Alaska Department of Fish and Game

JAMES W. BROOKS, COMMISSIONER

Federal Aid in Fish Restoration
Sport Fish Division

VOLUME 16
July 1, 1974
through
June 30, 1975

Study R-I: Distribution, Abundance, and Natural History of the Arctic Grayling in the Tanana River Drainage

By: Stephen L. Tack

Subport Building
Juneau, AK. 99801

F-9-7

Volume 16 STUDY R-I

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA RIVER DRAINAGE

by

Stephen L. Tack

ALASKA DEPARTMENT OF FISH AND GAME
James W. Brooks, Commissioner

Alaska DIVISION OF SPORT FISH
Rupert E. Andrews, Director
W. Michael Kaill, Chief, Sport Fish Research

TABLE OF CONTENTS

RESEARCH PROJECT SEGMENT

State: Alaska

Name: Sport Fish Investigations of Alaska.

Project No.: F-9-7

Study No.: R-I

Study Title: DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA RIVER DRAINAGE

Period Covered: July 1, 1974 to June 30, 1975.

ABSTRACT

Population levels of Arctic grayling, Thymallus arcticus, declined from 1973 to 1974 in three out of four study sections in the lower 76 km of the Chena River. The decline was associated with a failure of the 1971 year class of grayling and a sharp rise in angling effort.

A creel census on the upper Chena River showed 11,680 angler hours expended during July and August yielding 18,049 grayling. Another creel census at Bailey Bridge military campground on the middle Chena River during May, June, and July revealed 5,498 angler hours expended and a yield of 6,700 grayling.

A population estimate of the Goodpaster River using two years of data revealed a decline from 1973 to 1974 in the lower 53 km and upper 87 km of the 185 km study area. The central 45 km had comparable estimates in the two years. The 1971 year class was weak in the Goodpaster River as well as the Chena River, which would partially explain the population decline in the lower 53 km where this age class is normally abundant. During July, 1974, tag loss rate of 38.6% was found among recaptures of grayling tagged in the Goodpaster River in 1973.

The survival rate calculations for Goodpaster River and Chena River grayling were both affected by apparent variable recruitment.

Preliminary short term holding experiments (43-65 hr) indicated higher mortality and injury rates in grayling captured by A-C electroshocking than for grayling captured by seine.

Sampling of young-of-the-year grayling along the Chena River, once in July and once in September, showed a pattern of decreasing size as one moved up river, however all fish sampled had begun scale development.

Evidence is presented which indicates that grayling of the Chena River overwinter in the Chena River and do not move out into the Tanana River as previously assumed.

RECOMMENDATIONS

It is recommended that:

1. Grayling population estimates and age class frequency be determined in index sections of the Chena River.
2. Studies to evaluate effects of electrofishing on grayling be completed.
3. Efforts to determine the winter distribution of grayling be continued.

TECHNIQUES USED

The Chena (Table 1) and Goodpaster (Table 2) rivers were arbitrarily divided into sections to facilitate study of population parameters and migration patterns.

Table 1. Chena River Study Sections.

Section Number	Section Name	River Miles*	Section Length km	Section Length mi
1	River Mouth to University Ave.	0-6 (0-9.7)	9.7	6
2a	University Ave. to Peger Road	6-8 (9.7-12.9)	3.2	2
2b	Peger Road to Wendell Street	8-11 (12.9-17.7)	4.8	3
3	Wendell St. to Wainwright RR Bridge	11-14.5 (17.7-23.3)	5.6	3.5
4	Wainwright RR bridge to Badger Slough	14.5-21.5 (23.3-34.6)	11.3	7
5	Badger Slough		26.6	16.5
6	Badger Slough to Little Chena	21.5-25	5.6	3.5
7	Little Chena River		99.0	61.5
8	Little Chena to Nordale Slough	25-31.5 (40.3-50.7)	10.5	6.5
9a	Nordale Slough to Bluffs	21.5-55.5 (50.7-89.4)	38.6	24

Table 1. (cont) Chena River Study Sections.

Section Number	Section Name	River Miles*	Section Length km	Section Length mi
9b	Bluffs to Bailey Bridge	55.5-63 (89.4-101.4)	12.1	7.5
10	Bailey Bridge to Hodgins Slough	63-79 (101.4-127.2)	25.8	16
11	Hodgins Slough to 90 mi. Slough	79-90 (127.2-144.9)	17.7	11
12	90 Mi. Slough to 1st Bridge	90-92 (144.9-148.1)	3.2	2
13	First Bridge to 2nd Bridge	92-94.5 (148.1-152.1)	4.0	2.5
14	Second Bridge to North Fork	94.5-102 (152.1-164-2)	12.1	7.5
15	North Fork of Chena River		56.4	35
16	East Fork of Chena River		99.8	62

*km in parentheses

Table 2. Goodpaster River Study Section.

Area	River Section	Land Mark	River Miles	Section Length km	Section Length mi.
1	1	Flagged Tree	0-3	4.8	3
1	2	Flagged Tree	3-6	4.8	3
1	3	Flagged Tree	6-9	4.8	3
1	4	Flagged Tree	9-12	4.8	3
1	5	Flagged Tree	12-15	4.8	3
1	6	Flagged Tree	15-18	4.8	3
1	7	Flagged Tree	18-21	4.8	3
1	8	Flagged Tree	21-24	4.8	3
1	9	Flagged Tree	24-27	4.8	3
1	10	Flagged Tree	27-30	4.8	3
1	11	3 miles below the confluence of North and South Forks	30-33	4.8	3
2	12	Forks to Winter Trail Crossing on North Fork	33-36	4.8	3
2	13	Winter Trail to Central Creek	36-61	40.0	25
3	14	Central Creek to Indian Creek	61-74	20.8	13
3	15	Indian Creek to Glacier Creek	74-86	19.2	12
3	16	Glacier Creek to Slate Creek	86-102	25.6	16
3	17	Slate Creek to Eisenmenger Fork	102-115	20.8	13

A boat mounted electrofishing unit described by Van Hulle (1968) and Roguski and Winslow (1969) was used to capture Arctic grayling for population and frequency studies in the Chena and Goodpaster rivers.

Rod and line with small spinners was used to capture grayling in area III of the Goodpaster River.

A 7.5 x 1.2 m (25' x 4') seine with 0.95 cm (3/8") mesh and a 15.2 x 1.8 m (50' x 6') bag seine with 0.96 cm mesh were used to capture fry and yearling grayling.

Monofilament gill nets 7.5 x 1.8 m (25' x 6') with mesh sizes from 5.1 to 12.7 cm (2"-5") stretch measure were used during the spring netting at the mouth of the Chena River.

A Ryan 45 day recording thermograph was used to monitor water temperature at the mouth of the Chena River during spring netting.

A Hach Model Al-36-WR water test kit was used to determine dissolved oxygen, carbon dioxide, alkalinity, and pH.

A Friden Model 1155 calculator was used for most statistical calculations.

