A BIOLOGICAL ASSESSMENT OF ARCTIC CHARR IN THE KAGLUK RIVER, VICTORIA ISLAND, NWT, 1988

by

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December 1988

This report was prepared under contract for the Holman Hunters and Trappers Association.

Fisheries Joint Management Committee
Report #88-004

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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, 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 which flow into Prince Albert Sound (Kristofferson, pers. comm.). 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 testing of the Kagluk and Naloagyok rivers and limited testing at the Kuuk River (Baker 1986).

In 1987 the FJMC contracted Arctic Biological Consultants to conduct biological assessments of charr stocks in the Kuuk and Kagluk rivers, coincident with commercial test fisheries (Stewart and Sparling 1987). The Kuuk was found to have a healthy stock of anadromous Arctic charr, with a low rate of exploitation. However, there were too few charr to support a financially viable commercial fishery unless other commercially attractive anadromous stocks are found in the Prince Albert Sound area. Sampling at the Kagluk River suggested that it might support such a stock.

In 1988, the Holman Hunters and Trappers Committee (HTC) contracted P.D. Sparling and Arctic Biological Consultants to evaluate the potential of a fall commercial fishery for anadromous Arctic charr at the Kagluk River. This involved the ennumeration, tagging, and biological sampling of charr at a weir built across the river - coincident with a commercial test harvest, and assessments of site suitability for commercial fishing in terms of access, weir location, and run timing. The Naloagyok River was also visited to assess potential weir locations and accessability. This report describes that work.

METHODS

Weir Construction and Site Evaluation

The crew, consisting of John Alikamik, Noah and Earl Ahkaitak, and Paul Sparling arrived by Twin Otter from Holman on 6 August 1988. Weir materials were already on site, having been moved across Prince Albert Sound from the Kuuk River by snowmobile and komatik in the spring. Weir construction began immediately and the weir was completed and operating on 8 August.

The weir was erected 1.5 km inland from the river mouth in an area of quiet water, 35 m across and averaging 50 cm deep. It was similar in design and construction to the metal conduit pipe design that was described in Appendix 3 of Kristofferson et al. (1986). The trap was 1.23 m wide, 2.46 m long and 1.54 m high. It had a frame of wooden 2x4's with vertically mounted metal conduit pipes on the ends, plastic netting on the sides, and no rear drop gate.

On 5 September once the main run was complete, the weir was dismantled and stored on the north and south shores of the river in areas with good snowmobile access and low snow accumulation.

During the weir fishery the Kagluk and Naloagyok river'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 in the Kagluk River (Figure 1). The trap was checked at regular intervals to ensure that migrating fish were not unduly stressed, and that the run was not delayed.

During the migration biological samples were taken from whole trap loads of fish. For each Arctic charr, the fork length (±1 mm) was measured and tags and scars were recorded. Round weight was measured on a subsample of the fish (fish >350 g Accu-weigh hanging scale ±25 g; fish <350 g 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 pink plastic Floy spaghetti tags numbered sequentially from FC-60000 to FC-60443. 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. Few of the tagged fish were weighed because it appeared to stress them unduly.

To provide the basis for a regression of length against age, from which the age composition of the run could be determined, 10 fish were to be sacrificed per 5 cm length class. However, dead sampling was stopped when it became apparent that the run was small and a significant portion of the

population had been havested. For each fish autopsied the sex and stage of maturity were recorded, the stomach contents examined, 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.

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).

Using the age data from DFO, the length at age relationship was calculated by 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.

An estimate of the instantaneous rate of total mortality (Z) was obtained 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). Instantaneous natural mortality (M) was assumed to be 0.17 after Moore (1975) and Dempson (1978) and instantaneous rate of fishing mortality (F) was calculated from $Z = F + M$.

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 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% ($P<0.05$).

Commercial Fishery

A commercial harvest was conducted during the weir ennumeration of the Kagluk River charr population. It was coordinated with the Holman HTC and DFO. On 22 August a pen was constructed to hold fish for the commercial harvest. Fish were added to the pen until the harvest took place on August 27 and 28. The fish were measured for round weight and fork length and shipped to Holman round to be frozen for sale.

A subsample of 30 Arctic charr taken during the commercial fishery was consigned to the Scientific Authority for genetic and other analyses. The fish were frozen intact in Holman, about 12 hours after harvest, and flown to DFO Inuvik on 6 September for shipment to DFO Winnipeg for sampling. Biological data from those samples are included in this report.

RESULTS AND DISCUSSION

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. Drifting pack ice, high winds, fog, and snow interact to prevent reliable boat transportation.

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

Aircraft Access

Two 175 m landing strips were prepared at right-angles to one another near the weir. Both strips were used successfully by loaded Twin Otter aircraft on tundra tires. The aircraft were taxied close to the holding pen where they were loaded directly with the commercial catch. While an all-terrain trike and sled are not essential for transporting fish to the aircraft, they are useful for many other tasks.

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 1987. The lake immediately upstream from the river mouth is a potential landing site.

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.

Camping Sites

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

Fishing Methods

The weir worked well and fish were harvested efficiently and in good condition. Gillnets can be set and tended at the river mouth except during strong onshore winds.

Biological Evaluation

Run Strength and Timing

Between 8 August and 5 September 1988, one thousand eight hundred and seventy-eight (1878) anadromous Arctic charr were counted moving upstream past

the weir. The main charr run occurred between 23 and 29 August and had virtually stopped when the weir was removed on 5 September (Figure 2a). Silver-colored Arctic charr, fresh from the sea, were the only fishes seen at the weir.

Charr length (n = 611) decreased significantly as the run progressed but the decrease was weakly correlated with time (r^2 = 0.09) (Figure 2b). The youngest migrants were aged 6 y for males and 5 y for females (Table 1). 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 438 anadromous Arctic charr as they passed upstream through the trap. Pink plastic Floy spaghetti tags numbered from FC-60000 to FC-60443 were used, and data on the tagged fish is presented in Appendix 2. Five tags with the numbers FC-60119, FC-60190, FC-60208, FC-60228, and FC-60442 were lost or destroyed. Following tagging the fish moved quickly upstream.

The inland extent of the migration is unknown, but anadromous charr are reported to spawn in Quunnguq Lake (70°00'N, 112°33'W; Holman HTC, pers. comm.). None of the fish captured at the weir had been previously tagged.

Growth

Fork length was measured for 1184 charr that passed through the trap (Figure 3). Subsamples of these fish were measured for weight and sacrificed for age determinations. Data for the sacrificed fish is summarized by age class in Table 1, and by 5 cm length class in Table 2. The data are summarized overall and by sex in Table 3.

