AQUABIONICS INC

P.O. Box 80165
Fairbanks, Alaska 99708
(907) 479-2476

FALL AND WINTER FISH STUDIES ON THE UPPER TANANA RIVER DRAINAGE

by

Jack M. Van Hyning, Ph.D.
Fisheries Consultant

Report to the
NORTHWEST ALASKAN PIPELINE COMPANY
Anchorage, Alaska

June 1978

TABLE OF CONTENTS

(continued)

TABLE OF CONTENTS (cont.)

INTRODUCTION

The Northwest Alaskan Pipeline Company plans to construct a natural gas pipeline from the Prudhoe Bay fields to the lower 48 states which will traverse north-central and eastern Alaska and western Canada. At Delta Junction the gas pipeline will deviate from the Trans-Alaska oil pipeline corridor and will follow the Tanana River, a major tributary of the Yukon River, and the Chisana River, a major tributary of the Tanana, to near their headwaters before crossing into Canada. The proposed pipeline essentially parallels the Alaska Highway and will utilize to a large extent the Haines-Fairbanks military pipeline right-of-way. The pipeline will be almost entirely buried except at major stream crossings.

Protection of indigenous fish populations during pipeline construction requires knowledge of the seasonal changes in fish distribution and abundance in the streams to be crossed or otherwise impacted. While largely summer construction is proposed, it would be advantageous at times, from both the engineering and environmental standpoint, to be able to extend "windows" for stream crossings into the fall and winter months. Flexibility in construction scheduling implies a knowledge of the aquatic communities and water quantity and quality during the winter so that fish requirements and human water use can both be accommodated with minimal disturbance. Work camp water requirements, sewage disposal, hydrotesting of the pipeline, and possible ice road construction are also important considerations that require information on the fish stocks that would be impacted by such activities during the cold season.

Pipeline construction on the arctic North Slope by the Trans-Alaska Pipeline System (TAPS) brought widespread attention and concern to the competition between fish and man for a very limited winter water resource (Bendock, 1976). Several studies (summarized by Wilson, et al., 1977) on North Slope streams have shown that springs and deep pools in the river channels support overwintering concentrations of char and grayling. In some cases, a major portion of a river's fish population may be concentrated in a few critical areas. Heavy fresh water demands by the oil industry, with little or no replenishment in winter, resulted in the complete dewatering or reduction to a low level of some pools with subsequent high or total fish mortality. Subsequently the Alaska Department of Fish and Game (ADF&G) set forth stipulations and issued permits governing the removal of water from streams in winter, with water-use permit cancellation in the event that continued withdrawal was judged to be detrimental to overwintering fish. Environmental stipulations for TAPS dealt largely with the protection of fish spawning beds and uninterrupted movement; discussions with resource agency personnel indicate that the protection of overwintering areas will receive equal priority in future pipeline projects. Even under the best of natural conditions, winter is a time of stress for all northern animals with extreme cold, shortage of food, limited available range, and increased susceptibility to predation and disease; with aquatic organisms must be added the low levels of dissolved oxygen, concentration of waste products of metabolism and decomposition and the conversion of much of their environment from a liquid to a solid state. Any additional stress imposed by man under these conditions could be lethal.

To avoid potential problems with overwintering fish concentrations encountered during construction, and to respond to agency requests for information on winter distribution of fish along the proposed gas pipeline alignment east of Delta Junction, the Northwest Alaskan Pipeline Company funded a winter fish study on the Upper Tanana River. The objectives of the program were to locate and study fish overwintering areas, to determine winter water quality and quantity and ice conditions, to continue salmon spawning ground surveys, and to record the wildlife observed.

Summer fishery surveys of the upper Tanana River, its tributaries and adjacent lakes have been conducted by Pearse (1975 and 1976); Van Hyning (1976) and Valdez (1976); previous salmon spawning ground surveys were reviewed by Van Hyning (1976) and Geiger and Andersen (1976). Tack (1972 and 1973) studied grayling spawning behavior in the upper Tok River. Except for some observations on winter fish abundance at Big Delta and in the Delta-Clearwater River (Pearse, 1974) and a few lake water quality observations (Pearse, 1975 and 1976), there have been no winter studies on fish in the upper Tanana drainage.

ACKNOWLEDGEMENTS

I am particularly grateful for the assistance of Mr. Steve Tack, former ADF&G Sport Fish Division biologist, whose knowledge of the local waters and fish, and experience in winter sampling was invaluable. The courtesies extended by Mr. and Mrs. Dale Young of Tok and the cooperation and flying ability of Mr. Ron Warbelow of 40-Mile Air Service were greatly appreciated. Mr. Steve Jewett of the University of Alaska attempted a winter SCUBA dive in the Tanana River. Ms. Peggy Parker typed the manuscript.

The Northwest Alaskan Pipeline Company funded the study and Messrs. Walfred Hensala and Mark Luttrell offered much assistance and encouragement.

METHODS AND MATERIALS

Considerable "state-of-the-art" development was required to satisfy the objectives of the program since there have been few winter fish studies in sub-arctic Alaska and such work outdoors in cold climates is demanding on both equipment and personnel. Our field work encompassed the periods September 26 - November 18, 1977 and February 25 - April 26, 1978. No attempt was made to work during December and January due to the extreme cold and limited hours of daylight. Mid-April is still winter as far as the aquatic environment of Interior Alaska is concerned with below freezing average temperatures and low stream flows.

Access was mainly by 4-wheel drive vehicle along and near the Alaska Highway. A rubber raft was used on the Tanana River. For the upstream areas, cross-country skiis, a dog team and a Bell Jet Helicopter were utilized. Aerial observations were also made by fixed-wing aircraft--a Heliocourier.

Underwater television worked well for under-ice observations of fish concentrations in North Slope streams (Bendock, 1976), but discussions with ADF&G staff members suggested that the technology might have limited utility in the less-than-crystal-clear Tanana River and tributaries. A SCUBA dive confirmed this suggestion and the subsequent low density of fish found, large volume of flow present and the lack of fish concentrations probably would have resulted in few if any actual fish observations with underwater TV.

Echo sounding with a standard commercial recording fish finder (Simrad Skipper Model 701) was tried with the hope of obtaining some measure of fish abundance under the ice. Estimation of fish abundance by echo sounding is a standard procedure for summer lake surveys and is extensively used by commercial fishermen in the marine environment for locating concentrations of fish. Mapping of ice-covered lakes using a depth finder is a widely used technique, but as far as is known, fish detection through thick ice on a river system had not been previously attempted. Technical problems in the cold ambient air temperatures and the apparent scattering effect of sound waves passing though layers of ice, water, and air of differing temperature and composition resulted in generally very poor graphs. Often there was only a foot or two of fast flowing water under 4 or 5 feet of ice over a sand bottom and frequently there was not even a clear bottom record. The depth of ice could not be determined from the graphs. The general shallow waters found, the low fish density and lack of aggregation and movement in winter may effectively preclude fish detection by this method. However, further research and development in winter echo sounding would be worthwhile as a means of locating deep pools (and thus overwintering fish) in the flat, featureless expanse of frozen northern rivers.

Attempts to set nets under the ice were negated by ice depths often in excess of 5 feet, the difficulty involved in finding water under the ice of sufficient depth and proper current speed, and the time required to place the nets once water was found (Bendock, 1976, reported between 9 and 30 man hours required to set a single 25-foot net under the ice). Emphasis was thus placed on sampling the open water areas. There were considerable open areas present on the Tanana River, the springs, and the headwaters of several tributaries, due in part, at least, to a relatively mild 1977-78 winter.

Visual observation with polaroid glasses was used in the small, clear streams. With a careful approach and standing motionless for a few minutes, fish present in the ice-free areas would generally reveal themselves. Little could be ascertained regarding fish that might be under the ice along the stream bank or in ice-covered pools, but no other sampling technique available appeared any more satisfactory under these difficult conditions.

A Smith-Root Type VII Electrofisher was used as a basic sampling tool. After intial "start-up" problems were resolved, the unit worked very well. The Electrofisher Instruction Manual states: "Fish can be extracted from areas of heavy cover or from under shore ice by inserting the anode, turning the power on, and withdrawing the anode slowly and smoothly." We experienced little success with this technique however; most of the fish captured appeared to be residing in the open riffle or pool areas. At the periphery of the anode's electrical field fish are frightened rather than attracted and those present under the ice may have merely penetrated deeper under the ice cover or, if momentarily immobilized, may have been swept away by the swift current. In open water the electrical current causes the fish to jump or flash and thus reveal their presence, even though too far from the anode for capture, but this phenomenon could not be observed under the ice. There may not have been many fish under the ice, but Tack (pers. comm.) observed that grayling in the Chena River in early spring seemed to prefer to remain under the near shore ice rather than the open water.

Multi-filament nylon, variable-mesh gill nets measuring 25 x 6 feet, consisting of five 5-foot panels of ½-, 1, 1½, 2, and 3-inch stretched mesh (10 to 77 mm between the knots) were used in the Tanana River. Except for freezing in when temperatures dropped, the gill nets worked well. Fish were caught only in the largest two mesh sizes even though small fish were abundant as judged by seining and electrofishing. A 10-foot long, 4-foot deep, 1/8-inch mesh, knotless nylon seine was effective for the shallow beaches. A downstream migrant salmon fry trap (modified fyke net) was fished once, but filled with floating ice and did not appear to be a satisfactory gear for winter conditions considering the effort involved in setting and the constant attention necessary. Galvanized wire minnow traps measuring 17½ by 9 inches, baited with salmon eggs and chopped fish, were fished through holes in the ice on several occasions, but caught nothing. Angling with spinning gear was attempted on several occasions without success. Burbot hooks, baited with whitefish pieces, on set lines were used in the Tanana River.

A gasoline-powered Ardix Quick Digger Auger was used for drilling holes in the ice. With one extension a hole 5 feet deep could be dug. A 3½-foot hand auger and a 4½-foot ice chisel were also used for gaining access to the water.

Water quality was determined with a Hach Water Ecology Kit Model AL-36B and a LaMotte Multirange Conductivity Meter Model DA. The flow estimates given are visual order-of-magnitude "guesstimates" unless quoted from U.S. Geological Survey sources. A few flow measurements were taken by using the floating-chip method.

GENERAL AREA DESCRIPTION

The upper Tanana River, and its major tributary the Chisana River, meanders for some 200 air miles through a flat valley varying from a mile wide in restricted canyons up to 15 to 20 miles. Large expanses of the valley floor are covered with shallow lakes, marshes, and muskeg bogs, while forests of spruce, birch, poplar and aspen cover the higher ground. Willows and alder line the lower water courses of the tributaries, some of which originate in the alpinetundra-covered hills.

Tributaries descend from the Alaska Range and Wrangell Mountains to the south and the Tanana-Yukon Uplands to the north. Major rivers originating from large glaciers, such as the Johnson and Robertson, dominate the topography. These glacial rivers run heavy with silt during the summer and are almost sterile in terms of aquatic biota, but in the fall, as freezing temperatures reduce glacial melting, flow is greatly reduced and the water becomes clear. Smaller streams originating from glacial melting, springs and runoff, such as the Tok and Little Girstle Rivers, while somewhat murky in summer, often support substantial fish populations. A number of small, spring-fed and snow and rain runoff streams descend from higher elevations. They vary from typical streams having stable, year-round flows to rock and gravel washes containing water only during the spring snow melt; some flow as intermittent or interrupted streams on the valley floor with most of the flow subterranean except during spring breakup and heavy rains. Ground water surfaces in numerous places along the Tanana River in the form of springs that flow open and clear throughout the year. In the upper basin, a number of water courses originate from lakes and bogs and flow sluggishly in meandering channels across the broad valley floor. These streams are brown- or humic-stained from dissolved organic matter leached by the water during passage through muskeg bogs.

It is well known that many of the small streams crossed by the Alaska Highway dry up or freeze completely to the bottom during winter, but some contain flowing water all winter in the upper reaches, even though they may be dry at the highway, and others may contain flowing water throughout their length under thick ice cover. Springs and ground water upwelling areas remain open and flowing year round and the Tanana River flows heavily all winter although mostly ice covered. It is believed that most of the fish migrate from the smaller tributaries in the early fall, but it is not known to what extent they may winter in the upper areas or what role springs play in the winter ecology of the upper Tanana.

The upper Tanana basin in Interior Alaska is one of the coldest regions in North America with temperature reports from Northway commonly being the lowest in the state. The general lack of wind, however, makes life more bearable than the degrees alone would indicate. Average temperatures for Northway (from National Oceanic and Atmospheric Administration, 1978) for December and January are close to -20° F, with frequent descents to -50° F, rising to $+7^{\circ}$ F in March and $+27^{\circ}$ F by April. After the warm summer months, temperature averages descend to +22° F in October and -2° F in November. The following Northway average air temperatures (degrees Fahrenheit) were reported for 1977-78: September 42.9, October 31.7, November -10.3, December -22.7, January -15.6, and February -7.1 (March and April records were not available at the time of writing). November and December temperatures were significantly colder than average while January and February were slightly warmer.

Precipitation amounts to 10 to 14 inches annually with 1977-78 being considerably below average. Snowfall averages 33 to 54 inches annually. Average snow depth is normally less than 24 inches; however depths to 60 inches have been recorded at Big Delta and Northway. Twenty inches were measured on the ground at Northway in January and February 1978; 1977-78 was considered a low snowfall year by residents. Snow can be expected to remain from October through April, but much of it had disappeared by mid-April 1978. Freezeup of the river occurs in early November and breakup in late April with the lakes and ponds freezing over earlier and remaining frozen longer.

The upper Tanana basin is sparsely populated with about 6,000 people residing in the area from Big Delta east to the border. The principal communities are Delta (700 permanent population) and Tok (500), with important Native centers at Dot Lake (70), Tanacross (100), Northway (175), and Tetlin (100). A number of individual homes, small settlements, and businesses have developed along the highway--often in the vicinity of streams--a farming operation on Dry Creek, a notable example. Tourism and sport fishing and hunting is the major activity in the summer along with some farming and mining. There is relatively little outside activity in winter except for trapping, dog mushing, skiing and snowmachine related activities. Almost every valley supports a trap line with chum salmon carcasses from the Tanana River at Big Delta and whitefish being the principal bait. Subsistence fishing for whitefish and burbot is an important use of the fishery resource, although, except for some minor activity near Northway for burbot, we noted no subsistence utilization during the period October through April. Likewise we noted little sport fishing activity except at the Tanana River bridge at Big Delta, although there was some evidence of winter fishing at Jan and Craig Lakes and burbot gear at Crystal Springs and on the Tanana River at the Tok bridge.

NARRATIVE OF STREAM AND FISH OBSERVATIONS

WINTER 1977 - 78

A summary of the data collected is presented here. Miles refer to the Alaska Highway mileposts--distance from Dawson Creek, British Columbia. For ease of reading, the original metric measurements are converted to English equivalents. For water quality measurements and quantity estimates, refer to Appendix Table II, and for fish measurements to Appendix Table III.

Scotty Creek, mile 1223.5, is a deep, sluggish stream that drains a large lake and marsh complex before emptying into the Chisana River south of the highway. Grayling, whitefish, and pike are reported as being abundant during the spring and fall months (Valdez, 1976). At the highway bridge in late February 1978, over 4 feet of ice was measured without reaching water. A resident stated that there is water present during the winter in the deep holes under 5 to 6 feet of ice, but questions if there are any fish there as they have tried fishing through the ice without success. On April 23, we found 3½ feet of ice covering 2½ feet of good quality, clear water.

Desper Creek, mile 1225.5, is completely dry in winter, with ice and snow covering the stream bed. Residents state that many pike, whitefish and grayling appear in the spring and are often unable to pass upstream through the highway culverts when the water level is low--as it was last year (spring 1977) and appears likely this year due to the low snow fall. On April 23 we observed about 10 cfs of brown-colored water passing through the culverts with a 12- to 18-inch drop to the pool below (Figure 1). No fish were observed in 50 yards below the culverts, even though the stream was almost clear of surface ice. Although only two miles apart, Scotty Creek was completely ice covered on April 23, while Desper Creek was ice free; water temperatures were 34 and 33° F., respectively.

Two Unnamed Lakes, opposite mile 1228, were checked by helicopter on April 25. A realignment of the pipeline was being considered which would have passed near these lakes and information on ice and water depth and water quality was desired. Lake B (see map) adjacent to Desper Creek, had 2 feet of ice over 2 feet of water with a thick layer of soft muck on the bottom. The many holes in the ice kept open by muskrats contained large numbers of crustaceans and much vegetation was evident. It was impossible to determine dissolved oxygen because of the yellow color of the water. Lake B is unlikely to support fish because of its shallow depth and amount of organic matter. Lake A had 2 feet of ice over 10 feet of water; dissolved oxygen was 2 mg/l. Although somewhat marginal, fish could survive. Lake C is a diversion of Desper Creek, was partly open around the edges, and was not checked.

Sweetwater Creek and Tributaries, between mile 1234 and 1237, were all frozen over and appeared dry in late February. On April 23, various branches were flowing from ½ to 4 cfs of brown-stained water. There was no evidence of fish from visual observations 25 yards above and below the highway. Sweetwater Creek is a major stream system, but the highway and pipeline cross only headwater tributaries.

Unnamed Creek, mile 1241, had pools of snow melt, but no flow on April 23.

Unnamed Creek, mile 1242, was completely dry on April 23, with no snow.

