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SUMMER DISTRIBUTION OF ARCTIC FISHES IN THE OKPILAK, AKUTOKTAK, KATAKTURUK, AND JAGO RIVERS, ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA, 1990

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Summer Distribution of Arctic Fishes in the Okpilak, Akutoktak, Katakturuk, and Jago Rivers, Arctic National Wildlife Refuge, Alaska, 1990

David W. Wiswar

Fishery Assistance Office, U.S. Fish and Wildlife Service
101 12th Avenue, Box 17, Room 222, Fairbanks, Alaska 99701

Abstract.—The summer distribution of arctic fishes was investigated in the Okpilak, Akutoktak, Katakturuk, and Jago rivers during three sampling periods in 1990. Arctic char *Salvelinus alpinus*, Arctic grayling *Thymallus arcticus*, and ninespine stickleback *Pungitius pungitius* were captured.

In the mainstem Okpilak River, juvenile Arctic char were distributed throughout the lower 70-80 km of stream and in two tributaries. No adult or young of the year Arctic char were captured. Adult Arctic grayling were captured in the mainstem only one time (July) at one site and juveniles were captured in the mainstem between 50 - 80 km upriver. Young of the year Arctic grayling were present in two tributary streams and three mainstem sites adjacent to tributaries in July. In August and September, young of the year were widely distributed in the mainstem. Juvenile and adult Arctic grayling were captured during all sampling periods in a lake and feeder and outlet streams located in the foothills of the Brooks Range. Fork lengths (FL) of juvenile and adults at this site ranged from 105 to 331 mm.

In the Akutoktak River, only three juvenile Arctic char were captured in August. No adult or young of the year were captured. Adult Arctic grayling were distributed in the mainstem Akutoktak River to about 45 km upstream in July, in the lower reaches in August, and absent in September. Juveniles were caught in August only. Juvenile and adult Arctic grayling measured 142 - 395 mm FL. Young of the year Arctic grayling were present in the mainstem to 45 km upriver in July and August and in the lower river in September.

In the Katakturuk River only one juvenile Arctic char and one juvenile Arctic grayling were captured; both were captured in July. In the Jago River, two juvenile Arctic char were captured in July.

In the Okpilak River, distribution of juvenile Arctic char and young of the year Arctic grayling in 1990 was consistent with use in 1989. Both species used the river for summer rearing. The Akutoktak River is a perennial spawning and rearing area for Arctic grayling. Arctic char may use the Akutoktak River more frequently some years than in others. The Katakturuk and Jago rivers do not support a resident population of Arctic char or Arctic grayling.

Disclaimer

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Introduction

The U.S. Congress is considering whether to allow oil exploration and development activities to occur in the 1002 area of the Arctic National Wildlife Refuge. Should such activities be allowed, fishery resources could be affected by the construction and placement of roads and pipelines, oil spills, and water diversions. Baseline information on the range and distribution of fish in 1002 area rivers is limited. In order to be in a position to assess impacts from potential oil and gas activities, and recommend mitigation measures for such activities, river surveys begun in 1989 were continued in the summer of 1990 to provide additional information on fish distribution.

Freshwater fishery investigations in the 1002 area of the Arctic National Wildlife Refuge prior to 1989 (Ward and Craig 1974; Daum et al. 1984; Lyons and Elliott 1987) are limited in stream area sampled, and frequency and duration of sampling. In 1989, multiple sites in four rivers, the Okpilak, Akutoktak, Katakturuk, and Jago rivers, were sampled several times during the open water season (Corning *in preparation-a*; Wiswar 1991). The results of the 1989 investigations indicated that fish use these rivers more extensively than previously documented.

The objectives of this study are to:

1. Determine spatial and temporal distribution of arctic fishes by life stage (young of the year, juvenile, and adult) in rivers within the 1002 area.
2. Determine if multi-year use by juvenile Arctic char occurs in the Okpilak, Akutoktak, Katakturuk, and Jago rivers.
3. Determine length frequency, age structure, and length-weight relationship for Arctic char and Arctic grayling.

Okpilak River

Juvenile Arctic char were captured in the mainstem Okpilak River from the lower reaches to about 50 km upstream in 1989 (Wiswar 1991). Arctic char had not previously been documented in the mainstem. Juveniles have been observed or captured in two tributaries of the lower Okpilak River (Lyons and Elliott 1987; Wiswar 1991). The presence of adults and young of the year has not been documented.

Juvenile Arctic char have been located in non-natal streams in other arctic coastal plain drainages. Arctic char have been captured in the lower reaches of Weir Creek (Craig and Poulin 1975) and the Tamayariak River (Corning *in preparation-b*), and tributaries of the Kavik and Canning rivers.

Use of the mainstem by adult and juvenile Arctic grayling appears to be low (Ward and Craig 1974; Daum et al. 1984; Wiswar 1991). The mainstem is probably used as a migration corridor for Arctic grayling entering spawning streams, feeding areas, and returning to overwintering areas.

Young of the year Arctic grayling were present at a site in the lower mainstem Okpilak River in early and late August 1989 (Wiswar 1991). The presence of young of the year in the mainstem Okpilak River had not been previously been observed.

Arctic grayling were present in two tributaries in the lower Okpilak River and in a river-connected lake in the upper Okpilak drainage (Lyons and Elliott 1987; Wiswar 1991). Not all life history stages were represented at each area.

Akutoktak River

Juvenile and adult Arctic grayling are distributed throughout the mainstem Akutoktak River in July (Daum et al. 1984; Lyons and Elliott 1987; Wiswar 1991). However, in a mid-reach site sampled in late August 1989, no juveniles or adults were captured (Wiswar 1991). Fall movements to overwintering areas have been documented using radio telemetry during August through November 1984 and 1985 (West and Wiswar 1985; Wiswar et al. 1987). Arctic grayling were relocated in the lower Akutoktak River, about 40 km upstream in the Okpilak River, and the Hulahula River.

Arctic grayling young of the year were first observed on July 6 at upstream sites in the Akutoktak River in 1989 (Wiswar 1991). Craig and Poulin (1975) reported that young of the year emerged from the gravel in Weir Creek (30 km west of the refuge) between late June and early July. Young of the year have also been observed in the Akutoktak River in mid-July 1987 (Lyons and Elliott 1987), and in August 1982 (Daum et al. 1984). Outmigrations of large numbers of young of the year have been reported from Weir Creek (Craig and Poulin 1975) and a tributary in the upper Sagavanirktok River (Elliott 1982) in mid- and late September.

Over 40 juvenile Arctic char were captured in the mainstem Akutoktak River in early and late August 1989 at a site approximately 16 km upstream from its mouth (Wiswar 1991).

Katakturuk River

Prior to 1989, surveys indicate that use of the Katakturuk River by fish was very low. During brief surveys conducted between 1972 and 1987, only one Arctic char, one Arctic grayling, and one ninespine stickleback had been captured (Ward and Craig 1974; Smith and Glesne 1983; Lyons and Elliott 1987; West and Frugé 1989). During the summer of 1989, with more intensive sampling, 71 juvenile Arctic char were captured and an additional 29 observed along one reach of the lower river (Corning *in preparation-a*).

Jago River

Fishery surveys in the Jago River, prior to 1989, had not documented the presence of fish other than three ninespine stickleback (Ward and Craig 1974; Daum et al. 1984; Lyons and Elliott 1987; West and Frugé 1989). However, during the summer of 1989, seven juvenile Arctic char and 763 ninespine stickleback were captured and several more Arctic char had been observed (Corning *in preparation-a*). Arctic char were located in August and September, but not during June and July sampling.

Study Area

The Okpilak, Akutoktak, Katakturuk, and Jago rivers are entirely within the boundary of the Arctic National Wildlife Refuge. The rivers flow north across the Arctic coastal plain (Figure 1). The Okpilak and Katakturuk rivers flow directly into the Beaufort Sea while the Jago River flows into Jago Lagoon. The Okpilak River shares a common delta with the Hulahula River. The Akutoktak River flows into the Okpilak River approximately 30 km from the mouth.

The Okpilak and Jago rivers are glacial streams (Craig and McCart 1974) with predominately braided channels. The rivers originate in the Romanzof Mountains of the Brooks Range. The Akutoktak River is a tundra stream that drains the foothills of the Brooks Range. The Katakturuk River originates in the Shublik and Sadlerochit mountains but has no glacial origin.

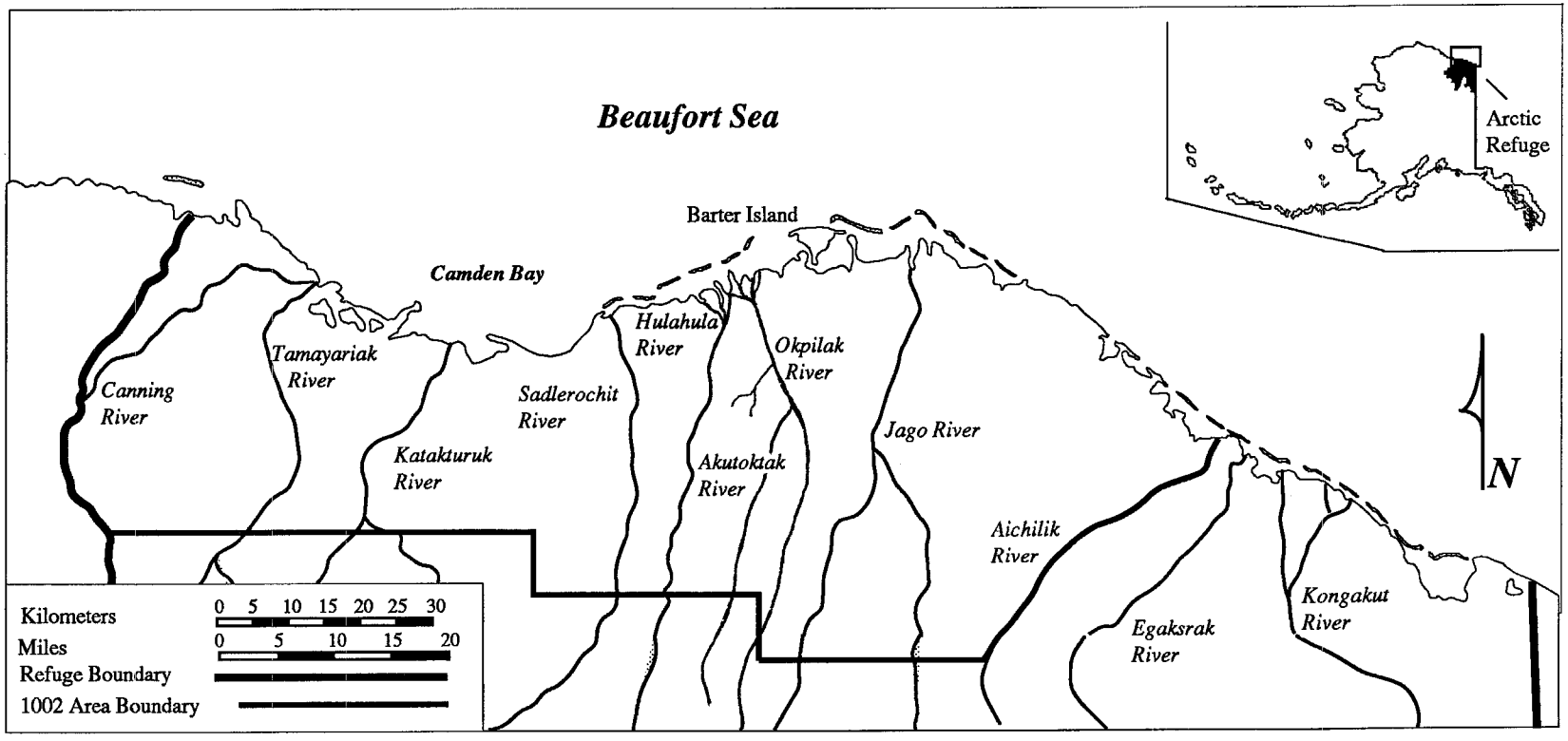

FIGURE 1.—Coastal plain of the Arctic National Wildlife Refuge.

ARCTIC REFUGE INLAND FISHERIES, 1990

The 1002 area of the Arctic National Wildlife Refuge is on the coastal plain and is underlain by continuous permafrost. The climate is arctic marine and is characterized by long, cold winters and short, cool summers. Snowmelt in the foothills does not begin until late May and is usually rapid (10-14 days). Rivers run full during this period with flows subsiding in late June or early July. Precipitation and storm events may increase flows again in July and August (Clough et al. 1987; Lyons 1990). Thermograph recordings of water temperatures in 1990 from the lower Akutoktak River ranged from 7.5° to 19.7°C during the later half of June, 7.7°-20.4°C in July, 3.4°-14.0°C in August, and 0.1°-6.1°C in September. Maximum and minimum flows recorded were 6.09 m^3/sec on June 20, and 0.02 m^3/sec during August 15-18, 1990 (Lyons and Trawicki 1991). Monthly average flows during July - August 1990 were an order of magnitude less than 1989 (Lyons 1990). Freeze-up on the coastal plain usually occurs in mid- to late September (Clough et al. 1987). River ice was forming on streams in the 1002 area on September 12, 1990.

Methods

The mainstems and tributaries of the Okpilak, Akutoktak, Katakturuk, and Jago rivers were sampled during the summer of 1990 for fish distribution. Although the Akutoktak River is a tributary of the Okpilak River, data is presented separately.

Fish sampling was conducted July 6-24, 1990 at 5-8 mainstem sites and 0-10 tributary sites on each river. Sites were resampled August 8-27 and September 11-18 to determine temporal changes in fish distribution. Mainstem sites were selected about 10 km apart or near the confluence of a major tributary. Tributary site selection was based on stream length and drainage pattern.

Fish were collected with baited minnow traps, hook and line, dip nets, backpack electrofisher (Smith-Root Model 15A, 600 - 1100 volts, 60 - 90 pulses/s), and gill nets. Because newly emerged Arctic grayling are sensitive to electrofishing, young of the year counts in July were made visually. Visual observations of other species were recorded as well. Minnow traps (40.6 x 20.3 cm, 0.6 cm bar mesh) were baited with processed salmon egg clusters and checked between 2 and 24 h. Catch rates at each station were standardized to number of fish/trap/h. The number of traps per site ranged from two to 10 and were spaced at least 12 m apart. Where the number of traps deployed was low (<5), sampling effort was generally supplemented with electrofishing. Dip nets were constructed of 0.16 cm ace mesh. Monofilament variable mesh gill nets consisted of four panels (3 m wide x 1.8 m deep) of 1.3, 2.5, 3.8, and 5.1 cm square mesh and were fished only in lakes.

Juvenile and adult fish captured were counted and fork lengths (FL) were measured to the nearest mm. Fish over 100 g were weighed to the nearest 10 g and fish less than 100 g to the nearest g. Smaller fish (<200 mm FL) were placed in a solution of tricaine (MS 222) before measuring. Young of the year Arctic grayling collected in August from the Akutoktak River for length and weight analysis were preserved in 5% formalin and later transferred to Caro-Safe. In the laboratory, these fish were blotted dry, measured and weighed to the nearest 0.01 g.

