AN EVALUATION OF THE LOGJAM CLEARING OPERATION AND WHITEFISH MIGRATIONS AT KENEKSEK CREEK, TUKTOYAKTUK PENINSULA, NORTHWEST TERRITORIES, 1987.

FJMC

FISHERIES JOINT MANAGEMENT COMMITTEE

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Prepared for

THE FISHERIES JOINT MANAGEMENT COMMITTEE

by

K.T.J. Chang-Kue and E.F. Jessop

June 1988

FISHERIES JOINT MANAGEMENT COMMITTEE
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DISCLAIMER

This report was prepared for the Fisheries Joint Management Committee, as part of the implementation terms of the Inuvialuit Final Agreement. The opinions, findings, conclusions and recommendations expressed in this report are those of the Authors and do not necessarily reflect the views of the Fisheries Joint Management Committee.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF PLATES

INTRODUCTION

In July 1986, residents from Tuktoyaktuk reported that a logjam on Keneksek Creek, a coastal stream fished seasonally by some local fishermen (Fig. 1 and 2), was blocking fish trying to migrate out of the creek. In response to a request for action, Michael Lawrence from the Department of Fisheries and Oceans (DFO) Winnipeg, Richard Barnes (DFO, Inuvik) and Ian Ross (Renewable Resources, Tuktoyaktuk) flew in to inspect the site. They reported that the logjam was quite extensive in size and was blocking fish passage at the present water level. Whitefish were observed trapped within the logjam and holding in pools upstream.

In September, 1986, the Hunters and Trappers Association of Tuktoyaktuk, with DFO initiative and Government of Northwest Territories funding, let a contract for a crew to cut a channel through the logjam on Keneksek Creek. At this point it was logical to follow through with inspections of the site and to evaluate the success of this operation. After an initial inspection on 7 October 1986, DFO submitted a proposal to the Fisheries Joint Management Committee (FJMC) to initiate a field study in 1987 aimed at evaluating the ultimate effectiveness of the clearing method and its outcome on fish migrations in the creek.

STUDY OBJECTIVES

The study objectives were:

A. To continue our on-going study of summer and fall migration patterns of whitefish that move out of north shore coastal streams of Tuktoyaktuk Peninsula. Keneksek Creek was to be chosen as one of our study streams in 1987.

B. To evaluate the effectiveness of logjam clearing operations done in September 1986 at one of the these coastal streams (i.e. Keneksek Creek).

DESCRIPTION OF STUDY AREA

Keneksek Creek, flows north into a coastal bay about 12 km west of Tuktoyaktuk (Fig. 2). The drainage area is approximately 100 square kilometers and flows over a north to south distance of 20 km. The stream, typical of numerous others on the peninsula, interconnects a large network of shallow, tundra lakes which, in this case, add up to 27 separate bodies of water. It is one of 7 major coastal streams between the Mackenzie River, East Channel outflow and Tuktoyaktuk, with the third largest drainage area following Canyanek Creek and Kittigazuit Creek. Two of these drainages, Keneksek Creek and Canyanek Creek, are blocked by logjams of accumulated driftwood at the mouth of each stream. Brought down by the Mackenzie River during peak discharge periods, driftwood has been depositing for centuries at high tide zones and have formed huge piles in numerous embayments and inlets. These log deposits are a prominent feature of the coastline adjacent to the Mackenzie Delta. Plates 1 and 2 show the Keneksek Creek logjam as viewed from the air.

METHODS AND MATERIALS

LOGJAM INSPECTION AND DOCUMENTATION

Between 7 October 1986 and 14 September 1987, DFO personnel made several on-site visits to the Keneksek Creek logjam to evaluate the cleared channel and to make observations on fish and fish movements. Inspections done in June-July 1987 provided the best information on fish passage when the stream was not frozen and partially obscured by snow. The authors made a detailed inspection on 18-19 July 1987 when the status of the cut channel after the spring freshet was recorded on videotape. A series of photographs (Kodachrome slides) was also taken as we walked along the length of the logjam. A final on-site inspection was made on 14 September 1987.

FISH TAGGING

By releasing fish tagged with Floy tags and radio tags above the logjam, we expected to determine if fish could move out of the creek based on the recapture of tagged fish outside the area by local fishermen or by our tracking of radio tagged fish. On 18-19 July 1987, we set up a camp at Keneksek Creek, adjacent to the logjam. A hoopnet 0.5 m in diameter was set in the stream about 500 m upstream from the logjam to monitor downstream movement of fish. This site, 0.5 m deep and 4.0 m wide, had a substrate of fine gravel. No upstream hoopnet was set since upstream migration was not occurring at the time and we wished to minimize any recapture of tagged fish.

All fish selected for tagging were first transferred with a dipnet to a holding tub where they were mildly anaesthetized in a solution of tricaine methanesulfonate (MS222). Each fish was measured for fork length (1.0 mm) on a 1 m measuring board and a scale sample taken for age determination. Radio tagged fish were also weighed (1.0 g) on an Alsep Model 5000 electronic balance prior to tagging. All tagged fish were released downstream from the hoopnet and allowed to proceed towards the logjam. Fish could still return upstream through a small space left open at the end of each hoopnet wing.

Floy tags

A total of 51 broad whitefish (Table 1) were tagged with numbered, yellow Floy tags (Plate 39-40). The tags were 5 cm in length with a nylon T-bar at one end. The T-bar was inserted below the dorsal fin using a Floy (Mark 2 model) tagging gun with a fine gauge tagging needle. Each fish was hand held in the stream until it recovered and was able to swim and maintain a position in the stream without assistance.

Radio tags

Ten broad whitefish (Table 2) were tagged with externally mounted radio transmitters (Plate 38). After taking a scale sample along with length and weight measurements, the fish was positioned for tagging. A 10 gauge hypodermic needle was inserted below the dorsal fin in two places to allow threading of the mounting wires. The needle insertion was done one at a time to allow accurate spacing of the radio tag's mounting wires. The wires were then threaded through plastic discs and cinched with a knot to hold the tag firmly against the back of the fish. After release, it was possible to observe radio-tagged fish for several hours swimming normally and holding in downstream pools with other fish. We have used these tags successfully on broad whitefish since 1982 (Chang-Kue and Jessop, 1983).

Radio Telemetry Equipment

The radio telemetry equipment was obtained from Advanced Telemetry Systems (ATS) of Bethel, Minnesota. One type of externally mounted radio tag was used for the study (Plate 38). The specifications (Table 3) provided a tag of flat configuration to minimize any snagging on driftwood or vegetation. Each tag had a unique frequency in the 48.000 to 50.000 mHz. range and was separated by at least 10 kHz. to allow recognition of the individual fish. A lifespan of 140 days allowed tracking of the fish to overwintering areas. A maximum tag weight of 1% of the weight of the fish minimized any effect on their natural buoyancy control.

An ATS (Challenger 200 model) programmable scanning receiver was used to detect and locate the tagged fish from a fixed wing aircraft. Two directional, 1/4 wavelength, loop antennae were mounted on the wing struts of a Cessna 185 aircraft. The planes of both antennae were mounted parallel to the fuselage for maximum fore and aft detection range. The coaxial cable for each antenna was attached to a left/right/or both switchbox to allow for directional tracking while homing in on a transmitter.

Fish Tracking

Tracking was done while flying at 250-400 m altitude. All radio tag frequencies were stored in the receiver's memory and scanned at a rate of 2 seconds per frequency. The area scanned included all nearshore, coastal waters between Tuktoyaktuk Harbour and Richards Island and the streams that drain into these waters. The headwaters of Keneksek Creek were given detailed coverage to seek any fish that may have returned upstream. In addition, all main Mackenzie Delta channnels were covered periodically to account for any spawning migrants. The schedule for radio tracking is summarized in Table 4.

RESULTS AND DISCUSSION

LOGJAM INSPECTION AND DOCUMENTATION

A. 7 October, 1986

Ian Ross, Paul Voudrach (Renewable Resource Officers, Tuktoyaktuk) and Bert Kimiksana (contractor) accompanied Jerry Hordal (DFO, Inuvik) on the first inspection of the clearing work that was done in September 1986.

Mr Hordal noted in a field report that the cleared channel varied in width from 1.3 to 3.1 meters and ran for a distance of approximately 0.5 km. The channel cut through the logjam was reported to have been cleared of logs to the bottom of the creek for most of its length; however, this was difficult to assess because freeze-up had occurred and the area was partially obscured by snow. One of the contractors also reported to Mr. Hordal that there were adult and juvenile coregonids migrating upstream at the time the channel was cleared.

Mr. Hordal expressed his opinion that spring flood waters would likely wash the logs out or else block the channel again.

B. 22 June 1987

Mr. Vic Gillman (DFO, Inuvik) accompanied by Fred Walkie and Willie Carpenter of the Tuktoyaktuk Hunters and Trappers Association flew in to make the first open water inspection of the site. Mr Gillman reported that the channel cleared through the logjam remained open but was gradually filling up again with driftwood and debris.

C. 18-19 July 1987

Ken Chang-Kue and Earl Jessop (DFO, Winnipeg) visited the site on 18-19 July, a date we expected to coincide with an active downstream migration of fish from the headwaters to the coast. The channel was examined for its entire length to assess its status and effects on whitefish. The set of photographs taken on this visit is included in this report (Plates 3 to 40).

We observed that the man-made channel had been cut through the logjam with chain saws and the cut out pieces of log appeared to have been deposited nearby. A few log sections were still conspicuous along the channel (Plate 9) while others had become scattered over the logjam by flood waters. The channel, varying from 1 to 2 meters in width and 0.1 to 0.5 meters in depth (Plates 6 to 10), was still quite intact and carried the main water flow. The channel bottom consisted of a layer of older, submerged logs of undetermined thickness.

It was quite evident, as we approached the site by helicopter, that several individual blockages had formed in the channel. We counted 8 individual blockages, most of which occurred as a result of floating debris caught at constrictions in the channel (Plates 5, 17, 18, 23, 24 and 31). The majority of these still allowed fish to move through; however, blockage No.3 (Plates 2, 11 to 15) and No.6 (Plate 20) were large enough to prevent fish passage at the existing water level. Large logs had been deposited back into the channel and the subsequent accumulations of smaller debris completed the blockage; consequently, water flow was diverted to trickling through the main body of the logjam. The nature and extent of the blockages made remedial clearing by a four man clean-up crew quite feasible if we had judged the numbers of fish trapped above the logjam to be critical. Our experience and familiarity with fish migrations in Tuktoyaktuk coastal streams since 1978 leads us to propose that the criterion for a critical number would be 1000 fish for this creek. This was not the case on this visit.

Groups of 2 to 7 broad whitefish were seen holding in pools between blockages (Plates 18, 19 and 21). Some fish had numerous abrasions resulting from their encounter with blockages (Plate 21), while others could be heard splashing as they attempted to escape from one pool to another. A few fish remained trapped and were near death in smaller pockets of water; this was particularly evident among the logs at blockage No.3 (plates 13 and 14). Bird predators left fish remains and other evidence of their presence at blockage No.3 and No.6 (Plates 15 and 16). A school of whitefish was seen holding in the first large pool located above blockage #8 (Plates 24 and 25). Proceeding further upstream for the next 400 meters, we observed another holding pool and piles of logs deposited by high tides of major storm surges in previous years (Plates 33 to 36).

