Fishery Data Series No. 97-15

Assessment of Arctic Grayling in Selected Streams of the Seward Peninsula, 1996

by

Alfred L. DeCicco

July 1997

Alaska Department of Fish and Game Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

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

Spell out year, month, and week.

Physics and chemistry

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

General

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

Mathematics, statistics, fisheries

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

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by

Alfred L. DeCicco
Division of Sport Fish, Fairbanks

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

July 1997

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Alfred L. DeCicco
Alaska Department of Fish and Game, Division of Sport Fish,
1300 College Road, Fairbanks, AK 99701-1599,USA

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TABLE OF CONTENTS

Page

LIST OF TABLES ii

LIST OF FIGURES ii

LIST OF APPENDICES ii

ABSTRACT 1

INTRODUCTION 1

METHODS 4

Sampling Gear and Techniques 4
Population Abundance Estimates 6
Age Composition 7
Length Composition 8
Mean Length-at-Age 8
Age Validation 8

RESULTS 8

Population Abundance Estimates 8
Age and Length Compositions 10
Mean Length-At-Age 12
Upper Pilgrim River 12
Eldorado River Age Validation 12
Pilgrim River Round Whitefish 12

DISCUSSION 18

ACKNOWLEDGMENTS 19

LITERATURE CITED 19

APPENDIX A 22

APPENDIX B 27

LIST OF TABLES

Table **Page**

1. Estimated freshwater sport fish harvests (catches are in parentheses) for Seward Peninsula and Norton Sound streams, 1980-1995. 2
2. Estimated proportion of Arctic grayling in the lower Pilgrim River by age class, 1996. 14
3. Estimated proportion of Arctic grayling sampled from the lower Pilgrim and Eldorado Rivers by 25 mm FL increments, 1996. 16
4. Mean fork length-at-age of Arctic grayling in Seward Peninsula rivers sampled during 1996. 17

LIST OF FIGURES

Figure **Page**

1. The southern Seward Peninsula. 3
2. Pilgrim River with areas sampled during 1996. 5
3. Cumulative length distribution plots (tests 1 and 2) of Arctic grayling >336 mm FL sampled from the lower (section 3) Pilgrim River in 1996. 9
4. Cumulative length distribution plots (tests 1 and 2) of Arctic grayling > 336 mm FL sampled from the middle section (section 2) Pilgrim River in 1996. 11
5. Age composition estimates of Arctic grayling from the Pilgrim River, and age distribution of Arctic grayling sampled from the Eldorado and Pilgrim rivers in 1996. 13
6. Length distribution in 25 mm increments of Arctic grayling sampled from the Pilgrim and Eldorado rivers in 1996. 15

LIST OF APPENDICES

Appendix **Page**

A1. List of numbered tags and finclips used to mark Arctic grayling from the Pilgrim River in 1996 23
A2. Age-length distribution of Arctic grayling sampled from the Pilgrim River in 1996. 24
A3. Age-length distribution of Arctic grayling sampled from the Eldorado River in 1996. 25
A4. Age-length distribution of round whitefish sampled from the Pilgrim River in 1996. 26
B. Data files used to estimate parameters of Arctic grayling populations on the Seward Peninsula in 1996 28

ABSTRACT

The number of Arctic grayling *Thymallus arcticus* over 336 mm in FL was estimated at 424 fish (SE = 63) in a 12 km index section of the lower Pilgrim River. In the middle 25 km section upstream from the Nome - Taylor Highway bridge, 233 Arctic grayling (SE = 66) greater than 412 mm in FL were estimated to be present. An abundance estimate was not obtained for the upper Pilgrim River. Arctic grayling captured from the Pilgrim River ranged from 191 to 496 mm in FL and in scale age from 2 to 15 years. Arctic grayling captured from the Eldorado River ranged in FL from 301 to 500 mm, and in scale age from 4 to 12 years. Of 75 Arctic grayling captured from the Eldorado River, 11 had been marked with OTC and were collected in order to validate aging techniques.

Key words: Arctic grayling, *Thymallus arcticus*, population abundance, age composition, length composition, Seward Peninsula, Pilgrim River, Eldorado River.

INTRODUCTION

The Seward Peninsula-Norton Sound area of western Alaska supports the second largest amount of recreational fishing effort in the Arctic-Yukon-Kuskokwim (AYK) region. From 1980 to 1995, an annual average of 15,549 freshwater angler-days of fishing effort occurred in this area (Mills 1981-1994, Howe et al. 1995, 1996). Reported freshwater fish harvests consisted primarily of Dolly Varden *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 through 1991, Arctic grayling had comprised an average of 19.4% of the harvest of these species, but dropped to 6.5% from 1992 through 1994, and increased to 10.6% in 1995 (Table 1). The harvest has remained fairly consistent, about 1,200 Arctic grayling, over the past three years.

The Seward Peninsula is the only area in Alaska outside of Bristol Bay which regularly produces trophy-sized Arctic grayling. Since 1983, 26 of 108 (24%) Arctic grayling registered in the Alaska Department of Fish and Game (ADF&G) Trophy Fish Program have come from the Seward Peninsula (ADF&G *Unpublished*).

Although not connected by road to the state highway system, the Nome area has approximately 420 km of maintained gravel roads which traverse the Seward Peninsula in three general directions from Nome (Figure 1). This road system provides angler access to many waters.

Local concerns about the stock status of Arctic grayling and angler reports that the abundance of large-sized Arctic grayling appeared to be declining in some streams led the Alaska Board of Fisheries to promulgate a regulation in 1988 which reduced the daily bag limit of Arctic grayling on the Seward Peninsula to five per day, five in possession, with only one over 15 inches (381 mm).

The first studies conducted by ADF&G on the basic life history and angler utilization of fish in the freshwaters of 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/Niukluk rivers were sampled for age, length and weight (Alt 1986). During 1988, a project was initiated to survey Arctic grayling stocks on Seward Peninsula rivers and to estimate average catch and harvest per unit effort on surveyed streams (Merritt 1989). A total of 887 Arctic grayling were tagged and

Table 1.-Estimated freshwater sport fish harvests (catches are in parentheses) for Seward Peninsula and Norton Sound streams, 1980-1995. Data from the Alaska statewide sport fish harvest survey (Mills 1981-1994, Howe et al. 1995, 1996).

