Volume 18

Study G-I-I

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Jay S. *Hammond, Governor*

Annual Performance Report for

INVENTORY AND CATALOGING OF ARCTIC AREA WATERS

by

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RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

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Period Covered: July 1, 1976 to June 30, 1977

ABSTRACT

Data and discussions regarding a three phase survey program in Arctic Alaska are presented.

The result of a creel census conducted along Prudhoe Bay showed low effort and catch success of all species.

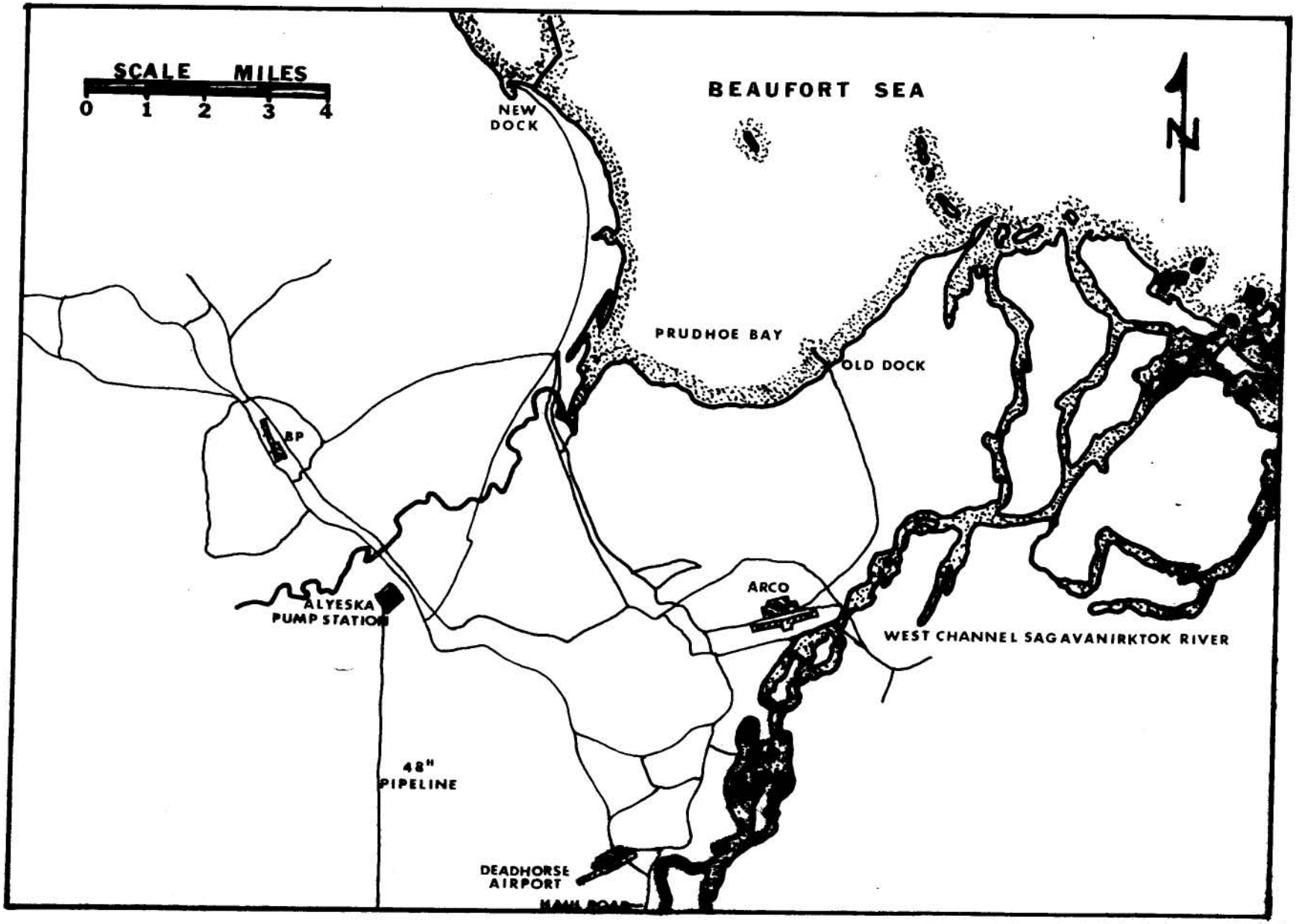
Aerial index counts of spawning Arctic char, Salvelinus alpinus (Linnaeus), showed stable population levels in the surveyed sections.

Studies on habitat type, movements and migrations, visible effects of pipeline construction, plus age and growth of selected fish species are presented for waters in the upper Middle Fork Koyukuk River drainage.

BACKGROUND

The study area for this report includes three locations north of the Arctic Circle in northern Alaska. The first includes an area surrounding Deadhorse at the northern terminus of the Trans-Alaska Pipeline and locations bordering Deadhorse along Prudhoe Bay in the Beaufort Sea (Figs. 1 and 2). Due to a 5-mile lateral closure to fishing on either side of the oil pipeline north of the Yukon River, the above areas were the center of major fishing pressure during the study period. Fishing pressure in these areas has been light in past years but is expected to increase with time, as explained in the findings.

The second study location (Fig. 3), includes a portion of the spawning grounds of Arctic char, Salvelinus alpinus (Linnaeus), in the upper Sagavanirktok River drainage. Index counts were conducted to monitor yearly trends in char abundance and are explained in detail in the findings.


SCALE MILES
0 1 2 3 4
NEW DOCK
BEAUFORT SEA
N
PRUDHOE BAY
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ARCO
ALYESKA PUMP STATION
WEST CHANNEL SAGAVANIRKTOK RIVER
48" PIPELINE
DEADHORSE AIRPORT

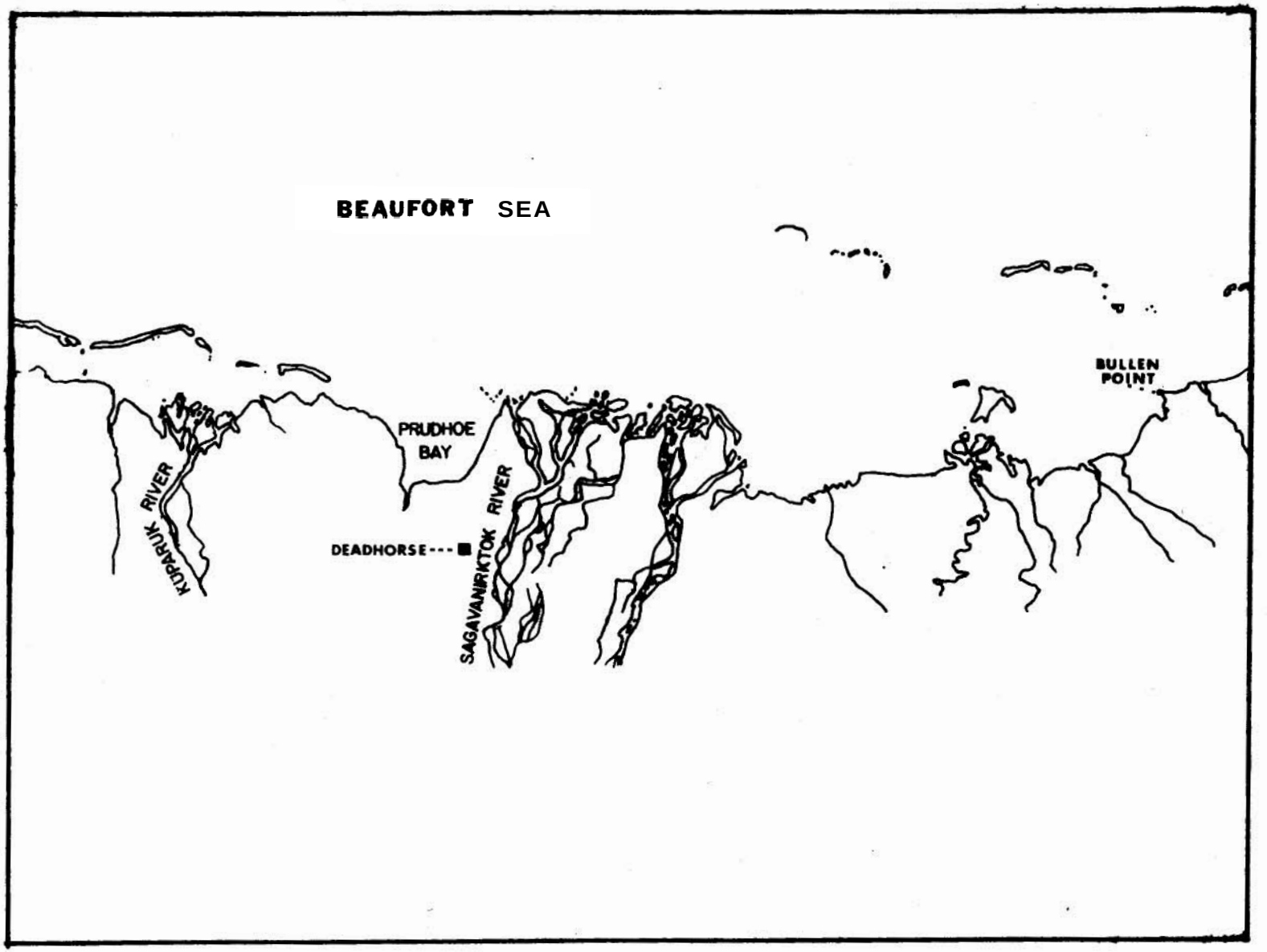

Figure 2. Creel census locations along Beaufort Sea, 1976.