We estimated that the holding pools held less than 300 fish and observed that numbers coming downstream were relatively small for this size of stream at this time of year. The situation can change with time and/or weather conditions so monitoring by a fish management biologist would be desirable in a similar situation in the future.

The videotape recording made on this inspection was edited and included in the project videotape accompanying this report.

D. 14 September 1987

A further inspection was made by Earl Jessop and Rick Erickson (DFO, Winnipeg) on 14 September 1987. In the interim a major coastal storm on 7-10 August caused a positive storm surge that resulted in the logjam being flooded. Logs and wood debris had been displaced extensively and the the cut channel was so obliterated that the area was essentially returned to its original logjam state. No still photographs were taken but video scenes from the air and on land were recorded.

Scanning locally for the ten fish previously radio-tagged above the logjam revealed the presence of only one fish (No. 87-6) upstream of the logjam. We tentatively concluded that water levels had been high enough to allow fish to escape and continue their migrations along the coast. We proceeded to test this conclusion during our Fall radio-tracking schedule which started 2 days later.

E. September-October 1987

Although numerous low level flights and visual checks were made of Keneksek Creek during subsequent radio-tracking flights, no on-site inspection was necessary since the status of the site did not change right up to freeze-up in mid-October.

All videotape footage was edited into a 50 minute videotape showing the logjam from the air and at ground level. Additional sequences showing the tagging of broad whitefish with radio tags and Floy tags were also included. Three copies of the videotape were made for distribution and should be available on request for interested viewers (Appendix).

FISH TAGGING

Sixty-one broad whitefish were captured in our downstream hoopnet at Keneksek Creek between 17:00 hr, 18 July and 17:00 hr, 19 July 1987. These fish represented the general age and size range of the downstream run occurring at that time. The fish ranged from 6-13 years in age most of which (87%) were aged 9-13 years. Ten were selected for radio tagging while the rest were tagged with Floy tags.

Floy tagged fish

The 51 broad whitefish tagged with Floy tags ranged from 368-590 mm in fork length and 7-13 years in age (Table 1). To date only 5 Floy tagged fish have been recaptured; these fish provided no migration information since all were caught above the logjam on 1-3 August by residents of Tuktoyaktuk fishing in the area. We thus had to rely on the radio-tagged fish to provide information on the eventual fate of the fish trapped above the logjam.

Radio-tagged fish

The 10 radio-tagged fish ranged in fork length from 355-527 mm and in age from 6-11 years (Table 2). We expected that some of the 5 oldest fish (9-11 years) would be potential spawners that, given the opportunity, would migrate into the Mackenzie River in the Fall. The other 5 fish represented the smaller, younger fish which were expected to migrate to nearby overwintering areas only. Twelve tracking flights were made between 22 July and 17 Novenber to obtain a fix on their individual locations. Detection success was very good (>75% positive fixes) for most of the fish that remained at large for the full duration of the study (Table 4).

Radio tracking was temporarily discontinued on 26 July as all fish were still holding in pools upstream from the impassable logjam. On 1 and 3 August two radio tagged fish (No. 87-2 and 87-7) were captured in the same pools by residents from Tuktoyaktuk. The next significant event was the major coastal storm on 7-10 August that raised the tide levels to flood the coastline including the logjam. Our expectation was that fish trapped above the logjam would escape and thus reach the coastal waters.

We resumed tracking on 16 September. Two fish, No. 87-1 and 87-4, escaped further detection; these tags may have either malfunctioned or had become detached and lost in deeper waters. One other tag, No. 87-6, remained immobile in the upstream pools at Keneksek Creek until the battery expired by mid-October; this was the same tag detected at streamside on our 14 September ground inspection. Because the tag had not moved at all, one could conclude that either the fish had died in the creek or that the tag, lost from the fish, was still sending its signal from the shallow creek bottom.

The premature recapture or loss of the preceding 5 fish unfortunately accounted for most (4) of the potential spawners in our small sample of radio-tagged fish.

The coastal storm surge in August raised water levels enough to allow 5 radio-tagged fish (Nos.87-3, 87-5, 87-8, 87-9 and 87-10) to escape the creek and migrate westward. These fish reached Whitefish Bay (Fig. 2) by 17 September and spent the rest of the fall season moving about in Whitefish Bay and Kittigazuit Inlet. Unlike the spawning migrants which continue on into the Mackenzie River to spawn in early November, these fish proved to be immature fish (Nos. 87-5, 87-8, 87-9 and 87-10) and one possible non-spawning adult (No. 87-3) that had reached their over-wintering site in this large coastal bay. There was no evidence, from this sample, of an eastward migration towards Tuktoyaktuk. The detection locations for each of these fish are shown on a tracking map (Fig. 3 to 7).

The Keneksek Creek data show a distinct similarity to our 1986 study when we also tagged and released 10 broad whitefish above a similar logjam at Canyanek Creek (Fig. 2). These fish remained trapped in upstream pools when monitored for 3 weeks after their release on 18 July 1986. After the season's largest storm on 22 August 1986, these fish escaped and migrated westward to Whitefish Bay. No eastward migration along the coast was observed. The smaller whitefish (age 5-7 yr) remained to overwinter while the older fish (8-9 yr) continued migrations to spawning sites in the Mackenzie Delta.

It was apparent from the 2 years of radio tracking at these creeks that fish migrations were interrupted by logjams and escape was possible during high water events brought on by an onshore storm.

During previous fish counting fence operations at similar streams without logjams, such as Freshwater Creek, Mayogiak Creek (Bond and Erickson, 1985) and Kukjuktuk Creek (authors' data), we observed that both upstream and downstream migrations of broad whitefish occurred throughout the open water season. Upstream migrants consisted of young-of-the-year, juveniles and immature fish coming up from the coast. Downstream fish were mostly immature fish going to presumed overwintering areas. Other coastal drainages from Richard's Island to McKinley Bay were surveyed by Lawrence et al (1984) in 1978-1979. Their seasonal, 1 to 2 day sampling program indicated that there were similar patterns of whitefish migratory behaviour in these creeks. We concluded by 1980 that most coastal streams functioned as the main access route to its chain of tundra lakes that provide summer feeding habitat for all age groups.

These migrations in the coastal streams make up just one component of the interesting and complex migration patterns that broad whitefish undertake between the Mackenzie River and Tuktoyaktuk Peninsula. It would be appropriate here to describe how our past studies have added to the existing knowledge on coastal migrations in order to appreciate the relationship of migrations to the timing of fish catches and numbers of fish taken by residents of the coastal area.

COASTAL MIGRATION PATTERNS

Late Summer and Fall Period

The actual source of the whitefish and details of their fall migration patterns along the north shore of the Tuktoyaktuk Peninsula were first revealed in 1978-1979 when we tagged a large number of fish with Floy tags at Kukjuktuk Creek (Fig. 2). Several of the large whitefish moving downstream in late July and August were captured by domestic fishermen in Tuktoyaktuk harbour within 1 week and other recaptures occurred further west at Whitefish Station within 2 weeks.

More precise information on this westward coastal migration toward the Mackenzie Delta from July to October was obtained in 1985 using radio tags. Large broad whitefish (age 8-12 yr), moving downstream in Kukjuktuk Creek, were radio tagged in mid-July. These fish left the creek within a few days and migrated westwards; none showed any eastward migrations. Tracking showed that whitefish stayed very close to the shoreline entering some of the large coastal bays and inlets on their journey. All but one fish entered Tuktoyaktuk Harbor where 60% were recaptured by fishermen. The remaining 40% that escaped capture continued westward along the shoreline through Keneksek Bay, Canyanek Inlet and Whitefish Bay. Spawning migrants continued up the East Channel into the Mackenzie Delta while non-spawners remained in Whitefish Bay to overwinter.

We believe that this westward migration of spawning and non-spawning broad whitefish along the Tuktoyaktuk coast provides the bulk of the domestic fishing harvest in Tuktoyaktuk Harbor and other fishing camps on the coast in the late summer and fall. While non-spawners stop to overwinter in an area such as WhitefishBay and possibly the East Channel, the spawning segment continues on into the Delta and Mackenzie River where they contribute to the domestic and commercial harvest. Floy tags returned by domestic fishermen over the past 10 years show that Tuktoyaktuk Peninsula whitefish have been taken further up the Mackenzie River at Fort Good Hope, at the Arctic Red River mouth and up the Peel River at Fort McPherson.

Spring and Summer Period

Very soon after ice breakup in coastal streams, large juveniles or immature broad whitefish migrate upstream to summer feeding areas in the headwater lakes of the Tuktoyaktuk Peninsula. These fish are returning after overwintering in the Mackenzie Delta and areas such as Whitefish Bay. These same fish, in the 225-474 size range (Bond and Erickson, 1985), will later comprise the majority of the late summer and fall downstream runs described in the preceding section. This annual cycle of feeding in lakes and overwintering at or near the Mackenzie Delta is an important life history aspect of the broad whitefish until the age of maturity (8-9 yr) is reached by which time the longer distance migrations to spawning areas in the Mackenzie system are initiated.

In late July the young-of-the-year (Y-O-Y), originating from spawning areas in the Mackenzie River, migrate in large numbers up these coastal streams into the lakes. They are also accompanied by a group of small juveniles (1-3 yr) that may have overwintered in the Delta or adjacent coastal stream systems. The young broad whitefish appear to remain in the lakes for up to 4 years before joining the large, prominent group of annual migratory whitefish. It should be noted that the head waters also provide alternate over-wintering habitat for some of the large juveniles that appear to choose residency in these lakes for 1 or more years (Bond and Erickson, 1985; authors' unpublished data).

LOGJAMS AND MIGRATION BLOCKAGE

The Mackenzie River driftwood accumulations are a natural phenomenon which has been occurring for centuries in this coastal area. There are 16 major coastal streams between the Mackenzie Delta's East Channel outflow and McKinley Bay. Keneksek and Canyanek are the only 2 streams blocked with logjams, so it is important to note that there are many alternate streams offering habitat for the coastal migratory whitefish. The most accessible alternate streams include: Kittigazuit Creek and the smaller unnamed creek flowing into Whitefish Bay; Mayogiak and Freshwater Creek flowing into Tuktoyaktuk Harbor; and, Kukjuktuk Creek flowing into Kukjuktuk Bay.

With our current knowledge of the coastal whitefish migration patterns, one can see how these established logjams have limited the use of Keneksek and Canyanek Creeks to the migrants coming back from the Mackenzie Delta and other overwintering areas. The fish that do use them have adapted to passage during high water levels on the coast or during high water flows accompanying the spring icemelt or major rainfalls. Those fish that cannot move upstream to feeding areas during the spring freshet in late May or June are most likely moving on to alternate streams. We have observed how upstream migrations by juveniles and Y-O-Y continue through the summer at other streams east of Tuktoyaktuk with the peak time for upstream runs of Y-O-Y broad whitefish occurring later in the season (August and September).

When downstream running fish encounter a stream blockage such as a logjam, some will manage to work their way through while others may become entrapped and thus perish. Most fish however, will hold in the river and pools above the logjam as confirmed by our radio tracking data for both Canyanek and Keneksek Creek. We believe that these fish would have returned upstream to their respective headwaters to overwinter in the deeper tundra lakes if the flooding of the logjam brought on by the August storm surges in 1986 and 1987 had not occurred.

