Alaska Fisheries Technical Report Number 27

SUMMER DISTRIBUTION OF ARCTIC FISHES IN THE 1002 AREA OF THE ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA, 1991, WITH SPECIAL EMPHASIS ON SELECTED LAKES, TUNDRA STREAMS, AND THE SADLEROCHIT RIVER DRAINAGE

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Abstract.—The summer distribution of Arctic fishes on the coastal plain of the Arctic National Wildlife Refuge was investigated in 19 lakes, 20 tundra streams, and the Sadlerochit River drainage during 1991. Fish sampling occurred July 2 - September 24. All lakes were sampled once except one river-connected lake that was sampled July, August, and September. Tundra streams and the Sadlerochit River drainage were sampled in July and sites were resampled in August and September. Fyke nets were used to capture fish in the lakes and hook and line and electrofisher were used in the rivers and streams.

In 14 isolated lakes, ninespine stickleback *Pungitius pungitius* was the only species captured and in three lakes no fish were captured. The number of species was higher in river-connected lakes; where, in two lakes in the Canning River delta, Dolly Varden char *Salvelinus malma*, Arctic grayling *Thymallus arcticus*, Arctic cisco *Coregonus autumnalis*, least cisco *C. sardinella*, fourhorn sculpin *Myoxocephalus quadricornis*, and ninespine stickleback were captured. Ninespine stickleback ranged from 22 to 82 mm fork length (FL), Dolly Varden char were 170 - 237 mm FL, and Arctic cisco were 58 - 109 mm FL.

In the tundra streams, juvenile Dolly Varden char, ninespine stickleback, fourhorn sculpin, and juvenile and young of the year Arctic grayling were captured. Dolly Varden char were captured in twelve tundra streams but only in Nataroarok, Marsh, and Carter creeks were juveniles captured during both July and August. Ninespine stickleback were captured in 18 streams but not during all sampling periods. Arctic grayling were found in two streams and fourhorn sculpin in one stream. Dolly Varden char ranged from 63 - 237 mm FL and ninespine stickleback were 20 - 89 mm FL.

In the Sadlerochit River drainage, resident Dolly Varden char, three life history stages (young of the year, juvenile, and adult) of Arctic grayling, and ninespine stickleback were captured. Dolly Varden char were captured during all three sampling periods and were distributed throughout the drainage although they were not captured at all sites. Juvenile and adult Arctic grayling were captured in July and August. Young of the year Arctic grayling were captured in August and September. Adult and juvenile Arctic grayling were captured in the Kekiktuk River in September. Dolly Varden char in the drainage ranged from 68 to 233 mm FL. Adult Arctic grayling were 304 - 369 mm FL, juveniles were 86 - 242 mm FL, and young of the year were 11 - 32 mm FL.

Introduction

The 1002 area, on the coastal plain of the Arctic National Wildlife Refuge (Arctic Refuge), was designated by the U.S. Congress for possible oil and gas exploration and development under the Alaska National Interest Lands Conservation Act of 1980 (U.S. Public Law 96-487). Should such activities be

allowed, fishery resources could be affected by the construction and placement of roads and pipelines, gravel removal, oil spills, and water diversions.

Freshwater fishery investigations in the 1002 area prior to 1989 (Ward and Craig 1974; Smith and Glesne 1983; Daum et al. 1984; West and Wiswar 1985; Wiswar et al. 1987; West and Frugé 1989; Corning, unpublished report-a) are limited in area sampled, and frequency and duration of sampling. In 1989, multiple sites in four rivers were sampled several times during the open water season (Wiswar 1991; Corning, unpublished report-b). Also in 1989, 52 lakes on the coastal plain were sampled (Elliott 1990; Trawicki et al. 1991). The results of the 1989 investigations indicated that fish were more widely distributed in rivers and lakes than previously documented. In order to assess impacts from potential oil and gas activities, and recommend mitigation measures for such activities, surveys begun in 1989 were continued in the summers of 1990 (Wiswar 1992) and 1991. This report is divided into three sections: lakes, tundra streams, and the Sadlerochit River drainage. Objectives and methods are defined under each section.

Study Area

The rivers and lakes are located on the Arctic coastal plain and within the boundary of the Arctic Refuge (Figures 1 and 2). The coastal plain is underlain by continuous permafrost. The climate is arctic marine and is characterized by long, cold winters and short, cool summers. Mean monthly temperatures are below 0°C nine months of the year (NOAA 1987). February is the coldest month with a mean monthly temperature of minus 28.9°C. July is the warmest month with an average temperature of 4.4°C. Snowmelt begins in the foothills in 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. Lakes become ice free by early July. Freeze-up on the coastal plain usually occurs in mid- to late September (Clough et al. 1987).

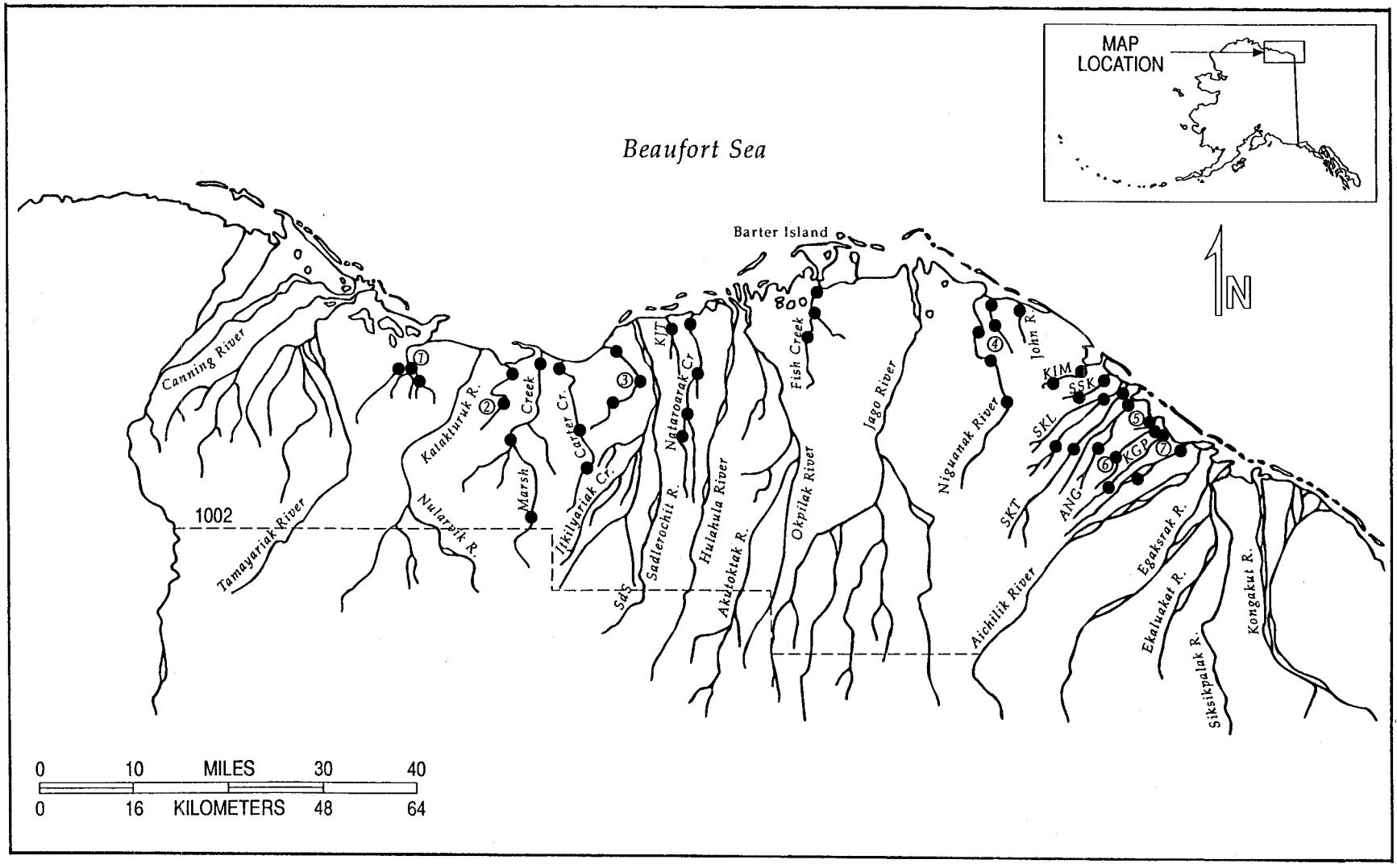


FIGURE 1.—Rivers and streams in the 1002 area of the Arctic National Wildlife Refuge, Alaska. SdS = Sadlerochit Spring, KJT = Kajutakrok Creek, KIM = Kimikpaurauk River, SSK = Siksik River, SKL = Sikrelurak River, SKT = Sikutaktuvik River, ANG = Angun River, KGP = Kogotpak River, streams 1-7 are unnamed, ● = sites in tundra streams sampled July - September 1991.

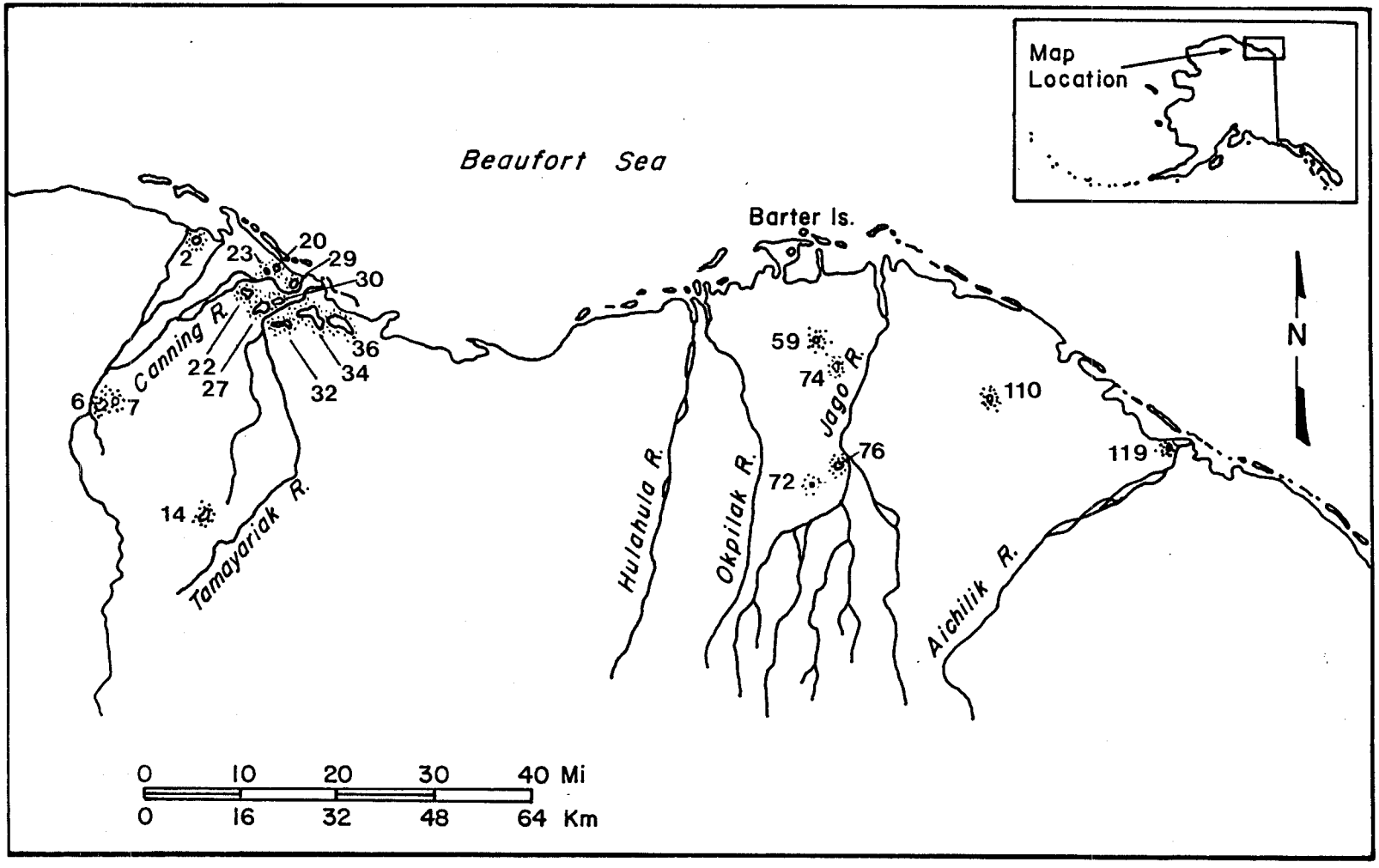


FIGURE 2.—Lakes in the 1002 area of the Arctic National Wildlife Refuge, Alaska sampled during the summer 1991.

Lakes on the Arctic coastal plain in the 1002 area

Fourteen lakes were sampled during the summer of 1973 (Ward and Craig 1974; Table 1). All but two lakes were in the Canning River delta. Arctic grayling *Thymallus arcticus*, Dolly Varden char *Salvelinus malma*, broad whitefish *Coregonus nasus*, round whitefish *Prosopium cylindraceum*, Arctic flounder *Liopsetta glacialis*, and ninespine stickleback *Pungitius pungitius* were captured in four river-connected lakes but not all species were caught in each lake. Arctic grayling and ninespine stickleback were captured in one isolated lake. In 1986, nine isolated lakes on the coastal plain were sampled and ninespine stickleback were captured in three lakes (West and Frugé 1989; Table 1).

Between 1989 and 1990, depth measurements along transects in 119 lakes in the 1002 area were used to quantify water availability (Elliott 1990; Trawicki et al. 1991). Ninespine stickleback were captured or observed in 36 of the 54 lakes surveyed for fish. Maximum depth in lakes where fish were found ranged from 0.7 to 7.6 m.

The objectives of this study in 1991 are to:

1. Determine spatial distribution of arctic fishes in river-connected and isolated lakes within the 1002 area.
2. Determine length frequency and weights for arctic fishes.

Methods

Nineteen lakes on the coastal plain were sampled for fish distribution during the summer 1991 (Figure 2). Lakes greater than 2.7 m maximum depth were initially selected for sampling (Elliott 1990; Trawicki et al. 1991). The depth criteria was based on late winter ice thickness and under ice water depth. In arctic lakes, ice normally does not exceed 2 m (Wilson et al. 1977), and fish have been captured under ice in water as shallow as 0.7 m deep (Craig 1989). Seventeen of the 19 lakes are deeper than 2.7 m (Elliott 1990; Trawicki et al. 1991). Thirteen lakes were sampled on July 5-13, six lakes on August 16-19, and two lakes on September 22, 1991. Lake 27, a river-connected lake in the Canning River delta, was sampled during all three periods. The numbering system used for the lakes follows that of Trawicki et al. (1991).