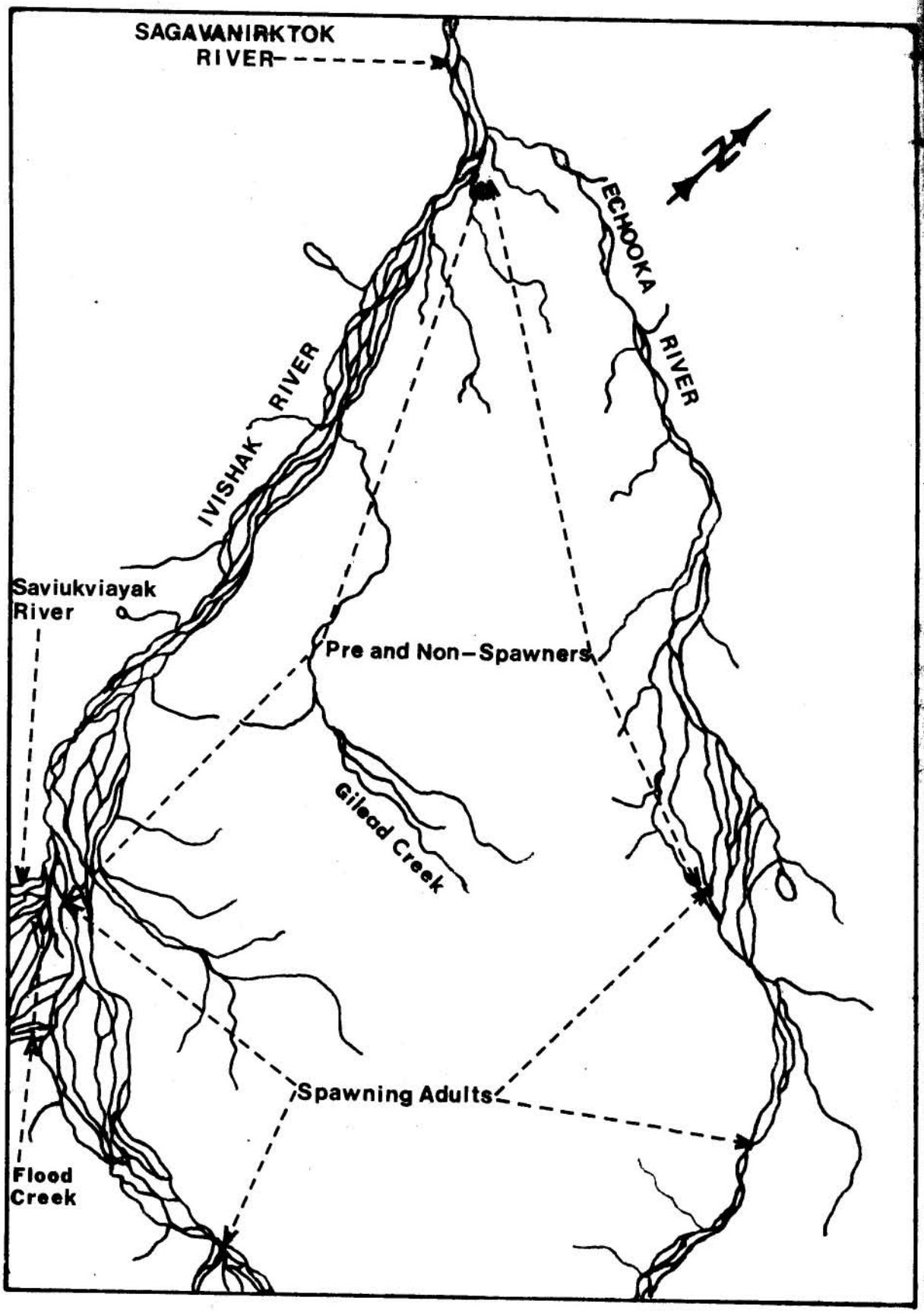

FIGURE 3. ARCTIC CHAR INDEX AREAS, UPPER SAGAVANIRKTOK DRAINAGE

The third location includes an approximate 180 mile section of pipe and haul road that lies between the Yukon River and Atigun Pass in the Brooks Range (Fig. 4). Specific studies were centered on the subsection between Prospect and Chandalar camps. For years, the only development in this area consisted of gold mining operations in and around the towns of Coldfoot and Wiseman. No direct assessment is available regarding fishery impacts incurred by these early developments. Streams were crossed and no doubt disturbance occurred in the mined areas.

A winter ice road (Hickel Highway) was constructed in 1968-1969 to allow supply movement for camp construction south of the Brooks Range and initial staging for access to the North Slope through the John River to the west. Past fishery research on waters adjacent to pipeline and haul road construction was essentially initiated and reported on by Netsch (1975). In 1971 he studied 209 waters along the 185 mile segment of the Trans-Alaska Pipeline route mentioned above. Intensive studies and further surveys continued until April 1974. Data collected included water qualities, fish presence, species diversity, age and growth relationships plus migration patterns of key species. Discussions on sampling gear effectiveness and general construction guidelines were presented.

As mentioned above, preliminary surveys had been conducted on the major streams in the areas by U.S. Fish and Wildlife Service, showing many to be important for spawning, rearing and as migration routes of king salmon, Oncorhynchus tshawytscha (Walbaum); chum salmon, O. keta (Walbaum); Arctic grayling, Thymallus arcticus (Pallas); round whitefish, Prosopium cylindraceum (Pallas); Dolly Varden, Salvelinus malma (Walbaum) and other species. However, detailed knowledge of most of these streams, and especially the smaller streams, was lacking.

The Alaska Department of Fish and Game began an assessment study in August, 1975. The study concentrated on areas of construction and attempted to evaluate stream alterations in terms of effects on various fish species and associated habitat. Movements of fish were to be monitored and age and growth of fish species determined. Preliminary findings are presented by Hallberg (1976).

This study continues to concentrate primarily on the Middle Fork Koyukuk River in the area of construction. It was conducted in conjunction with an Alyeska Pipeline Company funded program aimed at assessing effects of placement of approximately 30 spur dikes on the Middle Fork Koyukuk.

For the most part, data presented by previous investigators were not repeated and only new or updated information is discussed.

This study provides data presently lacking on many of the smaller streams that are believed to be high producers of grayling.

Seasonal fish movements were monitored in selected streams.

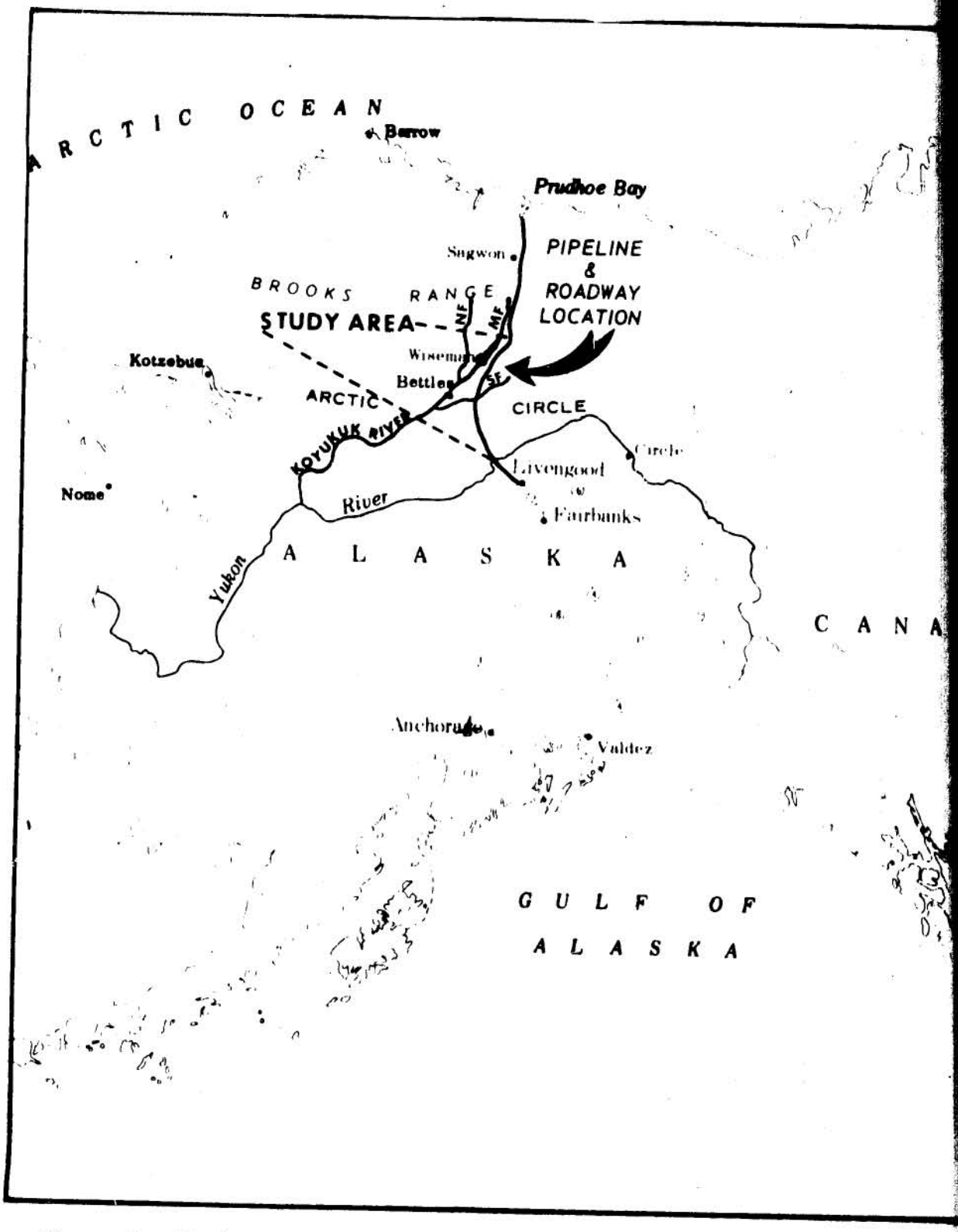

Figure 4. Study area along Upper Middle Fork Koyukuk and Dietrich rivers.

RECOMMENDATIONS

1. Conduct inventory and cataloging of area waters.

2. Continue the monitoring of the sport fishery in the study area.

3. Continue aerial index counts of char in the Sagavanirktok River drainage.

OBJECTIVES

1. To monitor the sport fishery in the study area.

2. To continue aerial index counts of char in the Sagavanirktok River drainage.

3. To monitor spring grayling movements and spawning along the North Slope haul road.

TECHNIQUES USED

The monitoring of the sport fishery was conducted by systematic angler interviews, usually conducted in conjuction with other studies or field work. When possible, the man hours of effort and catch statistics were recorded. The aerial char index counts were conducted by two observers in a Bell 206 helicopter. Sampling by hook and line yielded data relative to maturity and spawning timing.

Standard Alaska Department of Fish and Game stream and lake surveys were conducted in the job area. Visual observations of stream or lake type and cover, water quality, fish presence, temperature, and flow ranges were recorded. Depths of lakes were collected by fathometer and handline. Movements, relative numbers, and migration patterns of fish in streams were determined by visual observation, as well as collection by weirs, hook and line, and seines. Backpack shockers were used when conditions permitted. Graduated mesh gill nets 125' x 6' were set to collect fish in lakes as a supplement to hook and line methods.

All fish sampled were examined for tags or fin clips, a scale was taken for age determination, and fork length in millimeters and weight in grams were recorded when possible. A subsample was autopsied to determine sex and maturity.

The effects of pipeline pad, culvert, haul road, and spur dike construction were assessed mainly by visual observation. Loss of fish habitat, alteration of stream quality, and disruption to fish life history were similarly studied. Regular, systematic observations were made to note changes during the study period.