Population estimates were made using the techniques of Petersen, Schnabel, and Schumacher-Eschmeyer as described in Ricker (1958). Calculations of survival rates also follow those outlined in Ricker.

Dorsal fin punches were used for all marking during populations studies.

Grayling scales used for age determination were mounted on 20 mil acetate, using a heated press at 35,000 pounds pressure for 20 seconds. The scales were individually cleaned prior to mounting. The scales were read on a Bruning 200 Microfiche Reader.

JOB R - I - A Population Structure, Migratory Patterns and Habitat Requirements of the Arctic Grayling.

OBJECTIVES

1. Determine Arctic grayling age class abundance and distribution in the Tanana Drainage with emphasis on the Goodpaster and Chena rivers.

2. Determine the effects of capturing and handling techniques on Arctic grayling and other fish species as time permits.

FINDINGS

Population Estimates

In the Chena River estimates of the number of Arctic grayling, *Thymallus arcticus*, over 150 mm fork length, were made in sections 2a, 2b, 6, and in the area of the proposed Chena River Lakes Flood Control dam site km 71 to 76 (Table 1). Sections 2a and b which lie adjacent to Fairbanks and the dam site which will be directly impacted by construction of the Chena River dam are critical sections needing yearly information. Section 6 is relatively unaffected by development or angling and is easily accessible, so it is used as a control section. The population level in each of the four sections was calculated by both the Schnabel and Schumacher-Eschmeyer methods, which yielded similar results (Table 3). The 1974 population levels were the lowest since estimates were begun in 1968 (Table 4). There is no single apparent reason for the observed decline. The one major reason for the low levels was the failure of the 1971 year class (see section on survival rate) which would have been 3 years old in 1974, and would normally have been the dominant age class in the four sections sampled.

Data reported in 1971 (Tack, 1971) revealed the failure of the 1967 year class, presumably as a result of the severe flood in August of 1967. It is doubtful that a direct effect exists between the 1967 failure and the 1971 failure. The 1967 fish would have been age IV in 1971, and few grayling mature at age IV (Tack, 1971).

The winter of 1970-1971 saw a record snow fall, resulting in a high runoff that did not flood but remained high throughout the grayling spawning period. As spring runoff is often peaking at about the time grayling spawn, it was not expected that high water would adversely affect grayling spawning in 1971.

The time at which the population estimate was conducted might account for the difference estimated from year to year. There may well be some effect, but it was not the result of migration, as shown by a long term tag and recapture study (Tack, 1972). Standardization of time and conditions under which the estimates are conducted is certainly to be strived for.

Table 3. Grayling Population Estimate in Four Chena River Sections, 1974.

River Section	Date	Length of Section km (mi)	Number Marked	Schnabel Estimate GR/km	Schnabel Estimate (GR/mi)	Schumacher-Eschmeyer Estimate GR/km	Schumacher-Eschmeyer Estimate (GR/mi)	95% Confidence Limits for Schumacher-Eschmeyer GR/km
2a	June 26-28	3.2 (2)	36	56	(89)	65	(104)	36-372
2b	June 25-28	4.8 (3)	341	401	(642)	488	(780)	207-1,378
6	Aug. 13-15	4.8 (3)	82	86	(138)	100	(159)	71-164
Dam Site (km 71-76)	July 9-11	4.8 (3)	223	260	(416)	263	(421)	221-326

Table 4. Grayling Population Estimates for Various Sections of the Chena River, 1968-1974 (from Tack, 1974).

River Section	Year	Dates	GR/km	GR/mi
2a	1971	Aug 30-Sept 3	684	1,095
	1972	June 22-26	416	666
	1973	July 10-13	293	469
	1974	June 26-28	56	89
2b	1968		684	1,095
	1969		1,181	1,890
	1970	July 2-10	1,540	2,465
	1971a	June 2-7	2,036	3,257
	1971b	Aug 30-Sept 3	2,338	3,741
	1972	June 22-26	919	1,471
	1973	July 3-14	424	679
	1974	June 25-28	401	642
6	1968		282	452
	1969		571	913
	1970	May 26-30	481	769
	1971	June 21-24	368	589
	1972	June 19-20	207	331
	1973	July 16-17	243	389
	1974	Aug 13-15	86	138
9a at Dam Site (km 71-76)	1972	June 27-29	1,140	1,824
	1973	July 18-19	500	800
	1974	July 9-11	260	416

Length Frequency

The length frequency of all grayling captured during population estimation sampling in sections 2a, 2b, 6, and at the dam site is shown in Table 5. The mean lengths of the four samples are similar.

Section 2a, the furthest downstream of the 4 sections, differed from the rest by having substantially fewer grayling and by having a greater percentage (8.7) of mature grayling than the other three sections, which had 4.8, 5.3, and 5.3 % mature fish (greater than 270 mm - Roguski and Tack, 1970).

Table 5. Length Frequency (in percent of sample) of Grayling in Four Sections of the Chena River, 1974.

Fork Length in cm	Chena River Section			
	2a	2b	6	Dam Site
10-10.9			0.8	
11-11.9			3.0	
12-12.9			3.8	
13-13.9	1.1	0.6	1.5	
14-14.9	0.0	1.0	2.2	0.3
15-15.9	0.0	3.8	3.0	5.2
16-16.9	5.4	5.7	5.3	0.0
17-17.9	5.4	5.3	1.5	1.7
18-18.9	12.9	5.3	11.3	6.6
19-19.9	7.5	10.8	8.3	11.7
20-20.9	5.4	12.1	15.5	6.0
21-21.9	10.8	10.8	8.3	13.8
22-22.9	9.7	10.6	11.3	10.3
23-23.9	4.3	10.2	15.0	11.7
24-24.9	14.0	10.4	4.5	6.6
25-25.9	11.8	4.4	7.5	6.2
26-26.9	3.2	4.0	1.5	3.1
27-27.9	1.1	1.5	1.5	2.8
28-28.9	4.3	1.9	1.5	2.1
29-29.9	1.1	1.0	0.0	0.7
30-30.9	1.1	0.2	1.5	0.7
31-31.9	1.1	0.0	0.0	0.7
32-32.9		0.0	0.8	0.0
33-33.9		0.2		0.0
34-34.9				0.3
n	93	472	133	290
$\bar{x}$	222	215	208	220
Range	130-310	130-330	100-320	140-340

Capture Rate

The number of individuals of each fish species captured per hour of electrofishing is shown in Table 6 as a rough index of relative abundance of the resident fish. Grayling is the species sought during the sampling, so other species are probably under-represented. In sections 2a and 2b suckers, Catostomus catostomus, are numerous and were not collected.

Table 6. Capture Rate of Various Fish Species in the Chena River Using An A-C Electrofishing Unit, 1974.