Fish were collected with fyke nets (0.6 cm mesh, 0.8 m D-frame opening, 3 m long wings and 9.1. m long lead).

Fish captured were counted and measured to the nearest mm fork length (FL) or total length for fish species with truncate or rounded caudal fins. Fish over 200 g were weighed to the nearest 10 g and fish less than 200 g to the nearest 0.1 g. Smaller fish (<200 mm FL) were placed in a solution of tricaine (MS 222) before measuring. When a large (>100) number of fish was captured a random subsample was measured.

Results

Fish distribution.—Two lakes sampled are river connected. Lakes 27 and 30 (Table 2; Figure 2), are connected by a short channel (about 25 m long), and lake 30 is connected to a channel of the Canning River. Juvenile Dolly Varden char (N = 4) and three life stages of Arctic grayling (N = 2 adult, 11 juveniles, and 2 young of the year) were captured in one or both lakes within the three sampling periods. Juvenile Arctic cisco *Coregonus autumnalis* (N = 12), least cisco *C. sardinella* (N = 1), fourhorn sculpin *Myoxocephalus quadricornis* (N = 6), and ninespine stickleback (N = 7) were also captured.

Ninespine stickleback was the only species captured (N = 1 to 2,730) in 14 isolated lakes. No fish were captured in lakes 29, 59, and 72.

Biological characteristics.—Juvenile Dolly Varden char captured in lakes 27 and 30 ranged from 170 to 237 mm FL (Table 3). Juvenile Arctic cisco in July ranged from 58 - 109 mm FL. Ninespine stickleback from 16 lakes ranged from 22 to 82 mm FL. Adult size Arctic grayling captured in August were 294 - 297 mm FL; juveniles in July and August were 91 - 240 mm FL, and young of the year in September were 42 - 48 mm FL.

Discussion

The number of different fish species captured was greater in river-connected lakes than in isolated lakes in the 1002 area. Juvenile Dolly Varden char, juvenile Arctic cisco, Arctic grayling, fourhorn sculpin, least cisco, and ninespine stickleback were captured in river-connected lakes within the Canning River delta. Ward and Craig (1974) also captured round whitefish, broad whitefish, and Arctic flounder in other river-connected lakes in this area.

Ninespine stickleback was the only species captured in 14 of the 17 isolated lakes sampled. The wide distribution and occurrence of ninespine stickleback in isolated lakes compares favorably with other studies on the coastal plain (Ward and Craig 1974; West and Frugé 1989; Elliott 1990; Trawicki et al. 1991). At higher elevations (> 300 m), isolated lakes located in the foothills support Dolly Varden char, lake trout *Salvelinus namaycush*, and Arctic grayling populations (Daum et al. 1984; Wiswar 1992).

Arctic cisco were captured in lake 27 on July 12. This species had not been captured in inland waters of the Arctic Refuge prior to 1991. Lake 27, which is 5.5 m deep (Trawicki et al. 1991), may have provided overwintering habitat for these Arctic cisco during the previous winter. Arctic cisco are anadromous and occur in the nearshore coastal waters along the Arctic Refuge during the open water season (West and Wiswar 1985; Wiswar and West 1987; Frugé et al. 1989; Palmer and Dugan 1990; Underwood et al. 1992). Overwintering areas in Alaska have only been documented to the west of the refuge in the Colville River (Moulton 1989) and Sagavanirktok River delta (Schmidt et al. 1989).

TABLE 1.—Species occurrence documented in lakes in this study prior to 1991.

Lake	Date previously sampled	Species present
2	Jul 1990[a]	No fish documented
6	Aug 1973, Aug 1989[a]	Arctic grayling, ninespine stickleback
7	Aug 1973[b], Aug 1989	Ninespine stickleback
14	Not sampled	
20	Jul 1990	No fish documented
22	Aug 1990[a]	No fish documented
23	Jul 1990	No fish documented
27	Jul 1989[a]	Ninespine stickleback
29	Jul 1973[b], Aug 1990	No fish documented
30	Jul 1973, Aug 1990	Dolly Varden char, round whitefish
32	Aug 1990	No fish documented
34	Jul 1973, Jul 1986[c], Aug 1989	Ninespine stickleback
36	Jul 1973, Jun 1989[a]	No fish documented
59	Aug 1990	No fish documented
72	Not sampled	
74	Jul 1989	Ninespine stickleback
76	Jul 1989	Ninespine stickleback
110	Jul 1986, Jun 1989	Ninespine stickleback
119	Aug 1989	Ninespine stickleback

[a] Elliott 1990; Trawicki et al. 1991
[b] Ward and Craig 1974
[c] West and Frugé 1989

TABLE 2.—Summary of capture information for fish caught by fyke nets in lakes in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991. All lakes are deeper than 2.7 m except lakes 29 and 30. Lakes 27 and 30 are river-connected, all other lakes are isolated. ACi = Arctic cisco, DVC = Dolly Varden char, FHS = fourhorn sculpin, GR = Arctic grayling, LCi = least cisco, NSB = ninespine stickleback, a = adult, j = juvenile, yoy = young of the year.

Lake	Date sampled	Number of sites	Effort (h)	Species and life history stage	N
2	Aug 16	2	44.0	NSB	6
6	Jul 8	2	48.5	NSB	2,730
7	Jul 8	2	47.1	NSB	11
14	Jul 9	2	41.8	NSB	1
20	Aug 17	2	59.5	NSB	47
22	Jul 13	2	41.7	NSB	2
23	Aug 17	2	61.0	NSB	1
27	Jul 12	2	44.0	DVC j	2
				ACi j	12
				GR j	2
				NSB	5
27	Aug 16	2	48.5	DVC j	1
				GR a	2
				GR j	6
				LCi	1
27	Sep 22	1	43.0	GR yoy	1
				FHS	1
29	Jul 13	2	47.2		0
30	Sep 22	2	42.3	DVC j	1
				GR j	3
				GR yoy	1
				NSB	2
				FHS	5

TABLE 2.—Continued.

Lake	Date sampled	Number of sites	Effort (h)	Species and life history stage	N
32	Jul 12	2	42.7	NSB	3
34	Jul 10	4	98.2	NSB	10
36	Jul 11	4	98.2	NSB	38
59	Jul 6	2	44.0		0
72	Jul 5	2	48.0		0
74	Jul 6	2	44.5	NSB	2
76	Jul 5	2	49.8	NSB	6
110	Aug 19	2	51.5	NSB	17
119	Aug 19	2	47.3	NSB	7

TABLE 3.—Lengths and weights of fish captured in lakes in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991. ACi = Arctic cisco, DVC = Dolly Varden char, FHS = fourhorn sculpin, GR = Arctic grayling, LCi = least cisco, NSB = ninespine stickleback, a = adult, j = juvenile, yoy = young of the year.

				Length (mm)			Weight (g)		
Lake	Date	Species	N	Mean	SD	Range	Mean	SD	Range
2	Aug 16	NSB	6	47.7	4.2	41-53			
6	Jul 8	NSB	195	36.4	4.2	26-51			
7	Jul 8	NSB	11	51.9	12.1	22-69			
14	Jul 9	NSB	1	32					
20	Aug 17	NSB	47	61.9	4.6	54-69			
22	Jul 13	NSB	2	46.0	2.0	44-48			
23	Aug 17	NSB	1	40					
27	Jul 12	DVC j	2	176.5	6.5	170-183	50.5	5.9	44.6-56.4
		ACi j	12	89.0	12.9	58-109	6.1	1.7	2.7-9.7
		GR j	2	177.0	33.0	144-210	58.6	28.9	29.9-87.7
		NSB	5	54.4	14.7	39-82			
	Aug 16	DVC j	1	206			77.8		
		GR a	2	295.5	1.5	294-297	265.0	15.0	250-280
		GR j	6	187.5	53.6	91-240	79.4	48.1	5.9-135.0
		LCi	1	307			320		
	Sep 22	GR yoy	1	42					
		FHS	1	187			52.6		
30	Sep 22	DVC j	1	237			117.8		
		GR j	3	141.7	36.6	94-183	33.5	22.8	7.2-62.8
		GR yoy	1	48					
		NSB	2	51	8.0	43-59			
		FHS	5	39.2	7.1	30-48			

TABLE 3.—Continued.

				Length (mm)			Weight (g)		
Lake	Date	Species	N	Mean	SD	Range	Mean	SD	Range
32	Jul 12	NSB	3	52.3	5.7	45-59			
34	Jul 10	NSB	10	48.4	7.9	38-63			
36	Jul 11	NSB	38	42.7	5.8	31-60			
74	Jul 6	NSB	2	52.5	4.5	48-57			
76	Jul 5	NSB	6	49.2	7.6	39-62			
110	Aug 19	NSB	17	44.6	10.5	30-68			
119	Aug 19	NSB	7	39.3	4.3	31-46			

Tundra streams on the Arctic coastal plain in the 1002 area

Tundra streams drain the Arctic coastal plain and the foothills to the south. They are generally small streams confined to a single meandering channel, although there may be braided sections in the larger streams (Craig and McCart 1975). The twenty tundra streams in this study all flow directly into coastal waters. Seven of these streams had been sampled previously (Table 4). Ninespine stickleback were captured in Fish Creek and the Niguanak River (West and Frugé 1989) and one Dolly Varden char was captured in Marsh Creek (Daum et al. 1984). Fish distribution in other tundra streams is more extensive where Arctic grayling, ninespine stickleback, and juvenile Dolly Varden char were captured in the Tamayariak River (Corning, unpublished report-a), Akutoktak River, and two smaller tundra streams flowing into the Okpilak River (Daum et al. 1984; West and Wiswar 1985; Wiswar et al. 1987; Wiswar 1991, 1992).

The objectives of this study in 1991 are to:

1. Determine spatial and temporal distribution of arctic fishes in rivers flowing through the 1002 area.
2. Collect baseline length and weight data on arctic fishes in the rivers.

Methods

Fish sampling in 20 tundra streams was conducted July 2-18, 1991. The number of samples sites ranged between one and five sites in the mainstem of rivers and one and three sites in tributary streams. Sites were resampled August 6-21 and September 11-24 to determine temporal changes in fish distribution. In September, only the Kogotpak River, Nataroarok, Marsh, and Carter creeks, and stream 7 were resampled due to an abbreviated schedule caused by weather. Sites were selected about 10 km apart or near the confluence of a major tributary.

Fish were collected with backpack electrofisher (Smith-Root Model 15A, 600 - 1100 volts, 60 - 90 pulses/s). Fish captured were counted and measured to the nearest mm fork length (FL) or total length for fish species with truncate or rounded caudal fins. Fish over 200 g were weighed to the nearest 10 g and fish less than 200 g to the nearest 0.1 g. Smaller fish (<200 mm FL) were placed in a solution of tricaine (MS 222) before measuring.

Dolly Varden char were categorized by life history stage (young of the year, juvenile, and adult) based on length and age information from Yoshihara (1972), McCart (1980), Smith and Glesne (1983), Daum et al. (1984), and West and Wiswar (1985). Dolly Varden char less than 71 mm FL were categorized as young of the year, those between 71 and 300 mm FL as juveniles, and char greater than 300 mm FL as adults.

Spatial and temporal fish distribution during July through September 1991 is presented by species and life history stage on maps of each river drainage. Tundra streams were assumed to contain no overwintering habitat and be absent of resident fish prior to breakup. Therefore, fish entered these streams from their mouth and migrated upstream. Fish captured at two consecutive sites were assumed to be distributed between those two sites.

Results

Fish distribution.—In tundra streams (Tables 5 and 6; Figure 1) juvenile Dolly Varden char (N = 104), juvenile (N = 3) and young of the year (N = 1) Arctic grayling, ninespine stickleback (N = 716), and fourhorn sculpin (N = 4) were captured.

Juvenile Dolly Varden char were captured in twelve streams but only in Nataroarok, Marsh, and Carter creeks were they captured during both July (N = 21) and August (N = 82). In August, juvenile char had a broader range of distribution. In September, juvenile Dolly Varden char was captured only in Nataroarok Creek (N = 1).

Ninespine stickleback were captured in 18 streams, but not during all sampling periods. They were found in 14 streams in July, 16 streams in August, and four streams in September. Fourhorn sculpin were captured in only stream 4 in July and that occurred near the mouth. Juvenile Arctic grayling were captured in Nataroarok Creek in August and young of the year were captured in the Kogotpak River in September.

Biological characteristics.—Based on the presence of parr marks and coloration, juvenile Dolly Varden char captured in July were either resident or presmolt, while some Dolly Varden char found in the six additional streams in August had completed parr-smolt transformation. Dolly Varden char captured ranged from 92 to 182 mm FL in July, and 63 - 237 mm FL in August (Table 7; Figure 3). Juvenile char weighed betweeen 2.4 and 143.0 g. Ninespine stickleback measured July through September ranged from 20 to 89 mm FL (Table 8).

Discussion

The presence of ninespine stickleback and Dolly Varden char in tundra streams in 1991 compares favorably with other studies (Ward and Craig 1974; Craig and Poulin 1975; Smith and Glesne 1982; West and Frugé 1989; Wiswar 1991, 1992; Corning, unpublished reports-a and b). Ninespine stickleback were ubiquitous as this species was captured in 18 of the 20 streams in this study and its presence is recorded in most of the other studies. Arctic grayling, although generally associated with tundra streams on the arctic coastal plain, were not captured but in one stream. This was probably due to the lack of overwintering habitat and salinities in the coastal waters acting as a migration barrier. The presence of fourhorn sculpin during this study at the mouth of one river was probably an incidental capture. Fourhorn sculpin may be found in the brackish, nearshore waters but is regarded as a marine species (Craig 1984). Fourhorn sculpin were also captured in a river-connected lake in the Canning River delta which would imply some use of freshwater habitats.

Juvenile Dolly Varden char were captured in twelve streams but only Nataroarok, Marsh, and Carter creeks were inhabited by juveniles during both July and August. In July, juvenile Dolly Varden char inhabited those tundra streams closest to the Aichilik River and both the tundra streams and Aichilik River flow into Beaufort Lagoon. The Aichilik River is a natal stream for Dolly Varden char. Mean salinity in Beaufort Lagoon was still less than 3‰ in mid-July 1991 (Fairbanks Fishery Resource Office, unpublished data). Assuming the Aichilik River to be the stream of origin, salinity apparently did not impede fish movement from the Aichilik River to the tundra streams during this time. Similarly, Dolly Varden char from the Hulahula River may have migrated to Nataroarak Creek. In August, juvenile Dolly Varden char were found in six other tundra streams.

