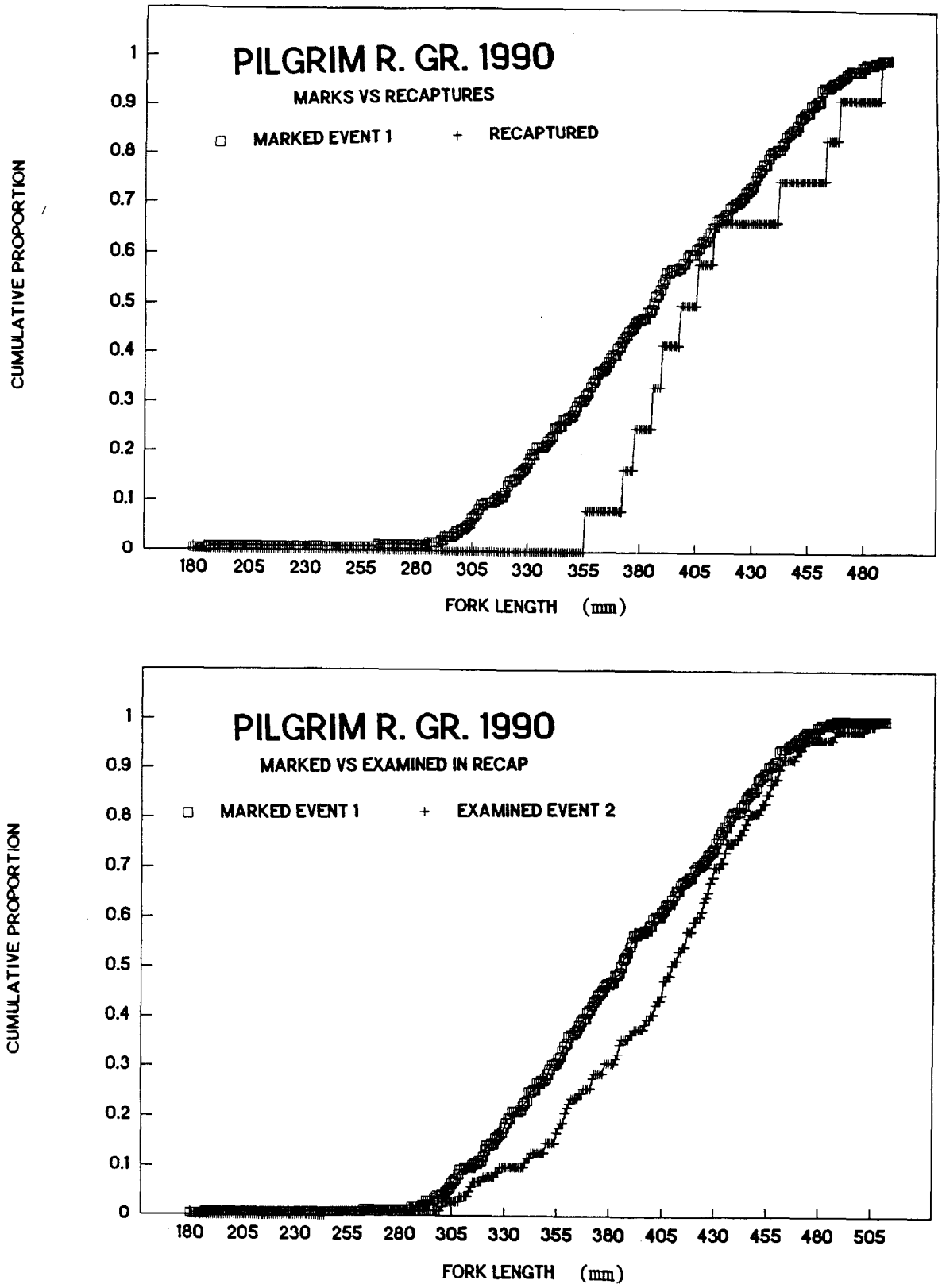


Figure 8. Cumulative length distribution plots, Kolmogorov - Smirnov test 1 (top) and test 2 (bottom), of Arctic grayling ≥ 150 mm FL sampled from the Pilgrim River during 1990, Seward Peninsula, Alaska.

of beach seining and hook and line. The sampling section was shortened from a planned 16 km because favorable habitat extended only 12 km downstream from the bridge and boat travel upstream of the bridge was impossible.

Contingency table analysis failed to detect any differences in the size distribution of Arctic grayling greater than 149 mm FL captured by beach seine and hook and line in the Pilgrim River ($\chi^2 = 2.76$, df = 5, $p > 0.95$).

Sinuk River:

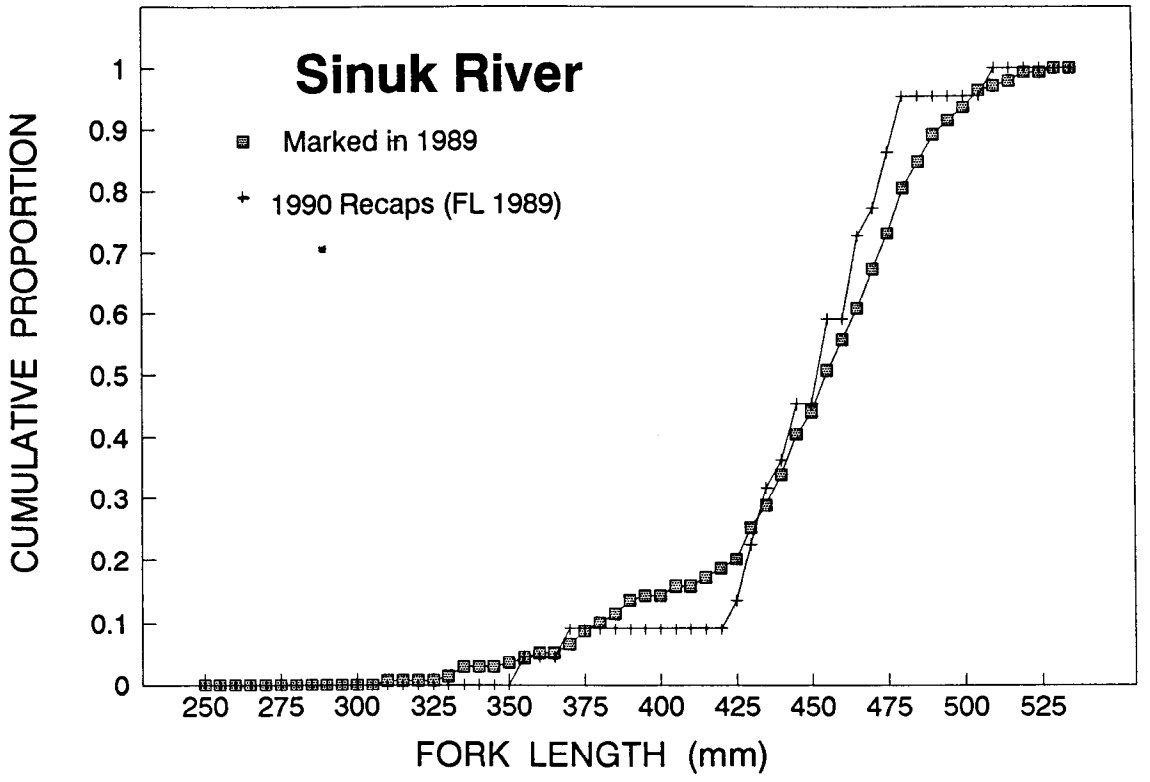
The Sinuk River (Figure 5) was floated during five days in August in order to increase the sample size for length-at-age data collected during 1989. Arctic grayling were sampled using hook and line and enough marked fish from 1989 were recaptured to calculate a multi-year Petersen estimate of abundance for this river.