LOGJAM CLEARING

Our conclusion is that the partial clearing operation, accomplished by cutting of a channel through the logjam at Keneksek Creek in September 1986, was limited in its success. Fish passage was possible before freeze-up in 1986 and most likely during the spring freshet; however, by June 1987, the channel was again blocked by several minor obstructions for the rest of the season. Even though remedial clearing of these obstructions by a small work crew was feasible, the whole operation would be rendered ineffective by a natural event such as the storm surge.

Total removal of this extensive, natural logjam seems attractive as it would appear to open up more feeding habitat. The implications of this expensive undertaking should be carefully considered in terms of effects on the creek habitat, impacts on the whitefish populations. In our opinion, we do not believe that any immediate benefits in terms of improved fish catches for all fishermen would be realized.

Since the logs have been coming into the area for centuries, they have become part of the stream and streambank's underlying substrate, thereby giving the stream its stability with the logjam as part of it. A major removal of the wood overburden could expose permafrost leading to erosion and bank instability problems. The natural holding pools for fish may also disappear if the stream grade is altered too suddenly and the access for fish may be denied for one or more years until the stream stabilizes.

While it is easy to visualize adult whitefish moving in or out of a newly cleared stream and thus becoming available to the fishery along the coast, we should consider the possible effect on the Y-O-Y. It is conceivable that the existing coastal dispersal of Y-O-Y broad whitefish, washed down from the Mackenzie River in the spring, may be altered by removal of the logjams in the 2 streams closer to the Delta. The Y-O-Y may be indiscriminate in their selection of streams for summer feeding. We have observed them moving into intermittent streams opportunistically feeding in their random search for a suitable feeding area. As stated before, if access is denied by natural blockages, we believe the Y-O-Y will move on to the streams further east. Because of time spent as residents in their early years, we strongly suspect that the chosen stream becomes their home stream. Clearing of logjams to give access to Keneksek and Canyanek may reduce the proportion of Y-O-Y seeking streams east of Tuktoyaktuk, thereby decreasing recruitment to streams such as Freshwater Creek and Kukjuktuk Creek. We have evidence that some immature broad whitefish (age 3-8 years) display a homing instinct in terms of returning to the same stream to feed each year. How strong this fidelity to a stream is not known. Assuming that Y-O-Y return to their home feeding stream during their next 2-8 immature years as coastal migrants, one could theorize that there will be a reduction in future years of these whitefish migrating through Tuktoyaktuk Harbor.

If we assume that returning migrants in the spring choose a feeding stream randomly, then the newly opened summer feeding habitat located closer to the Delta may attract migrants that would have gone further up the coast. This redistribution of fishes along the coast may or may not occur until the overall coastal population size has increased proportionally to the increased summer habitat. One can only speculate as to how many years it will take when this stability in population distribution among all the streams is reached.

The preceding scenarios, although quite speculative, is an attempt to illustrate that one should consider what broad impact an action can have on all age groups of a population over the long term instead of limiting our vision to only one particular age grouping.

The domestic fishing harvests in the Mackenzie Delta and Tuktoyaktuk Peninsula are a reflection of the success and timing of the broad whitefish migrations. We must appreciate the dynamic interaction that exists between the Mackenzie broad whitefish and the variety of habitats they require in their life history. Logjams are but one of many factors that determine the successful accomplishment of the migration process and attainment of annual activities. Variations in annual weather patterns can change their timing for summer feeding, fall spawning and overwintering. Success or failure in these activities may help determine the highs and lows in population numbers. We have observed that a very cool summer or unusual weather fluctuations in the fall causes a delay in downstream migrations in the coastal streams so that in some years the expected coastal runs may be very small or be late by 1-3 weeks. This may result in a poor domestic catch for the season or, if this delay disrupts spawning success, we may see a long term effect in the form of a poor year class of fish that is not available to the fisherman 8 to 10 years later.

Another factor that cannot be ignored is the affect on fish populations by fish harvesting activities, whether domestic or commercial. The harvesting of broad whitefish is not confined to coastal areas and it must be realized that residents in the Delta and lower Mackenzie River are also sharing the available fish population because of migrations into spawning and overwintering areas. The rate of exploitaion and the natural population fluctuations are not known and neither is their interrelationship.

Our discussion of the coastal migration patterns was relevant to this logjam clearing evaluation because it is our concern that all factors be considered when trying to understand why there are good years and bad years for broad whitefish. The reported decreases in domestic catches by local fishermen in the Tuktoyaktuk coastal area may have to be looked at in more depth. It may be an incorrect decision to pursue the logjam issue as the main reason for poor fish catches. We must establish if the poor fishing is localized near a logjammed stream or whether the problem is widespread along the whole coast including Tuktoyaktuk Harbor and perhaps even in the Delta. We recommend that broad whitefish populations in at least 2 to 3 coastal streams be monitored along with a program to document the fish harvest statistics. A sound information base on the broad whitefish population status and fish harvesting is the prerequisite for appropriate population management decisions in the future.

SUMMARY AND CONCLUSIONS

1. We conclude that the channel clearing operation done at the logjam at Keneksek Creek in September 1986 was of very limited success. Although a channel had been cut through the logs to allow fish passage, several small blockages were in place by June 1987 after the spring freshet. It was inevitable that this first high water event would displaced and redistribute the debris and logs to create several obstructions to fish migrations.

2. In August 1987 a coastal storm and the accompanying high tides flooded the logjam and effectively obliterated the channel as another complete logjam was created.

3. Our on site inspection and radio-tagging program showed that fish migrating downstream from feeding areas in the headwaters could not migrate past the Keneksek Creek logjam by mid-July 1987. We believe that the fish trapped above the logjam would have returned to head-water lakes to overwinter had the August coastal storm not occurred.

4. The high tide accompanying the storm allowed the whitefish to escape to the nearshore waters and thus complete their fall migration to the Whitefish Bay overwintering area.

5. Our observations at Keneksek Creek and at Canyanek Creek indicate that broad whitefish have adapted to using these streams as feeding areas despite the logjams. While some mortality is inevitable, most migrants can sustain delays while awaiting the limited access times offered by natural high water events.

6. Our tag information to date show no evidence of Keneksek Creek fish migrating eastwards, thereby suggesting that this creek contributes very little to the Tuktoyaktuk fish catches in the late summer.

7. Total removal of this extensive, natural logjam is a very expensive undertaking and the implications of removal should be carefully considered in terms of stability of the stream channel and effects on the whitefish populations as they relate to both short term and long term benefits to the subsistence fishery.

RECOMMENDATIONS

1. We recommend that further efforts to cut channels or remove logjams be discontinued. The two logjammed creeks are not the only drainages offering feeding habitat to coastal broad whitefish and, in their present state, may play some role in the the present day distribution of broad whitefish among the Tuktoyaktuk coastal streams. Understanding the year to year health of the population is the key to understanding coastal fish harvest success.

2. A program should be implemented to collect essential data on the coastal domestic fish harvests in terms of fishing sites, peak harvest times, catch composition, distribution of catch among sites and the year to year variation of these statistics, especially at Tuktoyaktuk.

3. To complement the domestic fish harvest study there should also be a concurrent study for several years to monitor the whitefish in at least 2-3 Tuktoyaktuk Peninsula streams (including one with a logjam) over a period of several years. This study must be designed to describe the general status of the population in terms of numbers of migrants, age structure and other relevant biological data. A tagging program should be conducted to establish the relative contribution of each stream to the fish harvest at Tuktoyaktuk. Data from both studies will be essential for the future management of the coastal broad whitefish population.

ACKNOWLEDGMENTS

The authors would like to thank the Polar Continental Shelf Project of the Department of Energy, Mines and Resources for logistical support provided to our field operations. J. Ostrick of the Inuvik Research Laboratory provided additional support while DFO staff at Inuvik offered backup assistance. We must also voice our appreciation to the numerous domestic fishermen who have returned tags to us since 1972. Our knowledge was definitely enhanced by their cooperation. Thanks also to the Fisheries Joint Management Committee who provided funding for this project and administered through Mr. G. Yaremchuk. DFO staff Mr. J. Stein, S. Harbicht, and R. Baker reviewed the manuscript and provided helpful suggestions.

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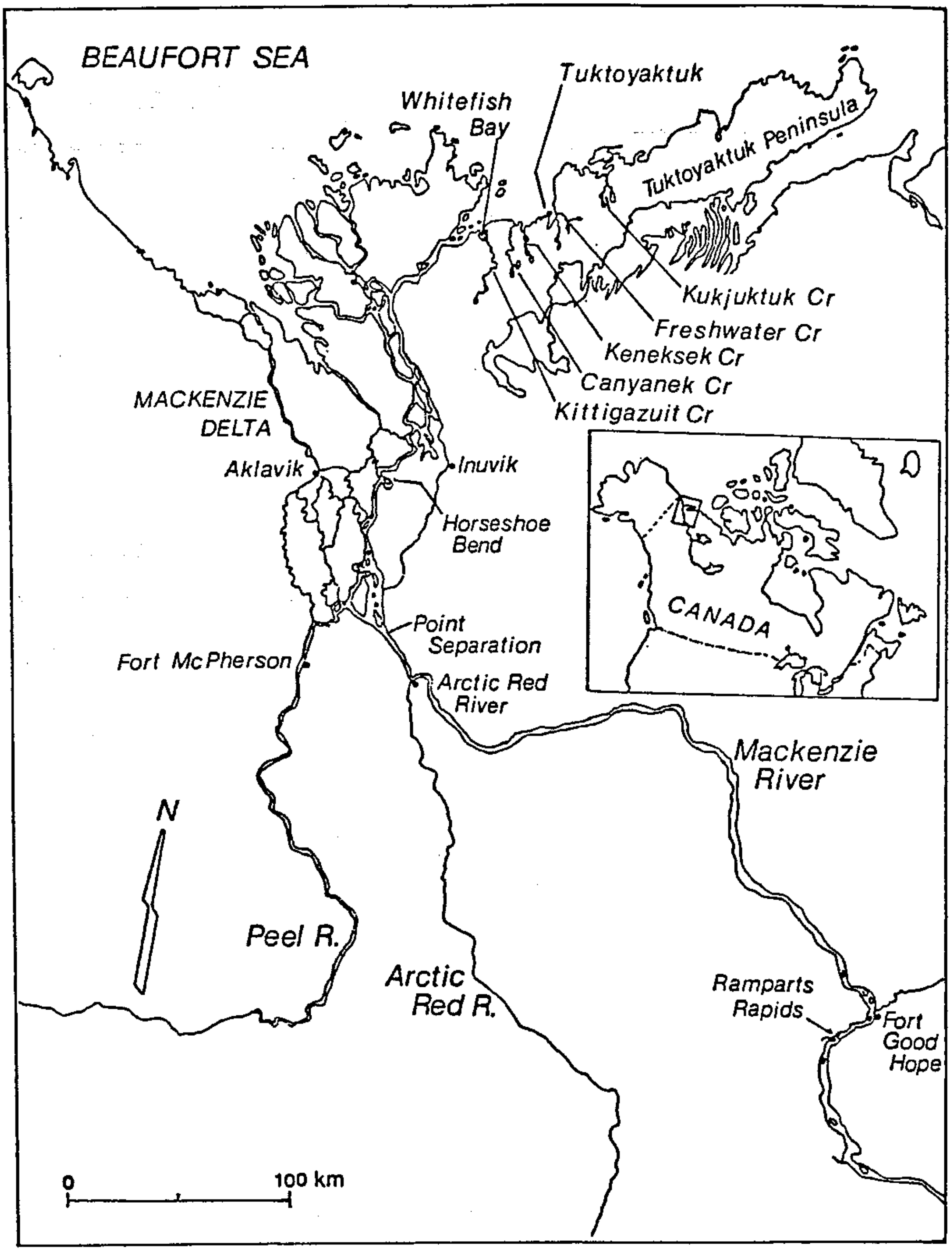


Fig. 1. Map of the Mackenzie Delta-Tuktoyaktuk Study area.