Gardiner Creek, mile 1246.6, is reported to support spring runs of grayling as well as seasonal occurrence of pike and whitefish. On October 30 it was largely ice covered, but with a flow of 5 cfs. No fish were observed in the open areas. On February 28 the stream was frozen to the bottom, and on April 23 was flowing at about 2 cfs but was still mostly ice covered. The water quality was poor (dissolved oxygen 2 mg/l) and no fish were apparent in the open areas for 50 yards above and below the bridge. A beaver had constructed a small dam below the bridge.

Tenmile Creek, mile 1253, is a small, marshy stream and its fish fauna is unknown. It was dry on October 30. On April 23, about 2 cfs of humic-stained water was flowing--most of it over the surface of the bottom ice. No fish were observed in 50 yards above and below the highway.

Silver Creek, mile 1259, is known to support only a small summer pike population (Valdez, 1976). On April 23 about 1 cfs of water was flowing over ice which was frozen to the bottom. No fish were observed for 50 yards downstream from the highway (Figure 2).

Chisana River, is a large glacial stream which roughly parallels the Alaska Highway, usually at some distance, before heading up into its source in the Wrangell Mountains. The Chisana and the Nabesna Rivers combine near Northway at mile 1268 to form the Tanana River. The river's ichthyofauna is largely unknown, but chum salmon probably pass upstream and down. Grayling, pike, whitefish and burbot, from the system's vast expanse of lakes, streams and ponds (many of which freeze solid in winter) must overwinter somewhere within the system. In late September 1977, the river was turbid and flowing heavily, but a month later was completely frozen over near the highway. On November 17, from the air, it could be observed that the river was mostly frozen in the lower part, but some areas from 10 to 20 miles above Northway were open, and 30 miles above Northway there were large open areas where the river alternately flowed over gravel riffles and under overflow ice. The springs below the mouth of Sheep Creek contained what were tentatively identified as chum salmon carcasses, but may have been beaver cuttings. As late as April 22, the Chisana was still mostly ice covered near Northway, but with turbid water flowing along each bank (Figure 3). On April 25, from the air, the upper areas were mostly open but with large areas of aufeis, especially above Sheep Creek. No fish were seen in the springs and beaver ponds from the helicopter on that date, nor have any whitefish been seen on the fall salmon surveys, even though the large populations present in many of the adjacent lakes are believed to spawn and winter in the main-stem of the Chisana.

Tanana River, Tanacross to Northway. The chronology of freezing and melting during 1977-8 was as follows:
October 15, water still murky and beginning to freeze along the edges with large volumes of slush ice coming downstream; October 30, mostly frozen over, but with some large open leads; November 17, almost completely frozen over with only a few small holes open; February 28, completely frozen and covered with snow; April 22, surface ice melting, flowing visibly only along the edges and mostly over the ice; April 25, most of the river still ice covered except along the edges, but with some large areas opening in the middle. On March 23 we dug four holes under the bridge east of Tok and found 2½ to 5 feet of ice over 0 to 14 feet of water. Baited lines set overnight produced one 24-inch burbot. An overnight gill net set in late April near Northway produced one 16-inch sucker.

Moose Creek, near Northway, is not crossed by the pipeline, but is an important fish stream inasmuch as large runs of humpback whitefish are reported migrating in and out of the extensive Fish Lake system in spring and fall via Moose Creek. In late September 1977, pike were still abundant in Fish Lake and had not yet emigrated. On October 30, Moose Creek had extensive edge ice, but was flowing open in the middle. On March 1, the stream was covered with a thin layer of ice and had a very low level (1.2 mg/l) of dissolved oxygen. On April 22 it was ice free and an overnight gillnet set near the mouth produced two large humpback whitefish (Figure 4).

Beaver Creek, mile 1268, in summer contains a good population of grayling and a few round whitefish (Valdez, 1976). On September

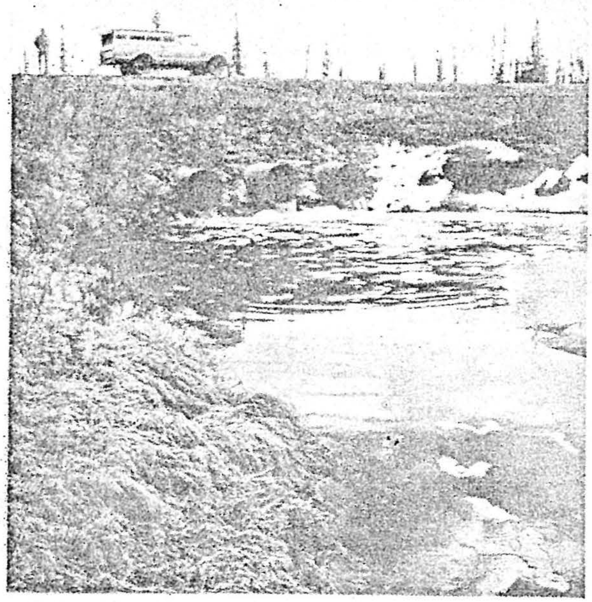


Figure 1. Desper Creek at the Alaska Highway, April 23, 1978.

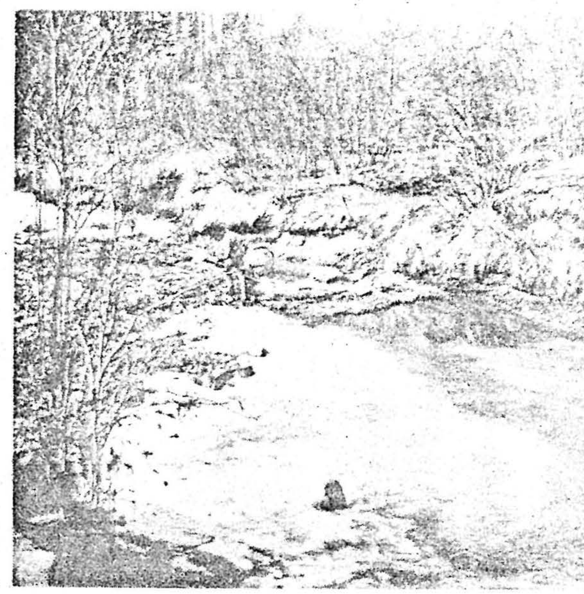


Figure 2. Silver Creek looking downstream from the highway, April 23, 1978.

Figure 3. Chisana River, looking downstream from the Northway bridge, April 22, 1978.

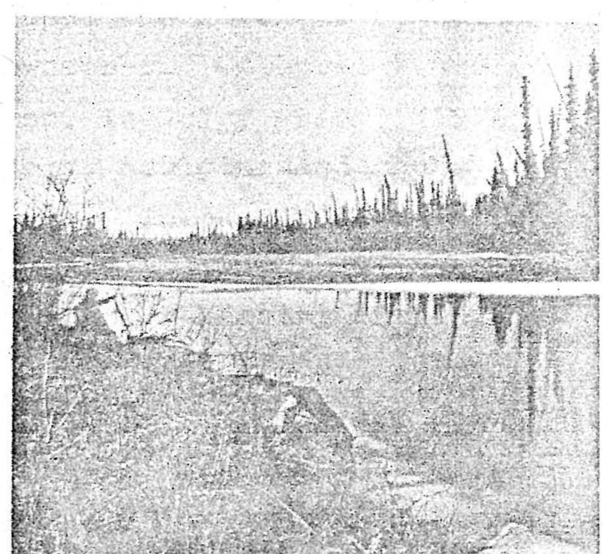


Figure 4. Gill net set on Moose Slough at the mouth of Moose Creek, April 22, 1978.

27 I made a careful visual survey from the highway to the mouth. No fish were observed even though the water was clear and flowing only about 10 cfs. By late October the stream was frozen to the bottom. On April 22, one or two cfs of water was flowing over the surface of the bottom-fast ice. No fish were observed at that time in walking 25 yard downstream from the culvert.

Unnamed Creek, mile 1278, was dry on April 22, 1978 with no ice or snow present.

Bitters Creek, mile 1280.2, contains grayling and sculpin below the highway during the summer (Valdez, 1976). It was dry during the winter; even on April 22 there was no surface flow with the culvert about ½ full of ice.

Tok River, mile 1309 at the Alaska Highway bridge, was open and flowing heavily on September 29, 1977. A month later (October 30) the river was completely ice covered; it is not known if there was water flowing under the ice. On November 18 I bored several holes through the ice down to the gravel and found the river to be completely dry from the bridge, 3/4 mile downstream. On April 9 and April 22 there was less than 1 cfs of flow. In July, Valdez (1976) captured grayling, round whitefish, suckers, sculpins and chubs near the highway. There is some sport fishery in the main-stem Tok River during spring and fall as the glacial flow is reduced and supplemented by springs and clear-water tributaries keeping turbidity at a moderate level. Upstream 20 miles from Tok at the bridge on the Glenn Highway, the Tok River was flowing about 30 cfs of clear water on October 13. It was largely open and in a visual spot check covering three miles only one small unidentified fish was sighted. On October 31 the upper Tok River was mostly ice covered, but with some open channels and still showing a substantial flow. On March 2 the river was completely frozen over. On April 25, from the air, the Tok River was open and flowing in the upper areas, but as the valley opened up into the flats the stream bed became completely snow covered and all the flow evidently went underground. We electrofished

50 yards near the mouth of the Tok Overflow on April 23 and caught only sculpins.

The Little Tok River at the Glenn Highway bridge about 25 miles above Tok Junction on October 13 was flowing open, fast, and clear; no fish were observed. On October 31, the Little Tok River was still open and flowing, but much anchor and shore ice were forming. On March 2 the river was completely ice covered at the bridge, and on March 23 still frozen over. Upstream areas below Mineral Lake were open and flowing, however, and some sections are reported to remain open all winter (Tack, pers. comm.). The Little Tok River and its tributaries support a substantial summer sport fishery for grayling. The outlet of Mineral Lake in particular is an important spawning area and has been extensively studied by the Alaska Department of Fish & Game. The implications of this work in terms of overwintering will be reviewed in the Discussion Section.

The Tok Overflow is a spring area 19 miles south of Tok on the Glenn Highway. These springs flow clear and ice-free year round and support an important fishery for grayling and whitefish. When checked on October 13, 1977 several schools of 6- to 8-inch grayling and round whitefish were visible in the pool below the highway culvert. On October 31, I surveyed from the highway downstream ½ mile and observed small- to medium-sized grayling and round whitefish in nearly every pool and eddy. This stream was not checked again until March 2, 1978 and on that date a visual survey for a distance of 25 yards above and below the highway revealed no fish in the very clear water. Again, on March 23, we surveyed one mile downstream with negative results. On April 13 we electrofished a 100-yard stretch below the highway with no fish captured or observed. On April 25 we electrofished a 50-yard section at the mouth where it enters the Tok River and caught one 8-inch char and one 4-inch grayling. As mentioned earlier, electrofishing in the Tok River at the mouth of Tok Overflow on the same date produced only sculpins. Evidently the grayling and whitefish which were abundant in the Tok Overflow in late October emigrated to a wintering area at some subsequent time and had not returned by the time sampling resumed in

March and April.

Tanana River, Tanacross to Crystal Springs, a river distance of about 5 miles. This section of the Tanana River remained open throughout the 1977-8 winter, although it was frozen over above and below. It was accessible by vehicle and boat and thus afforded an opportunity for study. The U.S. Geological Survey (1976) gives the winter flow in the Tanana at Tanacross generally between 2,500 and 4,000 cfs. During early October, the river was murky but gradually cleared and by November visibility was excellent over the extensive shallow gravel riffles. No fish were seen from several ground checks, and aerial observations on November 17. During April we periodically seined and electrofished along the beaches at the end of the Tanacross air field, across from Crystal Springs and at several points in between. Some deeper water shocking from the rubber boat was also accomplished. Moderately large numbers of small (1½-3 inch) grayling, suckers and sculpins were found at Tanacross with noticeably fewer at Crystal Springs. A few small chubs were caught in the lower part of the segment. Electrofishing the deeper areas produced adult round whitefish in the 12- to 15-inch range, and grayling in small numbers between 6 and 8 inches in length. An overnight gill net set off Crystal Springs in early April (Figure 5) caught one 9½-inch grayling and a fyke net set caught nothing. In late April we set three gill nets at intervals along the river and caught 5 large humpback whitefish (14-17 inches) and one round whitefish (11 inches) (Figures 6 and 7). Periodic angling and a set of 6 burbot hooks produced no fish. Nothing resembling an overwintering concentration of fish was detected in this area although the round whitefish seemed to be loosely aggregated in schools. The round whitefish were found in moderately shallow water of 3 to 4 feet deep, while the humpback whitefish were deeper although the deepest water found was only 10 feet. No small fish were caught in the small-mesh segments of the gill nets even though they were relatively abundant. Interesting age or size specific fish distributions were noted: small suckers were abundant along the beaches, but no large suckers were caught in this area; adult whitefish were common, but no juvenile whitefish were taken. No salmon fry were observed or captured even though at the same time large numbers were present in similar environments of the Tanana River at Big Delta. Most of the fish were feeding heavily on a thick green "soup" of algae and midge larvae. Large volumes of algae were noted, suggesting that the primary productivity of this part of the Tanana in late winter and spring might be surprisingly high. Some enrichment might be contributed by the village of Tanacross, however.

Crystal Springs originates in part from an upwelling source that crosses the Alaska Highway near mile 1328, and in part from springs near the Tanana River (Figure 8). It remains open and clear all winter and fish, if present, would be readily visible. Gravel and water quality appear suitable for salmon spawning and survival. On October 14, a few sculpins and unidentified fingerlings (probably round whitefish) were present. Subsequent visits on October 29, March 22, April 2, April 14, April 20 and April 21 revealed no fish utilization. In late April the water became murky from runoff.

Yerrick Creek, mile 1333.7, is a productive summer grayling stream in its upper reaches (Valdez, 1976). By late October it was largely frozen over, but with some open patches, and flowing perhaps 5 cfs at the bridge. On February 27 it was frozen to the bottom at the bridge and we walked ½ mile above the pipeline crossing, which is about ½ mile above the highway, without finding evidence of flowing water (Figure 9). One hole was dug to dry gravel at the pipeline crossing. On April 13 water was flowing 5 miles upstream from the bridge, but disappeared about 1½ miles upstream. We could see no fish in the limited open water areas (Figure 10). On April 19 and 26 the creek was still frozen at the bridge with no sign of surface flow.

Robertson River, mile 1347-1348, in summer is a very large, turbid, braided, glacial river. A previous summer survey (Valdez, 1976) indicated a paucity of aquatic life in the main river, but grayling, round whitefish and char were abundant in the clear spring areas upstream. Our observations began in late September 1977 at which time the river was still turbid and with a large flow. By early November the flood plain was largely ice covered, but with clear

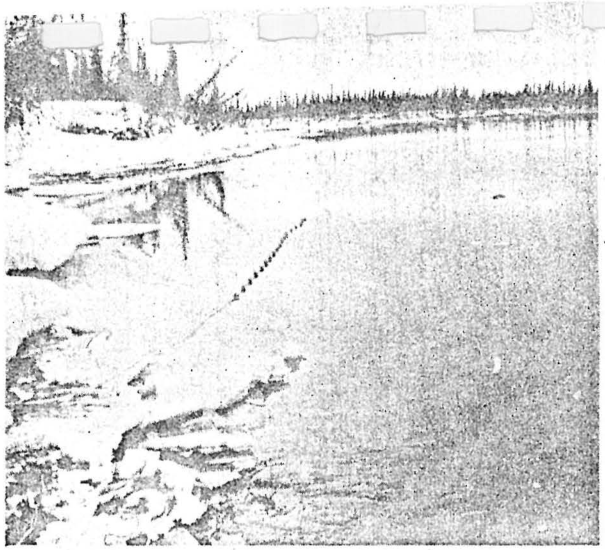


Figure 5. Gill net set in eddy of Tanana River at Crystal Springs, April 1, 1978.

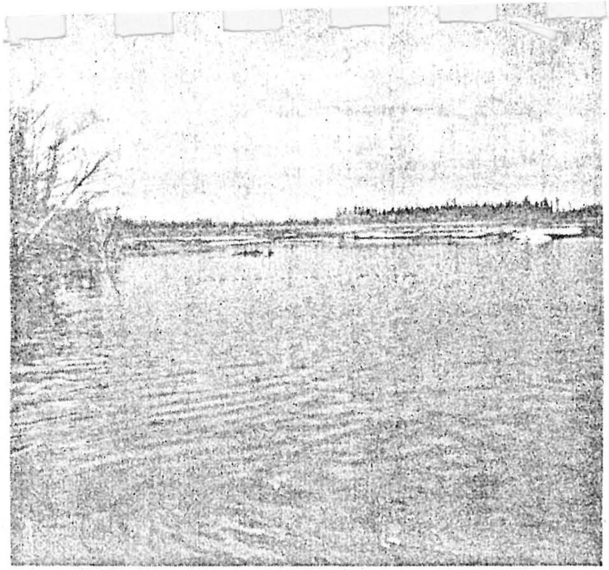


Figure 6. Gill net set in the Tanana River between Tanacross and Crystal Springs, April 21, 1978.

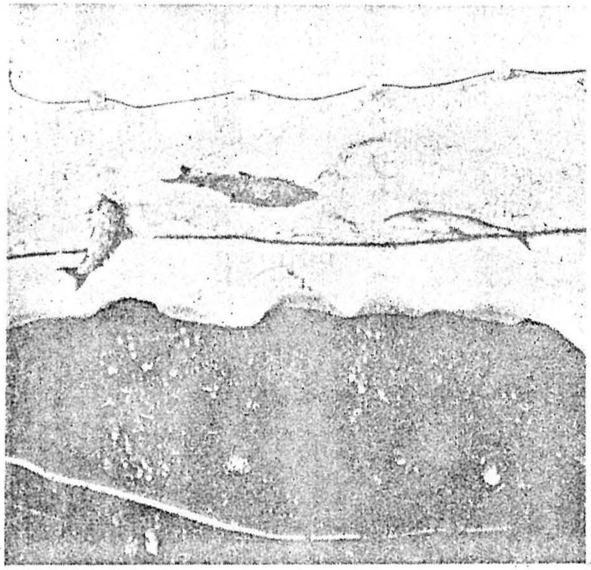


Figure 7. Humpback whitefish caught in gill net, Tanana River, April 21, 1978. Whitefish were caught only in the largest mesh size and near the bottom of the net.