The abundance of Arctic grayling greater than 249 mm FL in a 40 km section of the Sinuk River (Figure 5) in 1989, estimated from data collected during 1989 and 1990, was 1,120 fish (SE = 264, CV = 23.6 %). During the mark event in 1989, 138 tagged Arctic grayling were released in the Sinuk River. During 1990, 236 Arctic grayling were examined, of which 22 were marked in 1989. No evidence of tag loss was observed. A section of the Sinuk River downstream of the area used for the abundance estimate was also sampled during 1990. Only eight Arctic grayling were captured, none of which had been tagged in 1989, providing no evidence that fish moved downstream out of the sampling area between years.

Kolmogorov-Smirnov two sample tests of the cumulative length distributions of Arctic grayling tagged in 1989 with those recaptured in 1990 (FL in 1989; test 1) failed to detect significant differences (D = 0.17, $p = 0.59$, $n_1 = 138$, $n_2 = 22$, Figure 9) indicating that there was no size selectivity between events. A similar test of the cumulative length distributions of Arctic grayling marked in 1989 and those examined during the recapture event in 1990 (test 2) failed to detect a significant difference between these samples (D = 0.14, $p = 0.06$, $n_1 = 138$, $n_2 = 236$, Figure 9). Since it is likely that growth recruitment occurred, it was adjusted using the methods of Robson and Flick (1965; Appendix A4), and the abundance estimate was calculated in accordance with Seber (1982).

Age Composition

Although Arctic grayling sampled during 1990 ranged in age from 1 year on the Fish River to 13 years on the Pilgrim and Sinuk rivers, estimates of age composition and abundance by age class were restricted to fish larger than 149 mm FL on all rivers except the Sinuk River where only fish greater than 249 mm FL are included (Table 2). Estimates of age composition were significantly different among rivers ($\chi^2 = 240.52$, df = 20, $p = <0.001$). Age 7 and 8 fish dominated the estimates in both the Fish and Niukluk rivers (72% and 57% respectively). Age 6 and 7 fish dominated in the Sinuk River (59%) during 1989 (Figure 10). The oldest Arctic grayling sampled during 1990 were age 10 in the Niukluk and Fish rivers and age 13 in the Pilgrim and Sinuk rivers.



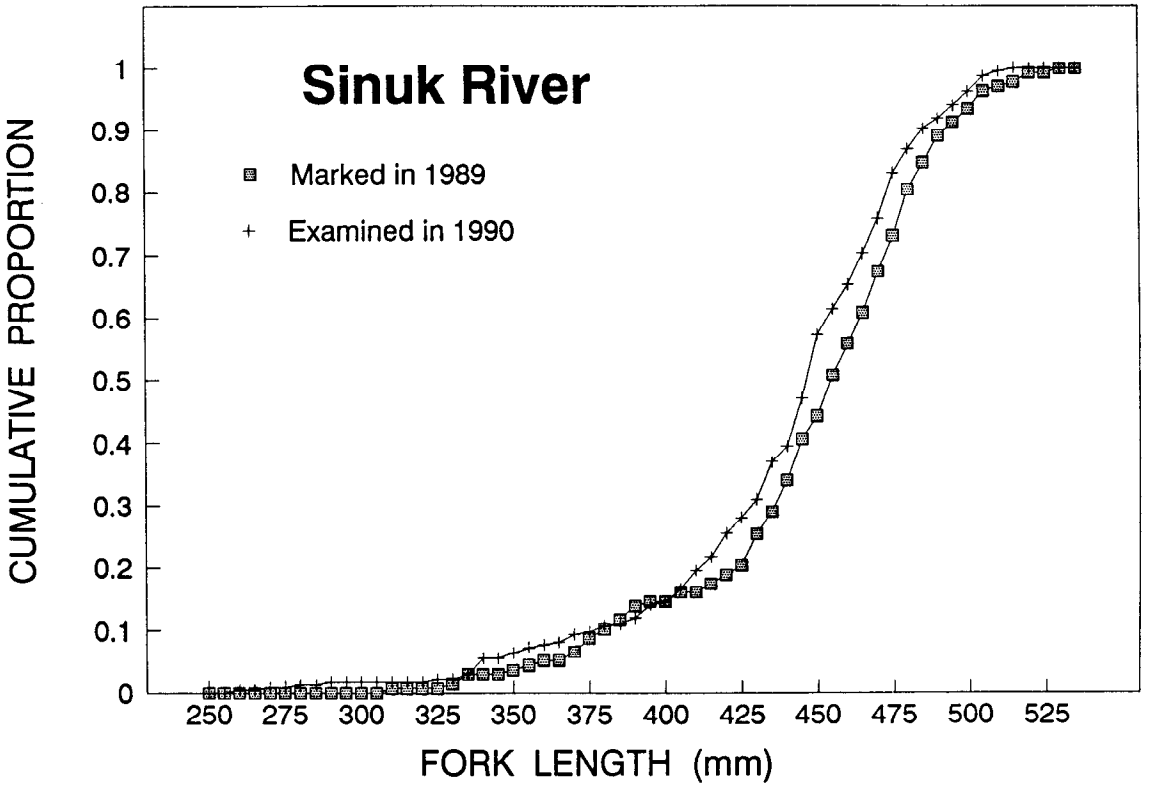


Figure 9. Cumulative length distributions plots, Kolmogorov - Smirnov test 1 (top) and test 2 (bottom), of Arctic grayling sampled from the Sinuk River during 1989 and 1990, Seward Peninsula, Alaska.

Table 2. Estimates of age composition and abundance of Arctic grayling ≥ 150 mm from the Niukluk, Fish, and Pilgrim rivers in 1990 and of Arctic grayling ≥ 250 mm from the Sinuk River in 1989, Seward Peninsula, Alaska.