Regression of log-normal transformations of length and weight was used to describe length-weight relationships (Ricker 1975). Slopes and intercepts of regression lines were compared (Kleinbaum and Kupper 1978) and where there was no significant difference ($P > 0.05$) data was pooled. When sample size was small ($N < 25$), homogeneity of the variances was tested with a *F*-test ($P < 0.05$; Zar 1984).

Ages of Arctic char and Arctic grayling were estimated from scales and otoliths (sagittae). Scales were removed from the left side of the fish between the lateral line and posterior portion of the dorsal insertion. Scales were pressed on triacetate slides and viewed through a microfiche reader. Sagittae were illuminated with a fiber optic light and viewed at a low magnification through a dissecting scope. When age could not be determined by surface reading, sagittae were broken at the nucleus and burned in an alcohol flame before viewing (Barber and McFarlane 1987). All scales and sagittae were read by two independent readers. When disagreement occurred, scales and sagittae were read by a third person. Mean length at age data was calculated for juvenile Arctic char from the Okpilak River and Arctic grayling from the tributary and lake at site OT 19. Inadequate sample size prevented using data from other locations.

Arctic char and Arctic grayling were categorized by life history stage (young of the year, juvenile, and adult) based on length and age information from Yoshihara (1972), Craig and Poulin (1975), McCart (1980), Smith and Glesne (1983), Daum et al. (1984), West and Wiswar (1985), Corning (*in preparation-a*), Wiswar (1991) and this study (Table 1).

TABLE 1.—Life history stage of Arctic char and Arctic grayling categorized by fork lengths.

Life history stage	Arctic char[a]	Arctic grayling[b]
Young of the year	≤ 70 mm	≤ 81 mm
Juvenile	71 - 300 mm	82 - 285 mm
Adult	> 300 mm	> 285 mm

[a] Yoshihara (1972); McCart 1980; Smith and Glesne (1983); Daum et al. 1984; and West and Wiswar (1985).

[b] Craig and Poulin 1975; Smith and Glesne 1983; Daum et al. 1984; Corning *in preparation-b*; Wiswar 1991; and this study.

Spatial and temporal fish distribution during July through September 1990 is presented by species and life history stage on maps of each river drainage. Fish captured at two consecutive sites were assumed to be distributed between those two sites.

Results

Okpilak River

Mainstem fish distribution (Sites OM 01 - OM 08).—Juvenile Arctic char were present in the mainstem Okpilak River during all three sampling periods. Thirty-two fish were captured in July, 97 were captured and 4 observed in August, and 26 were captured in September (Table 2). In July and September (Figure 2), their distribution extended from the mouth to 70 km upriver (site OM 07), and in August to 80 km upriver (site OM 08). No adult or young of the year Arctic char were located.

Only one adult Arctic grayling was caught in the mainstem in July at site OM 08 (Figure 3). Juvenile Arctic grayling were captured (N = 23) from 50 - 80 km upriver (sites OM 05 - OM 08) in July and

TABLE 2.—Summary of gear used and capture information for fish caught in the Okpilak River and its tributaries, July - September 1990. N = number of fish captured, CPUE = catch per unit effort, AC = Arctic char, GR = Arctic grayling, NSB = ninespine stickleback, a = adult, j = juvenile, yoy = young of the year.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
		Mainstem				
Jul 8-16	Minnow traps	72	615.4	AC j	25	<0.01
	Minnow traps	72	615.4	GR j	5	<0.01
	Minnow traps	72	615.4	NSB	37	<0.01
	Electrofisher		3.1	AC j	7	2.26
	Electrofisher		3.1	GR a	1	0.32
	Electrofisher		3.1	GR j	5	1.61
	Electrofisher		3.1	GR yoy	6	1.94
	Electrofisher		3.1	NSB	46	14.84
	Visual			GR yoy	85	
Aug 10-19	Minnow traps	79	378.6	AC j	79	<0.01
	Minnow traps	79	378.6	GR j	1	<0.01
	Minnow traps	79	378.6	GR yoy	12	<0.01
	Minnow traps	79	378.6	NSB	4	<0.01
	Electrofisher		2.9	AC j	18	6.21
	Electrofisher		2.9	GR j	12	4.14
	Electrofisher		2.9	GR yoy	24	8.28
	Electrofisher		2.9	NSB	1	0.34
	Visual			AC j	4	
	Visual			GR yoy	50	
Sep 12-16	Minnow traps	70	854.2	AC j	21	<0.01
	Minnow traps	70	854.2	GR yoy	18	<0.01
	Minnow traps	70	854.2	NSB	89	<0.01
	Electrofisher		3.0	AC j	5	1.66
	Electrofisher		3.0	GR yoy	200	67.67
	Electrofisher		3.0	NSB	34	11.33
		Lower tributary				
Jul 16-17	Minnow traps	22	34.4	AC j	1	<0.01
	Minnow traps	22	34.4	NSB	80	0.11
	Hook and line			AC j	1	
	Dip net			GR yoy	21	
	Visual			GR a	1	
	Visual			GR yoy	275	

TABLE 2.—Continued.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
			Lower tributary (continued)			
Aug 19-21	Minnow traps	5	23.8	AC j	3	0.03
	Minnow traps	5	23.8	GR yoy	1	0.01
	Minnow traps	5	23.8	NSB	39	0.33
	Electrofisher		1.7	AC j	15	8.82
	Electrofisher		1.7	GR a	2	1.18
	Electrofisher		1.7	GR yoy	125	73.53
	Electrofisher		1.7	NSB	126	74.12
	Visual			GR yoy	200	
	Visual			NSB	1020	
Sep 13-14	Minnow traps	10	195.0	NSB	28	0.01
	Electrofisher		1.4	AC j	1	0.71
	Electrofisher		1.4	GR yoy	5	3.57
	Electrofisher		1.4	NSB	107	76.43
			Mid-reach tributary			
Jul 10-12	Minnow traps	30	87.5	NSB	3	<0.01
	Gill net	2	3.6		0	
	Dip net			GR yoy	56	
	Visual			GR yoy	540	
Aug 17-21	Minnow traps	20	100.0	AC j	1	<0.01
	Minnow traps	20	100.0	NSB	61	0.03
	Electrofisher		2.3	AC j	2	0.87
	Electrofisher		2.3	GR yoy	42	18.26
	Electrofisher		2.3	NSB	48	20.87
	Visual			GR yoy	40	
	Visual			NSB	607	
Sep 13	Electrofisher		1.6	GR yoy	11	6.88
	Electrofisher		1.6	NSB	85	53.13
			Upper tributary and lake			
Jul 6-14	Minnow traps	4	20.0		0	
	Gill net	2	9.8	GR a	1	0.05
	Gill net	2	9.8	GR j	30	1.53
	Hook and line			GR j	13	
	Dip net			GR a	1	

TABLE 2.—Continued.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
	Dip net			GR j	10	
	Visual			GR a,j	45	
	Upper tributary and lake (continued)					
Aug 8-10	Minnow traps	10	60.0	GR j	3	<0.01
	Gill net	2	2.7	GR a	1	0.19
	Gill net	2	2.7	GR j	8	1.48
	Hook and line			GR a	5	
	Hook and line			GR j	16	
	Dip net			GR j	30	
	Dip net			GR yoy	1	
Sep 16	Minnow traps	10	42.5	GR yoy	1	<0.01
	Gill net	1	5.1	GR a	1	0.20
	Gill net	1	5.1	GR j	11	2.16
	Hook and line			GR a	1	
	Hook and line			GR j	8	
	Dip net			GR a	1	
	Dip net			GR j	5	

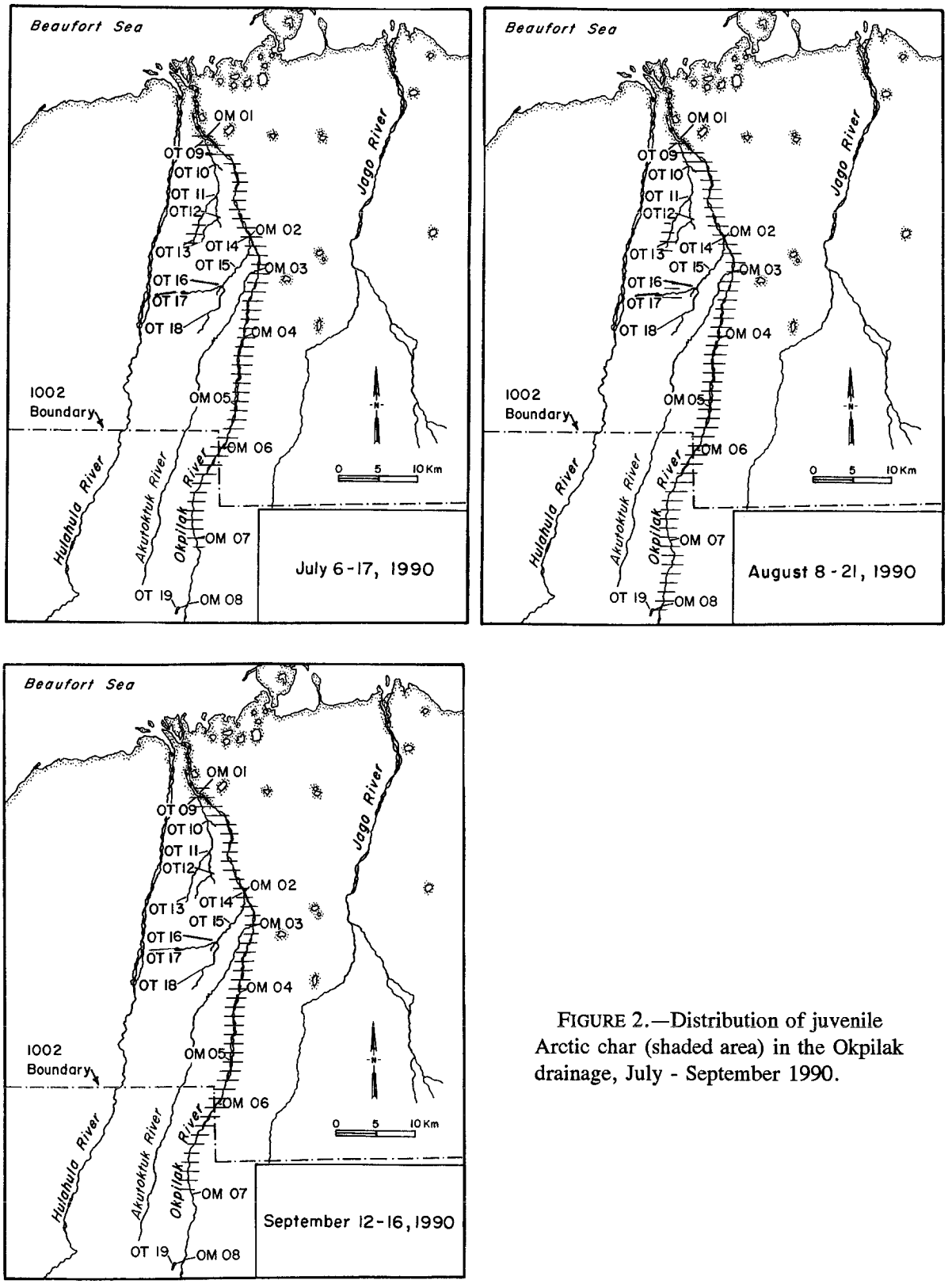

FIGURE 2.—Distribution of juvenile Arctic char (shaded area) in the Okpilak drainage, July - September 1990.

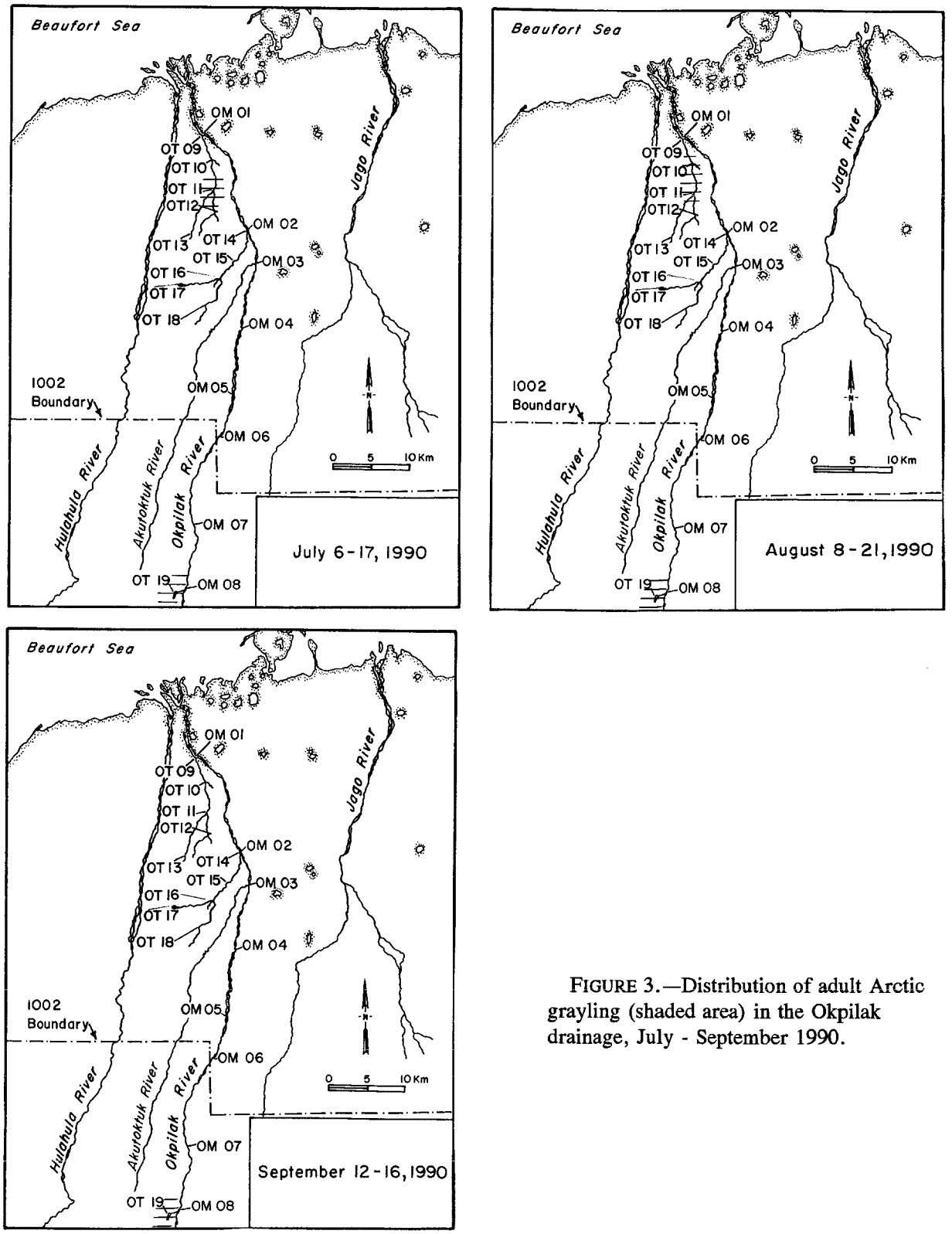

FIGURE 3.—Distribution of adult Arctic grayling (shaded area) in the Okpilak drainage, July - September 1990.

