

**Biological and Management
Investigations of the Arctic Char
Fishery at Nain, Labrador**

y L. W.

FISHERIES AND MARINE SERVICE
SERVICE DES PÊCHES ET DES SCIENCES DE LA MER

TECHNICAL REPORT No.
RAPPORT TECHNIQUE N° **624**

1976



Environment
Canada

Environnement
Canada

Fisheries
and Marine
Service

Service des pêches
et des sciences
de la mer

Technical Reports

Technical Reports are research documents that are of sufficient importance to be preserved, but which for some reason are not appropriate for primary scientific publication. Inquiries concerning any particular Report should be directed to the issuing establishment.

Rapports Techniques

Les rapports techniques sont des documents de recherche qui revêtent une assez grande importance pour être conservés mais qui, pour une raison ou pour une autre, ne conviennent pas à une publication scientifique prioritaire. Pour toute demande de renseignements concernant un rapport particulier, il faut s'adresser au service responsable.

Cat # 52276

Department of the Environment
Fisheries and Marine Service
Research and Development Directorate

Ministère de l'Environnement
Service des Pêches et des Sciences de la mer
Direction du Recherche et Développement

TECHNICAL REPORT No. 624

RAPPORT TECHNIQUE N^o. 624

(Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. The series name was changed with report number 457).

(Les numéros 1-456 dans cette série furent utilisés comme Rapports Techniques de l'office des recherches sur les pêcheries du Canada. Le nom de la série fut changé avec le rapport numéro 457).

Biological and Management Investigations
of the Arctic Char Fishery
at Nain, Labrador

by L. W. COADY and C. W. BEST

This is the forty-second
Technical Report from the
Research and Development Directorate
Newfoundland Biological Station
St. John's, Newfoundland

Ceci est le quarante-deuxième
Rapport Technique de la Direction du
Recherche et Développement
Station biologique de Terre-Neuve
Saint-Jean, Terre-Neuve

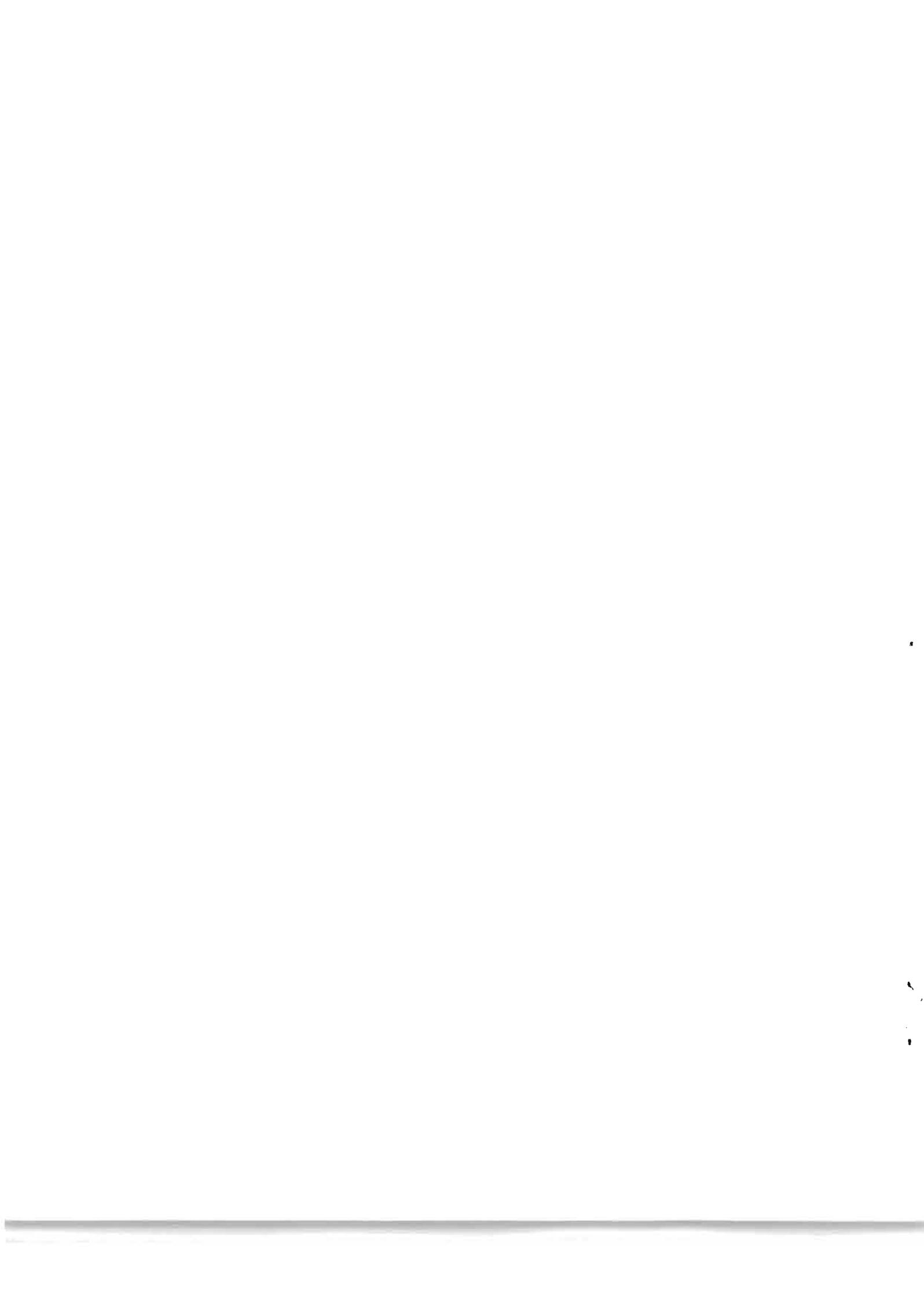
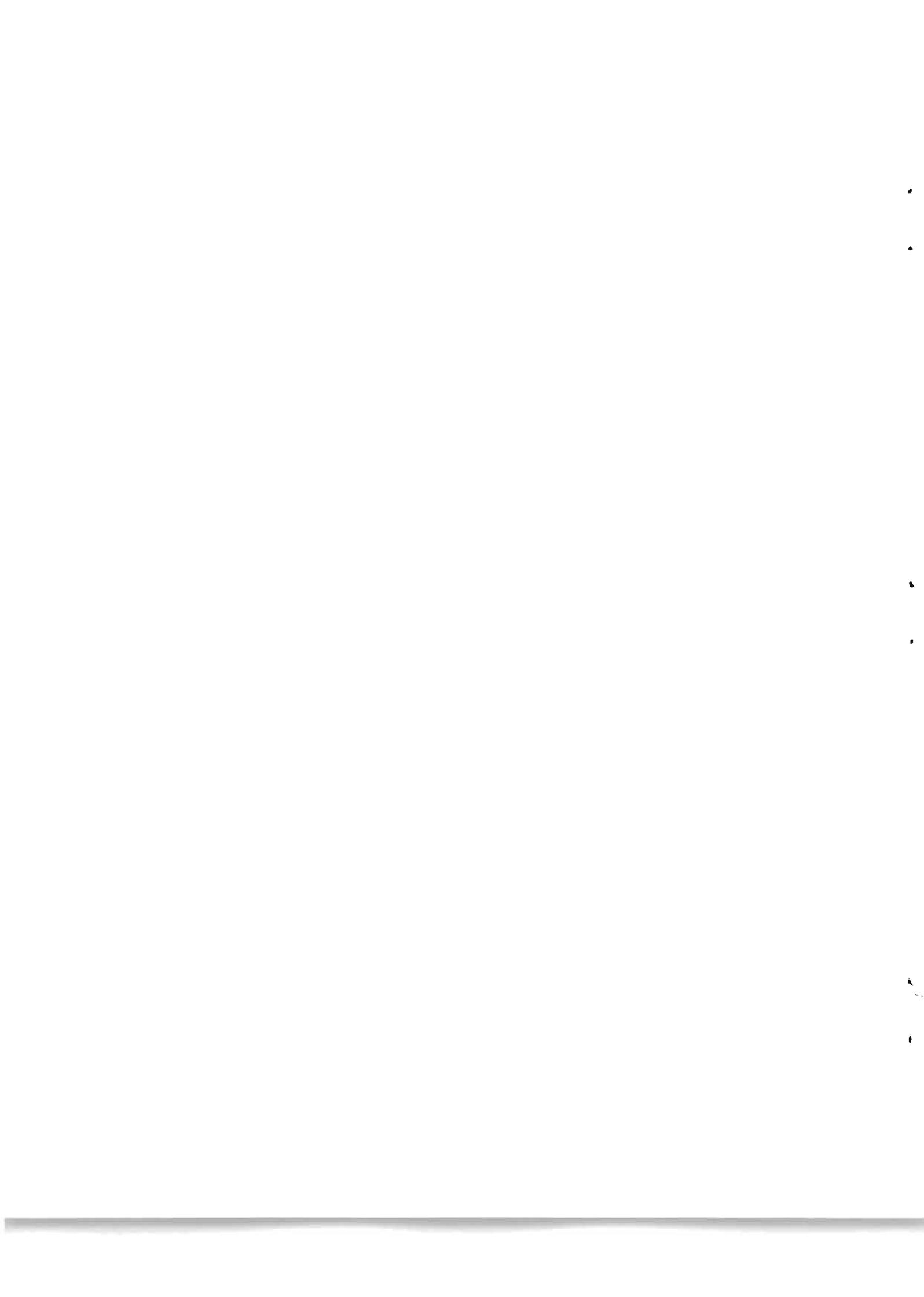


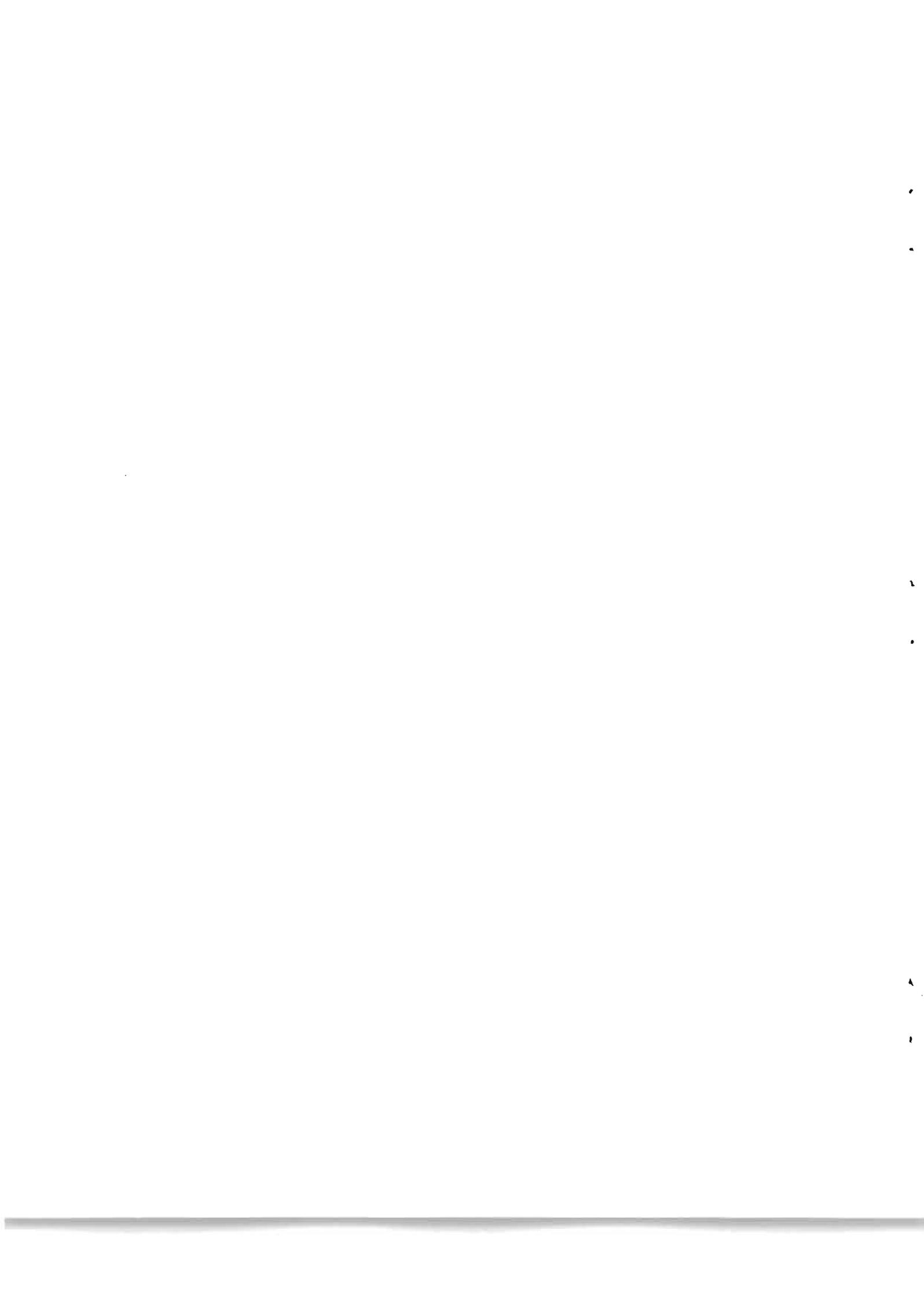
TABLE OF CONTENTS

| | Page |
|---|-------------|
| List of Tables | <i>v</i> |
| List of Figures | <i>vii</i> |
| List of Appendices | <i>ix</i> |
| Acknowledgments | <i>xi</i> |
| Abstract | <i>xiii</i> |
| Introduction | 1 |
| The Fishery | 3 |
| Methods | 4 |
| Commercial landings | 4 |
| Commercial sampling | 5 |
| Catch effort | 8 |
| Ageing | 8 |
| Age/length | 9 |
| Length/weight | 10 |
| Catch curves | 10 |
| Upstream migration | 10 |
| Results | 12 |
| Commercial landings, 1942-75 | 12 |
| Size breakdown of landings, 1970-75 | 12 |
| Catch effort | 14 |
| Catch/man-week | 14 |
| Catch/net-week | 21 |
| Ageing | 22 |
| Age/length | 24 |
| Individual samples | 24 |
| Major fishing areas | 24 |
| Combined data | 29 |
| Growth comparisons with other areas | 29 |
| Length/weight | 33 |
| Round/dressed weight | 37 |
| Males and females | 37 |
| Sex ratio | 37 |
| Maturation | 37 |
| Age/length | 37 |
| Length/weight | 42 |
| Catch curves | 42 |
| Upstream migration | 46 |
| Timing | 46 |
| Size distribution | 46 |
| Reproductive condition | 46 |
| Discussion | 46 |
| Biological aspects | 48 |
| The commercial fishery | 50 |
| Management guidelines | 52 |
| Summary | 56 |
| References | 58 |
| Appendices | 61 |



LIST OF TABLES

| | Page |
|--|------|
| Table 1. Area breakdown of Arctic char sampled at Nain, 1973-74. | 5 |
| Table 2. Size breakdown of char landings at the Nain fish plant, 1970-75. | 14 |
| Table 3. Area breakdown of char landings with estimates of pickled char production by individual fishermen, 1961-69. | 15 |
| Table 4. Weekly landings of char and salmon at the Nain fish plant, 1974 and 1975. | 17 |
| Table 5. Area breakdown of Nain char landings, 1974 and 1975. | 19 |
| Table 6. Area breakdown of Nain salmon landings, 1974 and 1975. | 20 |
| Table 7. Comparison of scale and otolith age determinations. | 22 |
| Table 8. Bertalanffy growth variables; major fishing areas. | 26 |
| Table 9. Bertalanffy growth variables; combined data. | 29 |
| Table 10. Representative growth data from nine studies of anadromous Arctic char. | 32 |
| Table 11. Bertalanffy growth variables for male and female Arctic char. | 42 |



LIST OF FIGURES

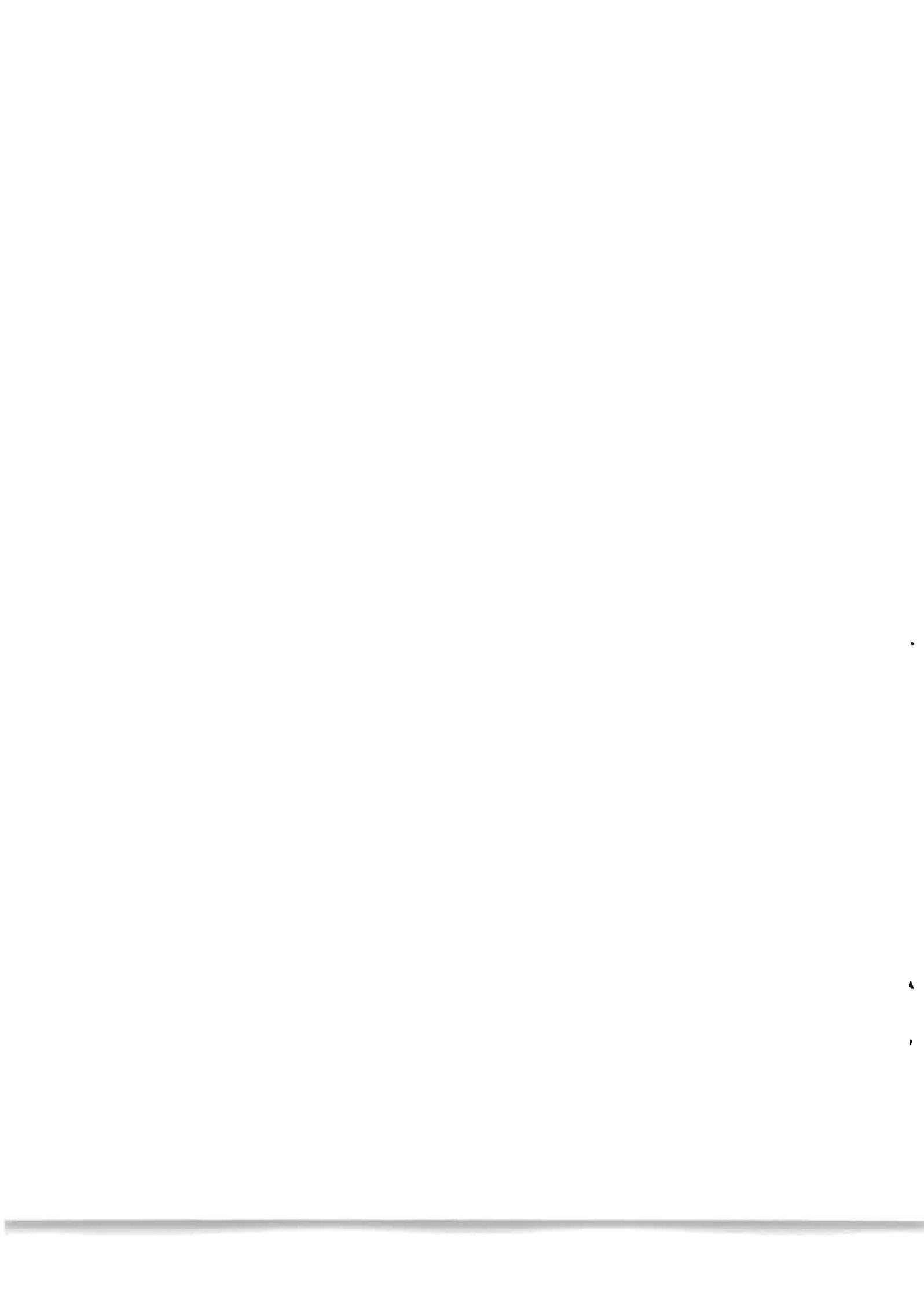
| | Page |
|--|---------------|
| Figure 1. Northern limits of the Nain char fishery from 1969 to 1973. | 2 |
| Figure 2. Major fishing areas and individual sampling locations. | 6 |
| Figure 3. A) Ice-packed char from fishing camps. B) Commercial sampling operations at Nain. | 7 |
| Figure 4. A) Partially constructed Fraser River counting fence. B) Aerial view showing upstream and downstream traps. | 11 |
| Figure 5. Commercial exports of Arctic char, Atlantic salmon and cod from the northern Labrador coast, 1942-75. | 13 |
| Figure 6. Breakdown of coastal fishing areas for catch-effort analysis. | 18 |
| Figure 7. Representative otoliths of Arctic char. | 23 |
| Figure 8. Age and length characteristics of Arctic char at each of nine sample locations. | 25 |
| Figure 9. Age and length characteristics of Arctic char in major fishing areas. | 27 |
| Figure 10. Comparison of instantaneous growth rates in major fishing areas (fitted values darkened). | 28 |
| Figure 11. Combined growth data from all areas sampled, 1973 and 1974. | 30 |
| Figure 12. Growth in Arctic char; a comparison of fourteen areas. | 31 |
| Figure 13. Length/G.H.0n weight relationship; combined data. | 34 |
| Figure 14. Length/G.H.0n weight relationships; major fishing areas. | 35 |
| Figure 15. Length/G.H.0n weight relationships; individual samples. | 36 |
| Figure 16. Round/dressed weight relationship in Arctic char sampled at Nain Bay. | 38 |
| Figure 17. Comparison of age and length characteristics in male and female Arctic char. | 39 |
| Figure 18. Comparison of instantaneous growth rates in male and female Arctic char (fitted values darkened). | 40 |
| | . . . Cont'd. |

LIST OF FIGURES (Cont'd.)

| | Page |
|---|------|
| Figure 19. Comparison of length/G.H.On weight relationships in male and female Arctic char. | 41 |
| Figure 20. Catch curves; Okak area; 1973-74. | 43 |
| Figure 21. Catch curves; Nain area; 1973-74. | 44 |
| Figure 22. Catch curve; Voisey area; 1974. | 45 |
| Figure 23. Number (A) and size (B) of upstream migrant Arctic char, Fraser River, 1975. | 47 |
| Figure 24. Proposed and potential expansion areas for the Nain char fishery. | 54 |

LIST OF APPENDICES

| | Page |
|---|------|
| Appendix I. Arctic char, Atlantic salmon and cod exports from the northern Labrador coast, 1942-75. | 61 |
| Appendix II. Summary of age, length and weight data for Arctic char; nine sampling locations. | 65 |
| (i) Anton's Point | |
| (ii) Voisey Bay | |
| (iii) Unity Bay | |
| (iv) Nain-Unity Bays | |
| (v) Nain Bay | |
| (vi) Tikkoatokak Bay | |
| (vii) Tasiuyak Bay | |
| (viii) Okak-Cutthroat | |
| (ix) Okak Bay | |
| Appendix III. Summary of age, length and weight data for Arctic char; major fishing areas. | 83 |
| (i) Voisey Area | |
| (ii) Nain Area | |
| (iii) Okak Area | |
| Appendix IV. Summary of age, length and weight data for Arctic char; combined data. | 91 |
| Appendix V. Comparison of age, length and weight data for male and female Arctic char sampled at Unity Bay. | 95 |
| (i) males | |
| (ii) females | |
| Appendix VI. Round/Dressed (G.H.On) weight relationship in Arctic char sampled at Nain Bay. | 101 |



ACKNOWLEDGMENTS

The authors wish to thank students Cam Wilson, Everett Gifford and Dave Long for their unfailing interest in the project. We only wish we could have kept them "drier" and gotten them back to university on time.