River Section	Fish* Per Hour					
	GR	RWF	S	NP	BB	Other Whitefish**
2a	82	58	-	0	5	6
2b	112	50	-	0	2	2
6	25	17	31	2	<1	4
Dam Site (9a)	44	16	25	<1	<1	<1

*GR - Arctic Grayling
RWF - Round Whitefish, Prosopium cylindraceum
S - Longnose Sucker
NP - Northern Pike, Esox lucius
BB - Burbot, Lota lota

**Other Whitefish - Humpback whitefish, Coregonus pidschian
Least cisco, Coregonus sardinella

Annual Survival Rate

To obtain a representative sample of grayling from the Chena River, subsamples of about 100 fish each were randomly taken from sections 2, 6, and the dam site. The age and length frequencies determined for the subsample appear in Table 7. The mean fork lengths of the combined sample correspond closely with the mean fork lengths of the original samples (see section on length frequency). Since all sampling was done in the lower 76 km of the Chena River, age classes V and above that migrate further upstream, are not represented (Tack, 1972).

Age class IV is the dominant class in the 1974 sample. This is not normally the case. In 1973, age class III made up 60% of the Chena River sample and 45% of the Goodpaster River sample. In previous years, strictly random samples were not used, but age class III is nearly always the dominant age class. Fish in age class III are readily captured by electrofishing and I feel they are representatively sampled.

Table 7. Age and Length Composition of Random Subsample of Grayling Captured in Sections 2a, 2b, 6, and at the Dam Site in the Chena River, 1974.

Length mm	Age Class I	II	III	IV	V	VI	VII	Total n	Length Frequency %
100	1							1	0.3
110	2							2	0.7
120	4							4	1.3
130	2							2	0.7
140	2	2						4	1.3
150		7	2					9	3.0
160	1	9		1				11	3.6
170		6	2					8	2.6
180		6	8	7				21	6.9
190		2	8	20				30	9.9
200			6	27	2			35	11.6
210			6	27	9			42	13.9
220			2	17	13	1		33	10.9
230			3	15	18	3		39	12.9
240				7	12	1		20	6.6
250				6	15	1		22	7.3
260				4	2	2		8	2.6
270				2	0	1		3	1.0
280					3	2		5	1.6
2									
90					1			1	0.3
300					1	1		2	0.7
310							1	1	0.3
n	12	32	37	133	76	12	1	303	
Age Freq-ency %	4.0	10.6	12.2	43.9	25.1	4.0	0.3		
$\bar{x}$ Fork Length	130	169	199	217	236	259	315	213	

The low representation of age class III (12.2%) in the 1974 sample indicates a failure of the 1971 year class. Probable reasons for the failure were discussed earlier in the section on population estimates.

Annual survival rates between age classes were calculated for the 1973 (Tack, 1974) and 1974 samples (Table 8). Annual survival rate probably only truly represents survival when applied to age classes III and IV. Older grayling migrate further upstream and cause the calculated survival rate to drop below the actual rate. Because of the variable recruitment, survival calculated between age classes is not particularly useful. An alternate measure of survival is between cohorts in successive years. This calculation is also affected by variable recruitment, but the effect can be somewhat removed by setting the initial recruitment at age III equal for the two years and recalculating subsequent frequencies proportionately. This was done by changing the age class III frequency for 1974 from 12.2% to 60.5%. The formula used follows:

$$C_{74i} = \frac{(O_{74i})\ (100\% - O_{73\ III})}{100\% - O_{74\ III}}$$

Where - C_{74i} = adjusted 1974 age frequency for any age class.

O_{74i} = observed 1974 age frequency for any age class.

O_{73III} = observed 1973 age frequency for age class III of 60.5%.

O_{74III} = observed 1974 age frequency for age class III of 12.2%.

The survival measured between cohorts (Table 8 last column) appears higher than survival rates measured between age classes. This should be nearer the actual rate, but more years of sampling are needed to smooth the effect of variable recruitment.

Table 8. Survival Rates of Grayling in the Lower 76 Km of the Chena River Based on Random Samples of 200 Fish in 1973 and 303 Fish in 1974.

Age Class	Percent Frequency			Annual Survival Rate			
	1973	1974	1974[a]	1973	1974	1974[a*]	1973-74 cohorts
III	60.5	12.1	60.5				
				.298		.327	.327
IV	18.0	44.1	19.8				
				.167	.562	.566	.622
V	3.0	24.8	11.2				
					.157	.161	.600
VI	0	3.9	1.8				
					.077	.056	
VII	0.5	0.3	0.1				

*1974[a] data adjusted by setting the frequency for age III equal to the 1973 frequency and recalculating the frequency for subsequent age classes.

Upper Chena River Creel Census

A random method of counts along the Chena Hot Springs Road between km 42 and km 99 was used to estimate the total angler hours of effort. Counts were made during randomly chosen 2 hour periods between 6 a.m. and 12 p.m. on one weekend day and two weekdays every other week during July and August. Interviews were obtained from anglers having completed their trip to determine the length of time fished and their success as well as the composition of the angling public. The results of the counts and interviews appear in Table 9.

An estimated 11,680 angler hours were expended during July and August, yielding 18,049 grayling. Most of the fishing pressure was in July and 74% was done by local residents. Tourists made up 11% and military personnel 15% of the people fishing.

The upper Chena River fishery involves about 56 km of main river and 48 km of tributary stream. If the yield came evenly from the 104 km of stream, it would be 174 grayling/km. This, however, is not exactly the case as angling is known to be heavier in the main river than in the tributaries.

The last creel census conducted in this area was in 1970. The angler hours then were about 6,000, the catch rate 0.72 grayling/angler hour, and the yield about 4,000 grayling (Tack, 1971). The increase in yield in 1974 was probably the result of the extremely low water during July and August. This concentrated the grayling and with the clear water made fishing very productive.

Table 9. Results of Upper Chena Creel Census, 1974.

Angler Hours

Period	Weekdays	Weekends	Total
July	2,976	6,572	9,548
August	88	2,044	2,132
Total Angler Hours			11,680

Fishery Statistics

	July	August	Total
No. Anglers Interviewed	198	150	348
Mean Hr. Fished/Angler Interviewed	2.33	2.10	2.28
Total GR Caught By Anglers Interviewed	936	738	1,674
Total GR Kept by Anglers Interviewed	632	735	1,367
GR Kept/Angler-Hour	1.37	2.33	1.72
Total Grayling Harvest	13,081	4,968	18,049

Angler Composition

	July	August	Total
Local Resident	76%	71%	74%
Military	14%	17%	15%
Tourist	10%	12%	11%

Bailey Bridge Campground:

The Bailey Bridge Campground located at 101 km on the Chena River is operated by Eielson Air Force Base and is accessible by road from the Base. The bridge has long since been removed. There is public access to the north bank from the Chena Hot Springs Road but the road is poor and there is limited parking area at the river, consequently most anglers are military personnel.

The census was conducted by U.S. Fish and Wildlife Service personnel following a sampling scheme I developed. The data were analyzed by Alaska Department of Fish and Game personnel.