To identify streams, the station number of the first crossing going north, either of the pipeline or haul road is used. When the stream or

an adjoining lake crosses both the pad and haul road, two station numbers are used to describe the same water. (R. L. Johnson and J. Rockwell, Jr., 1976). In this report the following pipeline construction abbreviations are used:

HR = Haul Road
SD = Spur Dike
VSM = Vertical Support Member
AS = Alignment Sheet

FINDINGS

Sport Fishery Monitoring

The monitoring of fishing pressure and degree of angler effort during the 1976 field season was concentrated mainly in the Deadhorse area, adjacent to Prudhoe Bay on the North Slope (Figs. 1 and 2). There is a 5-mile lateral fishing closure on either side of the entire pipeline north of the Yukon River. No legal fishing occurred except in areas outside of the closed corridor.

On a seasonal basis, fishing has been generally best conducted and most successful during open water periods. Breakup usually occurs in late May to mid June, depending on the winter's severity. During this breakup period, major rivers such as the Sagavanirktok and Kuparuk are swollen with high water and ice floes. These factors, coupled with increased levels of turbidity and often inclement weather, prevent successful early fishing in the major rivers. Certain clear feeder streams draining into the major systems are used at this time by spawning grayling, which are available for fishing outside of the closed corridor.

Clearing due to the lowering of silt content occurs in the major rivers in early to mid July. Water levels continue to decrease after the spring high water period. Grayling are best caught in the main systems as soon as the water clears in mid July until freezeup in mid to late September. Grayling locate in deep river holes after freezeup but little fishing pressure is placed on them at present.

Arctic char are generally available in the lower Sagavanirktok River from early August until early September. During this period, the char are enroute from summer feeding habitat in the adjacent Beaufort Sea to fall spawning and overwintering areas in the upper river sections. Creel census data of this emerging fishery are presented below. The upstream char migration lasts for an approximate two month period. At present, the middle river sections are unfished where they lie within the closed corridor or where access is difficult. Char are available in the upper river sections and adjoining smaller spawning streams from as early as mid August until freezeup. The lower Echooka River provides fair fishing while char are moving upstream to the spawning grounds. Access to these remote areas is limited to either helicopter or wheel planes on undeveloped gravel bars.

Spawning stocks are presently exposed to very light angler pressure due to this access difficulty. After freezeup, the char overwinter upstream in the major rivers, but these overwintering fish are not exposed to harvest.

In Prudhoe Bay, fishing is generally best from mid July to mid August. During this ice-free period the char are either feeding in selected areas (early) or moving into the Sagavanirktok River (late) for the purpose of spawning and overwintering. Good areas for fishing include land spits and man-made extensions such as loading docks along which char may pass.

Other good fishing areas are the outlets of brackish lagoons which occur behind sand pits. These outlets are favorite feeding areas for char as they concentrate feeding fish into a small area. As an example, at a lagoon outlet near Bullen Point, east of Deadhorse, three men caught 35 char in 45 minutes, an average of 15.6 fish per man hour. The char ranged in size from 410 mm to 530 mm. Of 27 autopsied, two were males and the rest females. Two of the char were immature, 14 were developing, and 11 were mature and would have spawned in the fall of 1976. At present, these known locations receive light fishing pressure. However, use is expected to increase and new areas will be exposed to effort as they are discovered.

In the Deadhorse area fishing pressure remains light and centers around docks and in the adjoining west channel of the Sagavanirktok River. In the river proper, there are only a few easily accessible sections with deep holes that are used for both char and grayling fishing.

A creel census program was conducted on an opportunity permitting basis for a six week period in the Deadhorse area from mid July to the end of August, 1976. A total of 42 fisherman was contacted along the docks during the period. Due to long working hours, fishing is limited in degree and time by good weather and free evenings. Pressure was moderate while success was low, with the best censused individual catch being eight char in one evening. Average success was far less and the typical fisherman angled less than one hour. Most anglers censused caught no fish at all. As mentioned, fishing occurred in evenings on a fairly regular basis, with from two to eight fishermen out on most occasions and with from 12 to 20 out in good weather periods. As the char enter the Sagavanirktok River in early August, pressure usually diverts to that location. A total of 15 anglers was censused fishing in the Sagavanirktok River. Their total catch consisted of 21 Arctic grayling up to 400 mm and 8 Arctic char up to 5 lbs. This census was random and the data did not lend itself to expansion and estimation of total catch and effort. It is obvious that effort is very light at present but may increase as new fishing locations are discovered.

Arctic Char Index Counts

Aerial index counts of Arctic char in the Sagavanirktok drainage have been conducted annually since 1971. These counts are done to index the relative abundance from year to year of char that ascend the Sagavanirktok

River and populate the drainage sections that are used for spawning. Several factors influence the variability among yearly counts. Changes in observers, pilot skill, weather conditions, channel and water level fluctuation in the rivers, timing of observation, and fish behavior all affect the counts. Variability is unavoidable under these conditions and thus the trend, as well as the actual numbers, should be considered when evaluating the results. Not all fish present are counted and estimates of the numbers accounted for range from 50%-90% of the total. Methods used and past results are discussed by Yoshihara, 1972, 1973; Furniss, 1974, 1975; and Alt, 1976 and are presented in Table 1 along with this year's data.

These data show a fairly consistent population level through 1974. Early counts in 1975 varied from those conducted later for the Echooka and Ivishak rivers, presumably due to a late arrival on the spawning grounds.

Aerial index counts were centered on the Echooka and Ivishak rivers on September 22, 1976. The intent was to concentrate on a smaller index section of the Sagavanirktok drainage (Fig. 3) that had shown a trend for greatest variability. The counts were conducted from a helicopter as in past years. The weather was good except for a wind in the Ivishak drainage which made counting difficult. There was no evidence of freezing at the time of the counts.

The Echooka River was counted from its confluence with the Ivishak River to about six miles into the Brooks Range (40 miles). The distribution of char in the Echooka River was very similar in 1976 to that in 1975. Nearly all the Echooka River char are spawners. Redds were clearly visible from the air, yet of seven females captured with sport gear, only one had loose eggs. The remainder were still in a prespawning condition. One of the spawners had been tagged in July 1976 at the new dock in Prudhoe Bay. The spawning area occupies the upper end of the section counted.

The Ivishak River was surveyed from the Mobil Echooka strip to approximately 10 miles into the foothills of the Brooks Range (35 miles). Nonspawning adults and juveniles were scattered throughout the river from the airstrip upstream. Spawners and nonspawners mixed in the lower section while the main spawning area occupies the upper section. The counts indicate that the char numbers are still good and the difference between 1975 and 1976 in the Ivishak is inconsequential considering the difficulty of the count.

Movements and Migrations - Middle Fork Koyukuk River

General Trends:

Because Arctic grayling are usually in greatest abundance in the study streams, they were the key species investigated during the movement and migration study. However, less abundant species such as round whitefish, longnose sucker, Catostomus catostomus (Forster); slimy sculpin, Cottus cognatus Richardson; and Dolly Varden followed closely the patterns on movement and trends noted for grayling.

Table 1. Comparative aerial counts of char in the Sagavanirktok River drainage from 1971 to 1976.

Location	1971	1972	1973	1974	1975*	1975**	1976
Accomplishment Creek	178	322	512	505	270	...	...
Ribdon River - Mainstem	400	467	123	240	153	...	...
Ribdon River - South Fork	49	276	1,183	1,330	395	...	...
Lupine River	Few	...	318	260	195	...	...
Sagavanirktok River	321	378	264	650	584	...	...
Flood Creek	350	508	512	370	300	...	...
Echooka River	1,137	1,688	1,883	2,160	473	852	2,254
Ivishak River - Echooka River to Flood Creek	12,470	11,937	8,992	11,000	2,485	8,306	7,657
Upstream from Flood Creek	1,488	...	1,017	2,140	710	337	913

* Counts September 7-10
** Counts September 21-22

Overwintering for all species most likely takes place in the major rivers of the area, mainly the Middle Fork of the Koyukuk River (Netsch, 1975). Open water areas where fish have been captured in winter are present in the upper Dietrich River. Grayling have also been captured through the ice in the Jim River. The South Fork of the Koyukuk River undoubtedly contains the above species, plus eggs and rearing sizes of salmon. With breakup and the commencement of flow in feeder streams such as Rosie, Spring, Organo, and Mary Angel creeks in early May, some or all of the above species enter from the larger rivers. Depending on the stream, sloughs of the major rivers play an important role as an avenue for migration at the time of high water. Ripe adult grayling are observed to enter their respective spawning streams and lakes, such as Spring Creek and Grayling Lake. They generally peak their efforts by mid May, often at water temperatures near 4°C. After spawning, many of the larger, adult grayling migrate back into the major rivers, presumably to move to optimum feeding habitat. Depending on the system, some adults may remain and feed through the summer. By the middle of August some streams, such as Mary Angel Creek, have a scarcity of adult grayling present. Weirs placed in Rosie, Mary Angel, and Organo creeks have shown peak outmigration in late August and early September as is discussed below. The various species then move typically to selected overwintering habitat.

The side sloughs of the Middle Fork, such as Texas and Jackson sloughs, generally contain fish through the open water period and may act as both migration routes and feeding habitat depending on water levels. Hence, any blockage or impediment to movement or successful reproduction in either the feeder streams or main rivers during the critical open water periods will have drastic and long range effects. For species other than grayling and char, the main rivers are probably the important spawning areas, thus winter habitat disturbance should be avoided for this and other reasons, such as overwintering of all species.

Tagging Operations:

Tagging operations were carried out in selected feeder streams of the Middle Fork of the Koyukuk River in 1975 by Hallberg. Emphasis was placed on waters in proximity to proposed spur dike or pad construction. The objectives were to mark these fish in order to note and evaluate their intra- and interstream movements and determine any yearly trend for returning to marking areas. Both grayling and round whitefish over 150 mm were tagged and nearly all were fin clipped (RV) to determine tag loss and as a means of further analyzing movement. Table 2 lists the tag numbers and tagging location of fish marked in 1975. All were yellow Floy tags.

Table 3 summarizes the numbers of fish tagged or clipped in 1975 and recaptured in 1976. Totals of 314 grayling and 17 round whitefish were tagged in 1975 in six streams near Coldfoot; the majority were marked in Organo Creek. Twelve grayling (3.8%) and six round whitefish (1.9%) were recaptured in the same stream as tagged. Two (0.6%) grayling moved to another study stream the following year. Of the 20 recaptures, 18 (90.0%) returned to the location where tagged. In 1975, 271 grayling and 20 round whitefish were marked with fin clips. Twenty-two (7.5%) of

Table 2. Yellow Floy tag series used in Upper Koyukuk Drainage, 1975.