	Harvests (Catches) in Number of Fish						
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
1990	18,720	11,227	3,765	1,378	1,957	33	299
		(24,705)	(9,118)	(6,119)	(4,145)	(33)	(315)
1991	22,118	8,928	10,365	5,121	1,429	116	1357
		(15,561)	(25,425)	(23,160)	(4,257)	(116)	(1,409)
1992	19,351	11,778	2,178	492	479	0	46
		(35,473)	(5,726)	(5,772)	(3,742)	(0)	(165)
1993	17,055	6,634	5,702	1,378	537	96	95
		(16,920)	(21,961)	(13,223)	(2,117)	(107)	(196)
1994	11,757	12,215	2,981	1,200	376	0	67
		(21,048)	(7,254)	(6,853)	(1,731)	(0)	(172)
1995	13,428	5,316	2,908	1,037	215	45	247
		(14,250)	(7,806)	(5,788)	(1,856)	(56)	(321)
MEAN	15,649	9,673	5,398	3,336	604	27	486
		(21,690)	(12,882)	(1,0153)	(2,975)	(52)	(430)

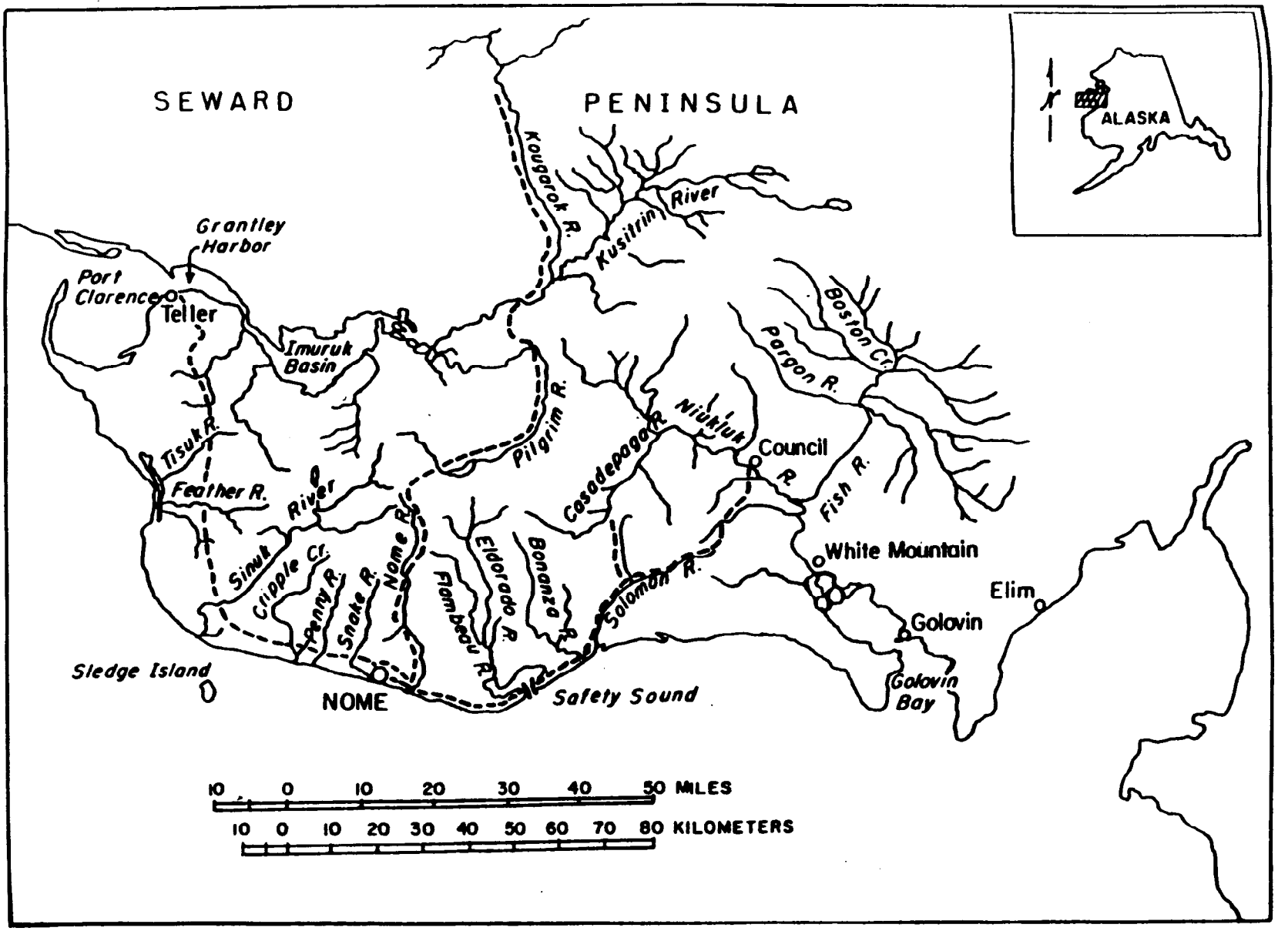


Figure 1.-The southern Seward Peninsula.

sampled for length and age on the Nome, Snake, Sinuk, Solomon, Eldorado, Pilgrim, Kuzitrin, Niukluk and Fish rivers and Boston Creek. Since 1989, population abundance, age at length, size and age composition have been estimated for Arctic grayling on the Niukluk, Fish, Pilgrim, Nome, Snake and Sinuk rivers (DeCicco 1990-1996). Problems with assigning ages to large Arctic grayling have been noted in recent years (DeCicco 1993-1995). Consequently, an age validation component was added to this project in 1994.

Several regulatory changes have recently been implemented based on data collected from this study. The Nome and Solomon rivers have been closed to Arctic grayling fishing by emergency order and will remain closed until it is determined that the populations have recovered. The daily bag and possession limits for Arctic grayling in both the Snake and Pilgrim rivers have been reduced to two per day, only one of which may be over 15 inches (381 mm) in length.

The long term goal of this project is to achieve sustained yield fisheries for Arctic grayling populations through regulation. Project objectives in 1996 were to:

1) estimate the abundance of Arctic grayling greater than 249 mm FL in a 12-km section of the Pilgrim River downstream from the Nome - Taylor Highway bridge
2) estimate the abundance of Arctic grayling greater than 249 mm FL in a 42-km section of the Pilgrim River from Salmon Lake downstream to the Nome - Taylor Highway bridge;
3) estimate age and length composition of Arctic grayling for give length ranges in the Pilgrim River;
4) capture a sample of Arctic grayling from the Eldorado River which were marked with floy tags and a substance to fluoresce bones, in order to validate ages as determined by various aging structures; and,
5) estimate the proportion of correctly aged otoliths from recaptured Arctic grayling.

In addition, mean length-at-age for Arctic grayling in the Pilgrim and Eldorado rivers was estimated.

METHODS

SAMPLING GEAR AND TECHNIQUES

Arctic grayling were sampled using hook and line, and a 50-m x 2-m, 6.5-mm mesh beach seine on the Pilgrim River (Figure 2). Access to the upper Pilgrim River was by inflatable raft, while the lower Pilgrim and Eldorado rivers was sampled using a 4.8 m outboard jet powered riverboat.