	Age												
	2	3	4	5	6	7	8	9	10	11	12	13	Totals
Niukluk R.[a]													
n[b]	8	37	14	5	15	72	52	14	2	0	0	0	219
P[c]	0.04	0.17	0.06	0.02	0.07	0.33	0.24	0.06	<0.01	0.00	0.00	0.00	1.00
SE[d]	0.01	0.03	0.02	0.01	0.02	0.03	0.03	0.02	<0.01	0.00	0.00	0.00	
Abundance[e]	137	632	239	85	256	1,229	888	239	34	0	0	0	3,739
SE[f]	57	179	84	42	88	321	240	84	25	0	0	0	911
Fish R.													
n	15	6	8	15	100	274	172	22	4	0	0	0	616
P	0.02	<0.01	0.01	0.02	0.16	0.44	0.28	0.04	<0.01	0.00	0.00	0.00	1.00
SE	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.02	<0.01	<0.01	0.00	0.00	0.00	
Abundance	71	28	38	71	472	1,294	812	104	19	0	0	0	2,909
SE	20	12	14	20	74	175	116	25	10	0	0	0	371
Pilgrim R.[a]													
N	0	1	1	7	15	22	21	18	4	1	1	0	91
P	0.00	0.01	0.01	0.08	0.12	0.29	0.25	0.19	0.04	0.01	0.01	0.01	1.00
SE	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.03	0.02	0.01	0.01	0.01	
Abundance	0	19	19	136	291	426	407	349	78	19	19	0	1,764
SE	0	19	19	58	97	129	125	111	41	19	19	0	428
Sinuk R.													
n	0	0	3	5	39	40	36	3	5	3	0	0	134
P	0.00	0.00	0.02	0.04	0.29	0.30	0.27	0.02	0.04	0.02	0.00	0.00	1.00
SE	0.00	0.00	0.01	0.02	0.04	0.04	0.04	0.01	0.02	0.01	0.00	0.00	
Abundance	0	0	25	42	326	334	301	25	42	25	0	0	1,120
SE	0	0	15	20	88	90	82	15	20	15	0	0	264

[a] Includes fish from the second sampling event only.
[b] The sample size.
[c] The estimated proportion of Arctic grayling in the age class.
[d] Standard error of the proportion.
[e] Estimated abundance in that river section by age class.
[f] Standard error of the abundance estimate.

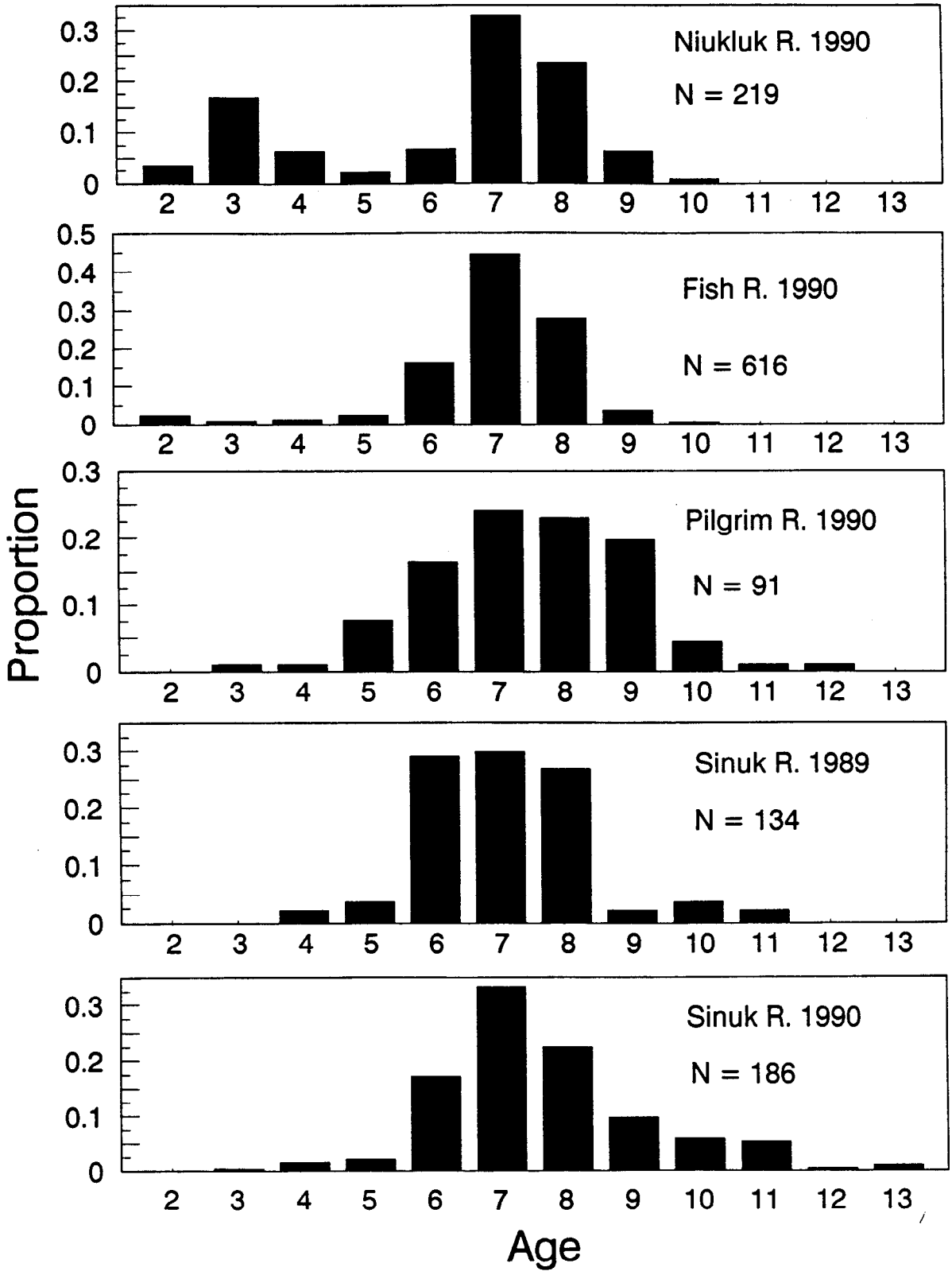


Figure 10. Age composition estimates of Arctic grayling from the Niukluk, Fish and Pilgrim rivers in 1990, and the Sinuk River in 1989, Seward Peninsula, Alaska. The Sinuk River 1990 plot is sample data and not an estimate of age composition.

Length Composition

Length composition of Arctic grayling stocks sampled within the study area was partitioned into Relative Stock Density categories (Figure 11). The majority of Arctic grayling sampled in all rivers were in the preferred or memorable categories (Table 3). Arctic grayling in the preferred category made up 72%, 92%, and 71% of the respective size compositions in the Niukluk, Fish, and Pilgrim rivers in 1990. Memorable fish were weakly represented in the Niukluk and Fish rivers (<1%), and moderately represented in the Pilgrim River (18%). No fish in the trophy category were encountered in any river. Few fish of stock size and smaller were sampled except in the Niukluk River where they comprised 22% of the composition estimate.

The Arctic grayling sample from the Sinuk River during 1989 was composed primarily of memorable fish (58%). In 1990, the sample was composed of <1% stock, 4% quality, 50% preferred, and 45% memorable fish. These percentages are most likely biased high except for the stock category which is likely biased low because no fish ≤ 250 mm were sampled.

Examination of the size distribution of all Arctic grayling sampled (Figures 12 and 13) shows that the majority of these fish represent limited length ranges by river. In the Niukluk and Fish rivers 59% and 74% were between 351 and 400 mm FL, respectively (Table 4). Arctic grayling in Sinuk River were larger, with 54% between 426 and 475 mm FL. Arctic grayling in the Pilgrim River ranged between 326 and 475 mm FL (Table 3).