To date, juvenile Dolly Varden have been captured in 19 (63%) of the 30 tundra streams sampled in the 1002 area (Tables 2, 6, and 7). Of the 30 tundra streams, 22 streams drain directly into coastal waters and juvenile char have been captured in 14 (64%) of them. Craig (1984, 1989) states that although tundra streams flowing directly into lagoons and coastal waters may support populations of Arctic grayling and ninespine stickleback, use by Dolly Varden char is incidental. While the 1991 study indicates tundra streams may further extend summer range for this species the extent of use and importance of this habitat is not known. Until such time when more information is available, as a conservation measure, rigorous sampling efforts should be conducted before site-specific development activities are permitted.

TABLE 4.—Documented species occurrence in tundra streams prior to 1991. DVC = Dolly Varden char, GR = Arctic grayling, NSB = ninespine stickleback, * = tundra stream resampled during this study (these streams flow into coastal waters with the exception of Itkilyariak Creek which is a tributary of the Sadlerochit River).

Stream	Date previously sampled	Species present
Tamayariak River	Jul 1982[a]; Jul-Sep 1988[b]	DVC, GR, NSB
Katakturuk River	Jul 1982; Jul-Aug 1989[c]; Jul-Sep 1990[d]	DVC, GR, NSB
Marsh Creek*	Jul 1983[e]; Jul 1986[f]	DVC
Carter Creek*	Aug 1982[a]; Jul 1983; Jul 1986	No fish documented
Sadlerochit River drainage		
middle tributary	Aug 1982[a]	GR
east side tributary	Aug 1982	No fish documented
Itkilyariak Creek*	Aug 1982	GR, DVC, NSB
Nataroarok Creek*	Jul 1987[g]	No fish documented
Okpilak River drainage		
lower tributary	Jul 1983; Jul 1989[h]; Jul-Sep 1990	DVC, GR, NSB
west side tributary	Jul, Aug 1989[h]; Jul-Sep 1990	DVC, GR, NSB
east side tributary 1	Jul 1989	No fish documented
east side tributary 2	Jul 1989	No fish documented
upper tributary	Jul-Sep 1990	GR
Akutoktak River	Jul 1974[i]; Aug 1982; Jul 1983; Jul, Aug 1989; Jul-Sep 1990	DVC, GR, NSB
Fish Creek*	Jul 1986	NSB
Jago River	Jul 1974; Jul 1982; Jul 1983; Jul-Sep 1989[c]; Jul-Sep 1990	DVC, NSB
Niguanak River*	Nov 1973[i]; Jul 1983	NSB
Angun River*	Jul 1983	No fish documented
Kogotpak River*	Nov 1973	No fish documented

[a] Smith and Glesne 1982
[b] Corning, unpublished report-a
[c] Corning, unpublished report-b
[d] Wiswar 1992
[e] Daum et al. 1984
[f] West and Frugé 1989
[g] Lyons and Elliott 1987
[h] Wiswar 1991
[i] Ward and Craig 1974

TABLE 5.—Summary of fish distribution in tundra streams in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991. DVC = Dolly Varden char, GR Arctic grayling, FHS = fourhorn sculpin, NSB = ninespine stickleback, j = juvenile, yoy = young of the year, 0 = no fish captured, — = not sampled.

Stream	July	August	September
1	NSB	NSB	—
2	0	DVC j	—
Marsh Creek	DVC j	DVC j	0
Carter Creek	DVC j	DVC j	NSB
3	NSB	0	—
Kajutakrok Creek	0	NSB	—
Nataroarok Creek	DVC j, NSB	DVC j, NSB, GR j	DVC j, NSB
Fish Creek	NSB	DVC j, NSB	—
Niguanak Creek	NSB	NSB	—
4	NSB, FHS	NSB	—
John River	0	NSB	—
Kimikpaurauk River	NSB	DVC j, NSB	—
Siksik River	NSB	DVC j, NSB	—
Sikrelurak River	NSB	DVC j, NSB	—
Sikutaktuvik River	0	DVC j, NSB	—
Angun River	NSB	NSB	—
5	NSB	NSB	—
6	DVC j, NSB	NSB	—
Kogotpak River	DVC j, NSB	NSB	GR yoy, NSB
7	DVC j, NSB	NSB	NSB

TABLE 6.—Summary of capture information for fish caught in tundra streams in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991. DVC = Dolly Varden char, FHS = fourhorn sculpin, GR = Arctic grayling, NSB = ninespine stickleback, j = juvenile, yoy = young of the year .

Stream	Dates sampled	Number of sites	Electrofishing effort (h)	Species and life history stage	N
1	Jul 13	3	1.5	NSB	4
	Aug 19	2	1.0	NSB	4
2	Jul 12	2	1.0		0
	Aug 18	2	1.0	DVC j	9
Marsh Creek	Jul 11	3	1.5	DVC j	1
	Aug 17-18	3	1.5	DVC j	3
	Sep 17-18	2	1.0		0
Carter Creek	Jul 10	3	1.5	DVC j	2
	Aug 16-17	3	1.5	DVC j	35
	Sep 17-18	2	0.6	NSB	2
3	Jul 7-9	3	1.5	NSB	4
	Aug 15	2	1.0		0
Kajutakrok Creek	Jul 7	1	0.5		0
	Aug 14	1	0.5	NSB	1
Nataroarok Creek	Jul 6-9	4	2.0	DVC j	8
				NSB	2
	Aug 14-15	3	1.5	DVC j	13
				GR j	3
				NSB	6
	Sep 17	3	1.5	DVC j	1
				NSB	2
Fish Creek	Jul 4-6	3	1.5	NSB	156
	Aug 6-10	3	1.5	DVC j	1
				NSB	18
Niguanak River	Jul 3-5	2	1.0	NSB	9
	Aug 10	3	1.5	NSB	3
4	Jul 4-6	2	0.9	NSB	30
				FHS	4
	Aug 10	2	0.9	NSB	18
John River	Jul 4	1	0.5		0
	Aug 9	1	0.5	NSB	3

TABLE 6.—Continued.

Stream	Dates sampled	Number of sites	Electrofishing effort (h)	Species and life history stage	N
Kimikpaurauk River	Jul 4	2	1.0	NSB	9
	Aug 9	2	1.0	DVC j	7
				NSB	45
Siksik River	Jul 4	2	1.0	NSB	5
	Aug 8	2	1.0	DVC j	4
				NSB	1
Sikrelurak River	Jul 3	2	0.9	NSB	3
	Aug 8-9	2	1.0	DVC j	3
				NSB	2
Sikutaktuvik River	Jul 4	1	0.5		0
	Aug 8-9	2	1.0	DVC j	7
				NSB	2
Angun River	Jul 3-4	2	1.0	NSB	7
	Aug 8	2	1.0	NSB	4
5	Jul 3	1	0.5	NSB	22
	Aug 7	1	0.5	NSB	40
6	Jul 2	2	1.0	DVC j	4
				NSB	39
	Aug 7	2	0.9	NSB	97
Kogotpak River	Jul 3	2	1.0	DVC j	3
				NSB	24
	Aug 7	2	1.0	NSB	115
	Sep 11	1	0.5	NSB	3
				GR yoy	1
7	Jul 2	2	1	DVC j	3
				NSB	16
	Aug 7	1	0.5	NSB	12
	Sep 11	1	0.5	NSB	8

TABLE 7.—Lengths and weights of Dolly Varden char captured in tundra streams in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991.

		Fork length (mm)				Weight (g)			
Stream	Date	N	Mean	SD	Range	N	Mean	SD	Range
2	Aug 18	9	182.4	17.0	139 - 197	9	65.3	13.8	39.3 - 89.4
Marsh Creek	Jul 11	1	182			1	57.9		
	Aug 17	1	191			1	77.0		
Carter Creek	Jul 10	1	170			1	58.3		
	Aug 16-17	15	187.1	14.5	165 - 211	14	70.8	16.2	49.2 - 98.4
Nataroarok Creek	Jul 6-7	4	109.3	13.7	92 - 130	4	13.2	4.0	8.6 - 19.6
	Aug 14-15	9	106.3	29.2	63 - 151	9	15.9	11.3	2.4 - 37.9
	Sep 17	1	127			1	22.5		
Fish Creek	Aug 10	1	186			1	73.6		
Kimikpaurauk River	Aug 9	6	185.0	11.3	170 - 200	6	63.0	9.6	49.5 - 74.7
Siksik River	Aug 8	3	185.0	18.4	159 - 198	3	61.1	10.8	48.4 - 74.8
Sikrelurak River	Aug 8-9	2	212.5	6.5	206 - 219	2	122.9	20.1	102.8 - 143.0
Sikutaktuvik River	Aug 8-9	6	201.7	24.3	163 - 237	5	83.9	31.5	37.2 - 133.7
6	Jul 2	1	116			1	20.4		
Kogotpak River	Jul 3	3	108.3	7.6	102 - 119	3	11.2	2.4	8.2 - 14.2
7	Jul 2	2	135.0	19.0	116 - 154	2	21.9	10.3	11.6 - 32.2

TABLE 8.—Lengths of ninespine sticklebacks captured in tundra streams in the 1002 area of the Arctic National Wildlife Refuge, July - September 1991.

Stream	Date of capture	N	Fork length (mm) Mean	SD	Range
1	Jul 13	2	35.5	1.5	34-37
	Aug 19	1	65		
3	Jul 9	3	53.0	3.7	48-57
Nataroarak Creek	Jul 7	1	48		
	Aug 14-15	4	67.5	5.1	63-76
	Sep 17	2	43.2	20.5	20-73
Fish Creek	Jul 6	51	38.7	6.7	28-54
	Aug 6-10	13	57.5	6.7	47-69
Niguanak River	Jul 3-5	4	48.0	11.4	37-67
	Aug 10	3	66.3	11.3	51-78
4	Jul 4	29	46.7	8.7	32-65
	Aug 10	8	54.4	9.5	43-72
John River	Aug 9	3	65.3	6.0	57-71
Kimikpaurauk River	Jul 4	6	39.5	5.7	32-48
	Aug 9	23	62.4	14.2	39-89
Siksik River	Jul 4	2	44.5	1.5	43-46
Sikrelurak River	Jul 3	3	46.3	6.3	40-55
	Aug 9	2	69.0	8.0	61-77
Sikutaktuvik River	Aug 9	2	72.5	10.5	62-83
Angun River	Jul 3	1	55		
	Aug 8	3	50.7	4.2	45-55
5	Jul 3	6	54.8	7.4	43-68
	Aug 7	22	66.6	7.0	55-79
6	Jul 2	19	47.2	13.2	30-74
	Aug 7	55	68.6	8.0	51-85
Kogotpak River	Jul 3	14	53.4	12.0	31-67
	Aug 7	52	65.3	6.2	51-83
	Sep 11	3	37.0	18.1	20-62
7	Jul 2	7	48.3	10.0	34-63
	Aug 7	5	57.8	4.3	54-64
	Sep 11	7	70.1	8.4	60-87

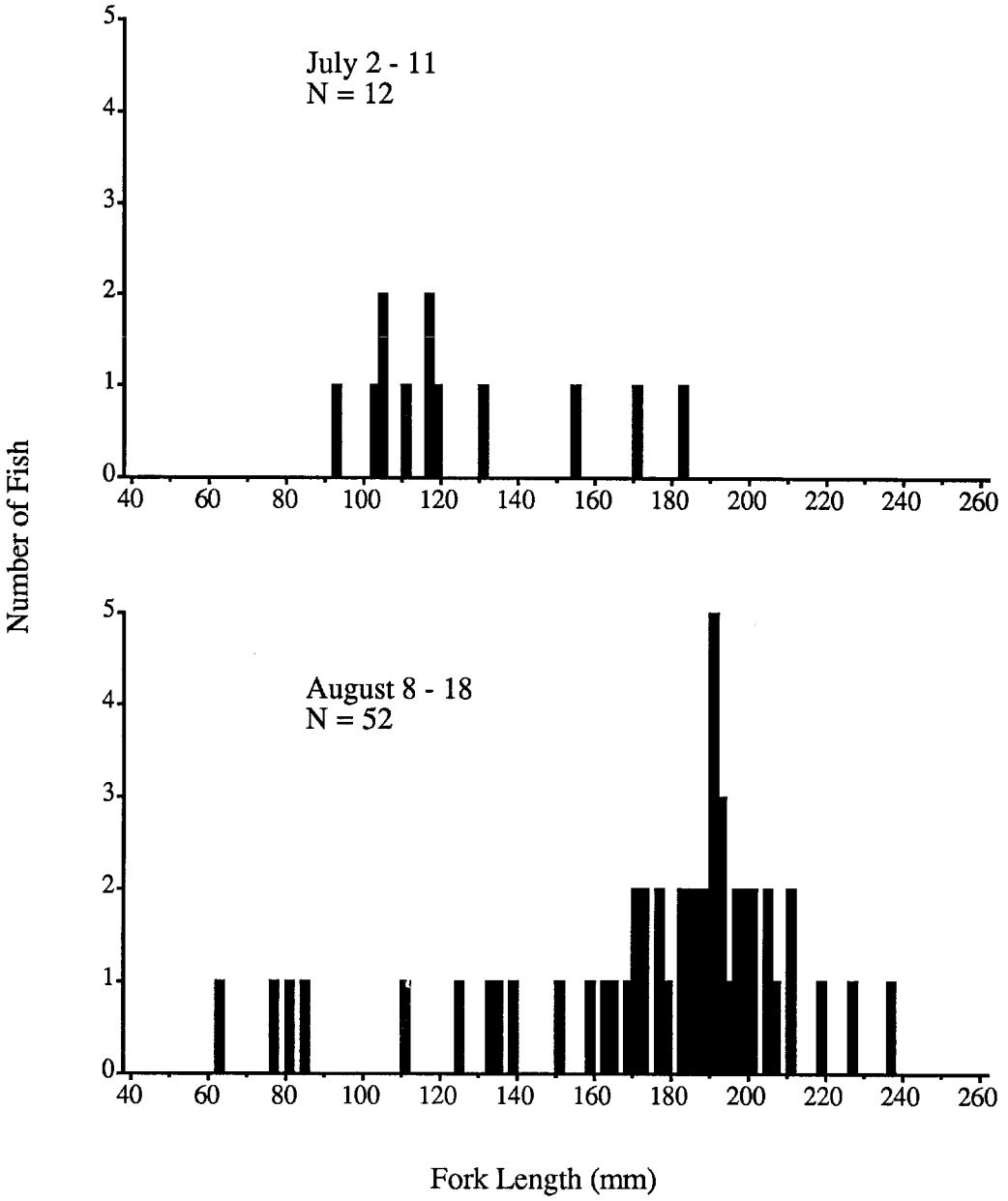


FIGURE 3.—Length-frequency of Dolly Varden char captured in tundra streams in the 1002 area of the Arctic National Wildlife Refuge during July and August 1991.