Tag Reference	Location
25210 - 25314	Organo Creek
25350 - 25366	Mary Angel Creek
25386 - 25419	Rosie Creek
25420 - 25446	Slate Creek
25447 - 25454	Marion Creek
25456 - 25490	Slate Creek
26050 - 26078	Organo Creek
26080 -	Mary Angel Creek
26120 - 26247	Rosie Creek
26540 - 26548	Minnie Creek
26549 - 26557	Slate Creek
26558 - 26574	Marion Creek

Table 3. Summary of fish tagged or clipped in tributaries to the Upper Middle Fork Koyukuk River, 1975 and 1976.

Location	1975 No. Tagged GR*	RWF**	Totals	1975 No. Clipped GR	RWF	1976 Recaptures No. Tagged Same Location GR	RWF	Different Location GR	RWF	1976 Recaptures No. Clipped GR	RWF
Rosie Creek	98	13	111	147	20	4	2	0	0	16	5
Mary Angel Creek	11	4	15	16	0	2	4	0	0	0	1
Organo Creek	118	0	118	108	0	6	0	1	0	0	0
Slate Creek	58	0	58	0	0	0	0	1	0	0	0
Marion Creek	22	0	22	0	0	0	0	0	0	0	0
Minnie Creek	7	0	7	0	0	0	0	0	0'	0	0
Spring Creek	0	0	0	0	0	0	0	0	0	0	0
Totals	314	17	331	271	20	12	6	2	0	16	6

* Arctic grayling
** Round whitefish

both species were later recaptured. Of 216 grayling and round whitefish examined in outmigrant weirs in 1976, 22 (10.2%) had been clipped in 1975. The above data indicate a definite trend to return to the same stream. The placement of weirs only in Rosie and Mary Angel creeks allowed unequal sampling and recovery probability to occur among all streams. Attempts were made throughout the summer on all streams to recapture tagged fish; the weirs are just more efficient during outmigration.

Table 4 summarizes weir operations and outmigration timing during 1975 and 1976. Catches were higher in Rosie Creek in 1976 for all species but declined in Mary Angel Creek. No weir was operated in Organo Creek in 1976. Rosie Creek experienced the greatest construction effects, yet showed few unfavorable results in regard to fish numbers. Some known illegal fishing may have influenced the decline in Mary Angel Creek. No data are available on cyclic abundance over an extended period.

Outmigration for most size groups usually commenced after weir installation in late August. Peak daily captures occurred as early as August 28 (1976) and as late as September 12 (1975), depending on stream. Early peaks led to early cessation of movement, and most fish were absent by the second week in September. It should be noted that, depending on the stream, the larger fish may leave earlier than smaller sizes. All species generally kept the same timing. The fact that interchange occurs throughout the open water period means that the outmigrant totals do not reflect the absolute number of fish occupying a stream on a seasonal basis.

System Descriptions

Introduction:

Following are detailed descriptions of streams observed on a regular basis during 1976. We attempted to select streams near Coldfoot Camp that we could observe with regularity and that may have been affected by nearby construction. Observations and problems from these streams would apply to others not studied. A discussion and recommendation section is usually attached to each system description.

Jim River:

This river was first surveyed by Netsch on July 28, 1971. It was found to be a clear river 150' wide, 2'-3' deep with 3.5 fps current. The water chemistry was: DO 12 ppm, CO_2 5 ppm, pH 7.0, total hardness 17 ppm, alkalinity 51 ppm, free acidity 0. Using gill nets, grayling ranging from 190 to 376 mm, and round whitefish from 219 to 384 mm were captured.

On August 14, 1975 this river was initially studied by Hallberg. He found grayling, sculpin, round whitefish, longnose suckers, and spawning chum salmon present. Grayling fry were observed and the stream was considered a good grayling spawning area. Twenty-eight fish ranging from 200 to 365 mm were captured by hook and line.

Table 4. Weir operations, tributaries to the Upper Middle Fork Koyukuk River, 1975 and 1976.

		Number Fish Captured in Weir						Out-migrant Weir Operations		
		GR*	RWF	DV	SSC	LNS	Totals	Start	Peak	Stop
Rosie Creek	1975	159	18	1	0	0	178	Aug 26	Sept 3	Sept 13
	1976	181	26	4	77	0	288	Aug 17	Aug 28	Sept 6
Mary Angel Creek	1975	18	4	0	306	50	378	Aug 22	Sept 12	Sept 18
	1976	7	2	0	14	22	45	Aug 22	Sept 5	Sept 8
Organo Creek	1975	116	0	7	0	0	123	Aug 21	Aug 27	Sept 16
Totals		481	50	12	397	72	1,012			

* GR - Arctic grayling
RWF - Round whitefish
DV - Dolly varden
SSC - Slimy sculpin
LNS - Longnose sucker

On April 29, 1976 the river was still frozen and had a small amount of surface flow. At this time we observed burning of oil on the river near Prospect Camp. The water temperature was 0°C. By May 18, 1976 the river was still partially ice covered. On July 21, 1976 we floated Jim River and caught approximately 30 grayling in 3 hours (6 man-hours).

It appears to be a good stream with a fairly large population of grayling. Spawning probably does take place in the river and fish overwinter in some of the deep holes.

Grayling Lake:

The first record we have of this 80 acre lake is a survey by Netsch on June 8, 1971. He found the lake to be brown in color with visibility of 0.9 m. Chemistry included: DO 11 ppm, CO_2 5 ppm, pH 6.4, total hardness 17 ppm, alkalinity 17 ppm, free acidity 0. Using gill nets, seines, and angling, Netsch captured numerous grayling from 37 to 347 mm. He lists both Grayling Lake and its outlet as productive, with a large population of young and adult fish.

Our observations began on April 28, 1976. At this time the lake was still completely covered with snow and ice. By May 18, the ice had melted out 50'-100' from shore and the inlet and outlet were open. The outlet was 4'-5' wide and the water temperature was 4°C. No fish were observed but the water was humic in color with poor visibility. Fish were seen feeding and possibly spawning where the outlet left the lake. At the inlet the water temperature was 2°C. Grayling were observed in the inlet stream on both sides of the haul road. Water velocity through the culvert was 3 fps. Downstream from the haul road grayling were observed actively spawning.

On July 13, 1976 the lake was surveyed, and water chemistry and depth sounding was conducted. Fish were sampled with gill nets. In 20 hours of effort, 54 grayling ranging from 103 to 343 mm were captured. The mean length was 206 mm. Two round whitefish, 271 and 279 mm, were also captured. Water temperatures had risen to 19°C.

In depth sounding the lake, several fathometer and handline transects were made, and no depths over 5' were encountered. This then rules out the possibility that Grayling Lake provides overwintering habitat, as the lake would freeze to the bottom most winters. Obviously, in the fall the fish must migrate through the outlet and into the Jim River.

Grayling Lake provides spawning habitat in its inlet and probably its outlet stream and serves as an excellent rearing and feeding habitat for all age classes of grayling and round whitefish.

The haul road crosses the inlet to Grayling Lake at approximately 2HR 1926-1967. Grayling were observed spawning above and below the road crossing.

Jackson Slough:

Jackson Slough 3HR 451+70 and 3HR 477+27 is a 1.5 mile long, mud-silt bottomed, high water slough of the Middle Fork Koyukuk. At the time of the survey in mid August, there was no water entering the slough from the Koyukuk, thus it was spring and runoff fed. Many small springs were observed. Construction activities, which have resulted in the channelization of much of the stream, appear to have reduced the spawning and rearing capabilities of the stream. Hallberg observed that man-made channels and blocked-off old original channels caused stagnant, sterile, and, for the most part, unproductive areas. Nonetheless, numerous fry and subadult grayling, as well as a few adults, were observed again this year using this slough as a rearing area. The slough is crossed by four spur dikes and flows near several others. All culverts allowed for fish passage.

Rosie Creek:

This five-mile stream was first surveyed by Netsch on June 17, 1971. He found it to be a clear stream (1.0+ m visibility) with an intensely shaded bank. The water chemistry included: temperature 5°C, DO 11 ppm, CO_2 5 ppm, pH 7, total hardness 34.2 ppm, alkalinity 34.2 ppm, and free acidity 0. He observed the presence of grayling and sculpin. On July 31, 1975 Hallberg observed the stream during construction; and using a weir, established the presence of Dolly Varden, and round whitefish as well. Approximately 180 fish were either fin clipped or tagged to help determine their movements in the Koyukuk River system.

Due to construction a fairly large part of Rosie Creek had to be diverted and channelized. The section between SD 10A and SD 10 received considerable siltation from the pad which it paralleled and from the two spur dikes which it crosses. By late summer 1976, the banks and culverts were being riprapped and it appears that most of the siltaton had stopped. This slow moving section of the stream appears to be the favored spot of an average of 30-50 subadults and a few adult grayling. A smilar number of grayling were observed in this section throughout the summer. Spawning habitat in this area may have been temporarily lost, however, because of the siltation.

Upstream from this section there is a length of faster moving water that extends for about a half mile. There are only a few pools, consequently the number of fish observed here was small. Several spawning adult grayling were seen here on May 12, 1976.

Above this section begins an area with a more moderate grade and hence more pools. Many adult grayling were observed and their size appeared to increase as we went upstream. The stream crosses the haul road at 3HR 599+00 and many adults were observed upstream.

A side, high-water channel splits off from Rosie Creek about 1/4 mile above the pad and flows down to the Koyukuk from there. The culvert that was originally located where the creek crosses the pad had been removed, presumably to prevent flooding in the spring. Apparently the

culvert wasn't large enough to handle the excess flow. On May 12, 1976, when fish were moving up the main channel, none were seen in the side channel which had a velocity of 2-3 fps. Water temperature was 0°C. Later in August many fish were observed in the side channel above the pad. None were seen below the pad. The stream below the pad was constantly silty because of truck movement through the stream channel. It appears that few, if any, fish migrate up the side channel. They probably come up the main channel and from there move into the side channel. Outmigration in this high water channel is difficult to determine due to the murkiness of the water. However two fish were observed feeding directly above the pad in this section.

Summer water temperatures in Rosie Creek were observed to reach 7°C. In general, the rechannelization of the lower segment of Rosie Creek adjacent to the pipe pad and spur dikes created a slow moving stream section with increased velocity pools below dike culverts. No barriers were noted and fish occupy the channelized section. Future problems may occur due to continued siltation from the east stream bank that has been cut into the adjoining hill. The spawning potential in this lower section may be lost if detrimental siltation continues.

Hallberg had a weir in Rosie Creek from August 26, to September 8, then on an intermittent basis until September 14, 1975.