The length at age relationship for anadromous charr is best described by the equation: $Y = 40.1X + 66.0$, where X is age in y and Y is fork length in mm (r^2 = 0.77, n = 69). It compares well with most other anadromous Arctic charr populations in the Canadian Arctic and with previous samples from the Kagluk population (Table 4). There was no significant difference (t-test) in mean age or length between sexes. The distribution of ages in the catch, predicted using the length at age regression from the lengths of fish sampled, is shown in Figure 4. Recruitment to the anadromous population is variable and complete by age 13 or 14 y and fork lengths of 600 to 650 mm (Figures 3 and 4).

The weight at length relationship for anadromous charr is best described by the equation: $\log_{10} Y = 3.02 \log_{10} X - 4.91$, where X is fork length in mm and Y is round weight in g (r^2 = 0.92, n = 602). Growth in the Kagluk 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). In 1988, the ratio of round to dressed weight was 1.12 (n = 39,

std. dev. = 0.03) whereas in 1987, the ratio was 1.17 (n = 29, std. dev. = 0.04) (Table 3; Stewart and Sparling 1987). This probably reflects the fact that more of the 1987 fish had food in their stomachs at capture.

Condition

The charr were in very good condition relative to other anadromous charr populations in northern Canada (Kristofferson et al. 1982; Stewart and Bernier 1982, 1983, 1984; McGowan 1985; Stewart and Sparling 1987). The mean condition factor was 1.29 and did not differ significantly between sexes (Table 3). Considering that few of the fish had food in their stomachs, this is a marked improvement over fish taken at the river mouth in 1985 (1.18; Kristofferson pers. comm.) and 1987 (1.18; Stewart and Sparling 1987), many of which had food in their stomachs.

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".

The age at first maturity was 14 y or younger for males and 12 y or younger for females, and the sex ratio was even (F/M = 1.02; Table 3). Of the 83 migrants sampled, 25% were immature, 4% were preparing to spawn in the fall, and the remaining 71% were probably resting spawners from the previous year or years. They were aged from 9 to 18 y, with thin transluscent testes, or ovaries containing small (1 mm) yellow eggs. The eggs were similar in size to those found with the atritic eggs in known resting fish. 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 Kagluk River charr probably spawn under the ice of Quunnguq Lake in late September and October. Spawning redds occur near shore in the northeastern arm of the lake (70°00'N, 112°33'W) (Figure 1; Holman HTC pers. comm.).

Diet

None of the 53 migrants sampled at the weir had food in their stomachs. This is in contrast to the 1986 test fishery at the river mouth where 83% of charr sampled had marine amphipods, fish or polychaets in their stomachs (Stewart and Sparling 1987).

Parasitism, Injury, and Disease

Four metazoan parasites were identified from the charr, Salmincola carpionis, S. edwardsii, Philonema agubernaculum, and Diphyllobothrium ditremum - unidentified cestodes were also present in the intestines of some fish (Bernier, pers. comm.). None of these parasites were numerous, 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; Stewart and Sparling 1987).

Physical damage, in the form of scars or net marks, was observed on 3.0% (n = 13) and 6.8% (n = 30) respectively of the tagged charr (n = 438). 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, new and old, suggest that the stock is being harvested elsewhere, probably in the Safety Channel area nearly 100 km distant.

Other Data Available

The 30 charr that were frozen whole and sent to the Freshwater Institute (DFO) in Winnipeg are being 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.

Present and Past Use of the Stock

The Kagluk was a traditional domestic fishery for Inuit before they moved to Holman, but appear not to have yielded many fish because there are few stone fish caches near the river mouth. The river is difficult to access by boat from Holman and has seldom been fished in recent years. It has no record of previous commercial harvest and test fisheries have been largely unsuccessful. Spawning fish, presumably from this 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.

Commercial Fishery

The commercial fishery took 551 charr weighing 1887 kg round weight, two full Twin Otter loads, from the river on 27 and 28 August. The fish were frozen on arrival in Holman. The local co-operative purchased 1390 kg for $5.50/kg, and Ulu Foods in Inuvik purchased the remainder for $4.40/kg.

Potential Yield

The Kagluk River anadromous charr stock is too small to support a commercial harvest. Indeed, it appears that this commercial fishery assessment harvested 34% of the 1988 fall run.

A catch curve constructed from the predicted age-frequency distribution shows complete recruitment to the anadromous population by age 13 or 14 y, an abrupt decline in year class strength from age 15 to 19 y, and an absence of old charr (Figure 5). The instantaneous total rate of mortality (Z) of 1.04 and instantaneous rate of fishing mortality (F) of 0.87 suggest a high rate of exploitation.

Since there is little fishing at the Kagluk River, the presence of net marks and the high mortality rates both suggest that the population is being

exploited in other areas, perhaps in the Holman-Safety Channel area or in the headwaters. It is important to determine the location and extent of this fishing since the mortality estimates suggest that the stock may be depleted by continued harvesting.

If exploitation in other areas and through the domestic fisheries proves to be less than 5% of the annual fall migration, the stock might be used for sport angling on a catch-release basis.

NALOAGYOK RIVER

Site Evaluation

On 19 August 1988, P. Sparling and N. Akhiatak travelled from the Kagluk River to the Naloagyok River to conduct a site evaluation (Figure 1). An inflatable 4.8 m Zodiac boat powered by a 10 hp outboard motor was used to travel between the rivers.

The Naloagyok River drains into a marine bay which has a narrow exit to Prince Albert Sound. Tides from the bay run part way up the river, which is about 200 m long and connects the bay with a small lake. The lower 100 m are fast flowing, about 30 m wide, and 0.5 m deep; the upper 100 m are split by a gravel bar into two fast-flowing channels. The river lengthens by nearly 100 m at low tide. Upstream from the lake it diverges into a series of interconnected lakes.

Weir Location

There is a good weir site immediately above the high tide mark on the river where the channel is about 30 m wide and 0.5 m deep, and water flows quickly over a cobble and boulder bottom. Siting a weir further upstream is not recommended as it might disturb juvenile charr which are present there in large numbers.

Boat Access

Boat access to the Naloagyok River is poor and should not be relied upon to conduct a commercial fishery. It suffers from the same adverse ice and weather conditions as were described for the Kagluk River.

Aircraft Access

There is good access for Twin Otter aircraft equipped with tundra tires on the west side of the lake and river, within 200 m of suitable weir locations. The runway is grass, underlain by mud-covered gravel and runs from northeast to southwest.

Small float planes might land on the bay at the river mouth or on the freshwater lake just upstream. Caution is advisable due to ice on the former and shallow shores on the latter.

Camping Sites

There are good tent sites near the recommended weir site. Remnants of an old outpost camp with a useable tent frame are also situated on the spit of land at the river mouth, a kilometre downstream.

Biological Observations

Adult Arctic charr were observed at the head of the river, below the freshwater lake, and thousands of juvenile charr were observed in the lake shallows and in quiet stretches of the river. No biological sampling was undertaken.