Mean Length-at-Age

Estimates of mean fork length-at-age were calculated for Arctic grayling sampled from the Niukluk, Fish, Pilgrim and Sinuk rivers. Arctic grayling in the Sinuk River appeared to be larger at all age classes than in other Seward Peninsula rivers, however there was little difference in mean length-at-age between the Sinuk and Pilgrim rivers at ages greater than eight years (Table 5). Arctic grayling from the Fish and Niukluk rivers were similar in mean length at all age classes except age five. Increase in mean fork length of Arctic grayling in the Niukluk and Fish rivers was rapid to age 6 slowing with the probable onset of sexual maturity. Increase in mean fork length in the Sinuk River was very rapid through age 7, the probable age at first maturity for that river. Mean fork length-at-age of Arctic grayling on the Pilgrim River was similar to that observed for fish in the Fish and Niukluk rivers through age 7, but older age classes were present, and fork length continued to increase through age 9. Samples of Arctic grayling from both the Sinuk and Pilgrim rivers contained fish of greater maximum age and length than those from the Fish or Niukluk rivers. Age and length distributions of Arctic grayling sampled are provided in Appendices A5 through A8.

DISCUSSION

Equal probability of capture for fish of different sizes occurred in both the mark and recapture events in the Fish and Sinuk rivers, so both samples were

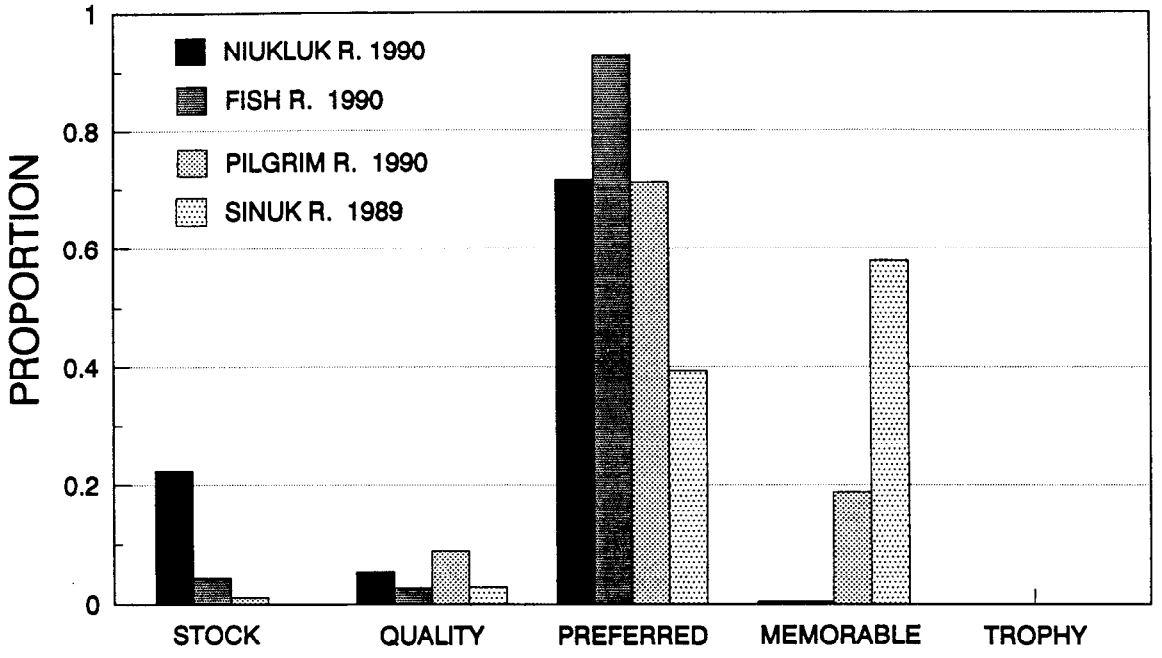


Figure 11. Length composition estimates, as Relative Stock Density categories, for Arctic grayling from the Niukluk, Fish, and Pilgrim rivers in 1990 and the Sinuk River in 1989, Seward Peninsula, Alaska. The Relative Stock Density categories (Gabelhouse 1984) for Arctic grayling are: "stock" (150 to 269 mm FL); "quality" (270 to 339 mm FL); "preferred" (340 to 449 mm FL); "memorable (450 to 559 mm FL), and "trophy" (greater than 559 mm FL).

Table 3. Number and proportion of Arctic grayling (≥ 150 mm FL) sampled and estimated abundances by RSD category in the Niukluk, Fish, and Pilgrim rivers during 1990, Seward Peninsula, Alaska. Information for Arctic grayling ≥ 250 mm from the Sinuk River in 1989 is also presented.[a]

	RSD Category[b]				
	Stock	Quality	Preferred	Memorable	Trophy
Niukluk River[c]					
Number sampled	53	13	170	1	0
RSD	0.22	0.05	0.72	<0.01	0.00
Standard Error	0.03	0.01	0.03	<0.01	0.00
Abundance	836	205	2,682	16	0
Standard Error	226	73	662	16	0
Fish River[d]					
Number sampled	31	19	674	3	0
RSD	0.04	0.03	0.93	<0.01	0.00
Standard Error	<0.01	<0.01	<0.01	<0.01	0.00
Abundance	124	76	2,697	12	0
Standard Error	27	20	345	7	0
Pilgrim River[e]					
Number sampled	1	9	72	19	0
RSD	<0.01	0.09	0.71	0.19	0
Standard Error	<0.01	0.03	0.05	0.04	0
Abundance	17	157	1,258	332	0
Standard Error	17	62	315	105	0
Sinuk River					
Number sampled	0	4	57	84	0
RSD	0.00	0.03	0.39	0.58	0.00
Standard Error	0.00	0.01	0.04	0.04	0.00
Abundance	0	31	440	649	0
Standard Error	0	17	113	159	0

[a] RSD percentages for the Sinuk River are likely biased high except for the stock category which is likely biased low because no fish ≤ 250 mm FL were sampled.

[b] Minimum lengths for RSD categories (Gabelhouse 1984) are: Stock 150 mm FL; Quality - 270 mm FL; Preferred - 340 mm FL; Memorable - 450 mm FL; and, Trophy - 560 mm FL.

[c] Includes fish from the second sampling event only.

[d] Includes fish from both sampling events.

[e] Includes fish from the second sampling event only.