The sampling was done in two parts, random counts and angler interviews. The counts were made during randomly selected one hour periods between 8 a.m. and 12 p.m. on one randomly selected weekend day and two weekdays every other week during May, June, and July. The interviews were limited to anglers who had completed their trip and gave information on length of time fished, catch, and residence.

During the three months studied 5,498 man hours were expended and 6,700 grayling were harvested (Table 10). The catch per man hour averaged 1.21 grayling kept. The anglers were primarily military (94%) with the remainder residents (6%).

Table 10. Results of Chena River Creel Census at Bailey Bridge, 1974.

Angler Hours

Period	Weekdays	Weekends	Total
May	872	459	1,331
June	1,094	1,179	2,273
July	910	984	1,894
Total Anglers Hours			5,498

Fishery Statistics

	May	June	July	Total
No. Anglers Interviewed	33	106	61	200
Mean Hr. Fished/Angler Interviewed	0.64	1.75	0.67	1.24
Total Gr. Caught by Anglers Interviewed	8	214	77	299
Total Gr. Kept by Anglers Interviewed	8	214	77	299
Gr. Kept/Angler Hour	0.38	1.15	1.89	1.21
Total Grayling Harvest	506	2,614	3,580	6,700
Angler Composition:				
Local Resident	03%	09%	03%	06%
Military	97%	91%	97%	94%
Tourist	0	0	0	0

Goodpaster River Studies

Population Estimates:

During late July a two week sampling trip was made over 160 km (100 mi) of the main Goodpaster River and North Fork as a follow-up to the intensive study conducted during the summer of 1973. Cpature methods were the same in 1974 as in 1973 (Tack, 1974) with areas I and II electrofished and area III hook and line sampled (Table 2). The number of fish captured and the number with 1973 marks were recorded. No new marking was done.

An estimate of the number of 1973 marked fish remaining in the population was obtained by assuming that survival of marked fish was the same as unmarked fish. The mean survival rate for grayling age III and older was 0.54 as calculated using the 1973 data (Tack, 1974). This value was used directly to estimate the number of marked fish remaining, as the present sample was taken approximately one year from the midpoint of the 1973 sampling. The assumption that survival among marked grayling equals that of unmarked grayling is probably not correct, but no estimate of the differential survival is available.

The estimates of population levels (Table 11) in the three areas of the Goodpaster River calculated from the 1974 sample by the Petersen method are 201, 298, and 39 grayling/km in areas 1, II, and III respectively. In 1973, the Schnabel estimates were 480, 322, and 81 grayling/km. This represents a decline in areas I and III and a comparable level in area II.

The 1974 estimates are the best possible with the data available but should be regarded as rough estimates because of the assumptions involved. If marked fish suffered a greater mortality than unmarked fish the 1974 estimates would be even lower.

Tag Loss Rate:

During 1973, 5,293 grayling were tagged in the Goodpaster River with Floy internal anchor tags and the left pelvic fin was removed. Eighty-eight of these 1973 tagged grayling were recaptured in the July 1974 sample. Of the 88 recaptures 34 had lost the tag for a loss rate of 38.6%. The losses occurred in small grayling and large grayling alike. Several fish retaining tags were about to lose them through ulceration. All of the fish that lost their tags had healed completely but most had a large scar indicating that the tag had ulcered out or had been torn out.

Table 11. Calculated Arctic Grayling Population Estimate for 185 km of the Goodpaster River, 1974.

Area	km	Tagged in Population(M) 1973	Tagged Fish Remaining (M_1)* 1974	No. in Samples(C) 1974	Recaps(R) 1974	Petersen Estimate**	GR/km
1	53	2,253	1,217	489	55	10,648	201
2	45	887	479	279	9	13,412	298
3	87	636	343	275	27	3,381	39
Combined areas		3,776	2,039	1,043	91	27,441	148

*Assuming a constant annual rate of mortality of 0.46

** $N = \frac{(M_1)\ (C+1)}{(R+1)}$

Length Frequency

The length frequency distribution of grayling in each of the three areas of the Goodpaster River is shown in Figure 1. The modal length in Area I of 215 mm is considerably higher than the July 1973 mode of 170 mm (Tack, 1974). This is probably the result of the weak age class III as shown in age class frequency (next section). The mean length of the 1974 sample in area I (213 mm) was also higher than the 1973 mean (196 mm). In area II the form of the graph changes from a relatively flat one in July 1973 to one with a definite mode at 225 mm. This would indicate a strong age IV group, perhaps stronger than average. The mean length of the 1974 sample (233 mm) in area II dropped from the 1973 mean (244 mm). The mean length (328 mm) in area III also dropped in 1974 from the 1973 mean (335), however the modal length rose from 345 to 355 mm.

The mean length frequency by river section (Figure 2) has the same pattern as the 1973 samples. The low representation of age class III resulted in means for sections 2 through 11 being higher than in 1973.

Annual Survival Rate

The age frequency data needed for the calculation of survival rate were prepared by first determining the age of 100 randomly chosen scale samples from each of the three Goodpaster River areas. A combined age frequency for the entire 185 km sample section was then generated by weighting the area frequencies by the 1973 population estimate in grayling/km for the three areas. The age frequency (Table 12) obtained reveals the weak representation of age class III in the 1974 sample. This situation was also noted in the Chena River data. In an attempt to show survival of cohorts from 1973 to 1974, the 1974 age frequency data were adjusted to reduce the effect of the weak age class III. The adjustment was done by setting the frequency of the 1974 age class III equal to the 1973 value and recalculating the subsequent age class frequencies proportionate to their 1974 values.

The pattern of survival was similiar for 1973, 1974, and the adjusted 1974 calculations, with high survival between age classes VI and VII, and low survival between age classes VII and VIII (Table 12). Survival calculated between cohorts showed the same pattern but somewhat less extreme variations.

The survival data are difficult to obtain in a stratified population but has considerable value for management. The data obtained in the two years of study must be regarded as preliminary and in need of refinement. The effect of variable recruitment needs study. The variable but apparently consistent lows and highs of survival between certain age classes needs explanation.