Each Arctic grayling was measured to the nearest mm in fork length. Fish over 149 mm FL in the Pilgrim and Eldorado rivers 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. Each fish was also marked with a partial fin clip (Appendix A1). Scales for age determination were taken 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 ADF&G 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

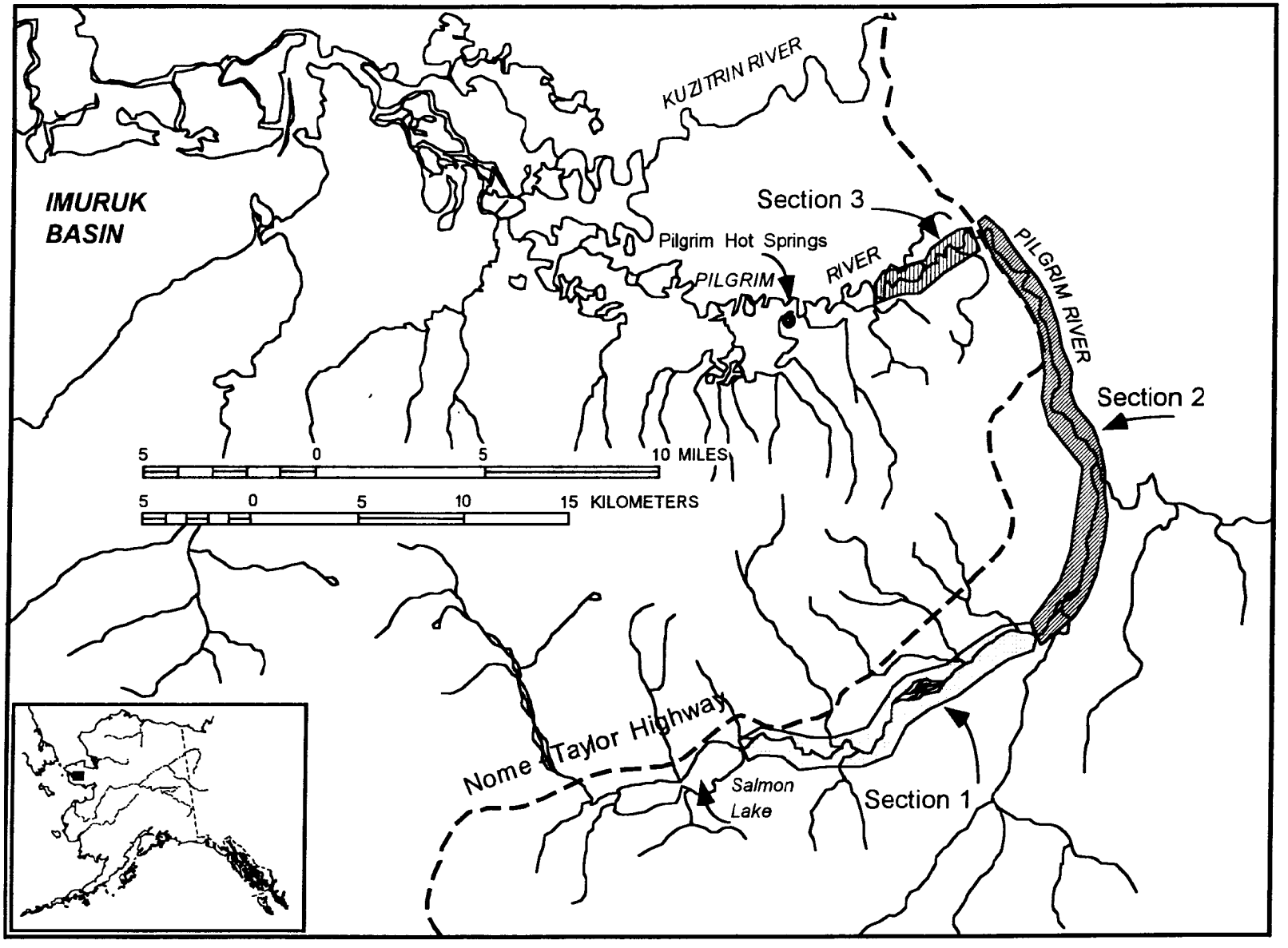


Figure 2.-Pilgrim River with areas sampled during 1996.

using a microfiche reader. All scale impressions were read by a trained scale reader and the project leader. Age determinations follow procedures outlined by Yole (1975). Scale impressions with questionable readings were read a third time as necessary. If the age assignment was still in question, the age sample was discarded. Regenerated scales were not aged. Data files were archived with ADF&G Research and Technical Services (RTS) in Anchorage (Appendix B1).

POPULATION ABUNDANCE ESTIMATES

A two sample approach using a Petersen mark-recapture estimator as modified by Bailey (1951, 1952) was used to estimate the abundance of Arctic grayling in sections of the Pilgrim River. Sampling for the population estimates was performed along the entire length of each river section 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 the cumulative length distribution of marked fish recaptured during the second sampling event (recapture event). In the second test, the cumulative length distribution of fish captured during the marking event was compared to the cumulative length distribution of all fish captured during the recapture event. 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, migration, or some other factor affecting the size distribution of the two samples was indicated. A more complete tracking of test results and consequences is contained in DeCicco (1994, appendix A2). All fish were released within the reach of the river in which they were captured. To meet conditions of assumption 4, all tagged fish were also marked with an appropriate fin clip or punch (Appendix A1). Finclips or hole punches were chosen so as to not duplicate those used for fish from a given river in previous years. Assumption 5 was met by the close examination of all fish for the presence of the double mark or fin punch.

Population abundance and the approximate variance of the estimate were calculated with Bailey's modified Petersen estimator (Seber 1982):

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

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

where:

$M =$ the number marked during the first event;

$C =$ the number captured during the second event;

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

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

$V =$ the approximate variance of the abundance estimate.

AGE COMPOSITION

Scales were collected from Arctic grayling sampled in conjunction with the abundance growth and age experiments. Ages were assigned to scales as indicated above to estimate age composition for the populations in sections of the Pilgrim River. The proportions of fish in each age category were estimated as multinomial proportions (Cochran 1977, Thompson 1987).

The proportion in each category was estimated as:

$$\hat{p}_i = \frac{n_i}{n} \tag{3}$$

where:

$n_i =$ the number in the sample from age category i;

$n =$ the sample size; and,

$p_i =$ the estimated fraction of the population that is made up of age category i.

The unbiased variance of this proportion was estimated as:

$$V\left[\hat{p}_i\right] = \frac{\hat{p}_i\left(1-\hat{p}_i\right)}{(n-1)} \tag{4}$$

Abundance of Arctic grayling by age was not estimated because size ranges represented in the abundance estimates were restricted only to the larger size groups, and estimates of abundance would be biased high for the population.

LENGTH COMPOSITION

Length composition of Arctic grayling residing in the Pilgrim River was estimated in 25 mm length increments. Estimates of the proportion of fish in size categories followed the same procedures used for age composition (equations 3 and 4).