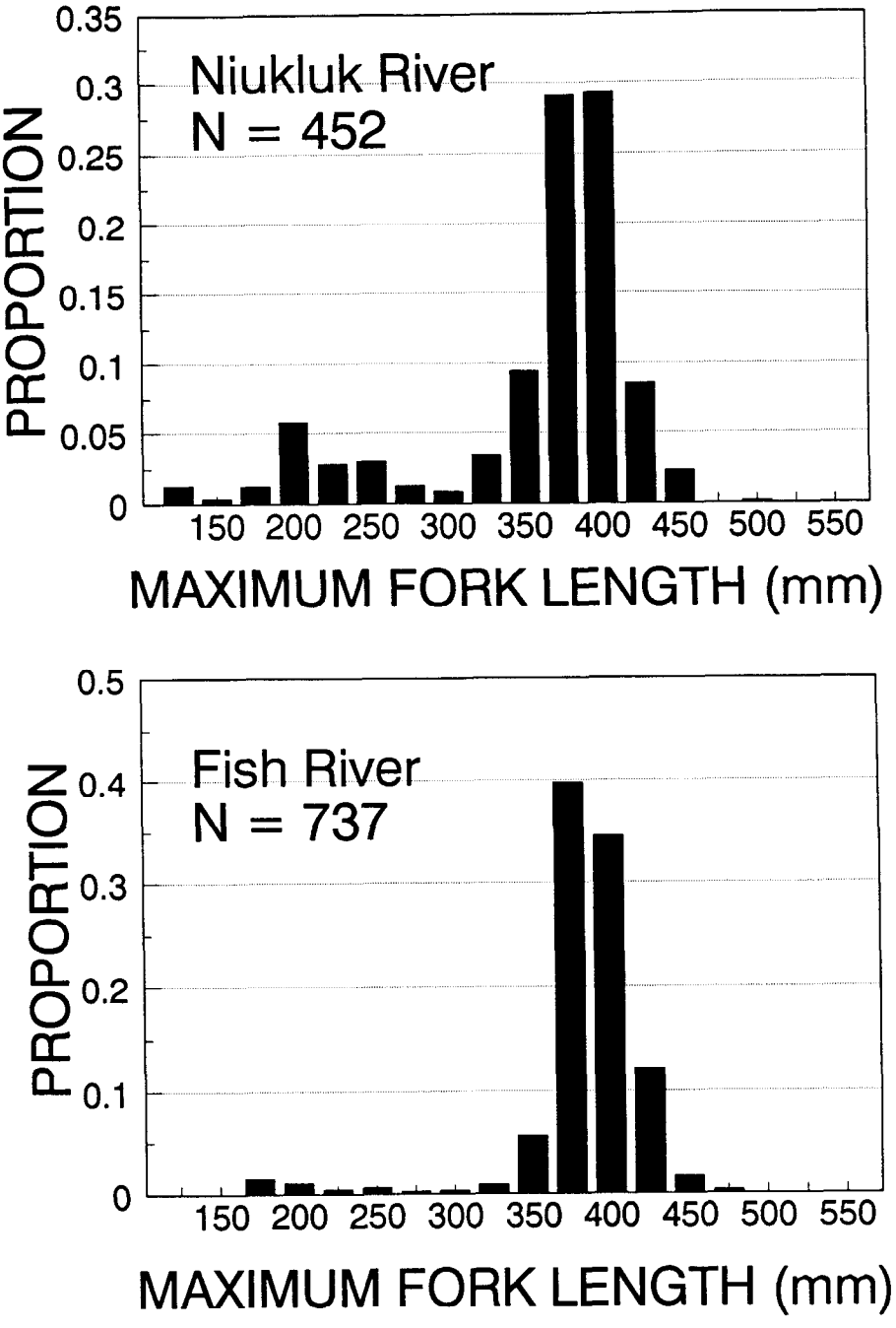


Figure 12. Length frequency distribution of Arctic grayling sampled from the Niukluk and Fish rivers during 1990, Seward Peninsula, Alaska.

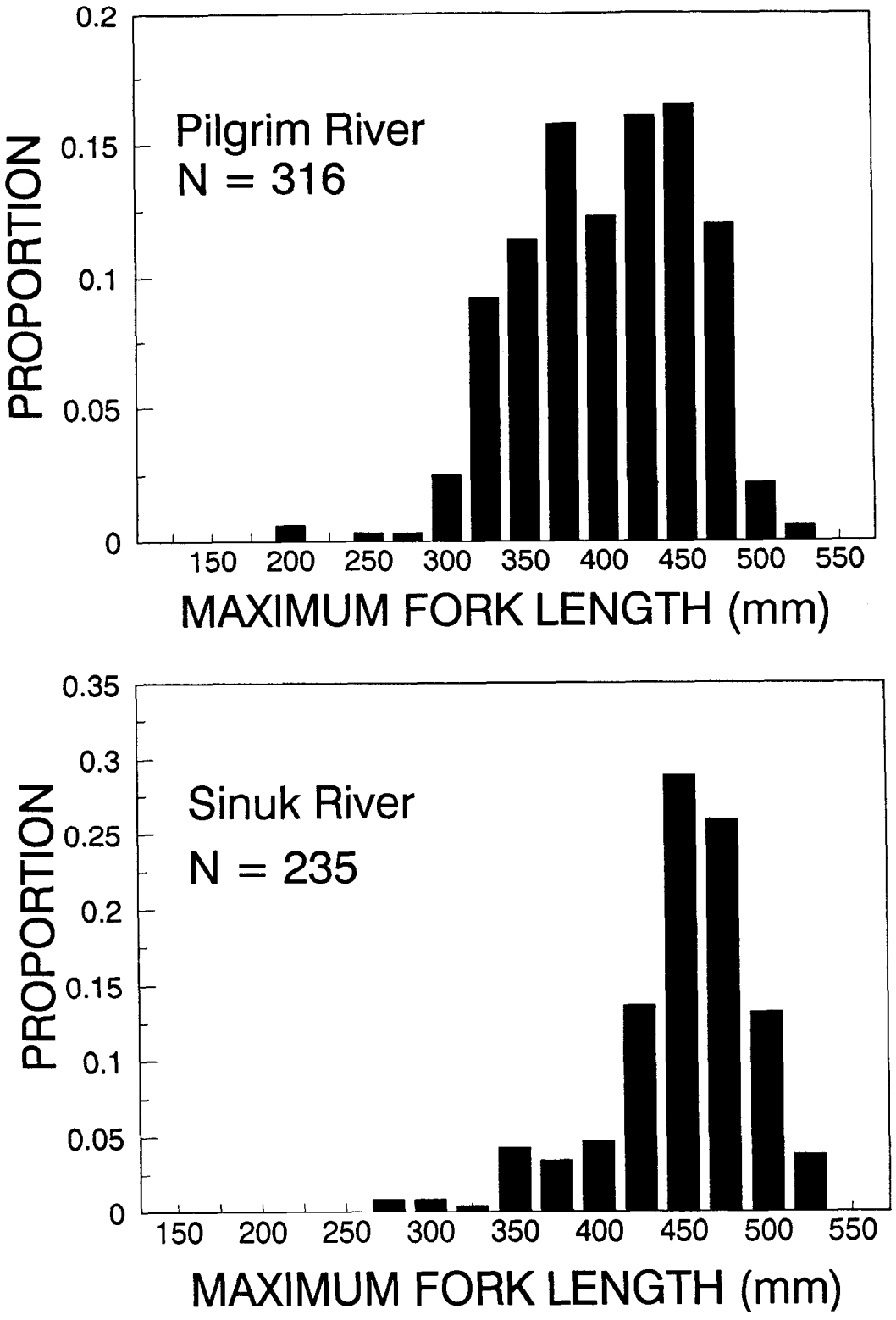


Figure 13. Length frequency distribution of Arctic grayling sampled from the Pilgrim and Sinuk rivers during 1990, Seward Peninsula, Alaska.