Our efforts were simplified on many occasions by the assistance of Labrador Services Division. Particular thanks are due to Aubrey Pike - Director, Max Tiller and Al Flynn.

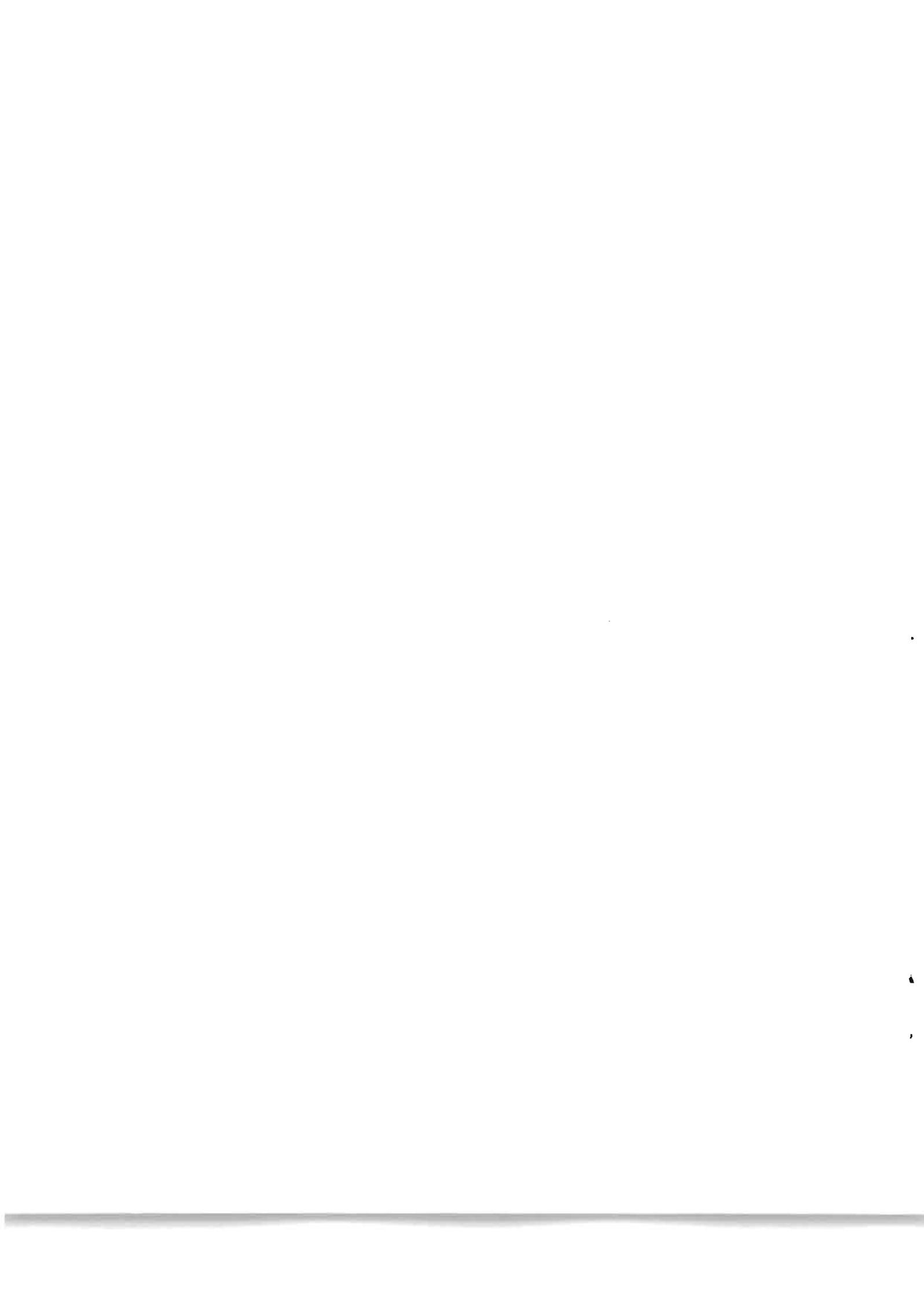
Thanks are extended to biologists Henry Lear, Willy Bruce, Vern Pepper and Rex Porter for their many helpful criticisms of the text.

We deeply regretted the passing in 1974 of Nat Duggan, District Fisheries Officer for Labrador. His death left a considerable gap in experience with the Labrador coastal fishery. His duties have been admirably filled by Mr. Tom Curran.

Mr. Randy Blundon assisted in the reading of otoliths, processing of purchase slips and drafting of illustrations. Char scales were read by Dennis Riche. Reg Tucker and Ned Rowe provided computer and photographic assistance respectively. Ms. Jean Maidment courageously undertook typing duties.

We very much appreciated the hospitality of Mr. Ian Strachan who understood our sense of humor and Mr. Artie Flynn who didn't. To Norman Anderson, Abel Leo, Amos Maggo, Wayne Jenkins and many other residents of Nain we owe a considerable debt of gratitude.

A final note of appreciation to Dr. John Pippy, Branch Head, who took an active part in management meetings with the fishermen of Nain and Labrador Services Division.



ABSTRACT

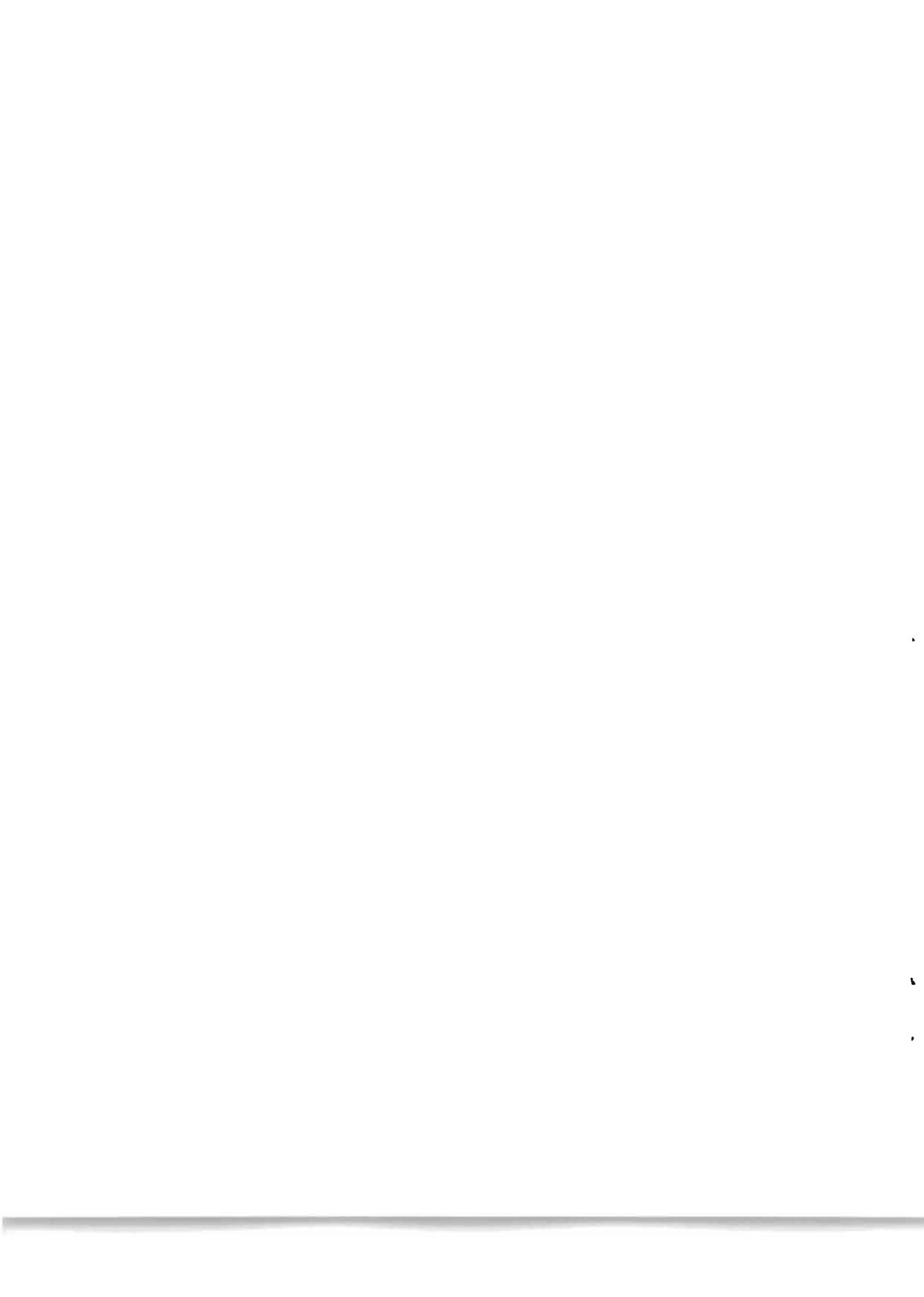
Coady, L. W. and C. W. Best. 1976. Biological and Management Investigations of the Arctic Char Fishery at Nain, Labrador. Fish. Mar. Serv. Res. Dev. Tech. Rep. 624: 103 p.

Growth characteristics of Arctic char from different areas of the Labrador coast vary significantly with populations slower growing in more northern regions. Male and female char exhibit similar growth rates (age/length) with males proportionately larger at a given length. Upstream migration from the sea lasts from July to September with peak runs coinciding with spring tide conditions at the river mouth. Larger char enter the rivers first. Few indications of advancing maturation were evident in char while at sea or during the upstream migration. Char stocks in areas currently exploited by Nain fishermen have been seriously overfished since 1970. Investigations undertaken from 1973 to 1975 have revealed total annual mortalities in excess of 50%, alterations in growth rate, reduced catch success on a unit effort basis and a decline in the average size of landed char. Recommendation is made that commercial operations be extended to unfished areas farther north, before the 1976 fishing season.

RÉSUMÉ

Coady, L. W. and C. W. Best. 1976. Biological and Management Investigations of the Arctic Char Fishery at Nain, Labrador. Fish. Mar. Serv. Res. Dev. Tech. Rep. 624: 103 p.

Les caractéristiques de la croissance de l'omble chevalier de la côte du Labrador sont très différentes de celles des populations à croissance plus lente des régions plus au nord. Les mâles et femelles ont des taux de croissance similaires (âge/longueur), mais les mâles sont proportionnellement plus gros pour une longueur donnée. La remontée des rivières dure de juillet à septembre, la période de pointe coïncidant aux marées du printemps à l'embouchure de ces dernières. Les plus gros poissons sont les premiers à entreprendre la remontée. On a pu déceler chez les ombles peu de signes de maturation avancée pendant qu'ils étaient en mer ou durant la montaison. Depuis 1970, les stocks d'ombles des zones de pêche des pêcheurs de Nain ont été surexploités. Des enquêtes menées de 1973 à 1975 ont mis en évidence une mortalité annuelle dépassant 50%, des modifications du taux de croissance ainsi qu'une réduction du rendement de la pêche et de la taille moyenne des débarquements. En prévision de la saison de 1976, on recommande que la pêche commerciale s'étende aux régions non exploitées plus au nord.





Gillnetted Arctic char



INTRODUCTION

The anadromous or sea-run Arctic char, *Salvelinus alpinus* (L.), is widespread throughout northern Canada and circumpolar in the northern hemisphere. The southward penetration of its range along the Labrador coast, in a region accessible to markets, was significant in the development of the first commercial fishery for the species in the 1860's. In other regions of Canada, commercial developments have been more recent: the first at Frobisher Bay in 1948 and since then at other localities in the Northwest Territories, notably Port Burwell, Cumberland Sound, Rankin Inlet, Pelly Bay, Cambridge Bay and the Queen Maud-Coronation Gulf area.

Principle char fishing areas on the Labrador coast are north of the community of Nain (Fig. 1). Prior to 1970, commercial landings were largely salted for export to overseas markets. In recent years, with improved market acceptance of the species in North America, emphasis has shifted to the fresh frozen and smoked items and with this, production levels have increased. In peak years, the area produces in excess of one-third of Canada's annual production of 450 metric tons of the species.

The traditional salt char fishery was typically wide-ranging with fishermen establishing summer fishing camps along several hundred miles of coast as far north as Seven Islands Bay (Fig. 1). Since 1970 and the introduction of large-scale refrigeration facilities at Nain, fishermen have ventured less farther afield to avail of the increased prices paid for fresh char. The resultant concentration of fishing effort in areas close to Nain threatens of overexploitation in these regions should current fishing trends continue.

Although positive management steps are required to promote desired growth and expansion of the Nain fishery, there is a basic lack of understanding of the resource to be managed.

The following report represents a summary of findings gathered during investigations in northern Labrador between 1973 and 1975. A primary aim of these studies has been to provide an accurate biological description of Arctic char in areas currently utilized by Nain fishermen. Attempts have been made throughout to demonstrate areas of management concern and, where possible, various remedial actions have been recommended. The eventual intent of this and ongoing studies will be to furnish estimates of the freshwater productivity of char in northern Labrador as well as allowable yield limitations to the fishery. Such data will hopefully form the basis of sound management policy for the Nain industry.

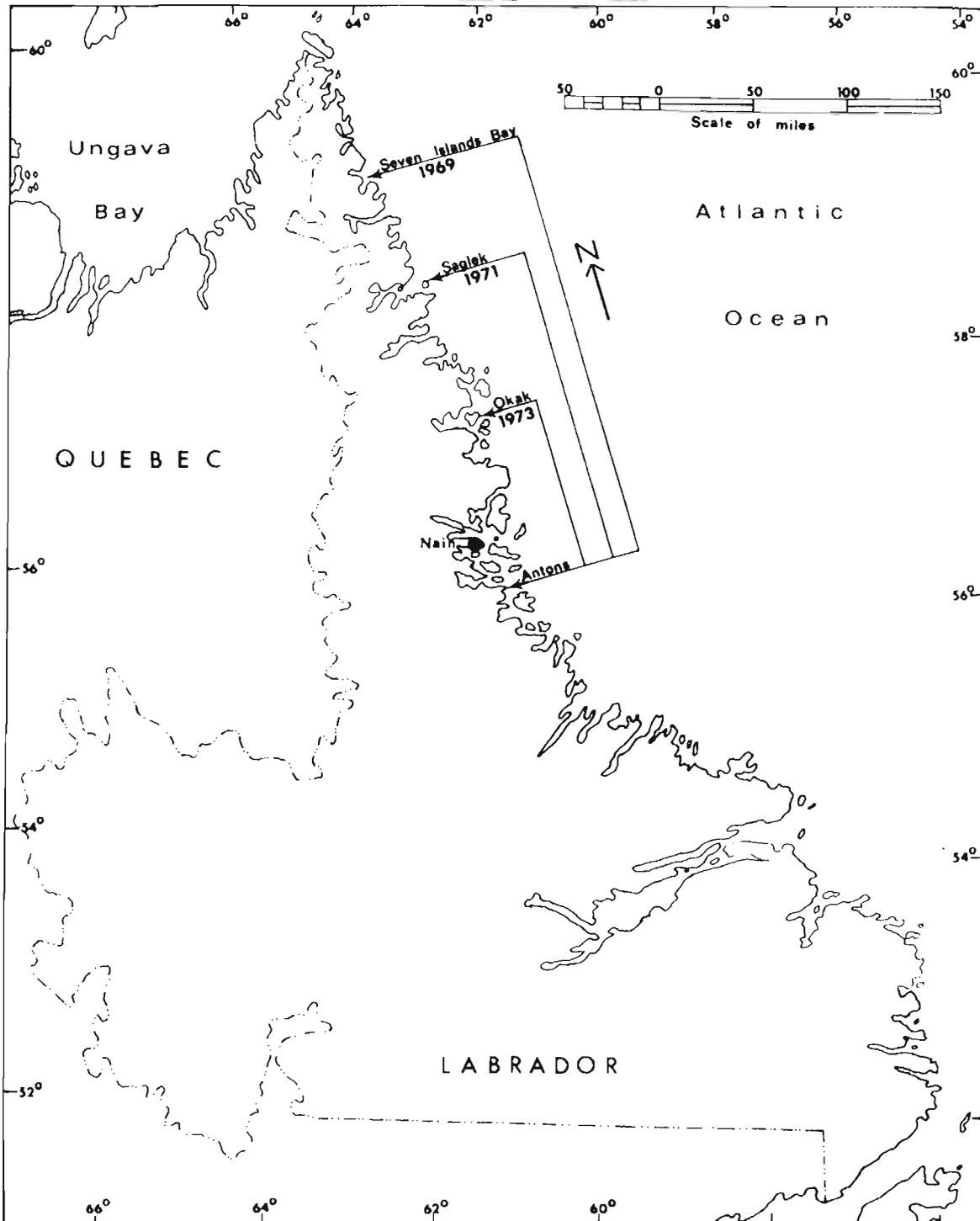


Fig. 1. Northern limits of the Nain char fishery from 1969 to 1973.

THE FISHERY

The following description of the Nain char fishery is provided as background information on current fishing patterns. For a more complete overview of social, economic and biological factors associated with the fishery since its inception, the reader is referred to Coady (1974).

The commercial fishing season at Nain, the northernmost settlement on the Labrador coast, commences with the opening of the fish plant in early July and lasts until mid or late September. Arctic char and Atlantic salmon account for 98% of fish production, with the relative contribution of each varying seasonally.

In addition to providing a valuable source of income, the fishery has been, and remains, of importance to the domestic economy as a source of food for human consumption.

Early season effort is concentrated in areas close to Nain, depending on local ice conditions. Activity then spreads progressively north as coastal ice recedes. Since 1973, commercial operations have ranged from Anton's north to Okak Bay (Fig. 1).

The majority of fishermen establish summer fishing camps along the coast. Approximately forty camps representing in excess of one hundred full-time fishermen are erected each year. Supplies are delivered and catches collected twice weekly by two vessels operating from Nain. Camps are relocated during the season depending on the availability of fish or the shift in emphasis from char to salmon as the latter become available during their northward migration along the coast.

Little was known of salmon fishing in the Nain area until 1969 and only then was any attempt made to utilize the species commercially. Salmon are most abundant along the offshore islands which abound in the Nain area, whereas char are commonly taken on the points or headlands of bays or inlets. Although this represents a distinct separation of gear, some char are taken in salmon nets and vice versa depending on the area.

Fishermen use anywhere from one to five surface gillnets each. Nets are most commonly nylon, 28 meshes deep and range from 20 to 40 fathoms in length. In most cases, nets are arranged in "fleets" (end to end) with an L-shaped leg on the seaward end.

Salmon nets are restricted by regulation to a minimum 5-inch stretched mesh, while char nets vary from 4 to 4½ and 5 inches in size. Nets are checked several times daily, cleared of debris and hauled from the water periodically for replacement with clean sets.

Fish caught are gutted (head on) and packed in ice prior to the arrival of the collection vessel. Considerable time is spent in procuring ice from passing icebergs or from land deposits persisting throughout the summer months.

Those fishermen who operate in areas close to Nain may deliver their catch directly to the fish plant. This latter group return to the community once or twice weekly and often remain weekends so that total landings will reflect varying degrees of effort in many instances.

At the peak of the fishing season, the government-run fish plant at Nain operates 24 hours/day in three 8-hour shifts and employs a maximum of 45 people, 85% of which are female. Fish returned for processing are graded on the basis of size, then cleaned, frozen, glazed, packaged and shipped to St. John's, Newfoundland, aboard Canadian National cargo vessels which visit the coast every 10-12 days during the summer and early fall months.

In recent years, a portion of the catch has been set aside for smoking purposes and a good possibility exists that smoking operations may be extended to the offseason when fishing activities have ceased. Buyers generally insist that smoked items arrive unfrozen so that the product is commonly flown from Nain on chartered aircraft.

METHODS

Commercial landings

Recent information on commercial fish landings in northern Labrador is available from the Economics and Intelligence Branch (E and I) of Environment Canada. E and I gather data from "purchase slips" filled out by fish dealers at the time of catch receipt. The purchase slip system was introduced in 1969 and each year provides an increasingly more accurate account of inshore landings by species and community throughout Newfoundland and Labrador.

Earlier data on total landings were gathered from records kept by Northern Labrador Services Division (NLSO) since 1942 when the agency took control of commercial fishing operations in the area. Prior to 1942, fishery products were marketed by both the Hudson's Bay Company and the Moravian Mission from which little insight is available into the success of the fishery (Coady, 1974).

Landed catches, whether pickled or fresh, were converted to total round or whole weights using the following conversion factors:

| | | |
|-----------------|------------------------------------|--------|
| Arctic char | Salted to Round | X 1.68 |
| | Gutted, Head On to Round | X 1.24 |
| Atlantic salmon | Gutted, Head On to Round | X 1.10 |
| Cod | Salted, Heavy to Round | X 2.70 |

These factors were recommended by the Economics and Intelligence Branch and are in wide commercial use throughout the province.

Commercial sampling

During the 1973 and 1974 fishing seasons, collection vessels operating from the processing plant at Nain gathered ice-packed char from three major fishing areas, i.e. Okak, Nain and Voisey (Fig. 2).

Fish were off-loaded at the plant in the gutted, head on (G.H.0n) condition (Fig. 3A). Char identifiable as to origin were then set aside for sampling prior to processing. A total of 2093 char, representing nine selected locations, were chosen randomly for use in the study. Table 1 lists the locations, dates and numbers sampled, and demonstrates the relationship of the samples on the basis of fishing area (Fig. 2).

Table 1. Area breakdown of Arctic char sampled at Nain, 1973-74.

| | Area | Location | Date sampled | Number sampled |
|------------------|-----------------|----------------|-----------------------|----------------|
| Combined | OKAK (591) | Okak-Cutthroat | Aug. 3-18, 1973 | 256 |
| | | Okak Bay | July 31, 1974 | 200 |
| | | Tasiuyak | July 29, 1974 | 135 |
| sample (2093) | NAIN (1096) | Nain-Unity | Aug. 3-20, 1973 | 149 |
| | | Nain Bay | July 30, 1974 | 210 |
| | | Unity Bay | July 17-Aug. 15, 1974 | 544 |
| | | Tikkoatokak | July 29-Aug. 3, 1974 | 193 |
| | VOISEY (406) | Voisey Bay | July 31, 1974 | 204 |
| | | Anton's Point | August 1, 1974 | 202 |

The fork length (cm) and dressed (G.H.0n) weight (kg) of each specimen were recorded (Fig. 3B). In each case, both otoliths (sagitta) were extracted and preserved dry for laboratory examination. Additionally, scale samples were removed from a total of 209 fish.