MEAN LENGTH-AT-AGE

Mean length-at-age was calculated as the arithmetic mean length of all fish assigned the same age. Samples were combined across years to increase sample sizes. Standard deviations of the mean lengths of each age class were calculated using standard procedures.

AGE VALIDATION

Arctic grayling were captured in the Eldorado River in order to validate aging techniques. Fish with Floy tags or adipose fin clips indicating that they carried oxytetracycline (OTC) marks were collected, kept cool and frozen at the first opportunity. Scales were collected from each fish not carrying a fin clip or tag, and otoliths were collected from all dead fish.

RESULTS

POPULATION ABUNDANCE ESTIMATES

The abundance of Arctic grayling in 1996 was estimated in the lower index section of the lower Pilgrim River, and in its middle section. Abundance could not be estimated for the upper Pilgrim River because only two tagged fish were recaptured during the second sampling event.

The marking event on section 3 (lower) of the Pilgrim River (Figure 2) was conducted during four days in mid-July and the recapture event was conducted during four days in late July - early August after a ten day hiatus. The smallest of 157 Arctic grayling marked was 191 mm FL and the smallest of 137 Arctic grayling examined during the second event was 212 mm FL. The smallest marked fish recaptured from the lower Pilgrim River was 337 mm FL. The abundance estimate for the lower Pilgrim River was calculated for Arctic grayling > 336 mm FL.

In this 12 km index section of the Pilgrim River downstream from the Nome - Taylor Highway bridge, the estimated abundance of Arctic grayling > 336 mm FL was 424 fish (SE = 63 fish, CV = 15%). A total of 114 Arctic grayling > 336 mm FL were marked during the first event (16 to 19 July). During the recapture event (30 July to 2 August), 118 Arctic grayling > 336 mm FL were examined of which 31 had tags from the marking event. No tag losses were detected, and no fish were killed during sampling in this section during 1996.

A Kolmogorov-Smirnov two sample test of the cumulative length distributions of Arctic grayling > 336 mm FL marked versus those recaptured during the recapture event (test 1) failed to detect significant differences ($D = 0.12$, $P = 0.91$, $n_1 = 114$, $n_2 = 31$). A similar test of those marked in the first event and those examined in the second event (test 2) did detect significant differences ($D = 0.19$, $P= 0.04$, $n_1 = 114$, $n_2 = 118$; Figure 3). A single unstratified abundance estimate was calculated for Arctic grayling greater than 336 mm FL. Fish from both samples were used for the length at age and for the age-length distribution (Appendix A2).

The upper Pilgrim River was divided into two sections. Section 2 extended from the Bridge on the Nome - Taylor Highway upstream for 25 km to Homestake Creek, and Section 1 extended from Homestake Creek for 20 km upstream to the origin of the Pilgrim River at Salmon Lake.

The marking event on section 2 (middle) of the Pilgrim River was conducted during five days in mid-July and the recapture event was conducted during five days in late July after an eight day hiatus. The smallest of 72 Arctic grayling marked was 334 mm FL and the smallest of 33 Arctic

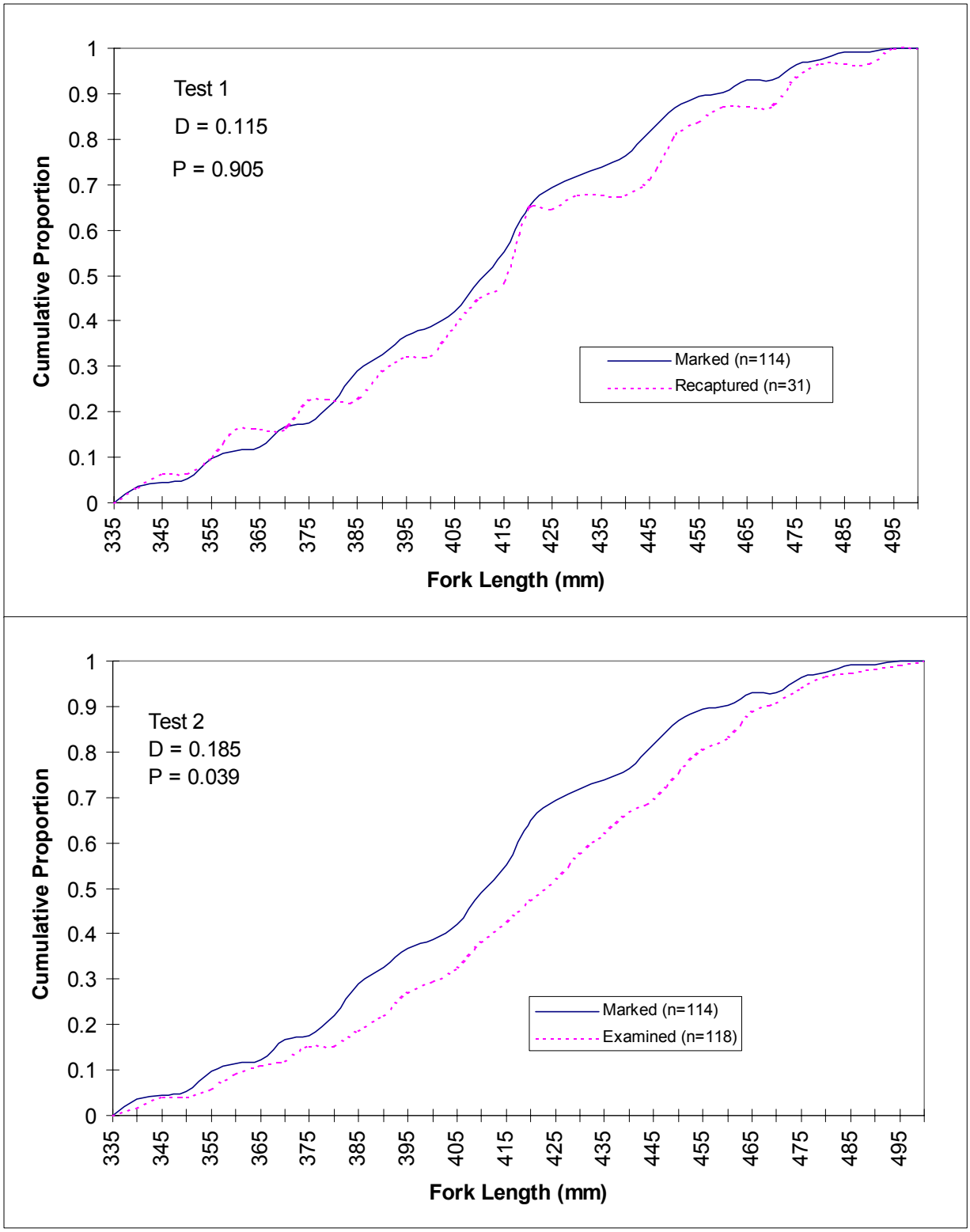


Figure 3.-Cumulative length distribution plots (tests 1 and 2) of Arctic grayling >336 mm FL sampled from the lower (section 3) Pilgrim River in 1996.

grayling examined during the second event was 375 mm FL. The smallest of the seven marked fish recaptured from the lower Pilgrim River was 413 mm FL. The abundance estimate for the middle section of the Pilgrim River was calculated for Arctic grayling > 412 mm FL.