Table 4. Length composition of Arctic grayling sampled from the Niukluk, Fish, Pilgrim and Sinuk rivers during 1990 by 25 mm increments, Seward Peninsula, Alaska.

Fork Length Range (mm)	Niukluk River			Fish River		
	N[a]	P[b]	SE[c]	N	P	SE
101 - 125	6	0.013	0.005	0	0.000	0.000
126 - 150	2	0.004	0.003	1	0.001	0.001
151 - 175	6	0.013	0.005	12	0.016	0.005
176 - 200	26	0.058	0.011	8	0.011	0.004
201 - 225	13	0.029	0.008	4	0.005	0.003
226 - 250	14	0.031	0.008	5	0.007	0.003
251 - 275	6	0.013	0.005	2	0.003	0.002
276 - 300	4	0.009	0.004	3	0.004	0.002
301 - 325	16	0.035	0.009	7	0.009	0.004
326 - 350	43	0.095	0.014	42	0.057	0.009
351 - 375	132	0.292	0.021	293	0.398	0.018
376 - 400	133	0.294	0.021	255	0.346	0.018
401 - 425	39	0.086	0.013	89	0.121	0.012
426 - 450	11	0.024	0.007	13	0.018	0.005
451 - 475	0	0.000	0.000	3	0.004	0.002
476 - 500	1	0.002	0.002	0	0.000	0.000
Total 101 - 500	452	1.000		737	1.000	

Fork Length Range (mm)	Pilgrim River			Sinuk River		
	N	P	SE	N	P	SE
151 - 175	0	0.000	0.000	0	0.000	0.000
176 - 200	2	0.006	0.004	0	0.000	0.000
201 - 225	0	0.000	0.000	0	0.000	0.000
226 - 250	1	0.003	0.003	0	0.000	0.000
251 - 275	1	0.003	0.003	2	0.009	0.009
276 - 300	8	0.025	0.009	2	0.009	0.009
301 - 325	29	0.092	0.016	1	0.004	0.004
326 - 350	36	0.114	0.018	10	0.043	0.067
351 - 375	50	0.158	0.021	8	0.034	0.069
376 - 400	39	0.123	0.019	11	0.047	0.067
401 - 425	51	0.161	0.021	32	0.136	0.062
426 - 450	52	0.165	0.021	68	0.289	0.055
451 - 475	38	0.120	0.018	61	0.260	0.057
476 - 500	7	0.022	0.008	31	0.132	0.062
501 - 525	2	0.006	0.004	9	0.038	0.068
526 - 550	0	0.000	0.000	0	0.000	0.000
Total 151 - 550	316	1.000		235	1.000	

[a] Number of fish in fork length range.
[b] Estimated proportion of fish in fork length range.
[c] Standard error of the proportion.

Table 5. Mean fork length-at-age of Arctic grayling sampled in Seward Peninsula rivers during 1990, Alaska.

Age	Niukluk River			Fish River			Pilgrim River			Sinuk River[d]		
	n[a]	FL[b]	SD[c]	n	FL	SD	n	FL	SD	n	FL	SD
1	---	---	---	1	92	0	---	---	---	---	---	---
2	10	131	22	16	167	12	---	---	---	---	---	---
3	45	200	20	6	209	25	4	230	58	1	260	0
4	17	261	33	8	254	34	5	299	9	3	318	33
5	6	295	20	15	344	31	24	327	34	4	356	46
6	47	368	34	100	377	20	54	355	44	32	408	45
7	149	373	24	274	380	17	78	380	35	62	445	26
8	111	379	21	172	379	26	60	410	31	42	456	26
9	22	381	23	22	375	28	45	439	20	18	455	30
10	2	384	13	4	386	18	22	442	33	11	449	23
11	---	---	---	---	---	---	7	447	45	10	482	24
12	---	---	---	---	---	---	3	456	9	1	485	0
13	---	---	---	---	---	---	1	445	0	2	477	30

[a] n is the number of fish of this age class.
[b] FL is the arithmetic mean fork length in millimeters.
[c] SD is the standard error of FL in millimeters.
[d] Sinuk River includes samples from 1989 and 1990.

used in the estimation of age and size compositions. Detection of size selectivity occurred during the first sampling events in the Niukluk and Pilgrim rivers, however not in the second event, so only age and sizes from the second event were used to estimate age and size compositions. This treatment of the data corrects for detectable bias. All sampling (except that on the Sinuk River) used a combination of gears: electrofishing, beach seine and hook and line. These gear combinations increased the chances of representative sampling of fish. The relative lack of small sized Arctic grayling in samples suggests that small fish may occupy different areas and habitats than were sampled.

Abundance estimates for the Niukluk, Fish, and Pilgrim rivers may be biased high because no small fish (< 340 mm FL) were recaptured with tags. It is thought that this bias is not great, because few small fish were present in the sample sections. The continuation of sampling in the same areas will probably result in data with similar length distributions as were observed in 1990 and 1989 (DeCicco 1990). Determining sampling areas which are representative of the Arctic grayling population in any single river would likely require one or more seasons of exploratory sampling. Young age classes of Arctic grayling were found in greatest abundance in the lower reaches of the Chena River (Tack 1980). At this time it is probably in the Division's best interest to collect comparative data on additional rivers to increase the overall knowledge of Arctic grayling stocks in the Nome area. In addition, more intensive work on a single system may be necessary to adequately describe younger age classes and follow the recruitment process through the population. Abundance estimates and length compositions of fish contained in this report are relevant only for the river sections sampled and should not be construed as representing the entire Arctic grayling populations in these rivers. The river sections were chosen for their relative ease of access and because these areas are where most of the sport angling occurs.

As in 1989 (DeCicco 1990) the use of electrofishing as a capture technique for Arctic grayling in the clear waters of the Seward Peninsula met with mixed results. When water levels were elevated and water slightly turbid, catches were good, however when water levels were down and the water clear, many fish were observed moving around the boat outside the effective range of the electrical field and catch rates were low. Arctic grayling mortality due to electrofishing was very low (one fish), however some other species were not as tolerant of the electrical field. Anadromous Dolly Varden appeared to be very susceptible to electrofishing injury. Several dead Dolly Varden were collected from the Fish River the day after electrofishing the section. Upon examination, all had ruptured vertebrae and/or hemorrhaging along the vertebral column consistent with injuries associated with electrofishing (Holmes *et al.* 1990). Future use of electrofishing to sample Arctic grayling in rivers which seasonally contain anadromous Dolly Varden should be timed to minimize overlap with Dolly Varden movements.