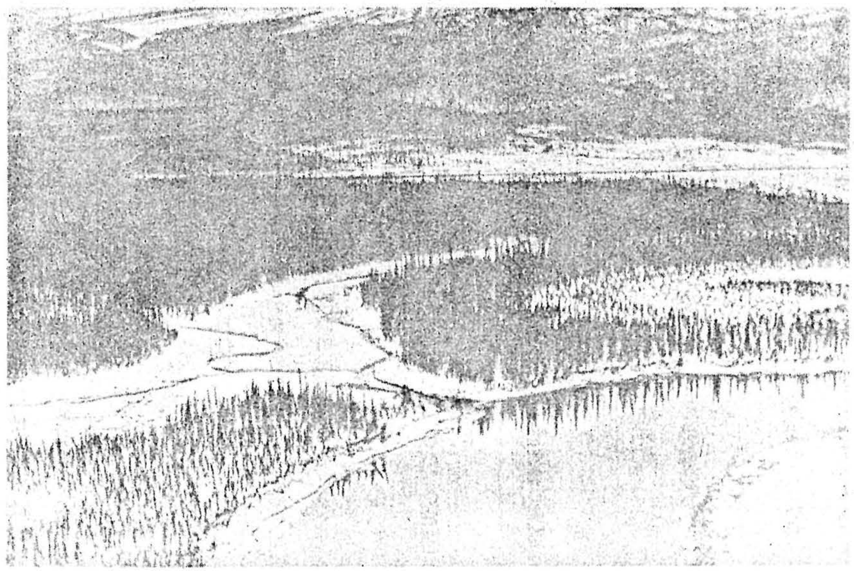


Figure 8. Crystal Springs adjacent to the Tanana River, Alaska Highway in the background, April 1, 1978.

water flowing over gravel beds in several channels. During the winter the entire stream bed, from several miles above the bridge to the mouth became covered with a solid sheet of overflow ice. Above the solid ice, channels with flowing water were alternately open and ice covered. In April we surveyed the spring areas 7 and 8 miles upstream from the bridge (on the south and north sides of the river, respectively) by dog team and helicopter. Visual inspection and an overnight gill net set showed no fish in the south side spring (Figure 11). Likewise visual inspection by foot and helicopter gave no indication of fish in the open areas of the north bank spring area. The springs were difficult to sample because of edge ice and snow, deep water, and mud bottom, but spot electrofishing was attempted with no success (Figure 12). These springs originate from several lakes and ponds, which are reported by local people to contain fish, but which were still frozen over in late April. Just at and below the spring's juncture with the Robertson River, two grayling (8 and 10 inches) and several sculpins were caught by electrofishing.

The fish residing during the summer in the Robertson River springs and ponds may thus winter: (1) in the lakes; (2) in the Robertson River itself; or (3) in the Tanana River. Option 3 would entail a spring and fall migration through the pipeline corridor. It is speculated that the char may winter in the lakes since they show little proclivity for migration, while the grayling, being characteristically migratory, may move down to the Tanana for the winter. Those we caught may be the vanguard of the spring upstream migration. As for the Robertson River as an overwintering stream, the water quality in the winter is good, but the current is fast and there are few deep pools which might be a requirement for resting fish in a state of low energy intake. Fish do not winter in the springs, but further studies should be done on this system to define migration and wintering patterns.

<u>Bear Creek</u>, mile 1357, is generally a small stream originating from both glacial and lake-fed tributaries. At the highway, grayling and suckers are summer residents and in the upper areas grayling and char are found in abundance during the summer (Valdez, 1976).

Figure 9. Yerrick Creek, walking downstream on a snowmachine trail towards highway bridge, March 22, 1978.

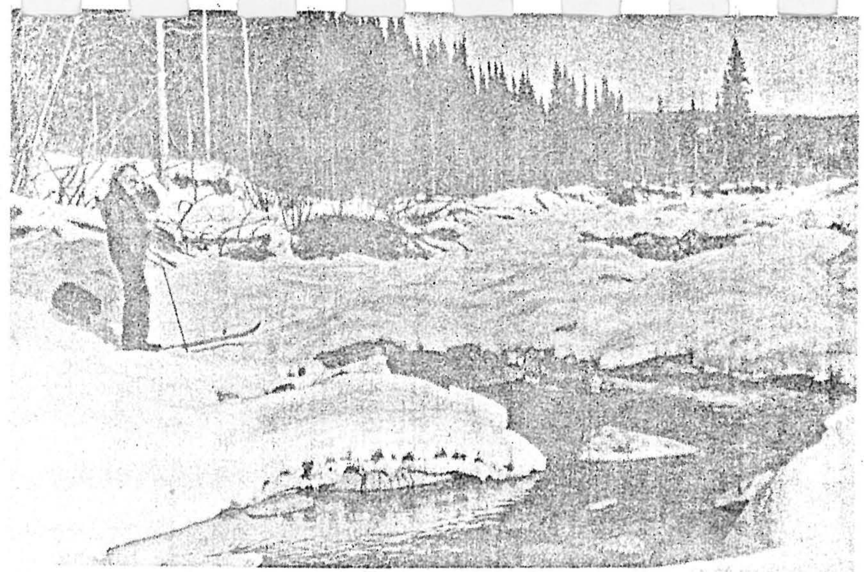


Figure 10. Open, flowing water on Yerrick Creek about 5 miles above the highway bridge, April 13, 1978.

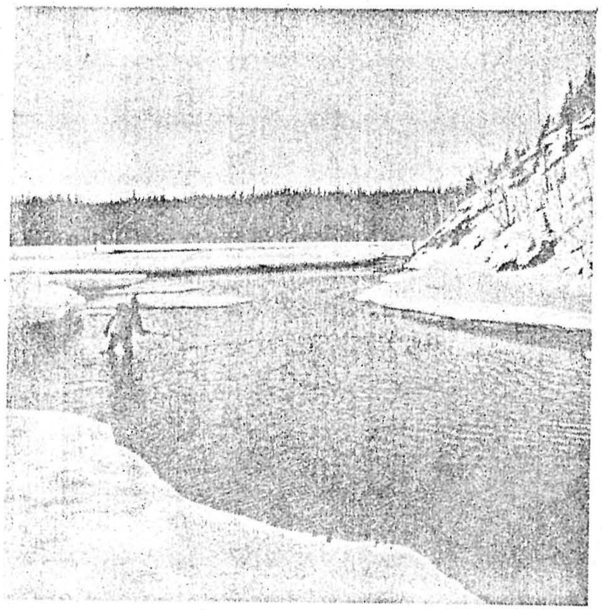


Figure 11. Gill net set in springs on south side of Robertson River, April 11, 1978.

Figure 12. Spring-fed creek on north side of Robertson River, April 25, 1978.

As of late September 1977 the stream was flowing clear at about 10 cfs; no fish were observed in 25 yards above and below the bridge. By November 1 it was completely frozen with no flow. In mid-April puddles of melt water were present but there was no flow; by late April the stream was flowing about 5 cfs mostly over bottom ice. On April 26 we elctrofished 100 yards of stream above and 50 yards below the highway and captured nothing. Via helicopter we sampled the stream about 8 miles upstream from the bridge on April 25. There was a good flow of about 5 cfs of clear water, mostly free of ice, and we electrofished about 100 yards of stream, capturing one 8-inch char and three sculpins (Figure 13). Fish Lake, one of the sources of Bear Creek, was still ice covered. It would thus appear that the grayling present in the upper areas during the summer migrated downstream prior to fall freeze-up in the lower portion. The upper areas contained flowing water all winter with char and sculpins wintering there. By late April, lower Bear Creek was flowing again, but the grayling had not yet begun their spring upstream migration.

Chief Creek, mile 1358.7, is an intermittent stream at the highway. Spot checks when flowing have not revealed the presence of fish, but grayling probably utilize it to some extent, at least in the spring. On September 29 it was flowing about 10 cfs, but for most of the season was dry and snow covered. On April 19 there were melt pools, but no flow.

Sam Creek, is a slough-like, spring-fed stream paralleling the Alaska Highway from near Dot Lake, mile 1362, to mile 1370. It originates from a number of springs and ponds in a large, marshy comlex (Figure 14). We studied an important tributary at mile 1369.1 and the main creek about one mile upstream from the mouth. The tributary was found to contain large summer populations of grayling, round whitefish, suckers and sculpins--especially the pool below the highway culvert (Valdez, 1976). There has been no recent sampling in San Creek itself, but local residents report catching grayling, round and humpback whitefish, pike and burbot seasonally. Pearse (1976) reports grayling, round whitefish and suckers in a sample taken

April 1, 1963. No fishing effort was observed during the fall and winter although a number of boats are kept there for access to the Tanana River and adjacent lakes. In mid-October the tributary was flowing 2 cfs. No fish were observed, but visibility was poor due to partial ice cover. On November 1 the tributary was frozen over, but water was flowing under the ice and sometime later it froze to the bottom. On April 25 the tributary was flowing about 5 cfs mostly over the surface of anchor ice; no fish were observed or collected electrofishing for 25 yards downstream from the highway. In mid-October Sam Creek was flowing about 10 cfs and open, but by November 1 the lower end was largely frozen over, but with some small open areas remaining. In mid-March small open areas still persisted and there was a flow of about 5 cfs. A minnow trap baited with salmon eggs, canned fish and corn was set overnight, but nothing was caught (Figure 15). A gill net was set in an open lead near the mouth on March 22 (Figure 16). On March 24 it contained one 12-inch pike, but was frozen in and was left until March 31. Nothing was in the net on that date. On April 24-25 large areas of open springs and ponds were evident from the air; no fish were observed, but the water was somewhat discolored. Obviously Sam Creek received little utilization by overwintering fish during 1977-78.

Berry Creek, mile 1371.4, is considered one of the most productive of the streams crossed by the pipeline and in summer supports grayling, char, round whitefish and sculpins and a sport fishery (Van Hyning, 1976; Valdez, 1976). In early November 1977, the stream was flowing about 5 cfs, but ice covered most of the channel. In February and March the creek was completely covered with ice and snow from the bridge to its mouth at Johnson Slough with some fresh overflow ice evident in the lower reaches. About a mile above the bridge there were a few open holes with at least a flow of about 5 cfs evident under the ice. A baited minnow trap was put in one of the holes for a week with no catch. Attempts to locate water underneath the ice at the bridge and in Johnson Slough were unsuccessful although water was flowing a mile upstream and the U.S. Geological Survey (1976) reports a winter minimum flow of 11 cfs at their gauging station near the bridge. Holes were dug through 4 or 5 feet of ice without finding water or bottom. On April 15, lower Berry Creek was

Figure 13. Electrofishing on Upper Bear Creek, April 25, 1978.

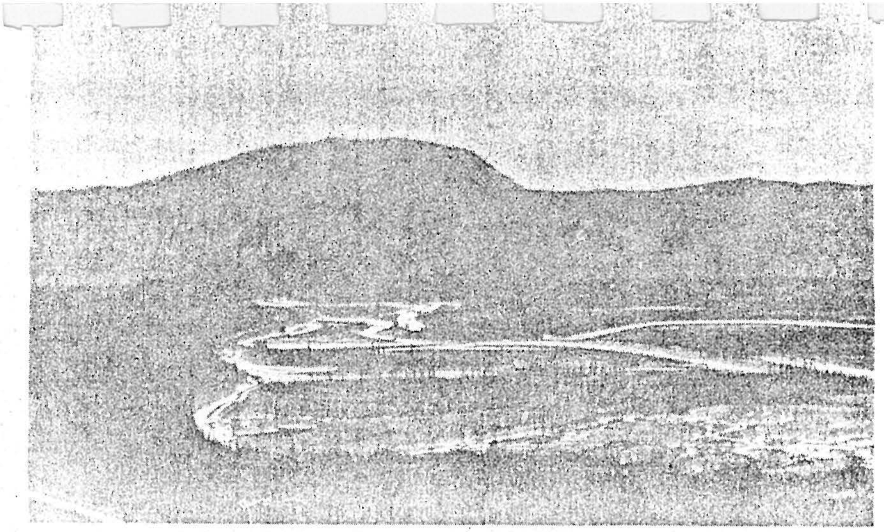


Figure 14. Sam Creek area looking west towards Tanana River, April 24, 1978. Alaska Highway is in left foreground.

Figure 15. Minnow trap set in an open area of Sam Creek, March 16, 1978.

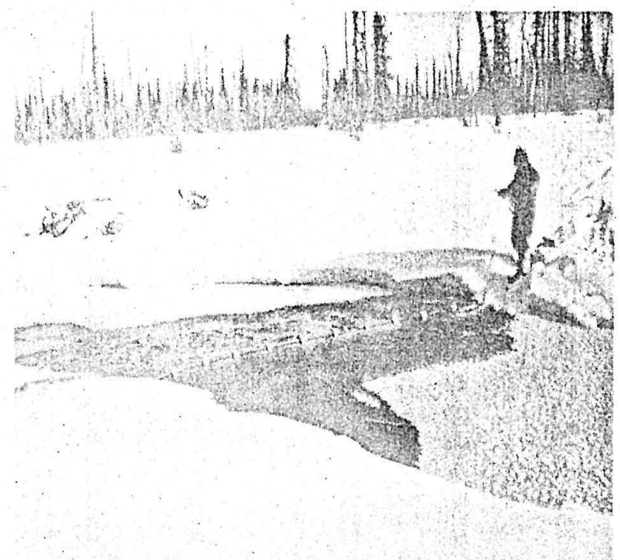


Figure 16. Gill net set in Sam Creek, March 22, 1978.

still completely ice covered, but upstream about three miles water was flowing at 5-10 cfs with about 30% of the stream open. One large char was observed in a pool on that date. Electrofishing the same upstream area (Figure 17) on April 24 produced one large char (15 inches, the same one previously observed; identifiable by a fungus patch on its head), one small char (8 inches) and a number of sculpins. A 15-inch (1 lb. 2 oz.) resident char from one of these small headwater streams could well be a record. Since there is a lake on the Berry Creek system it is possible that much of the fish's growth was actually made in the lake and the fish subsequently migrated downstream. The fish appeared to be in a stage of senility: thin, fungus present, small testes, spots on the liver, and an empty stomach. Previous summer surveys (Valdez, 1976) in an area about 5½ miles above the highway produced grayling, char, round whitefish and sculpins; from our winter data it thus appears likely that the grayling and whitefish migrated downstream while the char and sculpins remained as winter residents. Some of the char might also have emigrated as the winter fish density was low compared with the summer surveys. Further more comprehensive population studies would be necessary to determine this however, as the locations fished were not the same and it is impossible to determine how many fish may be hiding under the ice cover that persists in late winter and early spring. Lower Berry Creek was nearly at flood stage on April 26 (Figure 18).

<u>Sears Creek</u>, mile 1374.4, is a small, partly spring-fed creek which contains grayling, and possibly char, in the summer. By November 1 it was covered with slush ice. In late February overflow ice and water covered a large area near the bridge and Haines pipeline. An overnight minnow trap set on February 26-27 produced nothing. By late April the area was still mostly ice and slush covered, with no well defined channel for the flow of about 3 cfs.

<u>Dry Creek</u>, mile 1378, is, as the name implies, usually dry at the highway. However, several miles upstream it flows year round, albeit mostly under ice in the winter with only an occasional opening. Resi-

dents (Champagne, pers. comm.) report grayling, char and whitefish in summer which become winter residents if downstream access in the fall is denied by lack of flow in the lower portion. On September 26, the creek was dry at the highway, but on September 29 was flowing 2-3 cfs. Later the stream bed became dry and remained that way through April 26. On April 10 we traveled 3-4 miles up Dry Creek where the stream was flowing perhaps 5 cfs mostly under ice and with extensive glaciering. Observation of open areas recorded one small char and one unidentified small fish.

<u>Johnson River</u>, mile 1380.5, is another large, braided glacial river. No fish have been captured at the highway during summer surveys in the turbid water, but grayling, char and whitefish were found in upstream, clear tributaries (Valdez, 1976). Throughout the fall of 1977 the river remained open and clear, flowing in several channels over the gravel bottom. During the winter the lower river became completely ice and snow covered, but small open channels were present above the bridge. On April 1 several openings appeared in the 5-foot thick ice above and below the bridge. The water was clear and flowing about 15 cfs in the westernmost channel. In late April we electrofished about 100 yards of this channel above the bridge with no catch (Figure 19).

<u>Little Girstle River</u>, mile 1388.4, originates from mixed glacial and clear-water tributaries and is less turbid than the typical glacial stream. Grayling, whitefish, suckers and sculpins were sampled at the highway in July and grayling in the upstream tributaries (Valdez, 1976). We found the Little Girstle River to have a good flow of clear water in early fall, but by November 1 was dry and the channel covered with ice and snow. On April 19 it was still dry and on April 26 only flowing about 5 cfs.