Present and Past Use of the Stock

The Naloagyok River was a traditional domestic fishery for Inuit before they moved to Holman. There are many stone fish caches and tent rings in the area, but it is difficult to access by boat from Holman and has seldom been fished in recent years. It has no record of commercial harvest and a three-day test fishery in 1985 caught only 27 charr (Kristofferson, pers. comm.).

SUMMARY AND RECOMMENDATIONS

Between 8 August and 5 September, 1878 anadromous Arctic charr were counted migrating upstream in the Kagluk River, 438 of these fish were tagged. The main run occurred from 23 to 29 August. The charr grew quickly, and were in good condition relative to many commercially exploited anadromous charr populations; 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. Local fishermen were trained in weir operations and successfully harvested 1887 kg roundweight of charr from the river.

The Kagluk River charr stock is too small to support a viable commercial fishery. Indeed, high mortality rates and the presence of net marks on the fish suggest that significant numbers of charr from the Kagluk River are already being harvested in other areas. It is important that residents return tags so that the location and extent of the harvest can be determined. Otherwise the stock may be overfished and the size and number of fish will decrease.

If exploitation in other areas and through the domestic fisheries proves to be less than 5% of the annual fall migration, the stock might be used for sport angling on a catch-release basis. A sport fishery based at the Kuuk River with an outpost at the Kagluk River might provide greater economic benefit to the community than a commercial fishery.

There is good access to the Naloagyok River by Twin Otter aircraft, and good campsites are available at the river mouth. A suitable weir site is located on the river above the tide line, and exploitation of the stock is likely to be low. Data should be collected from the Naloagyok River in the same manner as at the Kuuk and Kagluk rivers, before the stock is commercially exploited. A sampling kit with tweezers, knives, and a tally counter should be purchased if further fisheries are planned. An inflatable Zodiac with a small outboard affords good access to other nearby rivers.

ACKNOWLEDGEMENTS

We thank John Alikamik and Noah and Earl Ahkiatak 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, Dr. Jim Reist and his staff for providing information from the Arctic charr we collected for DFO, members of the Holman HTC for their assistance with the project, and Cecile Stewart for editing the manuscript.

REFERENCES

Baker, R.F. 1986. Report on the test fishery of the Kuuk River, Prince Albert Sound, Northwest Territories, 1986. Fisheries Joint Management Committee Report 86-004: 25 p.

Dempson, J.B. 1978. Biological assessment of Arctic char (Salvelinus alpinus L.) stocks and summary of the Atlantic salmon (Salmo salar L.) fishery in northern Labrador. Can. Fish. Mar. Serv. Tech. Rep. 817: 54 p.

Dutil, J.D. 1982. Periodic changes in the condition of the Arctic charr (Salvelinus alpinus) of the Nauyuk Lake system. Ph.D. Thesis, University of Manitoba, Winnipeg, Manitoba. 149 p.

Grainger, E.H. 1953. On the age, growth, migration, reproductive potential and feeding habits of Arctic charr (Salvelinus alpinus) of Frobisher Bay, Baffin Island. J. Fish. Res. Board Can. 10(6): 326-371.

Johnson, L. 1980. The Arctic charr, Salvelinus alpinus, p. 15-98. In E.K. Balon (ed.) Charrs, salmonid fishes of the genus Salvelinus. Dr. W. Junk Publishers, The Hague.

Kristofferson, A.H., and G.W. Carder. 1980. Data from the commercial fishery for Arctic char, Salvelinus alpinus (Linnaeus), in the Cambridge Bay area, Northwest Territories, 1971-78. Can. Data Rep. Fish. Aquat. Sci. 184: v + 25 p.

Kristofferson, A.H., D.R. Leroux, and J.R. Orr. 1982. A biological assessment of Arctic charr, Salvelinus alpinus (L.), stocks in the Gjoa Haven-Pelly Bay area of the Northwest Territories, 1979-80. Can. Manuscr. Rep. Fish. Aquat. Sci. 1591: vi. + 51 p.

Kristofferson, A.H., G. Low, and D.K. McGowan. 1984. Test fishery for Arctic charr, Prince Albert Sound (Safety Channel), August-September 1983, and commercial fishery for Arctic charr, Kagloryuak River, August-September 1983. Draft report, 12 manuscript pages, on file with Department of Fisheries and Oceans, Western Region, Winnipeg.

Kristofferson, A.H., and D.K. McGowan. 1982. Test fishery for Arctic charr, Prince Albert Sound, August 1982. Unpublished report, 14 manuscript pages, on file with Department of Fisheries and Oceans, Western Region, Winnipeg.

Kristofferson, A.H., D.K. McGowan, and W.J. Ward. 1986. Fish weirs for the commercial harvest of searun Arctic charr in the Northwest Territories. Can. Ind. Rep. Fish. Aquat. Sci. 174: iv + 31 p.

McCart, P.J. 1980. A review of the systematics and ecology of Arctic char, Salvelinus alpinus, in the western Arctic. Can. Tech. Rep. Fish. Aquat. Sci. 935: vii + 89 p.

McGowan, D.K. 1985. Data from test fisheries conducted in the Baffin and central Arctic regions, Northwest Territories, 1980-84. Can. Data Rep. Fish. Aquat. Sci. 531: v + 68 p.

McGowan, D.K. 1987. Data on Arctic charr, Salvelinus alpinus (L.), from the Diana River, Northwest Territories, 1986. Can. Data Rep. Fish. Aquat. Sci. 666: iv + 19 p.

Moore, J.W. 1975. Distribution movements, and mortality of anadromous Arctic char, Salvelinus alpinus (L.), in the Cumberland Sound area of Baffin Island. J. Fish Biol. 7: 339-348.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: xviii + 382 p.

Stewart, D.B., and L.M.J. Bernier. 1982. An aquatic resource survey of the islands bordering Viscount Melville Sound, District of Franklin, Northwest Territories. Lands Directorate of Environment Canada and Northern Environment Directorate of Indian and Northern Affairs, Background Report 2: 110 p.

Stewart, D.B., and L.M.J. Bernier. 1983. An aquatic resource survey of King William and Victoria islands, and the northeastern District of Keewatin, Northwest Territories. Lands Directorate of Environment Canada and Northern Environment Directorate of Indian and Northern Affairs, Background Report 3: 127 p.

Stewart, D.B., and L.M.J. Bernier. 1984. An aquatic resource survey of Melville Peninsula, Southampton Island, and the northeastern District of Keewatin, Northwest Territories. Lands Directorate of Environment Canada and Northern Environment Directorate of Indian and Northern Affairs, Background Report 4: 144 + map.

Stewart, D.B., and P.D. Sparling. 1987. A biological assessment of Arctic charr stocks in the Kuuk and Kagluk rivers, Victoria Island, NWT, 1987. Fisheries Joint Management Committee Report 87-001: iv + 43 p.