August (Figure 4). Distribution of juveniles among sites during the sampling periods was not continuous. Juvenile Arctic grayling were not captured in September.

Young of the year Arctic grayling were located in the mainstem as early as July 10 (Figure 5). At site OM 08, two fish were captured and 85 observed in a clear, off-channel braid adjacent to the confluence of site OT 19. This braid was not connected to the mainstem, but was fed by numerous distributaries from an adjacent wetland. Two young of the year were captured in July at both sites OM 01 and OM 02 which are adjacent to the confluence of tundra streams flowing into the Okpilak River.

In August, 36 young of the year Arctic grayling were captured and 50 observed at the lower three mainstem sites (sites OM 01 - OM 03) and at sites OM 05 and OM 08 (Figure 5). In September, young of the year were captured (N = 218) at six of the eight mainstem sites.

Ninespine stickleback were captured during all three sampling periods (N = 211), but not above the confluence of the Akutoktak River (site OM 03).

Biological characteristics (Sites OM 01 - OM 08).—Juvenile Arctic char captured in the mainstem Okpilak River were 96 - 213 mm FL (Table 3; Figure 6). Although mean length increased during the summer, there was no significant difference ($P > 0.20$) in the length-weight relationship among the three sampling periods (Figure 7). Ages estimated from sagittae of Arctic char (N = 40) ranged from 1 to 4 years (Figure 8) with 1 and 2 year old fish in greatest abundance (83%).

Juvenile Arctic grayling were 92 - 169 mm FL in July (N = 10, $\bar{x}$ = 108.3, SD = 22.8) and 82 - 162 mm FL in August (N = 13, $\bar{x}$ = 110.6, SD = 18.0). The length-weight relationship is presented in Figure 9.

Young of the year Arctic grayling in the mainstem ranged from 27 to 81 mm FL (Table 4; Figure 10). Fork lengths averaged 56.5 mm in August and 61.5 mm in September. Mean lengths increased 0.15 mm/d between August and September.

Ninespine stickleback ranged from 20 to 74 mm FL (N = 144, $\bar{x}$ = 51.4, SD = 8.5).

Lower tributary fish distribution (Sites OT 09 - OT 13).—Twenty-one juvenile Arctic char were captured during the three sampling periods. Most fish (N = 18) were captured in August at sites OT 9, OT 12, and OT 13 (Figure 2).

Only three adult Arctic grayling were located in this tributary. One adult was observed in July and two were captured in the lower 8 km of the stream in August (Figure 3). No adults were captured in September. Juvenile Arctic grayling were not captured during any of the sampling periods.

Young of the year Arctic grayling were in the tributary during all sampling periods (Figures 5). Although their distribution was greatest in August, most were captured in the lower stream (site OT 9). In July and August, 586 young of the year were captured or observed in the lower 8 km; by comparison, 36 were found in the upper reaches (sites OT 12 and OT 13). In September, only 5 fish were captured at sites OT 9 and OT 12.

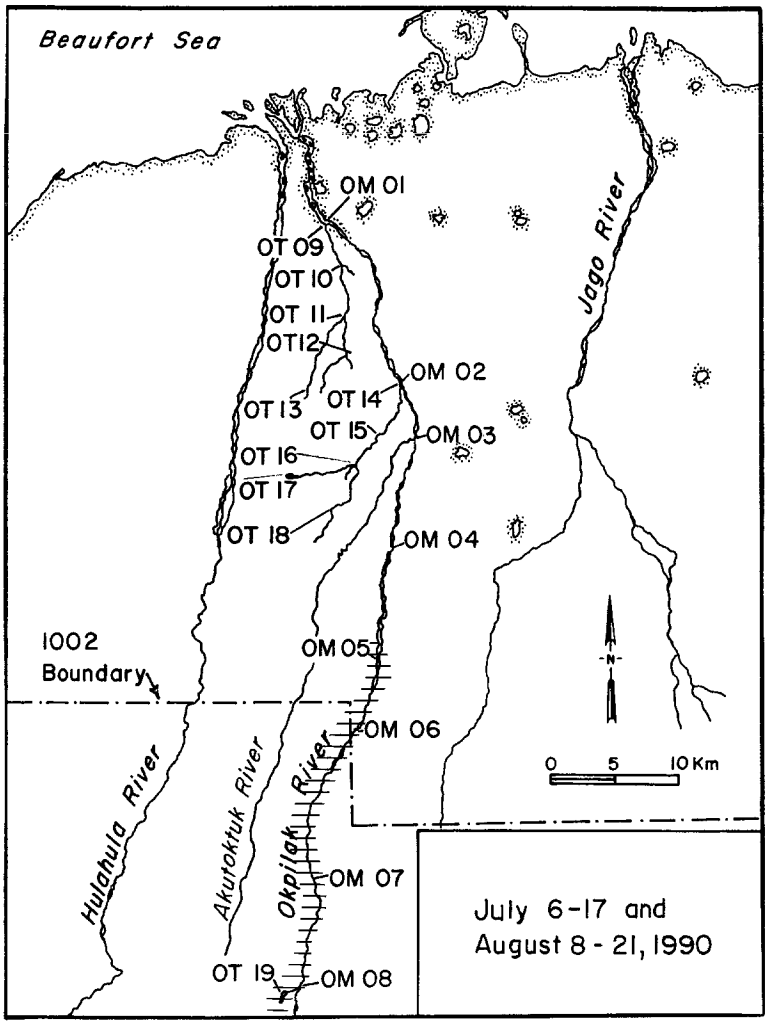

FIGURE 4.—Distribution of juvenile Arctic grayling (shaded area) in the Okpilak drainage, July - August 1990.

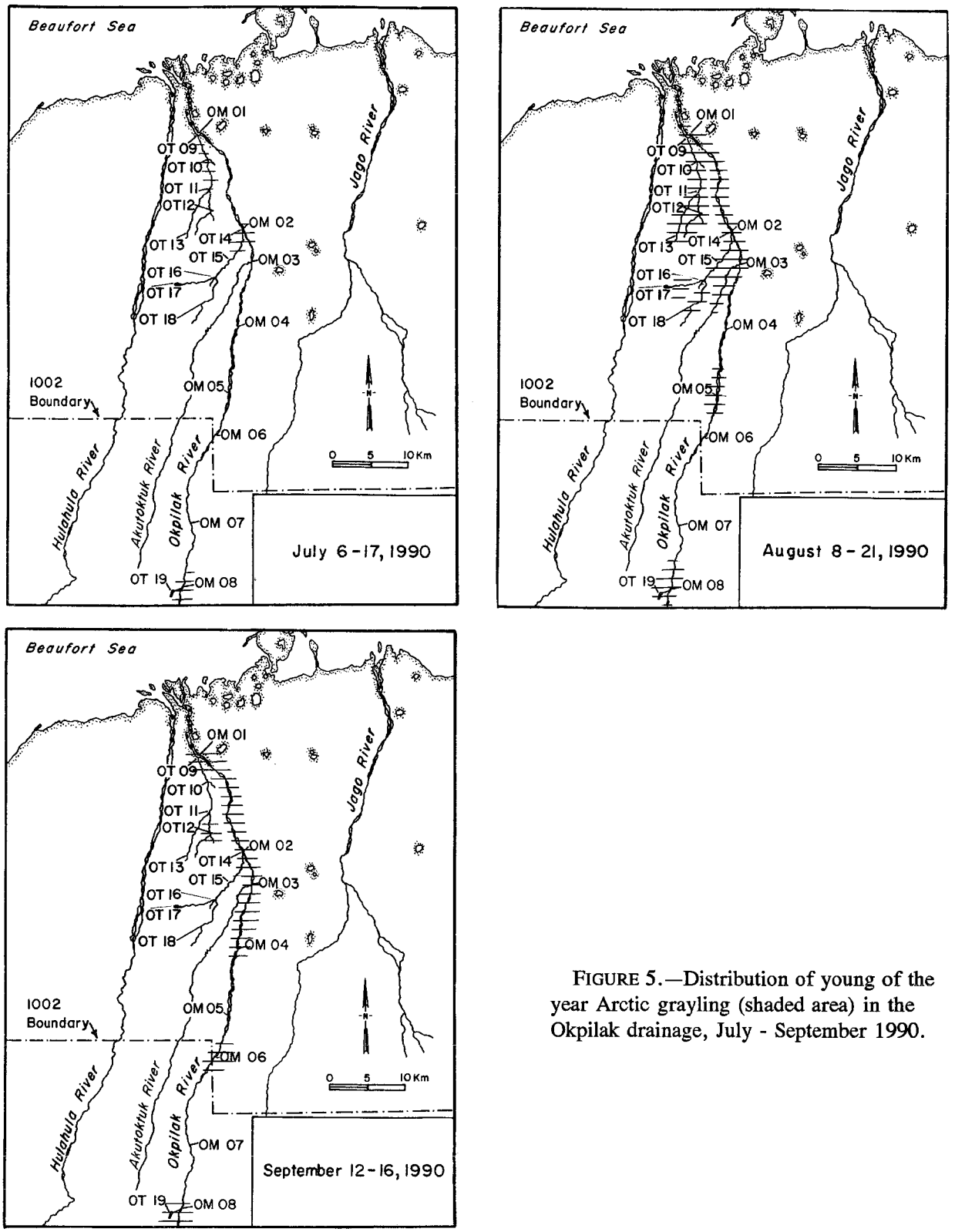

FIGURE 5.—Distribution of young of the year Arctic grayling (shaded area) in the Okpilak drainage, July - September 1990.

TABLE 3.—Fork lengths and weights of juvenile Arctic char captured in the mainstem Okpilak River (July - September 1990) and lower tributary (August 1990 only).

		Fork length (mm)			Weight (g)		
Sampling period	N	Mean	SD	Range	Mean	SD	Range
Mainstem							
July 8-16	32	123.3	17.0	96-166	19.8	7.5	9-43
August 10-19	97	137.2	14.2	109-213	26.6	9.2	14-44
September 12-16	26	142.2	12.9	114-166	28.5	8.3	15-47
Lower tributary							
August 19-21	18	172.2	28.3	136-256	58.9	34.5	25-180

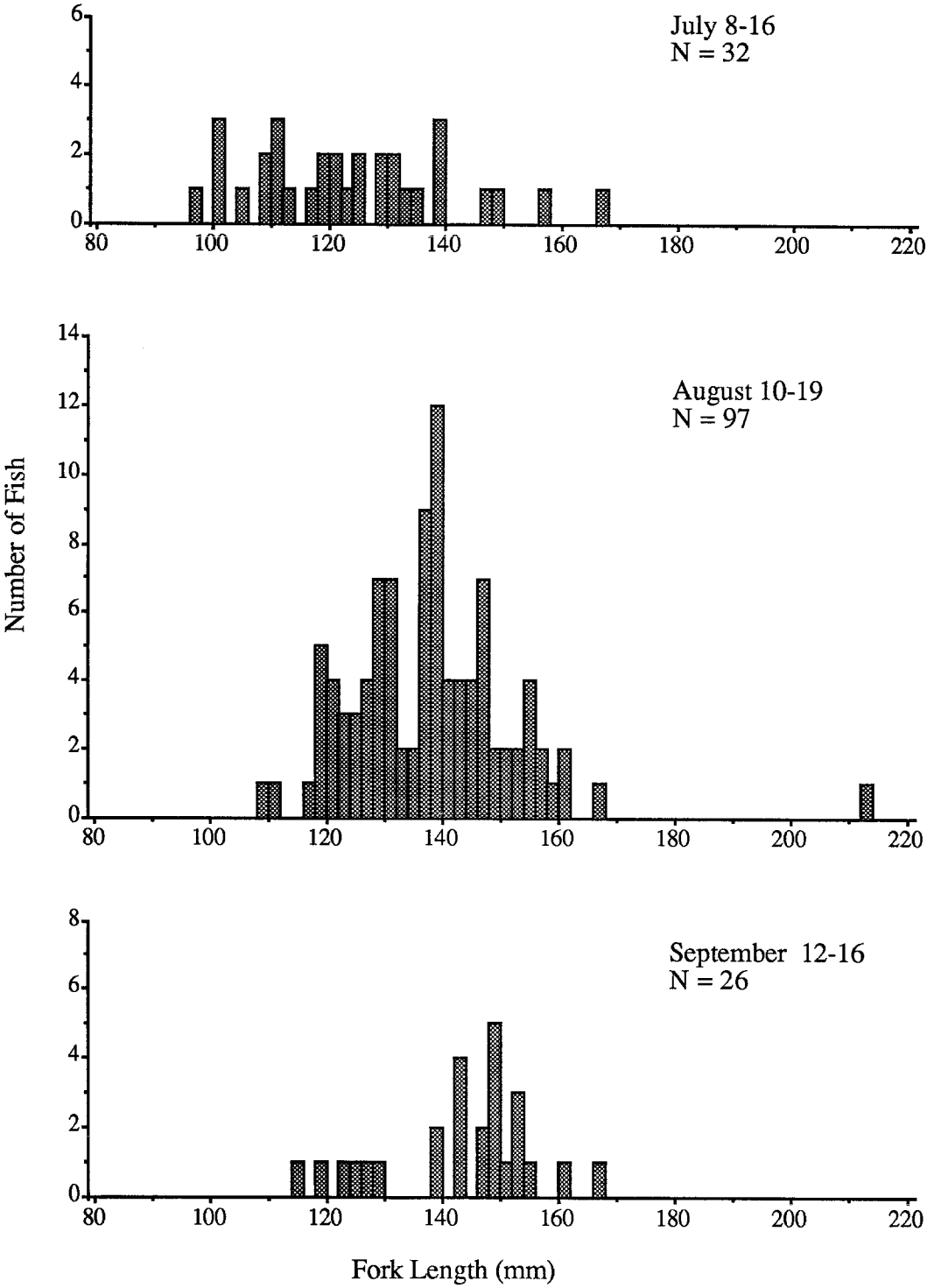

FIGURE 6.—Length-frequency of juvenile Arctic char captured in the mainstem Okpilak River, July - September 1990.

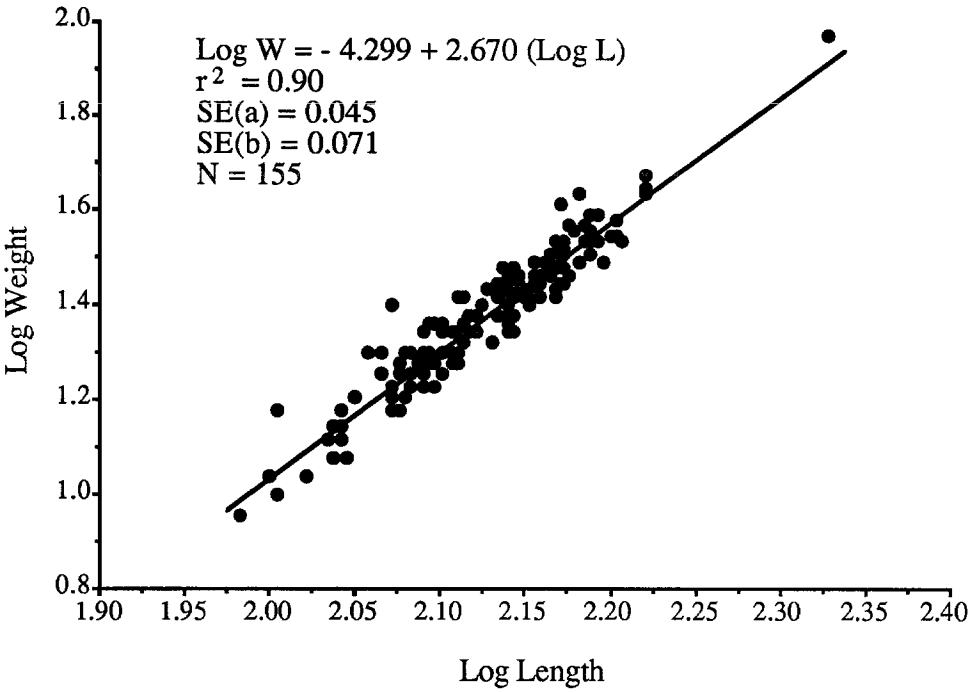

FIGURE 7.— Length-weight relationship of juvenile Arctic char captured in the mainstem Okpilak River (sites OM 01 - OM 08), July - September 1990.