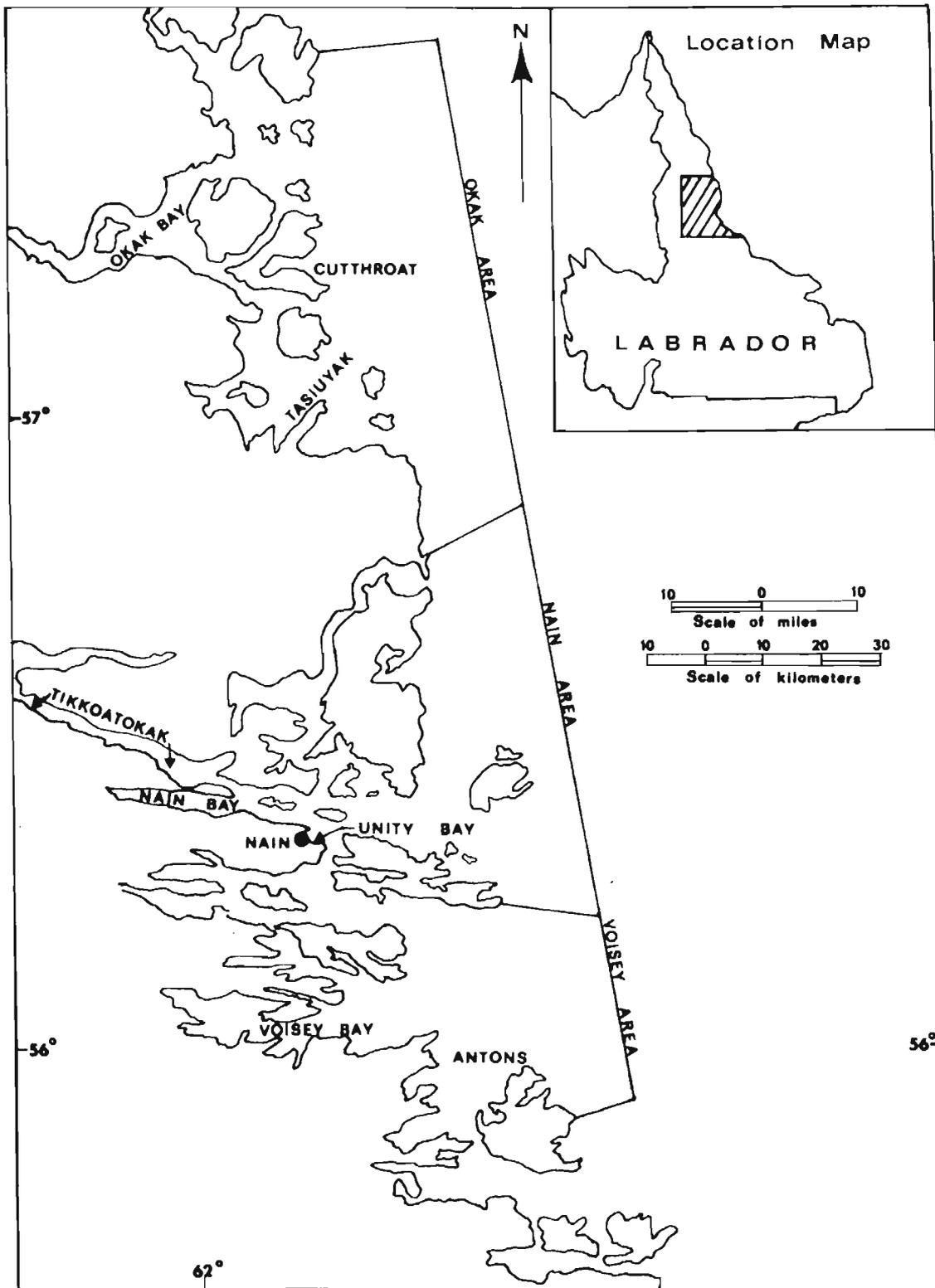
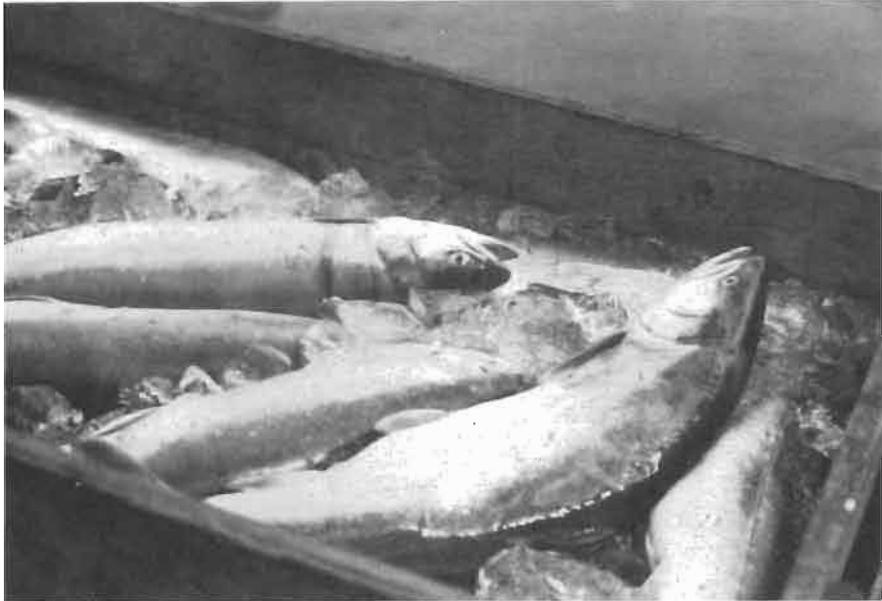


Fig. 2. Major fishing areas and individual sampling locations.



A



B

Fig. 3. A) Ice-packed char from fishing camps.
B) Commercial sampling operations at Nain.

As the use of gutted fish samples of commercial size was considered inadequate from several standpoints, further efforts were made to procure representative samples of juvenile and whole fish. Several fishermen in Nain Bay assisted by providing ungutted char from which sex, maturity and round weight determinations could be made. In addition, a number of juvenile, sea-run char were obtained from Unity Bay with 2-inch stretched mesh gillnets, beach seines and angling equipment.

Catch effort

During the 1974 and 1975 fishing seasons, the captains of collection vessels operating from Nain assisted in recording the date, location fished and number of nets in use by individual fishermen each time a collection was made. This information was subsequently entered on purchase slips as catches were weighed at the Nain fish plant.

At the conclusion of the fishing season, copies of all purchase slips were requested from E and I and breakdowns made of landings by area, as well as catch effort estimates on the basis of "man-weeks" and "net-weeks" fished.

Ageing

Although otoliths are generally considered more reliable than scales in ageing Arctic char (Nordeng, 1961), a comparison was made of both methods to determine the degree of inconsistency and to judge where discrepancies arise.

Scales were read at 43 magnifications using a Bausch and Lomb overhead projector.

Each set of otoliths was ground by hand to remove surface irregularities prior to reading. They were then cleaned in glycerol and viewed with a dissection microscope under both transmitted and reflected light sources. As the medial surface of the otolith consists of two lobes separated by a deep fissure, the smoother lateral surface was read.

Independent interpretations of otolith age were made by two readers and, in cases where readings did not agree, the sample was rejected. This latter precaution was deemed necessary due to the recurring problem of incomplete and misleading annular formations. Approximately 20% of the sample was rejected in this manner.

The uniformly dense central region or "core" of the otolith was interpreted as representative of embryonic growth in the fish. Each annulus then develops as alternating sets of wide/opaque and narrow/hyaline zones indicative of summer and winter growth respectively. Several radii were read to ensure accurate interpretation.

Annuli became progressively narrower toward the edge so that age determinations proved more difficult in older fish. The final winter or hyaline zone was followed in all cases by a noticeably incomplete summer or "plus" growth of variable thickness around the edge. Lee (1969) had found that otolith growth proceeds at a disproportionate rate relative to the size of the fish so that no attempt was made to backcalculate growth. Additionally, the narrow outer annuli in older fish are relatively imperceptible using standard measurement techniques.

Age/length

An empirical plot of growth was obtained using Von Bertalanffy's (1938) growth equation. Values were fitted by the least squares method of Allen (1966). The equation reads:

$$l_t = L_\infty (1 - e^{-k(t-t_0)})$$

where:

l_t = mean fork length (cm) at age t (years)

L_∞ = asymptotic or theoretical maximum length

k = constant determining the relative rate of approach to L_∞

and t_0 = theoretical age at which $l_t = 0$ (from which the curve arbitrarily originates)

Sandeman (1969) provides a convenient means of comparing the growth rates of populations having different parameters k , L and t_0 and how they change with age by a semi-logarithmic plot of: $\frac{dl}{dt}$ against t

where:

$$\frac{dl}{dt} = k L_\infty e^{-k(t-t_0)}$$

i.e. $\log \frac{dl}{dt} = \log k + \log L_\infty + k t_0 - kt$

This linear arrangement proved useful in comparing Voisey, Nain and Okak samples.

Length/weight

Length-weight relationships defined as: $W = cL^b$

where: W = weight

L = length

and c and b are constants

were fitted using the least squares regression of the logarithmic transformation

$$y = a + bx$$

i.e. $\log_{10}W = a + b(\log_{10}L)$

Catch curves

Data on the known frequency distribution of catch by age were gathered for the Voisey, Nain and Okak areas during 1973 and 1974.

Comparisons of annual (a) and total (z) mortality rates were drawn from least squares regressions fitted to the descending limbs of "catch curves" based on the distribution of the natural logarithm of numbers at age (Ricker, 1958).

Upstream migration

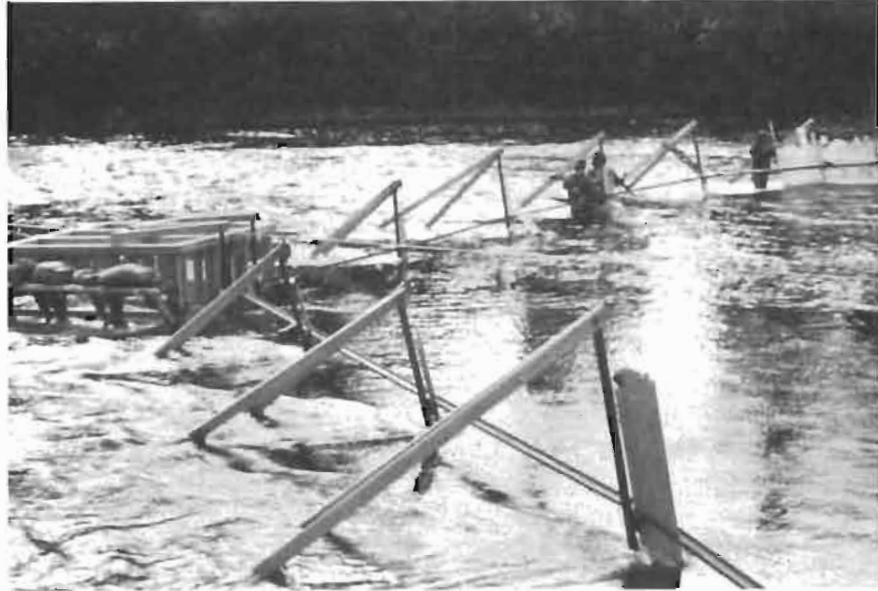
A temporary counting fence, 76 metres in length, was installed on the Fraser River northwest of Nain (56°37'00"N, 62°15'00"W) in July, 1975.

A complete physical description of the Fraser River has been provided by Murphy and Porter (1974). Approximately 64 linear kilometres of stream bed are accessible to fish. Arctic char are the predominant species. Populations of brook trout, mottled sculpin and stickleback are also present. Full watershed drainage area is 1605 square kilometres.

The fence consisted of 3-metre steel beam sections supported horizontally by A-frame stands set directly on river gravel (Fig. 4A). Each section was fitted vertically with 100 lengths of conduit tubing spaced less than 1 cm apart to prevent the passage of fish.

Upstream and downstream wooden traps were fitted at opposite ends of the structure (Fig. 4B) and daily counts made during the period July 28-September 8.

While 1975 findings are largely incomplete, various aspects of the timing, extent, size distribution and sex composition of the upstream run relate with some significance to commercial operations and will be included in this report.



A



B

Fig. 4. A) Partially constructed Fraser River counting fence.
B) Aerial view showing upstream and downstream traps.

RESULTS

Commercial landings, 1942-75

Nain is but one of five permanent communities on the northern Labrador coast from which commercial fish products are shipped to southern markets. Through the years, Nain has been a major collection centre for several of these settlements so that available records of Nain exports provide little insight into the success of the Nain fishery itself. For this reason, commercial landings of char, salmon and cod since 1942 have been presented as the combined harvest of the entire northern Labrador coast (Appendix I). As a rule, more than 90% of Labrador char landings originate near or north of Nain and are harvested by Nain fishermen, whereas salmon and cod catches tend to be more evenly distributed along the coast (Coady, 1974).

Total landings provided do not include cullage or domestic take. Cullage estimates would have been significantly high for char in years prior to 1967 when markets showed a strong preference for the red and pink rather than white-fleshed fish. At the same time, domestic take has decreased in recent years with less reliance on char as food for sled dogs and with the import of a greater diversity of staple foodstuffs.

Since 1942, and until modernization of fish processing facilities at Nain in the early seventies, fishing operations at Nain remained relatively unchanged. Char landings during this period (Fig. 5) fluctuate in a distinct cyclic pattern, peaking every 5 to 6 years.

Cod exports from the northern Labrador coast since 1942 have "slumped" on two separate occasions. The first, commencing in 1951 and lasting until 1956, coincides with a short-lived upswing in employment alternate to the fishery (Coady, 1974). The second, which has persisted since 1965, has been attributed to increased foreign trawler activities offshore (May, 1967). With the decline of cod stocks, increased commercial yields have been made of char and salmon.

The general upswing in char shipments reached a peak in 1972 but since then total yields have dropped rapidly.

Size breakdown of landings, 1970-75

Prior to 1970, char exports from the Labrador coast were sorted on the basis of flesh coloration and quality. With the switch to fresh frozen items, shipments have since been graded (in three categories) according to weight. A percentage breakdown of Nain landings on this basis (Table 2) has revealed a drastic reduction in the average size of commercial landings. Total numbers of landed fish over 5 pounds have declined. At the same time, char in excess of 10 pounds have been virtually eliminated from the fishery.

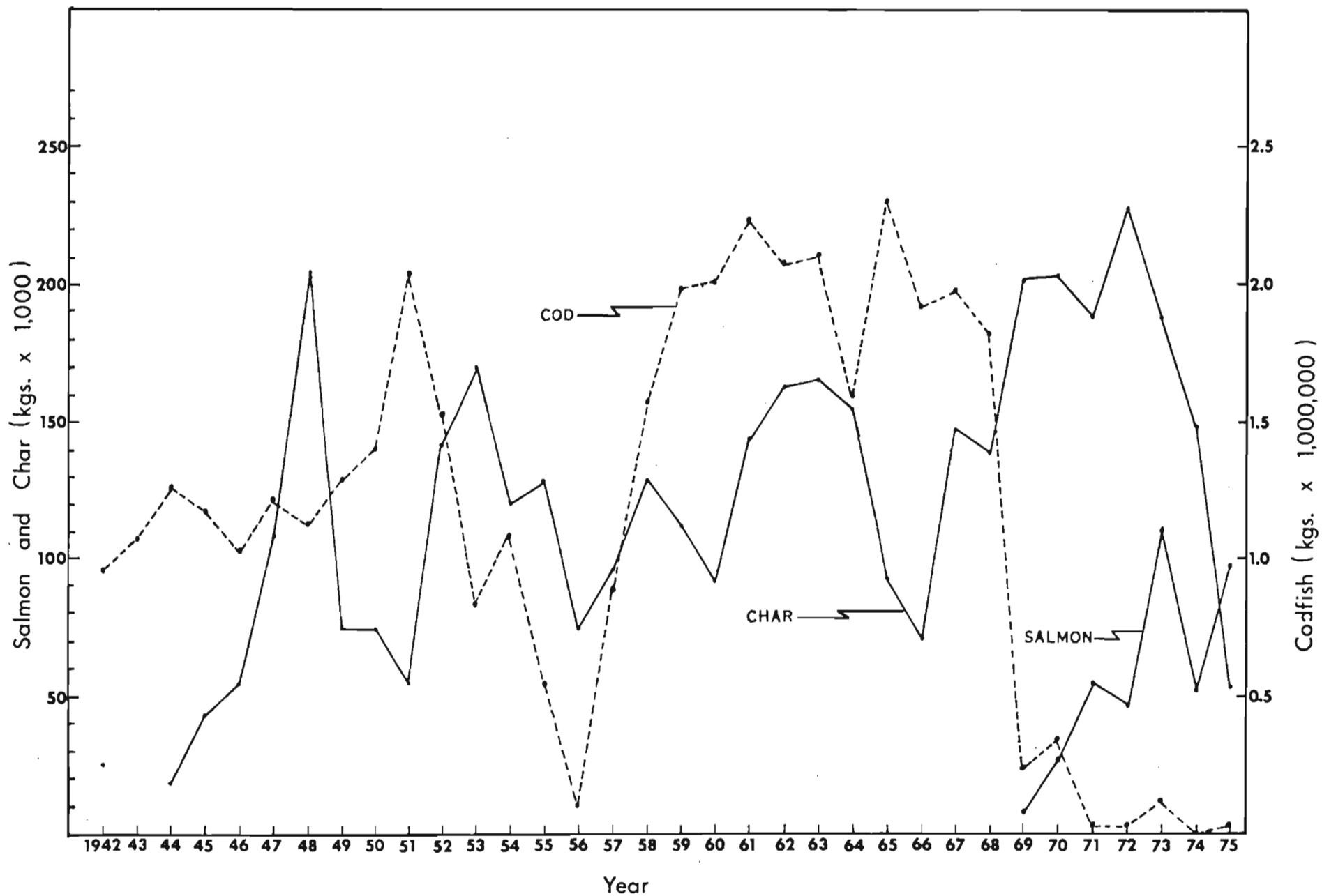


Fig. 5. Commercial exports of Arctic char, Atlantic salmon and cod from the northern Labrador coast, 1942-75.

Table 2. Size breakdown of char landings at the Nain fish plant, 1970-75.

| Year | Size category (lb)* | | |
|------|---------------------|-------------|----------------|
| | 2-5 (%) | 5-10 (%) | over 10 (%) |
| 1970 | 35.27 | 53.26 | 11.47 |
| 1971 | 62.01 | 35.60 | 2.39 |
| 1972 | 82.69 | 16.06 | 1.25 |
| 1973 | 58.38 | 38.87 | 2.74 |
| 1974 | 79.51 | 20.19 | 0.30 |
| 1975 | 78.30 | 21.59 | 0.10 |

*gutted, head on weight

Catch effort

The primary aim in evaluating effort information is to determine the level of success of some clearly defined unit of fishing effort. Such estimates aid in establishing management controls as they enable reliable predictions of the impact that changes in fishing effort will have on existing fish stocks.

Seasonal breakdowns of Nain char landings by week, area or effort involvement are generally lacking until 1974.

Limited data for the period 1961-69 (Table 3) were extracted from reports prepared annually by District Fisheries Officers stationed in Labrador. Although char landings were higher per fisherman in years when fewer men were engaged in the fishery, this is not true for separate areas. In the latter case, estimates fluctuate widely in relation to the effort involved. The overall average of 1838 kg per man per season is of salted fish for which considerably more effort is expended in handling and processing than is now required for the fresh product.

More refined analyses were compiled from commercial purchase slips for the 1974 and 1975 fishing seasons during which all landings were sold fresh. As the majority of fishermen net both char and salmon, both species are treated together.

Catch/man-week. Catch per man-week is here defined as the weight of fish sold commercially by a fisherman in a 1-week period. Similarly, unit effort is expressed in terms of the total number of "man-weeks" fished.

Table 3. Area breakdown of char landings with estimates of pickled char production by individual fishermen, 1961-69.

| Area* | 1961 | | | 1962 | | | 1966 | | | 1967 | | | 1968 | | | 1969 | | |
|---------------------|---------|------------|------------------------|---------|------------|------------------------|---------|------------|------------------------|---------|------------|------------------------|---------|------------|------------------------|---------|------------|------------------------|
| | Pounds | No. of men | Landings per fisherman | Pounds | No. of men | Landings per fisherman | Pounds | No. of men | Landings per fisherman | Pounds | No. of men | Landings per fisherman | Pounds | No. of men | Landings per fisherman | Pounds | No. of men | Landings per fisherman |
| Ryans | | | | | | | | | | | | | | | 9,900 | 3 | 3,300 | |
| Nackvak | 41,136 | 9 | 4,571 | 33,660 | 7 | 4,809 | 37,338 | 5 | 7,468 | 49,720 | 8 | 5,524 | 50,600 | 8 | 6,325 | 38,060 | 8 | 4,758 |
| Ramah | 8,560 | 3 | 2,853 | | | | | | | | | | | | | | | |
| Saglek | 48,980 | 10 | 4,898 | 62,920 | 22 | 2,860 | 60,745 | 12 | 5,062 | 109,120 | 27 | 4,041 | 108,020 | 27 | 4,001 | 101,970 | 21 | 4,856 |
| Hebron | 20,604 | 5 | 4,121 | 35,860 | 12 | 2,988 | 10,932 | 3 | 3,644 | 18,700 | 8 | 2,330 | 17,600 | 8 | 2,200 | 49,060 | 12 | 4,068 |
| Napartok | 5,930 | 2 | 2,965 | | | | | | | | | | | | | | | |
| Okak | 52,706 | 9 | 5,856 | 52,580 | 11 | 4,780 | | | | 2,200 | 2 | 1,100 | 2,200 | 2 | 1,100 | 21,780 | 6 | 3,630 |
| Tasuiyak | 9,093 | 2 | 4,546 | 4,840 | 2 | 2,420 | | | | | | | | | | | | |
| Webb | | | | | | | 443 | 1 | 443 | 1,540 | 1 | 1,540 | | | | | | |
| Nain** | 14,994 | 11 | 1,363 | 15,400 | 12 | 1,283 | | | | | | | | | | | | |
| Anton's | | | | | | | 4,720 | 1 | 4,720 | 9,020 | 4 | 2,255 | 4,400 | 1 | 4,400 | 4,180 | 2 | 2,090 |
| Totals | 202,003 | 51 | 3,961 | 205,260 | 66 | 3,110 | 114,178 | 22 | 5,190 | 190,300 | 51 | 3,731 | 182,820 | 46 | 3,974 | 224,950 | 52 | 4,326 |
| Estimated round wt. | 339,365 | 51 | 6,654 | 344,837 | 66 | 5,225 | 191,819 | 22 | 8,719 | 319,704 | 51 | 6,269 | 307,138 | 46 | 6,677 | 377,916 | 52 | 7,268 |

Overall averages: 4,049 pickled lbs/fisherman/season (ie. 1,838 Kg.)
or 6,802 round lbs/fisherman/season (ie. 3,088 Kg.)

* Areas are arranged north to south

** Nain area - includes area approximately 30 miles north and south of Nain, i.e., Webb's Bay, Black Island, Nain Bay, The Lakes, Anaktalik Bay, Voisey's Bay, Zoar.