PERSONAL COMMUNICATIONS

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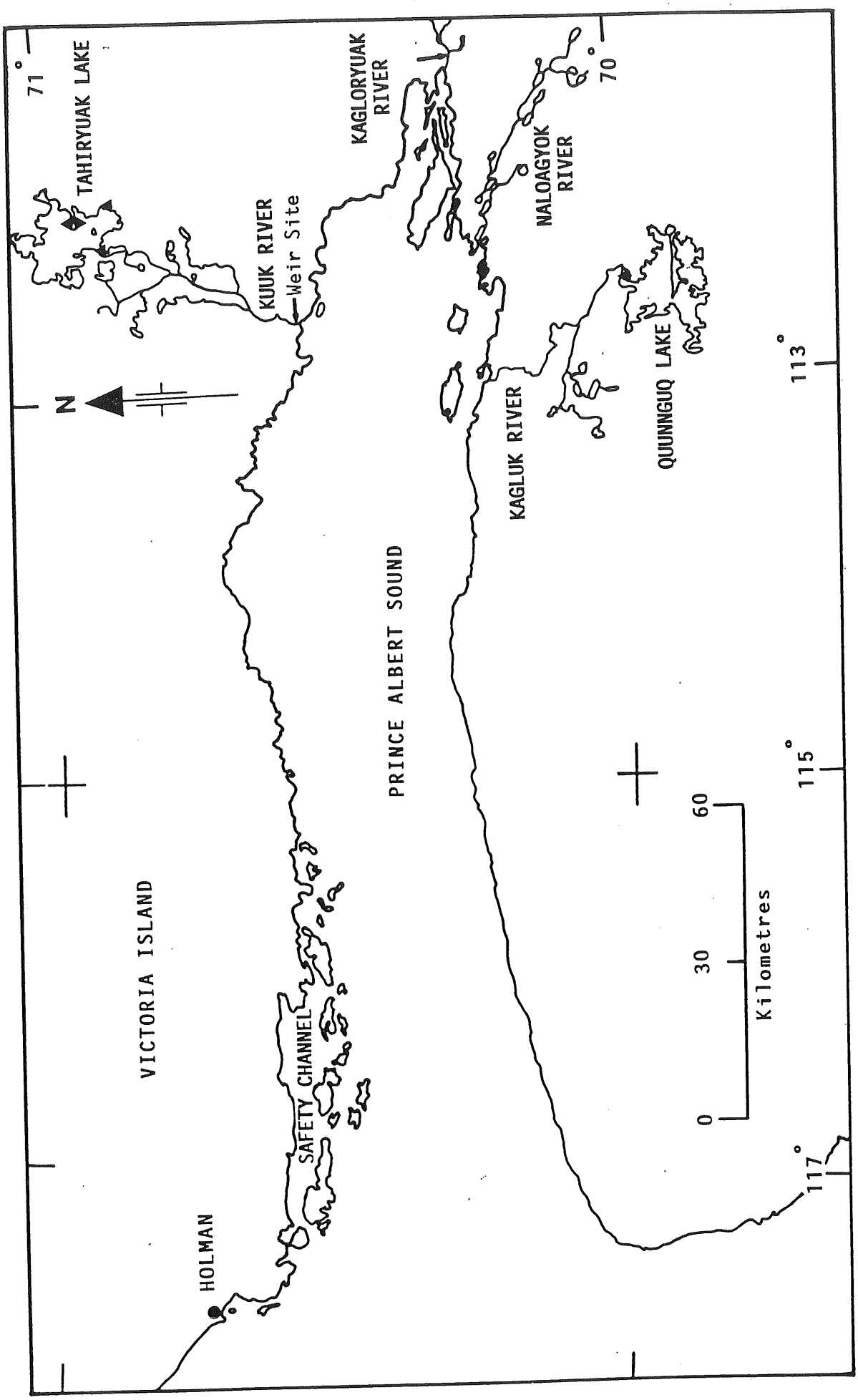


Figure 1. Map of Prince Albert Sound, Victoria Island, N.W.T., showing the Kuuk and Kagluk rivers and spawning areas (▲) in their headwater lakes.