On August 17, 1976 a trap was installed in the main channel 1/4 mile upstream from the channelized section. Its purpose was to capture previously tagged grayling, to determine movement, and to give some idea of the relative species abundance of this stream; results are reported in the migration section of this report.

Spring Creek:

Spring Creek is a fairly large, clear stream which crosses the pipeline pad three times near SD 15 and 16 on AS 97 and then flows into the Middle Fork Koyukuk River. It averages about 10' wide and flows for approximately 2 1/4 miles. It has its source from ground water seepage in a wide marshy-muskeg environment adjacent to the Koyukuk River.

It was first observed on July 29, 1975 by Hallberg. He found many grayling fry present in the lower mile of the stream. In the next upstream section, several beaver dams were located and many adult grayling were present. Using hook and line, 26 adult grayling were sampled.

On May 12, 1976 numerous adult grayling were observed in all areas of the stream. A seine haul made in the pool 200' south of SD 15 yielded 9 ripe males, 7 ripe females, 10 immature grayling and 1 slimy sculpin. At the pad crossing below Coldfoot Hill another seine haul was made. Three ripe males, three ripe females, and one immature fish were captured. These findings, plus the fact that numerous other adult size grayling were observed in other parts of the stream, indicate that Spring Creek is an important grayling spawning stream. The water temperature at this time was 2°C.

At this time, one tagged fish was sighted in Spring Creek and several others were reported by pipeline employees. Since no fish were tagged in Spring Creek this could be an indication that it is a spawning area for some fish which then move to another stream for the rest of the summer. No tagged fish were observed in Spring Creek later in the summer. On June 1, 14 grayling (2 with tags) and 1 round whitefish, were found dead by Spring Creek, most of them cleaned. Three fish had net marks. The two tagged fish, a grayling and a round whitefish, were tagged in Mary Angel Creek in September 1975. However, it is probable that the fish were captured in Mary Angel Creek and moved to Spring Creek to be cleaned. A trap was subsequently found in Mary Angel Creek. There have been no round whitefish reported in Spring Creek, whereas they are known to be present in Mary Angel Creek.

By the beginning of June, the number of adult grayling sighted in Spring Creek had greatly decreased; by June 8, the only place where adults were observed in any numbers was above the third beaver dam just north of SD 16. Numerous adults were observed here throughout the rest of the summer.

In many other sections of the stream fry and subadult grayling were seen in fairly large numbers. In a large pool in a small tributary of Spring Creek, to the west of the pad south of VSM 15, many subadult grayling were observed from May 19 onward. It appeared to be an important rearing area.

Construction effect upon Spring Creek was mainly siltation due to nearby vertical support members and pad constuction. Culvert placement, through both pad and spur dikes, seemed adequate with attendant habitat loss due to culvert length. Fish pooled below culverts in this area seemed to favor the pools as a feeding and rearing area. This was typical of most culvert placements in Spring Creek. No culvert was observed to be a fish barrier. Siltation, due to overrun of vertical support member slurry and stream bank exposure would be a considerable future problem if it continues. Bank armoring and reseeding is essential. Hopefully, silt will not continue to be a problem in this fish spawning stream after the 1977 spring flush.

Organo Creek:

Organo Creek was first reported on in 1975 by Hallberg. It is a short stream approximately 1/4 mile long, 4' deep and 4' wide. It originates from spring areas between SD 1 and 2 on AS 98 and flows from between the pad and the road and empties into Texas Slough. Grayling and Dolly Varden are present; however, it did not appear to be a good spawning stream.

Sampling in 1975 by hook and line and by weir yielded a total of 149 grayling and 7 Dolly Varden which were either tagged with yellow Floy tags or fin clipped. The fish ranged from 148 to 308 mm and were from 3+ to 8+ years old. The mean length was 228 mm and the most common age was 5 years. The visual absence of fry indicates that Organo Creek is

probably not a major spawning stream, but rather is used for feeding and rearing.

Organo Creek was first observed in 1976 on April 27. At this time the stream channel west of the pad had been torn up by pipe burial and subsequent attempts to rechannelize the stream. There was no flow at this time.

By May 1 there was runoff and several grayling were observed in the pool below the pad culvert. Upstream the creek was still frozen. A seine haul was made and five grayling ranging from 100 to 220 mm were captured. One had been tagged on August 25, 1975 in Organo Creek. By May 19 the water level had dropped 6" and only a few small grayling were present.

By June 1, 1976 the water had dropped even further and the fish had begun to distribute into all sections of the stream. By June 8, water flow had ceased, only the pools had any water.

It appeared that all the fish in the pool below the pad had been removed by someone, but six grayling were observed to be trapped in a small pool above the pad. Two of these fish were tagged, August, 1975. By June 16, 1976 Organo Creek was completely dry.

On July 13 Organo Creek was again running water, and adult grayling were present. On the downstream side of the pad, Organo Creek was over-flowing its banks in places.

The exact cause for this gradual decline in the amount of water present in Organo Creek with a subsequent rapid increase is not known. However, it is probable that the initial stream flow represented runoff from snow and ice melt. As this source gradually declined, the amount of water in the creek decreased then terminated. As the ground began to thaw, the springs (source unknown) started to flow and the stream had water flow for the rest of the summer.

By August 10 Organo Creek was up 4" due to heavy rain. Twenty adult grayling were observed in a 200' section above the pipe pad.

Two fish that had been tagged in August 1975 were recaptured. One, a 314 mm female had retained eggs. As no grayling have been observed spawning in Organo Creek, this fish probably entered the creek after spawning elsewhere.

On August 20, 1976 Organo Creek was still very high. In the pool below the pad 3 tagged grayling and 10 other adult grayling were present. From the pad to Texas Slough a number of fish were present and fish were in the slough itself. Above the pad only four fish were seen. It appears that the fish were beginning to move downstream.

By September 2 there were only three fish in a big pool and about 50 adult grayling in Texas Slough directly below Organo Creek. Five tagged fish were present. One had been tagged the previous season in Organo Creek. It appeared that most of the fish had left Organo Creek at this time.

From the observations made it seems evident that Organo Creek is not a grayling spawning stream. The lack of good spawning habitat, the lack of adults at spawning time, and the fact that the stream did not flow for a short period directly after spawning time are all indications that spawning would not occur here yearly. Rather, it seems that the cool spring water, abundant shade, and rich food source make Organo Creek an excellent rearing and feeding area for grayling from the end of June to the end of August.

The effects of pipe burial and subsequent attempts at reehannelization are quite evident on a visual basis. The old, deeply cut stream channel is presently lost and a wide, shallow pool now takes its place. The direct effects on fish populations are harder to assess. Not allowing for yearly cyclic variations in fish pressure and abundance, it appeared that fewer grayling were present in 1976. Whether this was due to construction or natural causes is not known and only long term observations will tell. It is believed, however, that the fish present were able to successfully grow and feed despite the habitat alteration. No connection between the cessation of water flow and pipeline construction could be readily determined.

Mary Angel Creek:

Mary Angel is a spring and runoff fed creek approximately 2 miles long. It crosses both the haul road and the pipeline pad 4 miles north of Coldfoot Camp at 3HR 1055+54 and empties into the Middle Fork Koyukuk River. It is about 3' wide, about 4' deep and the water is clear. Grayling, longnose suckers, round whitefish, slimy sculpin, and burbot, Lota lota (Linnaeus), are known to be present. In 1975 Hallberg placed a weir in Mary Angel Creek but high water allowed flow to go around the weir and very few fish were tagged. Of the fish that were caught, a high percentage were suckers and sculpin.

Observations were made in the spring of 1976 to determine if the stream was used for spawning. On April 28 ice cover was still present. By May 12 the ice was gone and many grayling were present. Approximately 20 grayling representing all size classes were observed by the haul road culvert. On May 13, 5-10 grayling (one with tag) were observed in the pool by the pipeline pad. Several grayling 200 to 300 mm were captured and were in spawning condition. Thus it would appear that Mary Angel Creek is a grayling spawning stream although no active spawning behavior was seen.

From the beginning of June through August, fish representing all size classes were observed all through the creek. On July 22 a homemade fish trap was found about 100 yards east of the haul road in the stream channel. It contained 20 suckers, 4 dead grayling and 2 round whitefish. The whitefish had both been tagged in Mary Angel Creek in September 1975. A weir was operated in Mary Angel Creek in 1976 at the confluence with the Middle Fork Koyukuk River. Data are presented in the Age and Growth section.

Construction effects on Mary Angel Creek are minimal, and providing flow through the culverts under the haul road and pad remain unrestricted, no fish problems should result.

Marion Creek:

Marion Creek was first surveyed September 21, 1969 by Thurston, Arton and Burkholder(Johnson and Rockwell, 1976). They found it to be a clear rapid runoff stream 35' wide and 1' deep. In 1971 Netsch surveyed Marion Creek. The results of his water chemistry were: DO 14 ppm, CO_2 5 ppm, pH 6.5, total hardness 35 ppm, alkalinity 17 ppm, free acidity 0. Grayling, Dolly Varden, and sculpin were observed.

Marion Creek flows out of the mountains 10 miles to the east and into the Middle Fork Koyukuk. It crosses both the haul road and the pad. The pipe is buried under the stream and four large culverts are in place under the haul road.

Unfortunately, the main culverts present an extended velocity barrier to fish, especially in times of high water. In an attempt to alleviate this problem a bypass culvert was installed to the south in late April 1976. The bypass culvert did help control spring flooding problems, but the high velocities in the main culverts were still present. On June 2 the velocity in the northernmost culvert was 7.2 fps. The velocity in the bypass was 3.5 fps. Velocities also peaked in early July, nearly filling the two main culverts.

On June 8, grayling were observed on both sides of the bypass culvert. Flow at this time in the bypass culvert was 2 fps. Thus, it has been verified that fish are able to ascend past the haul road. What is not known is whether they can ascend in the critical spring spawning time when the water velocity is greatest. If not, over two miles of spawning habitat upstream is lost to them.

On July 22 a trip was made from the haul road to the falls, (approximately 2 miles upstream). At the falls approximately 150 grayling were observed pooled up. They would be susceptible to fishing pressure. One Dolly Varden 152 mm long was also captured.

The pipe is buried at its crossing of Marion Creek and due to heavy riprap bank armoring showed no present fish problems. The haul road crossing through the large culvert will continue to be a velocity barrier during periods of high water. By summer's end, the channel below the bypass culvert had silted in and was unusable as a fish channel at low water levels. A bridge is the best solution for returning the stream to its preconstruction flows.