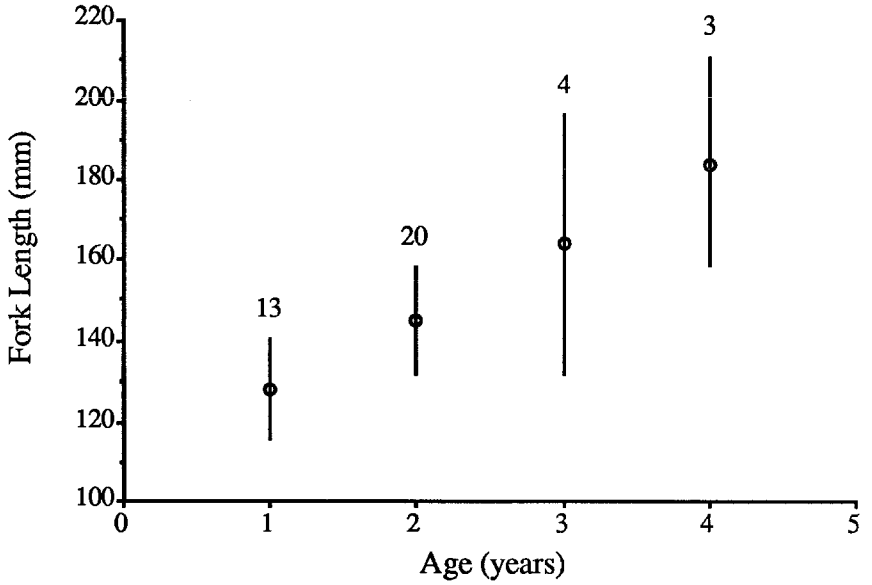

FIGURE 8.—Mean fork length at age of juvenile Arctic char captured in the Okpilak-Akutoktak drainage, August 10-19, 1990. Age determined from sagittae. Vertical lines represent ± SD; numbers indicate sample size for each age.

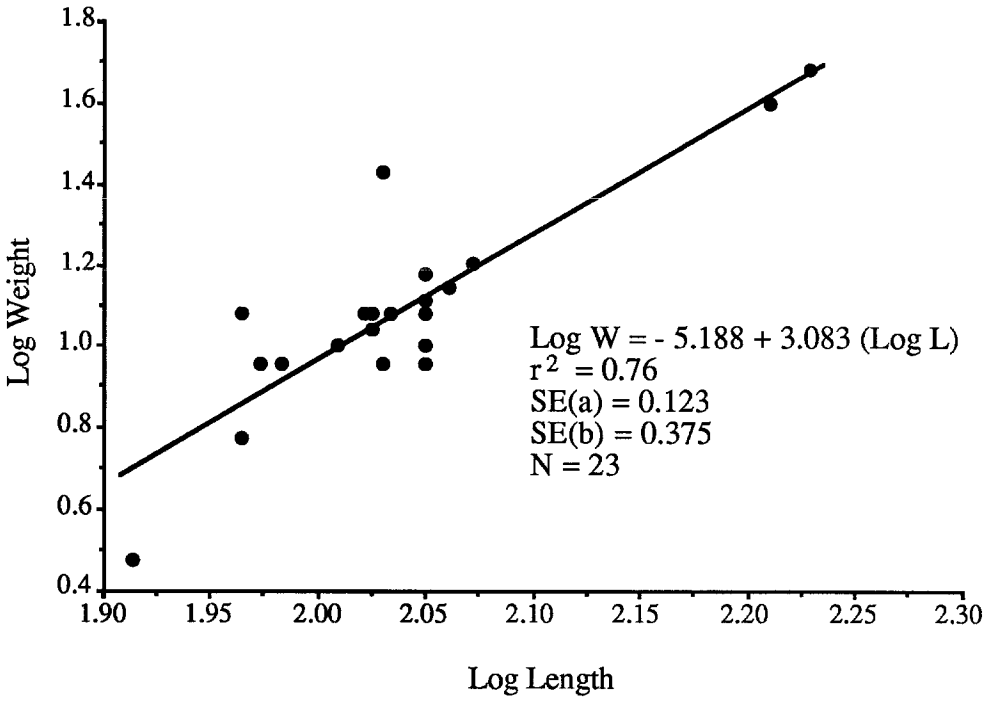

FIGURE 9.— Length-weight relationship of juvenile Arctic grayling captured in the mainstem Okpilak River (sites OM 01 - OM 08) during July and August 1990.

TABLE 4.—Mean fork length of young of the year Arctic grayling from the Okpilak River and its tributaries, July - September 1990.

Sampling period	N	Fork length (mm)		
		Mean	SD	Range
		Mainstem		
July 8-16	6	31.2	3.8	27-37
August 10-19	36	56.5	5.7	39-64
September 12-16	218	61.5	7.1	36-81
		Lower tributary		
July 10-12	21	33.6	3.5	27-41
August 17-21	126	56.9	5.5	39-69
September 13	5	63.2	7.8	56-75
		Mid-reach tributary		
July 16-17	56	29.6	2.8	20-36
August 19-21	42	55.8	7.6	41-74
September 13-14	11	58.6	3.4	54-65

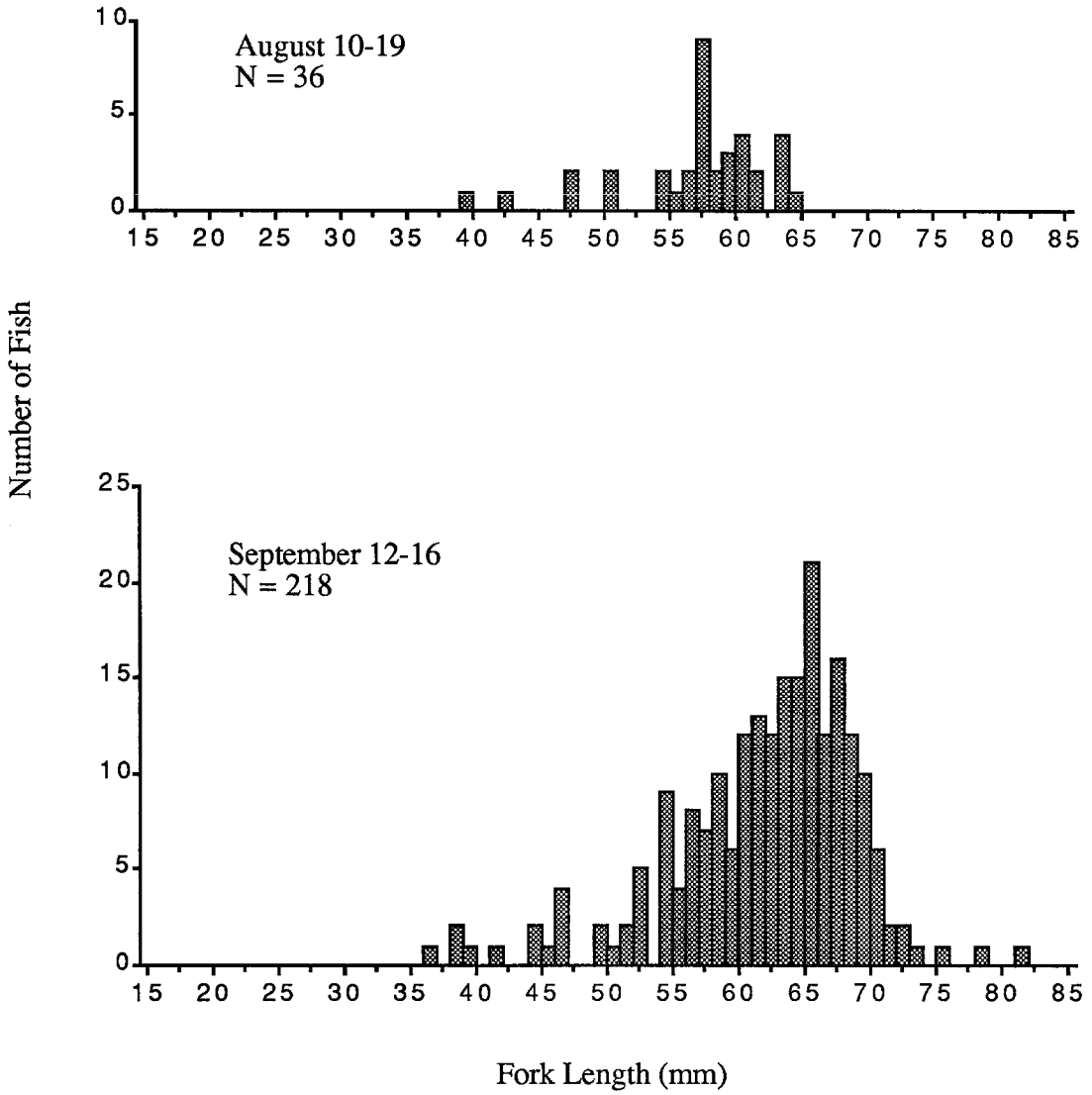

FIGURE 10.—Length-frequency of young of the year Arctic grayling from the mainstem Okpilak River in August and September 1990.

Fourteen hundred ninespine stickleback were captured or observed, most (N = 1,185) in August. Ninespine stickleback were distributed throughout the stream.

Biological characteristics (Sites OT 9 - OT 13).—Juvenile Arctic char averaged 172.2 mm FL (Table 3). In August, these fish were significantly larger ($P < 0.05$) than those in the mainstem Okpilak River. The length-weight relationship for Arctic char captured in August is presented in Figure 11.

The two adult Arctic grayling captured in August were 316 and 324 mm FL. Young of the year Arctic grayling ranged from 27 to 75 mm FL (Table 4; Figure 12). Mean length was 33.6 mm FL in July, 56.9 mm FL in August, and 63.2 mm FL in September. Mean length increased 0.59 mm/d between July and August and 0.24 mm/d between August and September.

Ninespine stickleback ranged from 20 to 80 mm FL (N = 315, $\bar{x}$ = 56.1, SD = 13.2).

Mid-reach tributary fish distribution (Sites OT 14 - OT 18).—Three juvenile Arctic char were captured in August; two near the mouth (site OT 14) and the other about 13 km upstream (OT 17; Figure 2). No adult or juvenile Arctic grayling were captured. In July, 596 young of the year Arctic grayling were captured or observed in the lower 5 km of the stream (Figure 5). In August, young of the year (N = 82) were located at all sites but OT 16, and in September, 11 were captured near the mouth. During the three sampling periods, 804 ninespine stickleback were captured or observed and were distributed throughout the stream.

Biological characteristics (Sites OT 14 - OT 18).— The three juvenile Arctic char captured were 166, 175, and 177 mm FL.

Young of the year Arctic grayling ranged from 20 to 74 mm FL (Table 4; Figure 12). Length averaged 29.6 mm FL in July, 55.8 mm FL in August, and 58.6 mm FL in September. Mean length increased 0.74 mm/d between July and August and 0.12 mm/d between August and September.

Ninespine stickleback ranged from 14 to 76 mm FL (N = 163, $\bar{x}$ = 45.8, SD = 12.4).

Upper tributary (and lake) fish distribution (Site OT 19).—Arctic char were not captured in the upper tributary. Adult (N = 11) and juvenile (N = 134) Arctic grayling were captured in the lake at site OT 19, its feeder stream, and outlet during all three sampling periods (Table 2; Figures 3 and 4). An additional 45 fish were counted in the outlet stream in July.

The feeder stream maintained its channel for about 300 m above the mouth before the stream banks sloughed into the channel effectively blocking fish passage. The channel of the outlet stream was well defined for about 400 m below the lake but became diffuse as it entered a wetland. There was no single, distinct channel where the outlet streams entered the floodplain of the Okpilak River. Arctic grayling were captured and observed in the channelized stream section, but not in the wetland.

Two young of the year Arctic grayling were captured at site OT 19, one in August at the lake margin and the other in September in the outlet stream.

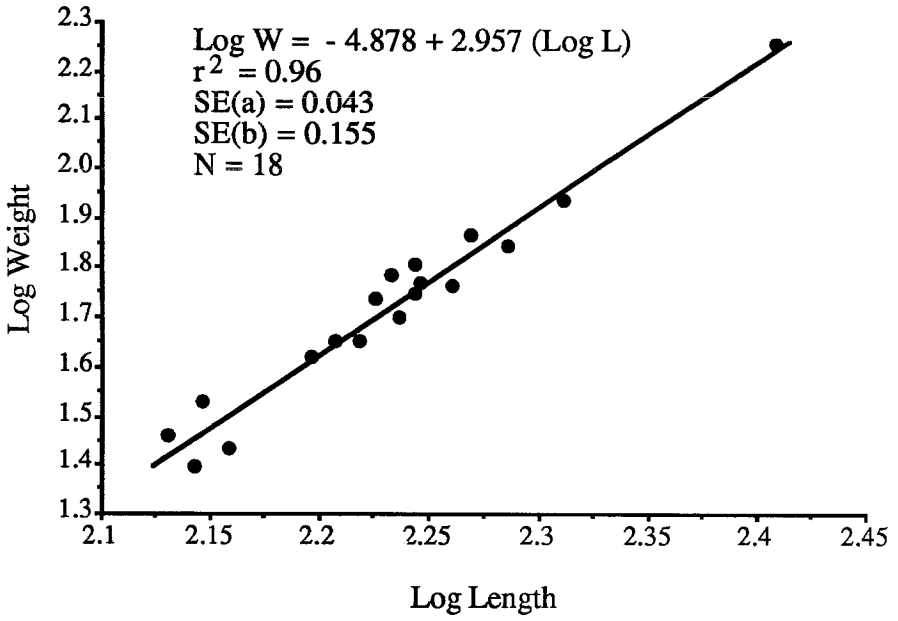

FIGURE 11.— Length-weight relationship of juvenile Arctic char captured in the lower tributary (sites OT 9 - OT 13) of the Okpilak River in August 1990.