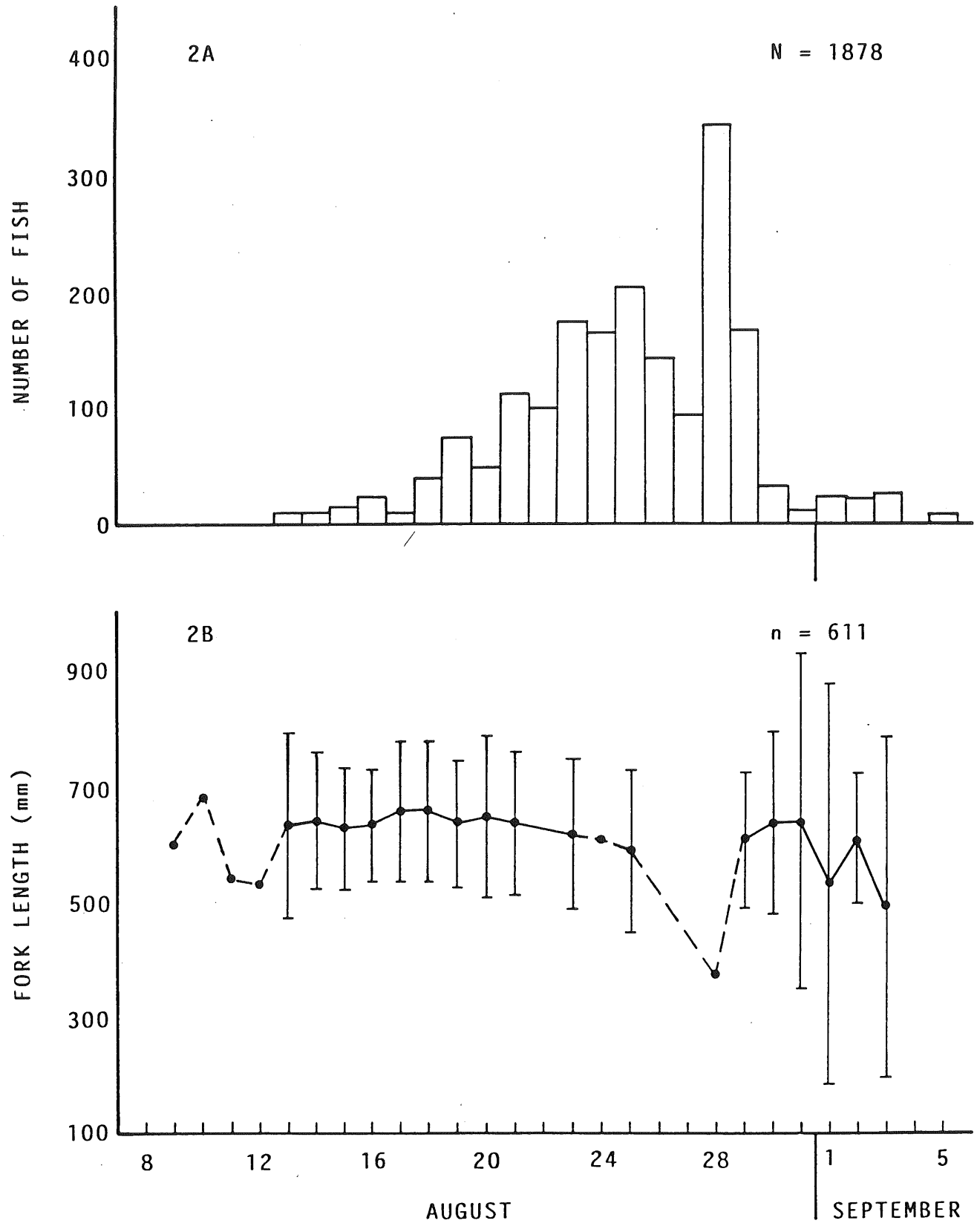


Figure 2 a and b. Daily counts (2a) and mean fork lengths (2b) of Arctic charr migrating upstream past the Kagluk River weir between 9 August and 5 September 1988. Vertical lines (2b) are 95% confidence limits for the means. Dashed lines join points representing only one or two measurements.

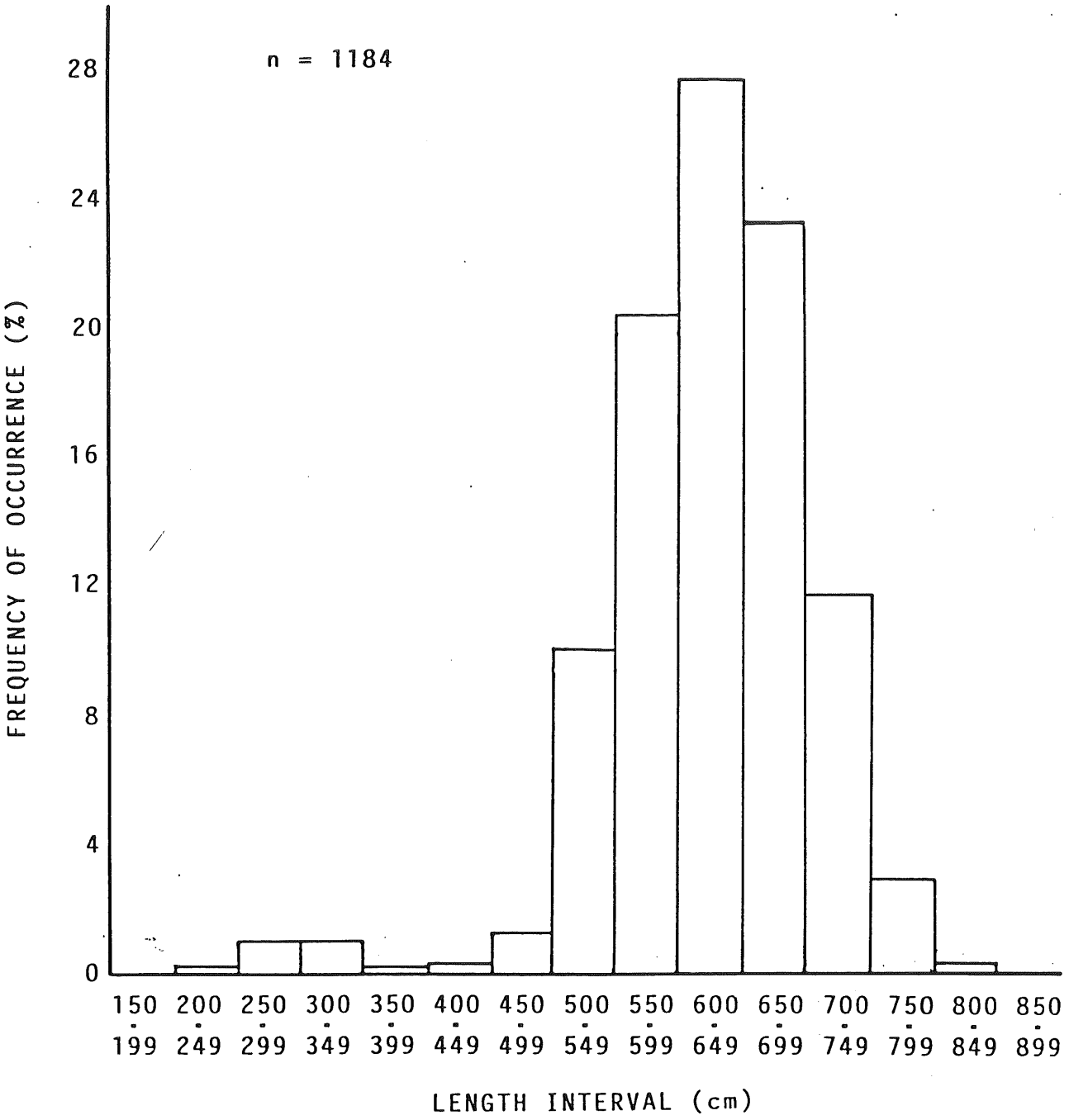


Figure 3. Length-frequency distribution for Arctic charr migrating upstream past the Kagluk River weir between 9 August and 5 September, 1988.