In this 25 km section of the Pilgrim River downstream from Homestake Creek to the Nome - Taylor Highway bridge, the estimated abundance of Arctic grayling > 412 mm FL was 233 fish (SE = 66 fish, CV = 29%). A total of 62 Arctic grayling > 412 mm FL were marked during the first event (8 to 12 July). During the recapture event (22 to 26 July), 29 Arctic grayling > 412 mm FL were examined of which seven had tags from the marking event. No tag losses were detected, and no fish were killed during sampling during 1996.

A Kolmogorov-Smirnov two sample test of the cumulative length distributions of Arctic grayling > 412 mm FL marked versus those recaptured during the recapture event (test 1) failed to detect significant differences ($D = 0.34$, $P = 0.45$, $n_1 = 62$, $n_2 = 7$). A similar test of those marked in the first event and those examined in the second event (test 2) likewise, did not detect significant differences ($D = 0.13$, $P= 0.88$, $n_1 = 62$, $n_2 = 29$; Figure 4). A single unstratified abundance estimate was calculated for Arctic grayling > 412 mm FL. Fish from both samples were also used for the length at age and for the age-length distribution (Appendix A2).

The marking event on section 3 (upper) of the Pilgrim River was conducted during five days in mid-July and the recapture event was conducted during five days in late July after an eight day hiatus. The smallest of 67 Arctic grayling marked was 218 mm FL and the smallest of 82 Arctic grayling examined during the second event was 250 mm FL. Because only two marked fish were recaptured from the upper Pilgrim River, a reliable abundance estimate could not be calculated for Arctic grayling in this section. However, length measurements and ages of the samples were combined with those of other sections for length at age and for the age and length composition estimates.

Recapture rates of fish marked in the first sampling events in river sections 2 and 3 were compared using contingency tables to examine capture probabilities between river sections. They were found not to be different ($\chi^2 = 0.055$, df = 1, $P = 0.8$). Since both rod and reel and beach seine were used to capture fish in river section 3, capture probabilities by gear type were examined using a contingency table which compared the number of fish recaptured to those marked (M vs M-R) by gear type. These were also found not to be different ($\chi^2 = 3.587$, df = 1, $P = 0.6$).

AGE AND LENGTH COMPOSITIONS

Abundances by age class were not estimated because the estimates would be restricted only to fish larger than 337 mm FL in the lower section of the Pilgrim River, and to even larger fish (> 412 mm FL) in the middle section. Since the estimates were germane only to these larger fish and biased high in relation to the entire population, they could not be usefully compared to past estimates on this river and their utility would be very limited. Therefore all the samples from the three reaches of the river were combined and presented as the best representation of size and age composition estimates (multinomial proportions) of the river's population during 1996.

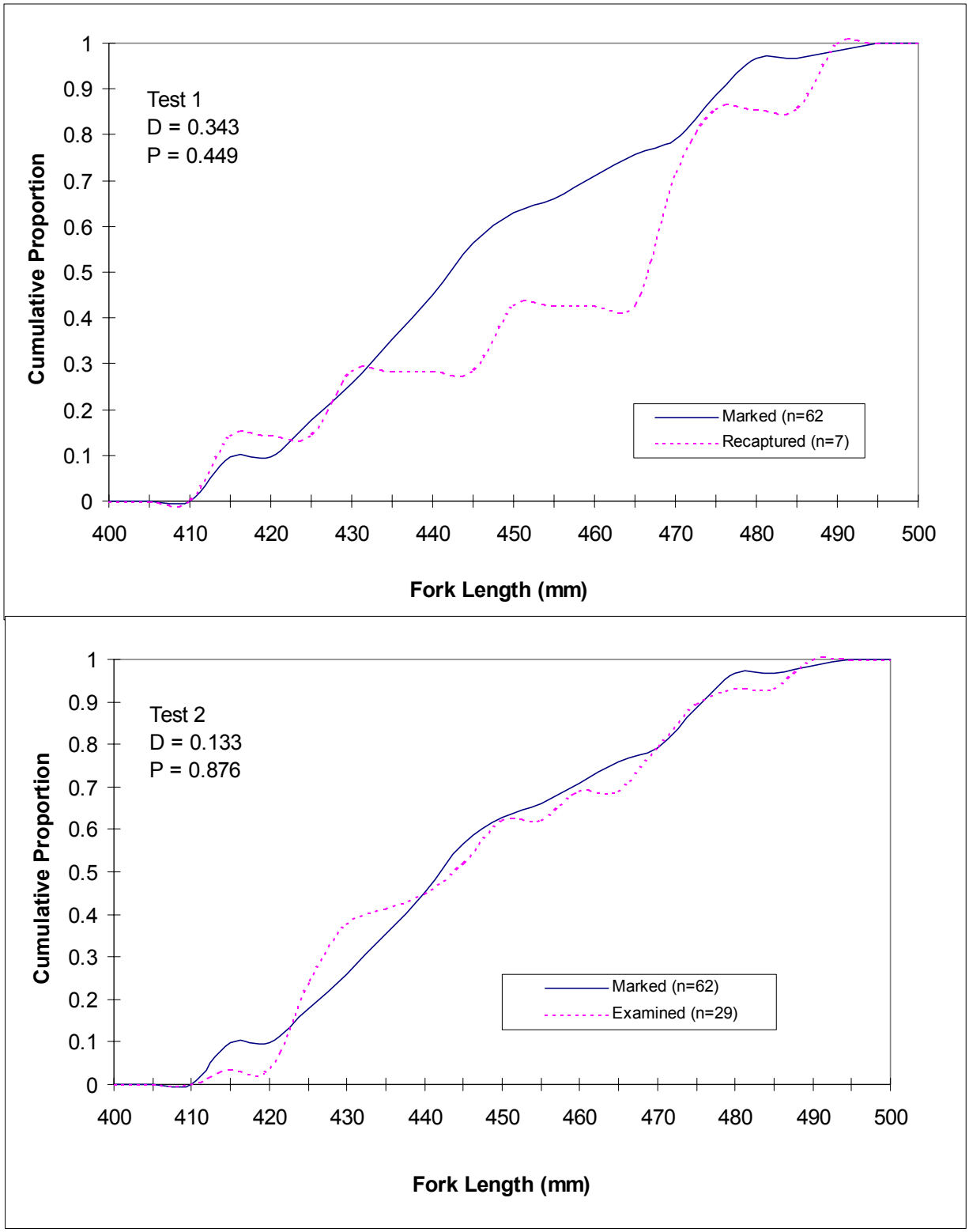


Figure 4.-Cumulative length distribution plots (tests 1 and 2) of Arctic grayling >336 mm FL sampled from the middle (section 2) Pilgrim River in 1996.