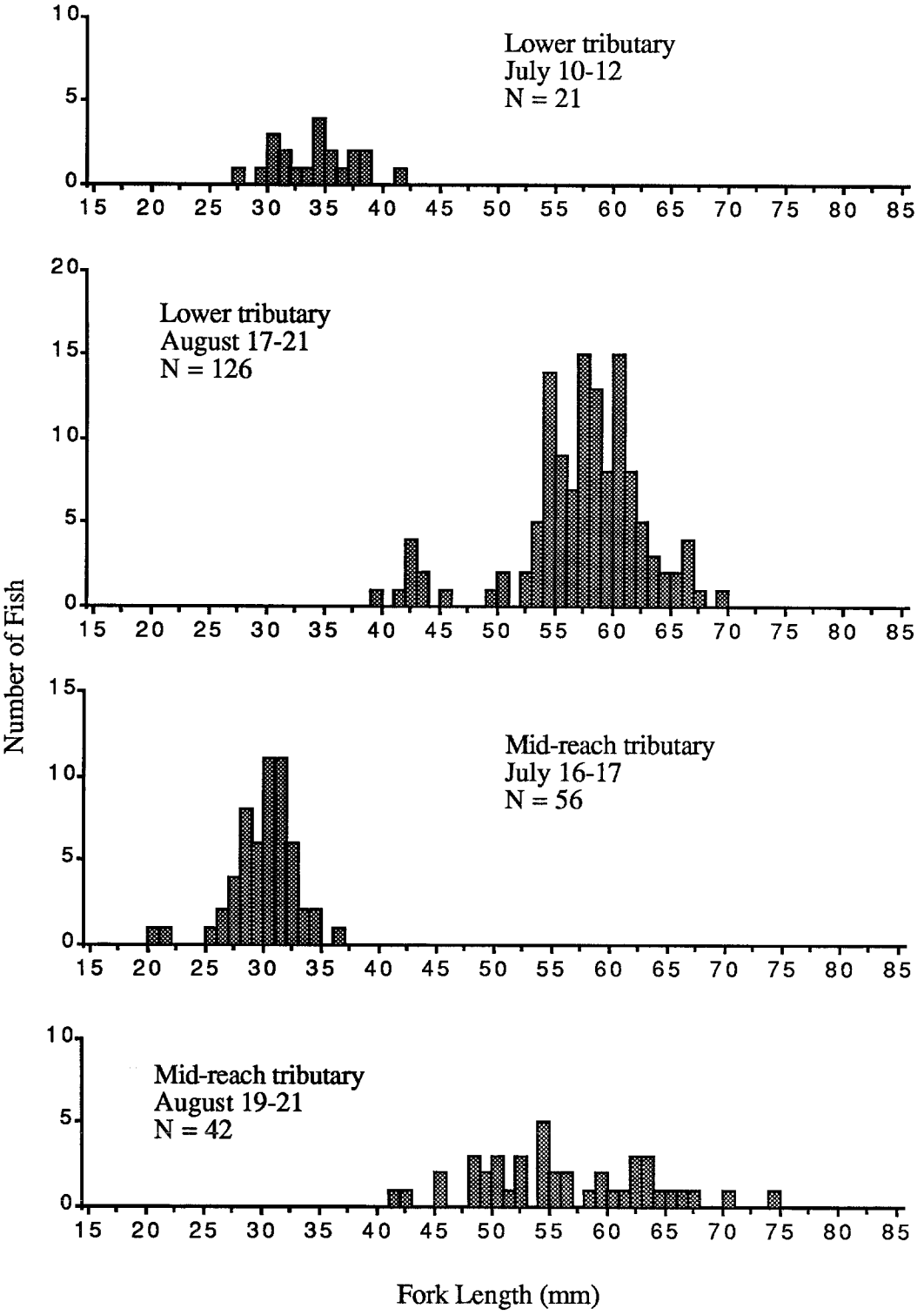

FIGURE 12.—Length-frequency of young of the year Arctic grayling from two tributaries of the Okpilak River in July and August 1990.

Biological characteristics (Site OT 19).—Juvenile and adult Arctic grayling captured at OT 19 ranged from 105 to 331 mm FL (Figure 13). There was no significant difference ($P > 0.10$) in the length-weight relationship between July and August sampling periods; however, the difference was significant ($P < 0.002$) when fish caught in July and August (pooled) were compared to September (Figure 14). Age estimates made on 140 Arctic grayling ranged from 0 to 5 years old with most (64%) 4 and 5 years old (Table 5). Mean lengths for 4 and 5 year old fish ranged from 236.8 to 264.1 mm FL and 236.6 to 256.4 mm FL, respectively (Table 5; Figure 15). Ages estimated from scales when compared to ages determined from sagittae were underestimated (Figure 16). Further analysis of ages determined from scales and sagittae will be presented in a final report.

Akutoktak River

Fish distribution.—Three juvenile Arctic char were captured in the mainstem Akutoktak River in mid-August (Table 6). Two were captured near the mouth (site AM 01) and one about 45 km upriver (site AM 05; Figure 17). Arctic char were not captured in July or September.

Adult Arctic grayling (N = 23) were distributed throughout the mainstem Akutoktak River in July (Figure 18). In August, two were captured; both in the lower 16 km. No adult Arctic grayling were captured or observed in September.

Juvenile Arctic grayling were not captured in the Akutoktak River until August when six juveniles were captured at three sites (Figure 19). No juveniles were captured in September.

Young of the year Arctic grayling were present in the river at all five sites in July and August (Figure 20); over 600 fish were captured or observed in each month. In September, 35 fish were captured or observed near the river's mouth at site AM 01, and 5 fish were found at sites further upstream (sites AM 2 and AM 3).

Six ninespine stickleback were captured in the lower river (site AM 01) during September, but none were found in July or August.

Biological characteristics.—The three juvenile Arctic char measured 164, 171, and 184 mm FL. Adult Arctic grayling in July ranged in length from 306 to 389 mm FL ($N = 16$, $\bar{x} = 342.2$, $SD = 26.7$). The length-weight relationship is presented in Figure 21. The two adults captured in August were 365 and 395 mm FL.

Juvenile Arctic grayling in August ranged from 142 to 231 mm FL ($N = 6$, $\bar{x} = 187.0$, $SD = 31.0$). The length-weight relationship is presented in Figure 21.

Young of the year Arctic grayling ranged from 39 to 71 mm FL ($N = 98$, $\bar{x} = 56.5$, $SD = 6.7$) in August and 37-73 mm FL ($N = 34$, $\bar{x} = 58.6$, $SD = 7.9$) in September (Figure 22). The length-weight relationship for young of the year captured in mid-August is presented in Figure 23.

Ninespine stickleback ranged in length from 29 to 36 mm FL ($N = 6$, $\bar{x} = 33.0$, $SD = 2.2$).

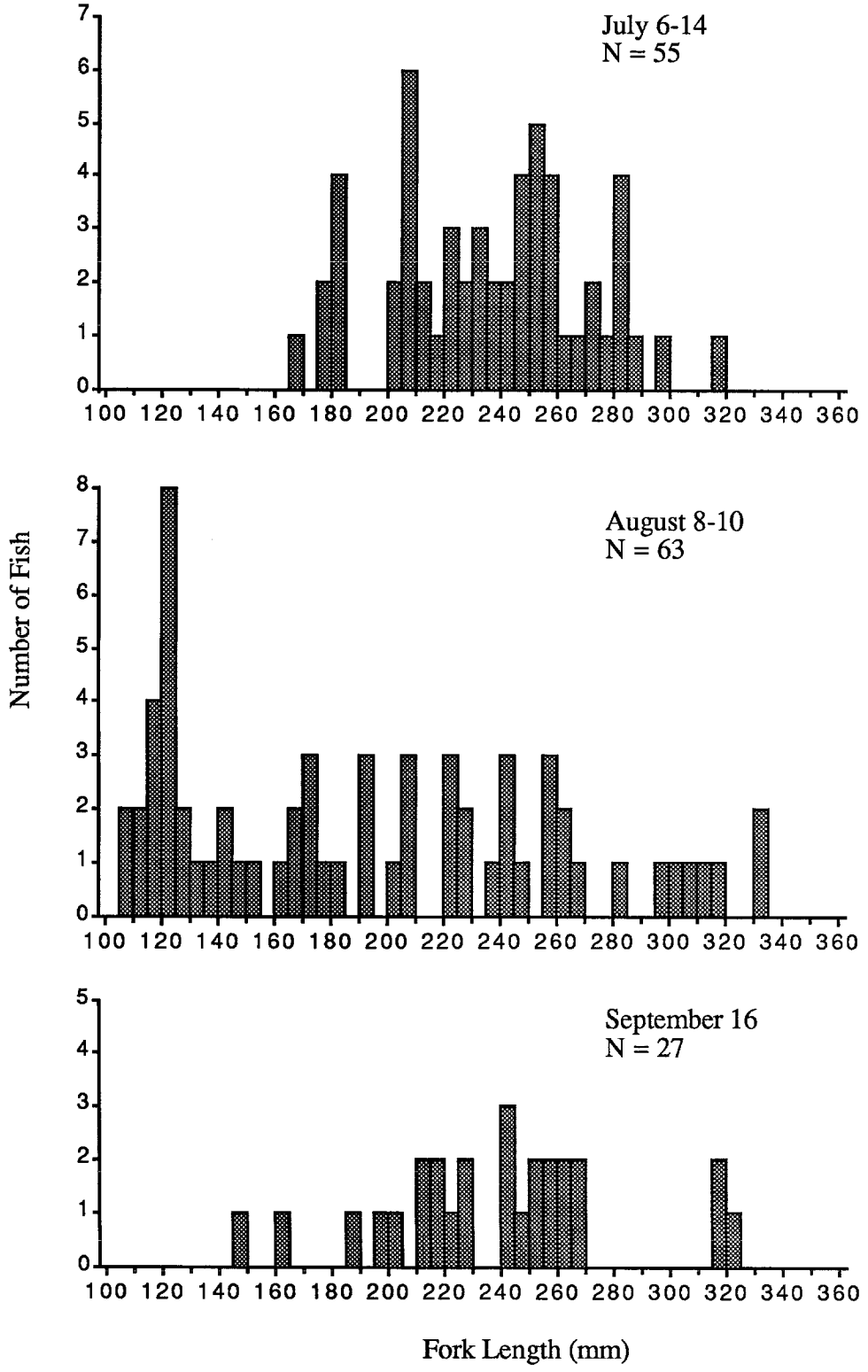

FIGURE 13.—Length-frequency of juvenile and adult Arctic grayling captured in the upper tributary and lake (OT 19) in the Okpilak drainage, July - September 1990.

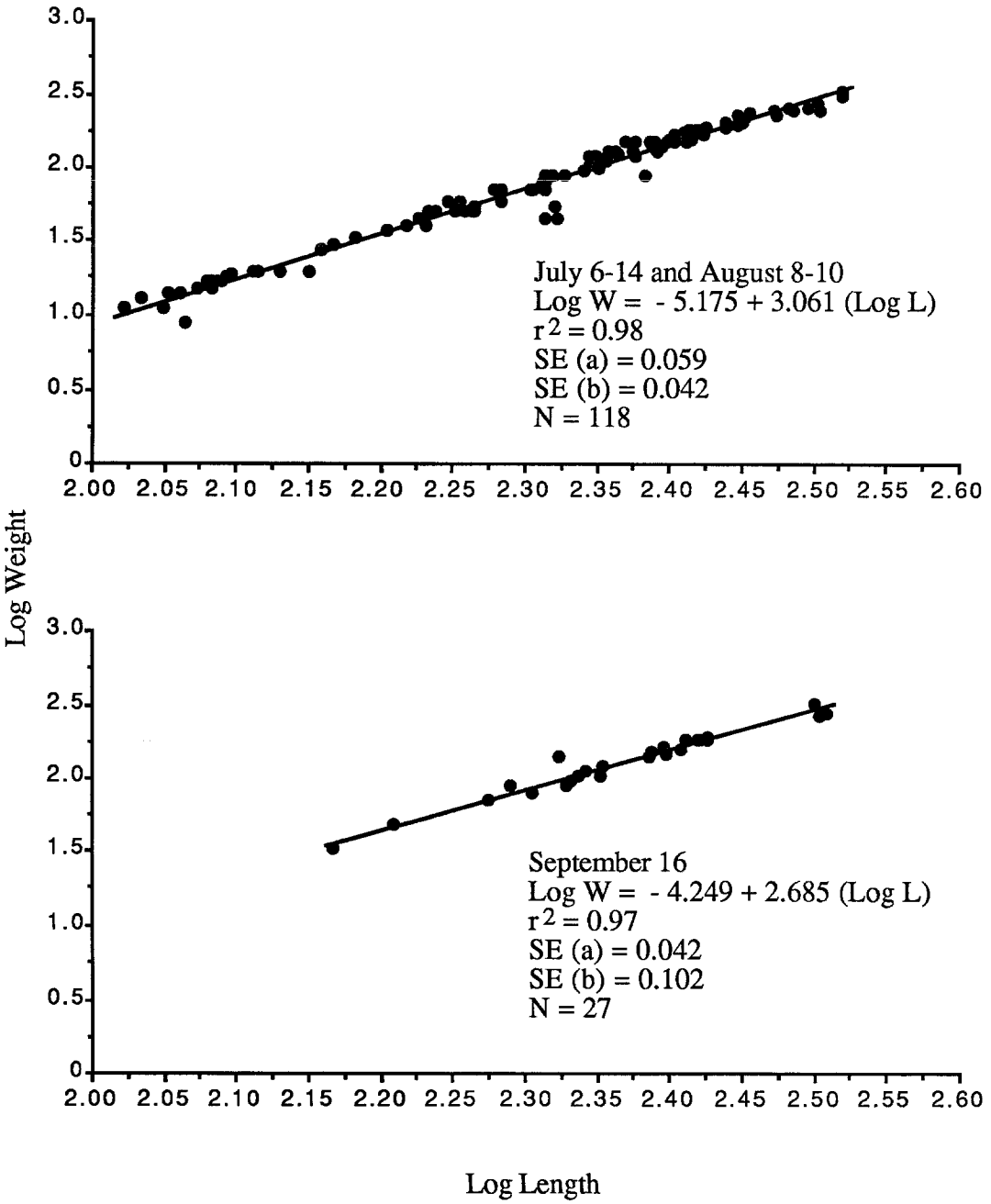

FIGURE 14.—Length-weight relationship of juvenile and adult Arctic grayling captured in the upper tributary and lake (OT 19) in the Okpilak drainage, July - September 1990.

TABLE 5.—Mean fork length and weight at age for Arctic grayling captured at site OT 19 in the Okpilak drainage, July - September 1990. Age determined from scales.