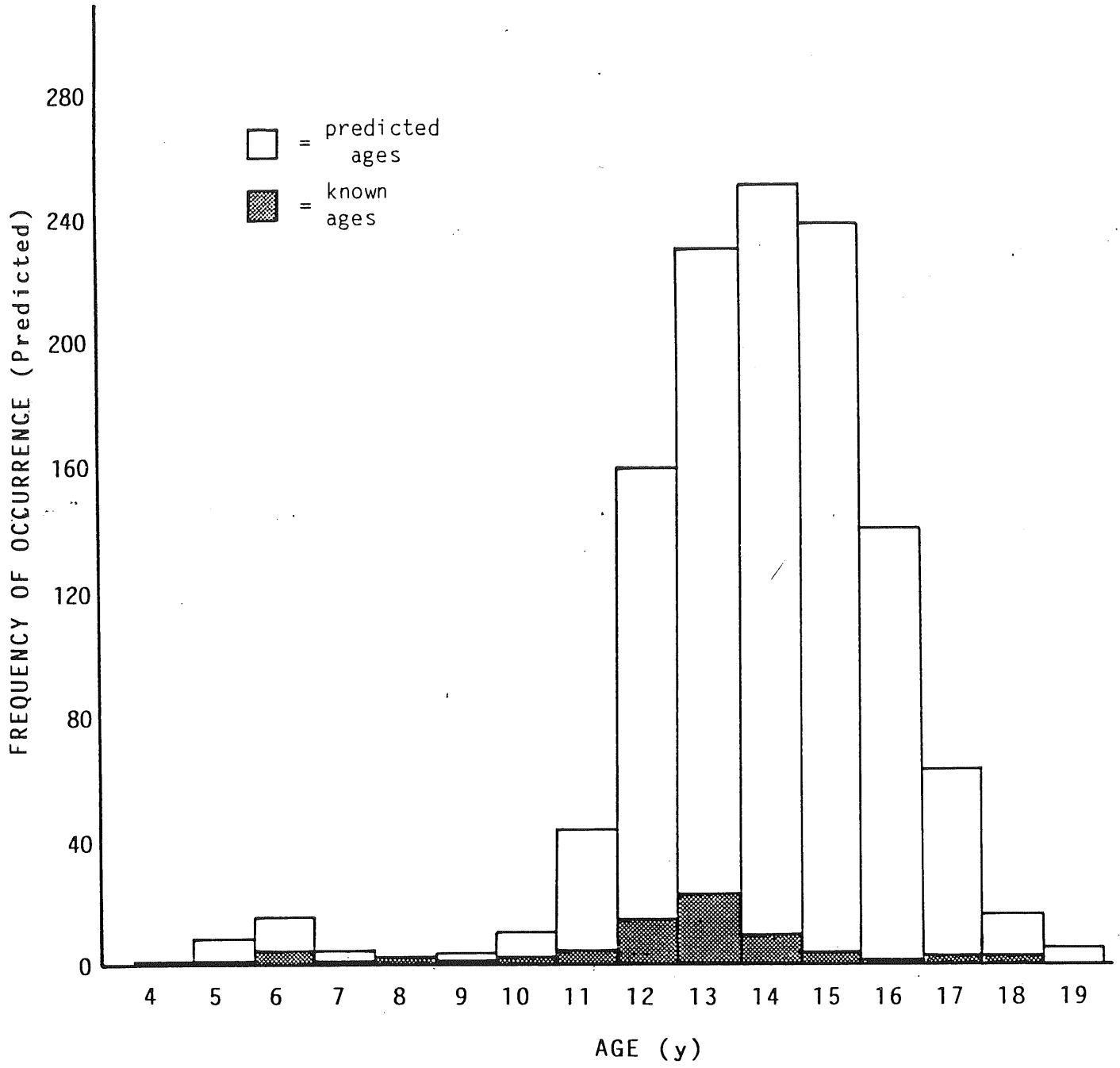


Figure 4. Age-frequency distribution for anadromous Arctic charr entering the Kagluk River between 9 August and 5 September, 1988. Ages were predicted from measured fork lengths (n = 1184) using the regression of length on age.

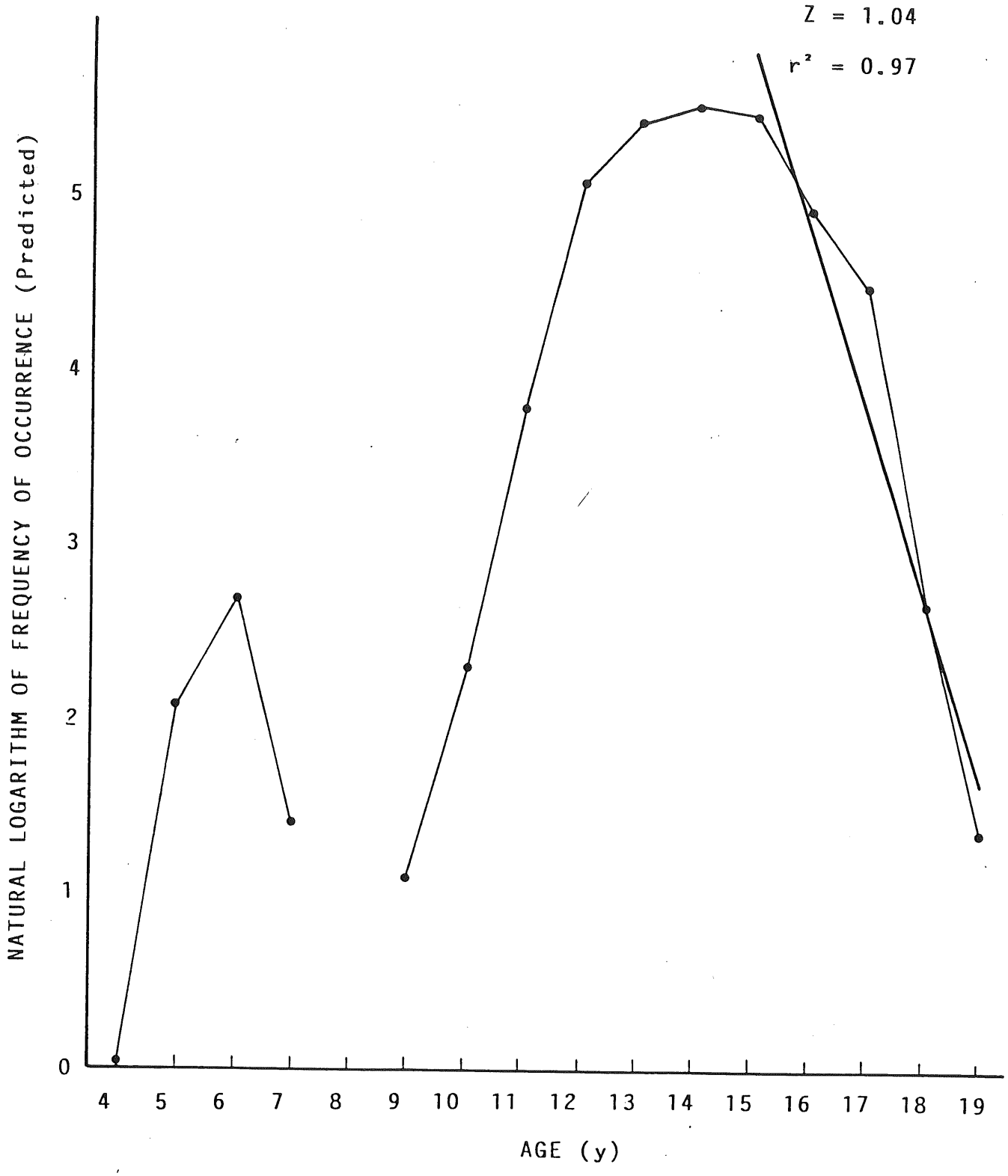


Figure 5. Catch curve for anadromous Arctic charr from the Kagluk River using ages predicted from measured fork lengths (n = 1184) using the regression of length on age. A least square linear regression over the range of 15 to 19 y was used to determine the instantaneous total mortality rate (Z).

Table 1. Growth, sex, and maturity data summarized by year class for Arctic charr taken from the Kagluk River, Victoria Island, N.W.T, in August and September 1988.