Sadlerochit River drainage

In the 1002 area, the Sadlerochit River drainage includes the mainstem Sadlerochit River, Itkilyariak Creek, their tributaries, and Sadlerochit Spring (Figure 1). Kekiktuk River is the outlet of lakes Schrader and Peters in the upper Sadlerochit drainage. Juvenile and adult Arctic grayling are distributed throughout the mainstem Sadlerochit River in June, July, and August (Ward and Craig 1974; Smith and Glesne 1983). Dolly Varden char, pink salmon *Oncorhynchus gorbuscha*, and young of the year Arctic grayling have been captured in the mainstem in July and young of the year Arctic grayling were found in one tributary (Smith and Glesne 1983). Although anadromous Dolly Varden char have been captured, there is no evidence that the Sadlerochit River supports a spawning population (Smith and Glesne 1983).

Resident Dolly Varden char and three life history stages (young of the year, juvenile, and adult) of Arctic grayling were captured in Itkilyariak Creek and a lower tributary during a survey in August 1982 (Smith and Glesne 1983). Ninespine stickleback were captured in lower Itkilyariak Creek. Fall movements of adult Arctic grayling from Itkilyariak Creek to potential overwintering areas have been documented using radio telemetry during August through October 1984 and August through December 1985 (West and Wiswar 1985; Wiswar et al. 1987). Arctic grayling were relocated in the mainstem Sadlerochit River, Kekiktuk River, and lakes Peters and Schrader.

Sadlerochit Spring supports a resident population of Dolly Varden char which are distributed throughout the spring above the *aufeis* (overflow icing) area (Craig 1977). The *aufeis* area is considered a migration barrier. Juvenile Arctic grayling were also found in the spring (Craig 1977).

The objectives of this study in 1991 are to:

1. Determine spatial and temporal distribution of arctic fishes in the Sadlerochit drainage within and flowing through the 1002 area.
2. Determine length frequency and length-weight relationship for Dolly Varden char and Arctic grayling and age structure for Arctic grayling.
3. Collect and measure young of the year Arctic grayling from the Akutoktak River and compare with young of the year from the Sadlerochit drainage.

Methods

Fish sampling in the Sadlerochit River drainage was conducted July 2-18, 1991. Sites were resampled August 6-21 and September 11-24 to determine temporal changes in fish distribution. Kekiktuk River was sampled on September 24. Sites were selected about 10 km apart or near the confluence of a major tributary.

Fish were collected with backpack electrofisher (Smith-Root Model 15A, 600 - 1100 volts, 60 - 90 pulses/s) and hook and line. Visual observations of fish were recorded.

Fish captured were counted and measured to the nearest mm fork length (FL). Fish over 200 g were weighed to the nearest 10 g and fish less than 200 g to the nearest 0.1 g. Smaller fish (<200 mm FL) were placed in a solution of tricaine (MS 222) before measuring.

Regression of $\log_{10}$ transformations of length and weight was used to describe length-weight relationships (Ricker 1975). Slopes and intercepts of regression lines were compared using dummy variables (Kleinbaum and Kupper 1978) and data were pooled when no significant difference was detected ($P > 0.05$) in the weight-length relationships.

Ages of Arctic grayling were estimated from scales. Scales were removed from the left side of the fish between the lateral line and posterior dorsal insertion. Scales were pressed on triacetate slides and viewed through a microfiche reader. All scales were read by two independent readers. When disagreement occurred, scales were read by a third person. Mean length at age data were calculated for Arctic grayling from Itkilyariak Creek and the Sadlerochit River. Inadequate sample size precluded using data from other locations.

Arctic grayling were categorized by life history stage (young of the year, juvenile, and adult) based on length and age information from Craig and Poulin (1975), Smith and Glesne (1983), Daum et al. (1984), Wiswar (1991, 1992), Corning (unpublished report-a), and this study. Arctic grayling less than 82 mm FL were categorized as young of the year, those between 82 and 285 mm FL were juveniles, and Arctic grayling greater than 285 mm FL were adults.

Resident Dolly Varden char in Sadlerochit Spring are a dwarf population (Craig 1977) and may be found in Itkilyariak Creek and the Sadlerochit River. Because there is little information on their population structure, no attempt was made to categorize this population by life history stage in the Sadlerochit River drainage.

Objective 3 was added to the study after the August 14, 1991 sampling in Itkilyariak Creek. It was noted then, that young of the year Arctic grayling appeared to be smaller than young of the year captured in the Akutoktak River during August the previous two years (1989 and 1990). Therefore, to determine if the presence of smaller fish in 1991 was a regional phenomena or restricted to Itkilyariak Creek, young of the year from the Akutoktak River were collected on August 16 and 17, 1991 and lengths were compared (t-test, $P < 0.05$; Zar 1984).

Results

Sadlerochit River fish distribution.—In the mainstem Sadlerochit River, Dolly Varden char and all three life history stages of Arctic grayling were captured (Table 9). Dolly Varden char captured in July (N = 6) and August (N = 9) were in the lower mainstem (site SM 1) and between 35 - 45 km upriver (sites SM 3 and 4; Figure 4). In September, Dolly Varden char (N = 6) were located in the mainstem between 45 and 55 km upriver. Adult Arctic grayling were captured at two mainstem sites in July (N = 26) and three sites in August (N = 5; Figure 5). Juvenile Arctic grayling were captured in the mainstem only in August (N = 4; Figure 6). Young of the year Arctic grayling were captured in August (N = 1) at one mainstem site (site SM 4) and in September (N = 23) between 45 and 55 km upriver (sites SM 4 and 9; Figure 7).

Two tributaries on the east side of the Sadlerochit River were sampled in July, but only the lower tributary was sampled in August and September. In the upper tributary (site ST 8), one adult Arctic grayling was found in July (Figure 5). In the lower tributary (sites ST 5 and 6), Dolly Varden char, Arctic grayling, and ninespine stickleback were captured. Dolly Varden char were captured only in September (site ST 5; N = 2; Figure 4). Adult (N = 4) and juvenile (N = 1) Arctic grayling were captured only in July (Figures 5 and 6). In September, young of the year Arctic grayling (N = 8) were captured in a lower reach of the tributary (site ST 5; Figure 7). Ninespine stickleback were captured in the lower tributary in both August (N = 3) and September (N = 1).

Juvenile (N = 7) and adult (N = 1) Arctic grayling were also captured at one site in the Kekiktuk River in September (Figure 8). No young of the year were captured.

Sadlerochit River biological characteristics.—Dolly Varden char captured in the mainstem and tributary ranged from 93 to 233 mm FL (Table 10). No young of the year or anadromous adult Dolly Varden char were captured.

Adult Arctic grayling captured in the mainstem and tributary were 304 - 338 mm FL (Table 11; Figure 9). Juvenile and young of the year Arctic grayling ranged from 86 to 242 mm FL and 32 - 47 mm FL, respectively.

Itkilyariak Creek fish distribution.—Stream discharge in Itkilyariak Creek was intermittent above the confluence of Sadlerochit Spring (near site IM 2; Figure 10) after late June and was not sampled. The lower tributary (site IT 4) was sampled only in August because of low discharge in July and high discharge in September. Dolly Varden char and all life history stages of Arctic grayling were captured in either the lower Itkilyariak Creek or two of its tributaries (Table 9). In the mainstem, Dolly Varden char were captured July through September (N = 15) and adult Arctic grayling were captured or observed in July and August (N = 9; Figures 10 and 11). Young of the year Arctic grayling were captured only in August (N = 3; Figure 12). Juvenile Arctic grayling were not captured.

In the upper tributary (sites IT 5 - 7), Dolly Varden char and Arctic grayling were found throughout the stream but their distribution was not uniform. Dolly Varden char were captured in July (N = 4) and August (N = 6; Figure 10). Adult Arctic grayling were captured and observed (N = 59) at all three sites but only in July (Figure 11). Juvenile Arctic grayling (N = 8) were found in both July and August but not at all sites (Figure 13). Young of the year Arctic grayling (N = 83) were located at the two lower sites (IT 5 and 6) only in August (Figure 12).

In the lower tributary (site IT 4) in August, Dolly Varden char (N = 1) and juvenile Arctic grayling (N = 4) were captured.

Itkilyariak Creek biological characteristics.—Dolly Varden char captured in the mainstem Itkilyariak Creek and tributary streams were 93 - 203 mm FL and weighed between 9.2 and 75.0 g (Table 10). Adult Arctic grayling captured in Itkilyariak Creek in July and August ranged from 304 to 369 mm FL and weighed between 304 and 369 g (Table 11; Figure 9). Juveniles were from 125 to 193 mm FL. Young of the year captured in one of the tributary streams on August 11 were 24 - 32 mm FL, while at a site in the lower mainstem Itkilyariak Creek on August 21, young of the year were 11 - 14 mm FL (Figure 14).

Sadlerochit Spring fish distribution.—Resident Dolly Varden char were captured in Sadlerochit Spring at an upper site (Sp 1) in August (N = 76) and a lower site (Sp 2) in September (N = 68; Table 9; Figure 10). The spring was not sampled in July.

Sadlerochit Spring biological characteristics.—Dolly Varden char in Sadlerochit Spring measured 68 - 184 mm FL and weighed between 3.5 and 75.7 g (Table 10; Figure 15). There was no significant difference ($P > 0.50$) in the weight-length relationship between months. The relationship for the pooled data is presented in Figure 16.

Age of Arctic grayling.—Ages estimated from scales of Arctic grayling from Itkilyariak Creek and the Sadlerochit River ranged from 1 to 8 years (Table 12). All adult size fish were 4 years old and greater.

Comparison with Akutoktak River young of the year Arctic grayling.— Young of the year Arctic grayling from the Akutoktak River were measured on August 16 and 17, 1991 ranged from 30 to 50 mm

FL (N = 53, $\bar{x}$ = 41.5 mm FL, SD = 4.9). When compared with young of the year from Itkilyariak Creek captured on August 11 and 14, Itkilyariak Creek Arctic grayling were significantly smaller ($P < 0.0001$) than those fish from the Akutoktak River.

Discussion

Sadlerochit River drainage.—The summer spatial distribution of Dolly Varden char and Arctic grayling in the Sadlerochit River drainage in 1991 was similar to that documented in 1982 by Smith and Glesne (1983). Dolly Varden char and Arctic grayling were found in the mainstem and tributaries of the Sadlerochit River and Itkilyariak Creek. Dolly Varden char captured in the drainage probably dispersed from Sadlerochit Spring. Adult Arctic grayling are found in the 1002 portion of the drainage primarily June through August, while young of the year occur in August and September.

Distribution of juvenile Arctic grayling in the Sadlerochit River drainage and other rivers in the 1002 area has not been adequately described. Catches 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, 1992; Corning, unpublished report-a). It is possible that lakes Peter and Schrader are used as rearing habitat for a major portion of the juvenile population in this drainage. Adult Arctic grayling captured in Itkilyariak Creek during summer use these lakes to overwinter (West and Wiswar 1985; Wiswar et al. 1987).

Mean length and frequency distribution of adult Arctic grayling from Itkilyariak Creek in 1991 was similar to that of 1982, except in 1982, there were more individual fish larger than 370 mm FL (Smith and Glesne 1983).

The use of scales to determine age of Arctic grayling in the Sadlerochit River drainage may tend to underestimate the true age. In this study, mean lengths at age determined from scales were greater than lengths from comparable aged fish where ages were estimated from otoliths in 1982 (Smith and Glesne 1983). Also, the oldest age fish in 1991 was 8 years old whereas Smith and Glesne (1983) reported Arctic grayling ages to 13 years. Other studies have shown that scales tend to underestimate age of Arctic grayling when compared to otoliths, vertebrae, and fin rays especially for older fish (Craig and Poulin 1975; Beamish and McFarlane 1987; Merritt and Fleming 1991; Wiswar 1992). Validation of age using any of the above mentioned structures has not been determined for Arctic grayling; therefore conclusions inferred from age estimates should be viewed with conjecture.

Young of the year in Itkilyariak Creek were first captured in August of 1991 which is later than what has been observed in nearby drainages. In the Akutoktak (Wiswar 1991, 1992), Tamayariak (Corning, unpublished report-a), and headwater streams in the Sagavanirktok and Atigun (Elliott 1982) rivers, young of the year were first captured in late June or early July. Although the causes are unknown, possible explanations may include a later migration by adult Arctic grayling to spawning areas or slower development of young of the year in Itkilyariak Creek.

Also noted in August 1991 was that young of the year Arctic grayling captured in Itkilyariak Creek were smaller than those captured on about the same time period in the Akutoktak River in 1989 and 1990 (Wiswar 1991, 1992). Small size young of the year Arctic grayling in Itkilyariak Creek captured in early August 1982 (Fairbanks Fishery Resource Office, unpublished data) were similar in length to those fish in 1991. This supports the hypothesis that 1991 was not an anomaly and that either timing of adult migration and spawning is later and/or young of the year growth is slower in Arctic grayling from Itkilyariak Creek.

Fish migration, spawning, development, and growth is generally regarded as temperature dependent (Lagler et al. 1962) and may explain the size difference of young of the year Arctic grayling from the two rivers. Mean daily water temperatures in Itkilyariak Creek in June (4.4° C) and July (8.6° C) 1991 (Lyons and Trawicki 1992) were slightly cooler (although not statistically different; $P = 0.065$, Mann-Whitney test; Zar 1984) than water temperatures in the Akutoktak River (5.6° and 9.3° C, respectively).

TABLE 9.—Summary of gear used and capture information for fish caught in the Sadlerochit River drainage, July - September 1991. DVC = Dolly Varden char, GR = Arctic grayling, NSB = ninespine stickleback, a = adult, j = juvenile, yoy = young of the year.