Two Duck Lake:

This 8-acre lake is located at 4HR 2699+00 just south of Galbraith pipeline camp. It lies between the haul road and pipe pad. A single outlet flows at the northwestern corner and drains into the Dietrich River. The water was humic stained. Emergent vegetation rimmed the

lake and was quite dense near the southern shore. A small inlet enters the southern shore but flows had almost ceased by August. Water temperature and chemistry on July 20, 1976 were as follows: temperature 65°F, total acidity 17 ppm, alkalinity 153 ppm, total hardness 187 ppm, CO_2 10 ppm, DO 10 ppm. Maximum depth was 15' in the southeast corner with the majority of the lake less than 6' deep. Angling for 1.5 man-hours resulted in 12 grayling with an average length of 228 mm ranging from 143 to 277 mm. Age and growth data are reported in the Age and Growth section. The lake could support a small roadside fishery.

Loon Lake:

This 10-acre lake is located at 4HR 3040+08 just north of Galbraith pipeline camp. It lies between the haul road and pipeline pad. The major inlet crosses the haul road and two outlets join to form a single stream prior to crossing the pipe pad enroute to the Dietrich River. The water was humic stained and emergent vegetation densely covers the western shore. The outlets provide good spawning habitat. Hills border the southeastern and eastern shore and muskeg adjoins the remainder of the lake. Water chemistries taken on July 20, 1976 are as follows: total acidity 17 ppm, alkalinity 136 ppm, total hardness 153 ppm, CO_2 10 ppm, pH 8.5, and DO 10 ppm. Maximum depth was recorded at 25' with the lake bottom essentially bowl shaped. A net set for 4 hours captured five grayling averaging 244 mm and three suckers. By using hook and line six grayling were caught. Age and growth data are reported in the Age and Growth section. This lake could support a small fishery and may retain oxygen through the winter, allowing for fish overwintering.

Age and Growth

Introduction:

The age and growth data discussed here were collected from selected lakes and streams in the study area. The fish include Arctic grayling, round whitefish and Dolly Varden, which together make up the greatest bulk of resident species in the job area. Grayling are the key sport-recreational fish. Most were captured by either weirs or hook and line. Weights were taken from fish captured in out-migrant weirs. Back-calculated age versus length data were determined to be linear with scale growth, and 35 mm was taken as the fish length at scale formation for all species. The following results are presented by species, with discussions included in the narrative.

Arctic Grayling:

Back calculated lengths of grayling captured in Rosie and Mary Angel creeks are presented in Table 5. Growth rates are very similar for both streams and are therefore combined. After an initial 77 mm growth the first year, rates dropped and ranged from 28 to 38 mm up to Age VII, after which the rate declined. Comparative growth data for grayling in the North Fork Koyukuk River, 14 miles west of Coldfoot, are shown in Table 6. Growth rates were higher in the North Fork up to Age VII, when they somewhat equalized. Grayling at Age VI in the North Fork were on

Table 5. Back calculated length at each year of life of Arctic grayling, Rosie and Mary Angel creeks, 1976.

Age at Capture+	N		Mean Fork Length at Annulus Formation (mm)										
			L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11
I	2		71										
II	4		67	90									
III	7		75	104	130								
IV	20		80	110	144	177							
V	35		78	110	140	171	196						
VI	44		78	107	136	168	197	224					
VII	18		76	105	135	166	196	228	256				
VIII	6		71	98	122	150	178	203	231	259			
IX	...												
X	...												
XI	...												
	136												
Weighted Mean Lengths		(mm)	77	107	137	165	195	223	250	259			
		(in)	3.0	4.2	5.4	6.5	7.7	8.8	9.8	10.2			
Average Annual Growth Increments		(mm)	77	30	38	28	30	28	27	9			
		(in)	3.0	1.2	1.5	1.1	1.2	1.1	1.1	0.4			

Table 6. Back calculated length at each year of life of Arctic grayling, North Fork Koyukuk River, 1976.

Age at Capture+	N	Mean Fork Length at Annulus Formation (mm)										
		L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11
I	...											
II	...											
III	...											
IV	...											
V	1	80	112	148	191	232						
VI	6	83	121	162	202	238	266					
VII	4	83	119	147	184	215	247	276				
VIII	7	80	113	145	184	213	249	282	307			
IX	5	91	120	155	187	211	237	270	297	326		
X	1	74	108	147	179	209	237	261	289	313	340	
XI	...											
	24											
Weighted Mean Lengths	(mm)	83	117	152	189	220	250	276	302	324	340	
	(in)	3.3	4.6	5.9	7.4	8.7	9.8	10.9	11.9	12.8	13.4	
Average Annual Growth Increments	(mm)	83	34	35	37	31	30	26	26	22	16	
	(in)	3.3	1.3	1.4	1.5	1.2	1.2	1.0	1.0	0.9	0.6	

the average 27 mm longer than in Rosie and Mary Angel creeks. Apparently the habitats vary enough to cause slower growth in the Middle Fork.

Growth in lakes adjacent to the haul road is presented for Grayling Lake in Table 7 and the more northerly Loon and Two Duck lakes, Table 8. Growth in Grayling Lake exceeds that of Loon and Two Duck lakes up to Age V. Grayling Lake is part of the Jim River-South Fork Koyukuk system, while Loon and Two Duck lakes drain into the Dietrich River. Growth rates for grayling in Grayling Lake and the North Fork Koyukuk are nearly identical up to Age VII.

Comparative lengths at annulus formation for grayling in Rosie and Mary Angel creeks, North Fork Koyukuk, and Delta Clearwater rivers (Pearse, 1974) are presented in Fig. 5. The Delta Clearwater River, which drains into the Tanana River approximately 135 km southeast of Fairbanks, has significantly larger fish at all ages and is considered good rearing habitat for central Interior Alaska.

Length frequencies of grayling from Rosie Creek captured in outmigrant weirs over a two year period are shown in Fig. 6.

By comparing the most abundant size groups with the age class length ranges at the top of the figure, it can be seen that the peaks were related to the overlap of Age Classes III, IV, V, VI, and VII in 1975. Age Classes I and II were nearly absent as were fish of Age VIII. Ages III through VI made up the bulk of the frequency curve. In the 1976 sample there was a shift to one year older, larger grayling, with a relative absence of 145-195 mm fish. Fish less than 145 mm were more numerous, however. The average length in 1975, 221 mm, declined slightly to 219 mm in 1976.

Figure 7 depicts the length-weight relationships of 127 grayling from Rosie Creek captured in 1976. Up to 280 mm, weights generally exceed those of more southerly Interior Alaska waters. After 280 mm, fish from Rosie Creek fall behind.

Table 9 presents calculated, average condition values for grayling in Rosie Creek. The higher the condition (K) value the greater the calculated weight at a given length. Fatness declined with length. Weights of fish from Rosie Creek at a given length were generally greater in fish up to 280 mm than for similar grayling near Fairbanks.

The direct effects of exploitation are difficult to project at this time due to a fishery closure, but it appears that construction has had little effect on fish size and presence in the streams studied.

Round Whitefish:

Back-calculated lengths of round whitefish from Rosie and Mary Angel creeks are shown in Table 10. Yearly growth increments generally declined after Age VI. Figure 5 compares data on round whitefish length for the Delta Clearwater River near Delta Junction with those above. As with grayling, round whitefish grow more slowly in the upper Middle Fork

Table 7. Back calculated length at each year of life of Arctic grayling, Grayling Lake, 1976.

Age at Capture+	N	Mean Fork Length at Annuulus Formation (mm) L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11
I	...											
II	15	83	111									
III	...											
IV	13	83	122	156	191							
V	13	84	115	149	186	221						
VI	4	81	116	153	186	214	247					
VII	3	86	122	158	191	226	271	307				
VIII	...											
IX	...											
X	...											
XI	...											
	48											
Weighted Mean Lengths	(mm)	83	116	153	188	220	257	307				
	(in)	3.3	4.6	6.0	7.4	8.7	10.1	12.1				
Average Annual Growth Increments	(mm)	83	33	37	35	32	37	50				
	(in)	3.3	1.3	1.5	1.4	1.3	1.5	2.0				

Table 8. Back calculated length at each year of life for Arctic grayling, Loon and Two Duck Lakes, 1976.

Age at Capture+	N	Mean Fork Length at Annulus Formation (mm) L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11
I	...											
II	...											
III	2	75	99	126								
IV	4	82	118	160	203							
V	10	77	110	142	162	217						
VI	...											
VII	...											
VIII	...											
IX	...											
X	...											
XI	...											
	16											
Weighted Mean Lengths	(mm)	78	111	145	174	217						
	(in)	3.1	4.4	5.7	6.9	8.5						
Average Annual Growth Increments	(mm)	78	33	34	29	43						
	(in)	3.1	1.3	1.3	1.1	1.7						