<u>Girstle River</u>, mile 1393, is an extensively braided glacial river. In September, the stream was flowing in five main channels. We seined and inspected the clear westernmost channel in several places at that time with negative results. By mid-October, the stream was very low. In contrast to the Robertson and Johnson Rivers which become covered

with solid ice and snow over their entire lower flood plains, the bed of the Girstle was largely bare. Some upwelling and minor flow occurred throughout the winter. On April 19 and 26 the flow was still low and a visual survey on the latter date of several small side channels produced no fish sightings. Since sampling near the highway has revealed a paucity of aquatic life and aerial reconnaissance of the upper reaches showed no productive tributaries, the Girstle River can probably be considered as an insignificant producer of fish.

The Tanana River near the mouth of the Girstle was completely ice covered throughout the winter. Two test holes on March 15 revealed 3 feet of ice over 5 feet of water and 4 feet of ice over one foot of water. Water under the first hole was flowing very swiftly.

Sawmill, Rhoads, and Granite Creeks, mile 1403.8-1409.6, remained dry throughout the period of the study. These streams contain flowing water during the summer in the upstream areas, but it is not known whether they support fish or not, or whether there are perennial springs which would permit winter survival of fish which might migrate upstream during freshets and then become landlocked.

Tanana and Delta Rivers at Big Delta. This area was observed extensively because of its importance as a chum salmon spawning ground and because ADF&G considers it an overwintering area for grayling and whitefish and thus might serve as a "control" for observations of other areas. Due to extensive ground water upwelling, the lower Delta and this section of the Tanana remain open and flowing all winter. From mid-October through mid-November, chum salmon, and a few coho salmon, were spawning actively throughout the area. On February 25, cursory digging in the Delta River revealed chum salmon alevins with considerable amounts of yolk sac still remaining; a similar effort on March 24 showed the yolk sac to be almost completely utilized although few fry had emerged. On March 30-31

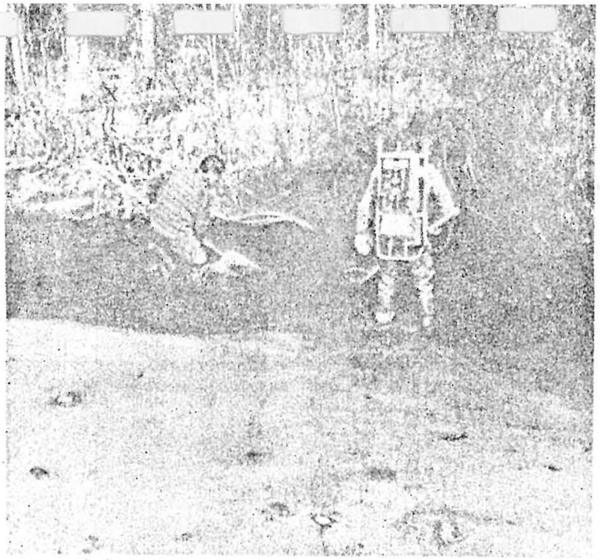


Figure 17. Electrofishing Berry Creek about three miles above the highway bridge. A 15-inch char was observed here on April 15 and captured on April 24, 1978.

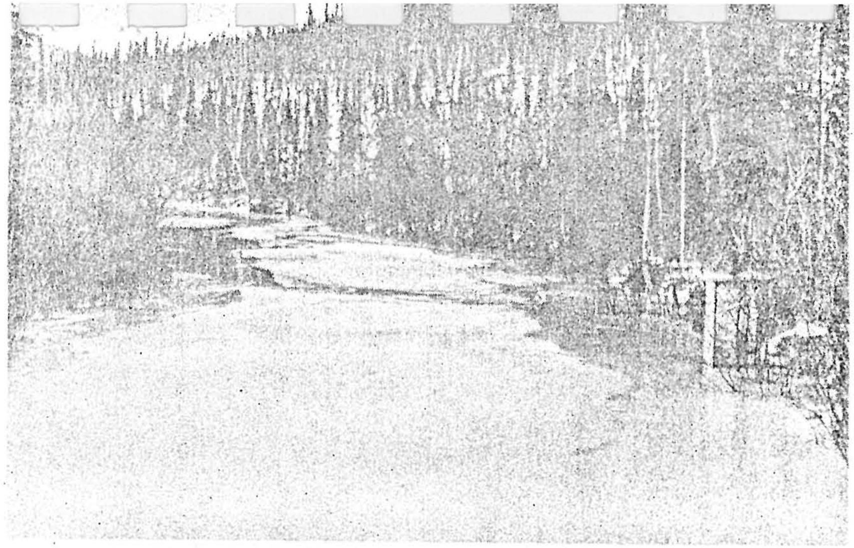


Figure 18. High water on lower Berry Creek, looking upstream from the Alaska Highway bridge, April 26, 1978. Much of the water is flowing over the surface of the ice.

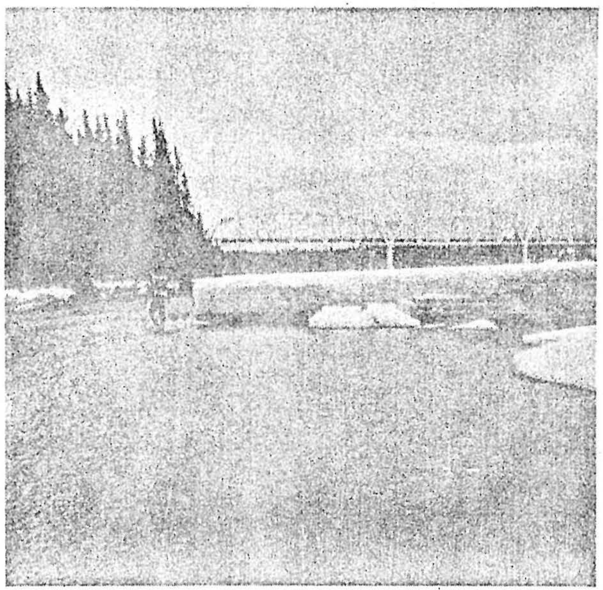


Figure 19. Electrofishing open areas of lower Johnson River, April 26, 1978. Looking downstream towards the highway bridge.

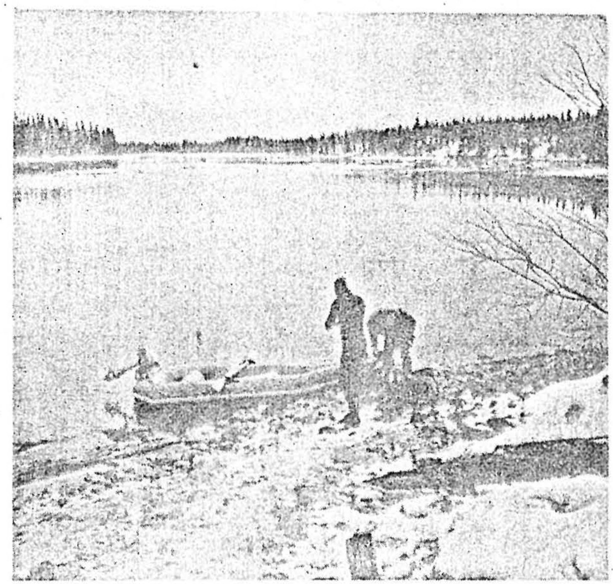


Figure 20. SCUBA and boat surveys of Tanana River at Big Delta, March 31, 1978.

we surveyed the south shore line from the Alyeska Camp to the highway bridge by boat and SCUBA diving (Figure 20). A few small schools of chum salmon fry were observed in the shallow areas and one large sucker in deeper water; the water was not clear enough for meaningful SCUBA observations, however. Even though the water appeared fairly clear along the edge of the river, the diver estimated the visibility at less than three feet in the deeper areas; a Secchi disk reading was 0.8 meters. In mid-April, chum fry were abundant in both the Delta and Tanana Rivers. On April 26 we electrofished along the south shore from the mouth of the Delta River to the Alyeska Pipeline Camp (Figures 21 and 22). Chum salmon were present by the thousands (average length about 1½ inches). In addition, we collected 5 chinook salmon smolts (3 inches in average length); 3 round whitefish from juvenile to adult (3 to 14 inches), with several others escaping; 2 grayling (9 to 10 inches); a few sculpins; and one 12-inch burbot. The burbot's stomach was crammed with 53 chum salmon fry; one chinook smolt had 2 chum fry in its stomach but the other fish were all feeding on aquatic insect larvae. One grayling had 7 salmon eggs in its stomach, but these were likely bait eggs used by sport fishermen. In contrast to Tanacross where the food of grayling and whitefish was almost entirely a thick "soup" of algae and midge larvae, here a variety of aquatic insects were consumed. It is also interesting to note other differences: (1) at Tanacross, small suckers were the most abundant fish of the shallow beaches while at Big Delta there were none; (2) only large round whitefish were present at Tanacross, while at Big Delta there were both juveniles and adults; and (3) no yearling grayling were found at Big Delta in contrast to their abundance at Tanacross. While estimates of fish density from these data would be premature, there appeared to be an order of magnitude more fish present at Big Delta than at Tanacross, at least in terms of biomass if not in species diversity, along with significant differences in specific size and age composition. From late February throughout the spring, fishermen were observed fishing the Tanana River near the highway bridge-pipeline crossing and upstream adjacent to the Alyeska Camp. Catches were poor and consisted mostly of round whitefish, even though grayling was the preferred species (Figure 23).

Jan Lake, mile 1353, lies about one-quarter mile from the highway by trail (Figure 24). This lake was visited on March 16, 1978 and two holes were dug through 2½ and 2 feet of ice over 4½ and 19 feet of water. A dissolved oxygen reading of only 2.0 mg/l suggests marginal survival conditions for the introduced rainbow trout and coho salmon. The low levels of hardness and conductivity (Appendix Table II) also indicate poor porductivity. An hour of angling through the ice yielded nothing and residents of Tok state that fishing at Jan Lake has become rather poor.

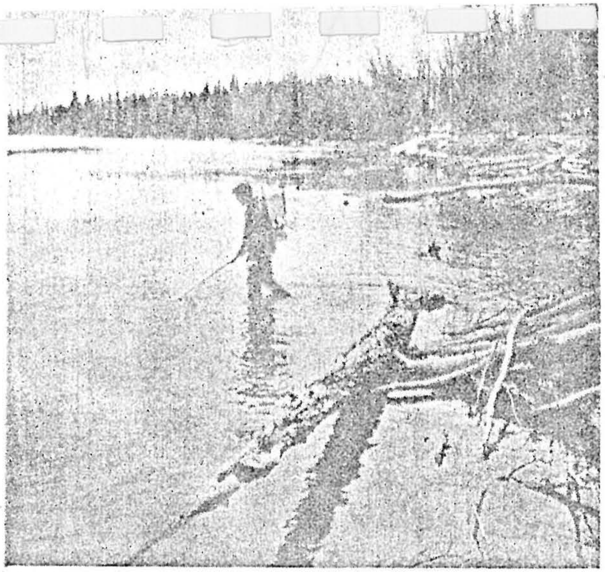


Figure 21. Electrofishing the Tanana River at Big Delta, April 26, 1978.

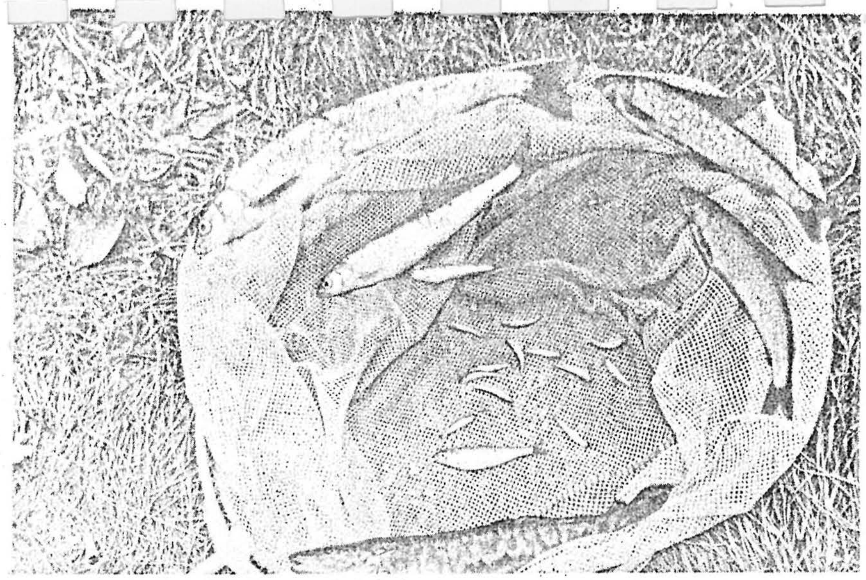


Figure 22. Fish caught by electrofishing Tanana River at Big Delta, April 26, 1978. At top left, 3 round whitefish from adult to juvenile; top right, 2 grayling; bottom, 1 burbot; center, 12 chum salmon fry and one chinook salmon smolt. The burbot's stomach contained 53 salmon fry.

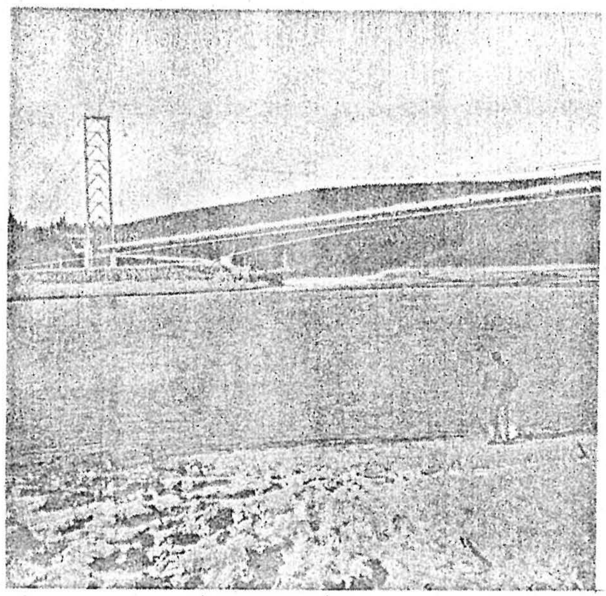


Figure 23. An angler fishing the Tanana River at the Alyeska pipeline crossing, April 2, 1978.

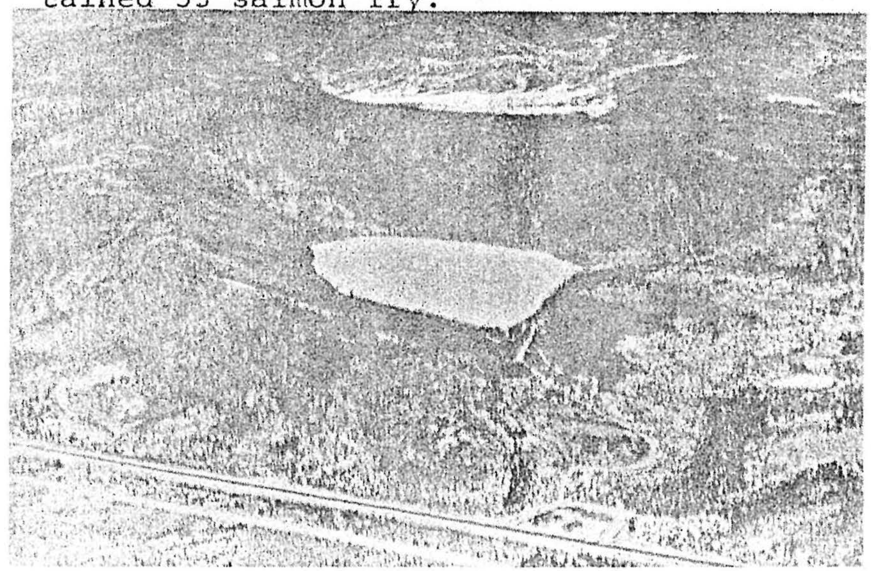


Figure 24. Jan Lake, with Alaska Highway and Haines pipeline right-of-way in foreground, April 1, 1978.

DISCUSSION

SALMON

Surveys to locate spawning salmon in the Tanana River above Delta Junction which started in 1975 (Van Hyning, 1976; Geiger and Andersen, 1976; Francisco and Dinneford, 1977), continued in the fall of 1977. Efforts were coordinated with ADFG and consisted of aerial reconnaissance flights of the major river systems and foot surveys of springs and streams adjacent to the Alaska Highway. In contrast to the fall of 1976, when generally fair weather prevailed, almost constant fog and snow in the mountainous areas during the fall of 1977 made aircraft surveillance difficult. Increased attention was thus paid to the accessible areas, not only in terms of adult salmon spawning, but also the presence of carcasses in the spring, as ice and snow melted, and of fry and fingerlings.

Van Hyning (1976) reviewed existing information on salmon spawning in the upper Tanana River. In summary, large numbers of chum salmon, and lesser numbers of coho, spawn in the lower Delta River, the Delta-Clearwater River, and in the Tanana River in the vicinity of Big Delta. Small numbers of salmon have been taken in subsistence and research netting operations above Delta Junction and old-time residents recall salmon being occassionally observed spawning near Tanacross and Tetlin. The only recent observation by biologists, however, of salmon spawning above Delta Junction is the Chisana River near its headwaters--a record open to some question. Geiger and Andersen (1976) observed salmon carcasses in 1975 near Sheep Creek on the upper Chisana from the air but were unable to land and confirm identification.

In the fall of 1976 I repeatedly surveyed the potential spawning grounds in this area from the air and found what appeared to be ideal conditions in terms of gravel and flow, but no salmon were observed. Predators such as bald eagles, commonly associated with salmon, were noted, however.