Dates sampled	Number of sites	Gear type	Effort (h)	Species and life history stage	N
Sadlerochit River mainstem					
Jul 10 - 17	5	Electrofisher	2.1	DVC	6
				GR a	2
Jul 6	1	Hook and line	3.0	GR a	24
Aug 10 - 14	3	Electrofisher	2.0	DVC	9
				GR a	5
				GR j	4
				GR yoy	1
Sep 18 - 19	2	Electrofisher	0.9	DVC	6
				GR yoy	23
Sadlerochit River upper tributary					
Jul 17	1	Electrofisher	0.5	GR a	1
Sadlerochit River lower tributary					
Jul 16	3	Electrofisher	1.5	GR a	4
				GR j	1
Aug 12 - 14	3	Electrofisher	1.2	NSB	3
Sep 18 - 19	3	Electrofisher	1.5	DVC	2
				GR yoy	8
				NSB	1
Kekiktuk River					
Sep 24	1	Electrofisher	0.5	GR a	1
				GR j	7
Itkilyariak Creek mainstem					
Jul 15 - 18	3	Electrofisher	1.5	DVC	1
				GR a	4
	1	Hook and line	1.2	GR a	2
	1	Visual		GR a	1
Aug 11 - 21	3	Electrofisher	1.5	DVC	13
				GR a	2
				GR yoy	3
Sep 18	1	Electrofisher	0.5	DVC	1

TABLE 9.—Continued.

Dates sampled	Number of sites	Gear type	Effort (h)	Species and life history stage	N
		Itkilyariak Creek upper tributary			
Jul 15 - 18	3	Electrofisher	1.5	DVC	4
				GR a	36
				GR j	7
	3	Hook and line	2.0	GR a	12
	3	Visual		GR a	11
Aug 11 - 14	3	Electrofisher	1.6	DVC	6
				GR j	1
				GR yoy	83
Sep 18	2	Electrofisher	1.0		0
		Itkilyariak Creek lower tributary			
Aug 12	1	Electrofisher	0.5	DVC	1
				GR j	4
		Sadlerochit Spring			
Aug 11	1	Electrofisher	0.5	DVC	76
Sep 19	1	Electrofisher	0.5	DVC	68

TABLE 10.—Lengths and weights of Dolly Varden char captured in the Sadlerochit River drainage, July - September 1991.

Dates of capture	Fork length (mm)				Weight (g)			
	N	Mean	SD	Range	N	Mean	SD	Range
Sadlerochit River and lower tributary								
Jul 14 - 17	3	125.0	31.8	102-170	3	24.1	25.6	5.8-60.3
Aug 12 - 14	6	171.0	37.1	124-233	3	69.9	34.9	26.2-111.7
Sep 18 - 19	5	148.8	50.2	93-224	3	45.0	44.9	7.2-108.1
Itkilyariak Creek and tributaries								
Jul 15 - 18	3	119.6	24.9	93-153	3	20.1	11.4	9.2-35.8
Aug 11 - 21	18	138.3	30.2	105-203	14	25.9	15.3	14.3-75.0
Sep 18	1	167			1	58.3		
Sadlerochit Spring								
Aug 11	44	113.6	30.9	68-184	44	19.5	16.1	3.5-75.7
Sep 19	23	102.1	23.4	74-157	23	13.5	10.6	4.5-44.5

TABLE 11.—Lengths and weights of Arctic grayling captured in the Sadlerochit River drainage, July - September 1991. yoy = young of the year.

Dates of capture	Life history stage	Fork length (mm) N	Fork length (mm) Mean	Fork length (mm) SD	Fork length (mm) Range	Weight (g) N	Weight (g) Mean	Weight (g) SD	Weight (g) Range
Sadlerochit River and lower tributary									
Jul 14 - 17	adult	3	332.3	7.3	322-338	3	372.7	26.6	350-410
	juvenile	1	153			1	19.0		
Aug 12 - 14	adult	5	315.0	10.0	304-332	5	359.8	31.4	299-380
	juvenile	4	135.0	63.2	86-242	4	47.9	65.7	5.8-161.4
	yoy	1	33						
Sep 19	yoy	10	41.4	4.4	32-47				
Kekiktuk River									
Sep 24	juvenile	2	96.0	0.0		2	8.8	0.3	8.5-9.0
Itkilyariak Creek and tributaries									
Jul 15 - 18	adult	24	335.3	17.7	304-369	24	421.5	52.6	350-575
	juvenile	3	141.0	10.7	129-155	3	27.5	5.7	21.2-35.1
Aug 11 - 14	adult	1	335			1	450		
	juvenile	5	171.2	23.8	125-193	5	68.8	26.7	19.3-98.7
	yoy	38	27.4	1.7	24-32				
Aug 21	yoy	3	12.3	1.3	11-14				

TABLE 12.—Length and weight at age of Arctic grayling from the Sadlerochit River drainage, July and August 1991. Ages estimated from scales.

			Fork length (mm)			Weight (g)		
Age	Sampling period	N	Mean	SD	Range	Mean	SD	Range
1	Jul	3	141.0	10.7	129-155	27.5	5.7	21.2-35.1
	Aug	4	105.8	17.4	86-125	12.4	5.9	5.8-19.3
	Sep	2	96.0	0		8.8	0.3	8.5-9.0
2	Jul	1	153			19.0		
	Aug	4	182.8	6.5	175-193	81.2	11.0	68.8-98.7
3		0						
4	Jul	2	328.0	24.0	304-352	405.0	55.0	350-460
	Aug	1	242			161.4		
5	Jul	1	368			575		
6	Jul	5	327.6	10.0	311-338	412.0	19.4	380-440
7	Jul	11	338.3	17.0	322-369	407.7	46.5	350-505
	Aug	3	319.3	12.0	306-335	403.3	33.0	380-450
8	Jul	4	328.3	6.1	322-337	400.8	29.1	358-440
	Aug	2	324.0	8.0	316-332	370.0	10.0	360-380

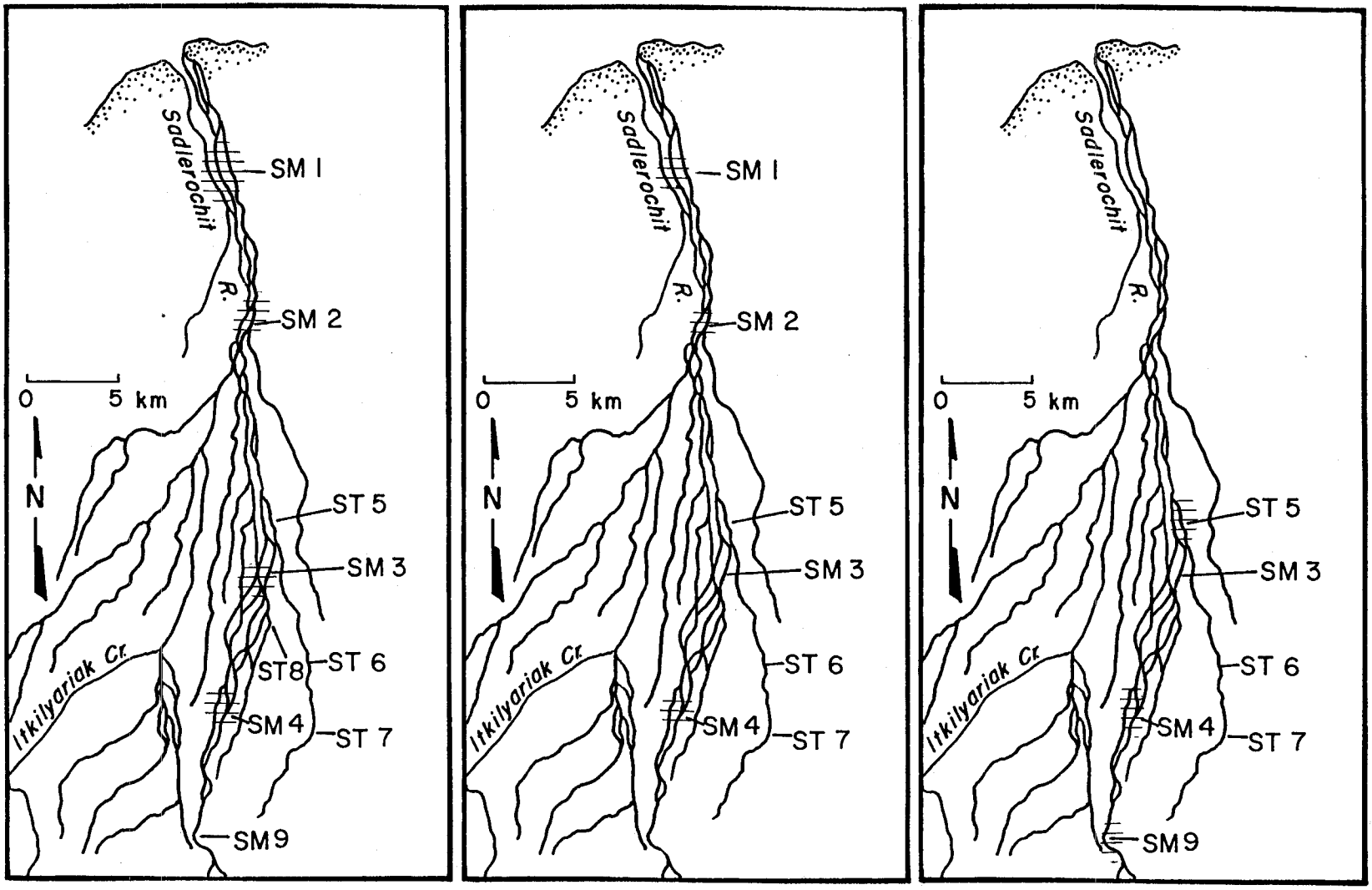
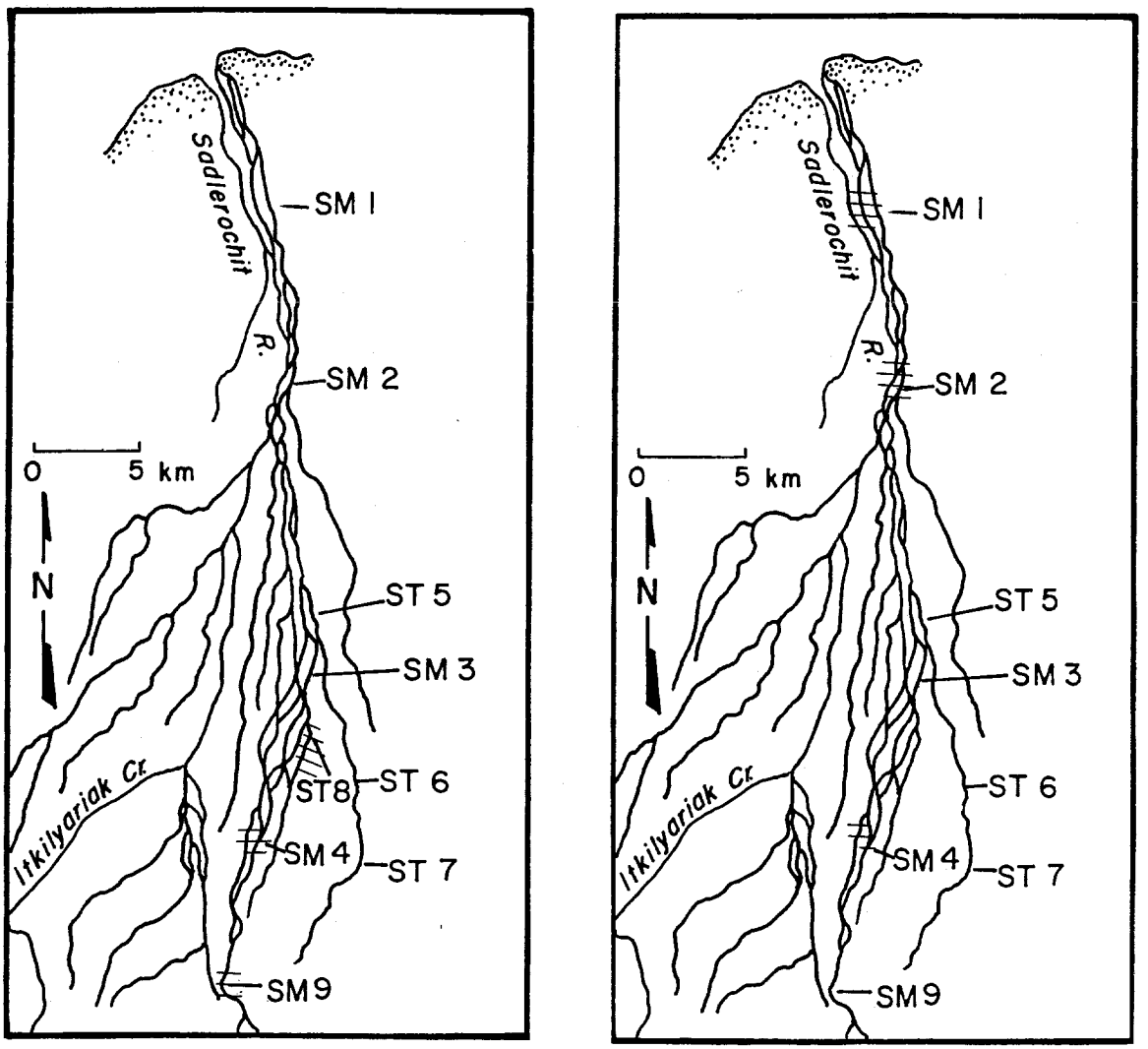


FIGURE 4.—Distribution of Dolly Varden char (hatch marked) in the Sadlerochit River during July - September 1991. SM = mainstem sample site, ST = tributary site.



July 6 - 17, 1991

August 10 - 14, 1991

FIGURE 5.—Distribution of adult Arctic grayling (hatch marked) in the Sadlerochit River during July and August 1991. SM = mainstem sampling site, ST = tributary site.