Several interpretations were attempted:

(i) A breakdown of 1974 and 1975 char and salmon landings by week (Table 4) provides a general impression of the availability of both species throughout the season. The manner in which landings relate to effort is also expressed.

Landings appear less related to effort than to the abundance or availability of salmon. Char sales were highest during the first several weeks of the season before salmon became available but as salmon catches increased, char landings declined.

While the total effort directed toward salmon remained about equal in both years, overall landings and catch success (catch/man-week) doubled in 1975. Fishing operations along the outer islands near Nain, where the bulk of salmon fishing is carried out, had been unduly hampered during 1974 by severe coastal ice conditions.

Greater significance can perhaps be attached to the sudden decline in char landings from 1974 to 1975. Even though less effort had been involved in the fishery in 1975 due to increased interest in salmon, the individual success of those fishermen who continued to fish char decreased a full one-third from 176 kg to 118 kg (gutted, head on weight) per man-week fished.

(ii) An estimate was made of expected catch success when the primary effort is directed toward either char or salmon.

A review was made of all purchase slips and those landings considered as "incidental" catch rejected. A species catch was considered incidental if it represented a minor portion (less than 10-15%) of a fisherman's total landings for that week. In cases where sizeable weekly landings were made of both char and salmon by a given fisherman, each figure was rejected. In this way, catch/man-week values derived imply "directive" effort toward one species or the other.

As expected, catch per man-week estimates increased: 21% for char, 47% for salmon, over 2 years. Revised estimates were, however, based on less than 35% of total landings for the season. The usefulness of this approach is therefore questionable; at best it demonstrates the close interrelationship of the two fisheries and the degree of variation which sometimes arises in the impartial treatment of bulk commercial data.

(iii) The relationship between landings and effort can further be interpreted on the basis of fishing location.

Twelve areas were chosen according to berth locations recognized by Nain fishermen (Fig. 6). A summary was then prepared of area landings and effort for both char (Table 5) and salmon (Table 6) during 1974 and 1975.

Table 4. Weekly landings of char and salmon at the Nain fish plant, 1974 and 1975.

| Fishing week | | | Landings (kg) | | Man-weeks fished | | Catch/man-week (kg) | |
|--------------|-------|-------|---------------|--------|------------------|--------|---------------------|--------|
| | | | char | salmon | char | salmon | char | salmon |
| 1974 | | | | | | | | |
| 1 | July | 7-13 | 12,902 | | 55 | | 235 | |
| 2 | | 14-20 | 11,503 | | 55 | | 209 | |
| 3 | | 21-27 | 16,248 | 285 | 63 | 12 | 258 | 24 |
| 4 | | 28-3 | 9,748 | 2,795 | 71 | 43 | 155 | 65 |
| 5 | Aug. | 4-10 | 13,275 | 3,977 | 78 | 61 | 170 | 65 |
| 6 | | 11-17 | 13,574 | 3,502 | 84 | 52 | 162 | 67 |
| 7 | | 18-24 | 13,285 | 2,254 | 59 | 52 | 225 | 43 |
| 8 | | 25-31 | 6,982 | 3,821 | 57 | 48 | 122 | 80 |
| 9 | Sept. | 1-7 | 717 | 4,012 | 27 | 35 | 27 | 115 |
| 10 | | 8-14 | 39 | 2,486 | 8 | 27 | 5 | 92 |
| 11 | | 15-21 | 4 | 1,525 | 2 | 20 | 2 | 76 |
| 12 | | 22-28 | | 566 | | 10 | | |
| SUMMARY | | | 98,277 | 25,223 | 559 | 360 | 176 | 70 |
| 1975 | | | | | | | | |
| 1 | June | 29-5 | 96 | 31 | 1 | 1 | 96 | 31 |
| 2 | July | 6-12 | 9,601 | 14 | 27 | 1 | 356 | 14 |
| 3 | | 13-19 | 9,000 | 4 | 37 | 1 | 243 | 4 |
| 4 | | 20-26 | 4,648 | 4,079 | 33 | 27 | 141 | 151 |
| 5 | | 27-2 | 2,512 | 12,769 | 42 | 53 | 60 | 241 |
| 6 | Aug. | 3-9 | 3,687 | 15,570 | 52 | 75 | 71 | 208 |
| 7 | | 10-16 | 3,032 | 4,728 | 33 | 44 | 92 | 107 |
| 8 | | 17-23 | 2,576 | 9,361 | 45 | 67 | 57 | 140 |
| 9 | | 24-30 | 453 | 2,779 | 25 | 45 | 18 | 62 |
| 10 | | 31-6 | 14 | 1,149 | 4 | 18 | 4 | 64 |
| 11 | Sept. | 7-13 | 2 | 753 | 2 | 12 | 1 | 63 |
| 12 | | 14-20 | | 587 | | 5 | | 117 |
| 13 | | 21-27 | | 184 | | 2 | | 77 |
| SUMMARY | | | 35,621 | 52,008 | 301 | 351 | 118 | 148 |

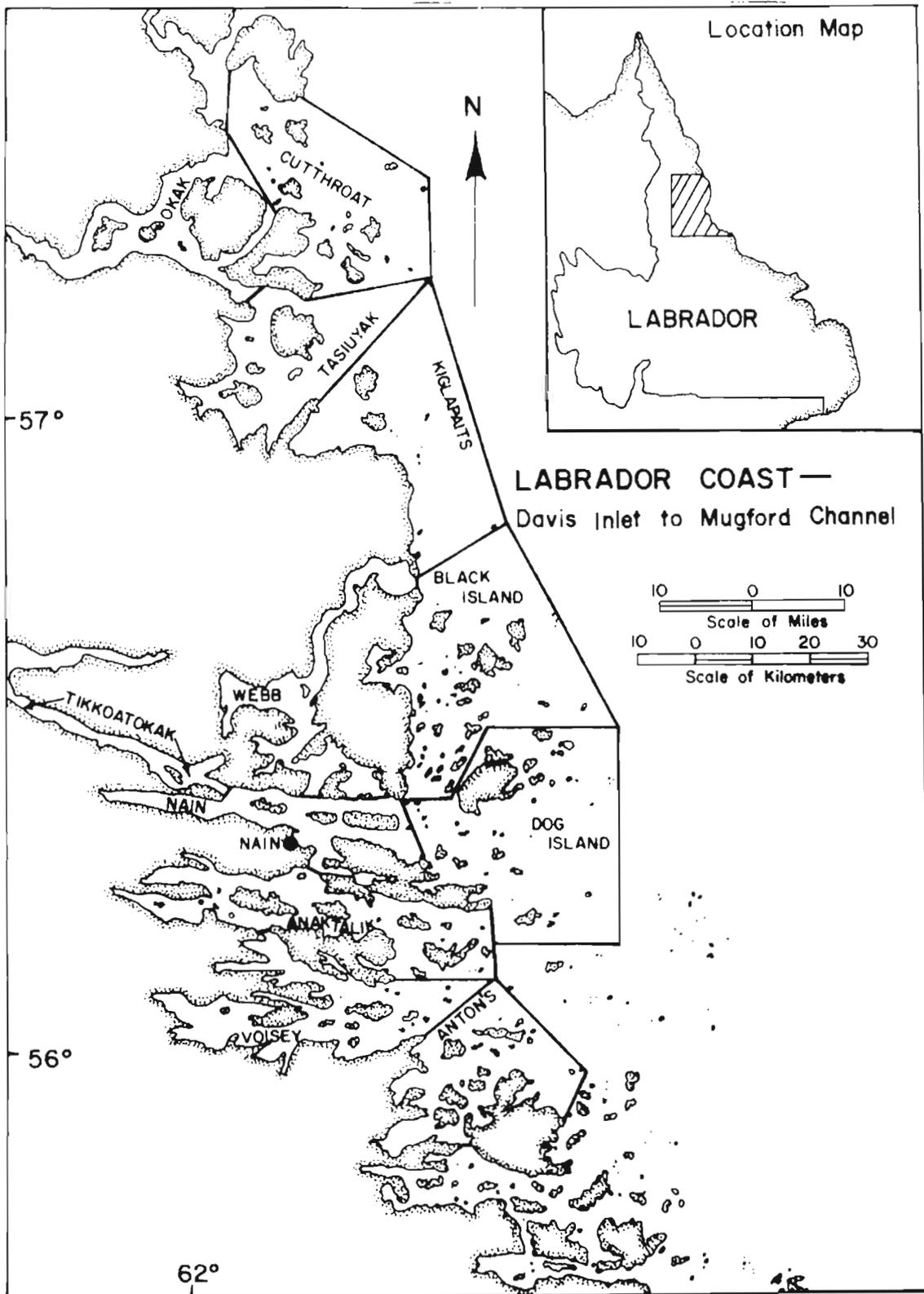


Fig. 6. Breakdown of coastal fishing areas for catch-effort analysis.

Table 5. Area breakdown of Nain char landings, 1974 and 1975.

| Area | Total catch (G.H.On weight) (kg) | | Man-weeks fished | | Catch per man-week (kg) | | Net-weeks fished | | Catch per net-week (kg) | | Average number of weeks fished per fisherman | Average number of nets used per fisherman |
|---------------|--|--------|---------------------|------|-------------------------------|------|---------------------|------|-------------------------------|------|--|---|
| | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | | |
| Cutthroat | 10,194 | 2,180 | 95 | 47 | 107 | 46 | 194 | 88 | 53 | 25 | 3.8 | 2.0 |
| Okak | 27,621 | 1,898 | 105 | 15 | 263 | 127 | 155 | 32 | 178 | 59 | 3.5 | 1.5 |
| Tasiuyak | 1,183 | - | 15 | - | 79 | - | 15 | - | 79 | - | 1.8 | 1.0 |
| Kiglapaits | 4,138 | 1,213 | 26 | 32 | 159 | 38 | 62 | 63 | 67 | 19 | 1.8 | 2.4 |
| Black Island | 3,439 | 1,694 | 60 | 62 | 57 | 27 | 152 | 195 | 23 | 9 | 4.6 | 2.5 |
| Webb Bay | 468 | 672 | 1 | 5 | 468 | 134 | 3 | 8 | 156 | 84 | 1.0 | 3.0 |
| Tikkoatokak | 8,032 | 22,335 | 28 | 76 | 287 | 294 | 47 | 131 | 171 | 171 | 2.0 | 1.7 |
| Dog Island | 2,144 | 527 | 38 | 40 | 56 | 13 | 96 | 133 | 22 | 4 | 2.9 | 2.6 |
| Nain Bay | 10,049 | - | 37 | - | 272 | - | 65 | - | 155 | - | 1.6 | 1.8 |
| Anaktalik | 6,307 | 2,055 | 28 | 10 | 225 | 206 | 50 | 15 | 126 | 137 | 2.3 | 1.8 |
| Voisey Bay | 16,165 | 192 | 64 | 2 | 253 | 96 | 117 | 4 | 138 | 48 | 2.4 | 2.0 |
| Anton's Point | 7,367 | 2,814 | 34 | 20 | 217 | 141 | 53 | 39 | 139 | 72 | 3.1 | 1.6 |
| SUMMARY | 97,107 | 35,580 | 531 | 309 | 183 | 115 | 1,009 | 708 | 96 | 50 | Av. 2.6 | Av. 2.0 |

Table 6. Area breakdown of Nain salmon landings, 1974 and 1975.

| Area | Total catch (G.H.On weight) (kg) | | Man-weeks fished | | Catch per man-week (kg) | | Net-weeks fished | | Catch per net-week (kg) | | Average number of weeks fished per fisherman | Average number of nets used per fisherman |
|---------------|--|--------|---------------------|------|-------------------------------|------|---------------------|------|-------------------------------|------|--|---|
| | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | | |
| Cutthroat | 7,779 | 19,456 | 94 | 81 | 83 | 240 | 202 | 150 | 39 | 130 | 3.0 | 2.1 |
| Okak | 1,175 | 2,854 | 57 | 17 | 21 | 168 | 81 | 35 | 15 | 82 | 2.5 | 1.8 |
| Tasiuyak | 6 | - | 1 | - | 6 | - | 1 | - | 6 | - | 1.0 | 1.0 |
| Kiglapaits | 4,140 | 7,683 | 29 | 48 | 143 | 160 | 71 | 100 | 58 | 77 | 2.5 | 2.4 |
| Black Island | 6,430 | 8,793 | 90 | 86 | 71 | 102 | 228 | 291 | 28 | 30 | 6.9 | 2.5 |
| Webb Bay | - | 69 | - | 4 | - | 17 | - | 7 | - | 10 | - | 1.8 |
| Tikkoatokak | 6 | 1,521 | 1 | 8 | 6 | 190 | 1 | 14 | 6 | 109 | 1.0 | 1.0 |
| Dog Island | 3,724 | 10,028 | 43 | 85 | 87 | 118 | 121 | 258 | 31 | 39 | 2.4 | 2.7 |
| Nain Bay | - | - | - | - | - | - | - | - | - | - | - | - |
| Anaktalik | - | - | - | - | - | - | - | - | - | - | - | - |
| Voisey Bay | 364 | - | 9 | - | 40 | - | 27 | - | 14 | - | 1.8 | 3.0 |
| Anton's Point | - | 1,037 | - | 13 | - | 80 | - | 29 | - | 36 | - | 2.4 |
| SUMMARY | 23,624 | 51,441 | 324 | 342 | 73 | 150 | 732 | 884 | 32 | 58 | Av. 2.6 | Av. 2.1 |

Of the twelve areas listed, char landings in the inner bays Okak, Tasiuyak, Webb, Tikkoatokak, Nain, Anaktalik, Voisey and Anton's are generally higher than along the outer islands. Contributions of salmon vary, depending on marine ice conditions throughout the summer and/or the general abundance of the species. Average catch values in these areas during 1974 (a "heavy" ice year) and 1975 (a "normal" year) were as follows:

| | <u>1974</u> | <u>1975</u> | |
|--------|-------------|-------------|--------------------------|
| Char | 247 | 234 | kg (G.H.0n) per man-week |
| Salmon | 23 | 131 | kg (G.H.0n) per man-week |

The bulk of salmon landings originate at Cutthroat, Kiglapaits, Black Island and Dog Island. The relative contributions, on a unit effort basis, of char and salmon in these areas is again related to the general availability of salmon:

| | <u>1974</u> | <u>1975</u> | |
|--------|-------------|-------------|--------------------------|
| Char | 91 | 31 | kg (G.H.0n) per man-week |
| Salmon | 86 | 153 | kg (G.H.0n) per man-week |

Catch/net-week. Catch per net-week is here defined as the weight of fish taken commercially in a 30-fathom gillnet over a 1-week period. Similarly, unit effort is expressed in terms of "net-weeks" fished.

Data are again treated according to location (Tables 5 and 6). In the eight areas previously listed as "char berths", the following estimates were obtained:

| | <u>1974</u> | <u>1975</u> | |
|--------|-------------|-------------|--------------------------|
| Char | 153 | 131 | kg (G.H.0n) per net-week |
| Salmon | 14 | 64 | kg (G.H.0n) per net-week |

Corresponding values in the four remaining areas, listed as "salmon berths", averaged as follows:

| | <u>1974</u> | <u>1975</u> | |
|--------|-------------|-------------|--------------------------|
| Char | 40 | 12 | kg (G.H.0n) per net-week |
| Salmon | 36 | 58 | kg (G.H.0n) per net-week |

Ageing

Age determinations from scales and otoliths of the same fish were found to agree in only 24.4% of the 209 comparisons made (Table 7). Of the remaining 158 samples where inconsistencies developed, scale readings averaged 1.5 years less (mean of differences) than those of the corresponding otolith pair. Overall findings agree with those of Gullestad (1974) who found that the first and/or second winter zones were commonly lacking in scales from Arctic char.

Table 7. Comparison of scale and otolith age determinations.

| Scale age | Number (N = 209) | Percentage |
|---------------------|---------------------|------------|
| Agreed with otolith | 51 | 24.4 |
| -1 otolith | 72 | 34.5 |
| -2 otolith | 52 | 24.9 |
| -3 otolith | 19 | 9.1 |
| -4 otolith | 5 | 2.4 |
| +1 otolith | 8 | 3.8 |
| +2 otolith | 2 | 0.9 |

While scale regeneration was evident in many cases, core interpretation and the denseness of outer annuli were felt to be the major problems of interpretation.

The proportion of otolith readings rejected as "unreliable" varied from one location to another. Otoliths from Nain and Voisey areas, for example, were more consistently readable than those originating in Okak where the incidence of "false" or "double" annuli (Fig. 7B) was high.

Certain morphometric characteristics of the char otolith, such as the distance of the first annulus from the core, the length and shape of the rostrum, the incidence of crystallization (Fig. 7D) and the occurrence of false annuli re-occur with some frequency in given samples. Although detailed analysis of such features would be required, variations in the physical appearance of char otoliths may be of use in stock segregation.

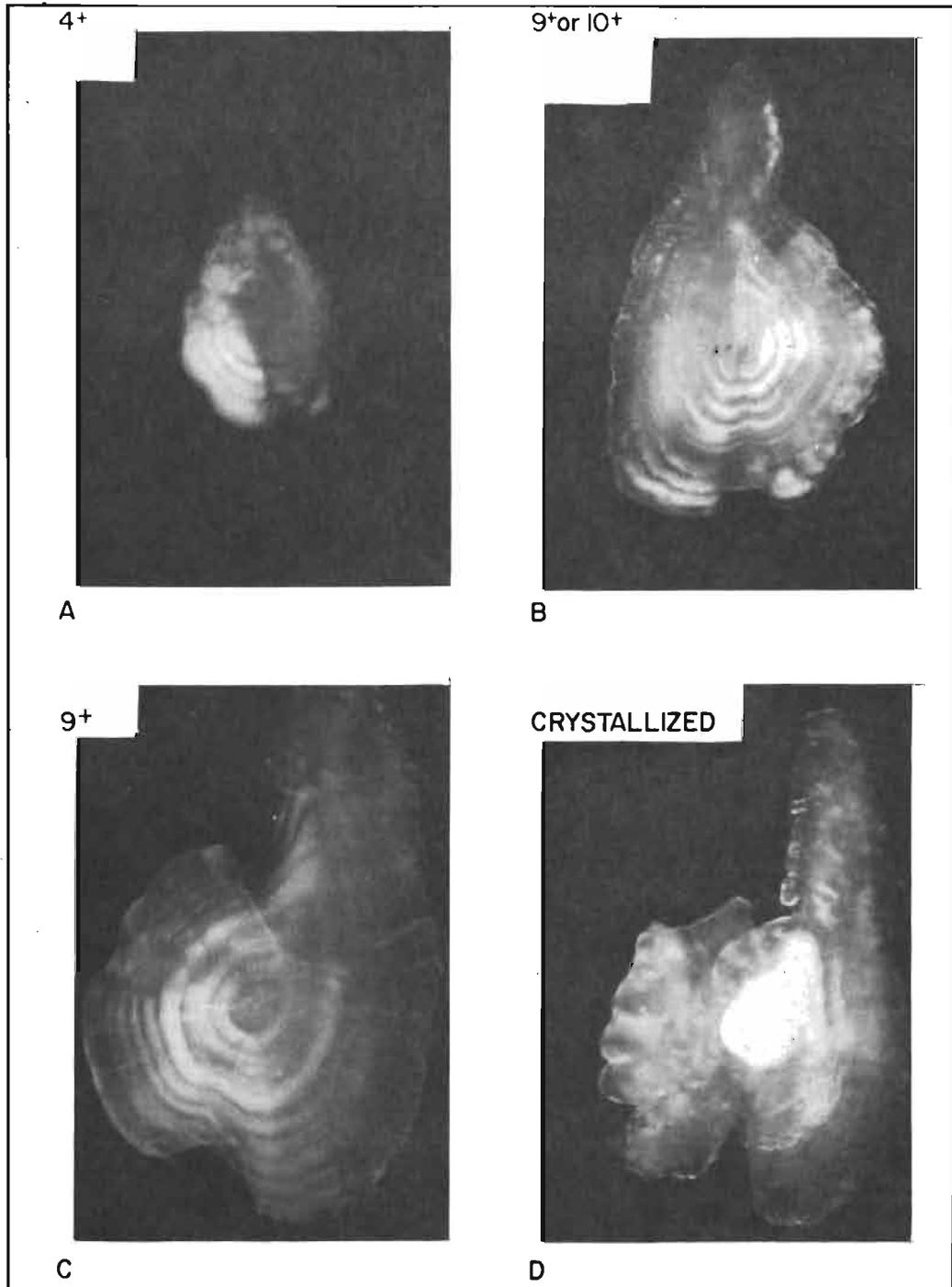
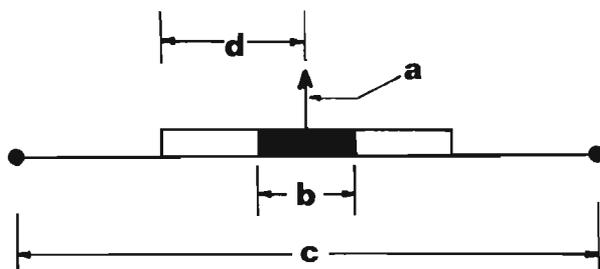


Fig. 7. Representative otoliths of Arctic char.

Age/length

Individual samples. The mean length of individual year-classes was determined for each of the nine locations sampled. The tabulated data appear as Appendix II and are represented graphically for visual comparison in Fig. 8. The method used is that of Hubbs and Hubbs (1953) where statistical parameters defining the mean are combined in "dice-grams" as follows:



- a) the sample mean is shown by the arrow indicating a location along the abscissa (variable studied);
- b) the shaded portion of the bar represents the confidence limits of the mean, i.e. $2 \times$ estimated standard error;
- c) the total range of variation for each age class is shown as a base horizontal line;
- d) the shaded bar plus the unshaded portion on either end indicates one sample standard deviation(s) on either side of the mean.

For those age classes represented by less than five samples, the mean value alone is shown.

Growth was exceedingly slow in all areas. The overlap of length ranges and confidence limits through successive year-classes is considerable.

Major fishing areas. Data from individual samples were combined according to fishing location, i.e. whether Voisey, Nain or Okak (Appendix III) and a comparison made of growth characteristics for each area. The data arrangements used and a summary of parameters describing the Bertalanffy growth equations obtained have been provided (Table 8).

Plotted Bertalanffy values agree closely with empirical data (Fig. 9). Extrapolation of curves above and below fitted values is less accurate than might have been obtained if younger and older age groupings had been more extensively sampled. Final estimates of t_0 , for example, are less reliable for Okak and Voisey samples than for the Nain area where larger numbers of younger fish had been taken.

k - the rate of approach to maximum length (L_∞) - is progressively lower in more northerly regions. This variation indicates real differences in growth rates which have been further substantiated by a comparison of instantaneous growth rates (Fig. 10). Covariance analysis of these plots revealed significant differences at the .01 level ($P = .002$).