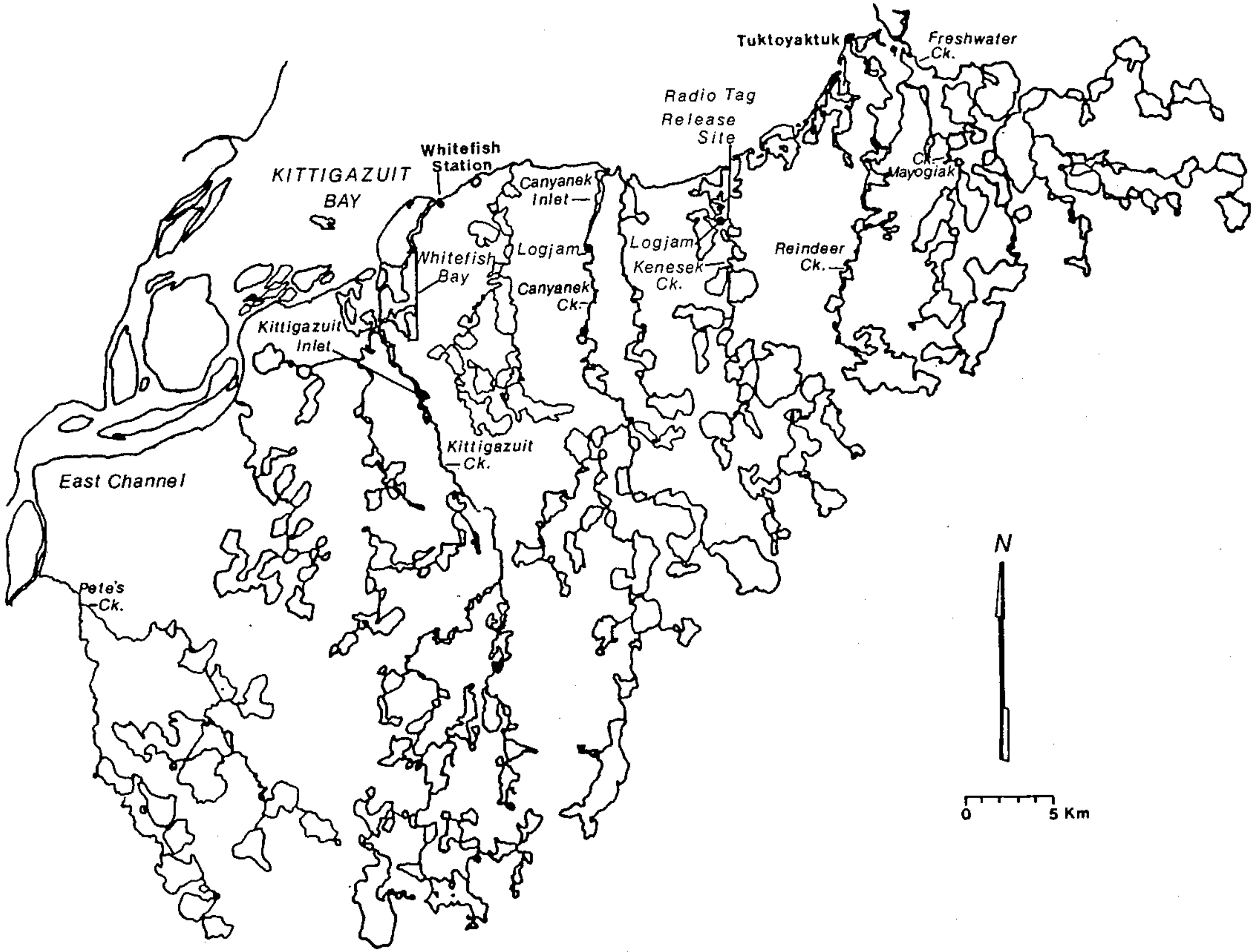


Fig. 2. Map of the Tuktoyaktuk Peninsula showing the main coastal streams in the study area.

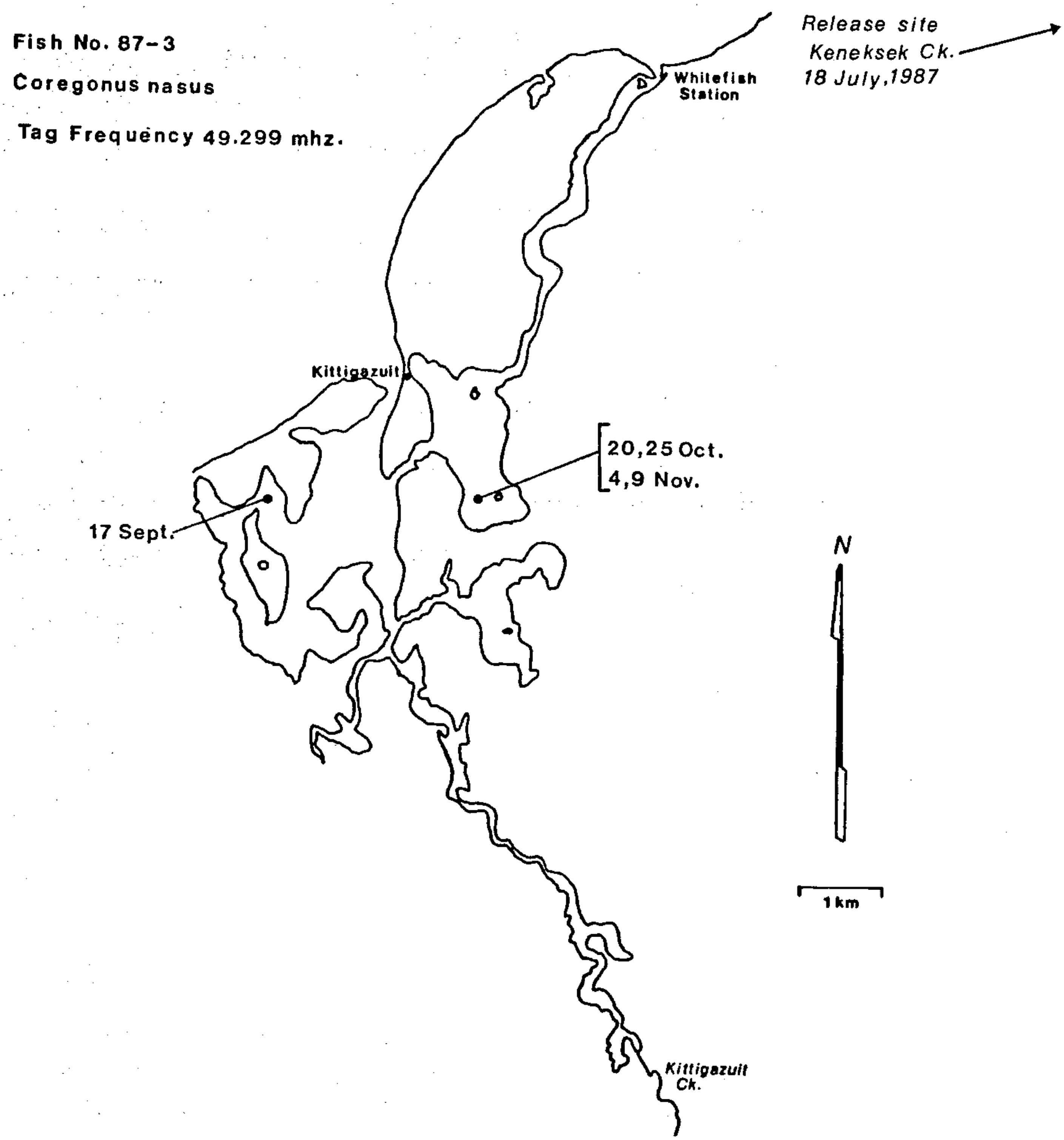


Fig. 3. Tracking locations of radio tagged fish (No. 87-3) from Keneksek Creek.

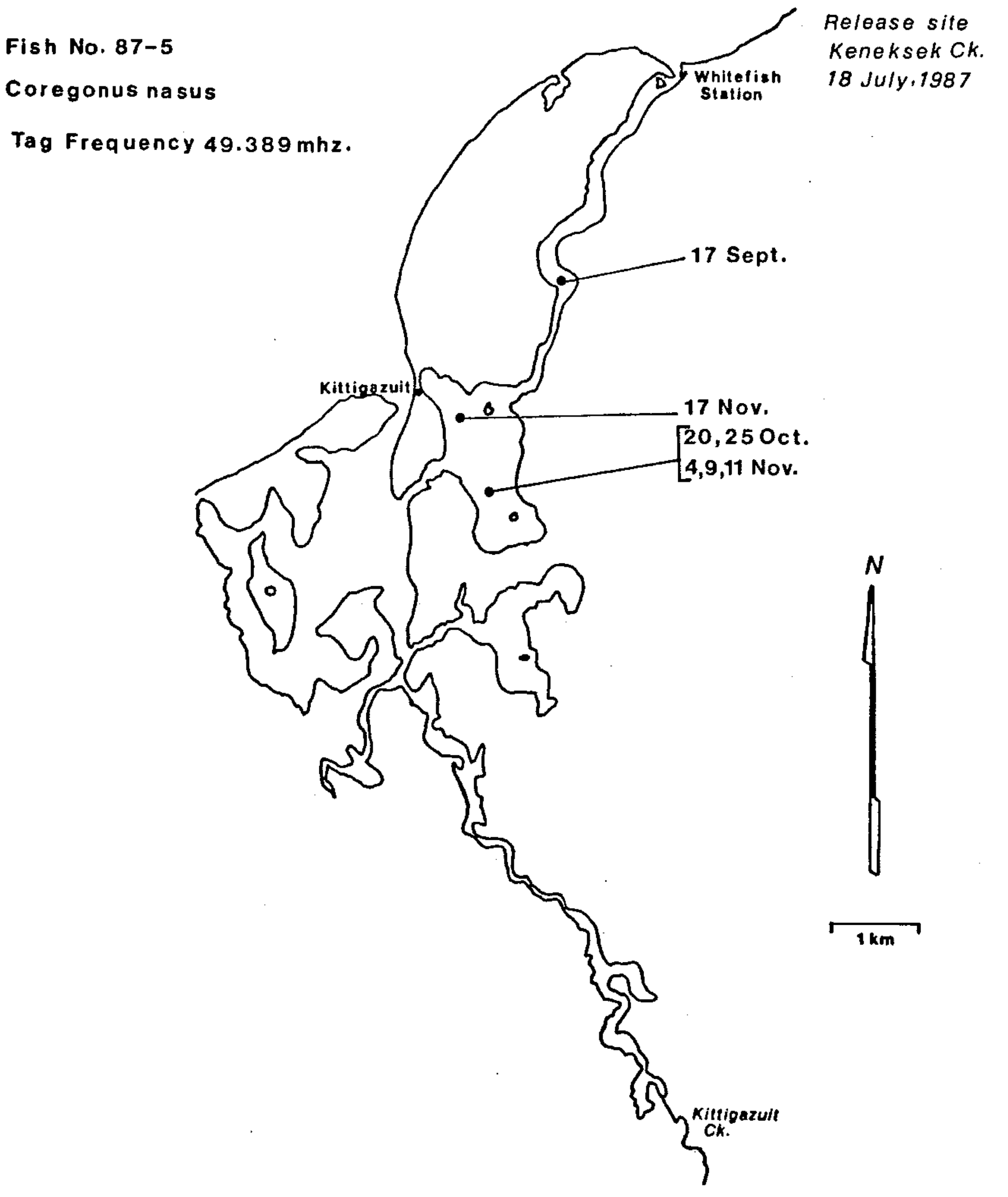


Fig. 4. Tracking locations of radio tagged fish (No. 87-5) from Keneksek Creek.