On September 16, 1977 ADFG biologists surveyed the Nabesna River and Stuver Creek, on October 21 the Johnson and Little Girstle Rivers, on November 4 the Tanana and November 9 the Chisana and Nabesna Rivers without finding any salmon (Dinneford, 1978). On November 17 I examined the entire watershed by air; the only indication of salmon spawning activity was the sighting of what appeared to be about 50 salmon in a spring area below Sheep Creek on the Upper Chisana River. Again it was not possible to land to confirm identification and Dinneford (pers. Comm.) from observing the same area on November 9 was of the opinion that they were beaver cuttings.

In the fall of 1977, ADFG (Dinneford, 1978) expanded their sampling of the main stem of the Tanana River by test gillnetting above Delta Junction. From September 19-October 5, 12-foot 5½ inch and 45-foot 4 3/4-inch monofilament gillnets were fished 22 miles upstream from the mouth of the Girstle River; 69 chum and 1 coho salmon were caught. From September 23-October 15 a site two miles above the mouth of George Creek was fished with 100-feet of variable mesh gillnet up to 5 inches; 84 chum salmon were caught along with a number of other fish species that will be discussed later. On October 14-15 a 100-foot 4 3/4-inch gillnet was fished just downstream from the mouth of the Tok River and caught one coho salmon.

Dinneford (1978) estimated the chum salmon escapement to known spawning beds of the upper Tanana River in 1977 at 30,400, the largest since surveys began in 1972 (6-year average 19,000; 1976 was 15,600). Coho were estimated at 5,900, the second best since 1972 (average 4,000, 1976 was 2,500). This record escapement of chums, plus the good catches taken by test fishing in the Girstle River - George Creek area, indicated that a run of some magnitude spawned somewhere above Delta Junction, but their spawning areas remain to be discovered. About 32% of the chums netted at the Girstle River site resembled "partially spent" fish and may have been spawning nearby, but 100% of the fish at George Creek (farther upstream) were unspawned.

Throughout April, chum salmon fry, as well as carcasses of adults from the previous fall's spawning, were abundant along the shores of the Tanana River at Big Delta and in the Delta River (Figure 25). Concomitantly, visual observations as well as intensive netting and electrofishing in similar areas along the Tanana River between Tanacross and Crystal Springs, Sam, Bear, and Berry Creeks and the upper Tok and Robertson Rivers failed to reveal spawned-out carcasses, downstream migrant smolts or rearing fry or fingerlings. We could find no coho fry wintering in any of the springs. Pearse (1974) however, found coho fry overwintering in the spring areas of the Delta-Clearwater River. An adult coho was caught off the Tok River in the fall and the Tok Overflow would appear to be an ideal coho stream, resembling the Delta-Clearwater River on a small scale, but frequent checks throughout the season failed to reveal the presence of any salmon.

A possible explanation for the lack of salmon in the upstream areas is the slight temperature differential which exists. For example, the Delta River, in which salmon eggs incubate successfully, has winter water temperatures consistently between 35 and 39° F, while Crystal Springs has 33-34° and the Tok Overflow 34-35°. Sam Creek was measured at 32° even though it is of spring origin. The Tanana River at Big Delta was generally around 35°, at Tanacross 33-34°, and at several points checked under the ice 32°. These small differences could be critical to embryonic development at such low temperatures.

The spawning grounds of the upper Tanana River salmon remain a mystery, but there appears little chance that construction and operation of the Alaska Highway pipeline will impact either spawning or rearing areas. The most probable scenario now suggest that the salmon are spawning over groundwater upwellings in deep waters of the mainstem Tanana River. Because of the absence of salmon fry at Tanacross and the indication of partially spawned-out fish near the mouth of the Girstle River, most of the spawning activity probably occurs below Tok. The physical characteristics of the ecosystem make this hypothesis difficult to test because by the time the river clears sufficiently for good visibility it begins to freeze over. Sonar, underwater television and/or fishing nets under the ice may at some future time reveal answers to the questions.

DOLLY VARDEN CHAR

Mystery also surrounds the life history of the char of the headwater tributaries of the upper Tanana River. In mid-summer, Valdez (1976) found char in upstream tributaries of the Johnson and Robertson Rivers and distributed fairly widely throughout Berry, Bear and Yerrick Creeks. We found them wintering in upstream portions of Dry, Berry and Bear Creeks and the Tok Overflow. We did not find them wintering in upstream tributaries of the Robertson River or in Yerrick Creek, but that does not preclude their presence since sampling areas were severely limited by ice cover.

A conceptual model of char migration suggests an upstream movement in the late summer from throughout the individual watersheds --lower parts of which typically go dry or freeze solid in the fall. Char are fall spawners and their expected behavior might be to migrate upstream both to seek spawning sites and areas of perennial flow the fall and winter. Char have not been recorded from the Tanana River and there seems little evidence of interchange between populations. In the spring, as flows increase, the char disperse downstream throughout the individual tributaries. We found in the winter that char were much less abundant per unit area checked than during the summer. However, due to ice cover we could only make a partial census and we did not sample the same areas that were sampled in the summer. There may be a concentration of char in certain areas and thus be unavailable to the sampling gear. Sculpins and char always occurred together and generally were the only fish found in the upstream areas in the winter. In some cases grayling may also be present if they have become "landlocked" in the fall due to lack of flow in the downstream reaches of the stream.

The char we captured in winter ranged from 7.5 to 8.5 inches in length with the exception of one 15-inch specimen. We also observed an additional char in the 6 to 8-inch range. The fish all appeared to be sexually mature. No evidence of juveniles was found although the electrofisher captured very small sculpins so size selectivity was not a factor.

Winter activity along the pipeline corridor should have little or no impact on the resident Dolly Varden char population.

GRAYLING

The artic grayling is ubiquitous throughout Interior Alaska, common during summer in nearly every accessible habitat. It is the most important sport fish of the Interior and has been extensively studied in the Tanana Basin. The reports of Reed (1964), Pearse (1974), and Tack (1971, 1972, 1973, and 1974) were integrated with our work to provide this preliminary synthesis of grayling winter distribution in the upper Tanana Basin.

It is believed that grayling migrate downstream out of most of the tributaries of the upper Tanana River in the early fall and winter in the main stem. The migration occurs for the most part before late September as we found no fish in the creeks checked during October, and by November many of the streams are dry or frozen solidly to the bottom in the lower reaches. No wintering grayling were found in the upper flowing areas of tributaries where they were found in summer, and which harbored overwintering char, indicating that the grayling had migrated downstream in the fall. In the Delta-Clearwater River, a large spring-fed system, some grayling were observed as late as December, but there was a strong downstream trend of movement in late August and September. From mid-winter through March there was an absence of grayling in the Delta-Clearwater River. We found grayling in the Tok overflow, a small spring-fed system similar to the Delta-Clearwater River, through October but they subsequently disappeared and had not returned in any numbers by late April. The lack of fish in these spring-fed streams in winter seems surprising since they would appear to be ideal for over wintering--offering a constant flow, clear water, food and slightly warmer water temperatures; the finding is, however, consistent with the general observation that fish in the upper Tanana avoid spring areas in the winter.

Small grayling entered the Delta-Clearwater River in April with larger fish arriving in mid May and June. Very few grayling spawn in the Delta-Clearwater River, but use it primarily as a summer feeding area. It is thus assumed that these fish winter in the Tanana, followed by a spring spawning migration into such streams as the Goodpaster River and Shaw Creek beginning in late April, with spawning during May. Some of these fish reside in these tributaries through the summer, but others evidently return down stream to the Tanana River and they migrate up spring-fed streams such as the Delta-Clearwater for summer residence. A typical spring stream such as the Delta-Clearwater, is not used for either wintering or spawning, and the same conclusion can be extrapolated to the springs farther upstream. In our sampling of the small tributaries in late April 1978, we could find no grayling indicating that the spring migration had not yet commenced in these streams. One exception was the Robertson River where we found grayling just below a spring-fed tributary; it is unknown whether the fish were wintering there or migrating upstream.

In contrast to the Delta-Clearwater River, Tack found grayling wintering throughout the Chena River. Based on tagged fish recovered, some grayling either remain in the same section year around or return to the same section in successive summers. The Chena River grayling prefered the deeper holes under the ice, with few being found in the open areas.

We found grayling wintering sparingly througout the Tanana River from Tanacross to Crystal Springs and at Big Delta but no concentrations were found. Based on the Chena River work, more grayling would likely be found under the ice than in the open areas we checked. Unlike whitefish, there seemed no particular size segregation; yearlings were common along the shoreline, with larger fish in the same area but in deeper water. Dinneford (1978) in the fall salmon test netting program caught only one grayling at George Creek. Tack (1974) reported on attempts to locate grayling in the Tanana River adjacent to the mouth of the Goodpaster River and at Big Delta on March 28 - April 1, 1973: "Very few grayling were captured, although large numbers of round whitefish were taken. It is possible that grayling remained under the iced-over portion of the Tanana River at this time". The mouth of the Goodpaster River was dry, but flows and water quality upstream appeared suitable for winter survival although no grayling were captured: "It seems probable that most grayling left the Goodpaster River and overwintered in the Tanana River or some other tributary of the Tanana".

The outlet of Mineral Lake, which drains into the Little Tok River and then the Tok River, about 35 miles south of Tok on the Glen Highway is an important spawning ground for grayling. The fish approach Mineral Lake from the Little Tok River; there is no evidence of overwintering in the lake or its tributaries. The mature fish arrive on the spawning beds from mid -to-late May and continue spawning into early June. Spawning activity is triggered by the water temperature reaching 4° C (39°F) and varies from year to year depending on weather conditions. After spawning the grayling distribute themselves in the upper Little Tok River, Mentasta Creek and Mineral Lake for summer residence. Little is known about the fall movement; the Mineral Lake outlet spawning population may winter in the Little Tok River, the upper Tok River or the Tanana River, with the upper Tok River being the most plausible based on circumstantial evidence. This hypothesis is based on the following considerations (see Narrative of Stream & Fish Observations for details): (1) superficial examination of the Little Tok River suggested poor wintering conditions with extensive anchor ice formation in the lower areas and complete ice cover; (2) open areas of the Little Tok River below Mineral Lake have been checked in winter and no fish have been found; (3) no fish winter in spring areas such as the Tok Overflow; (4) the lower Tok River goes dry from early November through April which would preclude the long migration necessary from the Tanana River to Mineral Lake to arrive by mid-May; and (5) the upper Tok River appears to maintain a good flow all winter even though largely ice covered. If it is confirmed that large and important Tok River grayling stocks do not migrate to the Tanana River for wintering then the problems of protection during pipeline construction are greatly simplified.

In summary, grayling migrate out of most of the tributaries of the Tanana River in late summer and early fall (they are essentially gone by October) and do not return until late April or early May depending on seasonal characteristics. An exception to this generalization may be the Robertson and Tok Rivers, the upper areas of which may hold wintering fish and warrant further study. The spring-fed streams are not utilized for wintering or spawning. The Tanana River must be the principal wintering area for grayling, but the open areas sampled have produced only scattered fish of a generally small size, suggestingthat larger numbers, and larger fish, must be overwintering under the extensive ice-covered stretches.

WHITEFISH

Two species of whitefish, the round and humpback, are common in the upper Tanana River. We found round whitefish adults to be abundant at Tanacross (mean length 13.8 inches), but at Big Delta all sizes were represented (mean length 8.3 inches). Pearse (1974) also found round whitefish to be abundant in the Tanana River during the winter with an estimated population during late March and early April 1973 of about 2,000 per mile at Big Delta and 3,500 per mile just below the mouth of the Delta-Clearwater River, 14 miles upstream. At Big Delta all sizes from 7.2 to 17.2 inches were evenly represented with a mean length of 12.0 inches , while below the Delta-Clearwater River the larger fish from 13.2 to 15.6 inches were more common with a mean 14.0 inches. Pearse's data were obtained with an electrofishing boat while we waded the shallower waters at Big Delta with a back-pack shocker (Figure 21). Both sets of data indicate some size or age segregation in different sections of the Tanana River, with the smaller fish being further downstream. Pearse (1973) found large round whitefish (mean length 14.4 inches) in abundance in the Delta Clearwater River during the summer (population estimate of 13,600 fish; 8.5 times more biomass than grayling). Apparently few round whitefish spawn or winter in the Delta-Clearwater River; no juveniles were found during Pearse's study with the smallest captured being 7.5 inches, and by early September whitefish were scarce with most apparently migrating downstream to the Tanana. Whitefish are fall spawners so after reaching the Tanana they presumably migrate up other tributaries to spawn, although there could be main stream spawning also. Pearse observed spawning concentrations 50 miles up the Goodpaster River on September 17- 19, 1973 which contained fish tagged in the Delta-Clearwater River during the summer. After overwintering elsewhere, round whitefish were again first observed in the Delta Clearwater River on April 10, becoming abundant by May; they also return to other tributaries for summer residence.

Valdez (1976) found round whitefish in July 1976 in the Little Girstle River, tributaries of the Johnson and Robertson Rivers, Berry Creek, a tributary of Sam Creek, Yerrick and Beaver Creeks, and the Tok River. We did not find round whitefish in any of the tributaries we checked from late September to late April except for the Tok Overflow. Round whitefish were abundant in the Tok Overflow on October 31, 1977, along with grayling, but departed some time during the winter and were absent during March and April. These fish appeared to be mostly in the 6 to 8 inch size range and were not spawners. The comments given for the probable overwintering areas for Tok River grayling would also be applicable to the round whitefish.

Round whitefish generally occur sympatrically with grayling in the summer seemingly occupying the same niche, and having similar migratory patterns and habitat preferences. The chief differences are that grayling are spring spawners and round whitefish are fall spawners, and round whitefish seem to concentrate in open areas of the Tanana in winter while grayling do not.

Large humpback whitefish (mean length 16 inches) were commonly taken in the Tanana River near Tanacross, but we did not find them at Big Delta; likewise Pearse (1973) recorded them only as an incidental occurance in the Delta-Clearwater River in mid-May and did not report them for the Tanana River. We found no humback whitefish in the tributaries that we checked in winter (except for lower Moose Creek in late April), nor did Valdez (1976) find them in mid-summer. Residents report large migrations of humpback whitefish in spring and in Scottie, Desper and Moose Creeks, but probably these streams serve merely as migratory corridors between the lakes used for summer rearing and the Chisana and Tanana Rivers used for spawning and overwintering. Mr. Kenneth Alt (ADFG, pers. comm.) once set a gillnet in Moose Creek the first week of June and made a large catch of humpback whitefish and a few round whitefish. He states they appear there in late May and are headed for the Fish Lake complex for summer feeding. A trapper told us of catching large numbers of humpback whitefish for bait in the fall in the Tanana River near Riverside.

Pearse (1975 & 1976) collected humpback whitefish in Volkmar, George, Mansfield, Mineral and Yarger Lakes and they probably occur in most of the lakes of the upper Tanana in summer. Mansfield Lake support a substantial subsistence harvest; a Native of Tanacross informed us that the whitefish spawn in the fall in the outlet and then return to the lake for the winter; whether the larvae drift downstream or can return to the lake is unknown. Humpback whitefish are abundant in Mineral Lake in summer, but Pearse (1976) measured the dissolved oxygen in February at 0.0 mg/l and the maximum depth at only 12 feet. It would appear necessary for these fish to survive that they winter somewhere in the upper Tok River or migrate downstream to the Tanana before the lower river freezes solid in early November, a situation analagous to that of the grayling discussed earlier. Whitefish are fall spawners and it is generally believed that they migrate out of the lakes and tributaries in the early fall and spawn and overwinter in the main stem of the Tanana and Chisana Rivers.

During fall salmon surveys any indication of whitefish spawning concentrations or other activity has been watched for with negative results.

No small humpbacks were taken and the whereabouts of the juveniles is another mystery. Thus both the spawning and nursery areas of the humpback whitefish seem to be unknown.

Dinneford (1978) reported catching 167 broad white fish (*Coregonus nasus*) at the George Creek site while test fishing for salmon, and 15 at the Girstle River site. No whitefish were caught in a 2-day gillnet set in mid-October near the mouth of the Tok River. None of the other investigators list the broad whitefish as being a component of the fish fauna of the upper Tanana drainage and Mr. K. Alt (ADFG, pers. comm.) has not found them farther up stream than Fairbanks. A misidentification is possible, particularly since no humpback whitefish were recorded as being taken at the two sites. In any event, a large fall migration or pre-wintering concentration of humpback and/or broad whitefish were found in the Tanana River near George Creek in late September and early October.

Pearse (1974) reported a few least cisco (*Coregonus sardinella* in the Delta-Clearwater River in mid-May, but none in the Tanana and did not report them in his 1975 and 1976 lake inventory work. Likewise, neither Valdez (1976) nor this study found the least cisco. Dinneford (1978) however, caught 123 cisco in a gillnet in the Tanana River near George Creek, but none above the mouth of the Girstle River or near the mouth of the Tok River (a smaller mesh size used at the George Creek site may have accounted for some of the difference).

There are many unknowns concerning the distribution and life histories of the several species of whitefish found in the upper Tanana Valley, but it appears unlikely that there are overwintering concentrations in the tributaries to be crossed by the gas pipeline. The Tanana River at Big Delta does appear to be an overwintering area for round whitefish; the Tanana River crossing near Tok, and the sections of the Tanana and Chisana Rivers adjacent to the corridor near Northway bear further investigation.

OTHER FISH SPECIES

Several fishes occur in abundance throughout the upper Tanana Basin in summer, but we were unable to locate concentrations during winter sampling.

