A BIOLOGICAL ASSESSMENT OF ARCTIC CHARR STOCKS IN THE KUUK AND KAGLUK RIVERS, VICTORIA ISLAND, NWT, 1987

by

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December 1987

This report was prepared under contract for the Department of Fisheries and Oceans.

FISHERIES JOINT MANAGEMENT COMMITTEE
REPORT # 87-001

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INTRODUCTION

In 1982, responding to interest expressed by residents of Holman, the Department of Fisheries and Oceans (DFO) initiated studies to assess the commercial potential of Arctic charr (Salvelinus alpinus L.) stocks in the Prince Albert Sound area of Victoria Island, NWT (Figure 1). During August of 1982 and again the following summer DFO personnel conducted test fisheries near the community in Safety Channel (Kristofferson and McGowan 1982; Kristofferson et al. 1984). Concern had been expressed by DFO that these charr were migrants from the domestically exploited stock at the Kuujjua River, in Minto Inlet, and the studies found this to be the case. They recommended against establishing a commercial fishery in the Safety Channel area and, based on samples obtained from the coincident commercial fishery at the Kagloryuak River, near the head of Prince Albert Sound, suggested that the commercial potential of stocks further afield should be examined.

In 1985, in an attempt to identify rivers in Prince Albert Sound with stocks of anadromous Arctic charr that were capable of sustaining a commercial harvest, DFO tested the Kuuk (70°34'N, 112°38'W), Naloagyok (70°13'N, 112°13'W), Kagluk (70°13'N, 112°58'W), and Kagloryuak (70° 18'N, 111° 24'W) rivers. From the data collected neither the durations of migrations nor the relative numbers of charr in the stocks could be determined. The study was repeated in 1986 by North/South Consultants Inc. who were contracted by the Fisheries Joint Management Committee (FJMC). It was hampered by unfavourable ice conditions in Prince Albert Sound which prevented them from testing the Kagluk and Nalaogyok rivers and limited testing at the Kuuk River (Baker 1986). Based on the data, DFO set 1987 provisional harvest quotas of 2000 kg (roundweight) of anadromous Arctic charr at the Kuuk, 4500 kg at the Kagloryuak, and 2000 kg in total for the Kagluk and Naloagyok rivers combined (Gillman pers. comm.).

In 1987, the FJMC contracted Arctic Biological Consultants to collect the data necessary to evaluate the potential of a fall commercial fishery at the Kuuk River, and to conduct a test fishery and biological assessment of charr entering the Kagluk River. This involved: 1) the ennumeration, tagging, and biological sampling of charr at a weir built across the Kuuk River, coincident with a commercial test harvest, 2) a gillnet test fishery to assess the strength, health, and timing of charr entering the Kagluk River, and 3) assessments of site suitability in terms of access, weir location, and run timing. This report describes that work.

METHODS

KUUK RIVER

Weir Construction and Site Evaluation

Weir materials were flown from Holman to an island at the mouth of the Kuuk River on 9 August 1987. It took three flights by a De Havilland Twin Otter aircraft to transport the weir materials, camping supplies, ourselves, and Noah Akhiatak. We were followed to the river by John Alikamik and Robert Kuptana who travelled from Holman by boat with their families.

A suitable weir site was found 500 m upstream from the river mouth and the 2500 kg of trap and weir materials were moved there by 250 cc Honda trike and sled (Plate 1). At the weir site the river was about 70 m across with an average depth of 40 cm, current of 2 m/second, and a boulder bottom. The difficult processes of moving the materials over the rocky ground and erecting the weir in the strong current were completed on 14 August 1987 (Plates 2-4).

The weir was similar in design and construction to the metal conduit pipe design that was described in Appendix 3 of Kristofferson et al. (1986). It extended from shore to shore and its western and eastern wings, including rock weir extensions, were 92 and 16 m long, respectively. Due to exceptionally high water levels in the river there was not enough material to construct the weir at optimal angles to the trap and to the current, nor was there material to construct a chute or holding pen for the commercial fishery. However the weir/current angle was maintained as near 90° as possible and the trap was situated near the eastern shore to facilitate building of a rock holding pen for the commercial fishery. The trap resembled that shown on Figure A.1.1 of Kristofferson et al. (1986) but was 1.23 m wide, 2.46 m long and 1.54 m high, had a frame of wooden 2x4's, and vertically mounted metal conduit pipes instead of plastic netting. It lacked the rear drop gates, but had 2x4's extending from the four bottom corners on which rock ballast could be placed to keep the trap stationary.

Strong winds knocked over three sections of fence at the west end of the weir on August 31st, and rising water with new ice knocked down the same sections on 2 September - both breaks were fixed within hours and few fish passed upstream uncounted. The trap was moved closer to mid-channel on 1 September to improve the weir/current angle. This was accomplished without fish moving upstream uncounted.

On September 2, following the test fishery and the peak run, the Inuit workers took their families back to Holman. John and Noah and their sons Buddy and David returned by boat on September 6th to complete the fishery and remove the weir. The weir was dismantled on 12 September, once the majority of the run was complete, and the weir materials were stored on hills at either side of the Kuuk River. They were placed in areas with good snowmobile access and low snow accumulation.

During the weir fishery the Kuuk's accessibility to boats and planes and suitability for setting nets, erecting weirs, and setting up camps were assessed.

Biological Evaluation

Arctic charr were counted as they migrated upstream from Prince Albert Sound to Tahiryuak Lake via the Kuuk River (Figure 1). Shallow water, strong current, and the large size of the fish limited to 60 the number of Arctic charr that could hold position in the trap, so it was emptied hourly depending on the number of fish that were migrating. In order that the run was not delayed, fish were counted through the fence during the heaviest portion of the run. This was done by raising ten conduits and counting the number of fish that moved upstream through the gap in twenty minutes. This was repeated at intervals until fish had been counted through for a total of two hours per day.

During the course of each day biological samples were taken from whole trap loads of fish. For each Arctic charr, the fork length (±1 mm) was measured and tags, scars, and external parasites were recorded. Round weight was measured on a subsample of the fish (fish >350 g Accu-weigh hanging scale ±25 g; fish <350g battery operated pan balance ±1 g). Most of these fish were then released upstream, some were tagged and then released, and a few were sacrificed.

The fish were tagged with white plastic Floy spaghetti tags numbered sequentially from FC-60501 to FC-61000. The tags were inserted between the pterigiophores of the dorsal fin on the left side of the fish using a Floy Mark II tagging gun. The fish were not anesthetized and after tagging were released in a quiet backwater for observation. The needle, gun, and tag were sterilized in a 10% solution of Prepodyne between each fish to prevent the introduction or spread of infectious pancreatic necrosis virus.

To provide the basis for a regression of length against age, from which the age composition of the run could be determined, about 10 fish were sacrificed per 5 cm length class. Fish in the smaller length classes were sampled from the hoopnet. For each fish the sex and stage of maturity were recorded, the stomach contents examined, metazoan parasites counted, and the sagittal otoliths removed and stored dry in a coin envelope. Sampling did not alter the quality of the meat, which the fishermen dried for use in the winter.

The stage of maturity was determined by gross examination of the gonads following the classification code used by Kristofferson et al. (1982) (Appendix 1). Neither sex nor maturity could be reliably determined by external examination.

Food items in the stomachs were assigned fractional fullness values ranging from 0 (empty) to 1 (full) based on their apparent capacity and contents. A modification of Hynes' (1950) point method was used to assess the importance of food items consumed. Each food item was assigned 1, 2, 4, 8, or 16 points according to the volume of it present in the stomach, a full stomach, irrespective of the size of the fish, receiving a total of about 20 points. Modification consisted of assigning <1 point to minor quantities of small items, rather than ignoring their contribuiton to the diet (Smart and Gee 1979).

Representatives of the parasite species found in the Arctic charr were preserved in 70% ethanol and identified to genus or species in the laboratory.

Fish age determinations were made from sagittal otoliths which were treated as outlined in Kristofferson et al. (1982) and aged according to the method of Grainger (1953) by Mr. G. Carder (Fish and Marine Mammal Management Division, DFO Central and Arctic Region, Winnipeg).

Once the age data were received from DFO, the length at age relationship was calculated using least squares regression analysis on individual measurements. The relationship is described as follows:

$$\text{fork length in mm} = b \cdot \text{age in years} + a$$

Using this regression, the age composition of the run was predicted from the measured fork lengths and a catch curve was constructed.

Weight at length relationships were calculated using least squares regression analysis on logarithmic transformations of fork lengths and round weights. The relationship is described as follows:

$$\text{Log}_{10} \text{ round weight in g} = b \cdot \text{Log}_{10} \text{ fork length in mm} + \log a$$

The condition factor (K), a relative measure of the plumpness or robustness of the fish, was determine by the following formula:

$$K = (\text{round weight in g} \cdot 10^5) \cdot \text{fork length in mm}^{-3}$$

The length, age, and maturity composition of the run over time was described statistically by regression analyses on the individual measurements and t-tests on the population means. The data were tested for sex-related differences using analysis of covariance on the weight at length regressions and binomial t-tests on the mean length, weight, condition, and age. Statistical differences were considered significant if the probability of error was less than 5% ($P<0.05$).

Following the method outlined in Ricker (1975) a Schaefers stratified population estimate was made for the Kuuk River Arctic charr using tag-recapture data from a hoopnet which was set 500 m upstream from the weir on August 17th. The hoops, 61 cm in diameter with 3.7 m wings, were covered by #35 delta nylon with meshes 2.1 mm square. The hoopnet was checked at least once daily until its removal on 12 September.

Commercial Fishery

A commercial harvest was conducted during the weir ennumeration of the Kuuk River charr population (Plates 5-9). It was coordinated with the Holman Hunters and Trappers Committee (HTC) and DFO. On September 18 and 19, large rock holding pens were constructed between the trap and shore. Arctic charr passing through the weir from the 18th through the 20th were held for the harvest. On the 20th, once it was certain that a Twin Otter was arriving to pick up fish, the fish were removed from the holding pens with a beach seine and killed. They were shipped round or dressed in plastic fish tubs that had been sterilized with Prepodyne disinfectant and rinsed with clean water. They

were frozen on arrival in either Holman or Inuvik.

A subsample of 33 Arctic charr taken during the commercial fishery was consigned to the Scientific Authority for genetic and other analyses. The fish were frozen intact in Inuvik, about 12 hours after harvest, and flown to DFO Winnipeg for sampling. Biological data from them is included in this report.

The potential yield of the Kuuk River anadromous Arctic charr population was estimated using the Baranov catch equation (Ricker 1975; Kristofferson et al. 1982) as follows:

$$C = FAN \cdot Z^{-1}$$

where: Z = instantaneous rate of total mortality
A = annual mortality rate
F = instantaneous rate of fishing mortality
C = catch in numbers
N = stock size

A value for Z was calculated by fitting a least squares regression to the descending limb of the catch curve. Only fully recruited age groups were used. This was accomplished by using the next older age group from the modal age since the modal age will often lie quite close to the first year in which recruitment can be considered effectively complete (Ricker 1975; Kristofferson et al. 1982). The survival rate (S) was calculated directly from the catch curve and used to estimate A (Ricker 1975). Instantaneous natural mortality (M) was assumed to be 0.17 after Moore (1975) and Dempson (1978) and F was calculated from $Z = F + M$. The stock size (N) was assumed to equal the weir count.

KAGLUK RIVER

Test Fishery and Site Evaluation

On August 26th, the first day that ice and weather conditions permitted travel across Prince Albert Sound, Sparling, Alikamik and Kuptana travelled to the Kagluk River to conduct a test fishery (Figure 1). They set a 50 m gillnet across each of the two channels at the river mouth and a hoopnet 200 m upstream. The gillnets were 50 m long and 2 m deep. One net was 14 cm stretched mesh (5 1/2") and the other was a mixed gang with 10 m panels of five different mesh sizes: 14.0, 11.4, 8.9, 6.4, and 3.8 cm. The hoopnet was identical to that used for the Schaefer estimate at the Kuuk River. The nets were checked twice daily until August 29th, when the crew returned, between storms, to the Kuuk River.

During the fishery the Kagluk's accessibility to boats and planes and suitability for setting nets, erecting weirs, and setting up camps were assessed.

Arctic charr caught at the Kagluk River were sacrificed and sampled as described for the weir fishery. In addition to the biological measurement data, the number, mesh size, and length of nets set, the set times and the

catches of fish, both in weights and numbers, were recorded so that sampling effort could be determined.