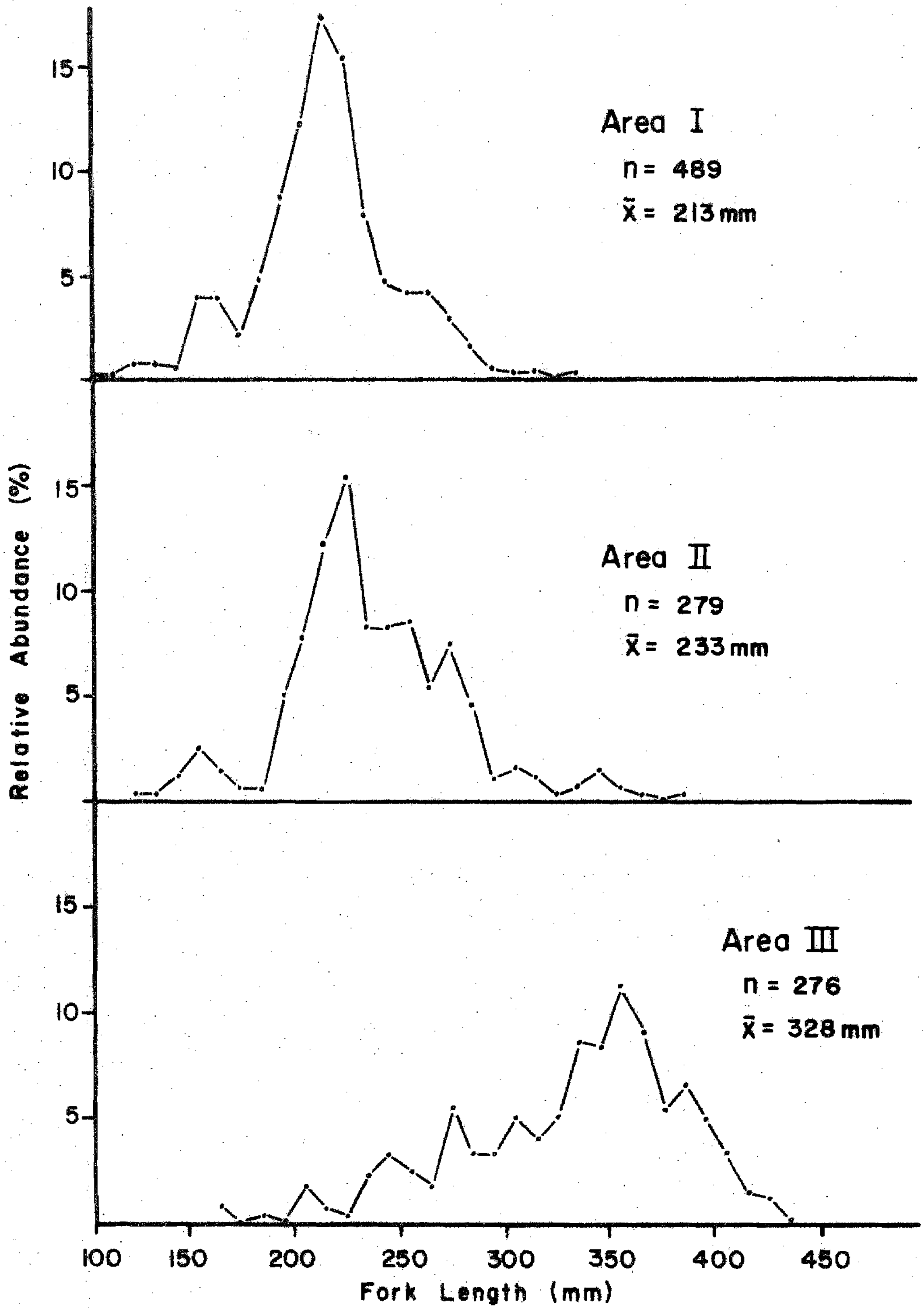

Figure I. Length Frequency Distribution of Arctic Grayling in Three Areas of the Goodpaster River, July 1974

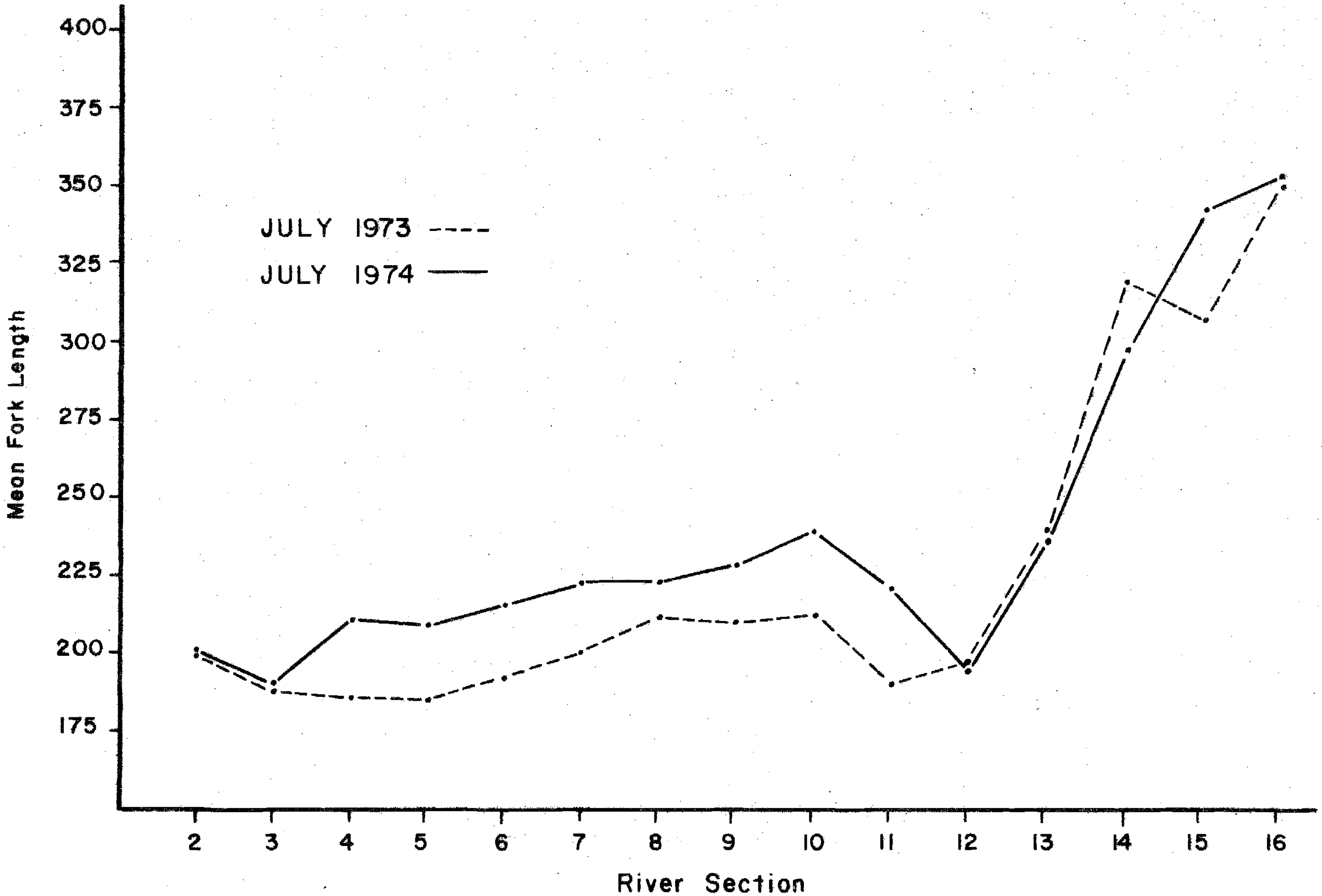

Figure 2. Mean Fork Length of Goodpaster River Arctic Grayling by River Section for July, 1973 and 1974

Table 12. Survival Rates of Grayling in the Goodpaster River Based on a Random Sample of 300 Fish Each Year.