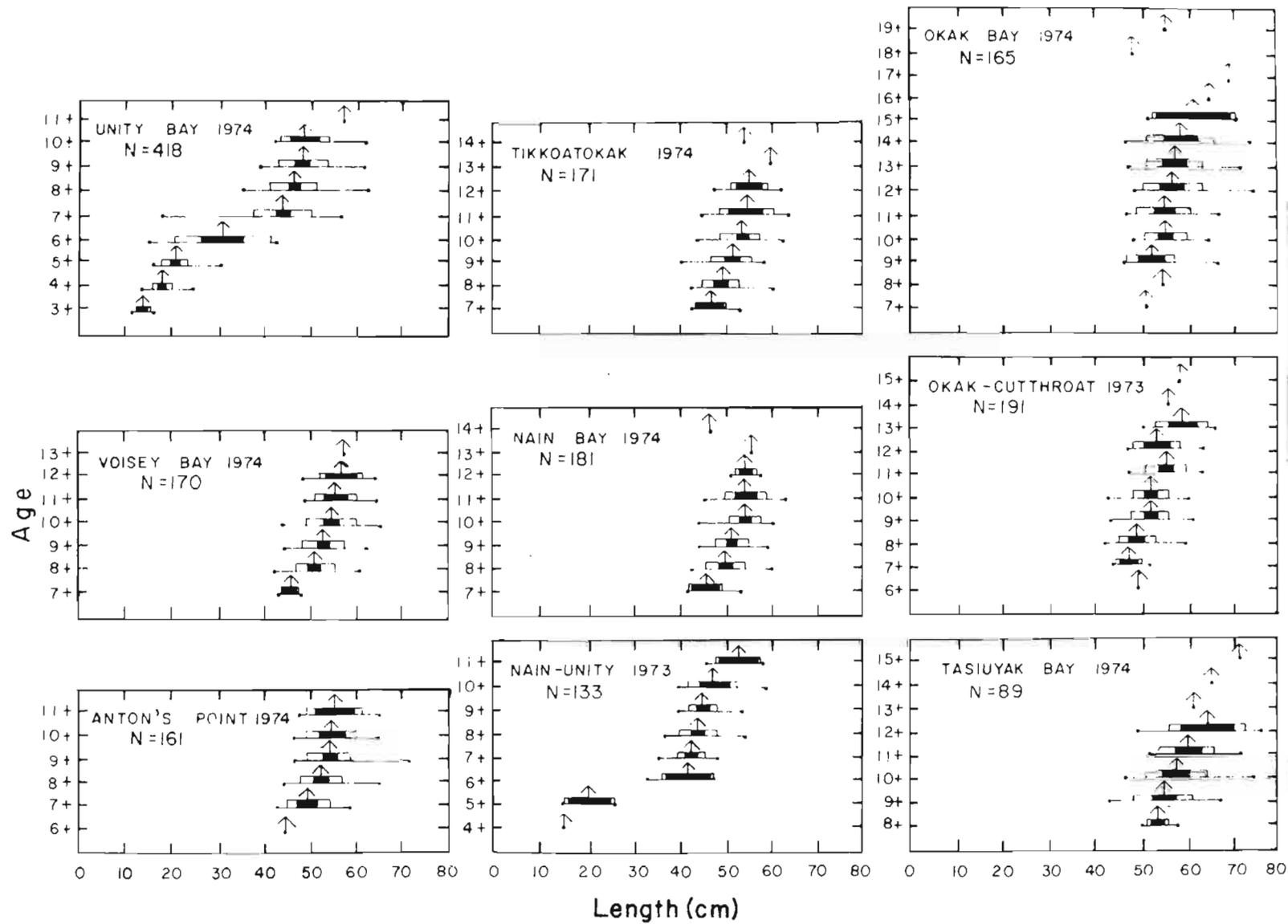


Fig. 8. Age and length characteristics of Arctic char at each of nine sample locations.

Table 8. Bertalanffy growth variables; major fishing areas.

| Okak Area (N = 445) | | includes samples: Okak-Cutthroat, 1973 Okak Bay, 1974 Tasiuyak, 1974 | | | |
|--------------------------|----------------|--|-------------------|-------------|-------------|
| Variable | Final estimate | Standard error | Confidence limits | | |
| | | | 1.96 x S.E. | Lower limit | Upper limit |
| k | 0.158 | ± 0.078 | 0.153 | 0.005 | 0.311 |
| t ₀ | -1.6 | ± 3.4 | 6.7 | -8.3 | 5.1 |
| L _∞ | 65.5 | ± 4.8 | 9.4 | 56.1 | 74.9 |
| Nain Area (N = 903) | | includes samples: Nain-Unity, 1973 Nain Bay, 1974 Tikkoatokak, 1974 Unity Bay, 1974 | | | |
| k | 0.270 | ± 0.018 | 0.035 | 0.235 | 0.305 |
| t ₀ | 2.6 | ± 0.1 | 0.2 | 2.4 | 2.8 |
| L _∞ | 61.1 | ± 1.4 | 2.7 | 58.4 | 63.8 |
| Voisey Area (N = 331) | | includes samples: Voisey Bay, 1974 Anton's Point, 1974 | | | |
| k | 0.320 | ± 0.162 | 0.318 | 0.002 | 0.638 |
| t ₀ | 1.5 | ± 2.2 | 4.3 | -2.8 | 5.8 |
| L _∞ | 59.6 | ± 2.9 | 5.7 | 53.9 | 65.3 |

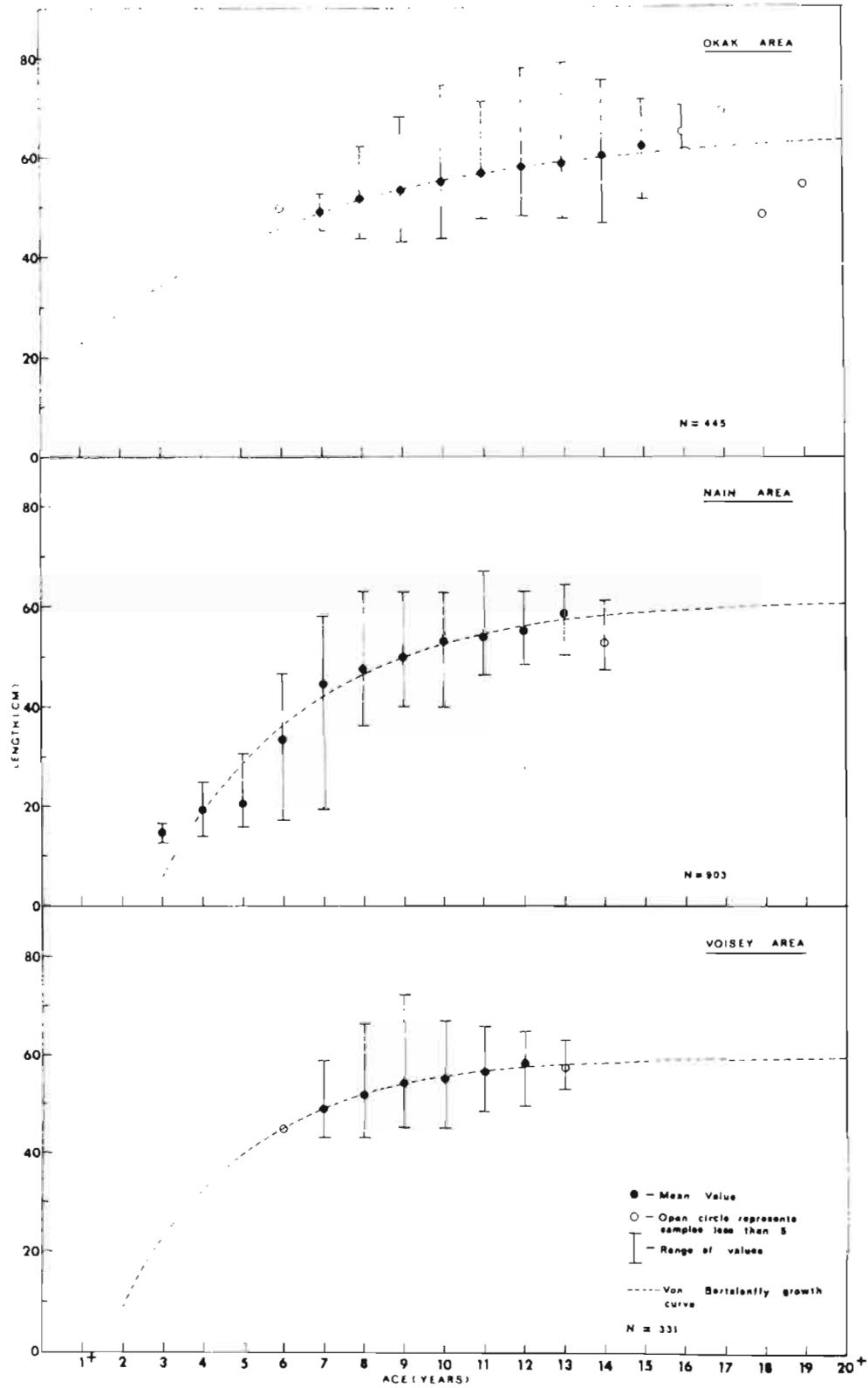


Fig. 9. Age and length characteristics of Arctic char in major fishing areas.

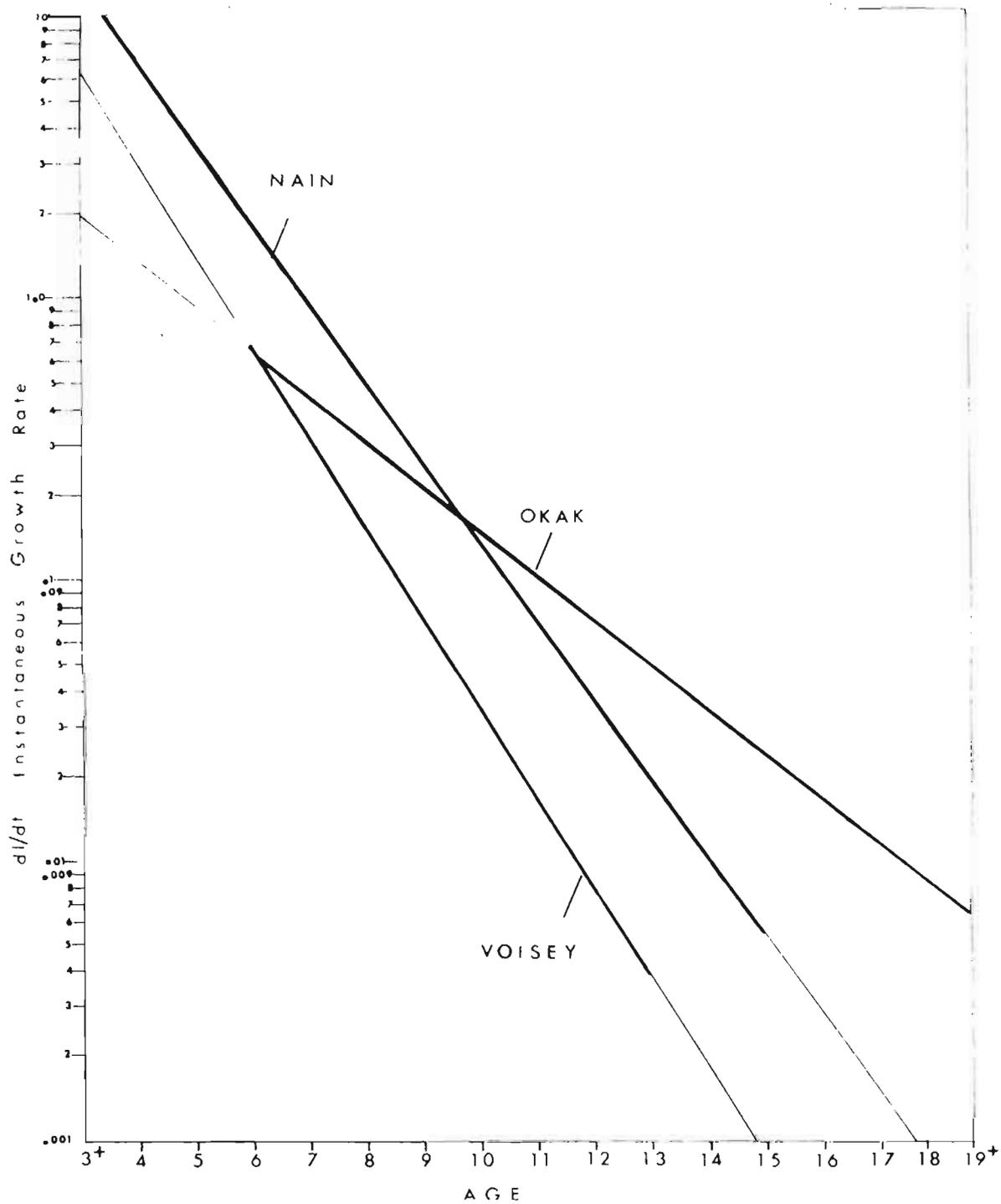


Fig. 10. Comparison of instantaneous growth rates in major fishing areas (fitted values darkened).

Combined data. Age and length data from all study areas were combined to provide a general representation of growth features for that section of the northern Labrador coast currently exploited by Nain fishermen (Appendix IV).

Char as young as 3+ were found at sea. The overall sample, representing fish 3+ to 19+ in age, ranged in length from 12.8 to 79.0 cm (Fig. 11).

Growth proceeds at markedly different rates with age. In younger year-classes, up to the age of seven, annual length increments averaged 7.7 cm; between the ages of 7+ and 12+, 2.5 cm; and for fish aged 12+ to 16+, 1.9 cm.

Small-sized fish (14-22 cm) were evident in all year-classes up to the age of 7+ (Fig. 11). On the assumption that growth proceeds rapidly during the first year at sea, these smaller fish are likely migrating to sea for the first time.

The observed Von Bertalanffy growth curve agrees closely with mean length at age data. Confidence limits pertaining to variables used in the calculation are listed in Table 9.

Table 9. Bertalanffy growth variables; combined data.

| Variable | Final estimate | Standard error | Confidence limits | | |
|----------------|----------------|----------------|-------------------|-------------|-------------|
| | | | 1.96 x S.E. | Lower limit | Upper limit |
| k | 0.285 | ± 0.012 | 0.023 | 0.262 | 0.308 |
| t ₀ | 2.7 | ± 0.1 | 0.2 | 2.5 | 2.9 |
| L _∞ | 62.2 | ± 0.7 | 1.4 | 60.8 | 63.6 |

Growth comparisons with other areas. Variations in the growth rate of anadromous Arctic char throughout different parts of its range have been well documented.

Growth data from several North American studies were compiled for comparison with Labrador stocks (Table 10). Char sampled at Frobisher Bay were slowest growing of the fourteen areas reviewed (Fig. 12). Southern Labrador, along with Ungava and Hudson Bay stocks were among the fastest growing. A marked

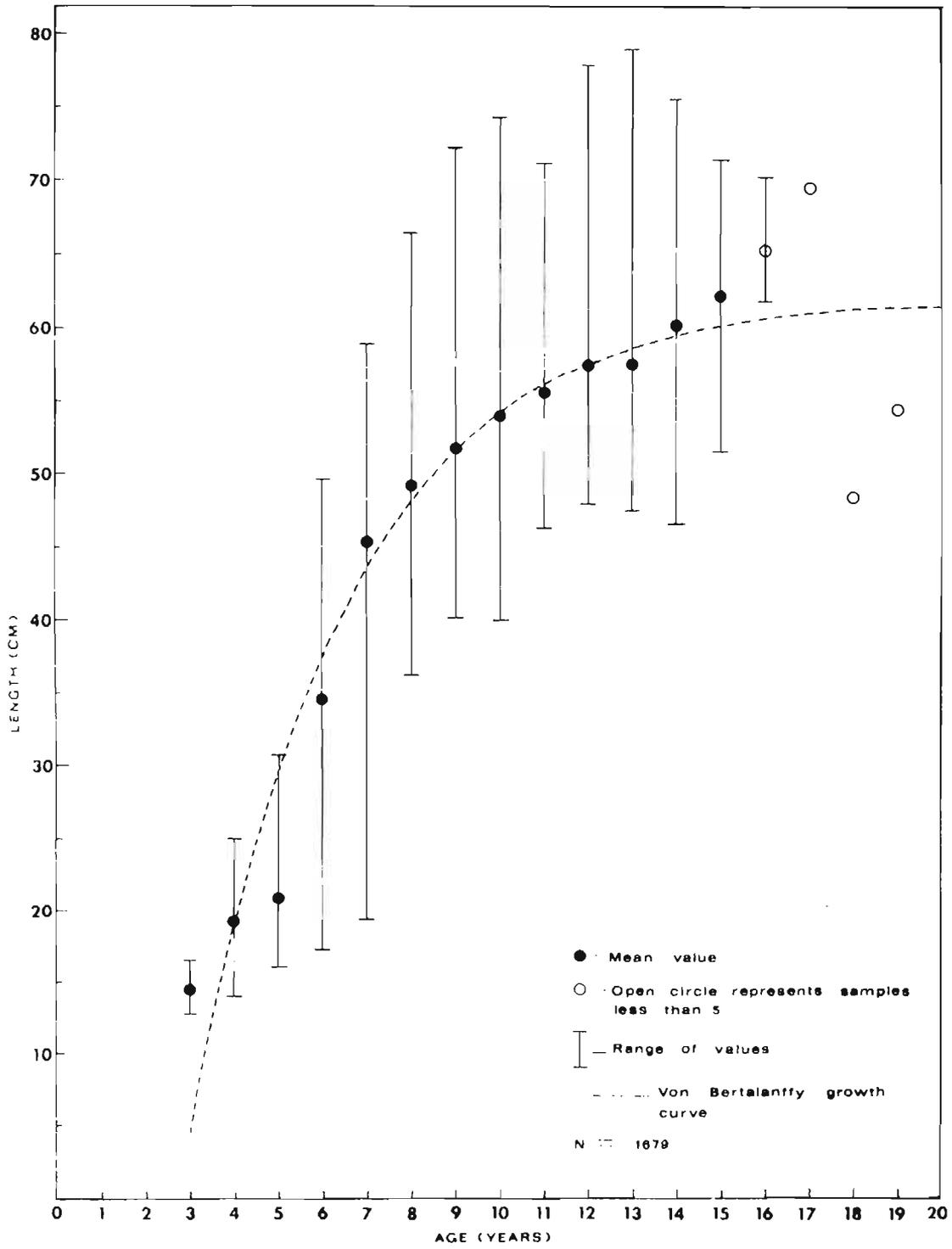


Fig. 11. Combined growth data from all areas sampled, 1973 and 1974.

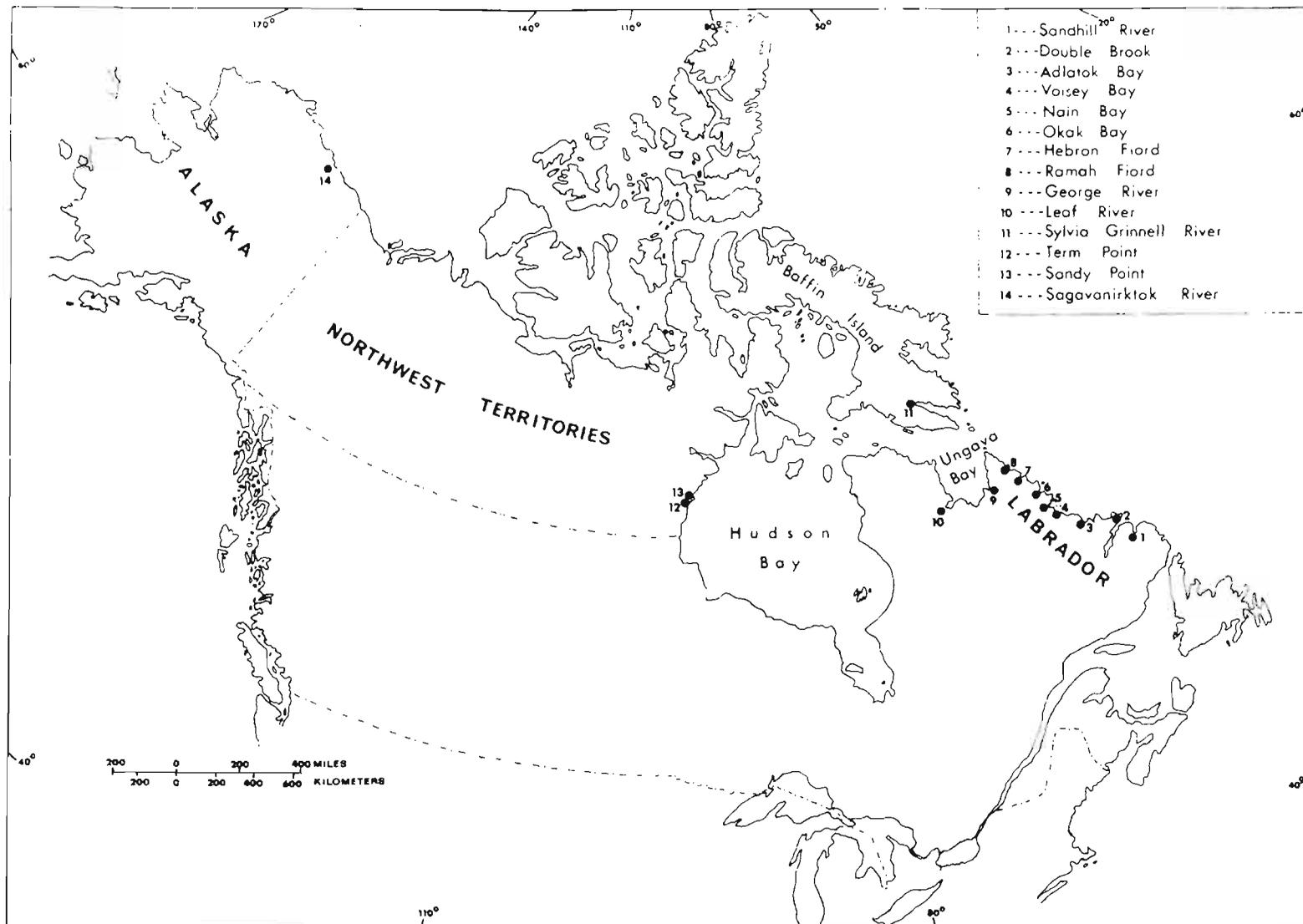


Fig. 12. Growth in Arctic char; a comparison of fourteen areas.