		Length (mm)			Weight (g)		
Age	N	Mean	SD	Range	Mean	SD	Range
				July 6 and 14, 1990			
0	0						
1	0						
2	0						
3	7	178.6	5.4	168-184	52.9	5.7	45-60
4	25	236.8	31.5	201-319	128.0	58.4	45-250
5	23	252.2	22.1	212-296	163.6	41.8	90-250
				August 8 and 10, 1990			
0	1	63					
1	21	122.5	12.8	105-160	17.4	6.5	9-37
2	7	158.9	22.4	135-190	38.3	18.8	20-70
3	9	203.1	51.5	165-331	91.1	84.9	40-310
4	14	253.9	42.2	202-303	163.9	81.2	70-340
5	10	256.4	24.9	206-298	158.0	46.9	80-230
				September 16, 1990			
0	0						
1	0						
2	2	154.5	10.6	147-162	41.5	10.6	34-49
3	4	230.8	62.7	188-323	135.0	97.5	70-280
4	12	264.1	27.7	226-319	187.1	56.7	120-325
5	5	236.6	15.8	215-250	127.6	24.2	98-150

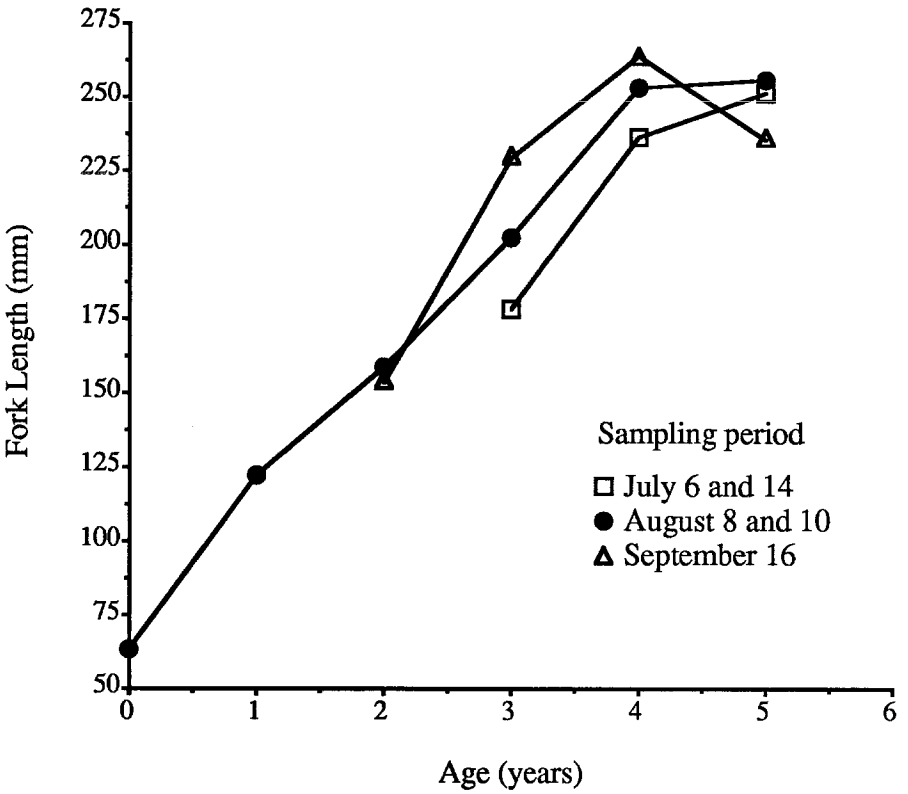

FIGURE 15.— Mean length at age of Arctic grayling captured at site OT 19 in the Okpilak drainage, July - September 1990. Age determined from scales.

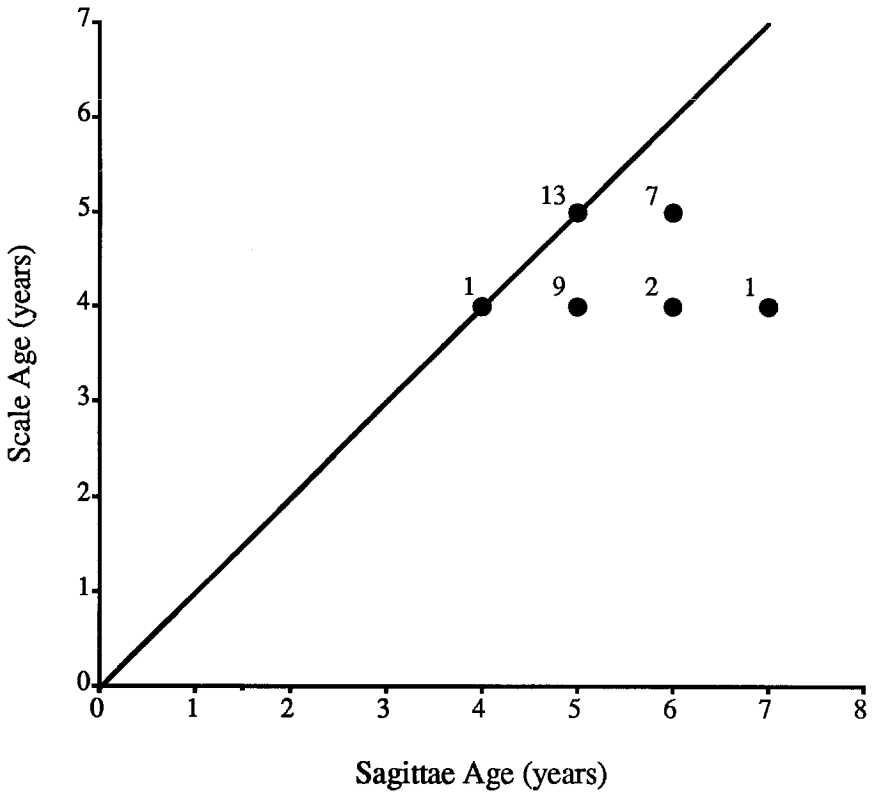

FIGURE 16.— Comparison of age estimations from sagittae and scales of Arctic grayling captured at site OT 19 in the Okpilak drainage, July - September 1990. Comparisons are based on fish with both readible sagittae and scales. The line representes a 1:1 relationship between age structures. Numbers indicate fish in each relationship.

TABLE 6.—Summary of gear used and capture information for fish caught in the Akutoktak River, July - September 1990. N = number of fish captured, CPUE = catch per unit effort, AC = Arctic char, GR = Arctic grayling, NSB = ninespine stickleback, a = adult, j = juvenile, yoy = young of the year.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
Jul 7-18	Minnow traps	45	327.7		0	
	Hook and line			GR a	16	
	Visual			GR a	7	
	Visual			GR yoy	662	
Aug 9-22	Minnow trap	70	1174.1	AC j	2	<0.01
	Minnow traps	70	1174.1	GR yoy	35	<0.01
	Electrofisher		3.0	GR a	1	0.33
	Electrofisher		3.0	GR j	5	1.67
	Electrofisher		3.0	GR yoy	63	21.00
	Hook and line			GR a	1	
	Hook and line			GR j	1	
	Dip net			AC j	1	
	Visual			GR yoy	534	
Sep 11-12	Minnow traps	20	464.2		0	
	Electrofisher		1.5	GR yoy	34	22.67
	Electrofisher		1.5	NSB	6	4.00
	Visual			GR yoy	6	

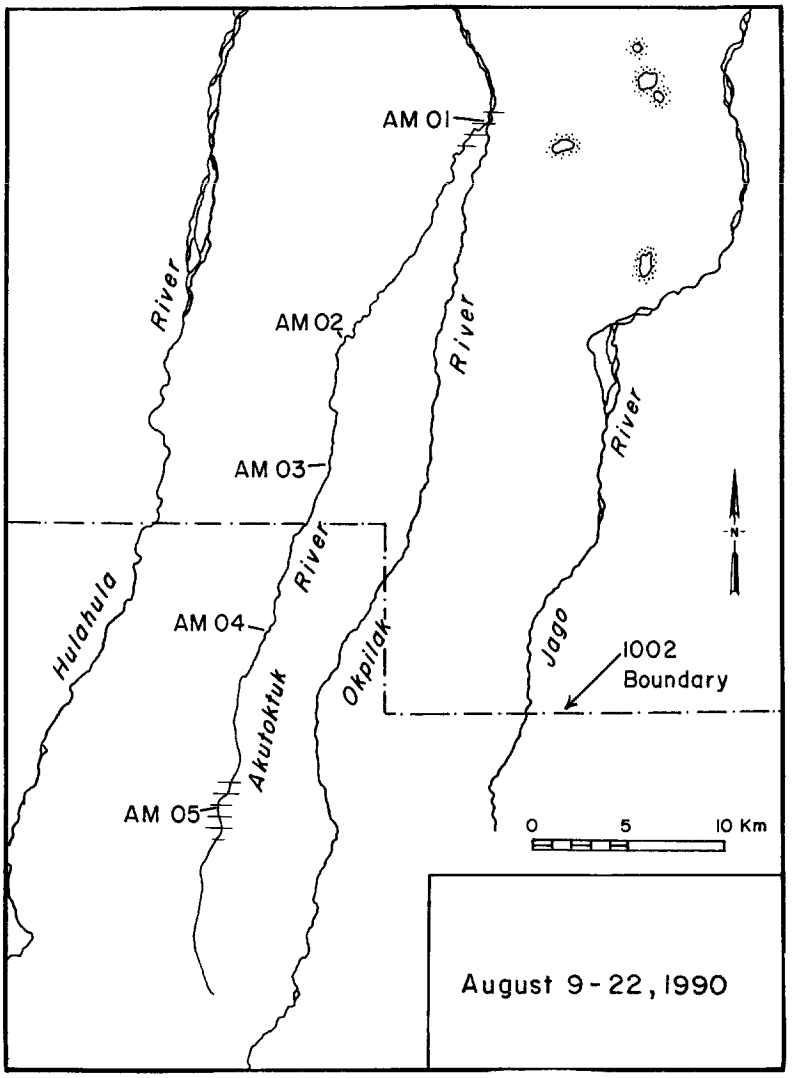

FIGURE 17.—Distribution of juvenile Arctic char (shaded area) in the Akutoktak River during August 1990.

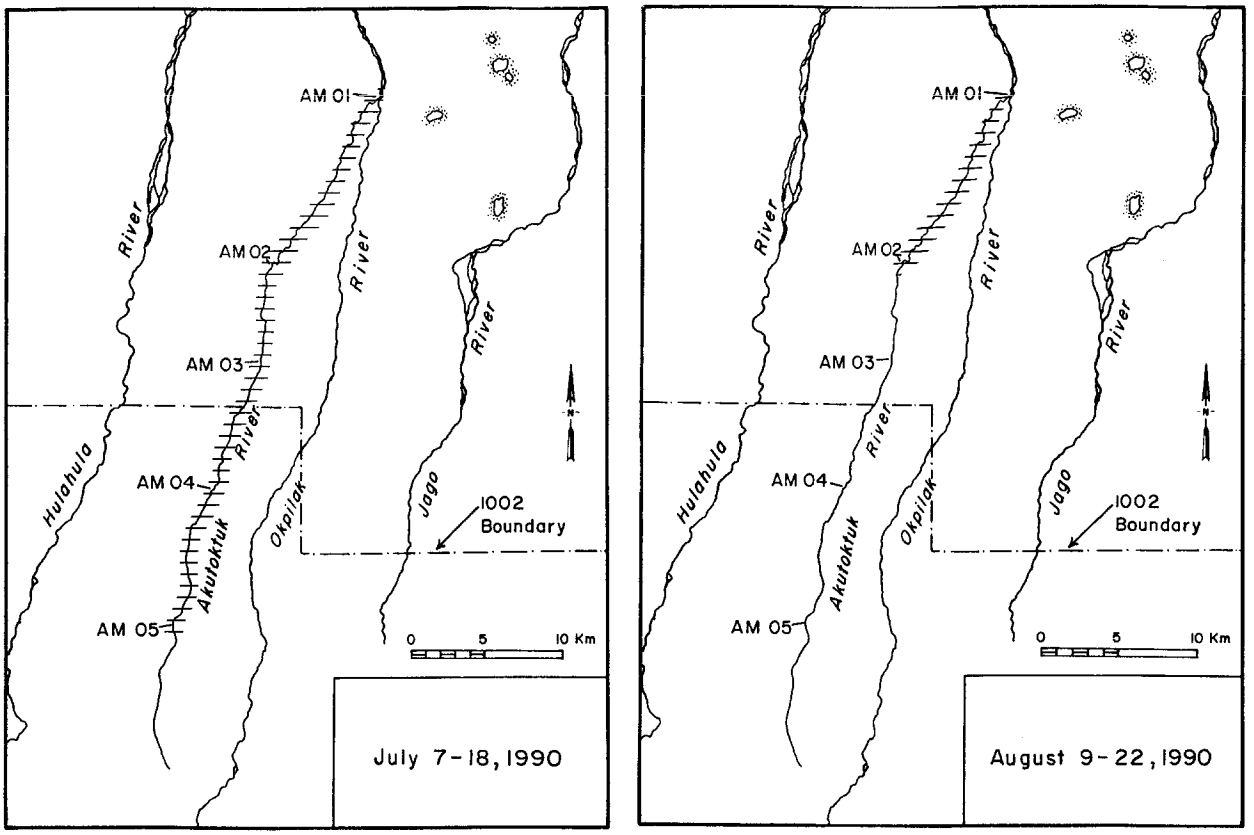

FIGURE 18.—Distribution of adult Arctic grayling (shaded area) in the Akutoktak River during July and August 1990.

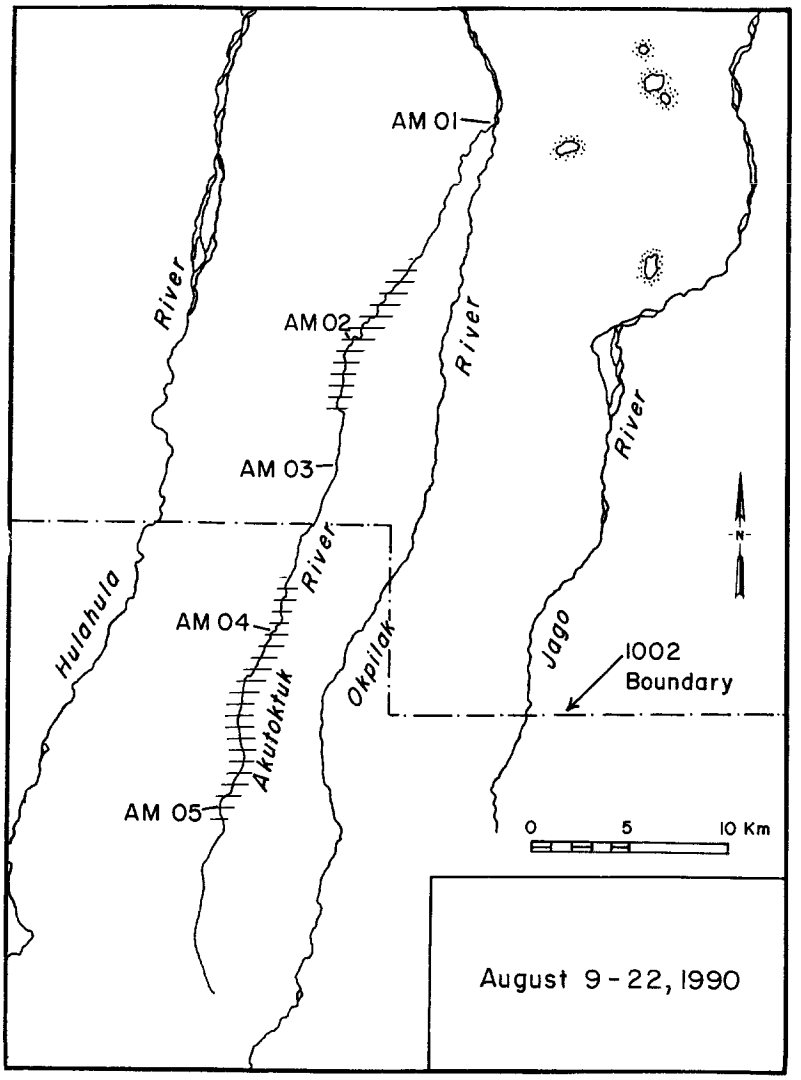

FIGURE 19.—Distribution of juvenile Arctic grayling (shaded area) in the Akutoktak River during August 1990.