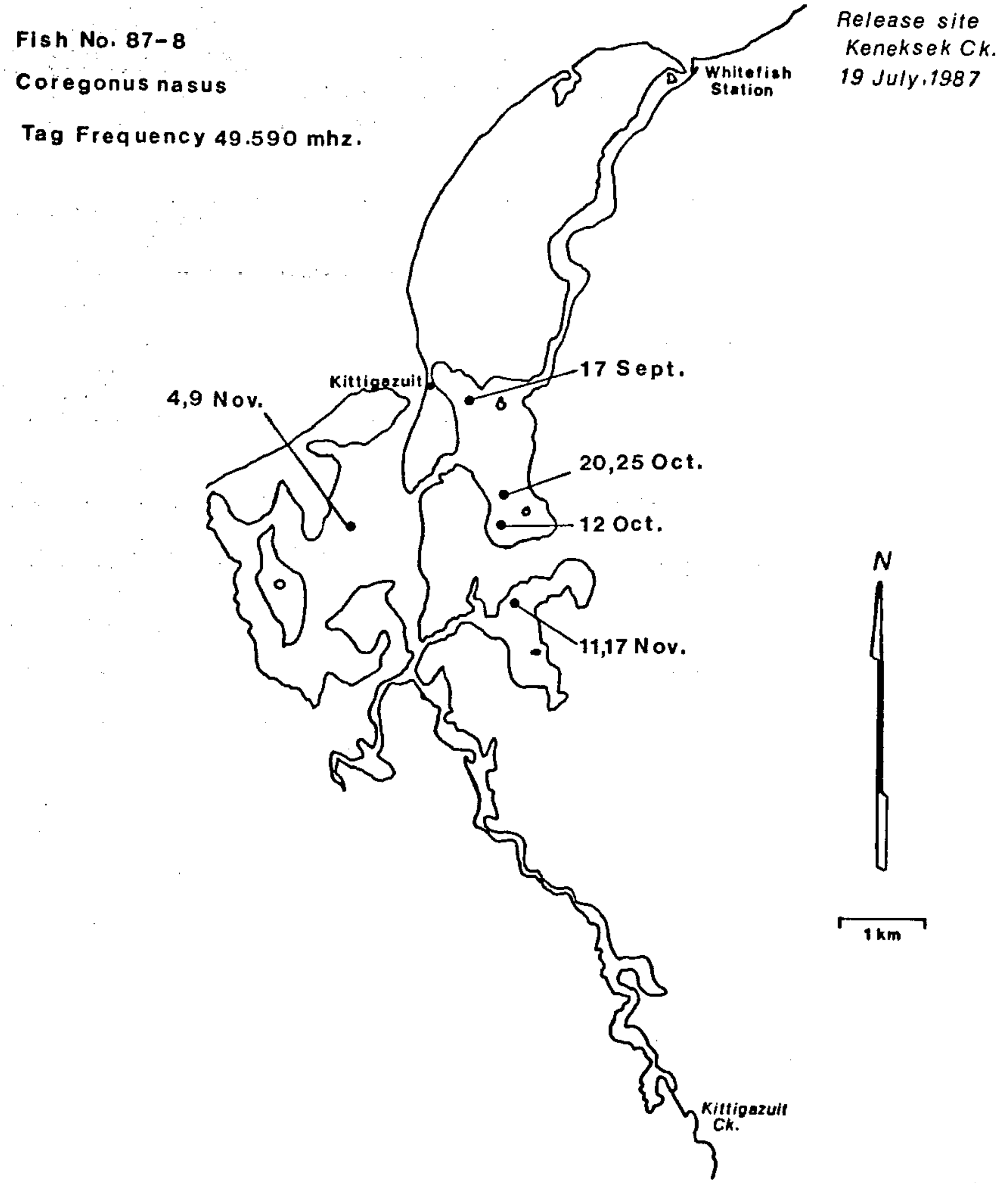


Fig. 5. Tracking locations of radio tagged fish (No. 87-8) from Keneksek Creek.

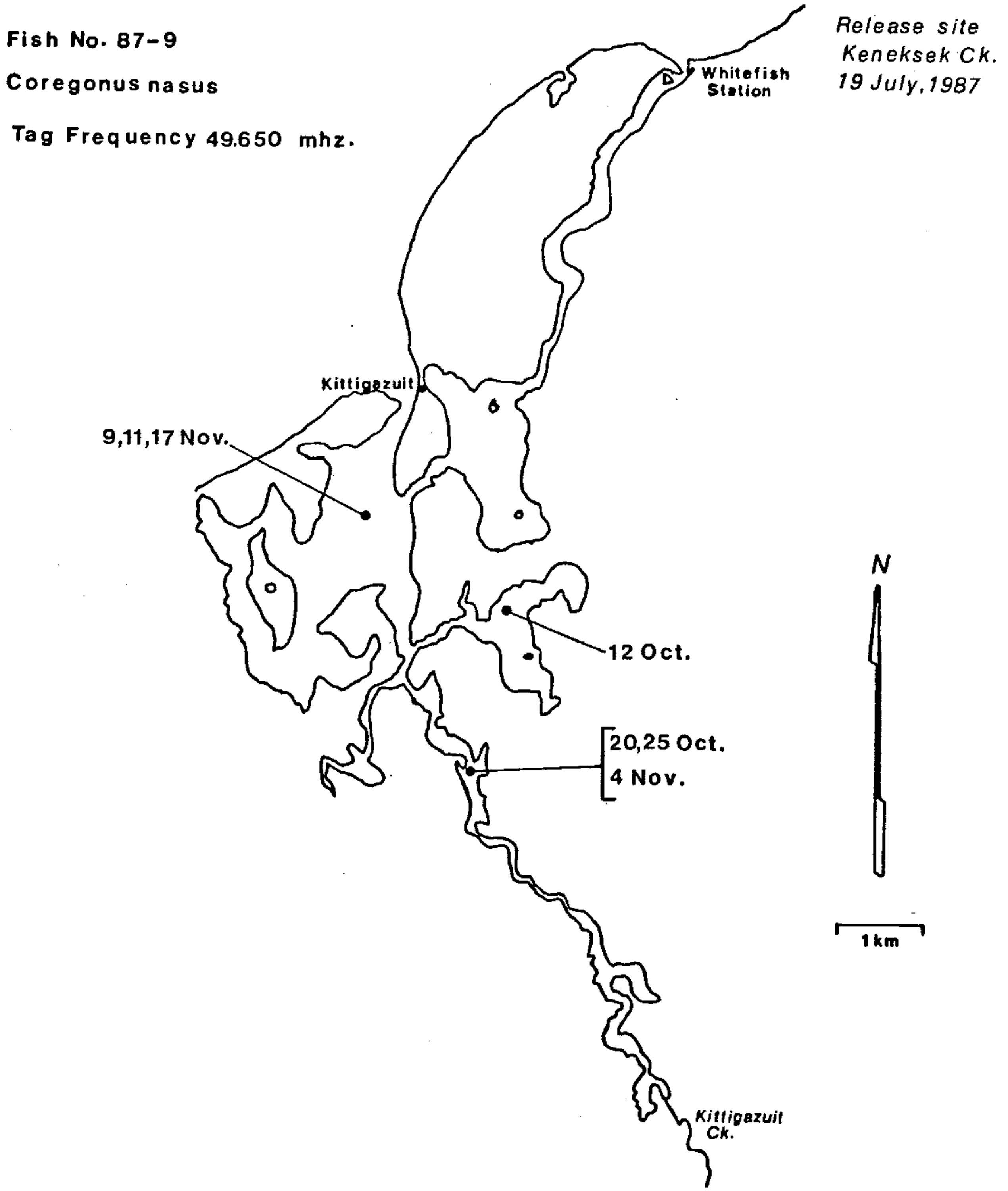


Fig. 6. Tracking locations of radio tagged fish (No. 87-9) from Keneksek Creek.

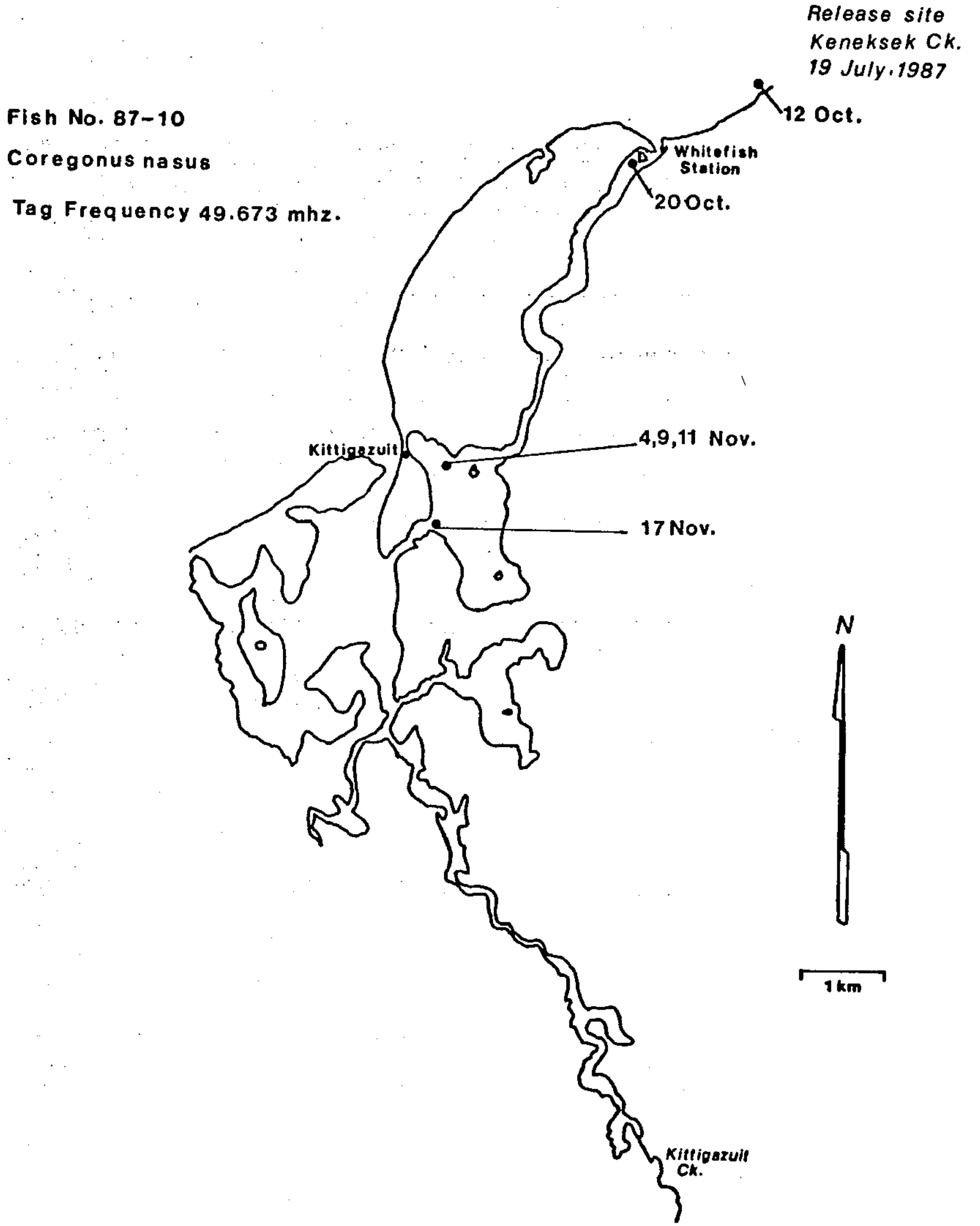


Fig. 7. Tracking locations of radio tagged fish (No. 87-10) from Keneksek Creek.