Age Class	Percent Frequency 1973	1974	1974a*	Annual Survival Rate 1973	1974	1974a*	1973-1974 cohorts
III	44.82	6.91	44.82				
				.618		.760	.760
IV	27.71	52.39	34.07				
				.480	.382	.382	.470
V	13.31	20.01	13.01				
				.391	.278	.278	.272
VI	5.20	5.57	3.62				
				.827	.986	.986	.686
VII	4.30	5.49	3.57				
				.107	.149	.148	.123
VIII	0.46	0.82	0.53				
					.341	.340	.391
IX	0.55	0.28	0.18				
				.673			.327
X	0.37	0.28	0.18				

*1974[a] Data adjusted by setting the 1974 age III frequency equal to the 1973 age III frequency and recalculating the frequency for subsequent age classes.

Migration:

The analysis of tag returns for migratory information will be done following the 1975 field season. Experience indicates that a substantial number of returns are obtained through the second summer following a tagging study on grayling.

King Salmon Count:

While sampling the 160 km of the Goodpaster River the number of king salmon, Oncorhynchus tshawytscha, observed were enumerated (Table 13). The kings were on the spawning redds during the counting period from July 27 to August 3. Some carcasses were counted but most of the fish were alive. An estimated 20% of observed kings were jacks (precocious males). During the count the weather was sunny except for one day when it rained heavily. The water was clear throughout the count. Chum salmon, O. keta, had just begun to appear in the river and only 24 were counted.

Table 13. Salmon Counted From Boat in the Goodpaster River From July 27 to August 3, 1974.

River Section	King Salmon	Chum Salmon
Mouth to 34 km	0	0
34 km to Forks	4	12
Forks to Airfield	153	12
Airfield to Indian Creek	41	
Indian Creek to Glacier Creek	29	
Glacier Creek to 160 km	21	
Total	248	24

Effects of A-C Electrofishing Techniques

Long term and short term holding experiments were undertaken to determine the effect of A-C electrofishing equipment on growth and survival of grayling. The long term experiments involved treating grayling in various ways (Table 14) and holding them for one year in a small barren lake. The capture and handling techniques were as follows: grayling were captured in the Chena River by a designated method (Table 14) and put in streamside holding pens. When collecting was finished for the day, the grayling were given the designated treatment (Table 14), and put in large plastic containers for transport to the nearest landing (maximum of 5 km). At the landing, the fish were placed in a 500 gallon fish transport tank and taken to North Twin Lake on Fort Greely. The trip from holding pen to transport tank took from 15 to 45 minutes and the trip to North Twin Lake took approximately 3 hours. Temperature change in the transport tank never exceeded 1°C. The tank temperature was usually about 6° to 7°C by the end of the trip and the lake surface temperature was 11°C. Five of 530 grayling used in the experiment died in transit. The grayling will be recovered from North Twin Lake in June 1975 and the results will be reported in the F-9-8 annual report.

The short term experiments were conducted in the Chena River during June 1974. The 4' x 4' x 3' knotless nylon holding pens were set up in about 3' of water at river km 13. Grayling used in the experiments were captured between km 11 and 20 by either seine or electroshocker. The seine samples took somewhat longer to collect so when one batch (25 fish) was collected it was transported to the holding pens.

Usually two batches were collected by shocker before taking the fish to the holding pens. The time involved from the start of collection until the fish were put in the pens was about one hour for both capture methods. Each batch was transported in a separate 30 gallon plastic container. Water in the containers was periodically aerated or exchanged with a bucket. When two batches of grayling were collected on one trip, the first 25 fish captured constituted the first batch and the next 25 fish the second batch. Upon returning to the study camp, the fish were immediately put into the pens. No effort was made to note injuries present at the onset of the holding period. The holding pens were covered with netting to keep the grayling from jumping out or birds from attacking them. An attendant was at the holding site during all experiments.

Seine capture was considered the least abusive capture method available, thus providing a base or control against which to compare groups captured by electrofishing. Grayling ranged in size from 126 to 330 mm (mean 216 mm) and no attempt was made to segregate batches by size.

At completion of the holding experiment all fish were examined externally for indications of injury or impaired swimming ability. Fish were judged healthy, injured, near death, or dead. Fish falling in the injured category could swim to some degree but showed such injuries as: lacerations, blood in the eye, necrotic skin or bent spine. The near death category included only those fish judged certain to die. Their sole vital sign was usually gill movement. Autopsy facilities were not adequate at the field site to accurately determine cause of death.

Table 15 summarizes the results of the three short term holding experiments. In general the number of grayling dead or near death was about the same (8%) for all voltages used, however, the number of injuries increased with voltage from 11% at 150 volts to 28% at 250 volts. The 53 grayling captured by seining showed one death (4.8%) attributed to the capture technique. Two others died when the chain used to weight the holding pen was placed on them. One seined fish had many scales missing and one had a cut on the head for an injury rate of 3.8%.

The most common injury type was necrotic skin. Necrotic skin appeared as pale, swollen patches, devoid of slime with the scales protruding nearly vertically from the body. The injuries ranged in size from small centimeter square patches to the entire caudal peduncle. The injury was most common in the posterior region of the body. This type of injury was not fatal to any fish during the time of the experiment but two with the entire caudal peduncle affected could not swim and were judged near death.

The short term experiments reported on here constitute only an initial inquiry to determine if a problem exists. It is apparent that there is a problem and that further study should be undertaken. The experiments reported here should be repeated and further experimentation done to reduce the injury and mortality rate of shocker captured fish.

Table 14. Treatments Used on Arctic Grayling From the Chena River to Test Their Effects on Growth and Survival After One Year of Holding in a Small Lake, 1974.

Effect Being Tested	Date of Capture and Transfer	Location of Capture*	No. Treated	Treatment: Capture Method	MS-222	Fin Clipped	Scale Sample	Length Sample	Tag Type	Tag Series
Shocker & Tag	May 20	Sec 8	17	Seine	X	X	X	X	Juv** Tag	B100-B116
Shocker & MS-222	May 20	Sec 8	27	Seine		X	X	X	Int Anch***	3035-3061
Shocker, MS-222, Fin Clip, Scale, Length, Tag	May 20	Sec 8	15	Seine					Juv Tag	B084-B099
Control	May 21	Sec 8	20	Seine						
Standard****	May 21	Sec 8	34	Shocker	X	X	X	X	Int Anch	3001-3034
Standard	May 22	Sec 8	30	Shocker	X	X	X	X	Int Anch	3069-3098
Fin Clip	May 22	Sec 8	30	Shocker	X		X	X	Int Anch	3099-3121 3146-3153
MS-222	May 22	Sec 8	17	Shocker		X	X	X	Int Anch	3122-3138
Int Anchor Tag	May 22	Sec 8	23	Shocker	X	X	X	X	Juv Tag	B117-B139
Shocker & MS-222	May 23	Sec 8	14	Seine		X	X	X	Int Anch	3062-3068 3139-3145
Standard	May 23	Sec 8	22	Shocker	X	X	X	X	Int Anch	3154-3175

Table 14. (cont.) Treatments Used on Arctic Grayling From the Chena River to Test Their Effects on Growth and Survival After One Year of Holding in a Small Lake, 1974.