The longnose sucker is one of the commonest fish noted during the summer months, but we observed only two adults in our winter sampling of the Tanana River--one at Big Delta and one near Northway--and none in the tributaries. Juvenile suckers were very abundant along the beaches at Tanacross in April, but there were no adults there and juveniles were absent at Big Delta. During ADFG gillnet fishing in late September and early October 1976 and 1977, 8 and 74 suckers, respectively, were caught near George Creek but none at the Gristle or Tok River sites (Francisco and Dinneford, 1977; Dinneford, 1978).

The northern pike is found in almost every lake and slough during summer, but we captured only one during the winter--in Sam Creek. ADFG sampling near George Creek captured no pike in 1976, but 67 in 1977; none were taken at the Gristle or Tok sites. We observed numerous pike in Fish Lake near Northway in late September; whether these fish descend to the Chisana River via Moose Creek for the winter or locate suitable wintering areas within the lake system is unknown.

Most of the lakes are very shallow and probably freeze to the bottom and decay of the abundant aquatic vegetation contributes to very low dissolved oxygen levels (only 1 mg/l measured in Moose Creek on March 2, 1978), so the second alternative seems unlikely.

The burbot or ling is another common fish of the upper Tanana River and is highly valued as food. The Chisana River near Northway is considered a good fishing area for burbot, but we found little evidence of utilization during the winter. A few recently used holes with blood-stained ice observed in late October indicated some success at that time, but little other effort was observed.

Pearse (1975) indicated that the best fishing occurs during April and early May. We made an overnight set of three lines under the Tanana River bridge near Tok in late March and caught one 24-inch burbot (cover); one 6-hook set line off Crystal Springs was examined on April 20 which was empty. ADFG test fishing efforts caught one burbot near George Creek in 1977 and 19 in 1978. One small burbot was caught by electrofishing at Big Delta in late April (Fig. 22) which was feeding exclusively on chum salmon fry. In a summer food-habits study in the Tanana and Yukon Rivers, Chen (1969) found salmon fry to comprise 1% of the burbot stomach contents and those instances were ascribed to the two species being retained together in a hoop net. Burbot spawn during the winter, peaking in February (Chen, 1969), but it is not known where in the Tanana River spawning occurs or if they aggregate in spawning concentrations as has been observed elsewhere.

The lake chub was captured sparingly along the beaches from Tanacross to Crystal Springs, although it is found in abundance in the lakes and tributaries in summer.

The slimy sculpin is the most ubiquitous of the sub-arctic fishes. It is common in every fluvial habitat in summer and winter from the main-stem Tanana to the isolated headwater tributaries in company only with the Dolly Varden char. Those we captured in the Tanana River tended to be smaller (mean length 47mm) than those found in the tributaries (73-90mm). The larger ones we observed were mostly mature females with ripe eggs.

WATER QUALITY AND HYDROLOGY

Spot checks of water quality were made to detect conditions that would limit survival of aquatic organisms (Appendix Table II). In general, levels of dissolved oxygen present in the streams during winter were adequate for fish survival, but many of the shallow lakes become oxygen deficient in winter. (Pearse, 1975 & 1976). Except for Gardiner Creek, Moose Creek, Jan Lake and the two lakes near Desper Creek we found no severe dissolved oxygen depression in the waters checked. Schallock and Lotspeich (1974) found dissolved oxygen levels to be severly depressed in some Alaska rivers in winter. They noted that the Tanana River at Fairbanks during February and March 1970 contained 9-11 mg/l of dissolved oxygen with values decreasing downstream to 6-7 mg/l near the mouth. We found dissolved oxygen levels of 7-10 mg/l in the upper Tanana River, with the springs and tributaries between 7 and 13 mg/l--corresponding approximately to what Schallock and Lotspeich observed in samples along the Alaska Highway. They found Gardiner Creek, for example, to have 0.0 mg/l dissolved oxygen and a sulfurous odor in February 1971; we found 4 mg/l on October 30, 1977, no flow on February 28, 1978, and 2 mg/l on April 23, 1978. Obviously conditions for winter survival of fish in Gardiner Creek were poor at best.

Stream water temperatures during mid-winter were usually at 32-33° F. with the springs showing 34-35°. PH was consistently between 7.5 and 9.0 with one exception--Sears Creek being slightly acidic.

Conductivity was generally high during the winter, usually in excess of 300 microhmos/cm; the flow is essentially all ground water and the springs have similar high values. Lower values in the spring months, between 84 and 150 microhmos/cm, reflect runoff from melting snow. The lowest value recorded was 62 for Jan Lake, suggesting a very low basic productivity for this water body. The values of total acidity, total alkalinity, hardness and carbon dioxide were quite variable, but well within the limits of aquatic organism survival. Water from the springs was very hard as would be expected.

Water Condition in Appendix Table II refers to clarity, ranging from clear to murky to turbid, with brown being the brown stain from dissolved organic matter leached by the streams passing through bogs and marshes.

It has been generally recognized that many of the small tributaries of the upper Tanana freeze to the bottom in winter, but site specific details were lacking. This study provided the following information on streams that do contain water during the winter at the pipeline crossings:

Scotty Creek - Water reported to be present under very thick ice--not confirmed;

Tanana River - Figures 23 and 26;

Crystal Springs - a branch upwells near the pipeline alignment and highway (Figure 8);

Robertson River - flows in lower section under very thick overflow ice;

Berry Creek - flowing upstream, and probably flowing under very thick ice at the highway, but could not be confirmed (Figures 17 & 18);

Sears Creek - a small upwelling flow;

Johnson River - open in upper areas, flowing in lower section under very thick overflow ice (Figure 19);

Girstle River - minor upwelling flow.

The Tok River, Yerrick (Figures 9 and 10), Bear (Figure 13), Dry Creeks and perhaps others flow in the upstream areas but are dry at the highway - pipeline crossings during the winter. Undoubtedly there are substantial subterranean ground water flows from these streams somewhere in the vicinity.

The Tanana and Chisana Rivers flow heavily all winter, albeit under mostly a solid ice cover. Tables in U.S. Geological Survey (1976) for the water years 1966-70 show the Chisana River at Northway generally in the range of 1,300 to 1,600 cfs in October, dropping to 1,000 in November, and from 600 to 1,000 from December through April. The Tanana River at Tanacross has 4,000 to 6,000 cfs in October, with a decline to 2,500 to 3,200 in November and generally 2,000 to 2,500 all winter. In most years the flows did not increase substantially during April. On February 16, 1978, the U.S. Geological Survey (Pres. Comm., Fairbanks Office) measured the flow in the Tanana at 2,360 cfs. Data for Dry Creek indicates no water flowing from October through April in any of the years 1966-70, but flows steadily increased during May and declined in June with only occasional flows showing for July, August and September; 1966, for example showed no flow in July, August and September, but 1968 had substantial flows in each of those months. This variable flow pattern would likely influence the abundance of wintering fish in the upstream areas, with egress impossible during the dry years. Berry Creek is the only other stream in the upper Tanana basin with a U.S.G.S. water gage giving daily discharges (Figures 18). During 1975-76, October had a mean flow of 31 cfs, November 15, December 12, January through March 11, and April 14. For comparison, summer means flows were 55, 153, 77, 90 and 44 cfs for May through September, respectively. On February

15, 1978 the U.S.G.S. (pers. comm., Fairbanks Office) measured the flow in Berry Creek, one mile above the bridge and gage, at 11.1 cfs (we estimated 5 cfs based on the small amount of open water visible through holes in the ice).

FISH OVERWINTERING

In our search for fish overwintering concentrations in the upper Tanana River basin, we seemed to have found instead where they were not concentrated. Considering the effort expended and area covered by electrofishing, seining and gillnetting, catches were sparse indeed. This seems contradictory since much of the water volume available in summer is converted to ice in winter and the fish must necessarily be restricted in their range and concentrated to some degree. The reason for this apparent contradiction is that the Tanana and other glacial rivers are so turbid in summer as to be of little or no value as fish habitat--in winter they become clear and present good fisheries habitat.

By the process of elimination, one must conclude that most of the fish in the upper Tanana River drainage probably winter in the main stem of the Tanana and Chisana. The Johnson, Robertson and Upper Tok rivers also present opportunities for wintering, but the extent to which these glacial tributaries may be utilized is unknown. Studies of the open areas of the Tanana River, however, revealed little indication of fish congregations or what might be considered a concentration in an overwintering area; instead the fish seemed more inclined towards solitary behavior. ADFG considers the Tanana River at Big Delta, where the Alyeska oil line crosses, as an overwintering area and round whitefish were found there in large numbers (Pearse, 1974), but relatively few of the other species were present (excepting the millions of salmon eggs nd alevins in the gravel). Substantial catches of a variety of pecies were taken by ADFG gillnetting near George Creek (Dinneford, 97), but the timing of the sampling (September 23 - October 15, 1977) uggests interception of migrating fish rather than a wintering con-entration. Our poor catches in gillnetting operations in April near an cross suggested a lack of movement at that time and place. What ight be present under the thick ice that covers much of the Tanana n inter remains a mystery and many questions remain unresolved: hether the fish are in concentrations or tend to be dispersed as in he open areas; where do two of the most abundant fish in the system -s cker and pike--winter?; where do the humpback whitefish spawn and here are the juveniles in winter?; are salmon spawning under the ice n idstream groundwater upwellings?

Populations of char and sculpin were found wintering in several ea water tributaries, but their density was low compared to summer bs rvations; whether this difference was real or due to many of the ish being under the ice and unavailable to the sampling gear is nk own. The lower reaches of most of these streams become dry and/or rozen to the bottom thus isolating these stocks for much of the year. he grayling and round whitefish, which are found with the char in um er, migrate downstream in the fall. Springs, so critical in the urvival of fish in North Slope streams, seem to be almost avoided in in er by the Tanana River fish. An obvious difference, of course, is hat virtually the only flowing water available in the arctic is the pri gs and the fish concentrate there to survive; in the Interior copious uan ities of water are available in the Tanana and other large rivers. ome deep lakes may provide satisfactory conditions for overwintering, lth ugh the extent to which they may be used is unknown. Most of the akes in the basin are shallow, with abundant vegetation, which would contribute to winterkill under the deep ice and snow cover.

While many unknowns regarding the winter distribution of fish in the upper Tanana Valley still persist, it can be stated with confidence that the pipeline in crossing the smaller tributaries will impact no important fish overwintering areas. Pipeline construction during the period October through mid-April would have minimal effect on fish and the aquatic environments.

WILDLIFE

The more conspicuous wildlife species observed in driving the Alaska Highway, flying and traveling the streams were recorded as noted (Appendix Table IV); no special effort was made to seek out concentrations except to drive through the grain fields north of Delta Junction when migratory birds were expected.

The taiga of the upper Tanana Valley is quiet in winter with often only the ubiquitous raven and gray jay breaking the silence, a stillness made deeper than usual in recent years because of low's in the cycles of snowshoe hares and grouse and the extremely poor population status of moose in the area. During the hundreds of miles of driving and flying only nine moose were seen. Wolf tracks were noted, but no wolves--nor bears. One red fox was seen and much beaver and muskrat activity noted. Along the roads and streams six hares, three ruffed grouse and one spruce grouse were noted. Dippers are resident on most open streams. The only winter resident raptor is the goshawk and they were frequently observed. A river otter track was followed from the Berry Creek bridge a mile upstream to where the trail dissappeared into a hole under the ice near the bank (Fig. 26). With fish being an important food source for otters, one might suspect that fish were wintering there.

In a very general way these figures may reflect the resident wildlife that would be encountered during any winter construction and operation of the pipeline, although population numbers of the cyclic species are beginning to increase from their low point and moose are also beginning to increase under protection.

By the last week of September 1977, most of the migratory waterfowl had left the region with only 20 sandhill cranes observed over the Delta fields on September 26th. On September 27-28 a variety of ducks were still present near Northway, but their numbers had decreased greatly over previous levels. Most of the small ponds freeze over in early October, but some waterfowl linger on later along the streams; e.g., six trumpeter swans and two green-winged teal at Crystal Springs on October 14 and mallards on the Delta River as late as November 16, the latter feeding on salmon eggs and perhaps carcasses.

A migration of bald eagles through the area seemed to be in progress during the first half of April, 1978. The numbers in the Appendix Table refer only to mature eagles; several large, dark raptors noted could have been immatures. One eagel nest was observed along the river between Tanacross and Crystal Springs in April, but it did not appear to be in use at that time.

In mid-April the forests again filled with bird song and the waterfowl returned. The first Canada geese were noted at Delta on April 15, 1978 and they were abundant by April 19, but there were no cranes present at that time. A pair of cranes were noted near Northway on April 25 and about 100 whistling swans further east near the border. The first ducks noted in the spring along the Tanana were goldeneyes on April 14; by April 20-21 mallards and pintails were abundant along with a few widgeon and buffleheads.

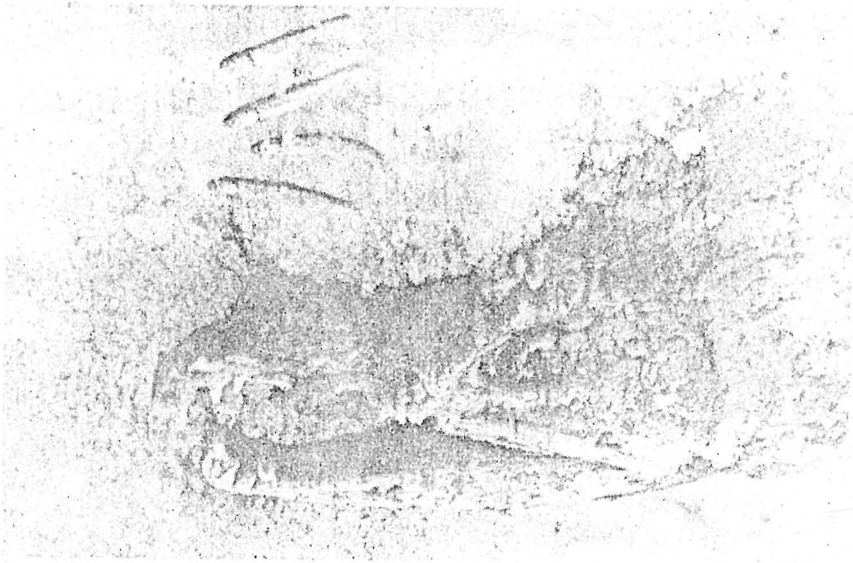
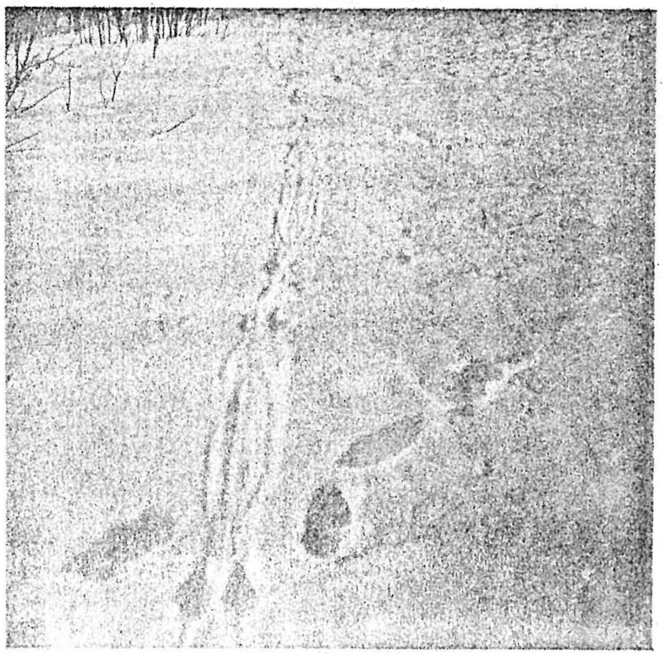


Figure 25. Chum salmon from the Tanana River at Big Delta, March 31, 1978. Spawned-out male from the late fall run of 1977 and newly emerged fry.

Figure 26. River otter tracks going up Berry Creek, March 31, 1978.



SUMMARY AND CONCLUSIONS

During construction of the Trans-Alaska Pipeline System concentrations of overwintering fish in several arctic streams were severly impacted by depletion of limited fresh water resources. To avoid a similar problem with construction of the natural gas pipeline, a study was made of possible fish overwintering areas along the Alaska Highway and proposed Northwest Alaskan Pipeline Company corridor between Big Delta, Alaska and the Canadian border. No winter fisheries work on the streams of this area had been done previously.

Visual observation from ground and air, electrofishing, seining, gillnetting and hook-and-line were employed from late September through November 1977 and February through April 1978 to sample fish populations. Echo sounding and SCUBA diving was tried without success. Water chemistry data was also taken and wildlife observed.

Surveys for spawning salmon above Delta Junction continued in the fall of 1977. Only one possible area of spawning activity was identified on the upper Chisana River. Alaska Department of Fish & Game counts of salmon in known spawning grounds on the Tanana River and test netting suggested a substantial run of chum salmon in the upper Tanana River however; there spawning area remains a mystery. Intensive sampling of the Tanana River near Tanacross and springs and tributaries failed to reveal the presence of rearing salmon fry or fingerlings or downstream migrant smolts. Water temperatures of the upper Tanana springs are slightly colder than those near Big Delta--possibly enough differential exists to inhibit successful salmon egg incubation and development.