Scale ages of Arctic grayling from the Pilgrim River ranged from 2 to 15 years and were normally distributed around 7 and 8 years which together comprised 30% of the entire sample (Figure 5, Table 2).

Length composition of Arctic grayling in the Pilgrim River was estimated in 25 mm increments (Figure 6, Table 3). The age and length distributions of Arctic grayling sampled from the Eldorado River in 1996 are also presented in Figures 5 and 6. Length distributions in both rivers were similar with 57% of the Pilgrim River sample > 400 mm FL, and 60 % of the Eldorado River sample > 400 mm FL.

MEAN LENGTH-AT-AGE

Estimates of mean fork length-at-age were calculated for Arctic grayling sampled from the Pilgrim, and Eldorado rivers (Table 4). When data were available, they were combined across years. Arctic grayling from the Eldorado River were larger at all ages than those from the Pilgrim River. Age and length distributions of Arctic grayling sampled are provided in Appendices A2 and A3.

Upper Pilgrim River

Abundance was not estimated for the upper Pilgrim River because too few fish were recaptured. During the first sampling event, 98 Arctic grayling were marked. During the second sampling event, 97 Arctic grayling were examined and marked. Of these, only four carried marks from the first sampling event. Fish from both samples were combined to present data on length composition (Table 3), length-at-age (Table 4), age composition (Figure 5), and age-length distribution (Appendix A3).

ELDORADO RIVER AGE VALIDATION

A total of 75 Arctic grayling were captured from the Eldorado River during 1996. Of these, 10 carried tags, four from 1994 and six from 1995. In addition, one fin clipped fish that had lost its tag was recaptured. All recaptured fish were killed and frozen whole for later analysis. Otoliths will not be analyzed until the remainder of the sample is collected. Approximately 23 otoliths must be analyzed to validate aging techniques. Assuming a similar recapture rate in the future, we should be able to obtain the remainder of the marked sample in 1997. Fish recaptured in 1996 provided additional support for the continuation of this study to conclusion. Of 13 consecutive year recaptures, with scale-ages, only two gave a +1-year age difference, and none of four captured two years apart gave a +2-year age difference.

PILGRIM RIVER ROUND WHITEFISH

During sampling for Arctic grayling in the Pilgrim River in 1996, 31 round whitefish were measured and aged using scales. They ranged in fork length from 186 mm to 523 mm, and in scale age from 2 to 14 years (Appendix A4).

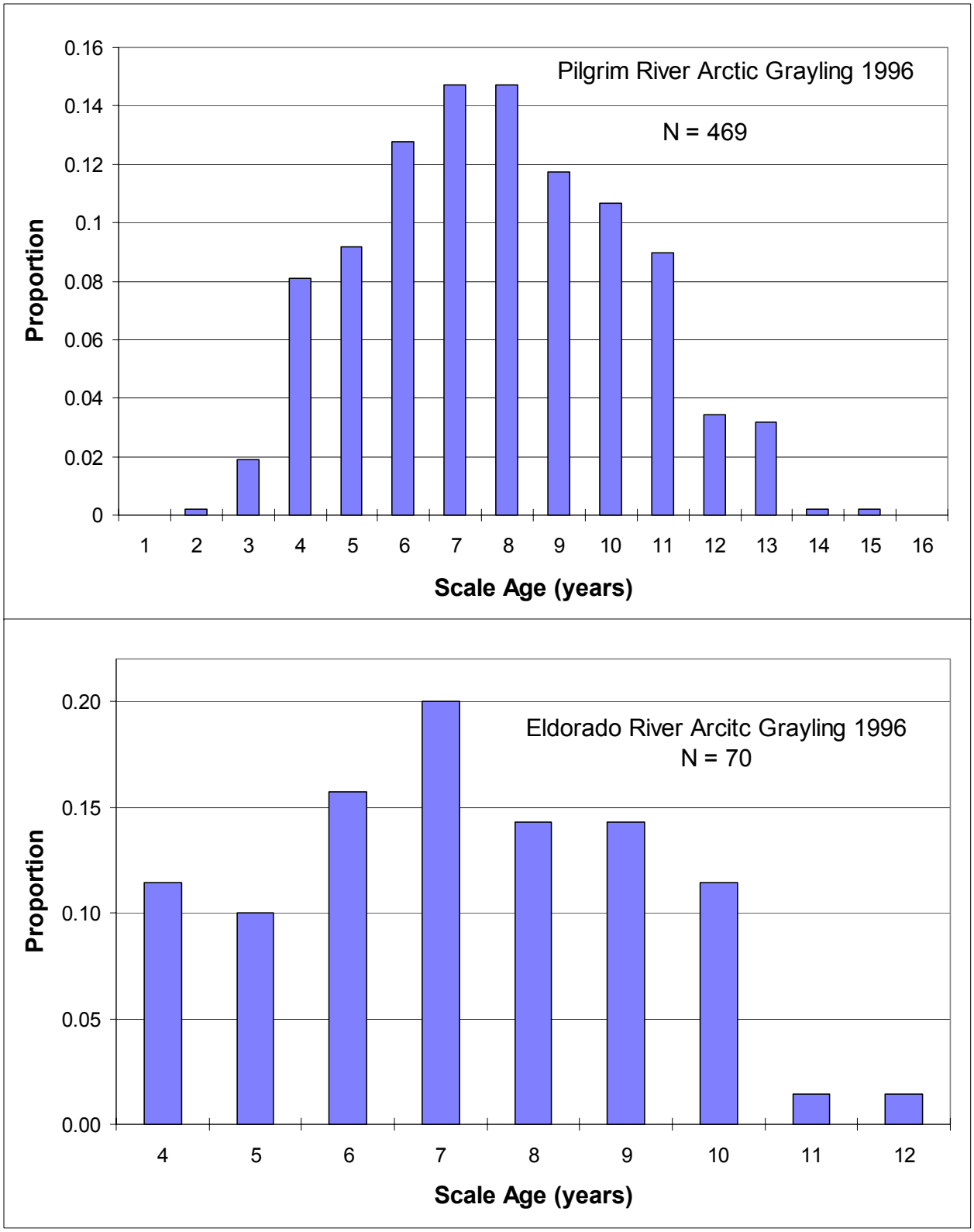
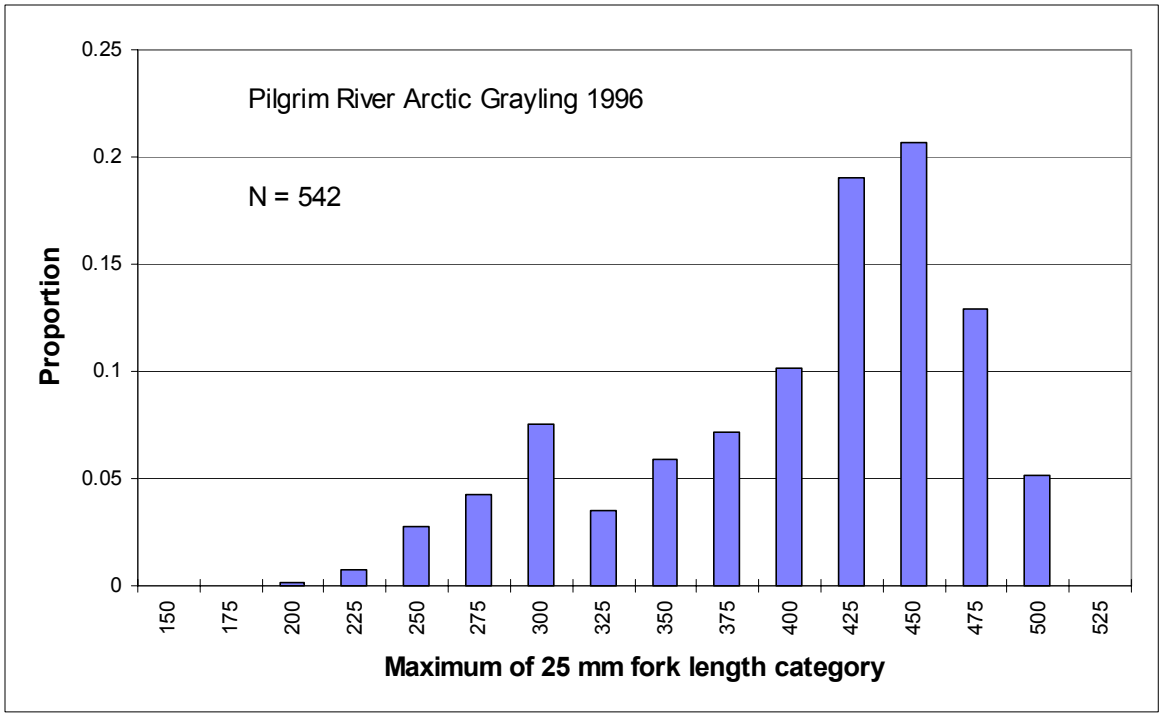