Biological Evaluation

Age, fork length, weight, sexual maturity, stomach contents, parasites, and condition factors are described as they were for the Kuuk River charr, and discussed in as much depth as the small sample allows.

The catch per unit of sampling effort (CPUE) was expressed in terms of the number or weight (kg) of Arctic charr caught per 100 m of net set for 24 h. Daily CPUE's values were calculated based on the sum of the number of metre-hours of gillnet that was set each calendar day. In calculating CPUE's each net set was assigned to the calendar day wherein the majority of its set time fell. No corrections were made to the catches to account for differences in mesh size, time of day, or location of the fishing.

RESULTS AND DISCUSSION

KUUK RIVER

Site Evaluation

Boat Access

Like Baker (1986) we found that boat access to the Kuuk River was not reliable. Drifting pack ice was present in Prince Albert Sound until the end of August, and together with the strong and variable winds it made travel in the fishermen's 18' aluminum boats hazardous and unpredictable. On several occasions we had winds of 60 to 80 kmph over periods of several days (Plate 10). Once the pack disappeared the winds raised 6 m rollers on the sound in hours. Fog, rain, and snow were also common in late August and September and it is common to be storm-stayed for a week at a time.

Boat access to the river mouth is obstructed by sandbars offshore which resulted in damage to several outboard propellors. The distance from Holman to the Kuuk River, about 200 km, means that gasoline and outboard motor oil must be transported to the river by snowmobile or plane if boat trips are planned to other systems.

There is a schooner in Holman that is about 12 m long and capable of travelling in rough weather. It could carry large loads of equipment and fish, but it is slow and, like the smaller boats, succeptible to ice damage. It cannot land at the river mouth because the water is too shallow and materials and fish would have to be ferried by boat from the HTC cabin on a small island about 2 km distant.

Aircraft Access and Availability

Aircraft access to the Kuuk River is relatively good. There are landing strips at right angles to one another on the island at the river mouth where fully-loaded de Havilland Twin Otter aircraft can land and takeoff. Landing on the plateau above the river is made difficult by patterned ground and sharp-edged limestone shale, but a Twin Otter can land on the western side about 3 km upstream from the river mouth.

Small float-equipped aircraft share many travel limitations with small boats and their use at the Kuuk River, as suggested by Baker (1986), should be approached with caution. Their access is particularly limited by weather. For example, heavy rainfalls such as occurred in 1987 make landing dangerous by creating strong currents at the river mouth and obscuring shallows at the river mouth with a plume of turbid water. There is also little shelter for a float plane to land or takeoff at the river mouth, and it would be succeptible to damage from strong, changeable winds that create large waves and carry drifting pack ice onshore.

Aircraft availability is problematic since the nearest Twin Otter is in Inuvik and the nearest single-engine float planes are in Cambridge Bay. This increases the cost to the fishery significantly and increases the possibility of flight disruption by poor weather between the river and their base of operations.

Logistics between the aircraft and the fishermen can be coordinated from Holman via SBX-11a HF radios. It would be helpful for the fishermen to have direct communication with the aircraft or it's base to ensure that fish are fresh when the aircraft arrives.

Camp Sites

The river-mouth island affords well-drained campsites with sheltered boat moorings and there is fresh water in the river nearby. The tidal range is small, 1 or 2 m, and even when it is augmented by violent onshore winds does not flood the island (Plate 10).

Fishing Methods

When Baker (1986) visited the Kuuk in 1986, the river channel was 40 to 50 m across and 0.5 m deep with moderate currents. In 1987, a year of high precipitation, the currents were strong and the channel was 70 to 80 m across and a metre deep. Runoff from high rainfalls and fast snowmelts swelled the river to its banks on August 31st and again between September 9th and 14th. Currents averaged 2.0 metres per second on September 13th, with the flows estimated at 60 cubic metres per second and very high silt loads in the water. During a high runoff year like 1987, it is not practical to set gillnets in the river and weir construction upstream is difficult. Gillnets can be set and tended near the river mouth except during strong onshore winds.

The weir worked well during the commercial harvest and will work better when it is set up specifically for commercial harvest. There are sufficient materials on site to construct a commercial weir that shuts off only a portion of the river and has a chute to a holding pen (Kristofferson et al. 1986). In dry years, when the river delta shrinks to a single channel, a weir can be placed within 200 m of the river mouth; in wet years it would be better placed 600 m upstream from the river mouth where the water is deeper and the flows are evener.

An all-terrain trike and sled were used to transport fish from the weir, 500 m upstream, to aircraft on the island landing strips (Plates 7 and 8). They were indispensable for carrying heavy tubs of fish over the rough terrain and should be used in any future weir fishery at the Kuuk River.

Biological Evaluation

Run Strength and Timing

Between 14 August and 12 September 1987, 9204 anadromous Arctic charr were counted moving upstream past the weir. The main charr run occurred between the 18th and 28th of August and had virtually stopped when we removed the weir on the 12th of September (Figure 2a). Silver-colored Arctic charr, fresh from the sea, were the only fishes seen at the weir.

Charr length ($n = 1453$) increased significantly as the run progressed but the increase was weakly correlated with time ($r^2 = 0.05$) (Figure 2b). The same was true for age, weight, and condition of the charr during the course of

the run.

Equal numbers of female and male charr were taken before and during the peak run, but after the run peaked the proportion of female charr in the samples was significantly lower (binomial t-test). The youngest migrants were aged 7 y for both sexes (Table 1). Non-migrating charr with parr marks, aged from 1 to 8 y, were caught in the hoopnet. The maturity of the charr did not appear to vary during the run and few fish had maturing sex products in their gonads.

Movements

Tags were placed on 494 anadromous Arctic charr as they passed upstream through the trap. White plastic Floy spaghetti tags numbered from FC-60501 to FC-61000 were used, and data on the tagged fish is presented in Appendix 2. Three fish were tagged improperly and died. They were sampled and the tags reused. Six tags with the numbers FC-60525, FC-60646, FC-60719, FC-60732, FC-60746, and FC-60920 were lost or destroyed. Following tagging the fish moved quickly upstream.

Tag-recapture data from the hoopnet upstream was used to calculate a Schaefer Population Estimate of fish moving upstream in the Kuuk River. The estimate of 4670 fish in the population was low. This may have resulted from selective capture of tagged fish that were resting in the river bend where the hoopnet was set. A more accurate population estimate, using the Schaefer method, might be obtained by replacing the hoopnet with a small metal conduit weir which would better withstand current and could be placed midstream to reduce the sampling bias.

In the future, the tag-recapture data can be used to delineate the extents of the fishes freshwater and marine migrations, to calculate rates of growth and mortality, and to estimate the population (Ricker 1975). To facilitate this, tag returns from the fishermen must be aggresively pursued. Many people in Holman do not understand the importance of the tags or where to send them. In our meetings with the Holman HTC we stressed the importance of returning tags from captured fish to DFO. Information on the tagging program should be posted in the community, in english and inuktitut, and disseminated over the community radio station if the program is to be a success.

Growth

Fork length was measured for 1453 anadromous charr that passed through the trap (Figure 3). Subsamples of these fish were measured for weight and sacrificed for age determinations. The data are summarized overall and by sex in Table 3. Data for the sacrificed fish is summarized by age class in Table 1, and by 5 cm length class in Table 2.

The length at age relationship for anadromous charr is best described by the equation: $Y = 35.29X + 129.23$, ($r^2 = 0.86$, $n = 109$). It compares favourably with most other anadromous Arctic charr populations in the Canadian Arctic and with previous samples from the Kuuk population (Table 4). There was no significant difference (t-test) in mean age or length between sexes. Mean length at age is illustrated in Figure 4, and the distribution of ages in the catch, predicted using the length at age regression from the lengths of fish

sampled, is shown in Figure 5. Recruitment to the anadromous population is variable and complete by age 12 or 13 y and fork lengths of 500 to 550 mm (Figures 3 and 5).

The weight at length relationship for anadromous charr is best described by the equation: $\log_{10} Y = 3.00 \log_{10} X - 4.96$, ($r^2 = 0.95$, n = 770). Growth in the Kuuk population is isometric. Based on the weight at length relationships the fish are in better condition than in previous years at this time (Table 5). These relationships tend to be unsatisfactory for assessing differences between stocks, since the values vary widely depending on year and season (Johnson 1980; Dutil 1982).

Male charr were significantly heavier on average than female charr (t-test). The ratio of round to dressed weight was 1.14 (n = 175, std. dev. = 0.04).

Condition

The charr were in good condition relative to many other anadromous charr populations in northern Canada (Kristofferson et al. 1982; Stewart and Bernier 1982, 1983, 1984; McGowan 1985). Condition appeared to improve with age and length of fish, peaking at about age 15 to 16 y and lengths of 65 to 70 cm and decreasing gradually thereafter (Tables 1 and 2). The mean condition factor was 1.13 and did not differ significantly between sexes (Table 3). This was a marked improvement compared to fish taken in 1985 (1.03; Kristofferson pers. comm.) and 1986 (1.00; Baker 1986) at the Kuuk. The improved condition may be related to weather, as Baker (1986) suggested, since 1987 had an early spring relative to those of 1985 and 1986. An earlier spring break-up would allow the charr more time to feed at sea.

Sex and Maturity

Sexually mature anadromous charr in Arctic populations seldom spawn every year (Johnson 1980), and there is no adequate classification for multi-year resting fish in the DFO Fish Management maturity code (Appendix 1). Following the code, these charr, which have spawned previously but often do not have resorbing or maturing sex products in their gonads, would be incorrectly classified as "immature". In an attempt to alleviate this problem charr which were not obviously virgin, with small transparent gonads, were classified as "resting". They were not classified as "unknown (11)" because their sex could be identified.

The age at first maturity was 13 y or younger for males and 15 y or younger for females, and the sex ratio favoured males (F/M = 0.79; Table 3). Of the 143 migrants sampled, 15% were immature, 6% were resting previous year spawners with resorbing milt or eggs in their gonads, and the remaining 79% were probably resting spawners from the previous year or years. They were aged from 8 to 20 years, with thin translucent testes or ovaries containing small (1 mm) yellow eggs. The eggs were similar in size to those found with the atritic eggs in the known resting fish. Three female charr with maturing gonads were taken in the commercial harvest. They represent about 1% of the charr seen sampled or dressed during the domestic and commercial harvests. Anadromous Arctic charr in the Nauyuk River system do not begin spawning until they are >650 mm in fork length and aged at least 10 y (Johnson 1980).

The Kuuk River charr probably spawn under the ice of Tahiryuak Lake in late September and October. Spawning redds occur near shore, where the Kuuk River exits the lake, in the southeastern arm of the lake (70°58'N, 111°57'W), and along the north and south shores of a point that extends from the eastern shore (70°57'N, 112°04'W) (Figure 1; Holman HTC pers. comm.).

Diet

The anadromous charr fed heavily on marine amphipods at the river mouth, but when they reached the weir 87% had empty stomachs (n = 111). Of those that had food in their stomachs, marine amphipods accounted for 74% of the dietary points, marine fish 19%, unidentified digested material 6%, and fish eggs and mysids 1%. Seventy-four percent of the small charr taken from the hoopnet (n = 19) had empty stomachs. Of those that had food in their stomachs, chironomids accounted for 54% of the dietary points, unidentified digested material 38%, and freshwater amphipods 8%.

Parasitism, Injury, and Disease

Nine metazoan parasites were found to infect the anadromous charr (n = 105) (Table 6). None of the fish were heavily infected by any of these parasites, none of the parasites infect man or reduce the commercial value of the charr, and all have been reported from fish on Victoria Island (Stewart and Bernier 1982, 1983, 1984). Many of the fish were voiding the marine tapeworm Bothrimonus sturionis as they swam upstream through the trap.

Physical damage, in the form of scars and net marks, was observed on 2.3% (34) and 0.7% (10) respectively of the 1453 charr that were examined at the weir. With the exception of one round scar, probably from a lamprey, the scars were slash marks, probably caused by seals. Some of the gashes were fresh, and seals were observed at the river mouth and along the coast during the fishery. The net marks were also recent and suggest that some of the fish had migrated at least 40 km westward along the coast during the summer.