Dolly Varden char and sculpins were found wintering in upstream areas of tributaries that were dry or frozen to the bottom in the lower portions. In general, grayling migrate out of the tributaries in the late summer and early fall, winter mostly in the ice-covered portions of the Tanana River, and return to the tributaries in late April and May for spawning and summer feeding. The larger glacial rivers may also contain overwintering grayling and this possibility needs further examination along with site-specific migration timing. Round whitefish were found wintering in open areas of the Tanana River in relatively large numbers compared to other fish species. In summer, round whitefish and grayling appear to occupy the same ecological niche, but fall and winter behavior differs. Neither species use the "typical" spring-fed streams for spawning or wintering. Adult humpback whitefish were taken in the Tanana River near Tanacross, but not in abundance considering the species' large biomass in the Tanana basin. The spawning, wintering and nursery areas of the humpback whitefish are largely unknown. The longnose sucker, northern pike, and burbot are common and widespread throughout the system in summer, but we were unable to locate any concentrations in winter. The slimy sculpin is ubiquitous, found in every habitat, winter and summer. The lake chub was taken occasionally.

Water quality in the streams was generally adequate for fish survival. Some lakes, and their outlet streams, had low dissolved oxygen levels. Typically, most of the tributaries at the lower elevations dry up or freeze to the bottom in the fall and do not flow again until melting snow water again fills the channels in spring. Most of the fish must migrate downstream to larger, permanent water bodies before freeze-up. Many of the streams contain flowing water in the upstream areas and winter, however; the streams crossing the highway- pipeline corridor that flow in winter were documented in the study.

The major wintering area at Big Delta where the highway and pipeline crosses the Tanana River harbors significant numbers of round whitefish, and relatively fewer numbers of a variety of other native species, in addition to the salmon eggs and alevins incubating in the gravel.

No other important overwintering fish concentrations were found in the areas sampled--primarily the open areas of the Tanana River, the springs and headwater tributaries. Most of the fish stocks of the upper Tanana Basin probably winter in the main-stem of the Tanana and Chisana Rivers, but much remains to be learned regarding aquatic life under the thick ice that covers much of the system in winter. Considering the vast complex of lakes and streams in the Tanana Basin, there could well be major concentrations of fish wintering somewhere in the system yet to be discovered. Different species apparently prefer different portions of the Tanana River for wintering and there exists size segregation within a species.

Wildlife was scarce during the winter, with snowshoe hares and grouse not yet recovered from the nadir of their natural cycles and the moose population severely depressed. Notes on the larger birds and mammals observed are included in the text and tables.

The most important conclusions from this study are: (1) The gas pipeline will impact no important fish overwintering or salmon spawning or rearing areas in crossing <u>tributaries</u> of the upper Tanana River: and (2) springs and upwelling ground waters east of Delta Junction are not directly utilized by fishes in winter.

REFERENCES

Bendock, T.N. 1976. De-watering effects of industrial development on arctic fish stocks. Alaska Dept. of Fish & Game, Sport Fish Division, Report to the Board of Fisheries, 13p.

Chen, L. 1969. The biology and taxonomy of the burbot, Lota lota leptura, in Interior Alaska. Biol. Papers of the Univ. of Alaska, No. 11, 51p.

Dinneford, W.B. 1978. Final report of the commercial fish technical evaluation study: Tanana and Delta Rivers. Joint State/Federal Fish & Wildlife Advisory Team, Special Report, in press.

Francisco, K. & W.B. Dinneford. 1977. Fourth Interim Report of the commercial fish - technical evaluation study: Tanana Delta Rivers. Joint State/Federal Fish & Wildlife Advisory Team, Special Report No. 19, 50p.

Geiger, M.F. & F.M. Andersen. 1976. Annual management report, 1975, Yukon Area. Alaska Dept. of Fish & Game, Division of Commercial Fisheries, 65p.

Morrow, J.E. 1974. Illustrated keys to the fresh-water fishes of Alaska. Alaska Northwest Publishing Co., Anchorage, 78p.

McPhail, J.D. & C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Fish Res. Bd. Canada. Bill 173, 381p.

National Oceanic & Atmospheric Administration. 1978. Climatological Data, Annual Summary, Alaska, 1977. Vol. 63, No. 13.

Pearse, G.A. 1974. A study of a typical spring fed stream of Interior Alaska. Alaska Dept. of Fish & Game, Ann. Performance Report for Lake & Stream Investigations, Vol. 15, Study G-III, 49p.

Pearse, G.A. 1975. Inventory and Cataloging of the Sport Fish & Sport Fish Waters of Interior Alaska - Tok District. Alaska Dept. of Fish & Game, Sport Fish Division, Federal Aid in Fish Restoration, Vol. 16, Study G-I, p. 208-240.

Pearse, G.A. 1976. Inventory and cataloging of the sport fish and sport fish waters of Interior Alaska, Tanana River drainage between Tok and Little Delta Rivers. Alaska Dept. of Fish & Game, Sport Fish Division, Federal Aid in Fish Restoration, Vol. 17, Study No. G-1, in press.

Reed, R.J. 1964. Life history and migration patterns of arctic grayling, Thymallus arcticus, (pallas), in the Tanana River drainage of Alaska. Alaska Dept. of Fish & Game, Research Report No. 2, 30p.

Tack, S.L. 1971. Distribution, abundance and natural history of the arctic grayling in the Tanana River drainage. Alaska Dept. of Fish & Game, Division of Sport Fish, Federal Aid in Fish Restoration, Project F-9-4, Vol. 12, 35p.

Tack, S.L. 1972. Distribution, abundance and natural history of the arctic grayling in the Tanana River drainage. Alaska Dept. of Fish & Game, Division of Sport Fish, Federal Aid in Fish Restoration, Project F-9-4, Vol. 13, 36p.

Tack, S.L. 1973. Distribution, abundance, and natural history of the arctic grayling in the Tanana River drainage. Alaska Dept. of Fish & Game, Sport Fish Division, Federal Aid in Fish Restoration. Project F-9-5, Vol. 14, 34p.

Tack, S.L. 1974. Distribution, abundance and natural history of the arctic grayling in the Tanana River drainage. Alaska Dept. of Fish & Game, Division of Sport Fish, Federal Aid Fish Restoration, Project F-9-6, Vol. 15, 52p.

Schallock, E.W. & F.B. Lotspeich. 1974. Low winter dissolved oxygen in some Alaskan rivers. U.S. Environmental Protection Agency, Ecological Research Series. EPA-660/3-74-008, 33p.

U.S. Geological Survey. 1976. Surface water supply of the United States, 1966-70. Part 15. Alaska. Water-Supply Paper 2136, 428p.

U.S. Geological Survey. 1977. Water resources data for Alaska Water Year 1976. Water-Data Report AK-76-1, 401p.

Valdez, R.A. 1976. Fisheries Survey of Tanana River tributaries along the Alcan Gas Pipeline route. Bio/west, Inc., TR-2-1, 59p.

Van Hyning, J.M. 1976. A reconnaissance of the fish resources of the Northwest Pipeline Corporation corridor--Alaska border to Delta Junction. A report to the Gulf Interstate Engineering Co., 28p.

Van Hyning, J.M. 1976. Salmon surveys of the upper Tanana River 1976. Nerka, Inc. A report to the Gulf Interstate Engineering Co., 31p.

Wilson, W.J., E.H. Buck, G.F. Player, & L.D. Dreyer. 1977. Winter water availability and use conflicts as related to fish and wildlife in arctic Alaska--a synthesis of information. Arctic Enviornmental Information & Data Center, A report to the U.S. Fish & Wildlife Service, 222p.

APPENDIX TABLE I

COMMON AND SCIENTIFIC NAMES OF SPECIES OBSERVED

Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*O. kisutch*
Chum salmon	*O. keta*
Arctic grayling	*Thymallus arcticus*
Dolly Varden char	*Salvelinus malma*
Humpback whitefish	*Coregonus pidschian*[1]
Round whitefish	*Prosopium cylindraceum*
Northern pike	*Esox lucius*
Lake chub	*Couesius plumbeus*
Longnose sucker	*Catostomus catostomus*
Burbot	*Lota lota*
Slimy sculpin	*Cottus cognatus*
Snowshoe hare	*Lepus americanus*
Red squirrel	*Tamiasciurus hudsonicus*
Coyote	*Canis latrans*
Gray wolf	*C. lupus*
Red fox	*Vulpes fulva*
Moose	*Alces alces*
Caribou	*Rangifer tarandus*
Beaver	*Castor canadensis*
River otter	*Lutra canadensis*
Muskrat	*Ondatra zibethicus*
Whistling swan	*Olor columbianus*
Trumpeter swan	*O. buccinator*
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhyncos*
Pintail	*A. acuta*
American widgeon	*A. americana*
Green-winged teal	*A. crecca*
Goldeneye	*Bucephala sp.*
Bufflehead	*B. albeola*
Red-breasted merganser	*Mergus serrator*
Northern shoveler	*Anas clypeata*
Scaup	*Aythya sp.*
Lesser sandhill crane	*Grus canadensis*
Mew gull	*Larus canus*
Herring gull	*L. argentatus*
Spruce grouse	*Canachitas canadensis*
Ruffed grouse	*Bonasa umbellus*
Great horned owl	*Bubo virginianus*
Bald eagle	*Haliaeetus levcocephalus*
Goshawk	*Accipter gentilis*
Gray jay	*Perisoreus canadensis*
Common raven	*Corvus corax*
Robin	*Turdus migratorius*
Rusty blackbird	*Euphagus carolinus*
Bohemian waxwing	*Bombycilla garrulus*
Snow bunting	*Picctrophenax nivalis*
Pine grosbeak	*Pinicola nucleator*
Dipper	*Cinclus mexicanus*

Diatoms	*Fragilaria* sp.
Midge larvae	Family Chironomidae
Stonefly larvae	Family Plecoptera
Mayfly larvae	Order Ephemeroptera
Caddisfly larvae	Order Trichoptera
Beetles	Order Coleoptera

[1]Ichthyologists disagree on the taxonomy of the humpback whitefish. McPhail and Lindsey (1970) include *Coregonus clupeaformis*, *C. pidschian* and *C. nelsoni* in the "*C. clupeaformis* complex" with only slight differences in gill-rakercount separating the three species. Morrow (1974) refers to the humpback whitefish of the Interior as the Alaska whitefish (*C. nelsoni*), however Alaska Department of Fish & Game biologists term them humpback whitefish (*C. pidschian*) which is the name adopted here.

APPENDIX TABLE II

WATER QUALITY AND QUANTITY OBSERVATIONS

Water Body & Location	Mile	Date	H_2O Cond.	H_2O Temp. °F	%Ice Cover	Flow (cfs)	Spec. Conductance (microhmhos)	pH	mg/l Total Acid.	mg/l Total Alkal.	mg/l Hardness	mg/l CO_2	mg/l Dislvd. Oxyg.	Comments
Scotty Cr.	1223.5													
at bridge		28 Feb.78			100									Flowing under thick ice.
"		23 Apr.78	clear	34	100		360						6	
Desper Cr.	1225.5													
at culvert		28 Feb.78			100	0								Frozen to bottom.
"		23 Apr.78	brown	33	10	10								
Sweetwater Cr.	1234													
	1237	23 Apr.78	brown	34	10	5								Flowing over top of ice.
Unnamed Cr.	1242													
at culvert		23 Apr.78			0	0								Dry
Gardiner Cr.	1246.6													
at bridge		30 Oct.77	brown	33	90	5			17	86	120	20	4	
"		28 Feb.78			100	0								Frozen to bottom.
"		23 Apr.78	brown	35	60	2	380	7.5					2	
Tenmile Cr.	1253													
at culvert		30 Oct.77			100	0								Frozen to bottom.
"		23 Apr.78	brown		50	2								Flowing over top of ice.
Silver Cr.	1259													
at culvert		23 Apr.78			50	1								Flowing over top of ice.
Chisana R.	1264													
at Northway		30 Oct.77		32	100									
above "		17 Nov.77			60									From air.
at Northway		22 Apr.78			80									

APPENDIX TABLE II
Water Quality & Quantity Observations
page two

Water Body & Location	Mile	Date	H_2O Cond.	H_2O Temp. °F	%Ice Cover	Flow (cfs)	Spec. Conductance (microhmhos)	pH	mg/l Total Acid.	Total Alkal	Hardness	CO_2	Dislvd Oxyg.	Comments
Moose Cr.	1265													
at Northway		1 Mar.78	clear		100	20		8.5	86	205	188	15	1	Thin ice cover; mossy taste.
at mouth		22 Apr.78	murky		0			7.5					6	
Unnamed Cr.	1266													
at culvert		27 Sept77	clear	34	0	5								Impassable culvert.
Beaver Cr.	1268													
at culvert		27 Sept77	clear	34	0	25								
"		30 Oct.77			100	0								Frozen to bottom.
"		22 Apr.78	brown		20	2								Flowing over bottom ice.
Unnamed Cr.	1278													
		1 Mar.78			100	0								
Bitters Cr.	1280.2													
at culvert		1 Mar.78			100	0								Dry
"		22 Apr.78			100	0								
Tanana River	1303													
at Tok Bridge		23 Mar.78	clear	32	100		360	8.5		154	171	20	9	Large flow under thick ice.
Tok River	1309													
at bridge		29 Sept77	murky	37	0	100								
upstream 20m.		13 Oct.77	clear		10	50				154	239	15		
at bridge		30 Oct.77			100									Flow unknown.
at bridge		18 Nov.77			100	0								Frozen to bottom.
at bridge		9 Apr. 77	clear	33	90	1	150	7.5	51	68	68	5	13	
Tok overflow														
at culvert		13 Oct.77	clear	36	0	10								
"		31 Oct.77	clear	35	10	10			17	137	171	10		
"		2 Mar. 78	clear	34	10	10		8.5	51	154	222	15	10	
"		23 Mar.78	clear	35	10	5	440							Side spring had 38°.
"		18 Apr.78	clear	36	10	10								

APPENDIX TABLE II
Water Quality & Quantity Observations
page three

Water Body & Location	Mile	Date	H_2O Cond.	H_2O Temp. °F	Ice Cover	Flow (cfs)	Spec. Conductance (microhmhos)	pH	Total Acid. (mg/l)	Total Alkal. (mg/l)	Hardness (mg/l)	CO_2 (mg/l)	Dislvd Oxyg. (mg/l)	Comments
Tanana River	1325													
at Tanacross		14 Oct.77	turbid	33	0									
"		29 Oct.77	murky	33	10				17	154	222	10	10	
"		18 Nov.77	clear	33	20									
"		27 Feb.78	clear		60									Frozen about ½ across.
"		13 Apr.78	clear	34	20		360							
Crystal Sprgs.	1328													
at mouth		14 Oct.77	clear	34	0	5								
"		29 Oct.77	clear	34	0	5			17	154	222	15	7	
at highway		27 Feb.78	murky		50	4								
at mouth		22 Mar.78	clear	33	0	3	320	8.0	51	188	222	15	7	
Yerrick Cr.	1333.7													
at bridge		29 Sept77	clear		0	10								
"		29 Oct.77	clear	32	80	5			17	55	86	5		
"		27 Feb.78			100	0								Frozen to bottom.
upstream 3 mi.		13 Apr.78	clear	33	80	4								
Unnamed Cr.	1344													
at culvert		26 Apr.78	brown		0	3								
Robertson R.	1347-8													
at bridge		29 Sept77	turbid		0	200+								Water clear along edge.
"		1 Nov.77	murky		80									Heavy flow in 4 open channels
"		27 Feb.78			100									Flood plain ice covered.
"		19 Apr.78			100									
Jan Lake	1353.5													
		16 Mar.78	clear	32	100		62	7.5	17	68	68	5	2	
Bear Creek	1357													
at bridge		29 Sept77	clear		0	10								
"		1 Nov.77			100	0								Frozen to bottom.
"		27 Feb.78			100	0								
		26 Apr.78	brown	33	50	5	84							Flowing over bottom ice.