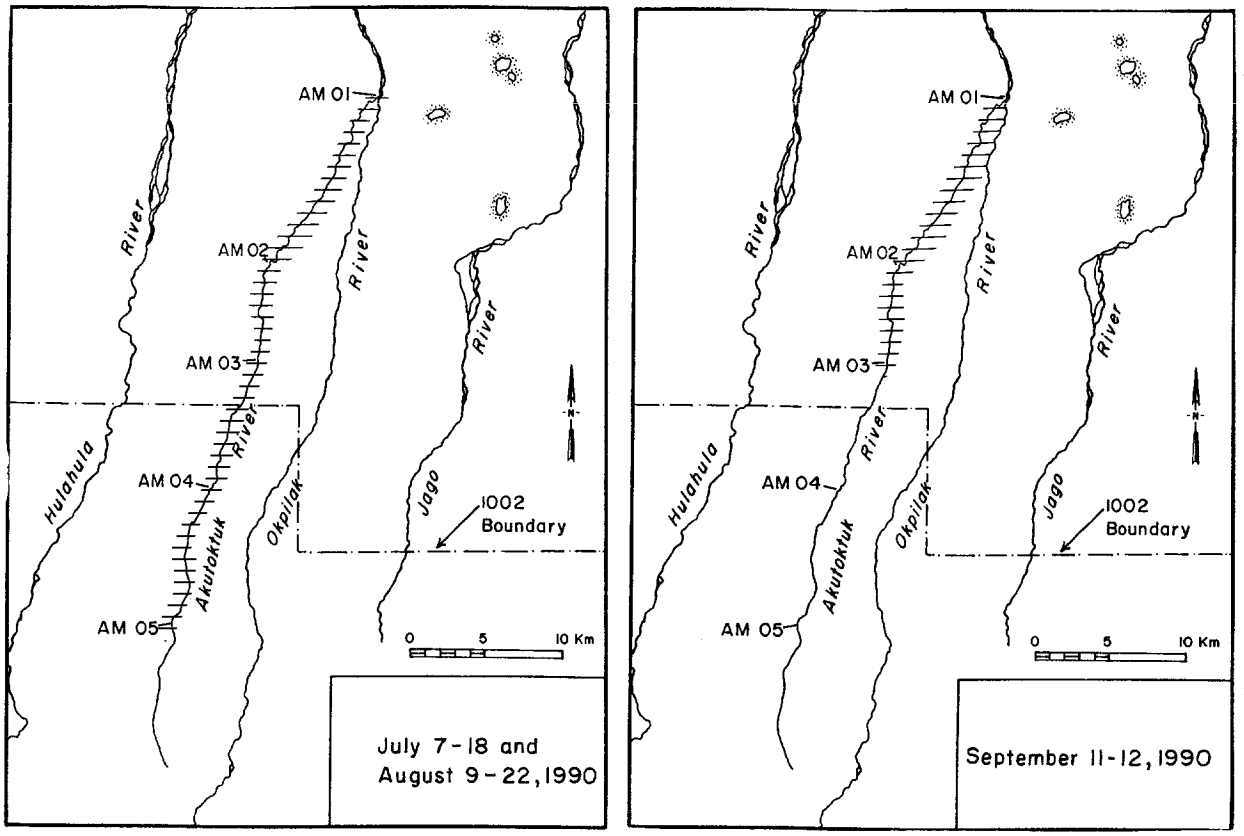

FIGURE 20.—Distribution of young of the year Arctic grayling (shaded area) in the Akutoktak River, July - September 1990.

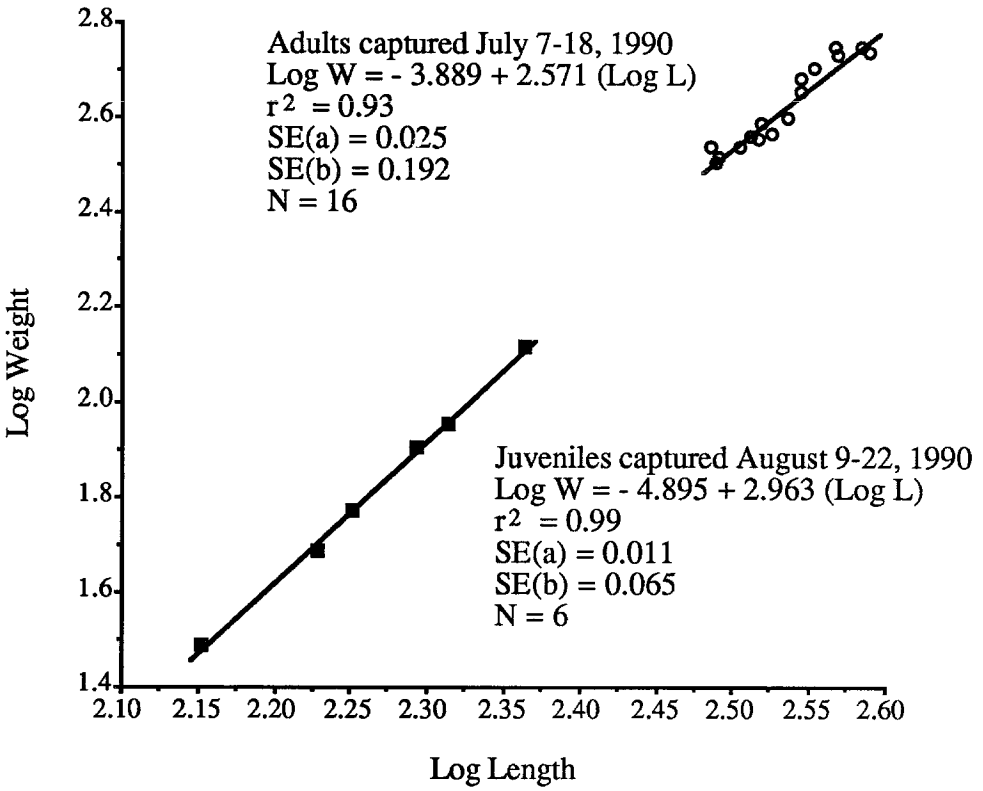

FIGURE 21.— Length-weight relationship of adult Arctic grayling (o) captured in July 1990 and juveniles (■) captured in August 1990 in the mainstem Akutoktak River.

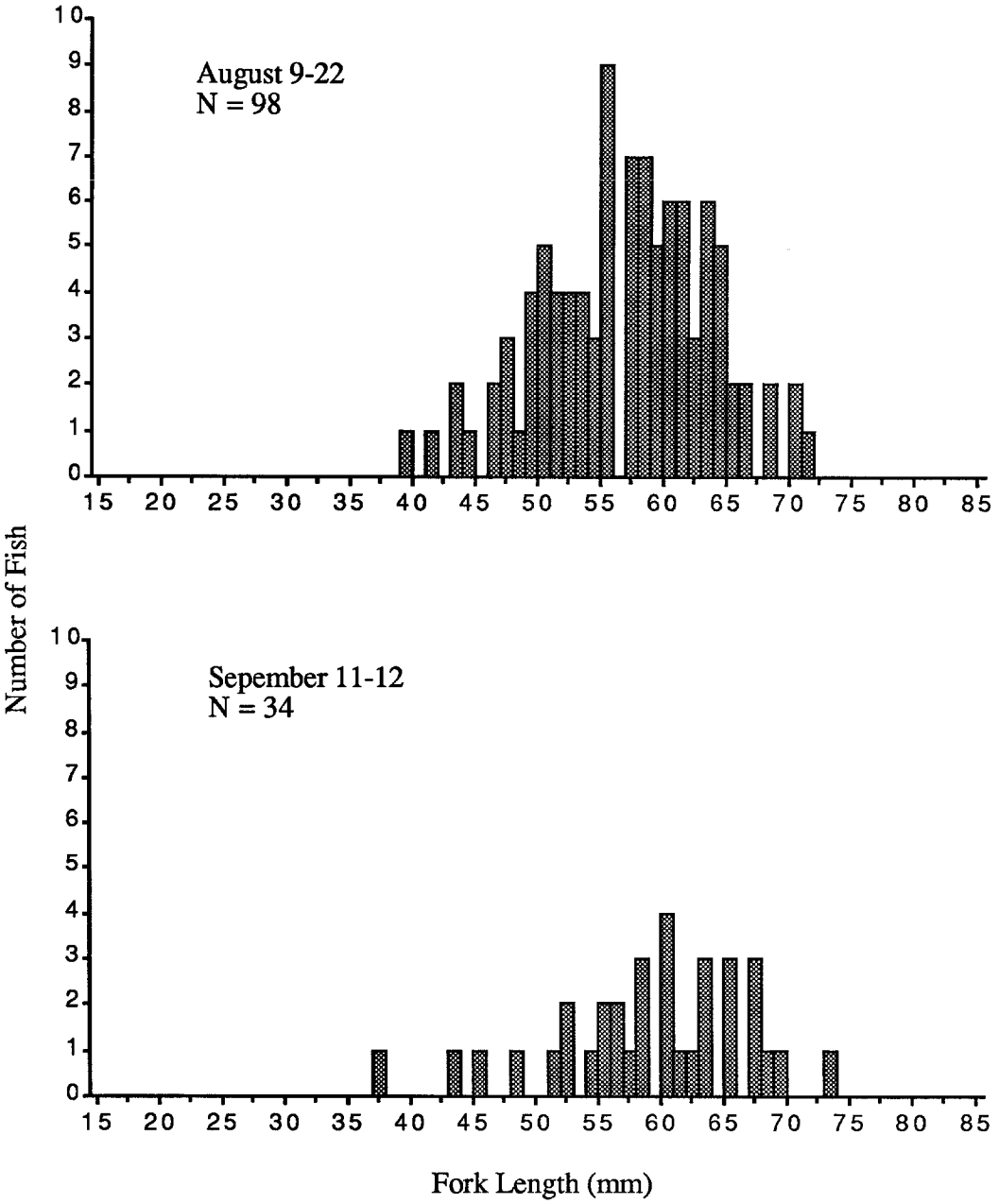

FIGURE 22.—Length-frequency of young of the year Arctic grayling in the Akutoktak River, August and September 1990.

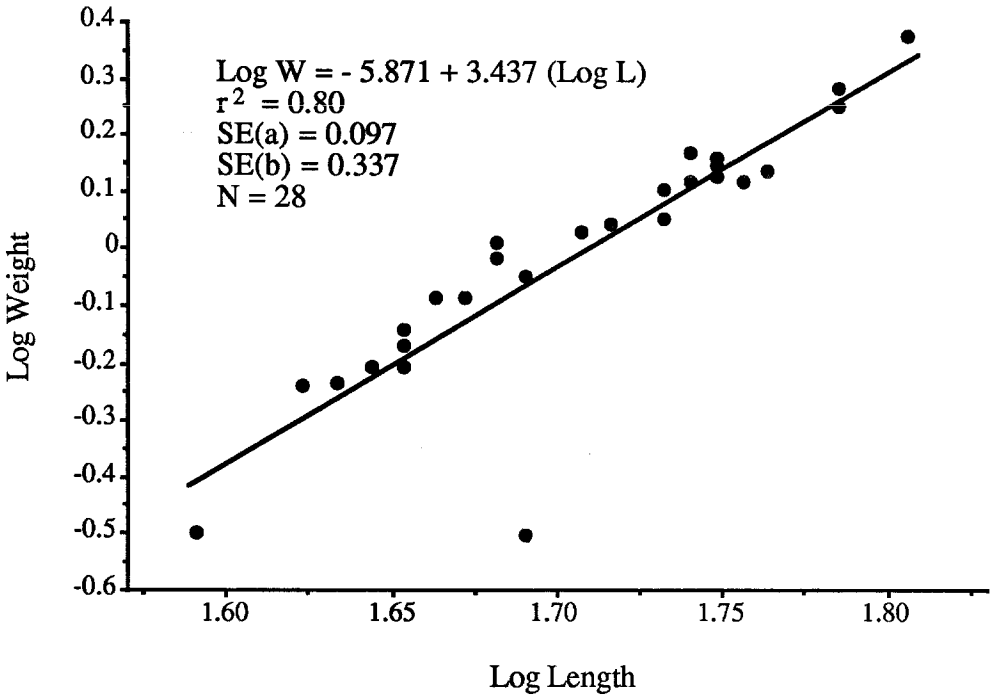

FIGURE 23.— Length-weight relationship of young of the year Arctic grayling captured in the mainstem Akutoktak River in August 1990.

Katakturuk River

Fish distribution.—In July, one juvenile Arctic char and one juvenile Arctic grayling were captured about 15 km upriver (site KM 04) in the mainstem Katakturuk River (Table 7; Figure 24). Neither species were captured in August or September in the mainstem nor at any tributary sites.

In July and August, 94 ninespine stickleback were captured in the lower 15 km of the mainstem (sites KM 01 and KM 02). Forty-four fish were captured in the lower reach of a tributary at site KT 09 in July and August, and one fish was captured in a tributary on the west side of the river (site KT 11). In September, only one ninespine stickleback was captured in the drainage.

Biological characteristics.—The Arctic char and Arctic grayling measured 207 mm FL and 116 mm FL, respectively. Ninespine stickleback ranged in length from 38 to 81 mm FL ($N = 101$, $\bar{x} = 63.7$, $SD = 8.6$).

Jago River

Fish distribution.—Two juvenile Arctic char were captured 15 km upriver at site JM 02, one in mid-July and the other in late August (Table 8; Figure 25). Arctic grayling were not captured during any of the sampling periods.

In the mainstem, 306 ninespine stickleback were captured at five of the six sites, but not on all occasions. In late August, 13 ninespine stickleback were captured at an unnamed tributary about 45 km above the mouth of the Jago River (site JT 10) and two fish were caught in the lower Okerokovik River (site JT 13). In September, 85 ninespine stickleback were captured in the lower 30 km (sites JM 01 - JM 04) of the mainstem Jago River, and one fish in the lower Okerokovik River (JT 13). No fish were captured in Okpirourak Creek.

Biological characteristics.—The two juvenile Arctic char were 150 and 154 mm FL. Ninespine stickleback ranged in length from 23 to 105 mm FL ($N = 279$, $\bar{x} = 51.6$, $SD = 9.5$).

Discussion

Fish Distribution

Arctic char.—Juvenile Arctic char were distributed throughout the lower 70-80 km of the mainstem Okpilak River and in two tributaries from July through September 1990. This was consistent with results from 1989 sampling (Wiswar 1991) where juveniles were captured in the lower 50 km of the mainstem Okpilak River and the lower reaches of two tributaries. Prior to 1989, only two juvenile Arctic char had been located in the mainstem or tributaries of the Okpilak River (Ward and Craig 1974; Daum et al. 1984; Lyons and Elliott 1987). Overwintering of Arctic char in the Okpilak River has not been documented and the absence of young of the year suggest that these juveniles may have migrated from the Hulahula River, which shares a common delta with the Okpilak River.