Symptoms of disease that were observed among the anadromous charr included open sores on the body of one fish, blood spots under another's skin, and rotting dorsal or caudal fins on 5 (0.3%) other fish. Eleven (0.8%) of the charr were slinks, most of them old fish. Infectious pancreatic necrosis virus which has been reported from Arctic charr stocks in the Mackenzie River drainages (Souter et al. 1986) was not found in the Kuuk River charr (Souter pers. comm.).

Other Data Available

The 31 charr that were frozen whole and sent to the Freshwater Institute (DFO) in Winnipeg are also being autopsied for parasites (Bernier pers. comm.), and used in genetic and feeding pattern studies (Reist pers. comm.). The genetic studies include a battery of enzymatic analyses and morphometric measurements, and the feeding patterns will be studied using stable isotope analyses.

Commercial Fishery

The commercial fishery took an estimated 560 fish or 1850 kg round weight, two full Twin Otter loads, from the river on 20 August 87. Due to poor communications with the incoming aircraft many of these fish had to be shipped round, increasing the weight, otherwise the 2000 kg test quota would have been met. The fish were in excellent condition and are among the best we have seen or tasted in Arctic Canada - they should prove very marketable.

The stock has not been subject to regular summer fishing, but Holman residents sometimes gillnet anadromous charr on their spawning beds in Tahiryuak Lake in October (Holman HTC pers. comm.). In 1987, the domestic fishery by Inuit families at the Kuuk took about 75 charr using hand lines and rod and reel. Fresh net marks on migrants at the weir suggest that the stock is also exploited to some extent by summer coastal fisheries. The nearest fishery in 1987 was over 40 km to the west.

Potential Yield

A catch curve constructed from the predicted age-frequency distribution shows complete recruitment to the anadromous population by age 12 or 13 y, a gradual decline in year class strength from then until age 18, and an abrupt decline thereafter (Figure 6). These suggest a low rate of exploitation, the presence of several strong year classes in the 16 to 20 y range, and high natural mortality after age 18 y. The latter may also reflect the absence of large, old fish due to spawning (Johnson 1980).

An instantaneous total rate of mortality (Z) of 0.32 and survival rate (S) of 0.85 were calculated from the catch curve over the range of 13 to 22 y. The annual mortality rate (A) calculated from S was 0.15, and the instantaneous rate of fishing mortality (F) calculated from Z was 0.15. The stock size (N) was 9204. The potential annual yield estimated using these values in Baranov's equation was 647 charr, 7% of the fall run. This may be purely fortuitous considering that the assumption of constant recruitment does not appear to have been met (Ricker 1975) (Figures 3, 5, and 6). Fluctuating water levels in the river may cause selective mortality among the anadromous charr which would also invalidate the Baranov's estimate. In any case, the estimate agrees well with Johnson's (1980) experience at Nauyuk Lake.

Johnson (1980) found that harvesting at a rate of 11% of the standing stock was excessive in the Nauyuk Lake system which had a fall run similar in size and composition to that in the Kuuk River. This seems to indicate a maximum harvest rate, including domestic catches along the coast southeast of Holman and at the river mouth, of less than 10% of the Kuuk's fall run. A safe commercial harvest level might be 5% of the fall run, which translates to 450 charr weighing about 1485 kg round or 1300 kg dressed.

Community Interest

There was strong interest among the HTC members, and in the community generally, in the fishery. Interest was also expressed in testing other rivers with a view toward establishing a commercial fishery if the resource permits, and in the sport fishing potential of the Kuuk River charr. Community members need the employment that a fishery would generate.

KAGLUK RIVER

Site Evaluation

Boat Access

Boat access to the Kagluk River is poor and should not be relied upon to conduct a commercial fishery. It suffers from the same ice and weather problems as were discussed for the Kuuk River but these are compounded by the prevailing summer winds which push the pack ice in Prince Albert Sound onto the south shore. Sparling, Alikamik, and Kuptana managed to cross the sound during a break in the weather on August 26th while the ice pack was spread out. They spent the next three days pinned on shore by poor weather and returned to the Kuuk in a snow storm on August 29th, minutes ahead of a violent gale.

There is a good natural harbour at the river mouth, but rapids prevent boat access to potential weir locations.

Aircraft Access

There is good access for Twin Otter aircraft on tundra tires at an esker 1.5 km from the weir site. Once runways have been marked it should be possible to land on firm grassy strips closer to the weir site.

Small float planes might be used successfully at the Kagluk. The bay outside the river mouth offers sheltered landing but still had some broken ice in late August. The lake immediately upstream from the river mouth and a quiet stretch of river further upstream have straight stretches of 500 m that are potential landing sites. However, both are shallow, 0.6 to several metres, and caution is advised when landing on them during normal and low rainfall years. As with the Kuuk, aircraft would have to be chartered from Inuvik or Cambridge Bay, raising the cost of any fishery significantly.

Camping Sites

There are good camping sites near the potential weir sites or at traditional locations beside the river mouth.

Fishing Methods

Gillnets can be set and tended at the river mouth except during strong onshore winds.

There are good weir sites 1.5 to 2 km inland from the river mouth where there is an area of quiet water. The river channel there varies in width from 25 to 60 m, averages 60 cm in depth - less in years with normal rainfall, and has a cobble bottom similar to that at the Kuuk. An all-terrain trike and sled would be necessary to transport fish to boats or planes from the weir.

Biological Evaluation

Run Strength and Timing

Anadromous charr were caught entering the river between 26 and 29 August. The catches per unit of fishing effort (100 m of gillnet set for 24 h) were low in terms of both the number (6-17) and weight (10-63 kg) of fish, suggesting that the main run had passed. Inuit who lived at the Kagluk River before Holman was built describe the fall upstream migration of anadromous Arctic charr there as occuring concurrent with the Kuuk run, and having a similar number of fish of similar size (Holman HTC pers. comm.). This means that the main run would have ended before we arrived on August 26th, as appears to have been the case. The 1985 test fishery was earlier in the month, August 20th to 23rd, and had better catches per unit effort, 33 charr weighing 99 kg (Kristofferson pers. comm.). There were traditional stone fish caches along the shores near the river mouth, and seals were common at the river mouth.

Movements

Extents of the marine and freshwater migrations are unknown for the Kagluk charr. However, anadromous charr are reported to migrate upstream to a large headwater lake (Figure 1) where they have been gillnetted in the fall at their spawning beds (70°00'N, 112°33'W) (Holman HTC pers. comm.). No fish were tagged at the Kagluk River.

Growth and Condition

Between 26 and 29 August, 31 anadromous Arctic charr were caught and sacrificed at the Kagluk River. The data are summarized overall and by sex (Table 3), by age class in (Table 7), and by 5 cm length class (Table 8).

The mean length, round weight, condition, and age of the Kagluk River charr were closely similar to those of the Kuuk River charr and the previous test fishery (Kristofferson pers. comm.), and compared favourably with growth parameters from other anadromous charr populations (Tables 4 and 5). Length at age and weight at length relationships calculated from the small sample are unlikely to accurately represent the population growth rates, but are included in Tables 4 and 5. The ratio of round to dressed weight was 1.17(n = 29, std. dev. = 0.04).

Sex and Maturity

The sex ratio favoured females (Table 8). Only one fish was considered immature, a 14 y old male. Of the remainder, which ranged in age from 11 to 21 y, 2 had resorbing sex products and were considered to have spawned the previous fall, and the other 28 were probably resting spawners from the previous year or years. The age at first maturity was 13 y or younger for females and could not be determined for males.

Anadromous charr, probably from this population, are gillnetted in October at spawning beds (70°00'N, 112°33'W) in a headwater lake of the Kagluk River system (Holman HTC pers. comm.).

Diet

Eighty-three percent of the charr had food in their stomachs when they were examined (n = 30). The charr were well fed. Marine amphipods accounted for 56% of the dietary points, followed by marine fishes 39% (cod, sculpin, sandlance), and polychaete worms 5%.

Parasitism, Injury, and Disease

Three metazoan parasites were identified from the charr (n = 29). Sixty-two percent of the fish were host to from 1 to 9 Salmincola carpionis, 45% from 1 to 8 S. edwardsii, and 17% less than 50 encysted larval Diphyllobothrium ditremum. Unidentified adult tapeworms (cestoda) infected 10 % of the fish. These are not high levels of infection, none of the parasites infect man or reduce the commercial value of the charr, and all have been reported from fish on Victoria Island (Stewart and Bernier 1982, 1983, 1984).

No physical damage, in the form of scars or net marks, or symptoms of disease were observed. However, when a seal that damaged two fish in the net was shot for food, by one of the Inuit fishermen, it was found to contain the remains of 7 charr.

Present and Past Use of the Stock

The Kagluk was a traditional domestic fishery for Inuit before they moved to Holman, but is difficult to access by boat from Holman and has seldom been fished in recent years. It has no record of commercial harvest and test fisheries have been largely unsuccessful. Fish from the stock are sometimes harvested at the spawning beds upstream (70°00'N, 112°33'W), and others may be harvested along the coast of Prince Albert Sound in summer, depending on the extents of their migrations.

SUMMARY AND RECOMMENDATIONS

Between 14 August and 12 September, 9204 anadromous Arctic charr were counted migrating upstream in the Kuuk River, 494 of these fish were tagged. The main run occurred from 18 to 27 August. The charr grew quickly, and were in good condition relative to many commercially exploited anadromous charr populations; few were current year spawners. The stock was healthy and the rate of exploitation appeared to be low. There is good access to the fishery by Twin Otter aircraft, and good campsites are available at the river mouth. Local fishermen were trained in weir operations and successfully harvested 1850 kg roundweight of charr from the river.

The Kagluk River could not be visited by boat until 26 August, after the main run had apparently ended. Between 26 and 29 August, 31 anadromous Arctic charr were caught entering the river and sampled. The charr were healthy and closely resembled the Kuuk River charr in growth and condition, few were current year spawners. There is good access to the fishery by Twin Otter aircraft, and good campsites are available at the river mouth. There are several suitable locations for weir construction and gillnets can be set and tended at the river mouth. There is little domestic or commercial exploitation of the stock at present.

We recommend the following with regards to:

1) Tag Returns: Holman residents should be informed of the importance and mechanics of tag returns.
2) Access: Twin Otter aircraft should be used to access future test and commercial fisheries in the Prince Albert Sound area. An all-terrain trike with sled should be used for local access at each fishery. Boat use is not recommended.
3) Kuuk River: Future commercial harvests should take place between August 18 and 28, using a metal conduit weir modified for commercial harvest. This will yield the most marketable fish and limit damage to other fish. Until tagging studies clarify the extent of domestic exploitation in the Holman, Safety Channel, and Tahiryuak Lake areas, commercial catches should be limited to 5% of the fall run, or about 450 fish per annum. If the stock is exploited commercially, it should be closely monitored for changes in growth parameters during the first few years.
4) Kagluk River: Data should be collected from the Kagluk River in the same manner as at the Kuuk River before the stock is commercially exploited.
5) Equipment: A commercial weigh scale and sweep nets should be purchased if further fisheries are planned.
6) Commercial Fishery Potential: Alone, the Kuuk river stock will not support a financially viable commercial fishery, but it would be an important contributor to such a fishery if other commercially attractive anadromous stocks are found in the Prince Albert Sound area, for example at the Kagluk, Kagloryuak and Naloagyok rivers. In that event, rotational fishing of the stocks should be considered.
7) Sport Fishing Potential: If a viable commercial fishery cannot be run from Holman, the sport fishing potential of the Kuuk and Kagluk rivers should be investigated. The rivers are accessible by air and have good camping, attractive settings, interesting animal and bird life, and superb sport fishing. A sport fishery might provide greater economic benefit to the community than a commercial fishery.

ACKNOWLEDGEMENTS

We thank John Alikamik, Noah Ahkiatak, Robert Kuptana and their families for their assistance in the field and their friendship; Vic Gillman and his staff at DFO Inuvik for their advice and support; Gary Carder of DFO Winnipeg for determining the ages of the charr; Lionel Bernier of Komuk Biological Consultants for identifying the parasites; Dr. Jim Reist and his staff for providing information from the Arctic charr we collected for DFO; personnel from the Department of Health and Welfare, Holman HTC and Aklak Air who cooperated to evacuate Noah to Inuvik when he injured his ribs; members of the Holman HTC for their assistance with the project; Chris Day for providing helpful criticism of the manuscript; and Cecile Stewart for editing the manuscript and helping to draft the figures.