APPENDIX TABLE II
Water Quality & Quantity Observations
page four

Water Body & Location	Mile	Date	H_2O Cond.	H_2O Temp. °F	%Ice Cover	Flow (cfs)	Spec. Conductance (micromhos)	pH	Total Acidity (mg/1)	Total Alkal. (mg/1)	Hardness (mg/1)	CO_2 (mg/1)	Dislvd. Oxyg. (mg/1)	Comments
Chief Creek	1358.7													
at bridge		29 Sept77	clear		0	10								
"		27 Feb.78			100	0								Frozen to bottom.
Sam Creek	1370													
trib. at culvert		14 Oct.77	clear	32	50	2								
at mouth		14 Oct.77	murky	32	10	10								
trib. at culvert		1 Nov. 77			100	2								Water flowing under ice.
trib. at culvert		27 Feb.78			100	0								Three feet of ice, no flow.
at mouth		1 Nov.78			100									
at mouth		15 Mar.78	clear	32	80	2	330		51	154	154	15	10	
trib. at culvert		26 Apr.78	brown		80	5								Flowing over bottom ice.
Berry Creek	1371.4													
at bridge		29 Sept77	muddy			50								
"		1 Nov. 77	clear	32	80	10			5	51	51	5	12	
1mi. upstream & downstream		27 Feb.78	clear		90	5								
1 mi. upstream		23 Mar.78	clear	32	90	5	120		34	102	68	10	10	
3 mi. upstream		15 Apr.78	clear	32	70	10								
Sears Creek	1374.4													
at bridge		29 Sept77	clear	33		8								
"		1 Nov. 77			100	0								
"		26 Feb.78	clear		100	3		6.5	34	103	103	10	7	Large overflow area.
Dry Creek	1378													
at bridge		29 Sept77	clear	35	0	3								
"		1 Nov. 77			100	0								
"		26 Feb.78			100	0								Stream bed dry, but snow covered.
4 mi. upstream		10 Apr.78	clear	32	80	4								

APPENDIX TABLE II
Water Quality & Quantity Observations
page five

Water Body & Location	Mile	Date	H_2O Cond.	H_2O Temp. ^oF	%Ice Cover	Flow (cfs)	Spec. Conductance (microhmos)	pH	Total Acid. (mg/l)	Total Alkal. (mg/l)	Hardness (mg/l)	CO_2 (mg/l)	Dislvd Oxyg. (mg/l)	Comments
Johnson R. at bridge	1380.5	26 Sept77	murky		0									Several open channels.
"		1 Nov. 77	clear		80									Water flowing under ice.
"		26 Feb.78			100									Several open channels.
"		15 Apr.78	clear		50									
Little Girstle River at bridge	1388.4	26 Sept77	clear		0	20								
"		1 Nov. 77			100									Frozen to the bottom.
"		26 Feb.78			100	0								
"		19 Apr.78	clear		100									
"		26 Apr.78	turbid		0	5								
Girstle R. at bridge	1393	26 Sept77	clear	42	0	40								Stream in five channels.
"		12 Oct.77	clear		10	20								
"		26 Feb.78			100	0								Upwelling.
"		2 Mar.78	clear		100	10								Upwelling.
"		15 Mar.78	clear		100	20								
"		15 Apr.78	murky		50	20								
"		26 Apr.78	turbid		0	15								
Tanana River at mouth of Girstle	1393	15 Mar.78	clear	32	100		190	8.5	34	154	171	10	7	Large and fast flow under thick ice.
at Big Delta		15 Oct.77	turbid	32	10									
"		21 Mar.78	clear	35	10		300							
Delta River at mouth		16 Nov.77	clear	35	10				17	114	137	10	11	
"		25 Feb.78	clear	37	10			9.0	34	86	120	10	12	
"		19 Apr.78	murky	39	0									

APPENDIX TABLE III

DATA ON FISH COLLECTED

Date	Location	Gear	Species	Length (mm)	Weight (gm)	Sex	Stomach Contents
24 March 78	Tanana R. near Tok	setline	burbot	600			Empty
	Sam Creek	gillnet	pike	about 12"			
2 April 78	Tanana R. at Crystal Springs	gillnet	grayling	247	160	F	2/3 full of insect fragments
13-14 April 78	Tanana R. Tanacross to Crystal Springs	electrofishing	16 suckers	(all small, 1-4 inches)			
			10 sculpins	(all small, 1-3 inches)			
			9 grayling	(all yearlings)			
		seine	9 suckers	(all small, 1-4 inches)			
			14 sculpins	(all small, 1-3 inches)			
			2 grayling	91mm 58mm			
			13 suckers	33-92mm, mean: 82.5	lumped sample		
			11 sculpins[1]	23-71mm, mean: 46.8			
20 April 78	Tanana R. Tanacross to Crystal Springs	seine	18 suckers	(all small, 1-4 inches)			
			2 sculpins	(small: 2")			
			3 chubs	(small: 2-4")			
			1 grayling	(about 8")			

[1] larger ones full of ripe eggs

Date	Location	Gear	Species	Length (mm)	Weight (gms)	Sex	Stomach Contents
21 April 78	Tanana R. Tanacross to Crystal Springs	gillnet	humpback whitefish	465		F	Nearly empty, few midge larvae
			"	440		F	Full of midge larvae
			"	357		F	Empty
			"	370		M	Full of midge larvae and algae
			"	383		F	Full of midge larvae
			round whitefish	270		F	
		electrofishing	round whitefish	352		F	Nearly full of midge larvae and green algae
			"	348		F	"
			"	334		M	"
			"	351		M	"
			"	307		F	"
			"	352		F	"
			"	375		M	"
			"	345		M	"
			grayling	202		M	Nearly full of midge larvae and green algae
			grayling	160			
			1 chub	Not measured			
			2 suckers	"			
			2 sculpins	"			
			1 round whitefish	"			
			1 grayling	(about 6")			
23 April 78	Tanana R. at Northway	gillnet	sucker	410		F	Empty
24 April 78	Berry Creek	electrofishing	char	214	100	M	Sand & detritus
			"	377	490	M	Empty
			sculpin	73		F	

Date	Location	Gear	Species	Length (mm)	Weight (gm)	Sex	Stomach Contents
25 April 78	Robertson R.	electrofishing	grayling	818	90		Detritus, midge larvae and insect parts
25 April 78	Bear Creek	electrofishing	char	221	75	M	Full of caddis flies
			sculpin	94		F	Full of midge larvae
			"	80			Full of dark "worms"
	Tok River	electrofishing	char	192	60	M	½ full of caddis fly cases
26 April 78	Tanana R. at Big Delta	electrofishing	round whitefish	361	450	F	Full of caddis fly larvae
			"	70			Full of midge larvae
			"	261	80	M	Full of "green larvae"
			grayling	207	80	M	Full of salmon eggs and insect parts
			grayling	233	125		Full of caddis and stonefly larvae
			burbot	310	240		Filled with 53 chum salmon fry
			chinook salmon	81			Two chum fry and insect parts
			" "	72			Full of insect larvae
			" "	73			½ full of insect larvae
			" "	81			½ full of insect larvae
			" "	76			1/3 full of insect and midge larvae
			sculpin	30			
			sculpin	30			
			13 chum salmon	34-40 (mean 37.8)			

APPENDIX TABLE IV

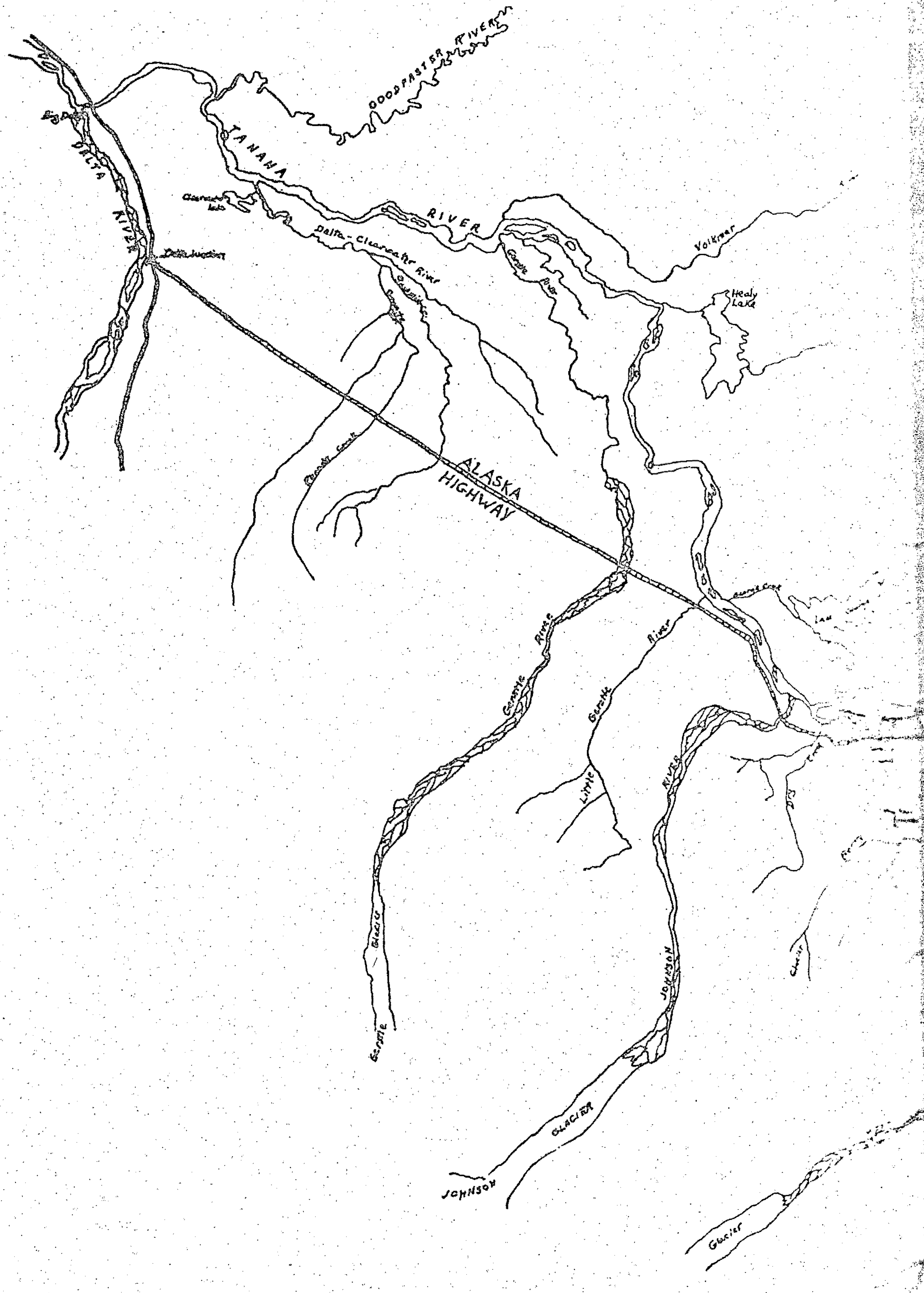
WILDLIFE OBSERVED

Date	Area Traveled	Method	Species
26 Sept. 77	Big Delta to Northway	vehicle	20 cranes over Delta fields
27-28 Sept. 77	Northway	vehicle	A few mallards, pintails, buffleheads, green-winged teal, widgeons, scaups, shovelers, 1 red-breasted merganser
29 Sept. 77	Northway to Big Delta	vehicle	1 spruce grouse near Berry Creek
13 Oct. 77	Tok overflow	foot	1 dipper; many moose tracks
14 Oct. 77	Crystal Springs	foot	6 trumpeter swans 2 green-winged teal
	Sam Creek	foot	1 ruffed grouse; 1 goshawk
15 Oct. 77	Tanana R. at Big Delta	foot	1 mallard
29 Oct. 77	Crystal Springs	foot	1 bald eagle; 1 dipper
30 Oct. 77	Tok to border	vehicle	1 red fox and 1 snowshoe hare near Mile 1253
31 Oct. 77	Tok to 20 miles upstream	vehicle	1 yearling moose near Tok, 2 magpies near Tok
1[illegible] Nov. 77	Big Delta to Tok	vehicle	4 mallards and 1 dipper on Delta River
17 Nov. 77	Tanacross-Northway-Chisana R.-Nabesna R.-Tanana R. to Robertson River	fixed-wing aircraft	1 red-breasted merganser and heavy beaver activity on upper Chisana; one cow moose on Stuver Creek
1[illegible] Nov. 77	Tok to Big Delta	vehicle	1 goshawk at Tanacross
27 Feb. 78	Berry Creek	foot	1 large moose, many moose and some wolf tracks
2 March 78	Tok overflow	foot	2 moose; 2 dippers
1[illegible] March 78	Big Delta to Dot Lake	vehicle and foot	1 snowshoe hare near Delta Jct.; 1 hare near Berry Creek; wolf tracks and wolf scat with moose hair on Berry Creek; 1 ruffed grouse near Dot Lake

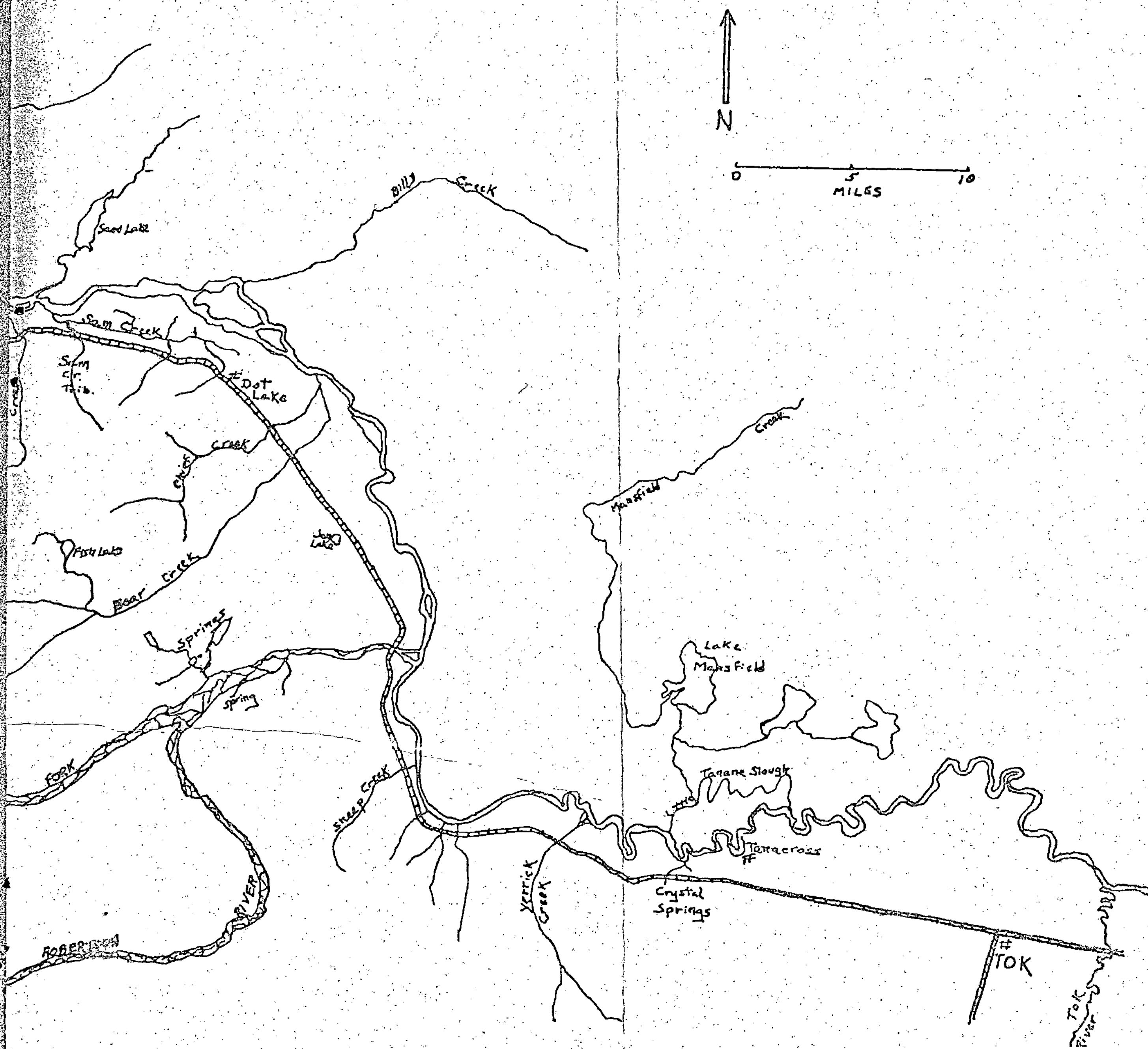
APPENDIX TABLE IV (cont.)
page two

Date	Area Traveled	Method	Species
2[illegible] March 78	Crystal Springs	foot	1 dipper
2[illegible] March 78	Tok to 20 miles upstream	vehicle	2 dippers at Tok overflow; flocks of snow buntings
3[illegible] March 78	Berry Creek	foot	Otter tracks going up creek
1 April 78	Crystal Springs	foot	2 bald eagles
	Tanana R., Robertson R., Dry Creek, Berry Cr.	fixed-wing aircraft	1 moose near Tanana River 1 moose on Berry Creek
1[illegible] April 78	Tok to Johnson River	vehicle	1 bald eagle at Mile 1370
1[illegible] April 78	10 mi. up Robertson River	dogteam	1 snowshoe hare
13 April 78	20 mi. up Tok River	vehicle	Cow moose and calf
14 April 78	Tanana R. Tanacross to Crystal Springs	boat	1 rusty blackbird and several flocks of Bohemian waxwings at Tanacross; heavy beaver activity 2 miles below Tanacross; pair of goldeneyes
15 April 78	Tok to Big Delta	vehicle	1 large dark raptor near Bear Creek; 1 bald eagle at Johnson R., 100 Canada geese and 1 marsh hawk in Delta fields
	Berry Creek	dogteam	Great horned owl
1[illegible] April 78	Big Delta to Tok	vehicle	50 Canada geese flying over Delta fields
2[illegible] April 78	Tanana R. - Tanacross to Little Tanana Slough	boat	Flocks of Bohemian waxwings at Tanacross; flocks of mallards, pintails and a few widgeon; 10 Canada geese on river and 20 high.
2[illegible] April 78	Tanana R. Tanacross to Crystal Springs	boat	1 ruffed grouse near Tanacross; mallards and pintails abundant, flock of goldeneyes, pair of buffleheads; large dark raptor near Crystal Springs
22 April 78	Tok to Northway	vehicle	2 snowshoe hares near Mile 1280; 1 marsh hawk near Northway

Date	Area Traveled	Method	Species
3 April 78	Northway to border	vehicle	Pairs of mallards and Canada geese near Northway; 1 marsh hawk; muskrat and beaver activity at Mile 1224 lake; 1 bald eagle at border
4 pril 78	Tok to Berry Creek	helicopter	Pair of swans on Sam Creek
5 pril 78	Tok to Bear Creek to Robertson River to Tok River to border to Upper Chisana	helicopter	Caribou tracks on upper Robertson River; 2 cranes near mouth of Tetlin River; about 100 swans and a large moose on lake near Desper Creek; pairs of mallards and pintails on small lakes near Desper Creek and many muskrat push-ups; much beaver activity on upper Chisana River.


GOODPASTER RIVER
TANANA RIVER
DELTA RIVER
Delta Junction
Delta-Clearwater River
Volkmar
Healy Lake
ALASKA HIGHWAY
Gerstle River
Little Gerstle River
JOHNSON RIVER
JOHNSON GLACIER
Glacier

UPPER TANANA RIVER — Big Delta to Tok



UPPER TANANA RIVER — Tok to Canadian Border