Distribution of juvenile Arctic char from the Akutoktak, Katakturuk, and Jago rivers occurred at only a few sites (≤ 2) per river in 1990. Their occurrence in these rivers during past surveys has been sporadic. In the Akutoktak River in 1989, 50 juveniles were captured at one site in early and late August (Wiswar 1991); however, none were captured in previous studies (Ward and Craig 1974; Daum

TABLE 7.—Summary of gear used and capture information for fish caught in the Katakturuk River and its tributaries, July - September 1990. N = number of fish captured, CPUE = catch per unit effort, AC = Arctic char, GR = Arctic grayling, NSB = ninespine stickleback, j = juvenile.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
		Mainstem				
Jul 23	Minnow traps	20	96.7	NSB	25	<0.01
	Electrofisher		0.5	AC j	1	2.00
	Electrofisher		0.5	GR j	1	2.00
	Electrofisher		0.5	NSB	1	2.00
Aug 9-11	Minnow traps	30	430.0	NSB	8	<0.01
	Electrofisher		2.2	NSB	60	27.27
Sep 17-18	Minnow traps	50	293.3		0	
	Electrofisher		2.7	NSB	1	0.37
		Tributaries				
Jul 23	Minnow traps	10	25.8	NSB	5	0.19
Aug 10-12	Electrofisher		1.6	NSB	40	25.00
Sep 17-18	Electrofisher		1.6		0	

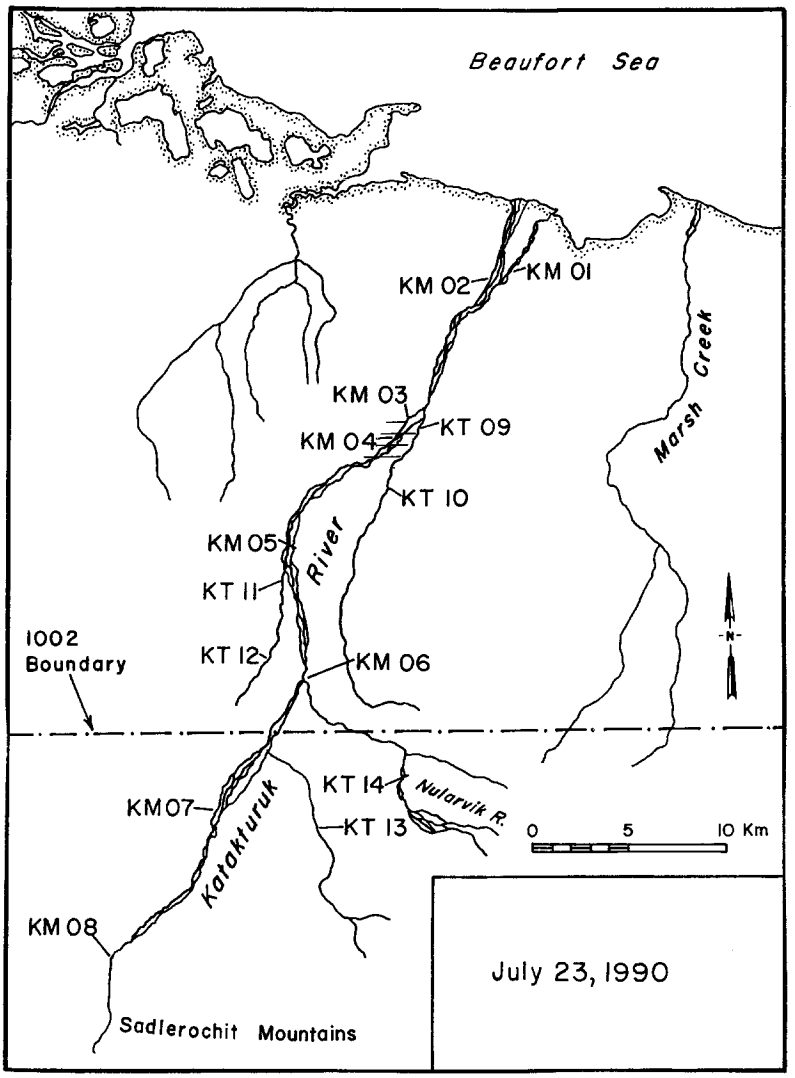

FIGURE 24.—Distribution of juvenile Arctic char and Arctic grayling (shaded area) in the Katakturuk River during July 1990.

TABLE 8.—Summary of gear used and capture information for fish caught in the Jago River and its tributaries, July - September 1990. N = number of fish captured, CPUE = catch per unit effort, AC = Arctic char, NSB = ninespine stickleback, j = juvenile.

Sampling period	Gear type	Number of sets	Effort (h)	Species and life history stage	N	CPUE (fish/h)
		Mainstem				
Jul 19-24	Minnow traps	55	297.5	AC j	1	<0.01
	Minnow traps	55	297.5	NSB	214	0.01
	Electrofisher		1.0	NSB	3	3.00
Aug 23-25	Minnow traps	68	265.7	AC j	1	<0.01
	Minnow traps	68	265.7	NSB	2	<0.01
	Electrofisher		2.0	NSB	2	1.00
Sep 14-16	Minnow traps	40	104.2	NSB	4	<0.01
	Electrofisher		1.4	NSB	81	57.86
		Okpirourak Creek				
Aug 27	Electrofisher		1.0		0	
Sep 12-14	Electrofisher		0.4		0	
		Okerokovik River				
Aug 25	Minnow traps	19	54.1		0	
	Electrofisher		0.5	NSB	2	4.00
Sep 14	Electrofisher		0.4	NSB	1	2.50
		Unnamed tributary				
Aug 27	Electrofisher		1.1	NSB	13	11.82
Sep 14	Electrofisher		1.1		0	

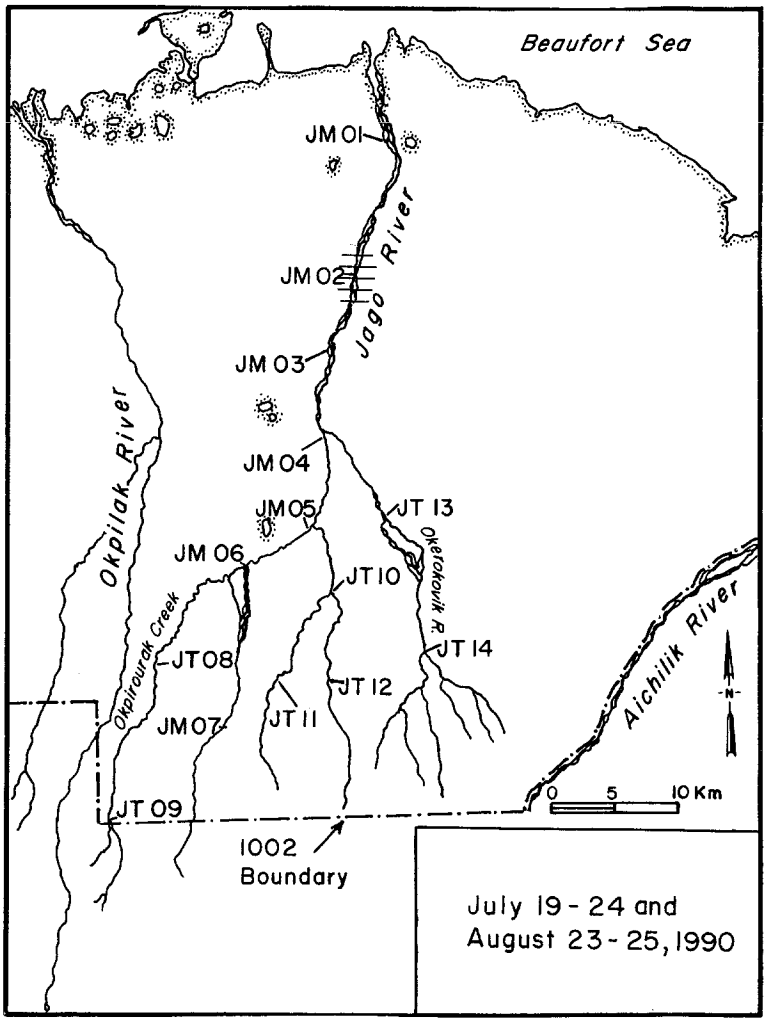

FIGURE 25.—Distribution of juvenile Arctic char (shaded area) in the Jago River during July and August 1990.

et al. 1984; Lyons and Elliott 1987). In 1990, three Arctic char were captured at two sites. Average stream flow in the Akutoktak River during the months of July and August 1990 was an order of magnitude lower than 1989 (Lyons and Trawicki 1991). Low flows may have inhibited upstream migration in 1990.

In the Katakturuk River in 1990, one juvenile Arctic char was captured about 15 km upstream. Similarly, one juvenile was captured in 1982 (Smith and Glesne 1983), but in 1989, 71 juveniles were captured (Corning *in preparation-a*). In 1989, most fish were captured in the lower 15 km but they were found 35 km upstream in the lower Nularvik River as well. In the Jago River, juveniles were not captured during surveys conducted prior to 1989 (Ward and Craig 1974; Daum et al. 1984; West and Frugé 1989), but seven were captured in 1989 (Corning *in preparation-a*) and two in 1990. Two lakes in the upper Jago drainage have a resident population of Arctic char (Daum et al. 1984). Jago Lake is land locked but the other lake is river-connected and may have been a source for Arctic char captured in the river. However, most fish have been found in the lower river, and therefore, could be immigrants from the coastal waters.

Arctic grayling.—In the mainstem Okpilak River, only one adult Arctic grayling was captured in 1990. In past studies conducted in the mainstem, catch rates of adults have been low (<2 fish) during July and August as well (Ward and Craig 1974; Daum et al. 1984; Wiswar 1991). Low catch rates may reflect low residence times. The mainstem Okpilak River is used by adults as a migration corridor to spawning and feeding areas in tributaries in early June and to overwintering areas in late summer (West and Wiswar 1985; Wiswar et al. 1987).

Juvenile Arctic grayling were captured in the upper mainstem Okpilak River in July and August 1990. In 1989, their distribution was more extensive and included the mid and lower reaches of the mainstem as well (Wiswar 1991). Young of the year Arctic grayling were captured in the mainstem in July at sites adjacent to tributaries where young of the year were present. Their distribution along the mainstem increased in August and September. Young of the year were also captured in the mainstem in August 1989 (Wiswar 1991). Young of the year were still present in the tributaries in August and September 1990. In September, distribution was generally limited to lower reaches of streams. Downstream migrations in other arctic streams peaked during mid-September (Craig and Poulin 1975; Elliott 1982). Overwintering locations of young of the year are unknown.

All life history stages of Arctic grayling were found in the Akutoktak River in 1990. This river is a perennial spawning and rearing area for Arctic grayling (Daum et al. 1984; Lyons and Elliott 1987; Wiswar 1991). Adult, juvenile, and young of the year fish were found 45 km upstream in July 1990 which compares with their distribution in 1989 (Wiswar 1991).

Arctic grayling are not resident fish of the Katakturuk and Jago rivers. Arctic grayling have not been documented in the Jago River, and previous to this study, only one other Arctic grayling had been captured in the Katakturuk River (Ward and Craig 1974; Smith and Glesne 1983; Lyons and Elliott 1987; West and Frugé 1989; Corning *in preparation-a*). Streams which support Arctic grayling populations, the Tamayariak and Akutoktak rivers and Itkilyariak Creek, share a delta or drainage with rivers with overwintering habitat (West and Wiswar 1985; Wiswar et al. 1987). The Katakturuk and Jago rivers do not have these characteristics. The distance between river mouths of the Katakturuk and Jago rivers and other rivers and saline coastal waters probably prevent migration of Arctic grayling to

them. Although perennial springs are found in both drainages, discharge, water temperature, or pool depth may not be adequate to support overwintering of a resident population.

Ninespine stickleback.—Ninespine stickleback are an ubiquitous species. They were captured in the Okpilak, Katakturuk, and Jago rivers during all three sampling periods and in the Akutoktak River in September. Their distribution in 1990 was consistent with surveys conducted in these rivers in 1989 (Corning *in preparation-a*; Wiswar 1991).

Biological Characteristics

Arctic char.—Juvenile Arctic char captured in the Okpilak and Akutoktak rivers were 96-256 mm FL and one to four years old. This corresponds to the size range and age distribution of fish captured in 1989 (Wiswar 1991). Most of the growth in young of the year Arctic char occurs between mid-June and mid-August (McCart 1980). At the end of their first year of growth, Arctic char in anadromous populations generally do not exceed 74 mm FL (Yoshihara 1972; McCart 1980; Daum et al. 1984; West and Wiswar 1985).

Arctic grayling.—The size of Arctic grayling captured in the lake and streams at OT 19 were generally less than 285 mm FL. Length at age analysis revealed that these fish were predominately juveniles between 3 and 5 years old. Distribution of juvenile Arctic grayling in the Okpilak-Akutoktak drainage and other rivers in the Arctic Refuge has not been adequately described. Catch rates of juveniles have been disproportionately low to that of adults or length classes have been missing (Smith and Glesne 1983; Daum et al. 1984; Wiswar 1991; Corning *in preparation-b*). It is possible that the lake is used as rearing habitat for a major portion of the juvenile population in this drainage. Access to the lake from the mainstem Okpilak River does not appear likely during low flows. It is unclear if the Arctic grayling in the lake are an isolated population.

Arctic grayling from the Akutoktak River in 1990 were similar in length to those captured in 1983 and 1989 (Daum et al. 1984; Wiswar 1991). While length frequencies also compare similarly to Arctic grayling captured in the Hulahula and Sadlerochit rivers and Itkilyariak Creek (Smith and Glesne 1983; Daum et al. 1984), larger adult Arctic grayling have been captured in the Tamayariak River (Smith and Glesne 1983; Corning *in preparation-b*). River drainages on the Arctic coastal plain may contain different stocks of Arctic grayling with specific length and growth characteristics. Alternatively, habitat variables in the Tamayariak River, including overwintering in the Canning River (West and Wiswar 1985; Wiswar et al. 1987), may be more favorable for growth.

The mean lengths of young of the year in both the Akutoktak and Okpilak rivers in August 1990 were significantly larger ($P = 0.0001$, t- test; Zar 1984) than those in August 1989 for each respective river. Although lengths differed, there was no significant difference ($P > 0.20$) in the length-weight relationship between fish collected in this study and those collected in August 1989 (Wiswar 1991).

Conclusion

The Okpilak-Akutoktak drainage is an important river system for Arctic char and Arctic grayling as a migration corridor and providing summer feeding and rearing habitat. In addition, based on the distribution of young of the year Arctic grayling, the Akutoktak River and two tributaries of the Okpilak River are spawning streams.

In the Katakturuk and Jago rivers, the low numbers of Arctic char and Arctic grayling captured and their presence at only a few sites indicate that use of these rivers is incidental (Smith and Glesne 1983; Daum et al. 1984; Wiswar 1991; Corning *in preparation-a;* and this study). However, the Katakturuk and Jago rivers, as well as the Okpilak River, are important to ninespine stickleback.

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