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Plate 1

Plate 2

Plate 3

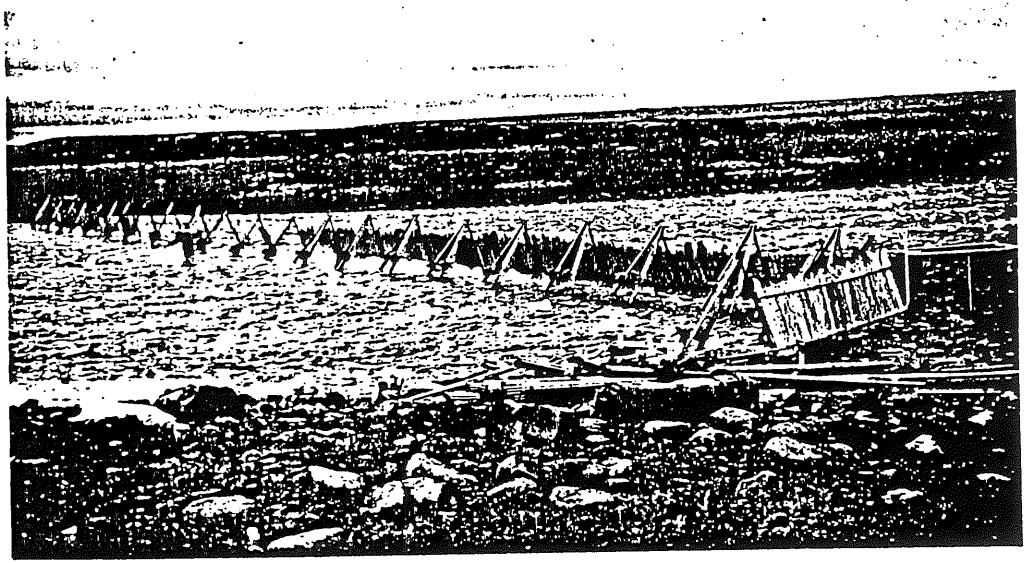

Plate 4

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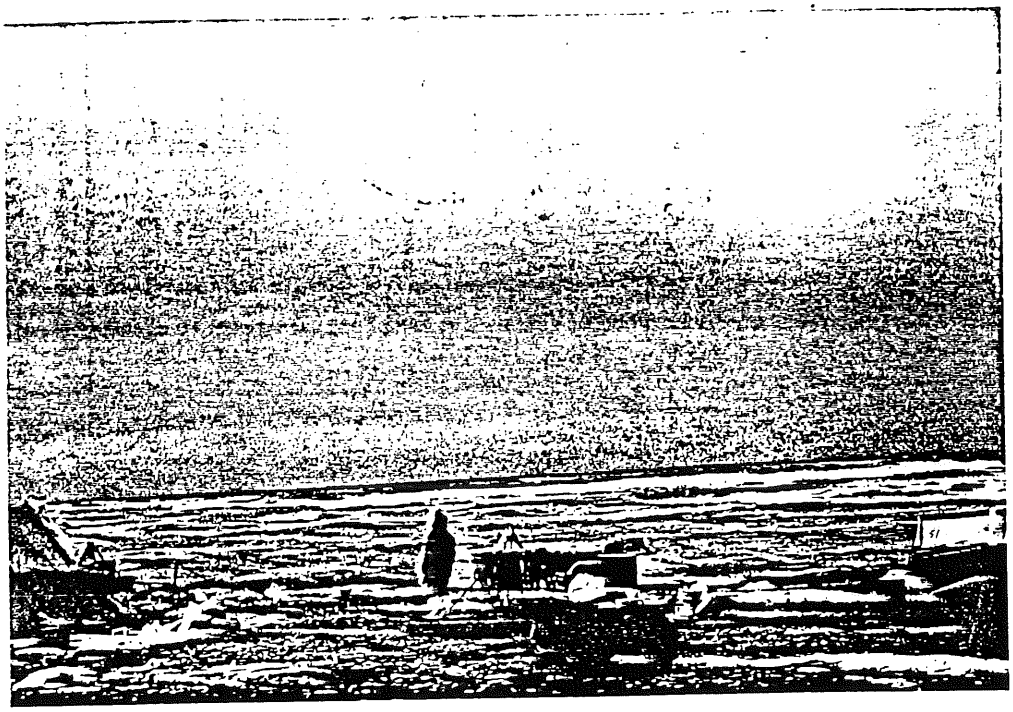

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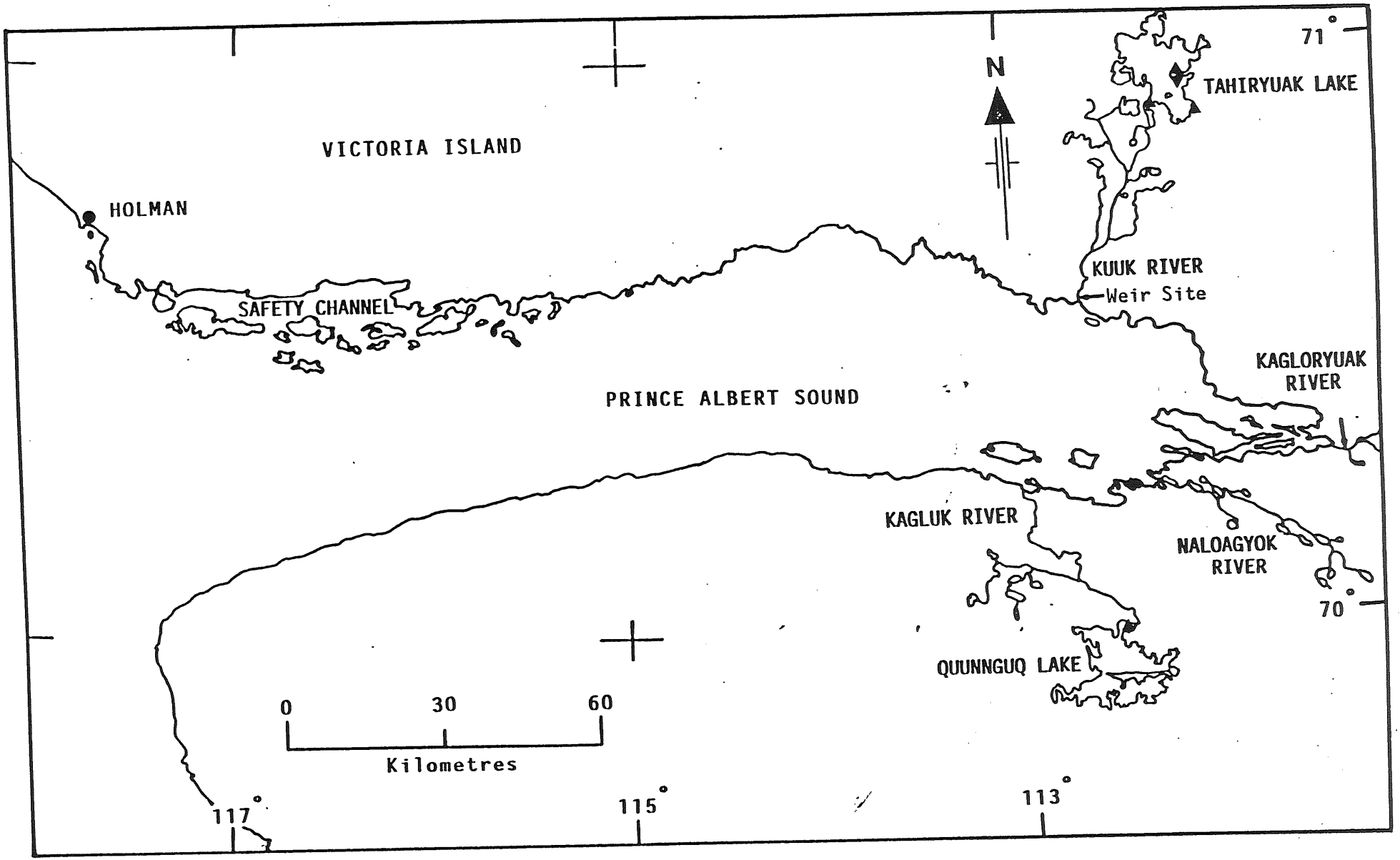


Figure 1. Map of Prince Albert Sound, Victoria Island, N.W.T., showing the Kuuk and Kagluk rivers and spawning areas (▲) in their headwater lakes.

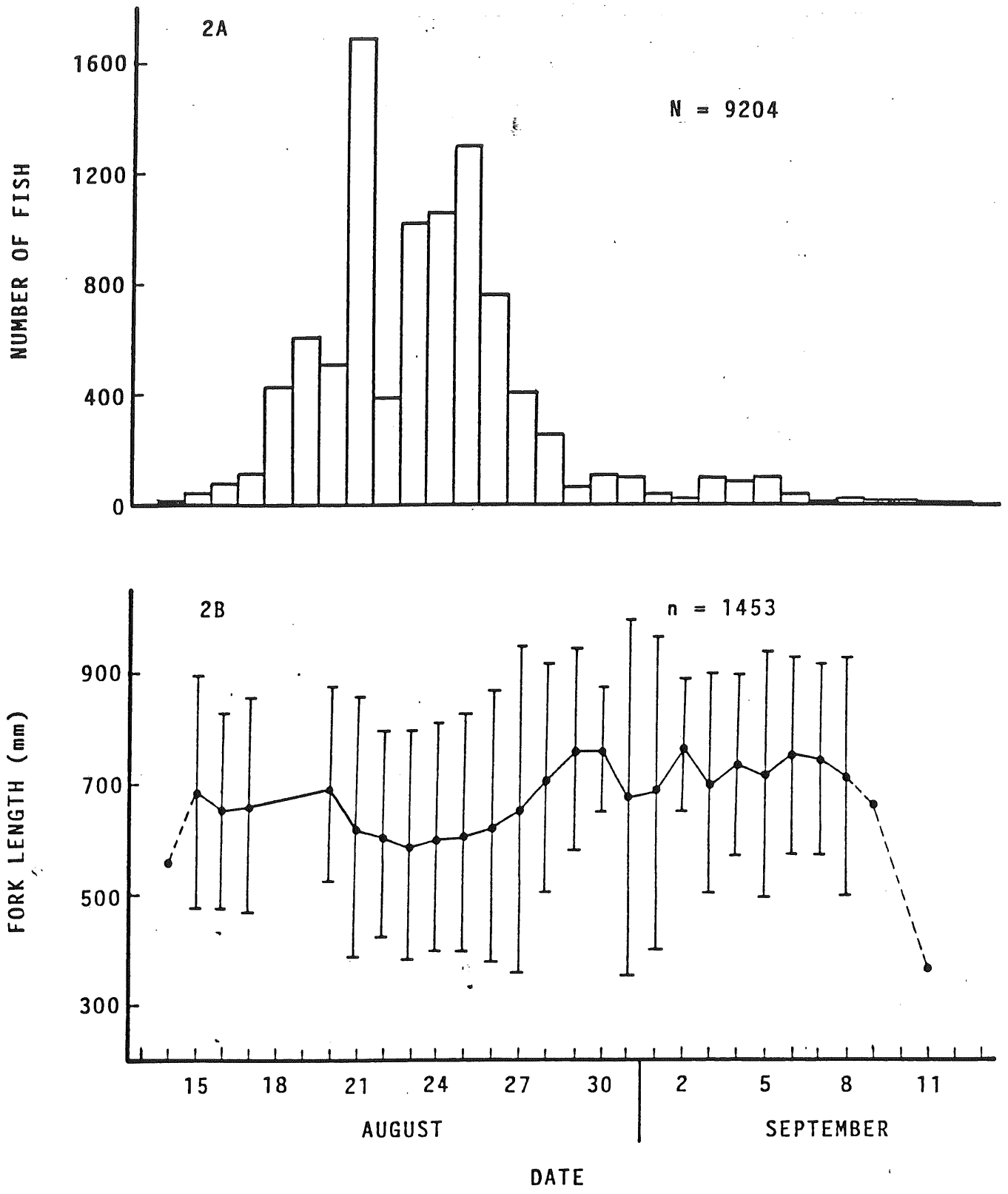


Figure 2 a and b. Daily counts (2a) and mean fork lengths (2b) of anadromous Arctic charr migrating upstream past the Kuuk River weir between 14 August and 12 September 1987. Vertical lines (2b) are 95% confidence limits for the means. Dashed lines join points representing only one or two measurements.