Table 10. Representative growth data from nine studies of anadromous Arctic char. Subscripts represent sample size.

| Age | Length | | | | | | | | | | | | | | | | | |
|-------------|-----------------------|---------------------|----------------------|---------------------|--------------------|---------------------|--------------------|--------------------|---------------------|---------------------|-------------------------------|-----------------------------|----------------------------------|------------------------------|------------------------------|-----------------------------|-------------------|-------------------|
| | Labrador | | | | | | | | | | Northwest Territories | | | | Alaska | | | |
| | Sandhill ¹ | Double ² | Adlatok ³ | Voisey ⁴ | Nain ⁵ | Nain ⁶ | Okak ⁷ | Okak ⁸ | Hebron ⁹ | Ramah ¹⁰ | George ¹¹ River | Leaf ¹² River | Sylvia ¹³ Grinnell | Term ¹⁴ Point* | Sandy ¹⁵ Point | Sagavanirktok ¹⁶ | | |
| 3+ | 23.8 ₇ | 23.2 ₂₈ | | | | 14.5 ₈ | | | | | | 19.6 ₂₃ | | | | | | |
| 4+ | 24.8 ₁₇ | 32.7 ₂₇ | | | | 19.3 ₄₄ | | | | | | 27.0 ₆₆ | 9.0 ₃ | 31.8 ₁ | | | | |
| 5+ | 31.6 ₂₂ | 36.9 ₃₈ | 44.5 ₁ | | | 20.7 ₃₉ | | | | | | 31.0 ₆₈ | 13.0 ₁₈ | 38.1 ₃ | | | | |
| 6+ | 46.6 ₁₄ | 45.4 ₄₃ | 48.2 ₆ | 44.9 ₁ | 39.8 ₃ | 33.6 ₂₉ | | 49.7 ₁ | | | | 42.7 ₄₈ | 13.9 ₇ | 40.8 ₃ | 50.1 ₅ | 47.3 ₂ | | |
| 7+ | 50.2 ₁₀ | 51.1 ₃₁ | 49.9 ₂₃ | 49.3 ₂₇ | 44.9 ₁₇ | 44.1 ₁₃₂ | 41.8 ₃ | 48.6 ₈ | 47.0 ₁ | 41.2 ₄ | 47.3 ₃ | 45.3 ₂₁ | 17.2 ₇ | 44.5 ₇ | 56.4 ₁₅ | 46.9 ₁₃ | | |
| 8+ | 51.4 ₄ | 54.0 ₉ | 55.7 ₂₀ | 52.0 ₁₀₄ | 47.9 ₂₄ | 47.8 ₂₆₆ | 44.0 ₁₅ | 51.0 ₃₄ | 47.6 ₆ | 42.3 ₁₄ | 49.9 ₂₄ | 54.1 ₁₆ | 30.2 ₂₅ | 46.8 ₁₄ | 58.0 ₂₈ | 47.7 ₃₆ | | |
| 9+ | 51.5 ₂ | 54.5 ₃ | 57.0 ₉ | 54.2 ₁₀₈ | 49.7 ₃₂ | 50.0 ₂₀₇ | 45.4 ₃₁ | 53.2 ₈₈ | 48.7 ₁₉ | 44.2 ₁₇ | 51.2 ₃₃ | 60.9 ₄₁ | 33.7 ₆₈ | 49.4 ₂₀ | 62.7 ₁₈ | 52.2 ₈ | | |
| 10+ | 48.0 ₁ | 59.7 ₁ | 58.4 ₁₆ | 55.2 ₅₆ | 50.1 ₁₉ | 52.7 ₁₁₃ | 45.3 ₂₄ | 55.1 ₉₆ | 49.5 ₁₆ | 47.2 ₂₄ | 54.1 ₅₉ | 63.0 ₅₅ | 36.3 ₆₈ | 52.3 ₁₇ | 66.7 ₁₄ | 53.2 ₄ | | |
| 11+ | | | 62.6 ₇ | 56.7 ₂₃ | 50.6 ₉ | 54.0 ₃₇ | 45.0 ₂₅ | 56.4 ₉₅ | 50.6 ₈ | 47.8 ₁₇ | 57.9 ₉₂ | 67.0 ₄₇ | 41.4 ₇₃ | 56.5 ₁₆ | 68.2 ₇ | 56.9 ₈ | | |
| 12+ | | | 62.5 ₂ | 58.1 ₉ | 54.2 ₇ | 55.7 ₁₈ | 47.4 ₉ | 57.9 ₄₈ | 51.4 ₆ | 49.5 ₂₀ | 61.3 ₄₅ | 67.2 ₄₈ | 42.5 ₈₅ | 60.2 ₄ | 69.5 ₆ | 58.2 ₅ | | |
| 13+ | | | 65.6 ₂ | 57.4 ₃ | 54.2 ₁ | 58.3 ₇ | 48.2 ₁₀ | 58.5 ₃₉ | 51.5 ₁₁ | 50.3 ₆ | 65.2 ₁₉ | 69.5 ₃₆ | 48.5 ₉₆ | 63.7 ₃ | 73.3 ₂ | 56.9 ₂ | | |
| 14+ | | | | | | 52.9 ₃ | | | | 60.3 ₂₂ | 47.6 ₃ | 60.8 ₂ | 65.0 ₉ | 69.9 ₂₀ | 51.0 ₇₁ | 63.5 ₂ | 75.7 ₁ | 57.2 ₂ |
| 15+ | | | | | | | | | | 62.1 ₈ | | 57.1 ₅ | 73.8 ₃ | 70.0 ₁₄ | 55.3 ₄₈ | | | |
| 16+ | | | | | | | | 62.0 ₁ | 65.3 ₃ | | | 76.4 ₁ | | 67.8 ₁ | 55.7 ₃₈ | 68.0 ₁ | | |
| 17+ | | | | | | | | | 69.7 ₁ | | | | | 55.9 ₃₁ | 78.7 ₃ | | | |
| 18+ | | | | | | | | | 48.5 ₁ | | | | | 60.0 ₁₉ | 74.9 ₁ | | | |
| 19+ | | | | | | | | | 54.5 ₁ | | | | | 61.3 ₂₃ | | | | |
| Sample size | 77 | 180 | 86 | 331 | 112 | 903 | 118 | 445 | 70 | 110 | 287 | 504 | 680 | 95 | 96 | 80 | | |

*aged by scales, all others with otoliths

¹Peet, 1971

²Peet, 1971

³Andrews and Lear, 1956

⁴Coady and Best, 1976

⁵Andrews and Lear, 1956

⁶Coady and Best, 1976

⁷Andrews and Lear, 1956

⁸Coady and Best, 1976

⁹Andrews and Lear, 1956

¹⁰Andrews and Lear, 1956

¹¹LeJeune, 1967

¹²Lee, 1969

¹³Grainger, 1953

¹⁴Sprules, 1952

¹⁵Bond, 1974

¹⁶McCart, 1972

variation in growth rate exists between southern and northern Labrador coastal populations, the latter generally smaller at a given age. Char sampled during the present investigation in areas near Nain exhibit growth characteristics similar to those reported for the Sagavanirktok River in Alaska.

Evidence also exists of alterations in the growth rate of char in areas currently exploited by Nain fishermen. Mean length at age, as reported by Andrews and Lear (1956) for both Nain and Okak populations, has changed appreciably in the 20-year period between samplings.

Length/weight

The mathematical relationship between length and weight is commonly defined so that one may be converted to the other. Moreover, the proportion of length to weight expresses general fish "condition" and, where several areas have been sampled, comparisons may be made on this basis.

Round weights were available for very few char so that the relationships expressed are those of fork length and G.H.On (gutted, head on) weight, the commonly marketed form.

Data pertaining to each length/weight relationship described below have been provided in Appendices II through to IV. Predictive, rather than functional, regressions have been employed to allow for covariance comparisons of major fishing areas (Ricker, 1973).

The following relationships were defined:

- (i) Fig. 13; Arithmetic and full logarithmic plots of combined data from all samples. Fitted points agree closely ($r = 0.98$) with raw empirical data.
- (ii) Fig. 14; Information was sorted on the basis of major fishing areas, i.e. Okak, Nain and Voisey. Covariance analysis revealed significant differences among areas in both slope and intercept ($P < .001$).
- (iii) Fig. 15; Length/weight characteristics are presented for each of nine separate sample locations. Significant variations are obvious even within major fishing areas.

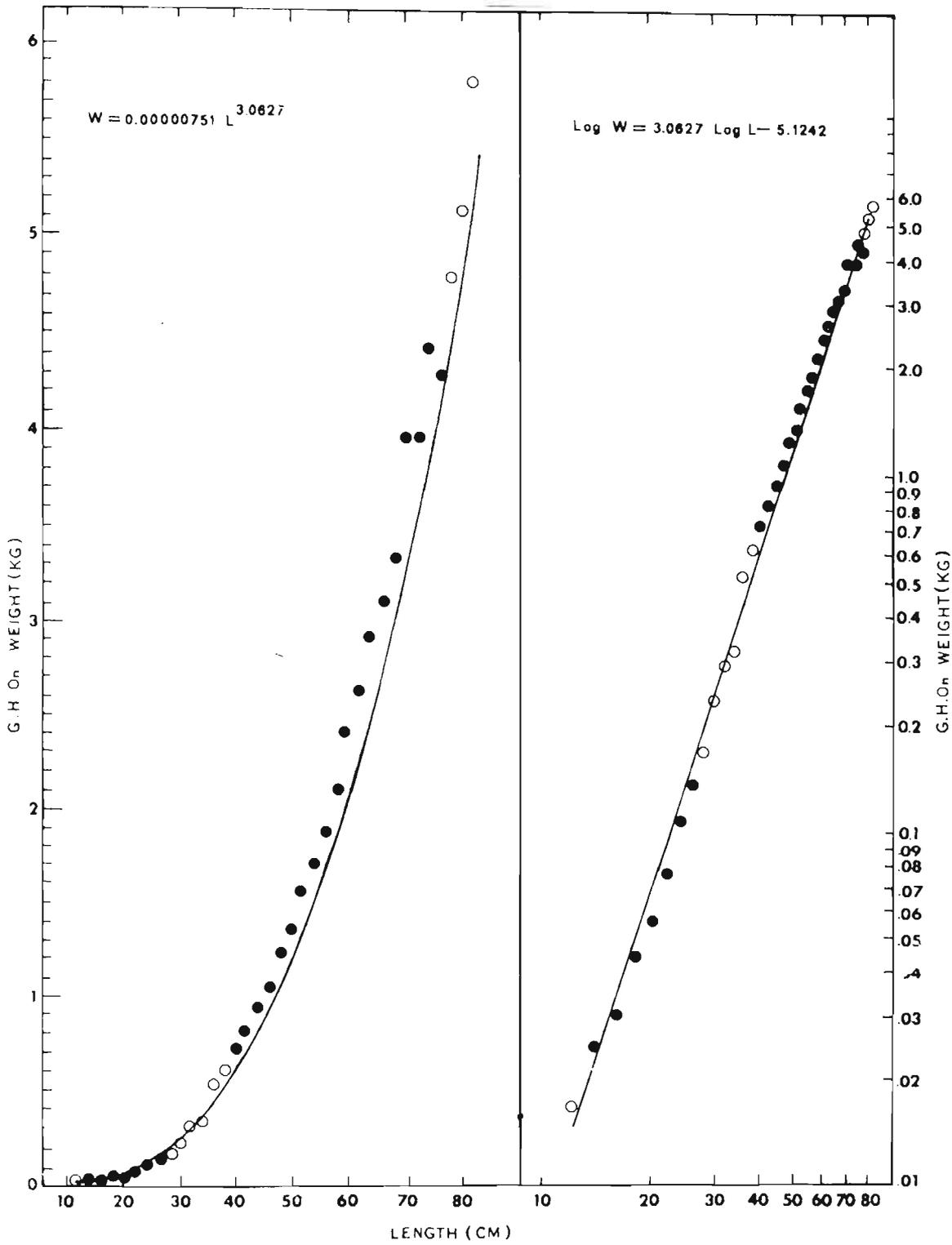


Fig. 13. Length/G.H.On weight relationship; combined data.

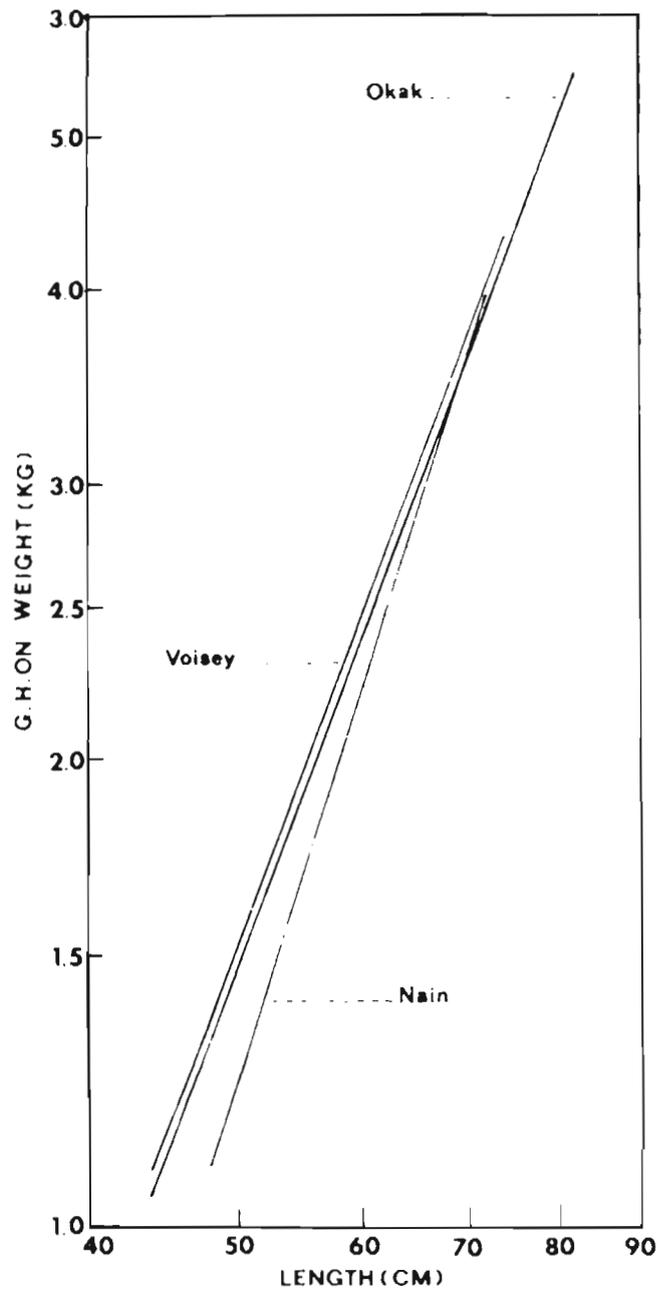


Fig. 14. Length/G.H.On weight relationships; major fishing areas.

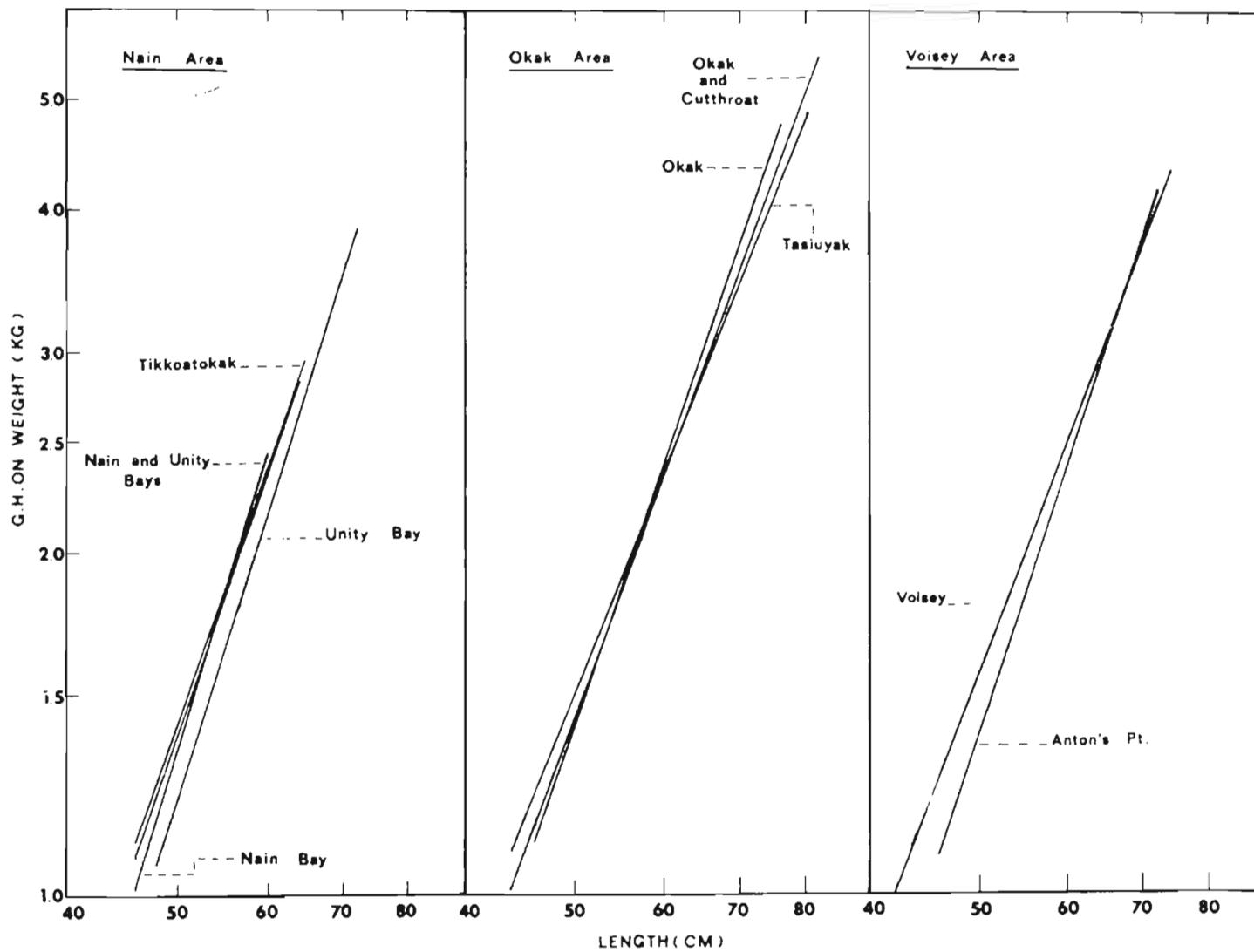


Fig. 15. Length/G.H.On weight relationships; individual samples.

Round/dressed weight

Since 1970, char have been marketed from the Nain processing plant in the gutted, head on (G.H.On) condition. Steps were taken to define the relationship between this and the round or whole weight condition (Fig. 16).

Comparisons were carried out for a total of 332 commercial-sized fish (Appendix V). All samples originated in Nain Bay.

Predictive regressions of round and dressed weight vary, depending on which values are placed along the X and Y axis, so that a reciprocal relationship of the central trend between both is more useful (Ricker, 1973). Such regressions are termed "functional".

The overall relationship may be defined as follows:

$$Y = -0.0323 + 1.2150 X$$

where Y = round, fresh weight (kg) and X = dressed, G.H.On weight (kg).

Males and females

Due to the difficulty of obtaining ungutted char from outlying fish camps, growth and other comparisons of male and female char were available for the Nain Bay area only.

Sex ratio. Of the 600 Arctic char sexed during 1973 and 1974, 272 (45.3%) were male and 328 (54.7%) female. Year-classes 4+ to 11+ were represented in the sample. No differences were apparent in sex ratios on an age-specific basis.

Maturation. Maturation of the male and female gonad while the fish is at sea is not highly progressive. Gonads sampled were invariably small, undifferentiated and poorly developed. In each case, no prediction could be made of char destined to spawn in the year of capture.

Age/length. Although the range of year-classes identifiable as to sex (4+ to 11+) was limited, Von Bertalanffy growth convergences were obtained for both sexes (Fig. 17, Table 11).

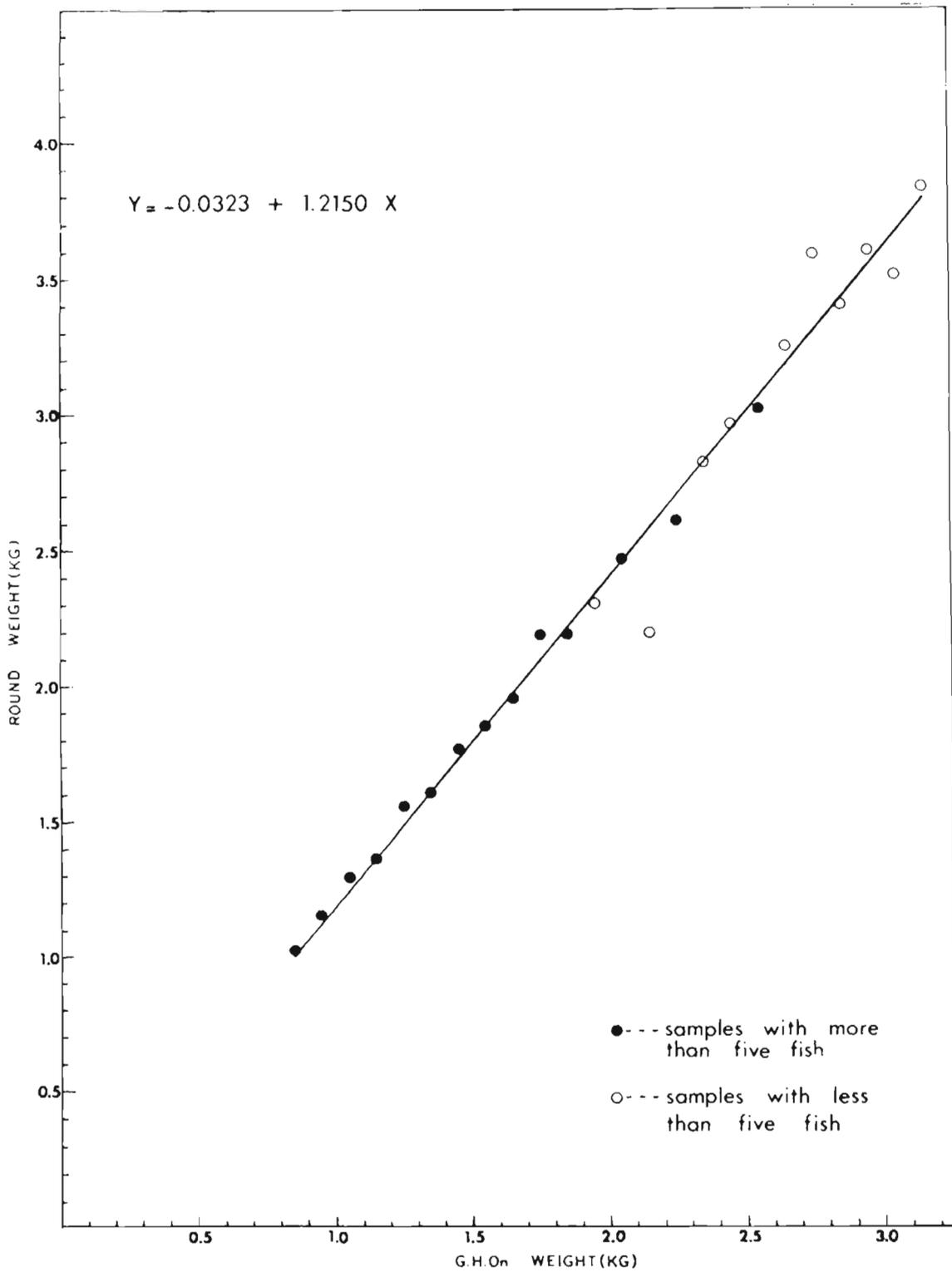


Fig. 16. Round/dressed weight relationship in Arctic char sampled at Nain Bay.