Effect Being Tested	Date of Capture and Transfer	Location of Capture*	No. Treated	Treatment: Capture Method	MS-222	Fin Clipped	Scale Sample	Length Sample	Tag Type	Tag Series
Int Anchor Tag	May 23	Sec 8	19	Shocker	X	X	X	X	Juv Tag	B140-B143 B145-B151 B153-B160
Fin Clip	May 23	Sec 8	20	Shocker	X		X	X	Int Anch	3176-3195
Shocker, Fin Clip, Tag	May 31	North Fork	11	Weir	X		X	X	Juv Tag	B161-B168 B182-B184
Shocker, Fin Clip, Tag	May 31	North Fork	17	Sport Gear	X		X	X	Juv Tag	B169-B181 B185-B188
Shocker, Fin Clip, Tag	June 5	North Fork	14	Sport Gear	X		X	X	Juv Tag	B189-B202
Shocker, Fin Clip, Tag	June 7	Sec 2	100	Seine	X		X	X	Juv Tag	B203-B302
Fin Clip, Tag	June 10	Sec 2	100	Shocker	X		X	X	Juv Tag	B303-B349 B351-B539 5 Dead

*Location of Capture - See table 1
**Juv Tag - Floy Juvenile Tag
***Int Anch - Floy Internal Anchor Tag
****Standard - Treatment normally given grayling during a tagging study.

Table 15. Results of Three Short term Holding Experiments to Test the Effects of Various Levels of A-C Electro Shock on Arctic Grayling.

Experiment 1

One hundred grayling captured at 150 volts and 2 to 3 amps held 65 hours in water temperatures between 14°C and 14.75 °C and dissolved oxygen of 14 ppm

Escaped	Healthy	Dead	Near Death	Injured
6	75	3	2	13

Experiment 2

Seventy-six grayling held 62 hours in water temperatures between 14.8°C and 15.5°C and dissolved oxygen of 11 ppm.

Pen No.	Number of Grayling	Treatment*	Healthy	Dead	Near Death	Injured
1	25	175V, 4A	19		2	4
2	25	200V, 5A	19		2	4
3	25	Seine	25			1

Experiment 3

Seventy-eight grayling held 43 hours in water temperatures between 13.8°C and 14.1°C and dissolved oxygen of 11 ppm.

Pen No.	Number of Grayling	Treatment*	Healthy	Dead	Near Death	Injured
1	25	225V, 4.3A	16	1	1	7
2	25	250V, 3A	16	2		7
3	28	Seine	24	3**		

*V-Volts; A-amperes

**Two accidental deaths not related to capture method.

R - I - B Early Life History of Arctic Grayling.

OBJECTIVES

1. Determine growth and scale development of young-of-the-year grayling in the Chena River.

FINDINGS

Collections of young-of-the-year Arctic grayling were made on July 15 and September 25, 1975 at various sites along the Chena River in an effort to relate growth with location in the river. Though the samples were not evenly spaced over the length of the river and the lower river was not well represented, the pattern of development clearly shows the mean size to decline as one moves upstream (Figure 3). The decline is not a straight line, probably as a result of differences in rearing conditions in the particular site from which the sample was taken.

The September sample from 186 km averaged 52 mm fork length and ranged from 43 to 68 mm. With scales beginning formation at 35 mm (Tack, 1971) all grayling sampled would have begun scale development in their first year of life. However, young-of-the-year grayling are known to rear further up the Chena River than 186 km and some of these may not begin scale formation in the first year.

The rapid growth of young-of-the-year grayling represented by the 17 km sample in September may be a local phenomenon resulting from the enriched aquatic habitat adjacent to the city of Fairbanks.