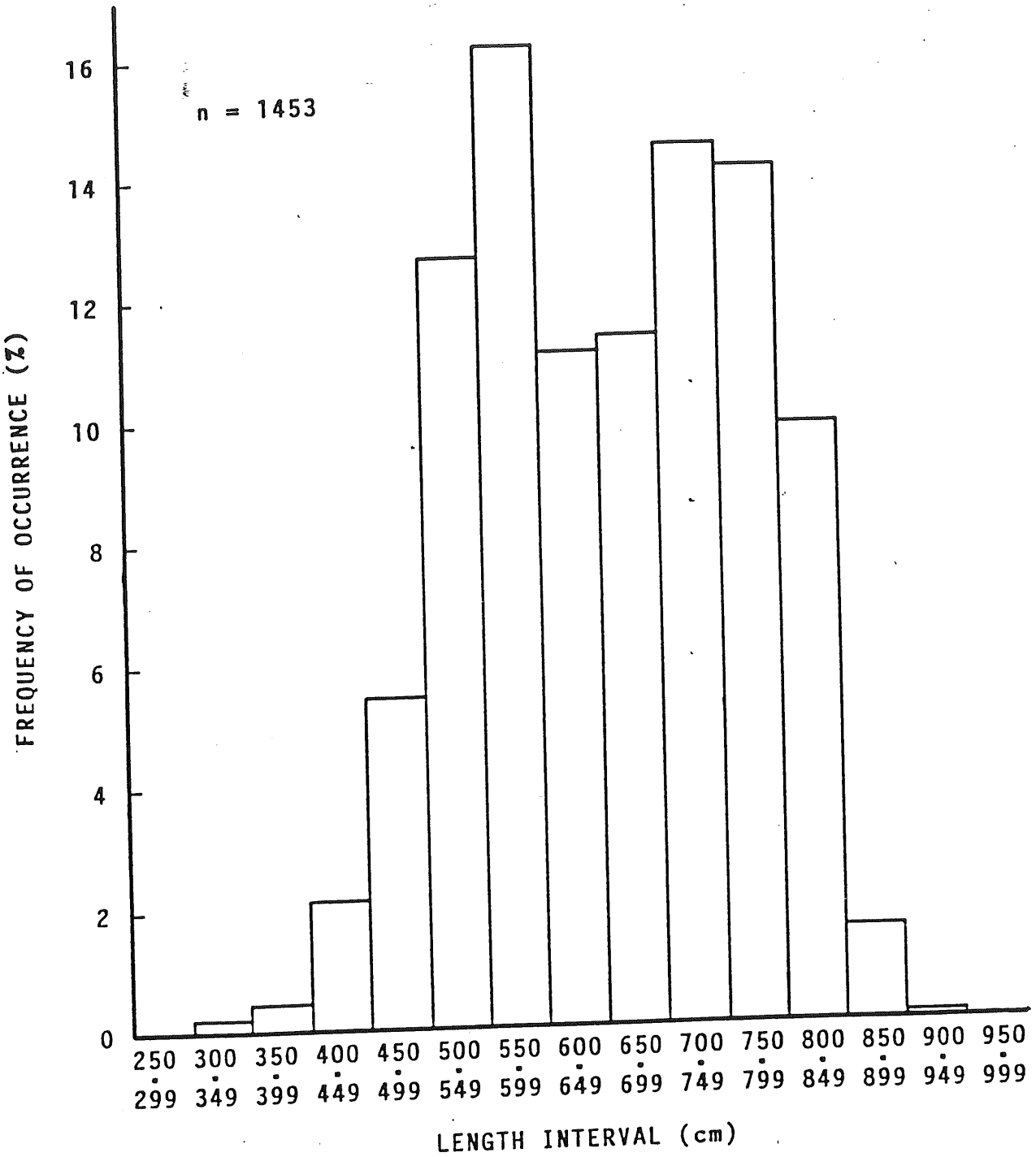


Figure 3. Length-frequency distribution for anadromous Arctic charr entering the Kuuk River between 14 August and 12 September, 1987.

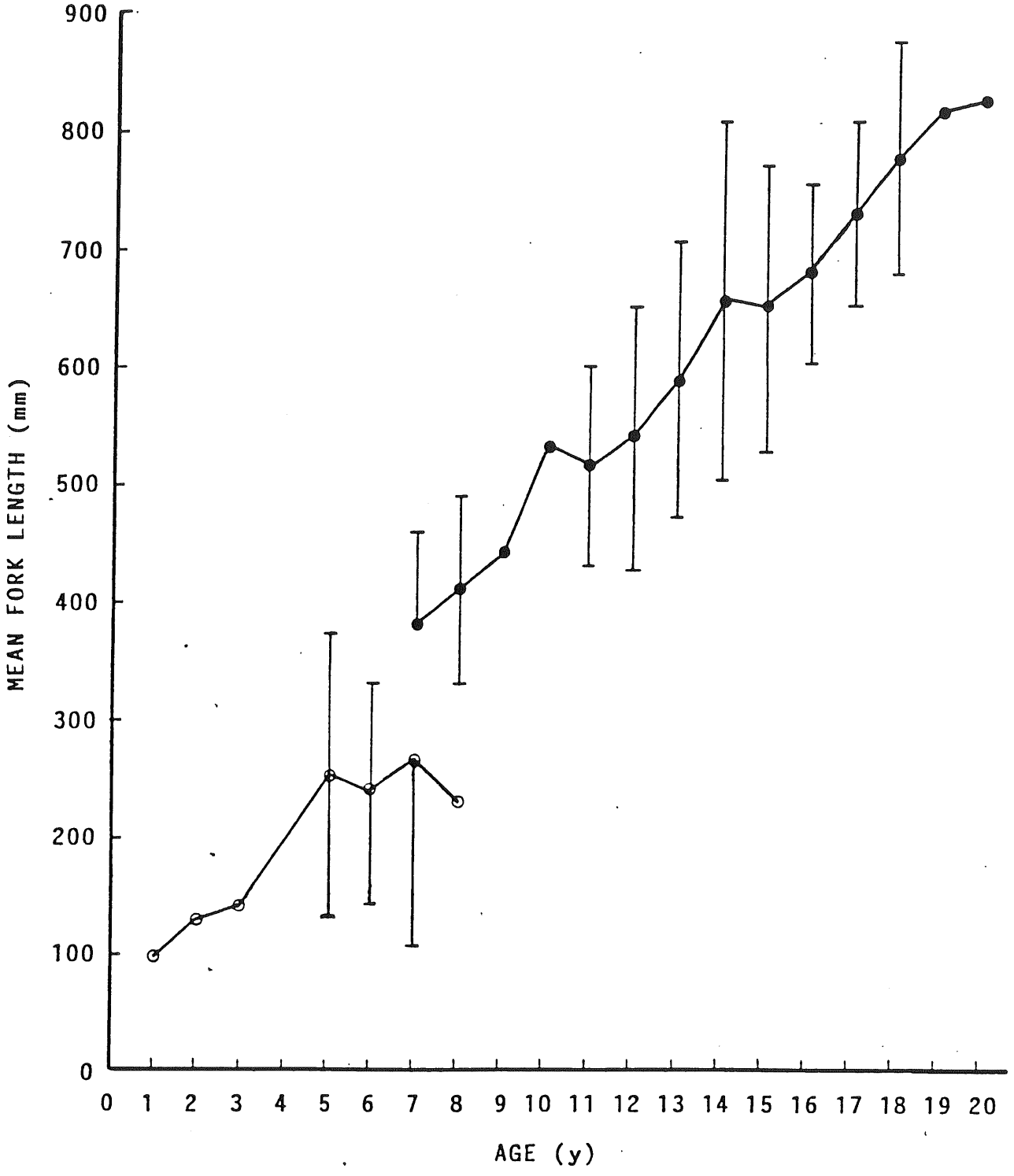


Figure 4. Mean fork length (mm) at age (y) for large anadromous Arctic charr sampled from the weir (n = 109, ●) and small charr from the hoopnet (n = 16, ○). Vertical lines are 95% confidence limits for the means, overlapping confidence intervals at age 7 are not shown.

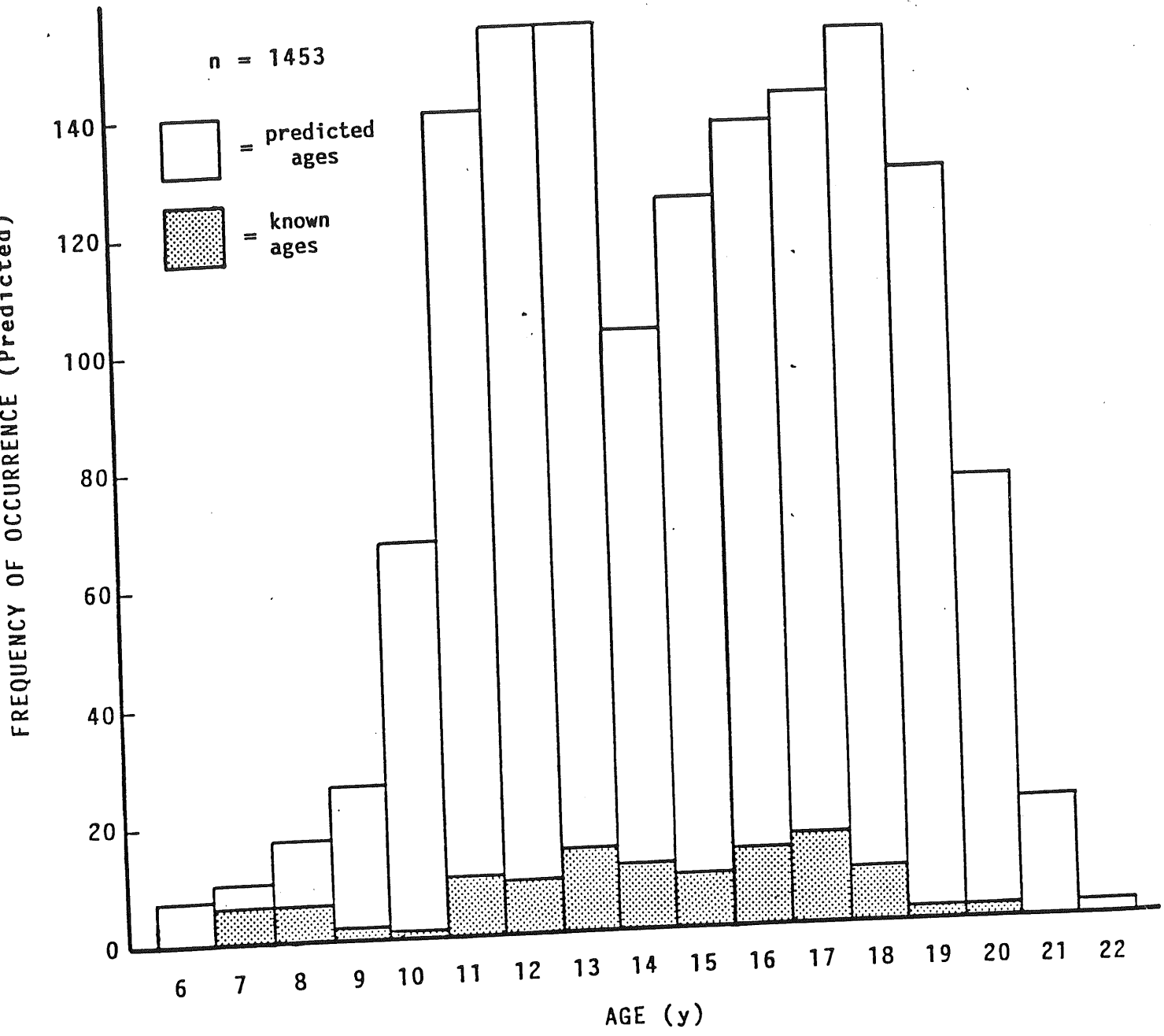


Figure 5. Age-frequency distribution for anadromous Arctic charr entering the Kuuk River between 14 August and 12 September, 1987. Ages were predicted from measured fork lengths (n = 1453) using the regression of length on age.