Table 1. Data on broad whitefish (Coregonus nasus) tagged with Floy tags and released upstream from the logjam at Keneksek Creek, 18-19 July 1987.

No.	Tag number	Fork length (mm)	Age (yr)	Comments
1	LY 05676	565	10	Recaptured 1 Aug.
2	LY 05677	460	7	
3	LY 05678	486	-	
4	LY 05679	459	9	
5	LY 05680	368	7	
6	LY 05681	479	9	
7	LY 05682	567	-	
8	LY 05683	590	13	Recaptured 3 Aug.
9	LY 05684	512	11	
10	LY 05685	495	11	
11	LY 05686	485	8	
12	LY 05687	495	10	Recaptured 3 Aug.
13	LY 05688	460	10	
14	LY 05689	515	9	
15	LY 05690	480	10	
16	LY 05691	505	10	Recaptured 3 Aug.
17	LY 05693	520	12	
18	LY 05694	490	10	
19	LY 05695	430	9	
20	LY 05696	515	10	
21	LY 05697	477	9	
22	LY 05698	493	10	
23	LY 05699	420	9	
24	LY 05700	472	9	
25	LY 05701	505	10	
26	LY 05702	393	9	
27	LY 05703	395	7	
28	LY 05704	382	8	
29	LY 05705	388	6	
30	LY 05706	480	9	
31	LY 05707	475	12	
32	LY 05708	477	10	
33	LY 05709	468	10	
34	LY 05710	450	12	
35	LY 05711	558	13	
36	LY 05712	430	10	
37	LY 05713	450	9	
38	LY 05714	475	10	
39	LY 05715	483	12	Recaptured 1 Aug.

cont'd

Table 1 continued.

No.	Tag number	Fork length (mm)	Age (yr)	Comments
40	LY 05716	500	11	
41	LY 05717	405	9	
42	LY 05718	475	10	
43	LY 05719	485	10	
44	LY 05720	510	12	
45	LY 05721	470	10	
46	LY 05722	452	11	
47	LY 05723	470	12	
48	LY 05724	455	10	
49	LY 05725	483	10	
50	LY 05726	470	12	
51	LY 05727	475	12	

Table 2. Data on broad whitefish (Coregonus nasus) tagged with radio tags and released upstream from the logjam at Keneksek Creek, 18-19 July 1987.

Fish No.	Tag Frequency (mHz)	Fork Length (mm)	Weight (g)	Age (yr)	Release Date
87-1	49.169	505	1845	10	18 July
87-2	49.230	468	1470	9	18 July
87-3	49.299	527	2075	11	18 July
87-4	49.341	501	1510	10	18 July
87-5	49.389	395	845	8	19 July
87-6	49.450	485	1820	10	19 July
87-7	49.540	480	1808	10	19 July
87-8	49.590	374	724	6	19 July
87-9	49.650	373	760	7	19 July
87-10	49.673	355	634	7	19 July

Table 3. Specifications of the radio transmitter tags used to tag fish at Keneksek Creek in 1987.

Manufacturer's Code	RM-625
Length (cm)	3.0-3.5
Width (cm)	1.6-1.8
Depth (cm)	1.0-1.3
Weight (g)	9-10
Antenna Length (cm)	17-18
Battery Type	1.40 volt (mercury)
Battery Rating (mah)	180
Pulse Rate (pulse/min)	51-55
Pulse Width (millisec.)	14-18
Current Drain (ma)	.085-.100
Lifespan (days)	140 (approx.)

Table 4. Schedule for radio tracking and summary of detection success for radio tagged broad whitefish released upstream from the Keneksek Creek logjam in July 1987.

Date	Fish Number									
	87-1	87-2	87-3	87-4	87-5	87-6	87-7	87-8	87-9	87-10
22 July	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
24 July	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
26 July	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16 Sept.	No	Rec.	Yes	No	Yes	Yes	Rec.	Yes	No	No
12 Oct.	No	-	Yes	No	No	Yes	-	Yes	Yes	Yes
20 Oct.	No	-	Yes	No	Yes	No	-	Yes	Yes	Yes
25 Oct.	No	-	Yes	No	Yes	No	-	Yes	Yes	No
4 Nov.	No	-	Yes	No	Yes	No	-	Yes	Yes	No
9 Nov.	No	-	Yes	No	Yes	No	-	Yes	Yes	Yes
11 Nov.	No	-	No	No	Yes	No	-	Yes	Yes	Yes
13 Nov.	No	-	No	No	Yes	No	-	Yes	Yes	Yes
17 Nov.	No	-	No	No	Yes	No	-	Yes	Yes	Yes

Rec. = recaptured

PLATES

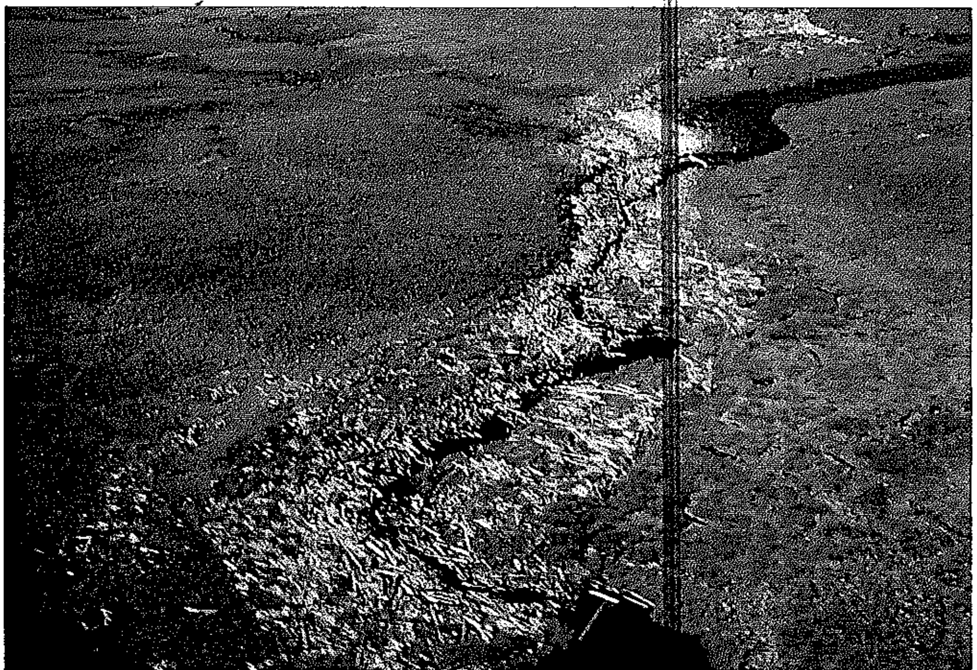


Plate 1.

Kenesek Creek logjam on 26 July 1987.

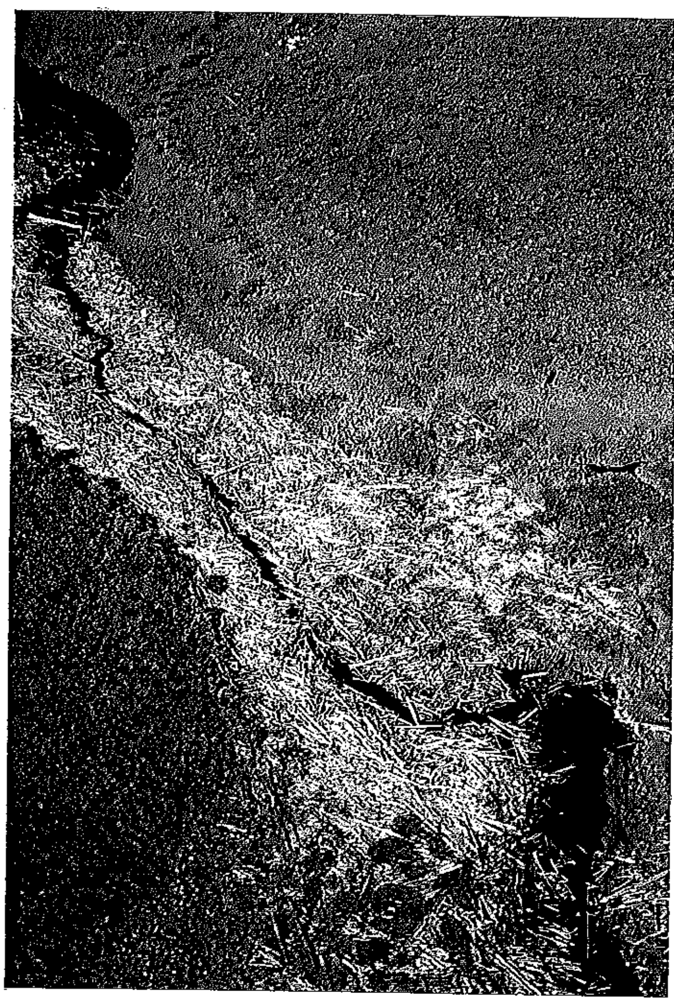


Plate 2.

Status of channel cut through logjam.

Note several small blockages, 26 July 1987.

Plate 3. Looking upstream from creek mouth; blockage #1 is located behind large log. The view continues to the right in Plate 4.

Plate 4. Upstream view from creek mouth.

Plate 5. Blockage #1; fish passage is possible.

Plate 6. Channel cut through the logjam at this location was 1.3 to 1.6 m wide and 0.1 to 0.5 m deep.

Plate 7. Proceeding upstream along the cut channel.

Plate 8. Proceeding upstream along the cut channel.