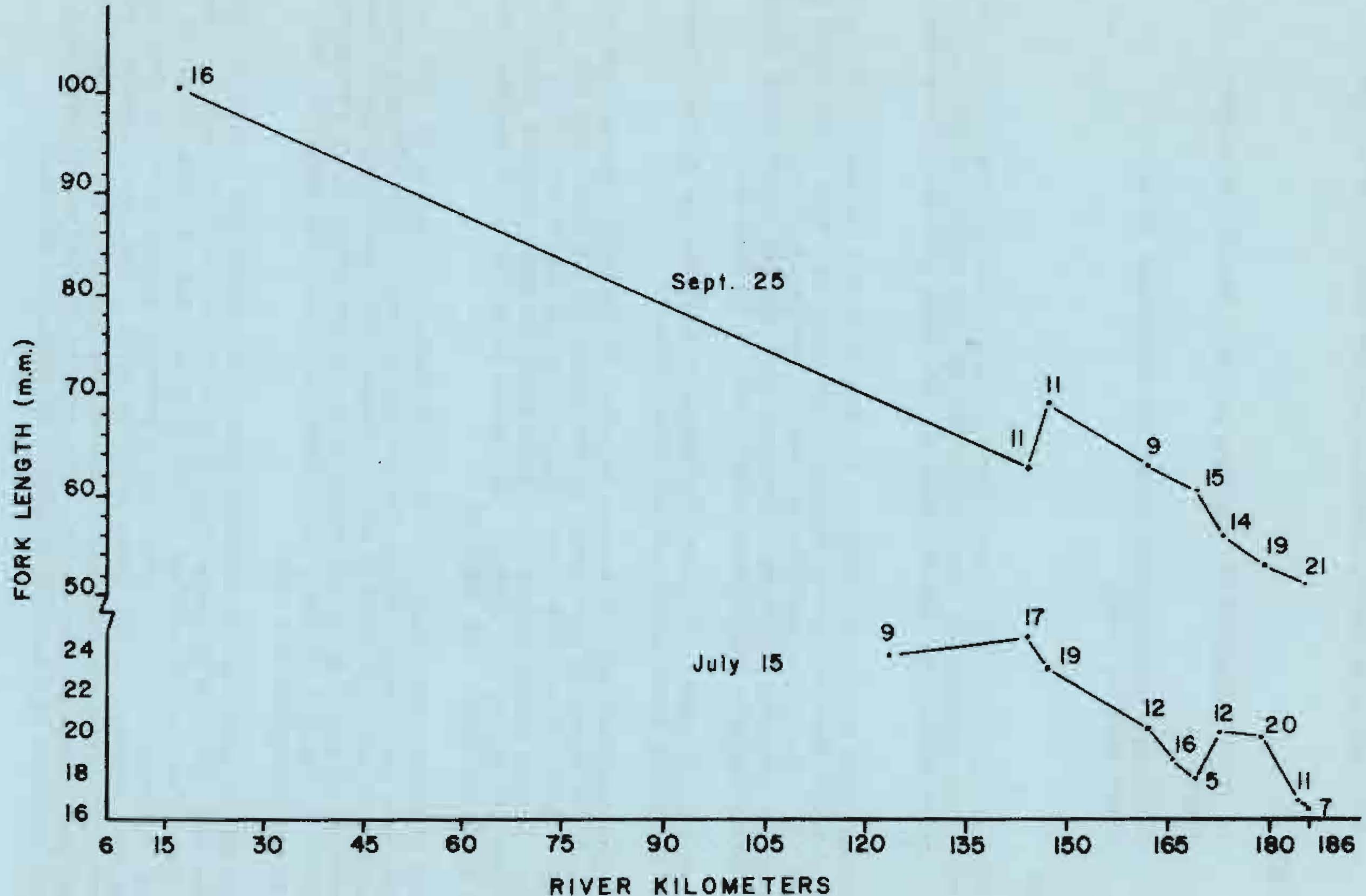

Figure 3. Mean Fork Length and Number in Sample of Young-of-the-Year Artic Grayling by Kilometer in the Chena River, 1974

R - I - C The Winter Ecology of the Arctic Grayling in the Tanana River Drainage with Special Emphasis on the Chena River System.

OBJECTIVES

1. To develop methods of sampling grayling during the winter months.

2. Determine overwintering areas and conditions extant in overwintering areas.

FINDINGS

The effort to determine the winter distribution of Arctic grayling in the Chena River was expanded to cover about 160 km (100 miles) of the river. In previous years effort was concentrated in the lower 30 miles of the Chena River.

Monofilament gill nets 7.6 m long, 1.8 m deep with 5.1 cm and 6.3 cm stretch mesh were set under the ice at several sites from the Chena River mouth to river km 157. The sites were chosen more on the basis of accessibility than to achieve an even distribution. The nets were checked about twice a week except during January when checks were a week to 10 days apart.

The catch record (Table 16) shows the marked difference in species composition between the Chena River mouth and all other sites.

Suckers and humpback whitefish were abundant at the mouth during spring and winter. A few sheefish were taken at the mouth during April and one in November. Burbot were also taken regularly at the mouth but not in large numbers. Gravid female burbot were also taken in small numbers at river km 147 and 157 during the winter. All sites above the mouth yielded predominantly round whitefish and grayling.

Only two grayling were caught at the mouth during the spring of 1974 and only two more were caught during the winter netting. This strongly indicates that no run of any significance occurs between the Tanana and Chena rivers. The presence of grayling at all other sites up the Chena River throughout the winter is further evidence that Chena River grayling remain in the Chena River throughout the year.

The pattern of grayling distribution (Table 17) during the winter definitely involves the entire main Chena River from mouth to the North and East forks at km 159. The largest catches of grayling were made at Nordale Bridge (km 42) in March, possibly indicating a greater concentration of grayling in the lower reaches of the Chena River by March. The data, however, were too sketchy to draw any conclusions concerning quantitative distribution of grayling throughout the winter. The catches were also too small and sporatic to yield any data on direction or timing of movement.

Table 16. Catch Record of All Fish Species Captured in the Chena River by Gill Net During the Spring of 1974 and the Winter of 1974-1975.

Month	Location mi	km	Net Days	Fish Captured** GR	RWF	HWF	S	BB	NP	SF
Apr, 1974	mouth	0	60	1	19	67	313	18	5	5
	26	42	11	1	0	10	20	8	1	0
May, 1974	mouth	0	8	1	0	2	25	2	4	0
Nov, 1974	mouth	0	8	0	1	5	16	0	0	1
	26	42	7	0	1	0	3	1	2	0
Dec, 1974	mouth	0	28	0	10	52	23	8	0	2
	80	128	27	4	2	0	0	0	0	0
	98	157	22	4	16	0	0	2	0	0
Jan, 1975	98	157	28	15	25	0	0	2	0	0
Feb, 1975	mouth	0	46	2	1	28	6	15	0	0
	92	147	45	22	115	0	0	1	0	0
	98	157	21	2	11	0	0	2	0	0
Mar, 1975	mouth	0	31	0	0	18	38	4	0	0
	26	42	18	79	71	3	0	1	0	0
	80	128	10	0	1	0	0	0	0	0
	92	147	4	1	1	0	0	0	0	0
	98	157	27	11	14	0	0	2	0	0
Totals			401	143	288	185	444	66	12	8

*Distances are from the river mouth.

**GR - Grayling
RWF -Round Whitefish
HWF - Humpback Whitefish
S - Sucker
BB - Burbot
NP - Northern pike
SF - Sheefish

Table 17. Catch Record of Arctic Grayling Captured Under the Chena River Ice with 1.8 m x 7.6 m, 5.1 cm and 6.3 cm stretch gill nets, 1974-1975.

Net Site Name	Location		November		December		January		February		March	
	Mi	km	ND*	GR***	ND	GR	ND	GR	ND	GR	ND	GR
Chena R. Mouth	0	0	8	0	28	0	...	...	46	2	31	0
Nordale Bridge	26	42	7	0	...	...	...	...	...	...	18	79
28 Mi C.H.S.R.*	80	128	...	...	27	4	...	...	...	...	10	0
40 Mi C.H.S.R.	92	147	...	...	...	...	...	...	45	22	4	1
43 Mi C.H.S.R.	98	157	...	...	22	4	28	15	21	2	27	11

*C.H.S.R. - Chena Hot Springs Road
**ND - Net days
***GR - Arctic grayling

LITERATURE CITED

Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fisheries Research Board of Canada, Narrain, B. C., Canada, Bull. 119.

Roguski, E. A. and Winslow, P. C. 1969. Investigations of the Tanana River and Tangle Lakes grayling fisheries: migratory and population study. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1968-1969, Proj. F-9-1, 10:333-351.

__________ and Tack, S. L. 1970. Investigations of the Tanana River and Tangle Lakes grayling fisheries: migratory and population study. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1969-1970, Proj. F-9-2, 11:303-319.

Tack, S. L. 1971. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1970-1971, Proj. F-9-3, Vol. 12: Study R-I, 35 pp.

__________. 1972. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1971-1972, Proj. F-9-4, Vol. 13: Study R-I, 36 pp.

__________. 1973. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1972-1973, Proj. F-9-5, Vol. 14: Study R-I, 34 pp.

__________. 1974. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1973-1974, Proj. F-9-6, Vol. 15: Study R-I, 52 pp.

Van Hulle, F. D. 1968. Investigations of the fish populations in the Chena River. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1967-1968, Proj. F-5-R-9, 9:287-304.

Prepared by:

Stephen L. Tack
Fishery Biologist

Approved by:

s/W. Michael Kaill, Chief
Sport Fish Research

s/Rupert E. Andrews, Director
Division of Sport Fish