Figure 5.-Age composition estimates of Arctic grayling from the Pilgrim River, and age distribution of Arctic grayling sampled from the Eldorado and Pilgrim rivers in 1996.

Table 2.-Estimated proportion of Arctic grayling in the lower Pilgrim River by age class, 1996.

Statistic	Scale Age														Total
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Pilgrim R.															
Sample Size	1	9	38	43	60	69	69	55	50	42	16	15	1	1	469
Estimated Prop.	<0.01	0.02	0.08	0.09	0.13	0.15	0.15	0.12	0.11	0.09	0.03	0.03	<0.01	<0.01	1.00
SE of Proportion	<0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	

14



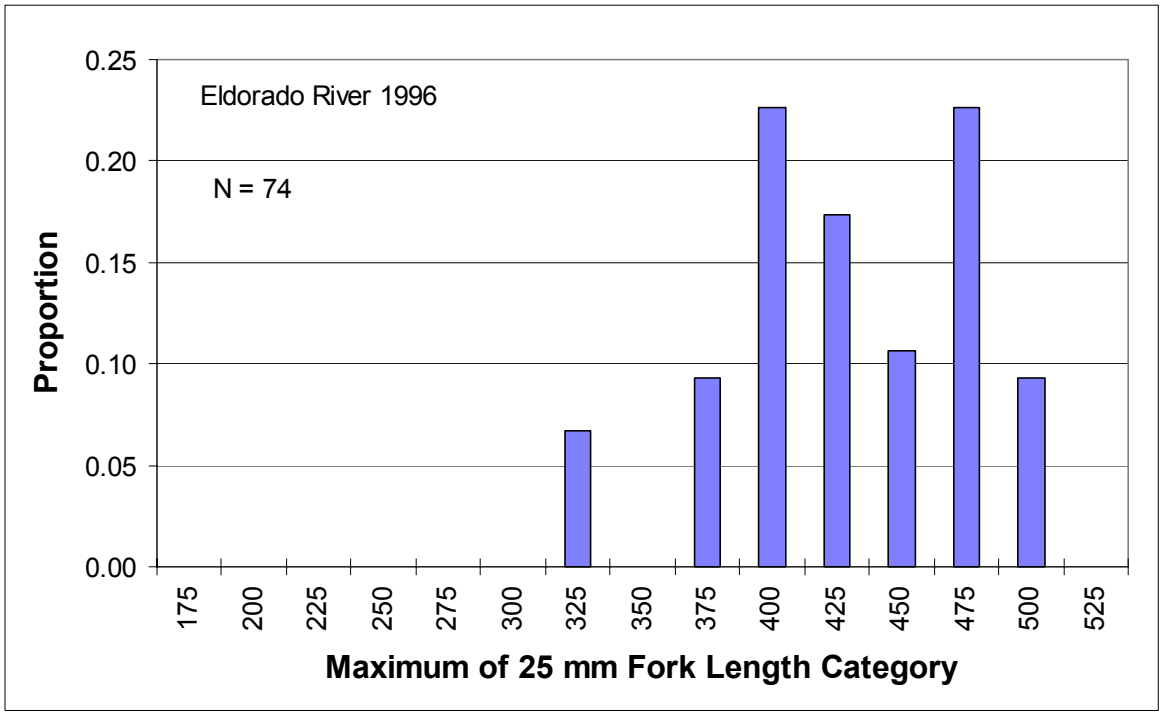


Figure 6.-Length distribution in 25 mm increments of Arctic grayling sampled from tne Pilgrim and Eldorado rivers in 1996.

Table 3.-Estimated proportion of Arctic grayling sampled from the Pilgrim and Eldorado River by 25 mm FL increments, 1996.

	Upper Bound of Fork Length Category													
Statistic	200	225	250	275	300	325	350	375	400	425	450	475	500	Total
Pilgrim River														
Sample Size	1	4	15	23	41	19	32	39	55	103	112	70	28	542
Estimated Prop.	<0.01	0.01	0.03	0.04	0.08	0.04	0.06	0.07	0.10	0.19	0.21	0.13	0.05	1.00
SE of Proportion	0.002	0.004	0.007	0.009	0.011	0.008	0.010	0.011	0.013	0.017	0.017	0.014	0.010	
Eldorado River														
Sample Size						5	0	7	17	13	8	17	7	74
Estimated Prop.						0.07	0.00	0.09	0.23	0.17	0.11	0.23	0.09	1.00
SE of Proportion						0.03	0	0.03	0.05	0.05	0.04	0.05	0.03	

Table 4.-Mean fork length-at-age of Arctic grayling in Seward Peninsula rivers sampled during 1996.