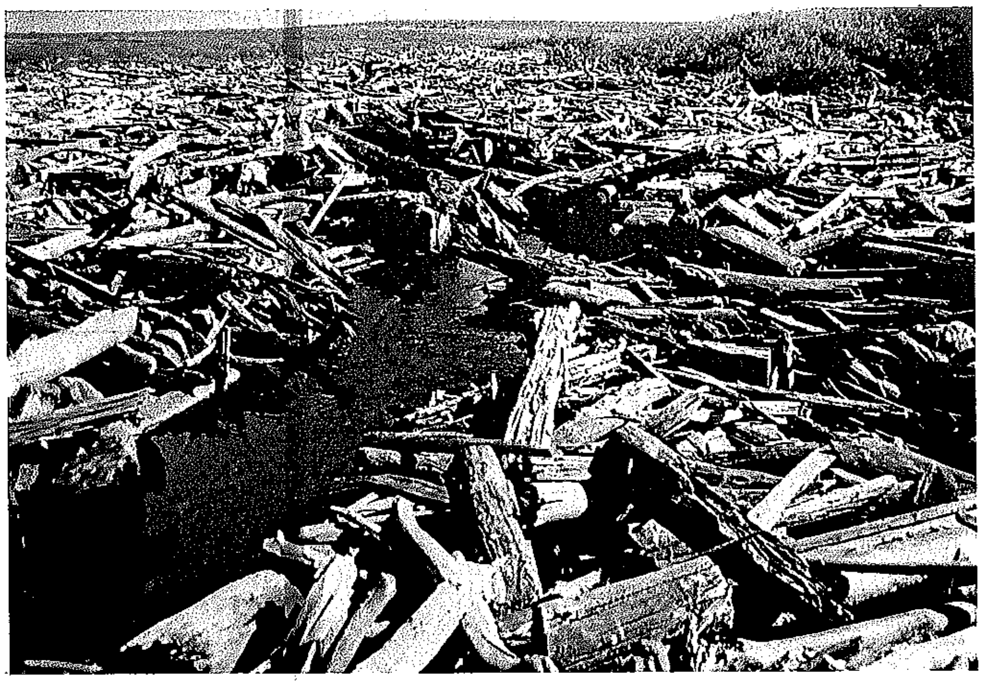


Plate 9. Proceeding upstream along the cut channel; note the cut out pieces of logs (0.6 to 0.8 m long) deposited on channel banks.

Plate 10. Blockage #2; fish passage is possible but debris was slowly blocking the streamflow.

Plate 11. Blockage #3, located 7 m upstream of blockage #2; fish passage was not possible.

Plate 12. Blockage #3 was the largest one (12 m long) and the main feeding site for seagulls. Water flow was diverted and flowing through the uncleared part of the logjam.

Plate 13. A broad whitefish trapped in a pocket of water in blockage #3.

Plate 14. One of several broad whitefish found trapped and near death in blockage #3; these fish were easy prey for predators.

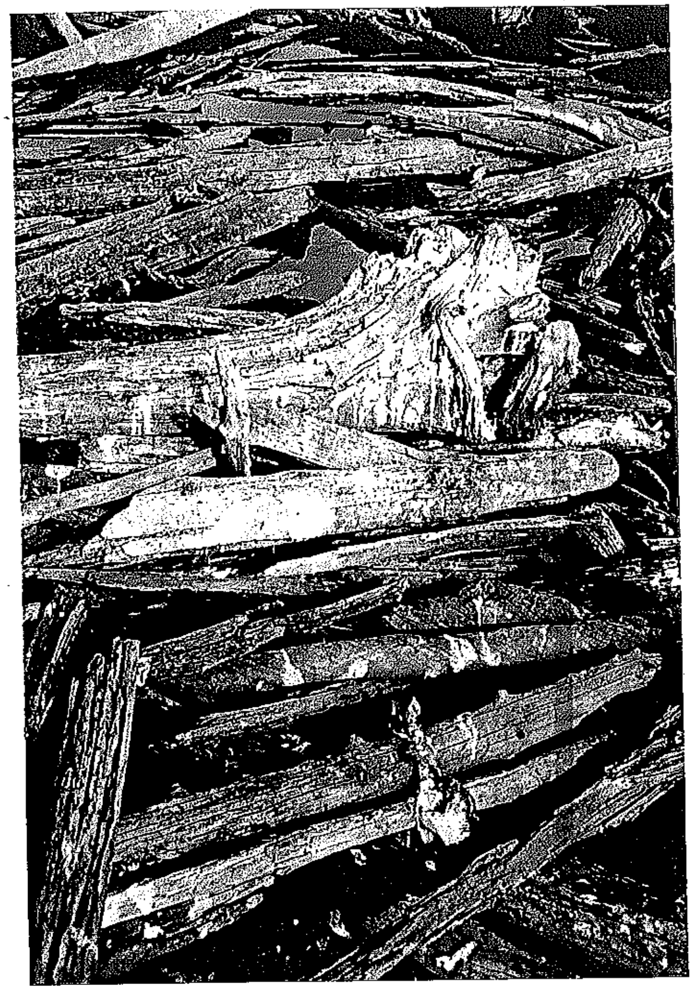


Plate 15.

Evidence of seagull feeding on whitefish at blockage #3.

Plate 16.

Blockage #4, about 4 m upstream of blockage #3.

Plate 17.

Blockage #4 looking down-stream; fish passage is possible.

Plate 18.

Blockage #5; fish passage is possible. Seven fish were holding in the pool above.

Plate 19. Broad whitefish in a pool above blockage #5.

Plate 20. Blockage #6, about 9 m long; fish were holding in the small pool at centre of picture.

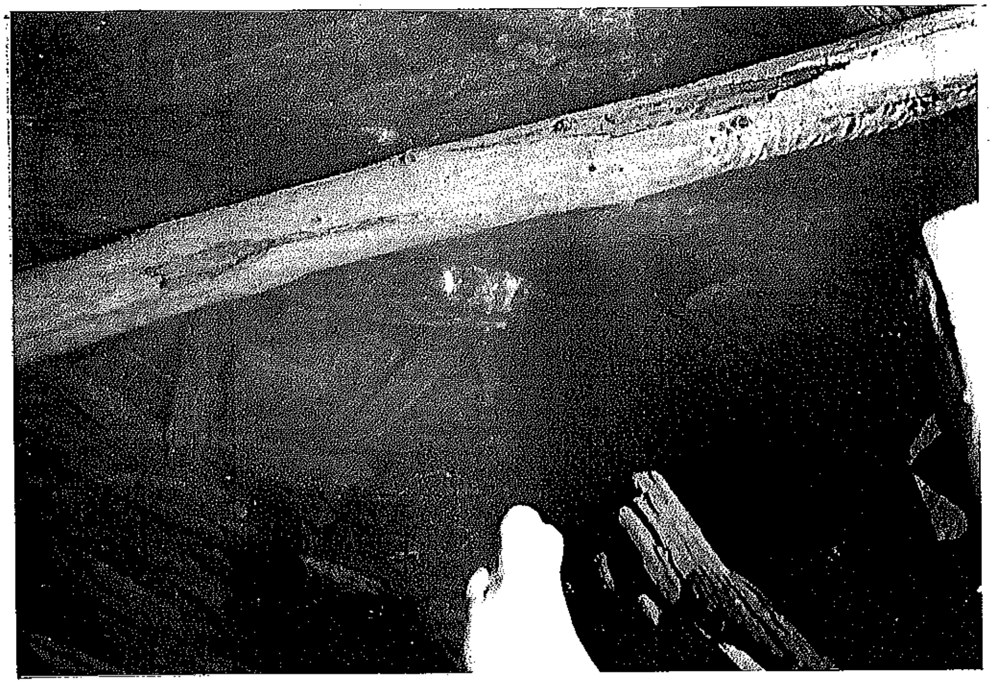


Plate 21.

Two broad whitefish trapped in pool at logjam #6; note the abrasions that were common on trapped fish.

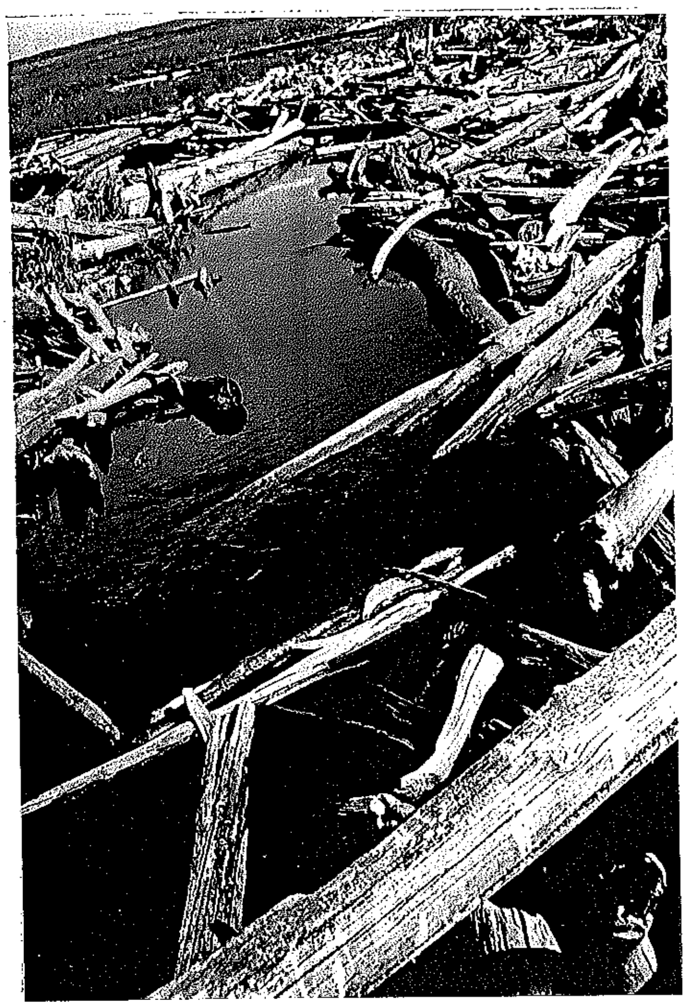


Plate 22.

Channel between blockage #6 and #7.

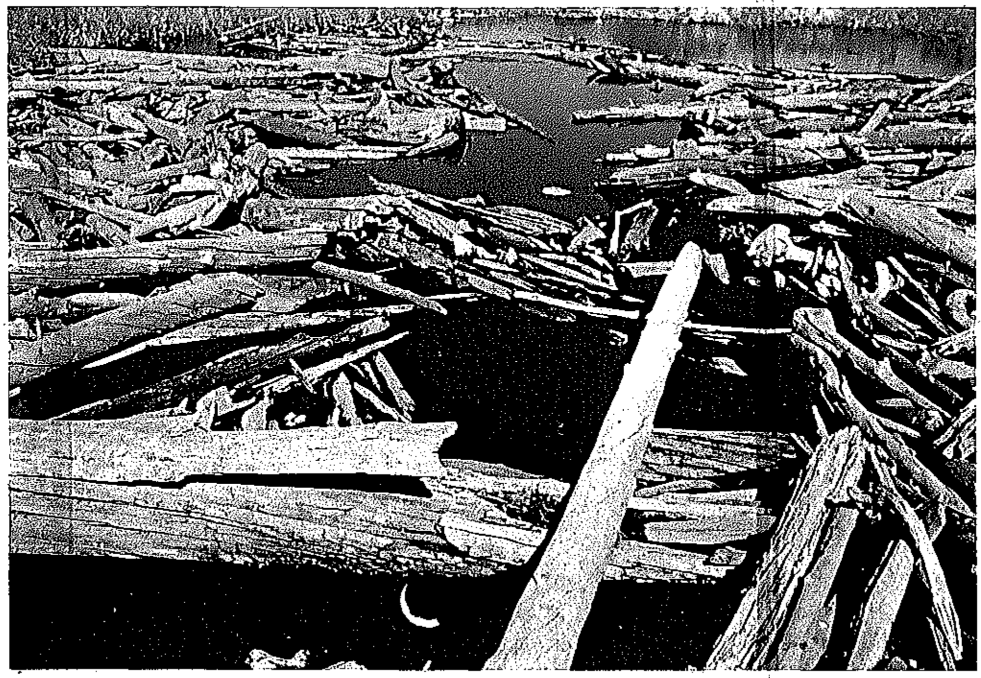


Plate 23. Blockage #7; fish passage was possible. The section cut through a submerged log was too narrow (1 m) thereby allowing debris to collect in centre of picture. Blockage #8 is visible in the background.