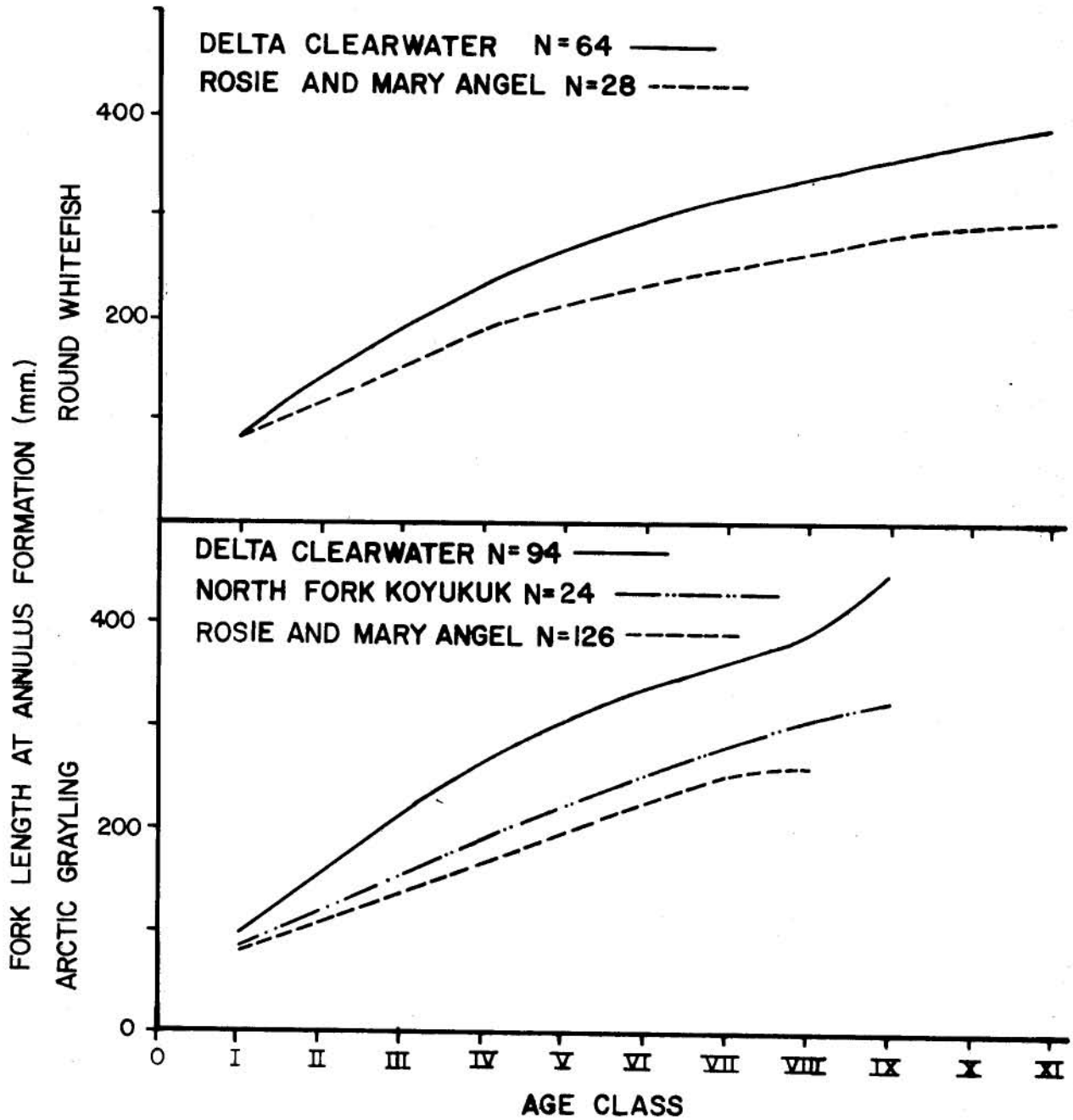

FIGURE 5. COMPARATIVE LENGTHS AT ANNULUS FORMATION FOR ROUND WHITEFISH AND ARCTIC GRAYLING, DELTA CLEARWATER, MIDDLE AND NORTH FORK KOYUKUK RIVERS.

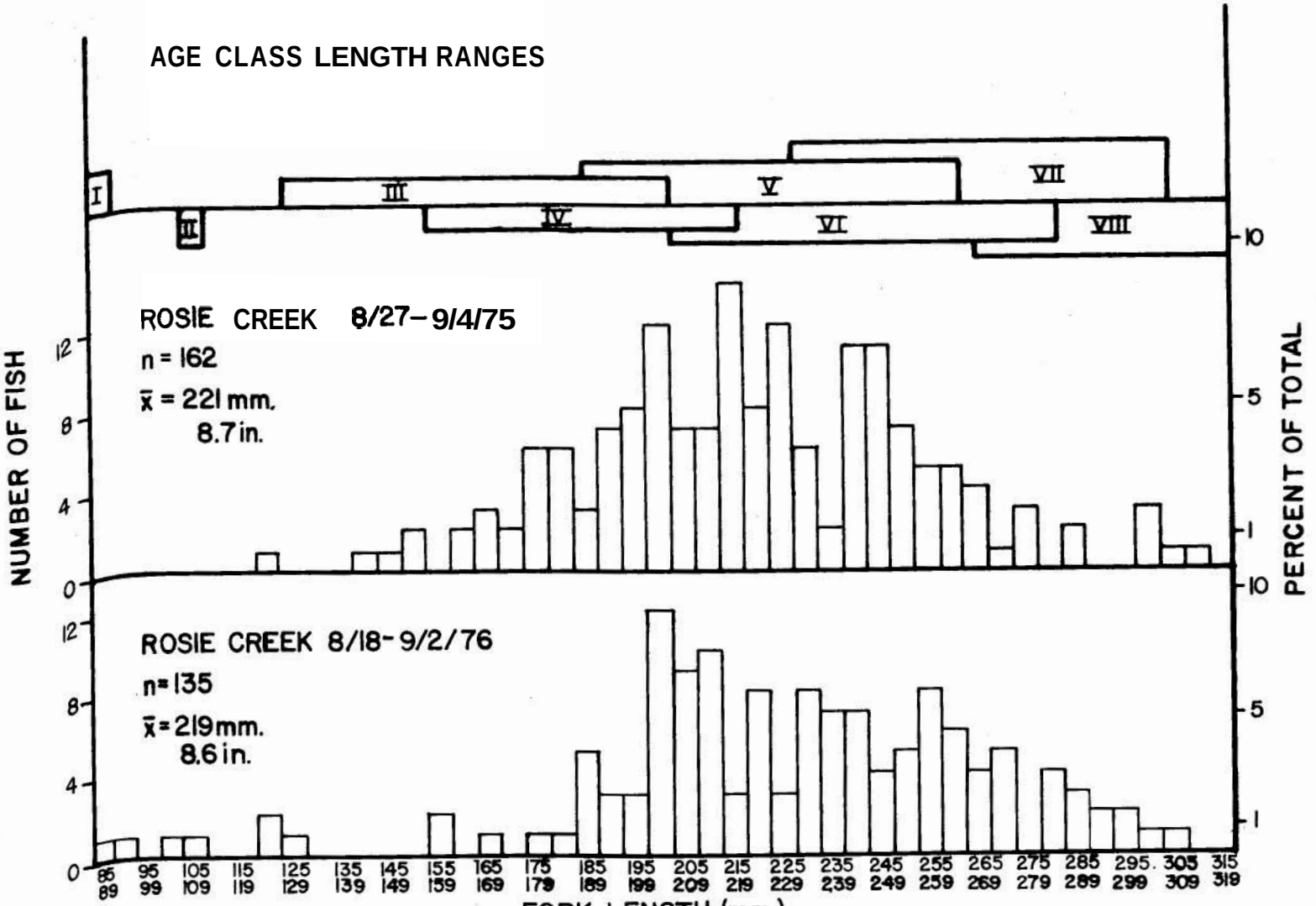

FIGURE 6 LENGTH FREQUENCY-AGE CLASS LENGTH RANGES OF WEIR CAUGHT ARCTIC GRAYLING ROSIE CREEK, 1975-1976.

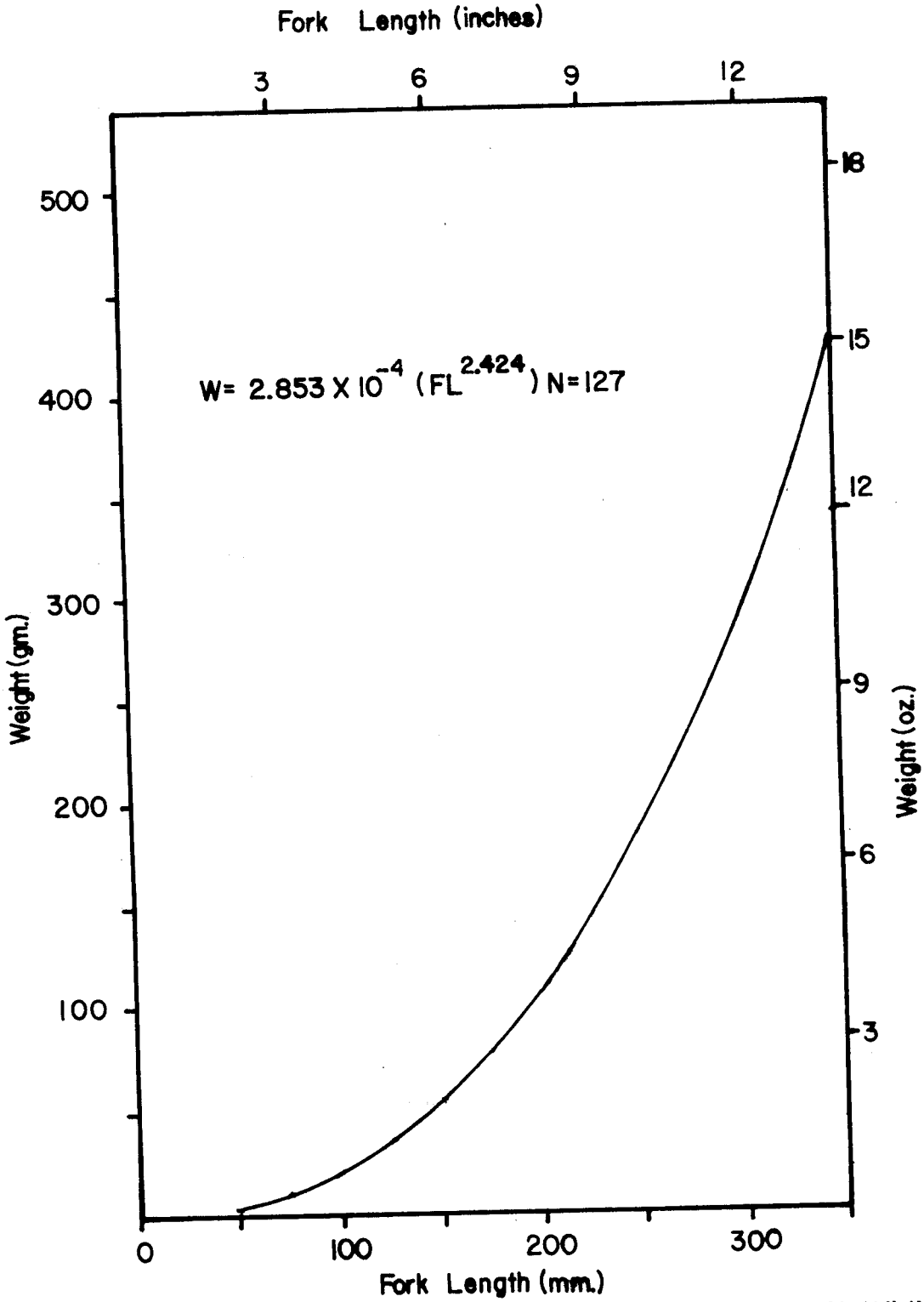

FIGURE 7 LENGTH – WEIGHT RELATIONSHIPS OF ARCTIC GRAYLING (SEXES GROUPED) FROM ROSIE CREEK, 1976.

Table 9. Relative condition factors for Arctic grayling in Rosie Creek, 1976.

Length Group (mm)	Condition Factor (K)*
100-119	1.901
120-139	1.730
140-159	1.630
160-179	1.425
180-199	1.391
200-219	1.307
220-239	1.241
240-259	1.187
260-279	1.135
280-299	1.090
300-319	1.049
320-339	1.018

* $K = \frac{\text{Weight}}{(\text{Fork length})^3} \times 10^5$

Table 10. Back calculated length at each year of life of round whitefish, Rosie and Mary Angel creeks, 1976.