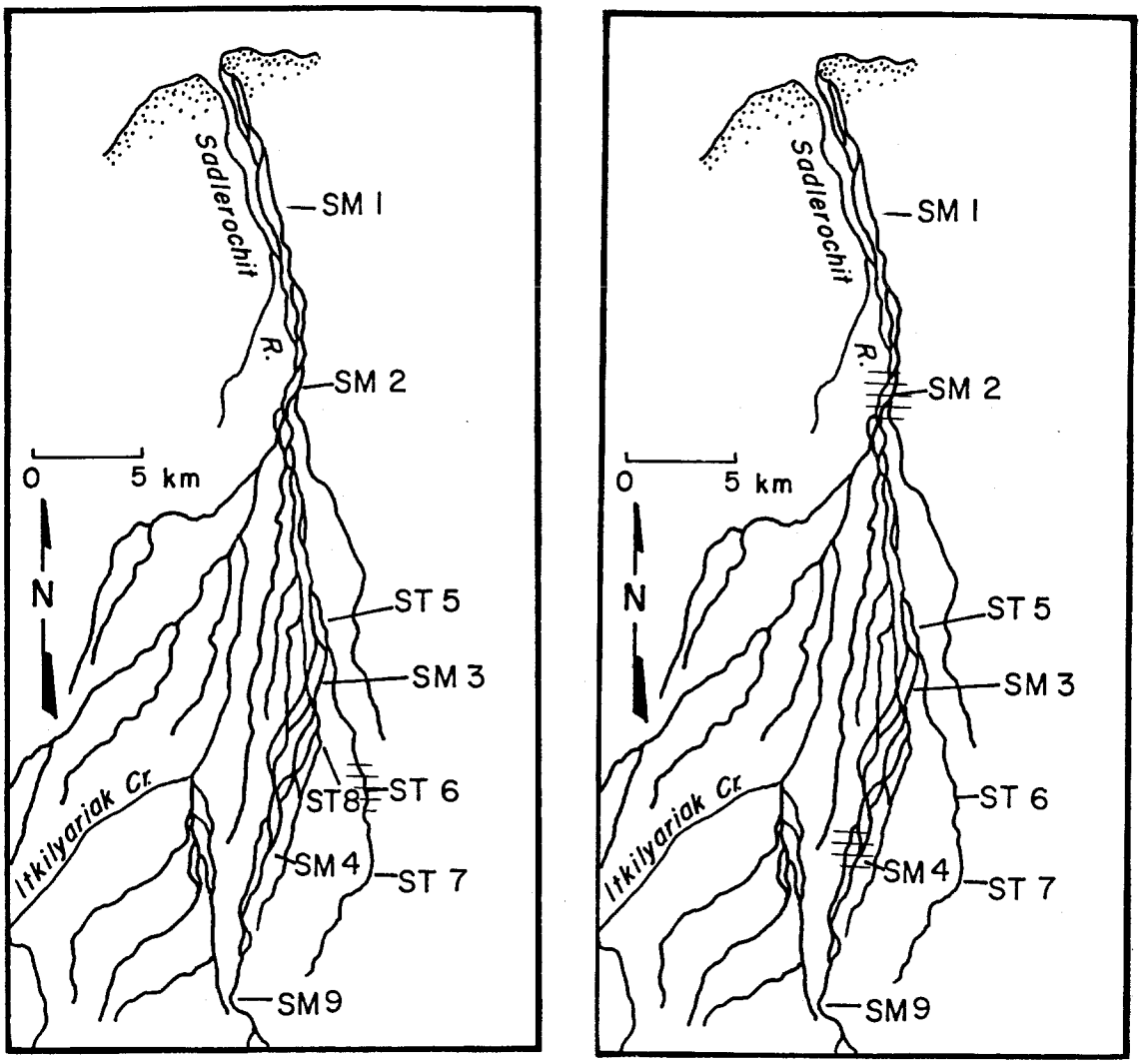
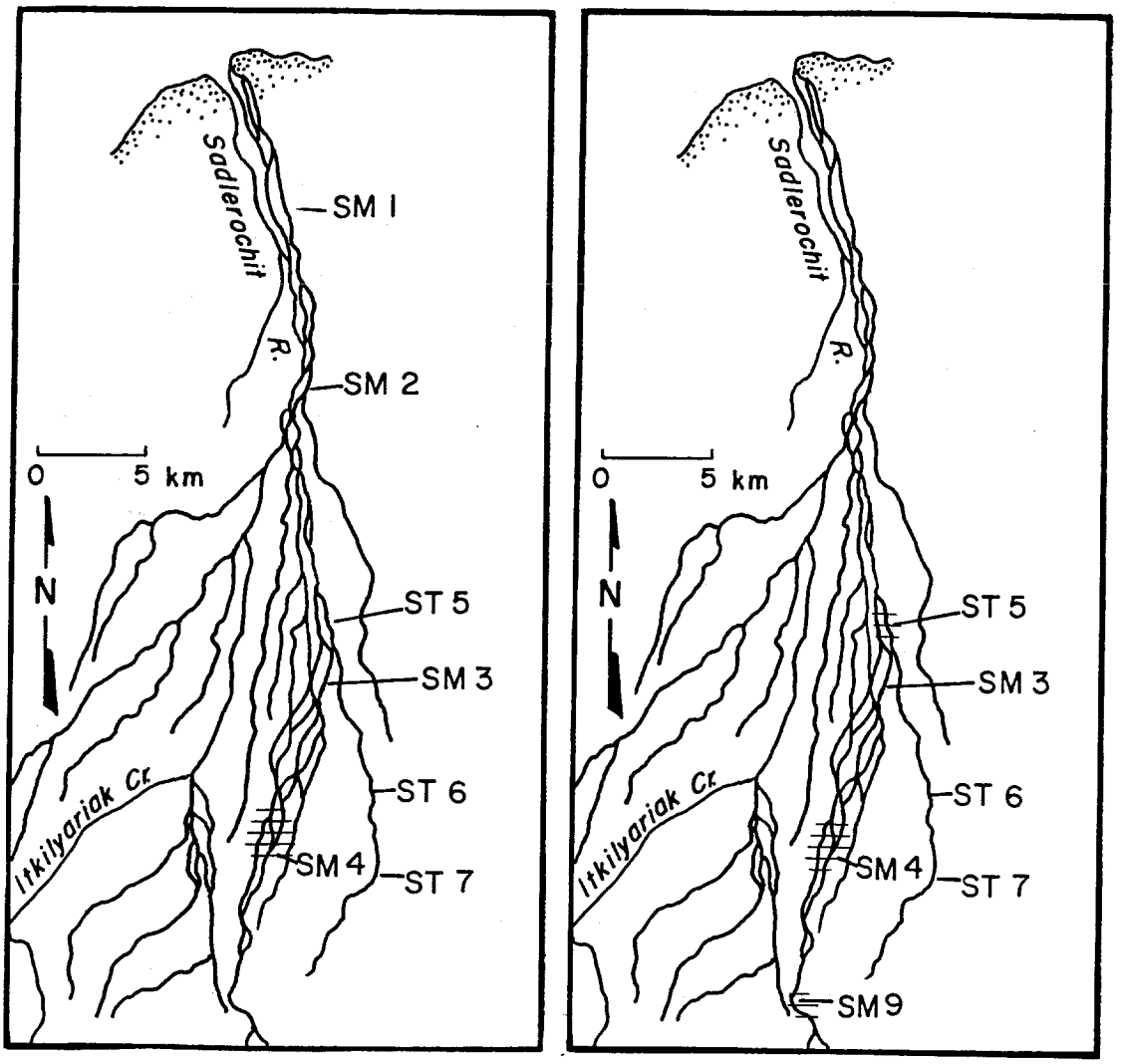


FIGURE 6.—Distribution of juvenile Arctic grayling (hatch marked) in the Sadlerochit River during July and August 1991. SM = mainstem sampling site, ST = tributary site.



August 10 - 14, 1991

September 18 - 19, 1991

FIGURE 7.—Distribution of young of the year Arctic grayling (hatch marked) in the Sadlerochit River during August and September 1991. SM = mainstem sampling site, ST = tributary site.

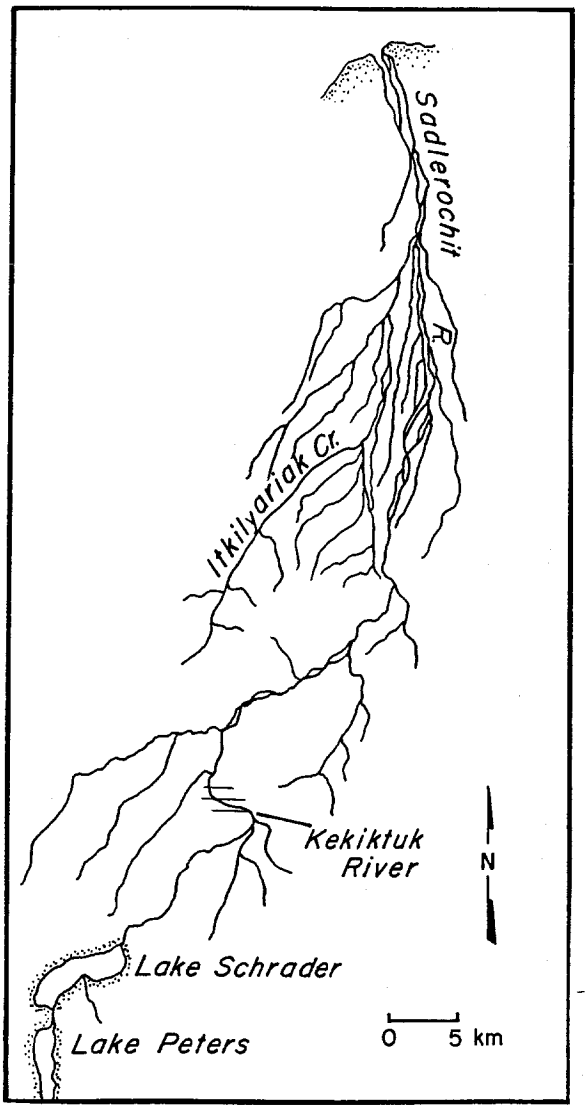


FIGURE 8.—Location of adult and juvenile Arctic grayling captured (hatch marked) in the Kekiktuk River on September 24, 1991.