Arctic grayling in all Seward Peninsula streams sampled were larger at a given age than those from the Chena River (Clark 1990) in interior Alaska (Figure 14). Age 7 and 8 Arctic grayling dominated samples from the Fish and Niukluk rivers in 1990. During 1989, age 6 and 7 fish were most strongly represented on the Niukluk River (DeCicco 1990). These data suggest that two strong year

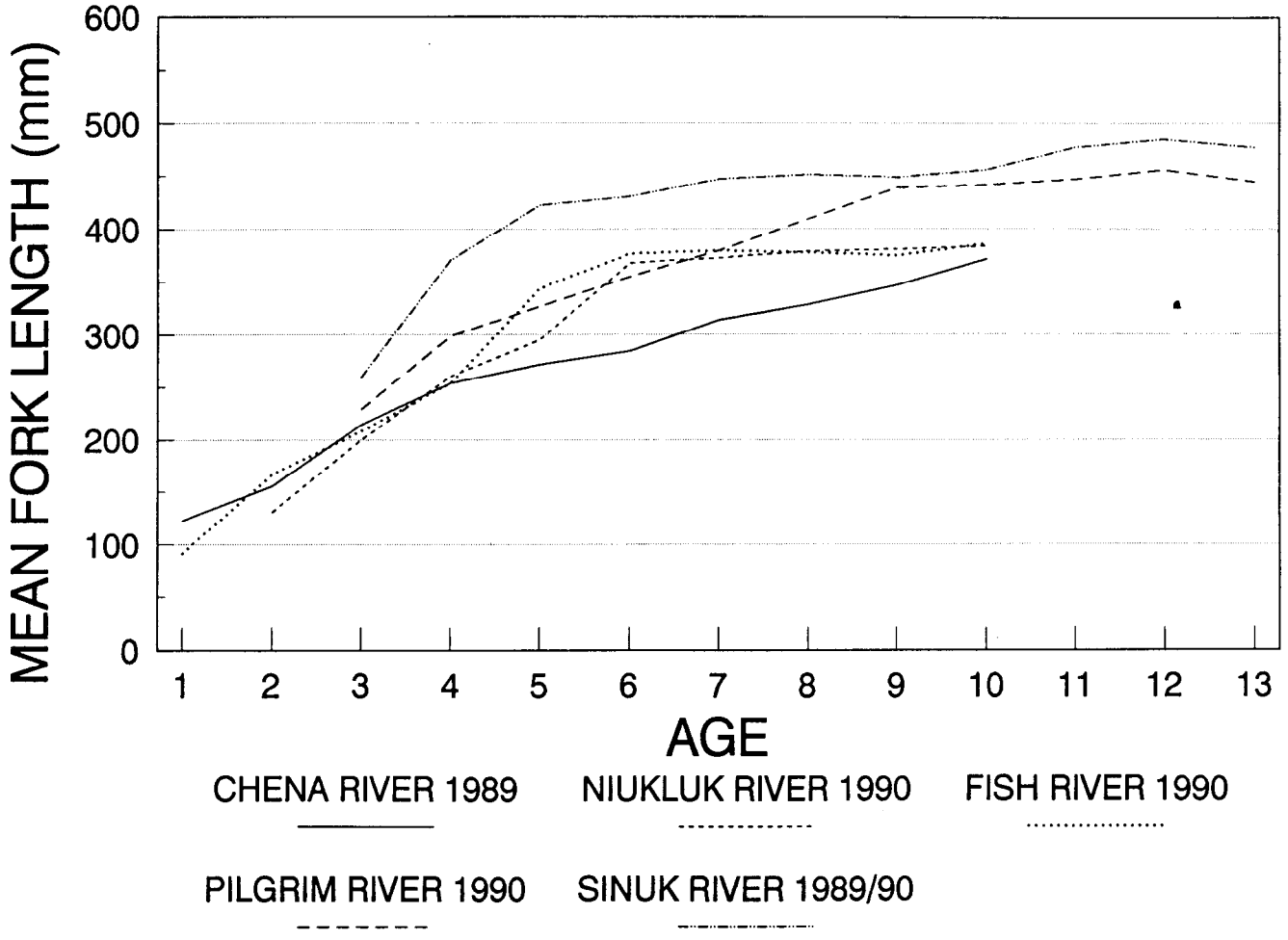


Figure 14. Mean fork length-at-age of Arctic grayling sampled from the Niukluk, Fish and Pilgrim rivers during 1990, the Sinuk River 1989-1990, and the Chena River during 1989 (Clark 1990), Alaska.

classes are moving through the populations of these closely located areas of the Fish River system. Arctic grayling of ages 6, 7 and 8 years were strongly represented in both the Sinuk and Pilgrim rivers which are also in close proximity.

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APPENDIX A

Appendix A1. List of numbered tags and fin clips used on Arctic grayling in the Niukluk, Fish, Pilgrim and Sinuk rivers during 1990, Seward Peninsula, Alaska.

Location	Month	Number Tagged	Tag Numbers	Color	Fin Clip
Niukluk River	July	213	50621 - 50833	Green	Left Ventral
	August	46	50834 - 50879	Green	Left Ventral
	August	119	50881 - 50999	Green	Left Ventral
	August	43	52900 - 52942	Green	Left Ventral
Fish River	July	673	52000 - 52672	Green	Right Pectoral
Pilgrim River	August	241	53001 - 53241	Green	Left Pectoral
	August	59	53243 - 53301	Green	Left Pectoral
Sinuk River	August	2	51090 - 51091	Green	Right Pectoral
	August	7	51093 - 51099	Green	Right Pectoral
	August	55	51126 - 51180	Green	Right Pectoral
	August	18	51182 - 51199	Green	Right Pectoral
	August	21	51226 - 51246	Green	Right Pectoral
	August	104	51248 - 51351	Green	Right Pectoral

Appendix A2. Inference as a means to detect bias due to gear selectivity.

Results of Hypothesis Tests (K-S and χ^2) on Lengths of Fish Marked during First First Event and Recaptured during Second Event	Results of Hypothesis Tests (K-S) on Lengths of Fish Captured during First Event and during Second Event
Case I:	
"Accept" H_o	"Accept" H_o
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_o	Reject H_o
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_o	"Accept" H_o
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_o	Reject H_o
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data.

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Also, calculate a single estimate of abundance without stratification.

- continued -

Case IVa: If the stratified and unstratified abundance estimates for the entire population are dissimilar, discard the unstratified estimate. Only use the lengths, ages, and sexes from the second sampling event to estimate proportions in composition, and apply formulae to correct for size bias to data from the second event.

Case IVb: If the stratified and unstratified abundance estimates for the entire population are similar, discard the estimate with the larger variance. Only use the lengths, ages, and sexes from the first sampling event to estimate proportions in compositions, and do not apply formulae to correct for size bias.

Appendix A3. Water temperatures and conductivity readings from rivers sampled with electrofishing by river and date, Seward Peninsula area, Alaska.

River	Date	T[a]	Conductivity[b]
Niukluk	7-6-90	15	126
	7-7-90	13.5	112
	7-8-90	11.5	118
	7-24-90	13	140
	7-25-90	11.5	190
	7-26-90	11.5	135
Fish	7-10-90	15.5	121
	7-11-90	15	126
	7-12-90	15	125
	7-13-90	13	155
	7-19-90	12	90
	7-20-90	12	138
	7-20-90	12	155
	7-21-90	11	100
	7-21-90	12.5	95
	7-22-90	12	120
Pilgrim	8-14-90	12.5	170

[a] Temperature in degrees Celcius.
[b] Conductivity in micromhos/cm.