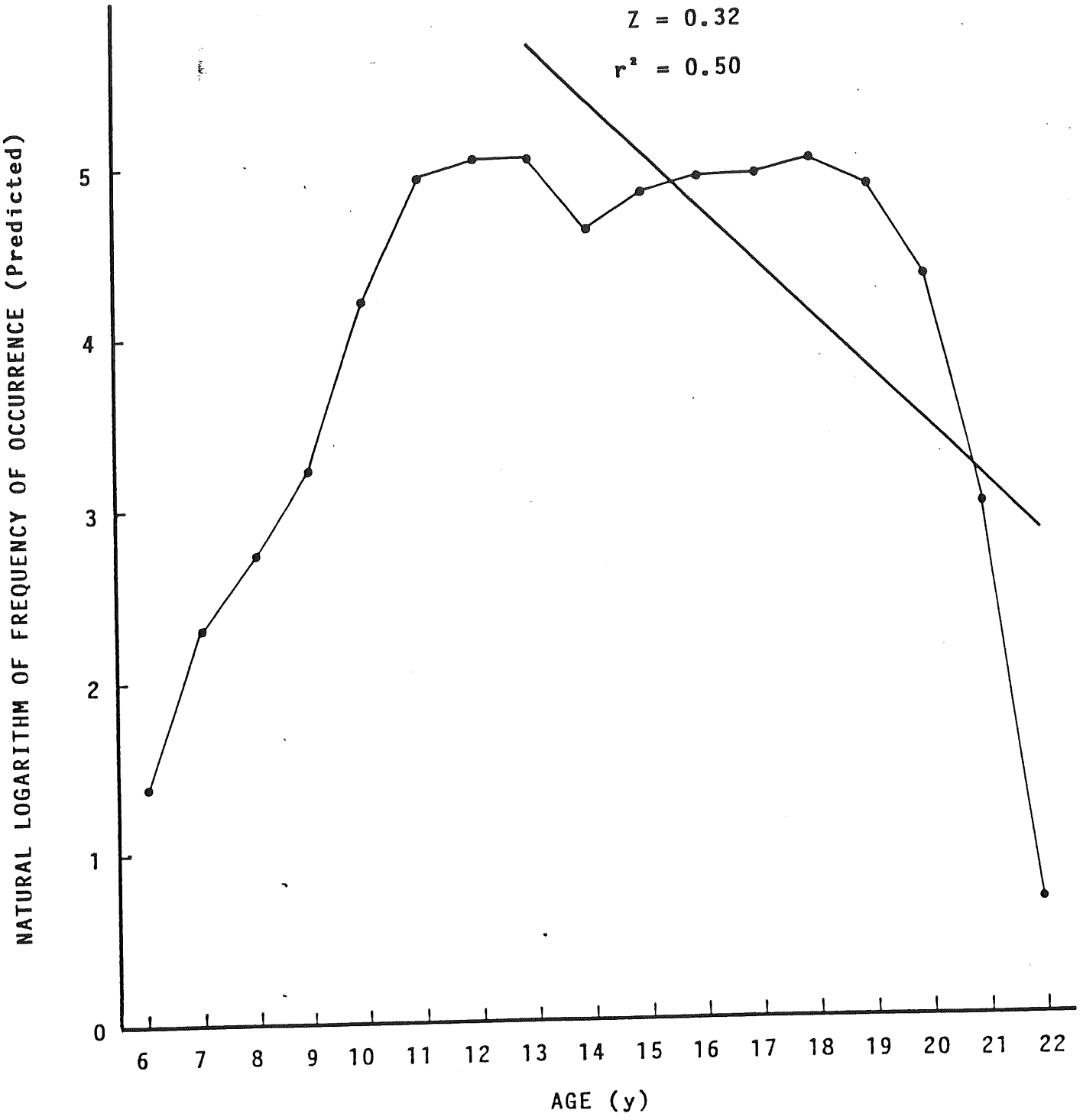


Figure 6. Catch curve for anadromous Arctic charr from the Kuuk River using ages predicted from measured fork lengths (n = 1453) using the regression of length on age. A least square linear regression over the range of 13 to 22 y was used to determine the instantaneous total mortality rate (Z).

Table 1. Growth, sex, and maturity data summarized by year class for Arctic charr taken from the Kuuk River, Victoria Island, N.W.T. in August and September 1987.

Age (y)	Number	Fork Length (cm)		Round Weight (g)		Condition Factor		Males		Females		F/M Ratio
		Mean	SD	Mean	SD	Mean	SD	No.	% Mature	No.	% Mature	
HOOPNET												
1	1	98	-	8	-	0.85	-	1	0	0	-	-
2	2	128	-	17	-	0.79	-	1	0	1	0	1.0
3	1	140	-	21	-	0.77	-	0	-	1	0	-
5	4	252	38	163	85	0.94	0.09	0	-	3	-	-
6	4	236	30	129	59	0.90	0.09	2	0	2	0	1.0
7	3	265	37	194	82	0.98	0.04	0	-	3	0	-
8	1	230	-	120	-	0.99	-	0	-	1	0	-
	Total = 16											
WEIR (anadromous fish)												
7	6	381	30	610	127	1.10	0.13	5	0	1	0	0.2
8	6[a]	409	31	790	250	1.15	0.10	4	0	2	0	0.5
9	2	441	-	1050	-	1.22	-	1	0	1	0	1.0
10	1	532	-	1900	-	1.26	-	0	-	1	0	-
11	10	514	37	1684	398	1.21	0.10	3	0	7	0	2.3
12	9	537	48	1871	520	1.18	0.07	5	0	4	0	0.8
13	14[a]	587	54	2354	763	1.12	0.11	10	0	4	0	0.4
14	11[a]	655	68	3473	889	1.18	0.17	6	0	5	0	0.8
15	9	648	53	3565	1180	1.27	0.18	5	0	4	0	0.8
16	13	677	35	3912	679	1.25	0.09	6	0	7	0	1.2
17	15	729	37	4814	884	1.23	0.11	5	0	10	0	2.0
18	9[a]	776	43	5740	1068	1.24	0.06	7	0	2	0	0.3
19	2	814	-	4830	-	0.90	-	2	0	0	-	-
20	2	821	-	6540	-	1.16	-	1	0	1	0	1.0
	Total = 109[b]	-	-	-	-	-	-	-	-	-	-	-

[a] = the number of fish whose round weights and condition factors were determined was one (1) less than the number of fish in the age class.
[b] = the total number of fish whose round weights and condition factors were determined was 105.

Table 2. Growth, sex, and maturity data summarized by length interval for Arctic charr taken from the Kuuk River, Victoria Island, N.W.T. in August and September 1987.

Length Interval (cm)	Number	Fork Length (cm)		Round Weight (g)		Age (y)		Condition Factor		Males		Females		F/M Ratio
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	No.	% Mature	No.	% Mature	
HOOPNET														
5.0 - 9.9	5 (1[a])	85	14	5	2	1		0.79	0.05	2	0	1	0	0.5
10.0 - 14.9	3 (3)	132	8	18	4	2.3	0.5	0.78	0.05	1	0	2	0	2.0
15.0 - 19.9	1 (1)	194	-	55	-	6	-	0.75	-	1	0	0	-	-
20.0 - 24.9	7 (7)	230	12	116	20	6.0	1.1	0.94	0.07	0	-	6	0	-
25.0 - 29.9	2 (2)	279	-	202	-	6.5	-	0.98	0.03	1	0	1	0	1.0
30.0 - 34.9	2 (2)	311	-	302	-	6.0	-	1.07	-	0	-	2	0	-
	Total = 20 (16)[d]													
WEIR (anadromous fish)														
30.0 - 34.9	1 (1)	327	-	440	-	7.0	-	1.26	-	1	0	0	-	-
35.0 - 39.9	6 (6)[b]	379	12	582	78	7.5	0.5	1.07	0.12	5	0	1	0	0.2
40.0 - 44.9	5 (5)[b]	421	12	870	136	7.8	0.7	1.18	0.10	2	0	3	0	1.5
45.0 - 49.9	9 (7)	468	14	1185	110	10.7	1.5	1.15	0.07	5	0	4	0	0.8
50.0 - 54.9	12 (12)[c]	525	15	1716	216	11.5	1.0	1.19	0.12	4	0	8	0	2.0
55.0 - 59.9	18 (15)[b]	573	15	2232	262	12.7	0.9	1.18	0.12	12	0	6	0	0.5
60.0 - 64.9	25 (16)[b]	629	13	3025	534	14.4	0.9	1.21	0.18	12	0	13	0	1.1
65.0 - 69.9	17 (14)[b]	669	12	3869	344	15.8	0.9	1.29	0.09	7	0	10	0	1.4
70.0 - 74.9	16 (15)	722	12	4582	433	16.5	1.4	1.22	0.08	10	0	6	0	0.6
75.0 - 79.9	16 (11)[b]	775	13	5827	738	17.4	1.1	1.25	0.14	6	0	10	0	1.7
80.0 - 84.9	13 (6)[b]	824	9	6065	1025	17.7	1.7	1.08	0.16	11	0	2	0	0.2
85.0 - 89.9	4 (1)	866	3	7275	820	20	-	1.12	0.12	4	0	0	-	-
90.0 - 94.9	1 (0)	906	-	5820	-	-	-	0.78	-	1	0	0	-	-
	Total = 143(109)[d]													

- = number of fish in each length interval whose ages were determined.
[b] = the number of fish whose round weights and condition factors were determined was one (1) less than the number of fish in the length interval.
[c] = the number of fish whose round weights and condition factors were determined was two (2) less than the number of fish in the length interval.
[d] = the total number of fish whose round weights and condition factors were determined was 20 at the hoopnet and 137 at the weir.

Table 3. Growth data summarized for all anadromous Arctic charr sampled, and for charr of known sex, that were caught entering the Kuuk and Kagluk rivers, Victoria Island, NWT, in August and September 1987. T-tests for differences between means of these parameters for male and female charr were considered significant (SIG) when the probability of error was less than 5%.

	Males				Females				T-Test	Overall			
	n	Mean	Standard Deviation	Range	n	Mean	Standard Deviation	Range		n	Mean	Standard Deviation	Range
KUUK RIVER													
Length (mm)	80	650	143	327-906	63	630	108	380-833	NS	1453	653	115	327-906
Weight (g)	74	3755	2080	440-7960	63	3258	1611	660-6940	SIG	770	3312	1613	327-7960
Condition	74	1.19	0.16	0.78-1.67	63	1.19	0.13	0.92-1.47	NS	770	1.13	0.13	0.76-1.89
Age (y)	74	13.7	3.5	7-20	49	14.0	3.0	7-20	NS	109	13.9	3.3	7-20
KAGLUK RIVER													
Length (mm)	12	652	72	524-745	19	609	97	445-843	-	31	626	90	445-843
Weight (g)	11	3627	1159	1640-5240	18	2943	1392	1200-6700	-	29	3203	1350	1200-6700
Condition	11	1.22	0.07	1.10-1.31	18	1.16	0.12	1.01-1.39	-	29	1.18	0.11	1.01-1.39
Age (y)	11	13.6	1.4	12-16	15	14.0	2.9	11-21	-	26	13.8	2.4	11-21

Table 4. Mean length (mm) at age (y) for various stocks of Arctic charr in the Northwest Territories.

Age (y)	Kuuk River[a]		Kagluk River[b]		Nauyuk[e] Lake	Sylvia[f] Grinnell River	Diana[g] River	Jayco[h] River	Hayes[i] River	Firth[j] River
	1987	1986[c]	1987	1985[d]						
0										
1	98					14				
2	128					25				
3	140				225	50	248			272
4					239	80	280			336
5	252				234	116	322			368
6	236				278	154	352			432
7	342				416	196	437			471
8	384				510	240	516			522
9	441				601	285	573			541
10	532	514		478	605	335	597		593	537
11	514	529	518	538	653	382	604		611	610
12	537	590	557	619	676	427	696	587	624	637
13	587	610	580	653	694	468	721	636	649	597
14	655	650	651	656	725	503		703	676	709
15	648	629	625	643	721	353		647	721	624
16	677	738	683	737	742	563		688	699	
17	729	723		770	736	586		709	723	
18	776	745			724	604		716	723	
19	814	798	745			623		698	690	
20	821	796				639		697		
21		860	843			653		758	830	
22						664		728		
23						675		748		
24						685		696		
25								778	718	
26								714		
27										
28										
29										
30										
31										
32								794		
N	109	78	26	44	264	680	130	130	166	281

a = The regression equation of length at age for Kuuk River anadromous charr was: fork length in mm = 35.3 *age in y + 129.2, (r^2 = 0.86, n = 109).

b = The regression equation of length at age for Kagluk River anadromous charr was: fork length in mm = 31.0 *age in y + 191.4, (r^2 = 0.64, n = 26).

c = Baker (1986), d = Kristofferson (pers. comm.), e = Johnson (1980), f = Grainger (1953), g = McGowan (1987), h = Kristofferson and Carder (1980), i = Stewart and Bernier (unpublished data), j = McCart (1980).