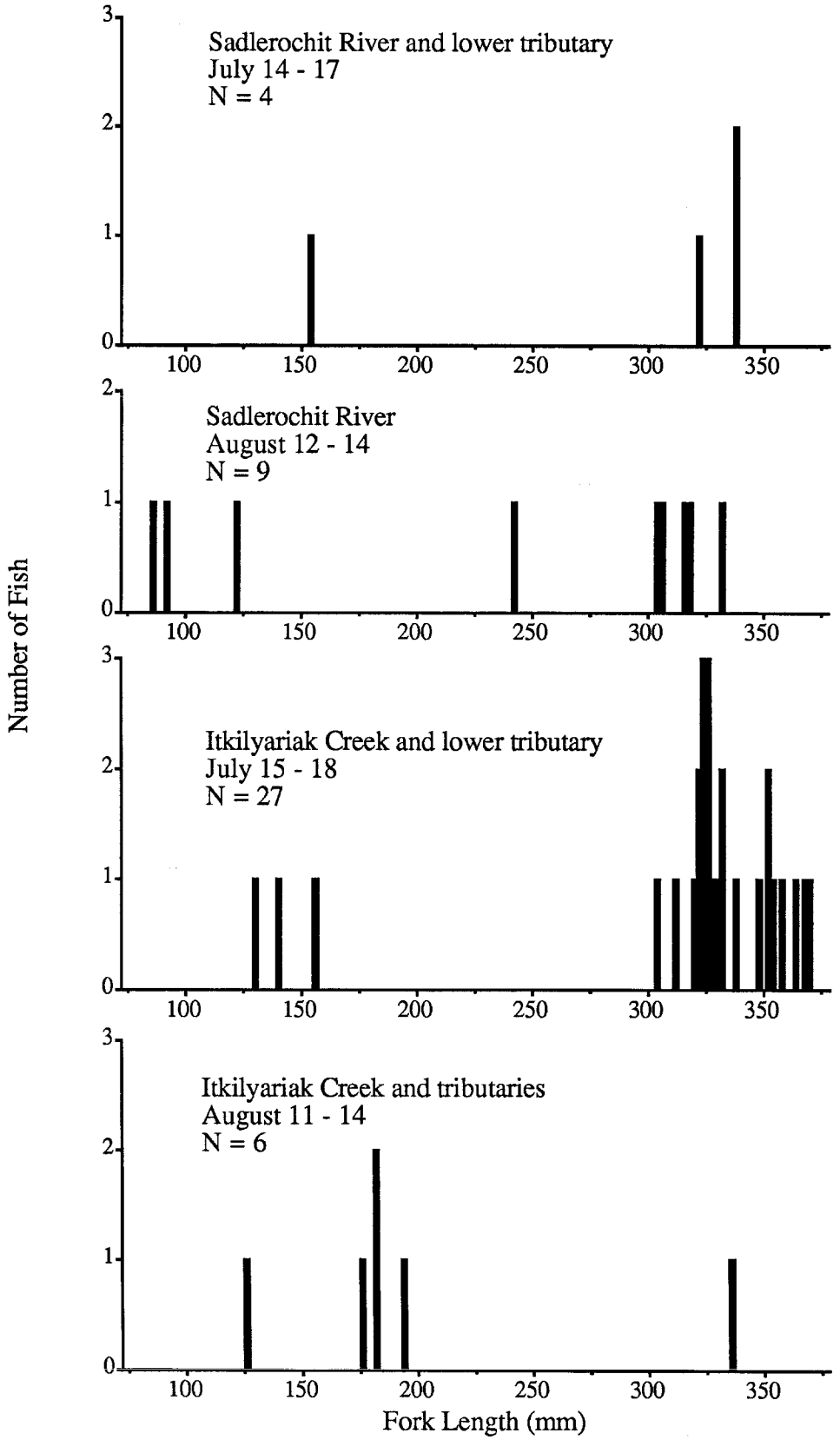
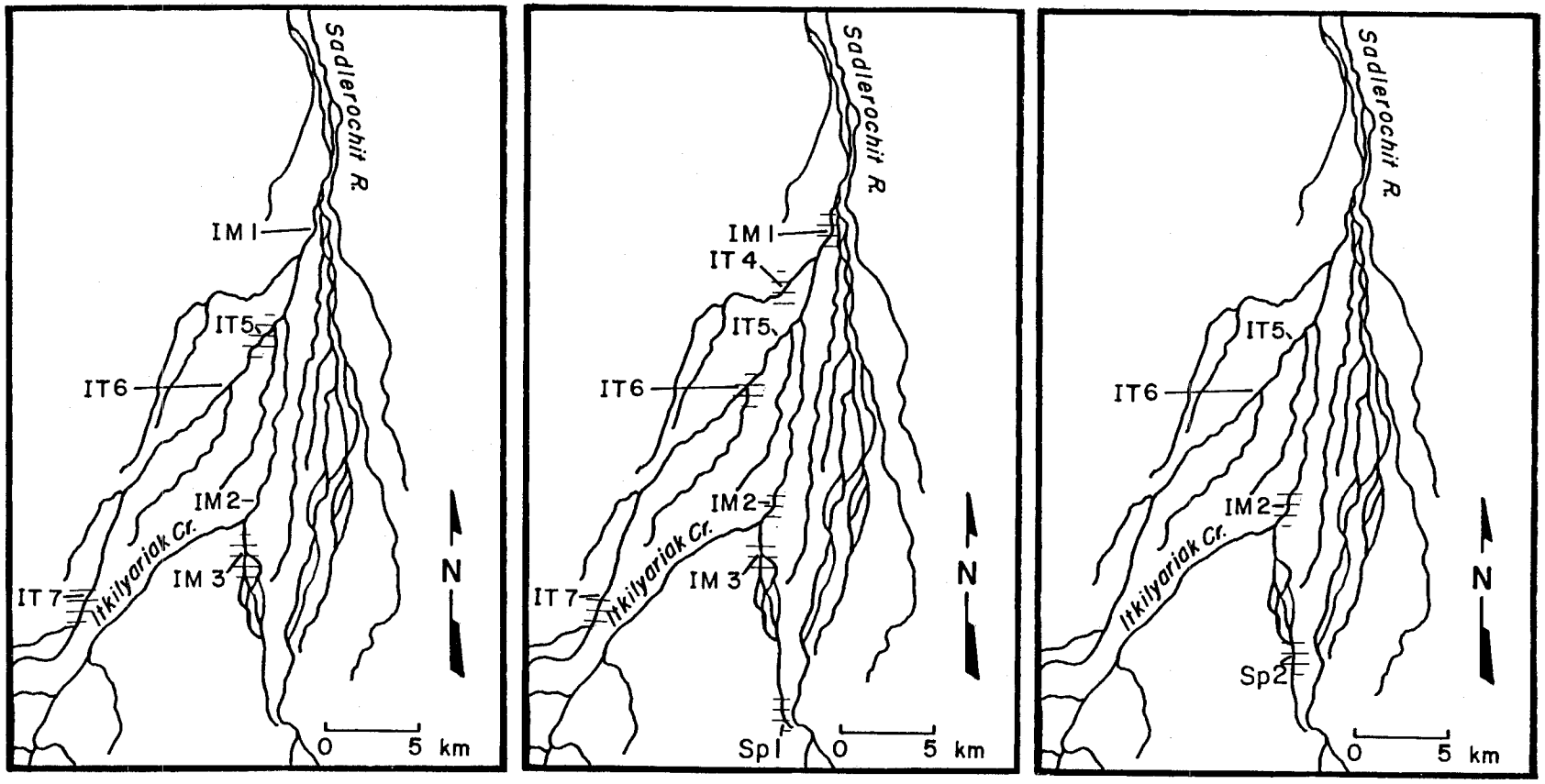
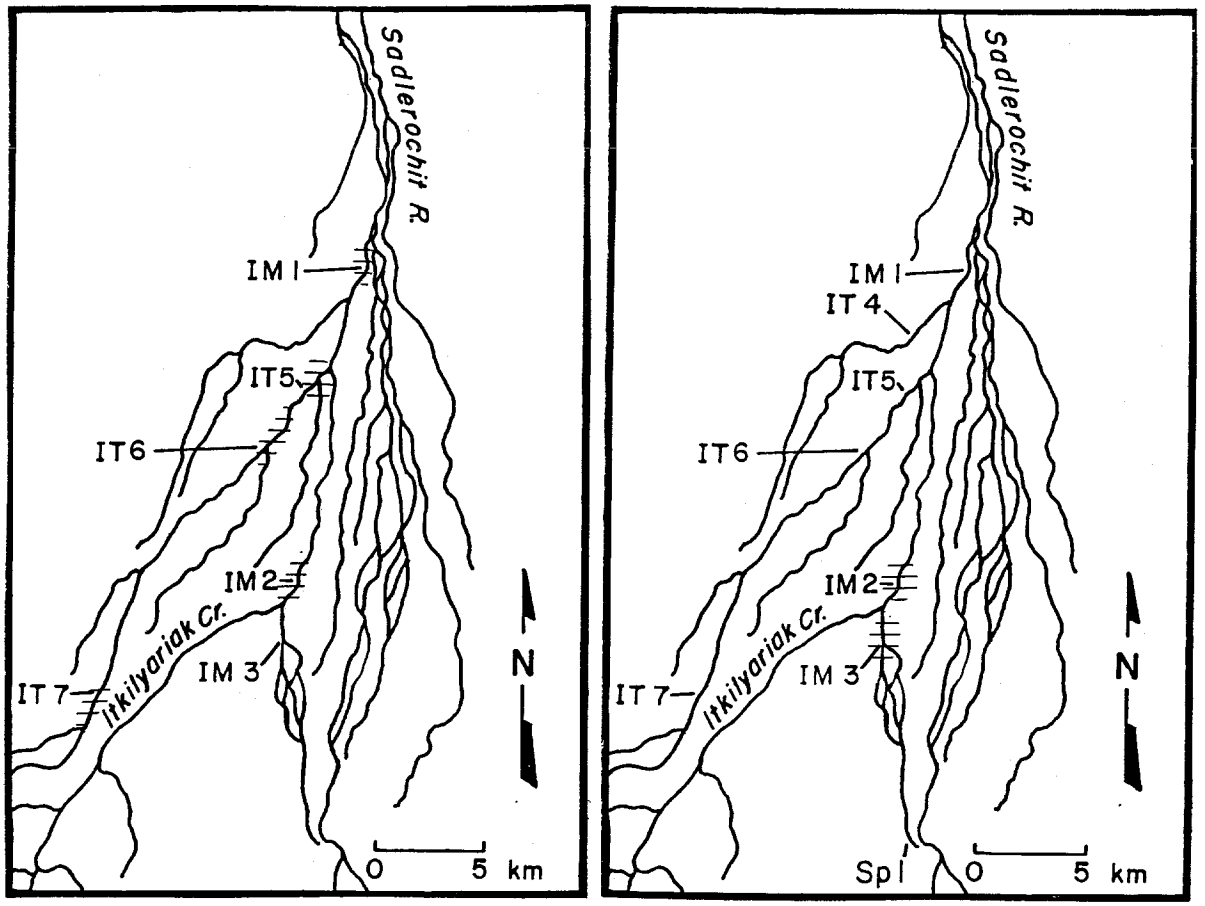


FIGURE 9.—Length-frequency of juvenile and adult Arctic grayling captured in the Sadlerochit River drainage during July and August 1991.



July 15 - 18, 1991 August 11 - 21, 1991 September 18 - 19, 1991

FIGURE 10.—Distribution of Dolly Varden char (hatch marked) in Itkilyariak Creek during July - September 1991 and Sadlerochit Spring during August and September 1991. IM = mainstem sample site, IT = tributary site, Sp = Sadlerochit Spring site.



July 15 - 18, 1991

August 11 - 21, 1991

FIGURE 11.—Distribution of adult Arctic grayling (hatch marked) in Itkilyariak Creek during July and August 1991. IM = mainstem sampling site, IT = tributary site, Sp = Sadlerochit Spring site.

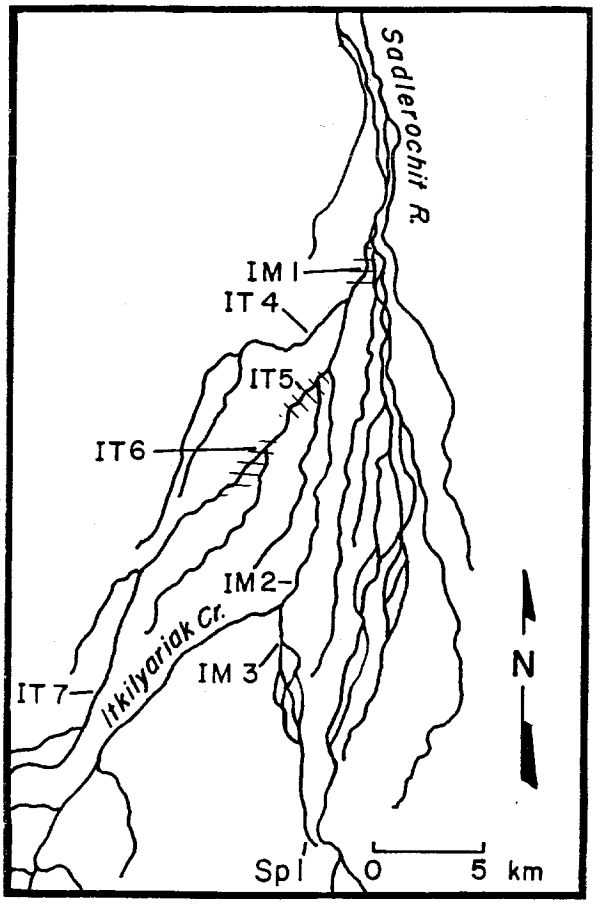
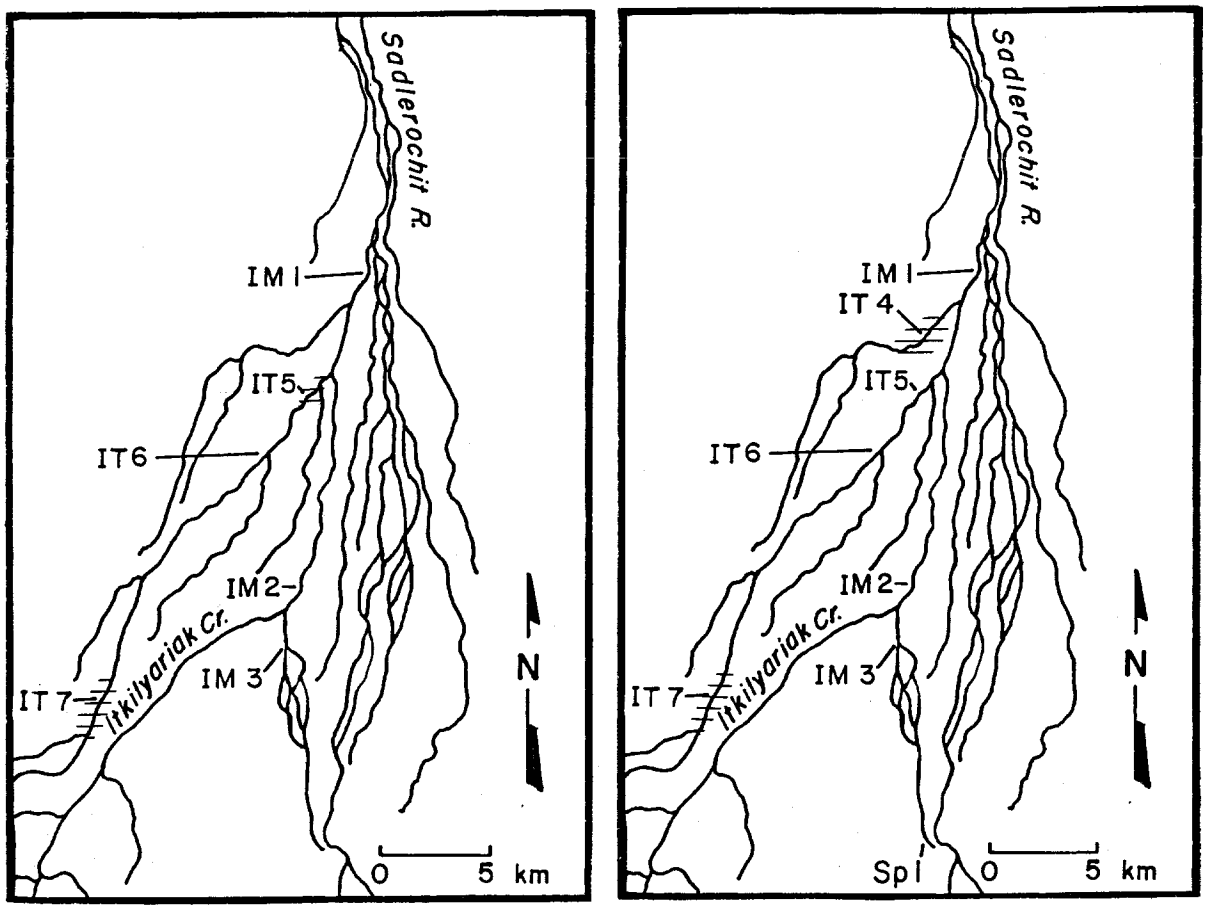


FIGURE 12.—Distribution of young of the year Arctic grayling (hatch marked) in Itkilyariak Creek between August 11 - 21, 1991. IM = mainstem sampling site, IT = tributary site, Sp = Sadlerochit Spring site.



July 15 - 18, 1991

August 11 - 21, 1991

FIGURE 13.—Distribution of juvenile Arctic grayling (hatch marked) in Itkilyariak Creek during July and August 1991. IM = mainstem sampling site, IT = tributary site, Sp = Sadlerochit Spring site.

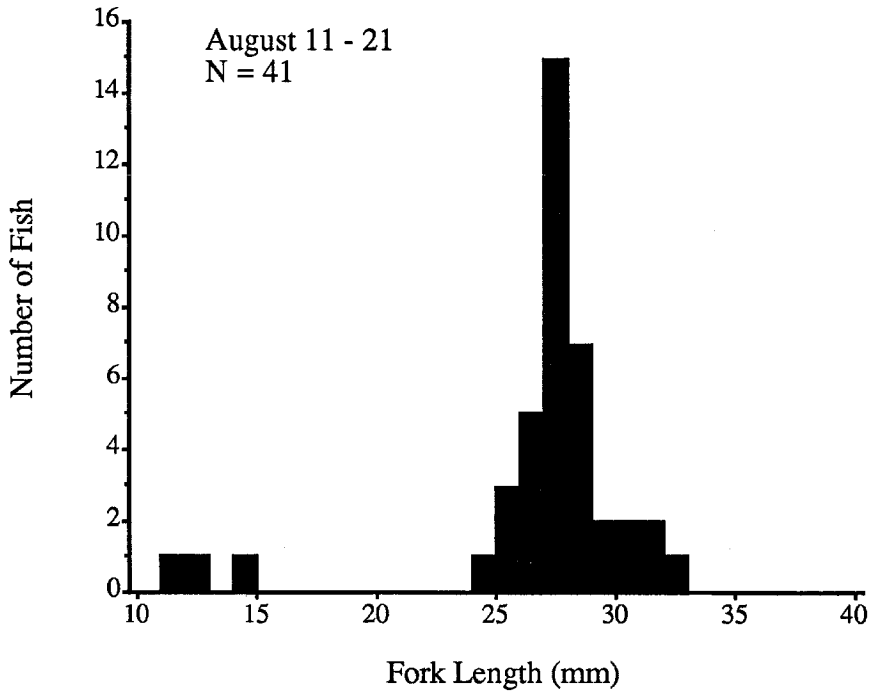


FIGURE 14.—Length-frequency of young of the year Arctic grayling captured in Itkilyariak Creek during August 1991.