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	
5	1	255	-	175	-	1.06	-	0	-	1	-	-
6	5	286	16	279	58	1.19	0.13	4	0	1	0	0.2
7	1	303	-	325	-	1.17	0.13	0	-	1	0	0.2
8	2	273	37	215	110	0.94	0.15	1	0	1	0	1.0
9	1	482	-	1300	-	1.16	-	0	0	1	0	-
10	2	492	46	1662	487	1.35	0.03	2	0	0	-	-
11	4	544	49	2449	918	1.45	0.12	1	0	3	0	3.0
12	14	584	52	2617	818	1.28	0.14	6	0	8	12	1.3
13	22	592	57	2922	1009	1.37	0.16	12	0	10	0	0.9
14	9	631	31	3566	587	1.41	0.09	5	20	4	0	0.8
15	3[a]	588	14	1948	327	1.11	0.08	0	-	3	0	-
16	1	610	-	2375	-	1.05	-	0	-	1	100	-
17	2	710	22	4250	550	1.18	0.04	1	0	1	0	1.0
18	2	804	43	6363	138	1.24	0.17	2	0	0	-	-

Total = 69

[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.

Table 2. 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 1988.

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	
20.0 - 24.9	1 (1)[a]	236	-	105	-	8.0	-	0.80	-	0	-	1	0	-
25.0 - 29.9	5 (5)	274	14	244	58	5.8	0.4	1.17	0.14	3	0	2	0	0.7
30.0 - 34.9	5 (3)	311	5	350	27	7.0	0.8	1.16	0.05	4	0	1	0	0.2
40.0 - 44.9	1 (1)	446	-	1175	-	10.0	0.7	1.32	-	1	0	0	-	-
45.0 - 49.9	2 (1)	472	10	1261	40	9.0	-	1.20	-	0	-	2	0	-
50.0 - 54.9	13 (12)[b]	524	16	1919	227	12.2	1.3	1.33	0.14	3	0	10	10	3.3
55.0 - 59.9	25 (22)	573	13	2531	319	13.0	0.9	1.34	0.13	10	0	15	0	1.5
60.0 - 64.9	11 (9)	620	15	3138	485	13.2	1.4	1.31	0.18	5	0	6	17	1.2
65.0 - 69.9	14 (11)	672	13	3914	570	13.5	1.3	1.29	0.21	10	10	4	0	0.4
70.0 - 74.9	4 (2)	726	10	5275	551	15.0	2.0	1.38	0.18	3	0	1	0	0.3
75.0 - 79.9	1 (1)	761	-	6225	-	18.0	-	1.41	-	1	0	0	-	-
80.0 - 84.9	1 (1)	847	-	6500	-	18.0	-	1.07	-	1	0	0	-	-
Total =	83 (69)													

[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.

Table 3. Growth data summarized for all Arctic charr sampled, and for charr of known sex, that were caught entering the Kagluk and Kuuk rivers, Victoria Island, NWT, in August and September of 1987 and 1988. 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
KAGLUK RIVER WEIR 1988													
Length (mm)	41	574	144	269-847	42	546	105	236-732	NS	1184	621	82	236-847
Weight (g)	41	2926	1671	222-6500	41	2333	1049	105-4800	SIG	602	3436	1171	105-7450
Condition	41	1.30	0.19	0.91-1.68	41	1.29	0.15	0.80-1.56	NS	82	1.29	0.17	0.80-1.68
Age (y)	34	12.2	3.0	6-18	35	12.2	2.6	5-17	NS	69	12.2	2.8	5-18
KAGLUK RIVER TEST FISHERY 1987													
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
KUUK RIVER WEIR 1987													
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

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

Age (y)	Kagluk River 1988[a]	Kagluk River 1987[b]	Kagluk River 1985[c]	Kuuk River[b]	Nauyuk Lake[d]	Sylvia Grinnell River[e]	Diana River[f]	Jayco River[g]	Hayes River[h]	Firth River[i]
0										
1				98		14				
2				128		25				
3				140	225	50	248			272
4					239	80	280			336
5	255			252	234	116	322			368
6	286			236	278	154	352			432
7	303			342	416	196	437			471
8	273			384	510	240	516			522
9	482			441	601	285	573			541
10	492		478	532	605	335	597		593	537
11	544	518	538	514	653	382	604		611	610
12	584	557	619	537	676	427	696	587	624	637
13	592	580	653	587	694	468	721	636	649	597
14	631	651	656	655	725	503		703	676	709
15	588	625	643	648	721	353		647	721	624
16	610	683	737	677	742	563		688	699	
17	710		770	729	736	586		709	723	
18	804			776	724	604		716	723	
19		745		814		623		698	690	
20				821		639		697		
21		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	69	26	44	109	264	680	130	130	166	281

a = The regression equation of length at age for Kagluk River charr was:
fork length in mm = 40.1 age in y + 66.0, (r^2 = 0.77, n = 69).

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

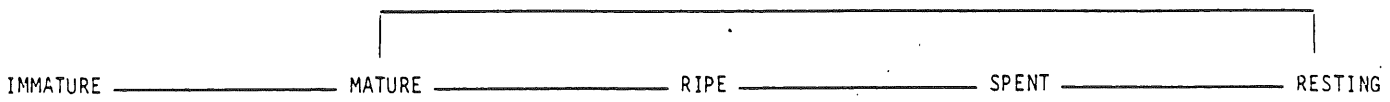
Table 5. Weight at length relationships (log weight in g = b·log length in mm + a) for anadromous Arctic charr from fisheries in the Prince Albert Sound area (Figure 1).

Location	Year	Group[a]	N	Y-intercept (a)	Slope (b)	r^2
Kagluk River	1988	Male	41	-5.26	3.13	0.98
		Female	41	-5.52	3.23	0.98
		Combined	82	-5.36	3.17	0.98
		Overall	602	-4.91	3.02	0.92
	1987[b]	Combined	29	-5.56	3.23	0.97
	1985[c]	Male	34	-5.42	3.18	0.98
		Female	22	-4.93	2.99	0.98
		Combined	56	-5.39	3.16	0.98
Kuuk River	1987[b]	Male	74	-4.90	2.99	0.97
		Female	63	-5.21	3.10	0.97
		Combined	137	-5.00	3.03	0.97
		Overall	770	-4.96	3.00	0.95
Prince Albert Sound	1983[d]	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[e]	Combined	137	-5.99	3.38	0.97
Naloagyok River	1985[c]	Combined	27	-5.47	3.18	0.99

a = "overall" includes all charr weighed and measured at the weir.
b = Stewart and Sparling (1987), c = Kristofferson pers. comm.,
d = Kristofferson *et al.* (1984), e = Kristofferson and McGowan (1982).