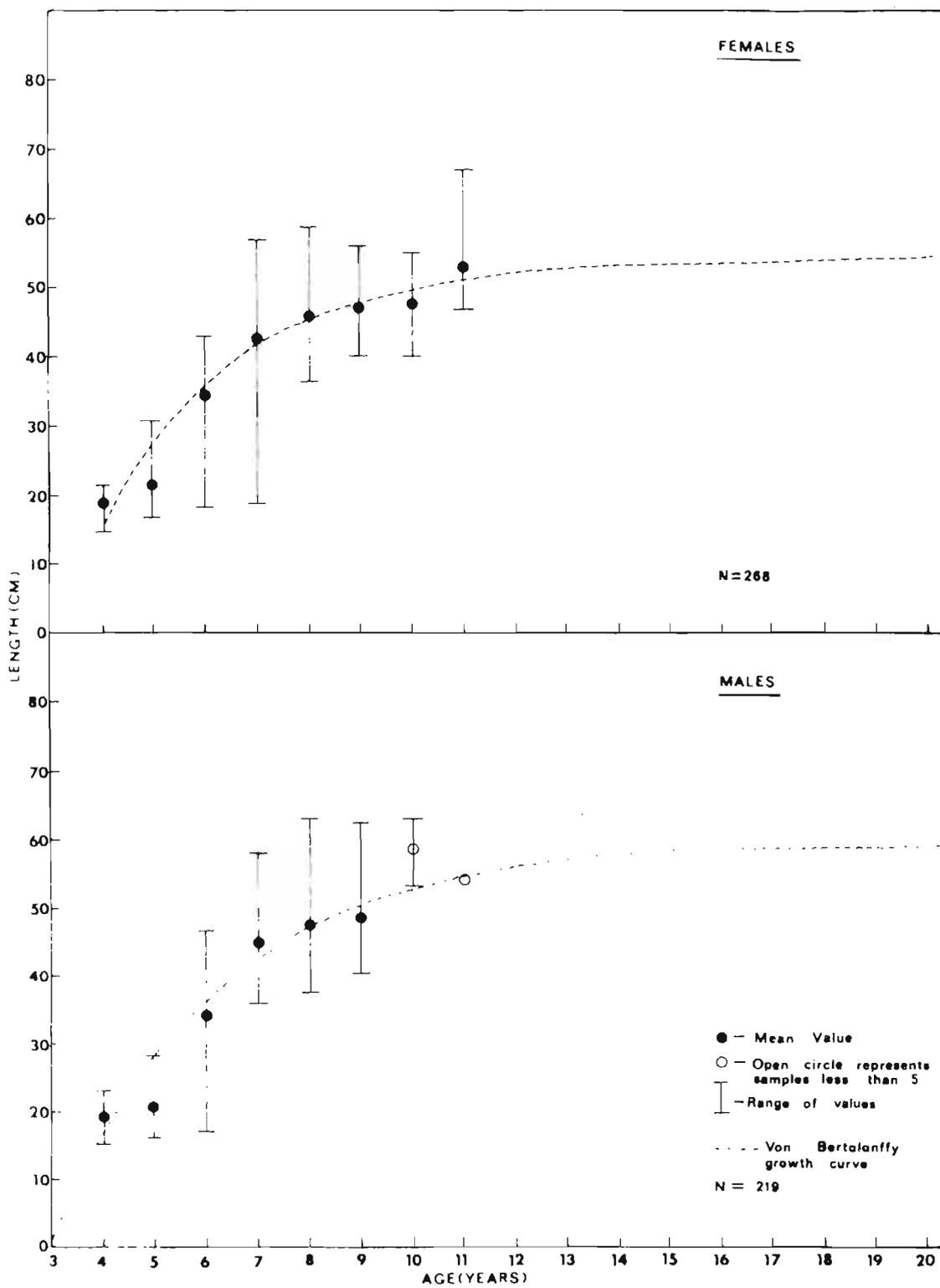


Fig. 17. Comparison of age and length characteristics in male and female Arctic char.

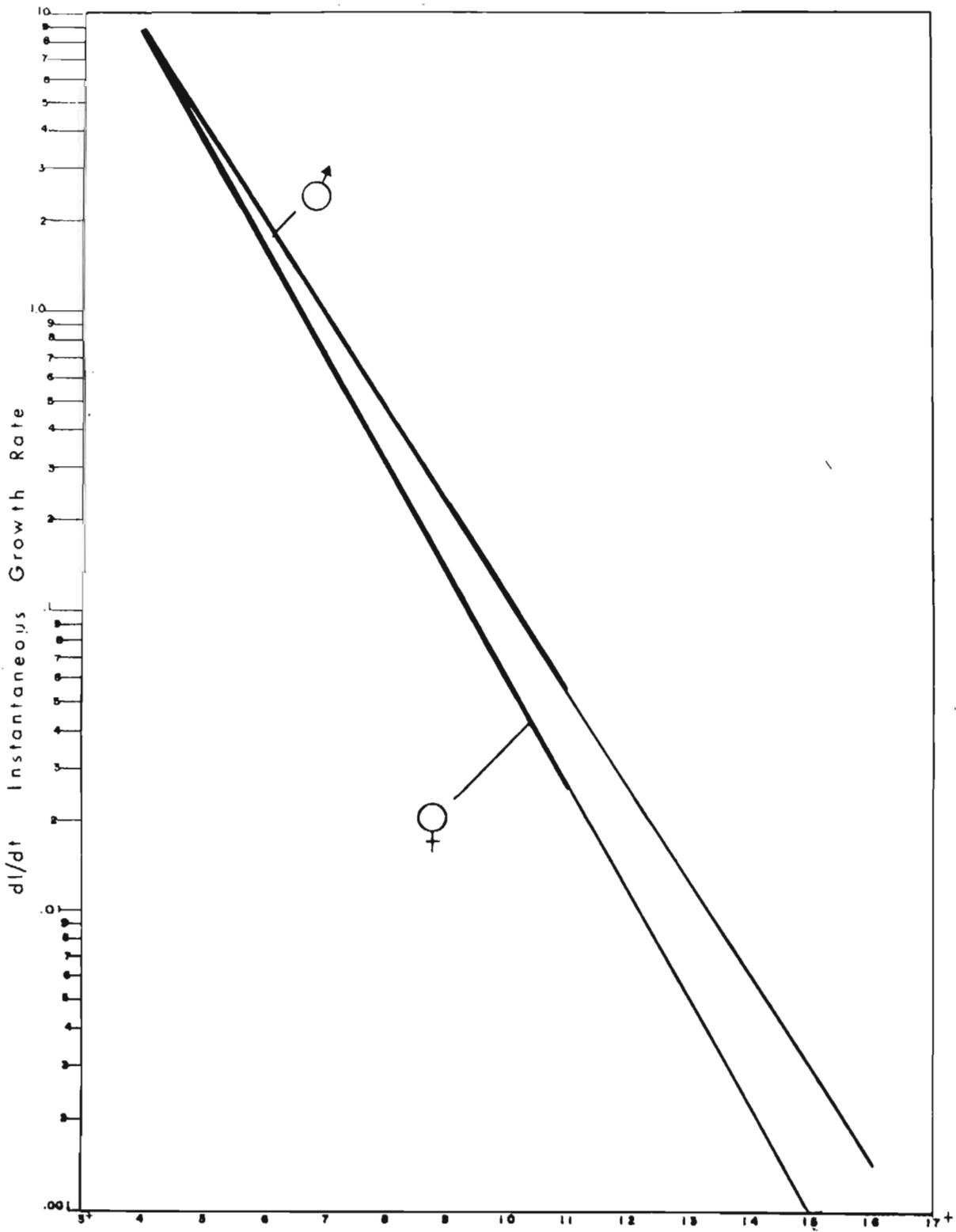


Fig. 18. Comparison of instantaneous growth rates in male and female Arctic char (fitted values darkened).

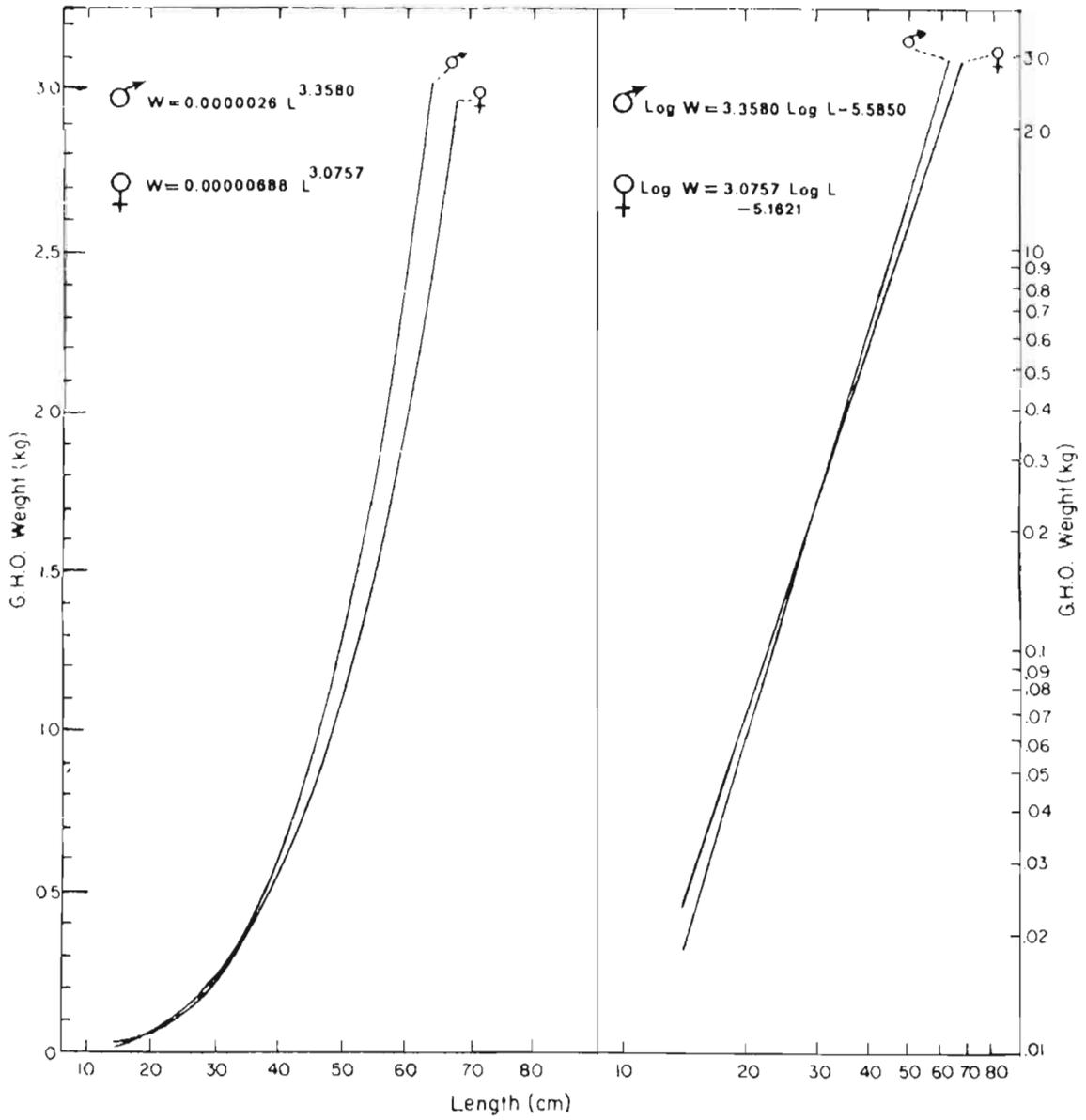


Fig. 19. Comparison of length/G.H.O. weight relationships in male and female Arctic char.

Table 11. Bertalanffy growth variables for male and female Arctic char.

| | Variable | Final estimate | Standard error | Confidence limits | | |
|--------|----------------|----------------|----------------|-------------------|-------------|-------------|
| | | | | 1.96 x S.E. | Lower limit | Upper limit |
| Male | k | 0.315 | ± 0.062 | 0.122 | 0.193 | 0.437 |
| | t ₀ | 2.9 | ± 0.2 | 0.4 | 2.5 | 3.3 |
| | L | 59.4 | ± 3.9 | 7.6 | 51.8 | 67.0 |
| Female | k | 0.359 | ± 0.050 | 0.098 | 0.261 | 0.457 |
| | t ₀ | 3.0 | ± 0.2 | 0.4 | 2.6 | 3.4 |
| | L | 54.3 | ± 2.2 | 4.3 | 50.0 | 58.6 |

Modification of the Bertalanffy equations to yield instantaneous growth rate relationships (Fig. 18) enabled covariance testing between sexes. No significant differences were found in either slope ($F = 0.36$) or intercept ($F = 0.05$).

Length/weight. Covariance testing of the regression of G.H. On weight on length for male and female Arctic char (Fig. 19) revealed highly significant differences ($P < 0.001$) between sexes.

In fish of commercial size (i.e. > 1 kg) males were found to be proportionately larger than females of a similar length.

Catch curves

Estimates of annual (a) and total (z) mortality rates as derived from "catch curves" are presented in Fig. 20-22 for Okak, Nain and Voisey areas respectively.

Annual mortality estimates, representing combined natural and commercial mortalities, were high, ranging from 44 to 59%.

Commercial landings were predominantly of fish 7+ to 11+ in age with generally younger fish removed in the Nain area fishery.

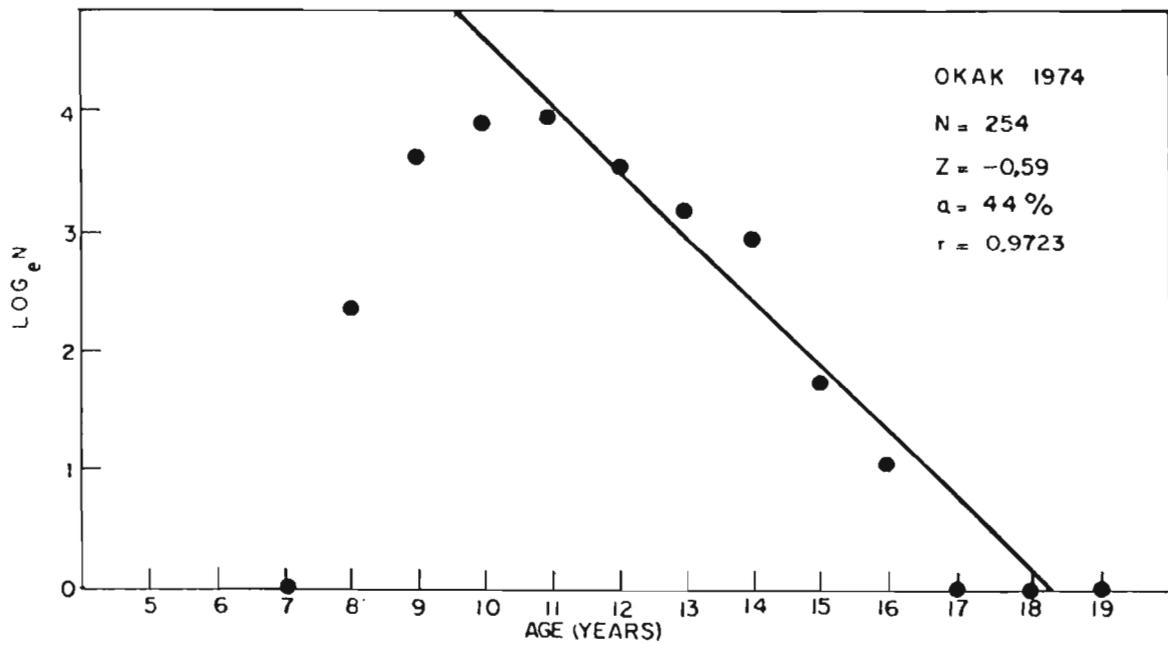
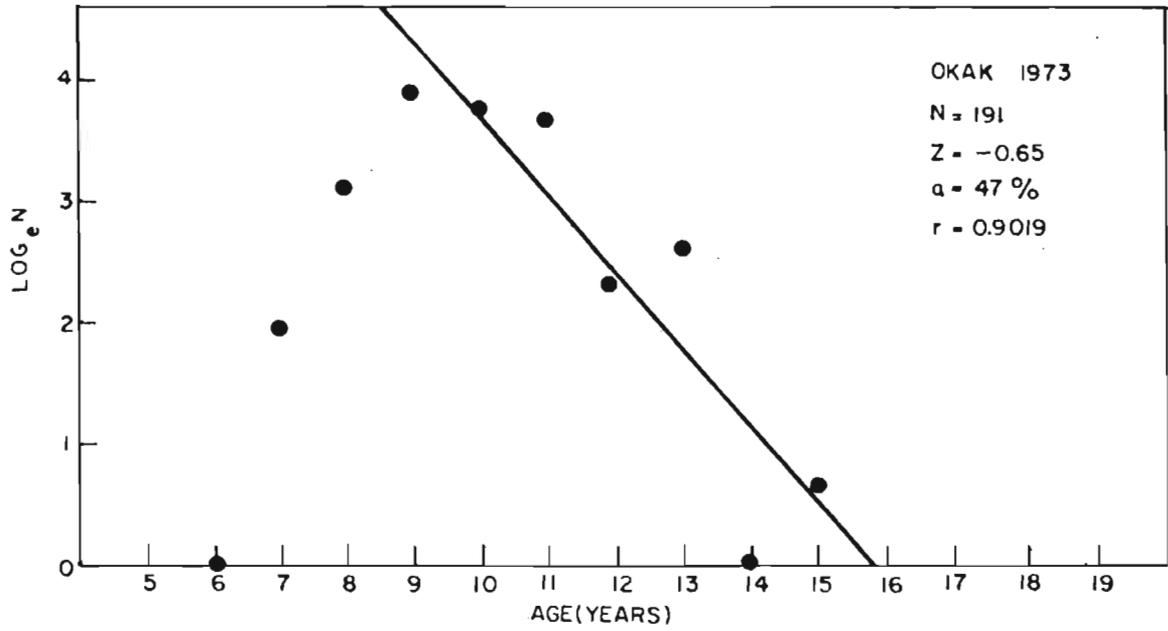


Fig. 20. Catch curves; Okak area; 1973-74.

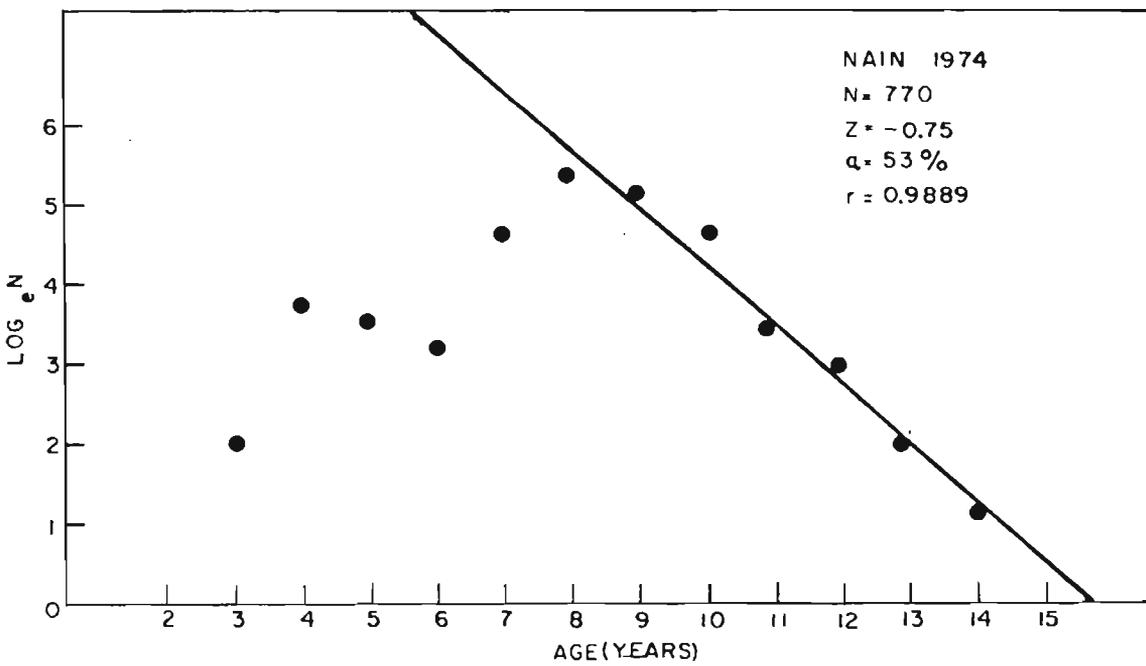
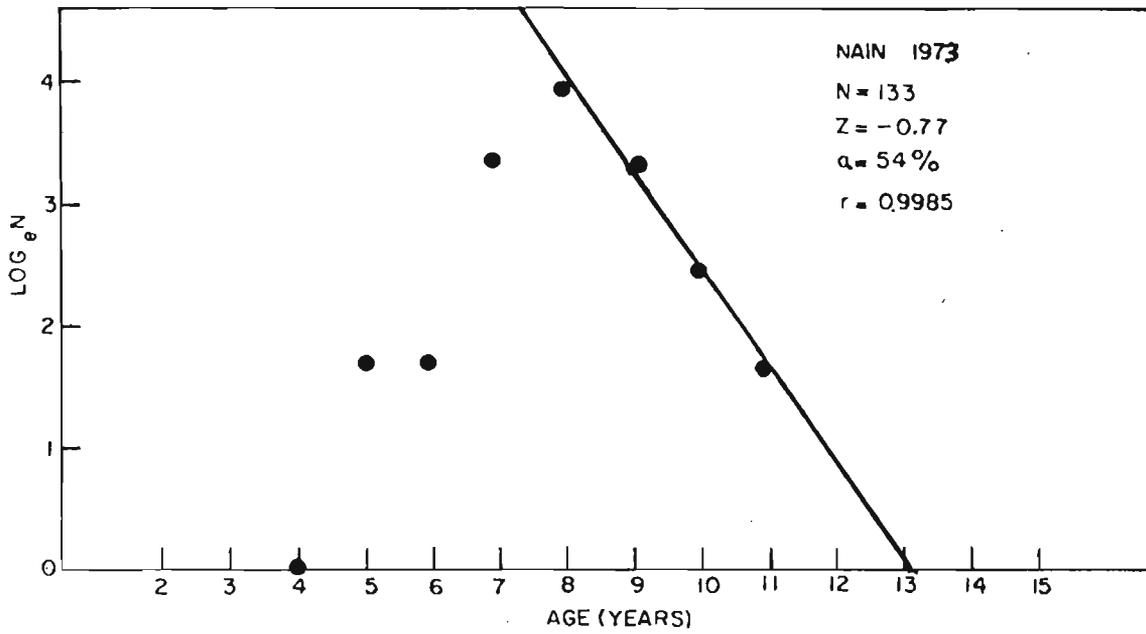


Fig. 21. Catch curves; Nain area; 1973-74.