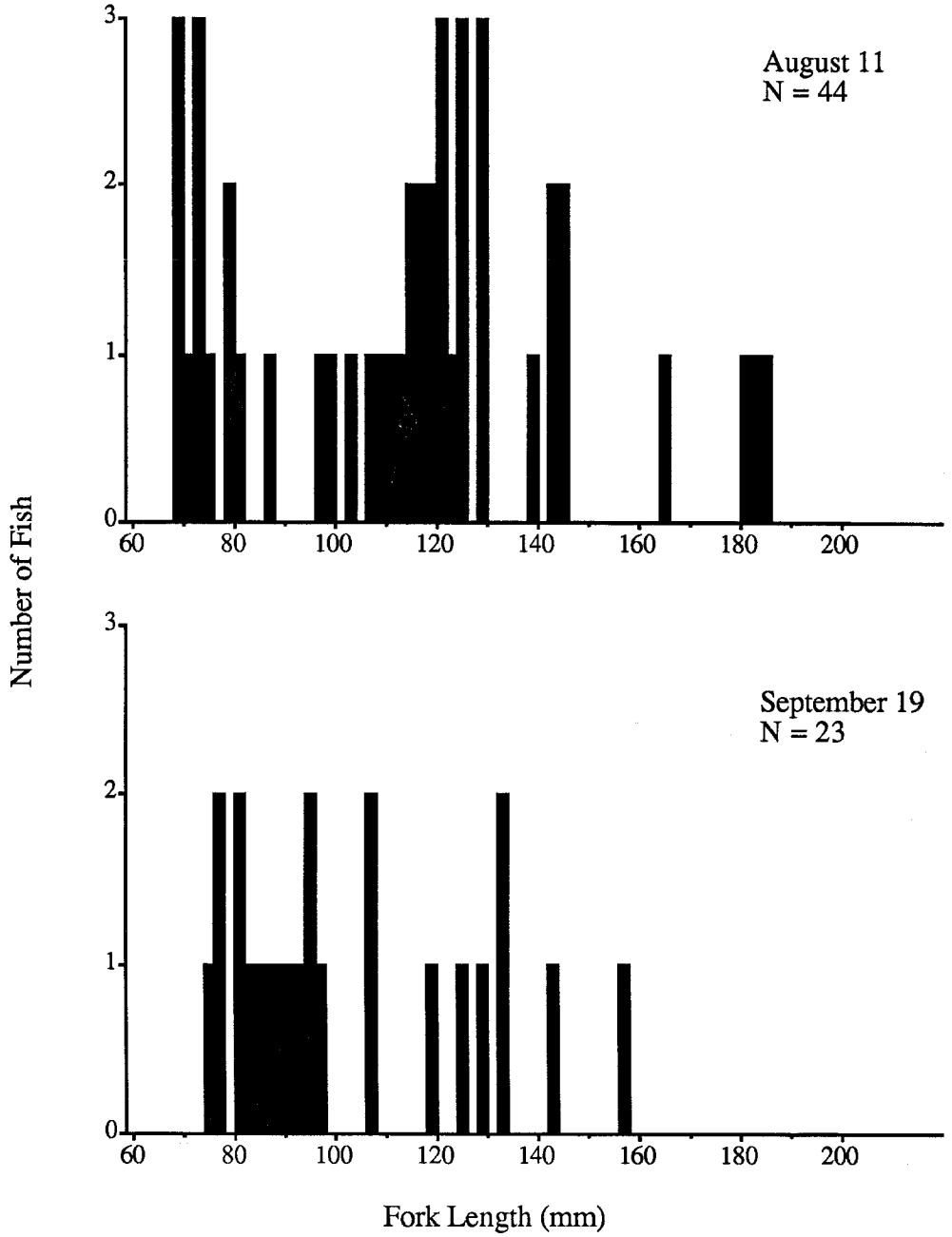


FIGURE 15.—Length-frequency of Dolly Varden char captured in Sadlerochit Spring during August and September 1991.

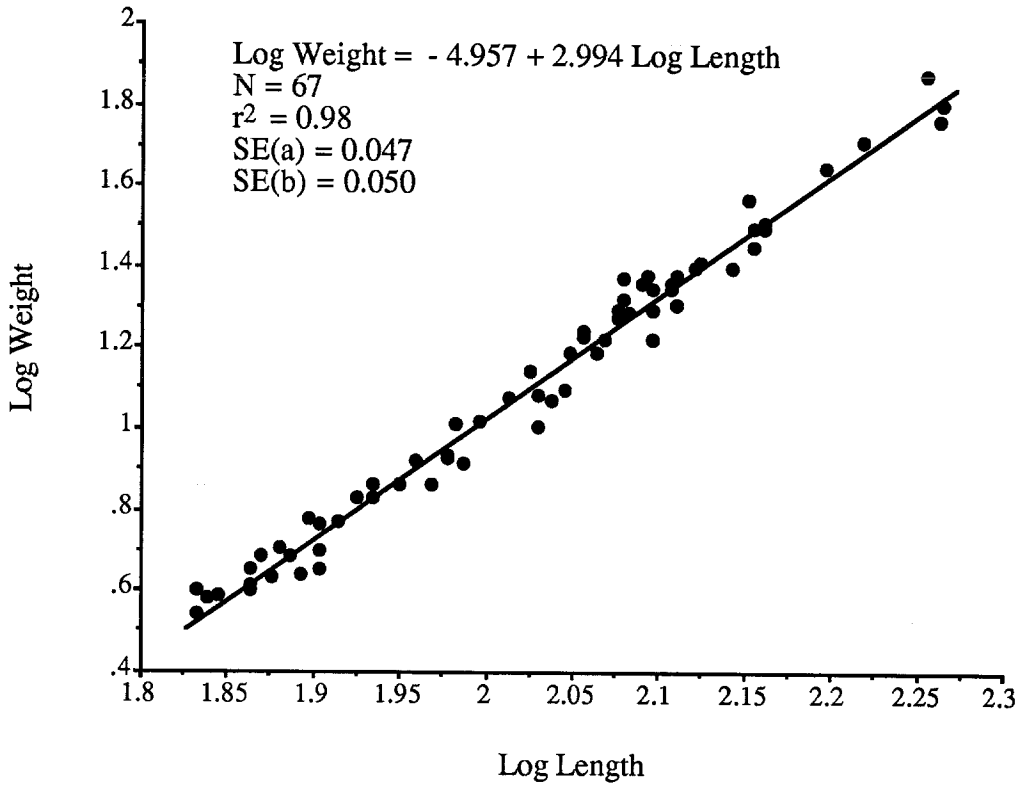


FIGURE 16.—Weight-length relationship of Dolly Varden char captured in Sadlerochit Spring during August and September 1991.

Conclusion

In 1991, the summer distribution of arctic fishes in the 1002 area of the Arctic Refuge was investigated in 19 lakes, 20 tundra streams and the Sadlerochit River drainage. Fish life history and distribution information was added to the baseline of previously sampled lakes and streams. In addition, this study documented the presence of fish in seven lakes, four tundra streams draining into coastal waters, and two tundra streams in the Sadlerochit River drainage where, prior to 1991, there were no data.

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References

Beamish, R., and G. McFarlane. 1987. Current trends in age determination methodology. Pages 15-42 *in* R. Sommerfelt and G. Hall, editors. The age and growth of fish. Iowa State University Press, Ames Iowa.

Clough, N.K., P.C. Patton, and A.C. Christiansen. 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment: report and recommendations to the Congress of the United States and final legislative environmental impact statement, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Bureau of Land Management, Washington, D.C.

Corning, R.V. (unpublished report-a). Life history findings for Arctic grayling (*Thymallus arcticus*) of the Tamayariak River drainage, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report, Anchorage, Alaska.

Corning, R.V. (unpublished report-b). Fish inventories of the Jago and Katakturuk river drainages, 1002 area of the Arctic National Wildlife Refuge, 1989. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report, Anchorage, Alaska.

Craig, P. 1977. Arctic char in Sadlerochit Spring, Arctic National Wildlife Range. Canadian Arctic Gas Study Ltd./Alaskan Arctic Gas Study Co. Biological Report Series 41, Calgary, Alberta.

Craig P. 1984. Fish use of coastal waters of the Alaskan Beaufort Sea: a review. Transactions of the American Fisheries Society 113:265-282.

Craig, P. 1989. An introduction to anadromous fish in the Alaskan Arctic. *In* D.W. Norton, editor. Research advances on anadromous fish in arctic Alaska and Canada. Biological papers of the University of Alaska Number 24:27-54.

Craig, P., and P. McCart. 1975. Classification of stream types in Beaufort Sea drainages between Prudhoe Bay, Alaska, and the Mackenzie Delta, N.W.T., Canada. Arctic and Alpine Research 7:183-198.

Craig, P., and V. Poulin. 1975. Movements and growth of Arctic grayling (*Thymallus arcticus*) and juvenile Arctic char (*Salvelinus alpinus*) in a small arctic stream, Alaska. Journal of Fisheries Research Board of Canada 32(5): 689-697.

Daum, D., P. Rost, and M.W. Smith. 1984. Fisheries studies on the north slope of the Arctic National Wildlife Refuge, 1983. Pages 464-522 *in* G.W. Garner and P.E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1983 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Elliott, G. 1982. Final report on the evaluation of stream crossings and channel modifications on the fishery resources along the route of the trans-Alaska pipeline. U.S. Fish and Wildlife Service, Special Studies, Anchorage, Alaska.

Elliott, G. 1990. Quantification and distribution of winter water within lakes of the 1001 area, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 7, Anchorage, Alaska.

Frugé, D., D. Wiswar, L. Dugan, and D. Palmer. 1989. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1988. U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report, Fairbanks, Alaska.

Kleinbaum, D., and L. Kupper. 1978. Applied regression analysis and other multivariate methods. Duxbury Press. Boston, Massachusetts.

Lagler, K., J. Bardach, and R. Miller. 1962. Ichthyology. John Wiley and Sons, Inc., New York.

Lyons, S., and J. Trawicki. 1992. Water resources and assessment, Arctic National Wildlife Refuge, 1991 streams discharge gaging data. U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report Number 92-2, Anchorage, Alaska.

Lyons, S., and G. Elliott. 1987. FY-1987 status report, quantification of federal reserved water rights, Arctic National Wildlife Refuge. U.S. Fish and Wildlife Service, Alaska Investigations Report, Anchorage, Alaska.

McCart, P. 1980. A review of the systematics and ecology of Arctic char, *Salvelinus alpinus*, in the western Arctic. Canadian Technical Report of Fisheries and Aquatic Science Number 935.

Merritt, M., and D. Fleming. 1991. Evaluations of various structures for use in age determination of Arctic grayling. Alaska Department of Fish and Game, Fishery Manuscript Number 91-6, Anchorage.

Moulton, L. 1989. Recruitment of Arctic cisco *Coregonus autumnalis* into the Colville delta, Alaska, in 1985. *In* D.W. Norton, editor. Research advances on anadromous fish in arctic Alaska and Canada. Biological papers of the University of Alaska Number 24:107-111.

NOAA (National Oceanic and Atmospheric Administration). 1987. Local climatological data annual summary with comparative data, Barter Island, Alaska. Asheville, N.C.

Palmer, D., and L. Dugan. 1990. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1989. U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report, Fairbanks, Alaska.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada Number 191.

Schmidt, D. W. Griffiths, and L. Martin. 1989. Overwintering biology of anadromous fish in the Sagavanirktok River delta, Alaska. *In* D.W. Norton, editor. Research advances on anadromous fish in arctic Alaska and Canada. Biological papers of the University of Alaska Number 24:55-74.

Smith, M.W., and R.S. Glesne. 1983. Aquatic studies on the north slope of the Arctic National Wildlife Refuge, Alaska, 1981 and 1982. Pages 291-364 *in* G.W.Garner and P.E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1982 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Trawicki, J., S. Lyons, and G. Elliott. 1991. Distribution and quantification of water within lakes of the 1001 area, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 10, Anchorage, Alaska.

Underwood, T., J. Gordon, and B. Osborne. 1992. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1990. U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report, Fairbanks, Alaska.

Ward, D., and P. Craig. 1974. Catalogue of streams, lakes, and coastal areas in Alaska along routes of the proposed gas pipeline from Prudhoe Bay to the Alaska/Canadian border. Canadian Arctic Gas Study Ltd./Alaskan Arctic Gas Study Co. Biological Report Series 19, Calgary, Alberta.

West, R.L., and D.J. Frugé. 1989. A review of coastal plain fish surveys and results of 1986 fish surveys of selected coastal lakes and streams, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 4, Fairbanks, Alaska.

West, R.L., and D.W. Wiswar. 1985. Fisheries investigations on the Arctic National Wildlife Refuge, Alaska, 1984. Pages 729-777 *in* G.W. Garner and P.E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1984 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Wilson, W., E. Buck, G. Player, and L. Dreyer. 1977. Winter water availability and use conflicts as related to fish and wildlife in arctic Alaska — a synthesis of information. U.S. Fish and Wildlife Service, FWS/OBS-77/06, Washington, D.C.

Wiswar, D.W. 1991. Distribution of Arctic Fishes in the Okpilak and Akutoktak Rivers, Arctic National Wildlife Refuge, Alaska, 1989. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 11, Fairbanks, Alaska.

Wiswar, D.W. 1992. Summer distribution of arctic fishes in the Okpilak, Akutoktak, Katakturuk, and Jago rivers, Arctic National Wildlife Refuge, Alaska, 1990. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 17, Fairbanks, Alaska.

Wiswar, D.W. and R.L. West. 1987. Fisheries investigation in Beaufort Lagoon, Arctic National Wildlife Refuge, Alaska, 1985. Pages 778-800 *in* G.W.Garner and P.E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Wiswar, D.W., R.L. West, T.M. Stevens, and M.W. Smith. 1987. Fall movements and overwintering of Arctic grayling in the Arctic National Wildlife Refuge, Alaska, 1985. Pages 801-813 *in* G.W.Garner and P.E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Yoshihara, H.T. 1972. Monitoring and evaluation of arctic waters with emphasis on the North Slope drainages. Annual progress report, Project number F-9-4, Job number G-III-A, Volume 13, Alaska Department of Fish and Game, Juneau.

Zar, J.H. 1984. Biostatistical analysis. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.