Table 5. Weight at length relationships (log weight in g = b·log length in mm + a) for anadromous Arctic charr from fisheries in the Prince Albert Sound area (Figure 1).

Location	Year	Group	N	Y-intercept (a)	Slope (b)	r^2
Kuuk River	1987	Male	74	-4.90	2.99	0.97
		Female	63	-5.21	3.10	0.97
		Combined	137	-5.00	3.03	0.97
		Anadromous[e]	770	-4.96	3.00	0.95
		Overall	790	-5.28	3.12	0.98
	1986[a]	Male	51	-4.57	2.84	0.98
		Female	47	-4.85	2.95	0.98
		Combined	98	-4.72	2.90	0.98
	1985[b]	Male	51	-3.93	2.63	0.94
		Female	50	-4.22	2.73	0.92
		Combined	101	-4.14	2.70	0.93
Prince Albert Sound	1983[c]	Male	57	-6.51	3.58	0.88
		Female	73	-3.14	2.38	0.82
		Combined	130	-4.19	2.75	0.84
	1982[d]	Combined	137	-5.99	3.38	0.97
Kagluk River	1987	Combined	29	-5.56	3.23	0.97
	1985[b]	Male	34	-5.42	3.18	0.98
		Female	22	-4.93	2.99	0.98
		Combined	56	-5.39	3.16	0.98
Naloagyok River	1985[b]	Combined	27	-5.47	3.18	0.99

a = Baker (1986), b = Kristofferson pers. comm., c = Kristofferson et al. (1984), d = Kristofferson and McGowan (1982).
e = "overall" includes all anadromous charr weighed and measured at the weir and all charr weighed and measured at the hoopnet.

Table 6. Parasites of anadromous charr entering the Kuuk River, Victoria Island, NWT, during August and September 1987 (Bernier pers. comm.).

Species	Site of Infection	Percent[a] of Charr Infected	Number of Parasites		
			Mean	Std. Dev.[c]	Range
Nematoda					
Philonema agubernaculum Simon and Simon 1936	body cavity	5	-	-	1-11
Cestoda					
Diphyllobothrium ditremum (Nitzsch 1824)	gut walls	40	-	-	<100
Bothrimonus sturionis Duvernoy 1842	intestine	48	-	-	-
Eubothrium salvelini (Schrank 1890) Nybelin 1924	pylorus	present[b]	-	-	-
Proteocephalus sp.	pylorus	present	-	-	-
Trematoda					
Crepidostomum sp.	intestine	present	-	-	-
Acanthocephala					
Echinorhynchus salmonis Muller 1784	intestine	1	-	-	2
Copepoda					
Salmincola edwardsii (Kroyer 1837) Wilson 1915	gills	41	3.7	3.0	1-14
Salmincola carpionis (Olsson 1869) Wilson 1915	mouth	49	4.0	3.2	1-14

a = 105 anadromous Arctic charr were examined for parasites.
b = *E. salvelini* and/or *Proteocephalus* sp. were present in 7% of the charr examined.
c = standard deviation.

Table 7. Growth, sex, and maturity data summarized by year class for Arctic charr taken from the Kagluk River, Victoria Island, N.W.T. in August and September 1987.

Age (y)	Number	Fork Length (cm)		Round Weight (g)		Condition Factor		Males		Females		F/M Ratio
		Mean	SD	Mean	SD	Mean	SD	No.	% Mature	No.	% Mature	
11	3[a]	518	52	1830	130	1.07	0.02	0	-	3	0	-
12	8	557	53	2143	746	1.19	0.11	4	0	4	0	1.0
13	1[a]	580	-	-	-	-	-	1	0	0	0	-
14	7	651	70	3371	1092	1.17	0.07	4	-	3	0	0.8
15	1	625	-	3240	-	1.33	-	0	-	1	0	-
16	4	683	42	4050	784	1.26	0.07	2	0	2	0	1.0
19	1	745	-	4600	-	1.11	-	0	-	1	0	-
21	1	843	-	6700	-	1.12	-	0	-	1	0	-
Total	26[b]	-	-	-	-	-	-	11	0	15	0	1.4
Mean	-	619	93	3131	1372	1.18	0.10	-	-	-	-	-

[a] = the number of fish whose round weights and condition factors were determined was one (1) less than the number of fish in the age class.
[b] = the total number of fish whose round weights and condition factors were determined was 24.

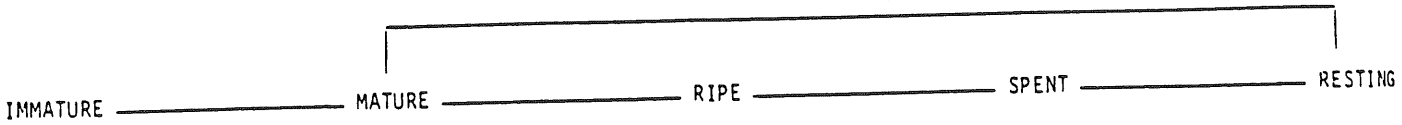
Table 8. Growth, sex, and maturity data summarized by length interval for Arctic charr taken from the Kagluk River, Victoria Island, N.W.T. in August and September 1987.

Length Interval (cm)	Number	Fork Length (cm)		Round Weight (g)		Age (y)		Condition Factor		Males		Females		F/M Ratio
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	No.	% Mature	No.	% Mature	
40.0 - 44.9	1 (1[a])[b]	445	-	-	-	11.0	-	-	-	0	-	1	0	-
45.0 - 49.9	1 (1)	479	-	1200	-	12.0	-	1.09	-	0	-	1	0	-
50.0 - 54.9	5 (5)[b]	528	10	1636	205	12.2	1.0	1.11	0.11	1	0	4	0	4.0
55.0 - 59.9	6 (5)	568	10	2036	195	12.4	1.0	1.12	0.09	3	0	3	0	1.0
60.0 - 64.9	7 (5)	639	8	3254	283	13.8	1.6	1.25	0.10	2	0	5	0	2.5
65.0 - 69.9	4 (4)	681	13	3860	108	15.0	1.0	1.22	0.08	2	0	2	0	1.0
70.0 - 74.9	6 (4)	732	10	4733	347	15.8	2.0	1.21	0.08	4	0	2	0	0.5
80.0 - 84.9	1 (1)	843	-	6700	-	21.0	-	1.12	-	0	0	1	0	-
Total	31 (26)[c]	-	-	-	-	-	-	-	-	12	0	19	0	1.6
Mean	-	626	90	3203	1350	14	2	1.18	0.11	-	-	-	-	-

[a] = number of fish in each length interval whose ages were determined.
[b] = the number of fish whose round weights and condition factors were determined was one (1) less than the number of fish in the length interval.
[c] = the total number of fish whose round weights and condition factors were determined was 29.

Appendix 1. A flow chart and code for the determination of the maturity stages of Arctic charr.

MATURITY FLOW CHART



FISH MATURITY CODE

Maturity State		Female	Male
Immature (virgin)	1	- ovaries granular in texture - hard and triangular in shape - up to full length of body cavity - membrane full - eggs distinguishable	6 - testes long and thin - tubular and scalloped shape - up to full body length - putty-like firmness
Mature	2	- current year spawner - ovary fills body cavity - eggs near full size but not loose - not expelled by pressure	7 - current year spawner - testes large and lobate - white to purplish color - centers may be fluid - milt not expelled by pressure
Ripe	3	- ovaries greatly extended and fill body cavity - eggs full size and transparent - expelled by slight pressure	8 - testes full size - white and lobate - milt expelled by slight pressure
Spent	4	- spawning complete - ovaries ruptured and flaccid - developing oocytes visible - some retained eggs in body cavity	9 - spawning complete - testes flaccid with some milt - blood vessels obvious - testes violet-pink in color
Resting	5	- ovary 40-50% of body cavity - membrane thin, loose, and semi-transparent - healed from spawning - developing oocytes apparent with few atretic eggs - some eggs may be retained in body cavity	10 - testes tubular, less lobate - healed from spawning - no fluid in center - usually full length - mottled and purplish in color
Unknown (virgin)	0	- cannot be sexed - gonads long or short and thin - transparent or translucent	
Unknown (non-virgin)	11	- resting fish - has spawned but gonads regenerated - sexing not possible	

ppe lix 2. Length, weight, and condition data for anadromous Arctic charr that were tagged during August 1987, as they migrated up the Kuuk River, Victoria Island, NWT. The tags used were Floy spaghetti tags, made of white plastic and numbered sequentially from FC60501 to FC61000. They were applied just below the dorsal fin on the left side of the fish.

Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
6 501	744	4050	0.98	
60502	763	4450	1.00	
6 503	784	5020	1.04	
6 504	782	4700	0.98	
60505	667	3350	1.13	
60506	564	2000	1.11	
6 507	678	3040	0.98	
60508	483	1100	0.98	
60509	541	1700	1.07	
510	581	2100	1.07	
60511	632	2800	1.11	
60512	576	1900	0.99	
513	657	2500	0.88	
514	716	4420	1.20	
60515	697	3680	1.09	
516	663	3060	1.05	chewed tail + dorsal
517	587	2400	1.19	
60518	495	1200	0.99	
519	683	3340	1.05	
520	631	2700	1.07	
60521	469	920	0.89	
60522	625	2520	1.03	
523	572	1660	0.89	
60524	612	2800	1.22	
60525	No Tag			
0526	818	5640	1.03	
0527	732	4400	1.12	
60528	708	3500	0.99	
0529	748	4580	1.09	chewed + healed tail
0530	696	3280	0.97	seal scars on tail
60531	641	3000	1.14	
0532	548	1680	1.02	seal scars on tail
0533	411	700	1.01	
60534	714	3800	1.04	
0535	593	2340	1.12	
60536	552	1700	1.01	net marks
60537	604	2000	0.91	
60538	672	3560	1.17	healed tail scars
60539	543	1900	1.19	
60540	877	6920	1.03	
60541	623	2720	1.12	
60542	671	3200	1.06	
60543	612	2640	1.15	
60544	787	5220	1.07	
60545	661	3180	1.10	
60546	631	2320	0.92	
60547	703	4400	1.27	
60548	578	2020	1.05	
60549	568	1860	1.02	
60550	584	2340	1.17	
60551	821	5840	1.06	
60552	795	4500	0.90	
60553	561	1800	1.02	
60554	683	3600	1.13	fin rot dorsal
60555	726	4280	1.12	
60556	749	3920	0.93	
60557	763	5300	1.19	
60558	786	5060	1.04	
60559	808	5480	1.04	
60560	727	4100	1.07	
60561	707	4180	1.18	
60562	767	5220	1.16	
60563	803	5380	1.04	
60564	794	5840	1.17	
60565		3860		
60566	722	4280	1.14	
60567	738	4460	1.11	
60568	718	4140	1.12	
60569	641	2580	0.98	
60570	700	4360	1.27	
60571	554	1800	1.06	
60572	587	2340	1.16	
60573	654	3420	1.22	
60574	529	1460	0.99	
60575	474	1120	1.05	
60576	528	1380	0.94	
60577	667	2760	0.93	
60578	806	6020	1.15	
60579	757	4280	0.99	fin rot, minor
60580	767	4580	1.02	
60581	680	3620	1.15	
60582	742	4400	1.08	
60583	533	1720	1.14	
60584	568	2020	1.10	
60585	621	2700	1.13	
60586	646	2940	1.09	
60587	614	2500	1.08	
60588	830	4820	0.84	