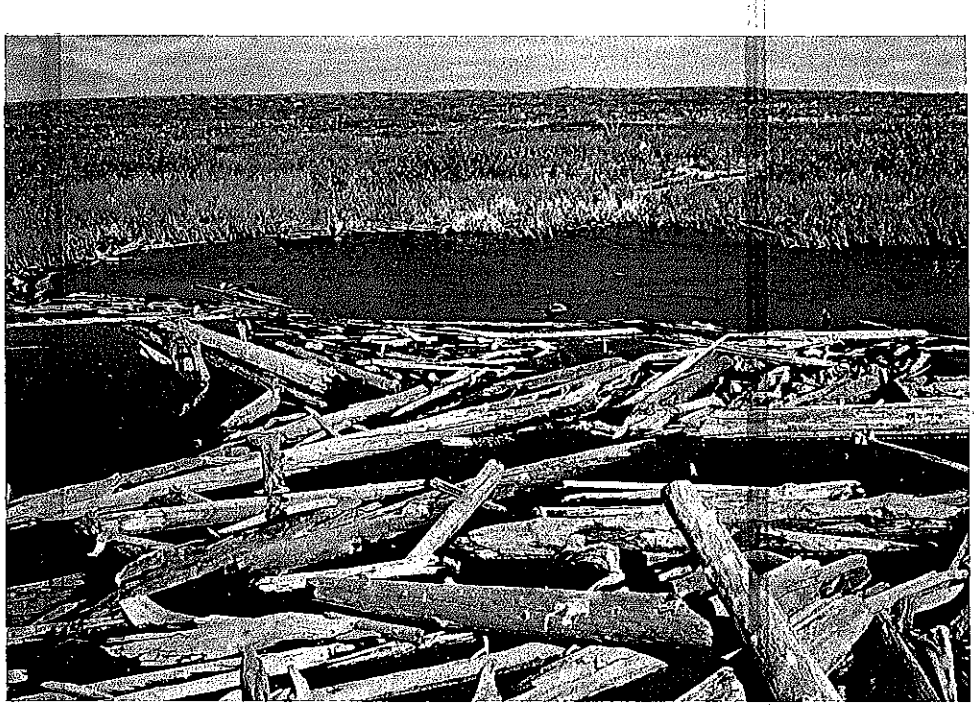


Plate 24. Blockage #8 was mostly floating debris; fish were holding in this first natural pool. The view continued to the right in plate 25.

Plate 27. Blockages #9 and #11 upstream.

Plate 28. Proceeding upstream towards blockage #12 and the second holding pool.

Plate 27. Blockages #9 and #11 upstream.

Plate 28. Proceeding upstream towards blockage #12 and the second holding pool.

Plate 29. Blockage #13 and second holding pool.

Plate 30. Numerous fish were holding is this second pool.

Plate 31. Blockage #14; fish passage was possible.

Plate 32. The third holding pool.

Plate 33. Upstream end of pool 3; note the pile of logs marking the high tide resulting from a major coastal storm in the past. The view continues to the right in plate 34.

Plate 34. Blockage #15, just right of pool 3. The view continues to the right in plate 35.

Plate 35. Blockage #15; the view continues to the right in plate 36.

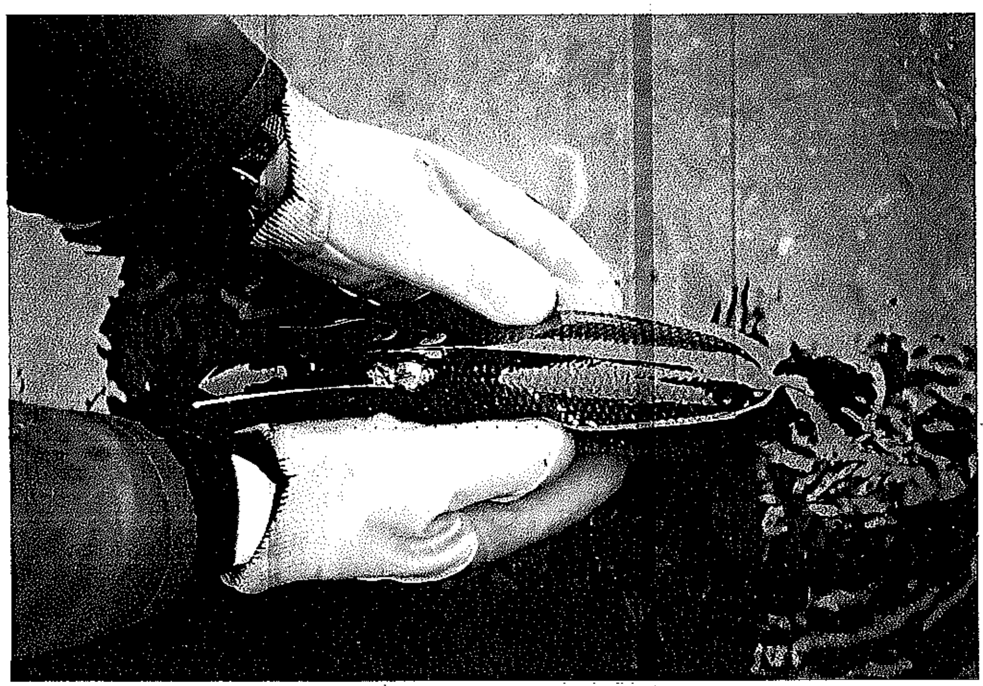
Plate 36. Three minor blockages were in place between blockage #15 and our fish tagging site 50 m upstream.

Plate 37.

Broad whitefish selected for radio tagging.

Plate 38.

Radio tagged broad whitefish being released back into the creek.



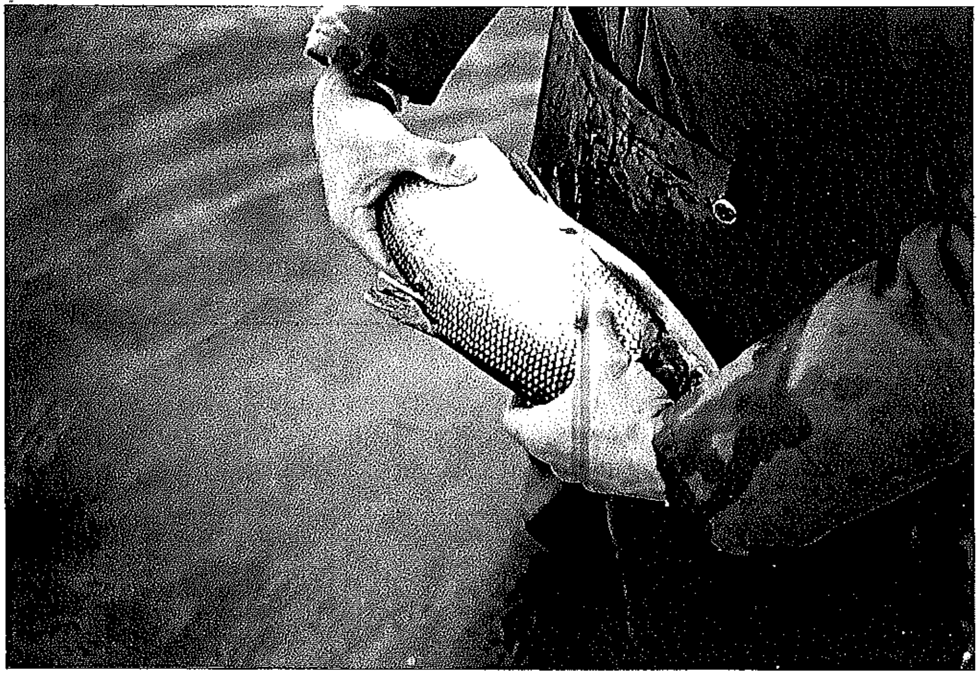


Plate 39. Broad whitefish with Floy tag.

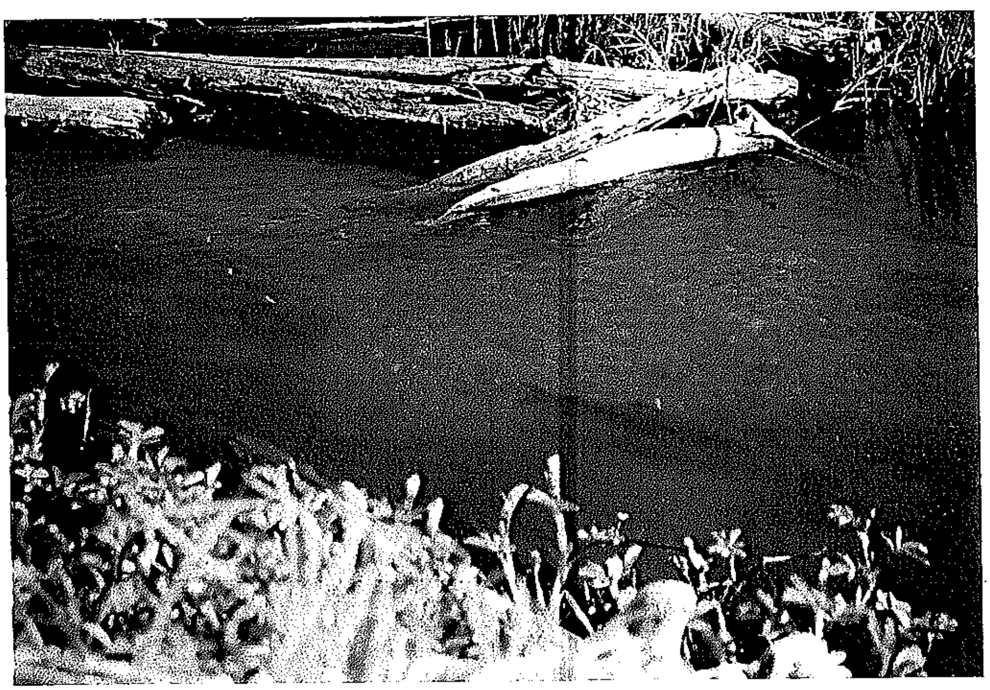


Plate 40. School of tagged broad whitefish in Kenesek Creek, 19 July 1987.

APPENDIX

Table A1. Distribution of project videotape entitled : "Logjam Inspection and Fish Migrations at Keneksek Creek, NWT 1987."

Tape No.	Location
1.	Mr. Robert Bell, Chairman Fisheries Joint Management Commission Box 837, Lac La Ronge Saskatchewan S0J 1L0 Phone: (306) 425-3136
2.	Mr. Vic Gillman, Area Manager Department of Fisheries and Oceans Box 1871, Inuvik, Northwest Territories X0E 0T0 Phone: (403) 979-3314
3.	Mr. J. Stein, Head, Resource Impact Section Resource Allocation and Habitat Management Division Department of Fisheries and Oceans 501 University Crescent Winnipeg Manitoba R3T 2N6. Phone:(204) 983-5164