Appendix A4. Results of the nonparametric test described by Robson and Flick (1965) for growth recruitment applied to data from the Sinuk River, Seward Peninsula, Alaska.

L_i[a]	C_i[b]	M[c]	C[d]	P[C > C_i][e]	
354	16	21	214	0.21	
370	6	20	198	0.56	
424	43	19	192	0.01	
429	5	18	149	0.56	
430	0	17	144	1.00	ULGR[f]
431	2	16	144	0.81	
435	11	15	142	0.32	
437	2	14	131	0.82	
444	13	13	129	0.27	
445	6	12	116	0.55	
453	25	11	110	0.07	
455	1	10	85	0.89	
462	13	9	84	0.24	
464	4	8	71	0.65	
465	2	7	67	0.82	
470	11	6	65	0.35	
471	5	5	54	0.63	
472	5	4	49	0.66	
476	7	3	44	0.61	
480	8	2	37	0.63	
506	29	1	29	----	

[a] Fork length in 1989 of fish recaptured in 1990.
[b] The number of fish in the second sample between length L_i and the next lower recaptured length.
[c] The number of fish recaptured in 1990 of length L_i and greater in 1989.
[d] The number of fish in the second sample of length L_i and greater.
[e] The probability that the proportion of fish sampled in this second event in this length category is greater than the actual proportion within this category in the population.
[f] The estimated upper limit of growth recruitment.

Appendix A5. Age-length distribution of Arctic grayling sampled in the Niukluk River during 1990, Seward Peninsula, Alaska.

Fork Length (mm)	AGE (Years)													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
76 to 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101 to 125	0	6	0	0	0	0	0	0	0	0	0	0	0	6
126 to 150	0	2	0	0	0	0	0	0	0	0	0	0	0	2
151 to 175	0	2	3	0	0	0	0	0	0	0	0	0	0	5
176 to 200	0	0	24	0	0	0	0	0	0	0	0	0	0	24
201 to 225	0	0	13	0	0	0	0	0	0	0	0	0	0	13
226 to 250	0	0	4	10	0	0	0	0	0	0	0	0	0	14
251 to 275	0	0	1	3	1	0	0	0	0	0	0	0	0	5
276 to 300	0	0	0	0	2	2	0	0	0	0	0	0	0	4
301 to 325	0	0	0	4	3	4	2	1	1	0	0	0	0	15
326 to 350	0	0	0	0	0	5	21	12	0	0	0	0	0	38
351 to 375	0	0	0	0	0	17	56	41	8	1	0	0	0	123
376 to 400	0	0	0	0	0	13	51	39	9	1	0	0	0	113
401 to 425	0	0	0	0	0	3	18	14	4	0	0	0	0	39
426 to 450	0	0	0	0	0	3	1	4	0	0	0	0	0	8
Totals	0	10	45	17	6	47	149	111	22	2	0	0	0	409

Appendix A6. Age-length distribution of Arctic grayling sampled in the Fish River during 1990, Seward Peninsula, Alaska.

Fork Length (mm)	AGE (Years)													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
76 to 100	1	0	0	0	0	0	0	0	0	0	0	0	0	1
101 to 125	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126 to 150	0	1	0	0	0	0	0	0	0	0	0	0	0	1
151 to 175	0	11	1	0	0	0	0	0	0	0	0	0	0	12
176 to 200	0	4	1	0	0	0	0	0	0	0	0	0	0	5
201 to 225	0	0	3	1	0	0	0	0	0	0	0	0	0	4
226 to 250	0	0	1	3	0	0	0	0	0	0	0	0	0	4
251 to 275	0	0	0	2	0	0	0	0	0	0	0	0	0	2
276 to 300	0	0	0	1	2	0	0	0	0	0	0	0	0	3
301 to 325	0	0	0	1	3	0	1	0	1	0	0	0	0	6
326 to 350	0	0	0	0	1	5	19	12	0	0	0	0	0	37
351 to 375	0	0	0	0	7	43	101	79	13	2	0	0	0	245
376 to 400	0	0	0	0	2	41	110	52	6	1	0	0	0	212
401 to 425	0	0	0	0	0	11	36	25	1	1	0	0	0	74
426 to 450	0	0	0	0	0	0	6	4	0	0	0	0	0	10
451 to 475	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Totals	1	16	6	8	15	100	274	172	22	4	0	0	0	618

Appendix A7. Age-length distribution of Arctic grayling sampled in the Pilgrim River during 1990, Seward Peninsula, Alaska.

Fork Length (mm)	AGE (Years)													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
76 to 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101 to 125	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126 to 150	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151 to 175	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176 to 200	0	0	2	0	0	0	0	0	0	0	0	0	0	2
201 to 225	0	0	0	0	0	0	0	0	0	0	0	0	0	0
226 to 250	0	0	1	0	0	0	0	0	0	0	0	0	0	1
251 to 275	0	0	0	0	0	1	0	0	0	0	0	0	0	1
276 to 300	0	0	0	2	5	1	0	0	0	0	0	0	0	8
301 to 325	0	0	1	3	9	10	2	0	0	0	0	0	0	25
326 to 350	0	0	0	0	7	16	11	1	0	0	0	0	0	35
351 to 375	0	0	0	0	2	13	23	9	0	2	1	0	0	50
376 to 400	0	0	0	0	0	5	24	12	1	0	0	0	0	42
401 to 425	0	0	0	0	0	5	12	16	10	4	1	0	0	48
426 to 450	0	0	0	0	0	1	4	16	18	6	0	1	1	47
451 to 475	0	0	0	0	1	1	2	5	15	7	3	2	0	36
476 to 500	0	0	0	0	0	0	0	1	0	3	2	0	0	6
501 to 525	0	0	0	0	0	1	0	0	1	0	0	0	0	2
Totals	0	0	4	5	24	54	78	60	45	22	7	3	1	303

Appendix A8. Age-length distribution of Arctic grayling sampled from the Sinuk River during 1990, Seward Peninsula, Alaska.

Fork Length (mm)	AGE (Years)													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
76 to 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101 to 125	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126 to 150	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151 to 175	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176 to 200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201 to 225	0	0	0	0	0	0	0	0	0	0	0	0	0	0
226 to 250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
251 to 275	0	0	1	0	0	0	0	0	0	0	0	0	0	1
276 to 300	0	0	0	1	1	0	0	0	0	0	0	0	0	2
301 to 325	0	0	0	0	0	1	0	0	0	0	0	0	0	1
326 to 350	0	0	0	2	0	5	0	0	0	0	0	0	0	7
351 to 375	0	0	0	0	1	2	1	0	0	0	0	0	0	4
376 to 400	0	0	0	0	2	4	2	0	0	0	0	0	0	8
401 to 425	0	0	0	0	0	6	10	8	3	2	1	0	0	30
426 to 450	0	0	0	0	0	9	25	9	7	4	0	0	0	54
451 to 475	0	0	0	0	0	5	17	13	4	3	4	0	1	47
476 to 500	0	0	0	0	0	0	7	11	3	2	0	1	1	25
501 to 525	0	0	0	0	0	0	0	1	1	0	5	0	0	7
Totals	0	0	1	3	4	32	62	42	18	11	10	1	2	186