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
60589	702	3320	0.96	
0590	773	5220	1.13	
60591	538	1620	1.04	
60592	633	2720	1.07	
0593	695	4040	1.20	
0594	636	3740	1.45	
60595	575	1900	1.00	
0596	683	3120	0.98	
0597	558	1800	1.04	
60598	621	2260	0.94	
0599	611	2420	1.06	
0600	531	1720	1.15	
60601	530	1520	1.02	
60602	594	1980	0.94	
0603	720	5100	1.37	
60604	581	2300	1.17	
60605	608	2700	1.20	
0606	758	5000	1.15	
0607	718	3200	0.86	
60608	615	2640	1.13	
0609	740	4480	1.11	
0610	735	4900	1.23	
60611	554	2000	1.18	
0612	595	1660	0.79	
0613	753	5080	1.19	
60614	550	2000	1.20	
0615	765	4900	1.09	
0616	660	2960	1.03	
60617	821	5520	1.00	
60618	740	4760	1.17	
0619	537	1660	1.07	
60620	475	1200	1.12	
60621	603	2700	1.23	
0622	425	740	0.96	
0623	555	2040	1.19	
60624	513	1420	1.05	
0625	481	1090	0.98	
0626	485	1100	0.96	
60627	430	700	0.88	
0628	580	2940	1.51	
0629	550	1540	0.93	
60630	596	2180	1.03	
60631	698	4040	1.19	
0632	591	2160	1.05	
60633	775	5540	1.19	
60634	598	2500	1.17	
60635	703	3920	1.13	
60636	714	4100	1.13	
60637	532	1500	1.00	
60638	624	2560	1.05	
60639	428	700	0.89	
60640	579	1800	0.93	
60641	534	1400	0.92	
60642	461	800	0.82	
60643	604	2260	1.03	
60644	691	3800	1.15	
60645	672	2920	0.96	
60646	No tag			
60647	632	2880	1.14	
60648	601	2220	1.02	
60649	662	3260	1.12	
60650	641	3040	1.15	
60651	718	3660	0.99	
60652	478	940	0.86	
60653	600	2240	1.04	
60654	600	2440	1.13	
60655	672	3100	1.02	
60656	600	2240	1.04	
60657	760	5680	1.29	
60658	578	2020	1.05	
60659	660	3040	1.06	
60660	834	6620	1.14	
60661	534	1540	1.01	chewed tail
60662	534	1640	1.08	
60663	645	3340	1.24	
60664	550	1920	1.15	
60665	525	1540	1.06	
60666	594	2000	0.95	
60667	600	2220	1.03	
60668	652	3200	1.15	
60669	696	3940	1.17	
60670	583	2000	1.01	
60671	540	1600	1.02	
60672	535	1400	0.91	
60673	675	3040	0.99	
60674	545	1400	0.86	slink
60675	515	1440	1.05	
60676	585	2100	1.05	
60677	545	1700	1.05	
60678	700	3700	1.08	chewed tail
60679	554	2060	1.21	
60680	590	2080	1.01	

ppe dix 2. Continued.

ag mber (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks	Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
60681	734	4400	1.11		60727	675	3880	1.26	
60682	480	1120	1.01		60728	590	2400	1.17	
683	702	4160	1.20		60729	770	4760	1.04	
684	582	2200	1.12		60730	781	5380	1.13	
60685	702	3660	1.06		60731	430	820	1.03	
686	516	1380	1.00		60732	No tag			
687	630	2600	1.04		60733	531	1800	1.20	
60688	523	1520	1.06		60734	644	3060	1.15	
60689	709	3420	0.96		60735	565	1800	1.00	chewed fins, net marks
690	506	1340	1.03		60736	552	1900	1.13	
60691	592	2340	1.13		60737	590	2580	1.26	
60692	591	2200	1.07		60738	544	1780	1.11	
693	646	2960	1.10		60739	497	1380	1.12	
60694	535	1542	1.01		60740	514	1460	1.08	
60695	530	1560	1.05		60741	483	1260	1.12	
396	780	4880	1.03		60742	572	2120	1.13	
60697	659	3140	1.10		60743	420	780	1.05	net marks
60698	803	6000	1.16		60744	778	4940	1.05	
699	780	5000	1.05		60745	722	4220	1.12	60746 No tag
700	775	4720	1.01		60747	788	5080	1.04	
60701	775	6360	1.37		60748	786	5280	1.09	
60702	730	4940	1.27		60749	576	2140	1.12	
703	735	4100	1.03		60750	757	5780	1.33	
60704	685	3600	1.12		60751	681	3740	1.18	
60705	661	2880	1.00		60752	754	6000	1.40	
706	560	1960	1.12		60753	792	6200	1.25	
60707	535	1580	1.03		60754	643	3460	1.30	
60708	710	4020	1.12		60755	815	4500	0.83	slink, scar on side
709	500	1240	0.99		60756	785	3840	0.79	
60710	582	2200	1.12		60757	602	2660	1.22	
60711	560	1700	0.97		60758	766	5260	1.17	
712	555	2060	1.21		60759	698	3960	1.16	
713	525	1440	1.00		60760	687	3600	1.11	
60714	725	4100	1.08		60761	715	4340	1.19	
60715	535	1620	1.06		60762	776	5500	1.18	
716	715	4050	1.11		60763	712	4320	1.20	
60717	770	5680	1.24		60764	669	3540	1.18	
60718	875	3140	1.02		60765	741	5560	1.37	
719	No tag				60766	804	6140	1.18	
60720	595	2640	1.25		60767	686	3720	1.15	
60721	625	3000	1.23		60768	567	2240	1.23	
722	770	4360	0.96		60769	714	3520	0.97	
60723	560	2100	1.20		60770	751	5160	1.22	
60724	735	4920	1.24		60771	531	1540	1.03	
725	750	4980	1.18		60772	574	2020	1.07	
726	710	5160	1.44		60773	575	2200	1.16	

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
60774	578	2360	1.22	
60775	688	3740	1.15	
60776	584	2040	1.02	
60777	536	1700	1.10	
60778	623	2820	1.17	
60779	540	1820	1.16	
60780	523	1460	1.02	
60781	537	1640	1.06	
60782	496	1220	1.00	
60783	515	1260	0.92	
60784	511	1420	1.06	
60785	611	2320	1.02	
60786	586	2140	1.06	scars, tail
60787	469	960	0.93	
60788	597	3400	1.00	
60789	575	2260	1.19	
60790	496	1300	1.07	
60791	525	1400	0.97	
60792	755	5800	1.35	
60793	757	4860	1.12	
60794	531	1680	1.12	
60795	747	5060	1.21	
60796	521	1480	1.05	
60797	596	2280	1.08	
60798	595	2090	0.99	
60799	622	2640	1.10	
60800	505	1460	1.13	
60801	666	3060	1.04	
60802	672	3400	1.12	
60803	617	2520	1.07	
60804	471	1160	1.11	
60805	631	2840	1.13	
60806	661	3000	1.04	
60807	545	1800	1.11	
60808	502	1260	1.00	
60809	509	1460	1.11	
60810	636	3240	1.26	scar, side
60811	565	2200	1.22	
60812	450	920	1.01	
60813	553	2180	1.29	
60814	466	1040	1.03	
60815	446	960	1.08	net mark
60816	515	1400	1.02	
60817	659	3100	1.08	
60818	460	1350	1.39	
60819	535	1800	1.18	
60820	515	1650	1.21	
60821	816	5850	1.08	
60822	680	4260	1.35	
60823	607	3000	1.34	
60824	800	5900	1.15	
60825	615	3310	1.42	
60826	682	4550	1.43	
60827	570	2210	1.19	
60828	764	4740	1.06	
60829	770	4800	1.05	
60830	675	3700	1.20	
60831	560	1900	1.08	
60832	770	5600	1.23	
60833	645	3450	1.29	
60834	630	3000	1.20	
60835	575	2200	1.16	
60836	605	2700	1.22	
60837	815	4600	0.85	
60838	590	2500	1.22	
60839	628	3200	1.29	
60840	545	2000	1.24	
60841	804	5250	1.01	
60842	700	4500	1.31	
60843	505	1550	1.20	
60844	470	1400	1.35	
60845	615	2400	1.03	
60846	525	1900	1.31	
60847	735	5500	1.39	chewed fins
60848	680	4280	1.36	
60849	690	3620	1.10	
60850	590	2000	0.97	
60851	815	4820	0.89	
60852	585	2180	1.09	
60853	752	5760	1.35	
60854	715	4340	1.19	
60855	796	4060	0.80	
60856	527	1600	1.09	
60857	750	5060	1.20	
60858	694	3620	1.08	
60859	735	4920	1.24	
60860	705	3720	1.06	
60861	695	3660	1.09	
60862	658	3160	1.11	
60864	815	6740	1.25	
60865	780	5460	1.15	
60866	798	6400	1.26	

dix ... Continued.

ag nber C-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
867	575	2100	1.10	
868	635	3100	1.21	
869	755	4620	1.07	
870	635	2540	0.99	
871	615	2620	1.13	
872	625	3220	1.32	
873	570	2100	1.13	
874	630	2900	1.16	
875	600	2560	1.19	
876	818	6020	1.10	
877	841	7220	1.21	
878	839	5400	0.91	
879	738	5040	1.25	
880	724	4360	1.15	
881	617	2120	0.90	
882	709	4600	1.29	
883	496	1380	1.13	
884	594	2420	1.15	
885	777	4620	0.98	
886	590	2620	1.28	
887	629	3020	1.21	
888	745	4820	1.17	
889	708	4460	1.26	
890	450	960	1.05	
891	720	5020	1.34	
892	705	4040	1.15	
893	741	3920	0.96	
894	563	1860	1.04	
895	442	1060	1.23	
896	551	1860	1.11	
897	576	2360	1.23	
898	721	4960	1.32	
899	604	2480	1.13	
900	443	860	0.99	
90	555	2060	1.21	
902	546	1920	1.18	
903	487	1320	1.14	
90	562	1580	0.89	
90	537	1820	1.18	
0906	532	1680	1.12	
90	580	1900	0.97	
90	565	1960	1.09	tail fluke bitten off
0909	440	960	1.13	
91	586	2500	1.24	
091	475	1340	1.25	
912	796	5920	1.17	

Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
60913	750	5260	1.25	
60914	532	1720	1.14	
60915	535	1700	1.11	
60916	604	2320	1.05	
60917	575	2360	1.24	
60918	494	1240	1.03	
60919	608	2540	1.13	
60920	No tag			
60921	510	1600	1.21	
60922	486	1300	1.13	
60923	475	1180	1.10	
60924	561	2160	1.22	
60925	510	1460	1.10	
60926	760	6920	1.58	
60927	711	4860	1.35	
60928	751	5460	1.29	
60929	582	2440	1.24	
60930	668	3580	1.20	
60931	802	6920	1.34	
60932	628	2740	1.11	
60933	760	5740	1.31	
60934	662	3300	1.14	
60935	499	1340	1.08	
60936	558	2200	1.27	
60937	549	2040	1.23	
60938	480	1140	1.03	net marks
60939	699	4560	1.34	
60940	429	920	1.17	
60941	573	2540	1.35	
60942	624	3300	1.36	
60943	850	6600	1.07	
60944	691	4460	1.35	
60945	874	7860	1.18	
60946	836	7360	1.26	
60947	663	3040	1.04	
60948	801	5060	0.98	
60949	725	4740	1.24	
60950	503	1400	1.10	
60951	785	5940	1.23	
60952	498	1360	1.10	net marks
60953	554	2040	1.20	
60954	725	5040	1.32	
60955	537	1900	1.23	
60956	816	6480	1.19	
60957	787	5600	1.15	
60958	489	1400	1.20	

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks	Tag Number (FC-)	Fork Length (mm)	Round Weight (g)	Condition Factor	Remarks
60959	482	1380	1.23						
60960	810	5480	1.03						
60961	545	1920	1.19						
60962	649	2620	0.96						
60963	522	1560	1.10						
60964	520	1600	1.14						
60965	535	1720	1.12						
60966	535	1800	1.18						
60967	560	2220	1.26						
60968	530	1440	0.97						
60969	493	1380	1.15						
60970	416	820	1.14						
60971	794	5520	1.10						
60972	611	2840	1.25						
60973	607	2780	1.24						
60974	760	5680	1.29						
60975	748	5120	1.22						
60976	757	5100	1.18						
60977	775	5420	1.16						
60978	692	3980	1.20						
60979	555	1980	1.16						
60980	697	3860	1.14						
60981	544	1720	1.07						
60982	654	3160	1.13						
60983	649	3100	1.13						
60984	525	1420	0.98						
60985	530	1560	1.05						
60986	715	3860	1.06						
60987	675	3580	1.16						
60988	535	1660	1.08	seal scars					
60989	665	3260	1.11						
60990	518	1860	1.34						
60991	570	2240	1.21						
60992	784	5880	1.22						
60993	680	3640	1.16						
60994	540	1860	1.18						
60995	555	1960	1.15						
60996	521	1900	1.34						
60997	750	4960	1.18						
60998	622	2900	1.21						
60999	793	6500	1.30						
61000	536	1900	1.23	net marks					