Age at Capture+	N	Mean Fork Length at Annulus Formation (mm)										
		L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11
I	...											
II	1	85	115									
III	1	64	97	145								
IV	4	76	108	144	189							
V	4	83	121	161	202	231						
VI	5	77	110	148	190	216	239					
VII	2	80	124	148	189	219	239	255				
VIII	3	82	116	153	185	219	237	253	269			
IX	5	84	126	163	189	214	234	252	261	283		
X	2	79	118	145	177	206	233	252	270	286	296	
XI	1	75	105	127	163	187	215	237	255	277	288	301
	28											
Weighted Mean Lengths	(mm) 80	116	149	189	217	235	252	264	283	293	301	
	(in)	3.1	4.6	5.9	7.4	8.5	9.3	9.9	10.4	11.1	11.5	11.9
Average Annual Growth Increments	(mm)	80	36	33	40	28	18	17	12	19	10	8
	(in)	3.1	1.4	1.3	1.6	1.1	0.7	0.7	0.5	0.7	0.4	0.3

Koyukuk River than in more southern locations. Figure 8 describes the length-weight relationships for a small sample (25) of round whitefish. At all lengths, round whitefish were lighter than those captured in the Delta Clearwater River. The length-weight relationships and condition coefficient, (Table 11) of round whitefish in Rosie and Mary Angel creeks from the same streams almost duplicate that for grayling.

Dolly Varden:

Several samples of char from Rosie Creek were examined to determine whether they are of the S. alpinus (Arctic char) or S. malma (Dolly Varden) complex. The meristics and morphometrics were examined. As the results indicated that the samples fall between those for clearly separated populations of the above species, it was decided to follow Netsch (1975) and call them Dolly Varden. Their numbers are low compared with other fish species and they seem to be in an unexploited condition. Their length-weight relationship (Fig. 9) and calculated condition coefficients (Table 12) are presented. They are generally heavier at a given length than all species studied.

Table 11. Relative condition factors for round whitefish in Rosie and Mary Angel Creeks, 1976.

Length Group (mm)	Condition Factor (K) *
100-119	1.900
120-139	1.725
140-159	1.588
160-179	1.480
180-199	1.386
200-219	1.310
220-239	1.242
240-259	1.185
260-279	1.133
280-299	1.088
300-319	1.047
320-339	1.010
340-359	0.977

* $K = \frac{\text{Weight}}{(\text{Fork length})^3} \times 10^5$

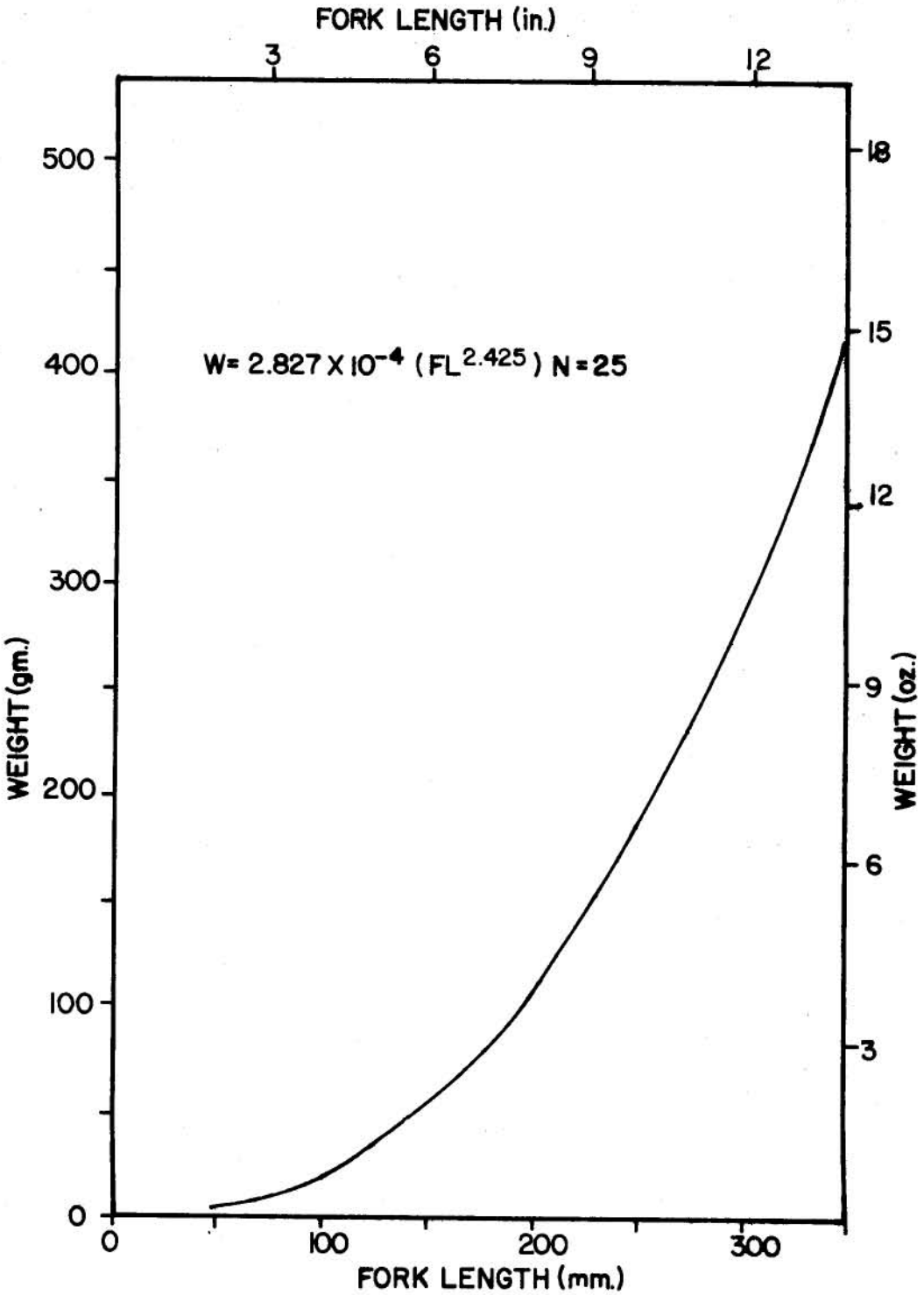

FIGURE 8 LENGTH – WEIGHT RELATIONSHIP ROUND WHITEFISH (SEXES GROUPED) FROM ROSIE AND MARY ANGEL CREEK, 1976.

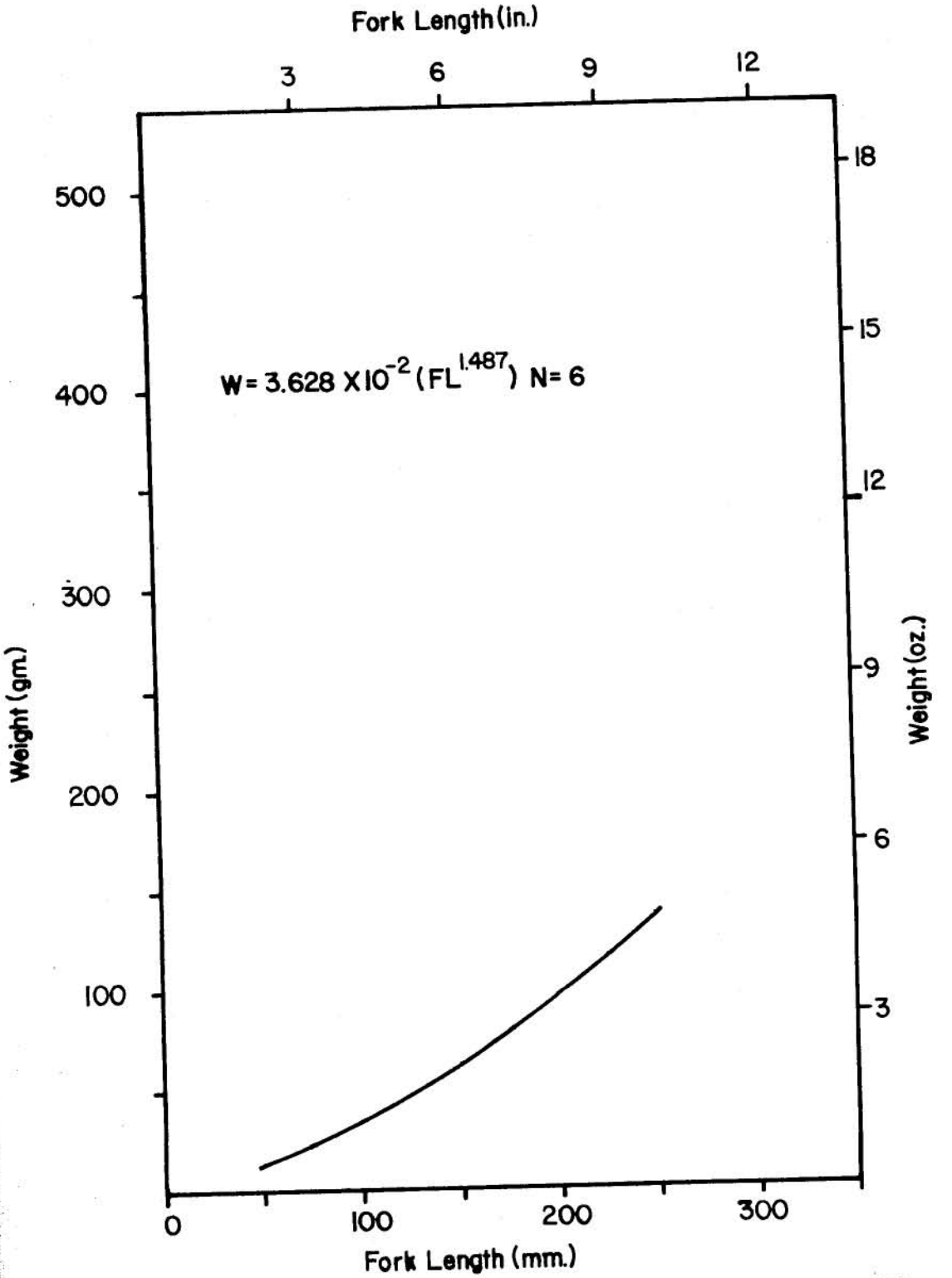

FIGURE 9 LENGTH-WEIGHT RELATIONSHIPS OF DOLLY VARDEN FROM ROSIE CREEK, 1976.

Table 12. Relative condition factors for Dolly varden in Rosie Creek, 1976.

Length Group (mm)	Condition Factor (K)*
100-119	2.968
120-139	2.308
140-159	1.858
160-179	1.539
180-199	1.300
200-219	1.118
220-239	0.974

* $K = \frac{\text{Weight}}{(\text{Fork length})^3} \times 10^5$

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