	Pilgrim River 1990-1996			Eldorado R.1988, 1993-1996		
Scale Age	Number of Fish	Fork Length (mm)	Standard Deviation (mm/FL)	Number of Fish	Fork Length (mm)	Standard Deviation (mm/FL)
1	---	---	---	---	---	---
2	10	193	21	---	---	---
3	149	253	30	4	265	19
4	308	290	28	27	305	33
5	335	323	36	36	349	45
6	384	355	39	28	373	35
7	381	388	38	35	411	24
8	288	408	33	51	442	26
9	238	425	32	63	453	24
10	156	444	30	32	466	18
11	82	447	31	14	462	18
12	27	453	23	6	483	12
13	16	468	23	---	---	---
14	1	473	---	---	---	---
15	1	480	---	---	---	---

DISCUSSION

The abundance estimates reported for the middle and lower Pilgrim River apply only to the size ranges indicated and are thought to be unbiased. Age and size composition estimates similarly apply only to the indicated size ranges. Since they are based on the entire sample, they are thought to be unbiased for the range of sizes covered, but are likely biased high in relation to the entire Arctic grayling population of the river because small fish were probably not adequately sampled. We were not able to calculate an abundance estimate for the upper section of the river, however, based on the catch rates and the low number of recaptured fish, there are likely more fish in this section than in either of the downstream sections, and the population in this section is probably not at risk given current levels of fishing effort. The upper section of the Pilgrim River is characterized by reaches of fast water and areas with many stream channels. The only suitable sampling method for this section was hook and line. It may be that the first sampling crew was not able to capture enough fish to adequately mark the population. During the second event, a different crew captured 50% more fish even though this sampling event was beset by terrible weather conditions and high water which caused sampling to end one day early.

In the downstream reach of the Pilgrim River (section 3), both hook and line and beach seines were used to capture fish during both sampling events. It is felt that these two methods are complimentary and maximize the efficiency of sampling effort. Seines can be deployed in only limited areas of the river while hook and line methods can be utilized in the areas where seines cannot be used. Most of the recaptured fish were caught using beach seines which suggests that there may be some differences in the likelihood of capture between the two methods. However, the recapture rates of fish marked using hook and line and using beach seines were similar and it is felt that both methods mark Arctic grayling equally. Once an Arctic grayling is caught using any method, it may be less likely to take a lure during the second sampling event. But, in river section 2, the recapture rate using only hook and line was similar to that in section 3 using both sampling methods. Since electrofishing has been shown to be unsuccessful as a sampling method in Nome area streams (DeCicco 1992) it is felt that the combination of hook and line and beach seine give the least biased Arctic grayling samples in this area.

One fish was recaptured in the uppermost section that had been originally marked in the lower index area during past years, and nine fish were recaptured in the middle section of the river that had been marked in prior years downstream from the bridge. These recaptures suggest that there is some movement of fish in an upstream direction as they get older, but that this movement does not often extend into the upper reaches of the river. There was no movement of fish between river sections detected during the course of this experiment.

During 1994, 60 Arctic grayling in the Eldorado River were measured, weighed and injected with OTC for age validation. During 1995, 43 additional Arctic grayling captured and marked for age validation. During 1996, 11 marked fish were collected of a desired 23 fish. In order to validate ages, additional OTC marked fish must be captured (DeCicco 1995).

It is recommended that studies on the Pilgrim River be discontinued because the population appears to be stable and sufficient data are available to allow population comparisons to be made in the future. Collection of OTC marked Arctic grayling from the Eldorado River should continue for an additional year to ensure sufficient marked fish are available to validate ages at desired confidence levels.

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APPENDIX A

Appendix A1.-List of numbered tags and finclips used to mark Arctic grayling from the Pilgrim River in 1996.

Location	Month	No. Fish	Tag Numbers	Color	Fin Clip
Upper Pilgrim R.	July	57	10463 - 10519	Gray	Upper Caudal
	July	29	10521 - 10549	Gray	Upper Caudal
	July	50	10575 - 10624	Gray	Upper Caudal
	July	1	10700	Gray	Upper Caudal
Middle Pilgrim R.	July	25	10550 - 10574	Gray	Lower Caudal
	July	52	10625 - 10676	Gray	Lower Caudal
Lower Pilgrim R. Caudal	July/Aug	171	55827 - 55997	Green	Ventral
Lower Pilgrim R. Caudal	Aug	99	29778 - 29876	Blue	Ventral

Appendix A2.-Age-length distribution of Arctic grayling sampled from the Pilgrim River in 1996.

Length	Age															
(mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
101-125																
126-150																
151-175																
176-200		1														1
201-225			3	1												4
226-250			4	7	2											13
251-275			2	10	3	2	1									18
276-300				16	12	7										35
301-325				1	10	3	3									17
326-350				1	8	10	6		1	1						27
351-375					4	17	8	4	3							36
376-400				1	3	14	10	9	3	3						43
401-425						4	25	25	19	8	7	3	1			92
426-450						3	12	26	19	17	10	3	2			92
451-475							2	5	9	13	20	4	6	1		60
476-500							1		1	8	5	5	6		1	27
501-525																
Total		1	9	43	37	60	68	69	55	50	42	15	15	1		465

Appendix A3.-Age-length distribution of Arctic grayling sampled from the Eldorado River in 1996.

	Age													
Length (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
101-125														
126-150														
151-175														
176-200														
201-225														
226-250														
251-275														
276-300														
301-325				4		1								5
326-350														
351-375				2	1	3								6
376-400				2	2	6	4	2						16
401-425					3		7	1						11
426-450					1		1	1	1	1				5
451-475								4	8	4	1			17
476-500								1	1	3		1		6
501-525														
Total				8	7	10	12	9	10	8	1	1		66

25

Appendix A4.-Age-length distribution of round whitefish sampled from the Pilgrim River in 1996.

	AGE														
Length (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
101-125															
126-150															
151-175															
176-200		1													
201-225															
226-250															
251-275															
276-300				1											1
301-325															
326-350					1										1
351-375					1	2		1							4
376-400						1	1								2
401-425								1	3	1					5
426-450										3		1			4
451-475									1		4		1		6
476-500												1	1		2
501-525												1		1	2
Total				1	2	3	1	2	4	4	4	3	2	1	27

APPENDIX B

Appendix B.-Data files used to estimate parameters of Arctic grayling populations on the Seward Peninsula in 1996.

Data File[a]	Description
W0120LA5.DTA	Data for Arctic grayling captured from the Snake River during 1995.
W006ALA5.DTA	Mark and recapture data for Arctic grayling captured from the Lower Pilgrim River during 1995.
W006BLA5.DTA	Mark and recapture data for Arctic grayling captured from the Upper Pilgrim River during 1995
W0110LA5.DTA	Data for Arctic grayling captured from the Eldorado River during 1995.

[a] Data files have been archived at, and are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage, Alaska 99518-1599.