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		

Appendix 2. Length data for anadromous Arctic charr that were tagged during August and September 1988, as they migrated up the Kagluk River, Victoria Island, NWT. The tags used were Floy spaghetti tags, made of pink plastic and numbered sequentially from FC60001 to FC60443. They were applied just below the dorsal fin on the left side of the fish.

Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks
60001	624		60045	646		60089	730	
60002	654		60046	671		60090	585	
60003	620		60047	724		60091	618	
60004	557		60048	607		60092	653	
60005	570		60049	654	tail scars	60093	627	
60006	667		60050	673		60094	651	
60007	565		60051	582	slink	60095	547	
60008	630		60052	720		60096	650	
60009	675		60053	705		60097	590	
60010	611		60054	612		60098	545	net marks
60011	650		60055	721		60099	627	
60012	724		60056	571		60100	700	
60013	600		60057	717		60101	695	
60014	525		60058	660		60102	644	
60015	624		60059	681		60103	659	
60016	691		60060	575		60104	570	net marks
60017	634		60061	684		60105	659	
60018	675		60062	673		60106	615	
60019	602		60063	752		60107	680	
60020	598		60064	548		60108	620	
60021	578		60065	638		60109	781	
60022	545		60066	754	back scar	60110	624	
60023	540		60067	564		60111	683	
60024	694		60068	543	net marks	60112	620	
60025	650		60069	532	net marks	60113	644	
60026	600		60070	678		60114	669	
60027	672		60071	595	net marks	60115	606	
60028	636		60072	622	net marks	60116	560	net marks
60029	624		60073	657		60117	610	
60030	645		60074	628	net marks	60118	625	
60031	630		60075	744		60119		tag lost
60032	634		60076	712		60120	715	
60033	684		60077	642		60121	659	
60034	620		60078	658		60122	683	net marks
60035	692		60079	662		60123	681	
60036	655		60080	564		60124	552	
60037	635		60081	667		60125	586	
60038	731		60082	625		60126	511	
60039	662		60083	692		60127	604	
60040	630		60084	672		60128	669	
60041	695		60085	685		60129	588	
60042	641		60086	735		60130	637	net marks
60043	710		60087	618		60131	630	
60044	575		60088	645		60132	677	

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks
60133	713	back scars	60178	700		60223	661	
60134	696		60179	793		60224	641	
60135	682		60180	677		60225	738	
60136	673		60181	768		60226	589	
60137	540	Net marks	60182	751		60227	605	
60138	612	Net marks	60183	594		60228		tag lost
60139	592		60184	645		60229	707	
60140	670	Net marks	60185	600		60230	590	
60141	652		60186	639		60231	635	
60142	637		60187	675		60232	698	belly scars
60143	591		60188	729		60233	698	tail scars
60144	505		60189	689		60234	661	
60145	702		60190		tag lost	60235	605	
60146	662		60191	624		60236	565	
60147	628		60192	731		60237	580	back scar
60148	552		60193	595		60238	552	
60149	765		60194	602		60239	729	
60150	782		60195	671		60240	634	
60151	644		60196	758		60241	635	
60152	727		60197	686		60242	654	
60153	730		60198	692		60243	548	
60154	572		60199	587		60244	554	
60155	667		60200	597		60245	631	net marks
60156	679		60201	704		60246	683	
60157	687		60202	662		60247	731	
60158	705		60203	675		60248	631	tail scar
60159	572		60204	692		60249	680	net marks
60160	567		60205	646		60250	709	
60161	630		60206	691		60251	561	
60162	641		60207	497		60252	708	
60163	626		60208		tag lost	60253	673	
60164	734		60209	597		60254	673	
60165	561		60210	576		60255	611	
60166	629		60211	582		60256	673	tail scars
60167	711		60212	561		60257	674	
60168	564		60213	648		60258	688	
60169	527		60214	576		60259	702	
60170	556		60215	532		60260	663	seal + net scars
60171	602		60216	585		60261	608	
60172	537		60217	645		60262	592	net marks
60173	574		60218	749		60263	548	
60174	578		60219	717		60264	552	
60175	680		60220	569		60265	552	
60176	661		60221	554		60266	733	
60177	651		60222	735	red	60267	605	

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks
60268	588		60313	656		60358	695	
60269	615		60314	614		60359	556	
60270	625		60315	511		60360	562	
60271	639	damaged tail	60316	587		60361	705	
60272	587		60317	600		60362	680	
60273	590		60318	584		60363	540	
60274	611		60319	609		60364	588	
60275	595		60320	594		60365	634	
60276	650		60321	611		60366	634	
60277	591		60322	585		60367	610	
60278	595		60323	556		60368	545	
60279	712		60324	632		60369	729	
60280	585	net marks	60325	614		60370	630	
60281	550		60326	743		60371	635	
60282	597	net marks	60327	624		60372	655	
60283	636		60328	621		60373	555	net marks
60284	579		60329	631		60374	695	
60285	593		60330	603		60375	565	
60286	586		60331	582		60376	762	
60287	671		60332	646		60377	785	
60288	515	net marks	60333	634		60378	675	
60289	581		60334	619		60379	585	
60290	545		60335	607		60380	612	
60291	636		60336	660		60381	644	
60292	581	net marks	60337	533		60382	639	
60293	669		60338	571		60383	580	
60294	674		60339	652		60384	612	
60295	576		60340	674	side scar	60385	600	
60296	711		60341	621		60386	591	
60297	733		60342	537		60387	664	
60298	554		60343	709		60388	609	
60299	587		60344	608		60389	775	scarring
60300	574		60345	610		60390	614	
60301	832		60346	488		60391	730	
60302	626		60347	567	tail scar	60392	675	
60303	534		60348	673		60393	609	
60304	634		60349	555		60394	528	
60305	648		60350	604		60395	638	
60306	636		60351	547		60396	701	
60307	576		60352	648		60397	668	
60308	603		60353	615		60398	649	
60309	727		60354	600		60399	630	
60310	680		60355	635		60400	735	
60311	503		60356	655		60401	607	
60312	601		60357	610		60402	612	net marks

Appendix 2. Continued.

Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks	Tag Number (FC-)	Fork Length (mm)	Remarks
60403	669							
60404	699							
60405	704	net marks						
60406	661	net marks						
60407	495							
60408	648							
60409	592							
60410	602	net marks						
60411	631							
60412	635							
60413	630							
60414	520							
60415	620							
60416	744							
60417	585							
60418	545							
60419	640							
60420	634							
60421	585							
60422	589							
60423	629							
60424	575							
60425	610							
60426	665							
60427	550							
60428	485							
60429	620							
60430	542							
60431	708							
60432	510							
60433	417							
60434	585							
60435	633							
60436	641	net marks						
60437	618	net marks						
60438	557	net marks						
60439	634							
60440	612							
60441	288							
60442		tag lost						
60443	350							