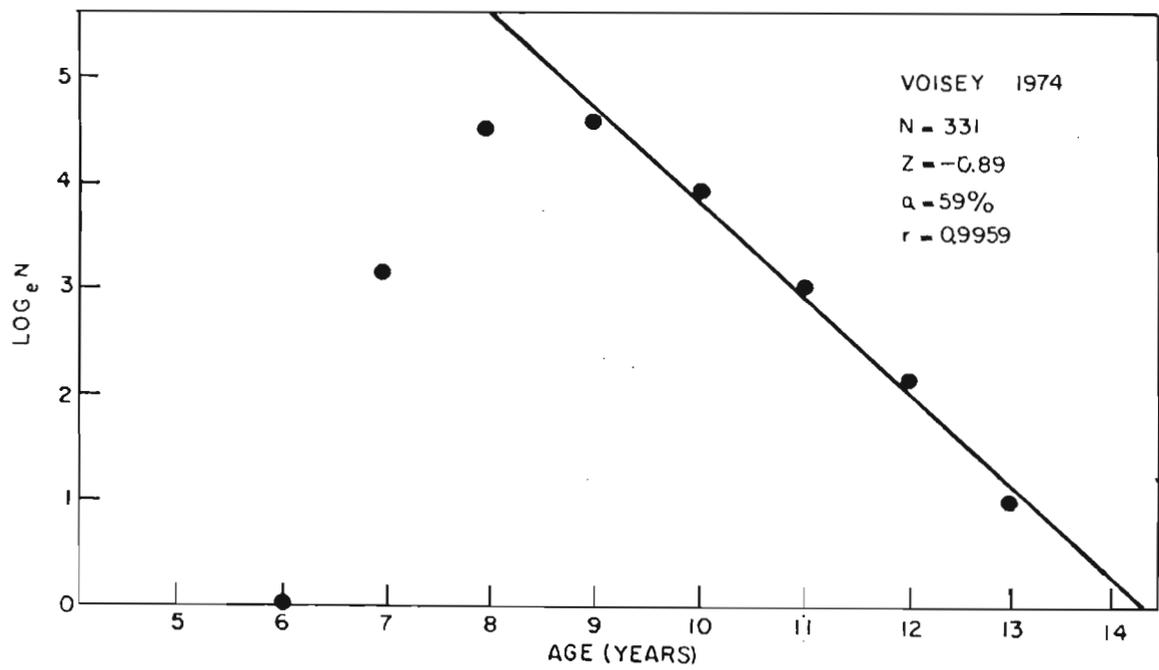


Fig. 22. Catch curve; Voisey area; 1974.

Upstream migration

1975 marked the first attempt in which the upstream movements of Arctic char were monitored on a northern Labrador river.

A full appraisal of the counting fence operation on the Fraser River will be prepared at a later date. For now, preliminary findings of the timing, size distribution and reproductive condition of upstream migrants will be considered.

Timing. As fence materials did not arrive at Main until mid-July, the early portion of the upstream run was missed in 1975.

Counts were made on the first full day of operation (July 28) with runs continuing until early September when daily counts declined. A total of 4058 char had passed through the fence when it was disassembled on September 7.

Numbers of char fluctuated daily with peak runs coinciding with spring tide conditions at the river's mouth (Fig. 23A).

Size distribution. The average fork length of fish moving upstream decreased steadily as the season progressed (Fig. 23B). This trend became even more evident during early September as the numbers of very small-sized juveniles increased dramatically. Prior to this late-season run, few juvenile char had been taken at the fence.

Reproductive condition. Seventy sex determinations were made from adult char sacrificed at different times during the upstream run. Females accounted for 49% of the total and males 51%. No evidence was obtained of males and females entering the system independently.

No single incidence was recorded of a "ripe" or "mature" gonad in any of the adults sampled. The reproductive condition of char taken at the fence site was identical to that of char taken commercially in the marine environment.

DISCUSSION

A major limiting factor in promoting desired growth and expansion of the Main char fishery has been the lack of background information on the biological nature of Labrador char stocks. Insufficient management experience has been accumulated with the species to provide an adequate basis for regulation. Current investigations have centered on filling these gaps.

Equal attention has been given to the fishery itself. Effective utilization of the resource requires co-ordinated use of fishing grounds as a basis of conservation and balanced development.

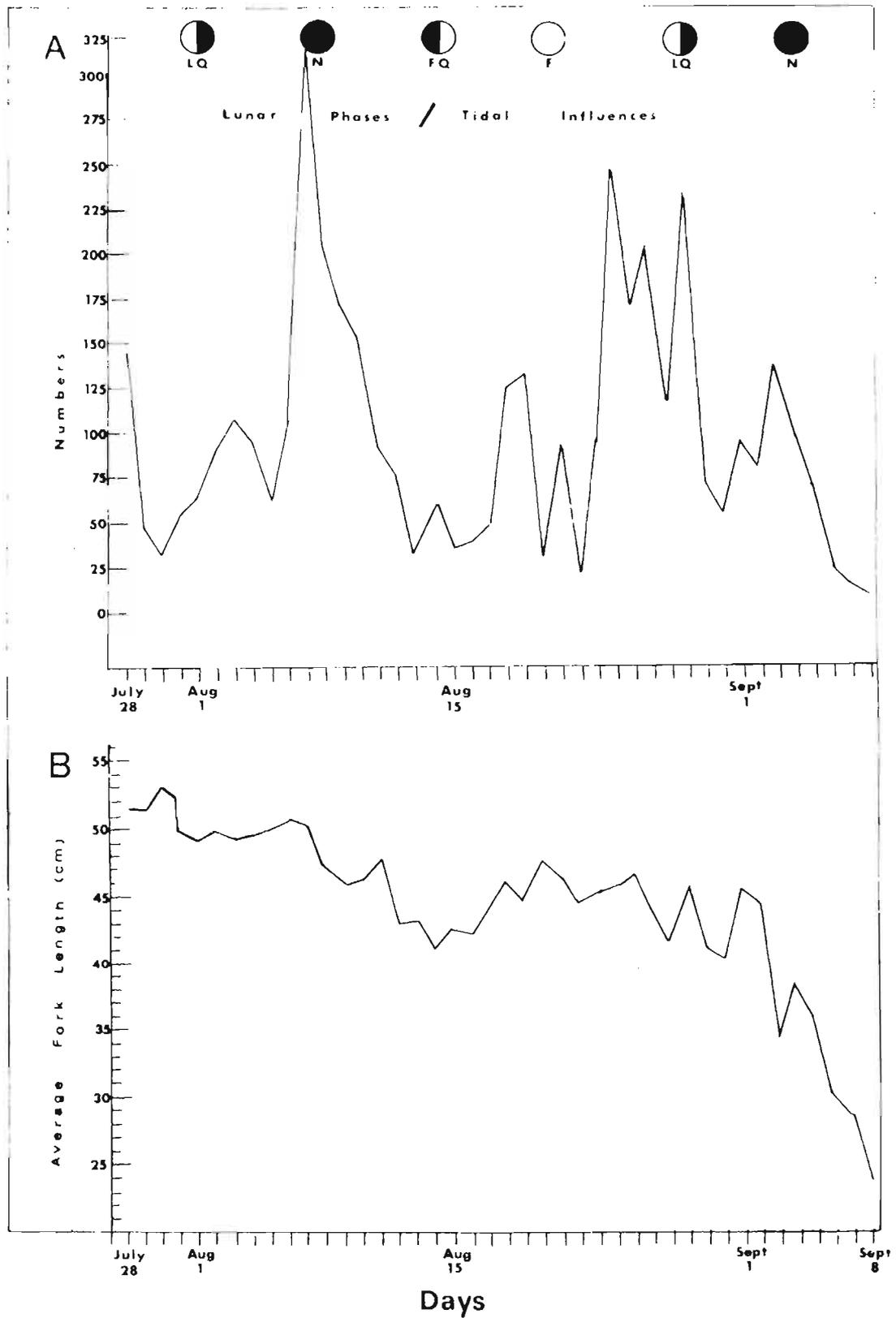


Fig. 23. Number (A) and size (B) of upstream migrant Arctic char, Fraser River, 1975.

Biological aspects

Aspects of the life history, taxonomy and general biology of Arctic char have been examined in the Northwest Territories (Sprules, 1952; Grainger, 1953; Thompson, 1957; McPhail, 1961; Lee, 1969; Hunter, 1970).

Few studies have been made of the species in northern Labrador. Andrews and Lear (1956) examined morphological and meristic variation in fish taken commercially along the coast and covered aspects of feeding and parasitism. Coady (1974) provided a general overview of the operation and status of the fishery.

Overwintering of Arctic char at sea is unknown. DeVries (1971), in a consideration of freezing resistance in marine fishes, feels that char avoid freezing by migrating to freshwater streams and lakes where winter temperatures are always well above the freezing point of body fluids.

Details as to the timing of the downstream migration of Arctic char from Labrador rivers are lacking. Residents of Nain report the appearance of "slink" char in areas of open ice near the mouths of rivers as early as mid-May. Whether larger char are the first downstream as indicated by Grainger (1953) on Baffin Island is still uncertain.

Scott and Crossman (1973) report that char move out of the rivers and downstream to the sea when 15-20 cm in length. In Nain Bay, char as young as 3+ and varying in length from 12 to 17 cm were found at sea. Small-sized fish varying from 14 to 22 cm and presumably migrating to sea for the first time were found with much larger individuals in all age groupings up to the age of 7+ (Fig. 11). Few small fish were evident in subsequent year-classes, implying that the majority of char have migrated to sea at least once by age 8+.

No evidence was found on the Fraser River, near Nain, of the completely non-anadromous form reported by McCart (1972) and others, for western Arctic and Bering Sea populations of char.

Younger char spend greater periods of time at sea during the summer months than older fish (Fig. 23B) which at least partially explains the more rapid growth evident during the first several seasons in the marine environment (Fig. 11). Commercial size is commonly reached by age 7+. Subsequently, growth rates slow with a considerable overlap of size ranges through older age groupings.

Distinct differences in the growth characteristics of char sampled at Okak, Nain and Voisey Bays (Fig. 9, 10 and 14) imply a somewhat minimal overlap among these stocks. L_{∞} estimates (i.e. theoretical maximum length) varied in each of the three fishing areas with k , the rate of approach to maximum length, progressively lower in more northern regions of the coast (Table 8). Latitudinal trends of this nature are clearly not the general rule throughout northern Canada where size increases variably slower or faster than in Labrador (Table 10).

The average size of landed char from areas currently exploited by Nain fishermen has declined drastically since 1970 (Table 2). Whether increased growth rates evident at Nain and Okak since 1956 (Table 10) represent a response to recently excessive levels of exploitation is not completely clear. Accelerated growth rates may be expected on the basis of lessened competition in depleted salmonid populations. Nevertheless, compensatory mechanisms such as lower ages at maturity, reduced survival rates and shorter life spans have been reported in similar circumstances (Healey, 1975).

While growth (length at age) was found to proceed at a similar rate in male and female char (Fig. 17), males tend to be proportionately larger at a given length (Fig. 19).

Few indications of advancing maturation were evident in male or female char while at sea. Gonads were invariably small and poorly developed. Of 600 sex determinations made from commercially caught fish in Nain Bay, the ratio of males to females for total numbers of each sex was 1:1.

Peet as well as Campbell (pers. comm.) feel that adult char are frequently non-migratory in the year of spawning. By contrast, early season aerial census trials of the Fraser River during 1974 and 1975 revealed a near total downstream run of char. Pritchard (1911) reported the system to be virtually devoid of char in early July, a point also noted by Sollows et al. (1954). Murphy and Porter (1974), in detailed helicopter surveys of watersheds north of Nain, further comment on the scarcity of adult char during early summer periods. Pritchard had further noted that fish schooling near the mouth of the river in early September were small in size, unintentionally alluding to the arrival of younger fish later in the season.

Char re-enter the Fraser River after periods at sea which, by available indications, rarely exceed 4 months. Upstream movements of char were recorded on the first day of fence operation (July 28). Undoubtedly, initial runs occur earlier. Now that fence materials are "on-site", it is anticipated that an earlier start and more complete evaluation can be made in 1976. In addition, a total of 303 adult upstream migrants were tagged on the Fraser River in 1975. Returns in the next few years will greatly aid in clarifying distances traveled, seasonal distribution and homing tendencies of char while at sea.

Peak upstream runs were found to coincide with spring tide conditions at the river mouth (Fig. 23A). As a rule, larger char enter the Fraser River earlier than smaller adults and juveniles (Fig. 23B). Commercial fishing activities at sea end around the beginning of September. Fence counts decreased shortly after this period with the total upstream run complete by mid-September.

In a netting survey of the Leaf River in Ungava Bay, Lee (1969) had found that the proportion of male to female char varied at different stages of the upstream run with females outnumbering males early in the season but ratios subsequently equalizing. On the Fraser River, the early portion of the run had been missed in 1975 but of the observed run, commencing in late July and lasting through to mid-September, sex ratios in upstream migrants remained equal.

The level of maturation in char passing upstream through the Fraser River fence differed little from the sea condition previously described and, similarly, provided little indication of whether the fish were destined to spawn that year.

Scott and Crossman (1973) state that "female char spawn every second or third year but seldom every year except in southern parts of its range". Whether northern Labrador runs are consecutive, alternate or irregular year spawners remains unclear. Gonad development, as noted in early-run Atlantic salmon (Rex Porter, pers. comm.) may progress most rapidly after entry into fresh water. The upstream movements of larger char earlier in the season than younger fish may relate, in this respect, to initial maturation requirements.

Lee (1969) had found that early upstream runs were composed almost exclusively of large ripe fish of both sexes. He further indicated that, as the numbers of "spawners" dropped, the numbers of immature and mature but not ripe char increased. As the early run of char was not sampled on the Fraser River in 1975 and as commercial samplings during 1973 and 1974 were carried out in late July and August, a similar situation could conceivably exist on Labrador rivers. Certainly, a poor understanding still exists of all matters pertaining to the reproductive biology of Arctic char in Labrador rivers. Age at first maturity and the time of spawning are still unknown and continuing efforts will be made on the Fraser River to interrelate these and other aspects of biological and management consequence.

Considering the high commercial take of 7+, 8+ and 9+ fish (Fig. 20-22) and the virtual elimination of "larger" fish from the fishery (Table 2), spawning escapement to rivers in areas now heavily exploited has certainly dropped. Should current exploitation trends continue, the heavy cropping of pre-spawning and maturing fish will exert even added recruitment stress on stocks already heavily taxed. The closure of the Frobisher Bay char fishery in just 10 years of commercial activity should serve as a useful reminder of the limitations of this resource.

The commercial fishery

Commercial char operations at Nain assumed significant economic promise in 1942 when the Newfoundland Commission of Government took control of northern Labrador affairs.

Initial market demands for "red-fleshed" char effectively restricted major fishing operations to the more northern regions of the coast where the incidence of red-flesh was higher (Coady, 1974). Although northern settlements at Nutak and Hebron were phased out in 1956 and 1959 respectively, the northern fishery endured with the development of a wide-ranging collection system from Nain. As catches were heavily salted, the problem of spoilage was minimal and reliance on "collectors" restricted mainly to provisions.

Char exports between 1942 and 1969 fluctuated widely with peak production years attained on a regular 5- to 6-year basis (Fig. 5). Considering that char exports during these years were largely of red-fleshed fish and reasoning that flesh coloration is food induced, these variations may have related to the cyclic abundance of major food items.

Commercial char operations on the Labrador coast remained relatively unchanged until 1970 when large-scale refrigeration facilities were installed at Nain. Emphasis shifted quickly from the salted to the fresh frozen product. With the added incentive of higher prices for fresh char and the overall decline of cod stocks, production levels in the char fishery practically doubled by 1972.

Several factors now limited the range of the collection system. Char were packed in ice at the fishing camps and collectors visited every 3 or 4 days depending on weather conditions. In increasing numbers, fishermen fished closer to Nain so as to avail of "fresh" fish prices and minimize spoilage. At the same time, market acceptance of the pink- and white-fleshed char had improved, placing less reliance on the "red" stocks farther north. With the refrigeration and storage capability now available at Nain, fishermen took an active interest in Atlantic salmon available on the outer islands and headlands of Voisey, Nain and Okak Bays. In the fresh form, salmon brings nearly three times the price per pound as char and fishermen became reluctant to move north of Okak as areas farther north were considered poor salmon berths. Traditional fishing patterns had changed quickly.

The commercial fishery at Nain is an extremely specialized one. Aside from char and salmon, few other species are taken to any extent. Salmon are not generally available to the Nain fishery until mid-July, their lengthy coastal migration originating along the southern Labrador coast and moving north during the summer months. As the fish plant opens at the beginning of July, initial effort is directed to char and, as salmon put in an appearance, berths are relocated.

The interrelationship of the char and salmon fisheries is extremely significant in that a great deal of effort is effectively withdrawn from prime char berths in years of salmon abundance. The general decline in char landings since 1972 is partially related to the general increase in the availability of salmon during the same period. At the same time, the individual catch success of fishermen who continue to fish char in prime char berths has decreased (Table 5). Should the salmon fishery fail in any one year (not improbable - considering the virtual absence of the species in the Nain area prior to 1969), it seems unlikely that char stocks in those areas now fished will be capable of withstanding a sudden renewal in fishing intensity.

The economic or "dollar-value" of the Nain char fishery is difficult to assess. As with most commercial char fisheries across northern Canada, the species provides, at best, a subsistence allowance to resident Eskimo, white settler and Nascaupi populations of the area. Overall benefits are nonetheless vital as few other sources of income are available. While profits from the char fishery are small, gains other than monetary and related to the traditional and deep-rooted existence of the community are important.

Unemployment benefits accrue in the offseason and profits of the government-operated fish plant are, in large measure, returned to the community in the form of subsidy and other benefits, thereby enabling a high degree of self-sufficiency.

The real threat to the viability of the Nain char fishery as now operated lies with the concentration of fishing effort in areas close to the community. Total annual mortalities in excess of 50% (Fig. 20-22) are to be considered unusually high in such slow-growing and localized species. While total effort (man-weeks fished) in the char fishery decreased from 1974 to 1975, catch per unit of effort similarly declined in obvious response to stock depletion. Further evidence exists of alterations in growth rate (Table 10) and a drastic reduction in the average size of landed char over the past 5 years (Table 2). Arctic char are not a highly productive resource. The species is locally susceptible to over-exploitation and depletion is assuredly followed by slow recovery.

With the decline of stocks in Voisey, Nain and Okak Bay, the char fishery in those areas is in imminent danger of collapse. This is not to say that the fishery no longer remains viable. The degree of utilization can be conceived of as a catch function of some kind related to stock size and fishing intensity. The char resources of areas north of Okak Bay and within the logistic capability of the Nain operation are virtually untapped so that solution of the immediate problem is within grasp if immediate and decisive action is taken to extend fishing effort farther north.

Management guidelines

A need has arisen for the curtailment of fishing effort in areas close to Nain. The intensity of exploitation at Voisey, Nain and Okak drastically affects the catch potential of these areas and indirectly the stability of the Nain fishery.

Federal regulations pertaining to commercial char operations on the northern Labrador coast were implemented in 1975. For all practical purposes, the new regulations were interwoven into those already existing for Atlantic salmon. Commercial effort has now been limited to resident fishermen who depend on the fishery for an important part of their income. Licensing requirements and restrictions limiting the size and amount of gear are included. In the case of residents ineligible for a commercial license, a single net not exceeding 25 fathoms in total length is permitted for domestic take only. Smaller-mesh nets have been permitted for char in more northern regions of the Labrador coast where growth is slower and char are generally smaller.

Whether these measures, of themselves, will ensure expedient recovery of char stocks already affected by overfishing is doubtful. The new regulations were intended primarily to curtail undue expansion of the fishery at a time when increased prices and expanded processing facilities might prove attractive to outside fishermen. Other than the elimination of 4-inch mesh nets and a minor reduction in the number of fishermen, little effective alteration of the fishery has been attained.

Immediate steps should be taken to offset localized overfishing in areas close to Nain by the establishment of a workable collection system north of Okak Bay. Significant alteration of current fishing patterns should be made prior to the 1976 fishing season and, while economic and social compromises will be abrupt, the long-term biological benefits to those stocks now heavily exploited will be considerable.

Little action will likely be taken until both fishermen and fish plant management agree that expansion will be a mutual effort. Fishermen will require guarantees of an adequate and timely collection service so as to reduce spoilage. At the same time, "collectors" will remain understandably steadfast from an economic standpoint unless significant numbers of fishermen return north. For these reasons, a joint consultation of all parties involved, in which the issues are outlined, the options presented and decisions agreed to, will be prerequisite.

Initial expansion should include Napartok, Hebron and Saglek (Fig. 24). Little benefit will be gained by a concentration of effort in new areas, and a repetition within 3-5 years of the problem which now exists near Nain. It may prove more realistic to permit a residual effort in areas now overfished so as to spread effort over greater distances thereby decreasing emphasis on separate stocks. Should this prove untenable following the 1976 season, several years of complete closure could be effected in those areas near Nain definable as prime char berths (Table 5), with the eventual intent of allowing return effort within several years. In any case, all stocks fished during 1976, whether previously exploited or not, should be monitored in the manner developed in 1974, where location, catch and gear are recorded by collectors and entered on purchase slip receipts for post-season analysis.

As delays in the collection service are unavoidable over distances from Nain to Saglek, less reliance could be placed on the actual timing of vessels by the installation of small-scale freezing and storage systems at each area. The compactness, simplicity and mobility of eutectic brine freezing systems have proven useful in equally remote areas of northern Canada where limited facilities are available (Lantz, 1966). Incorporation of services into floating barges as have been used in southern Labrador with a large measure of success may also be worth considering. Fishermen have suggested that a separate collection service in northern bays, acting in a relay fashion to an icing or freezing depot mid-way to Nain, should be considered. A further suggestion has been made that fishermen operating in more outlying areas be equipped with a supply of barrels and salt to be used in the event that collectors are unduly delayed and catches commence to spoil. Markets demand for salt char, however, appears limited to 800 barrels (110 lb per barrel) per season.

In 1969-70, an independent operator met with some success in air shipping substantial amounts of fresh char, netted in the immediate vicinity of Nain, to Goose Bay and thence to Montreal markets. Reasoning that expansion of the collection service north of Okak will require the addition of a third and perhaps fourth vessel, the cost of air charter as a means of shipping commercial landings to Nain should at least be weighed against the cost of purchase, maintenance and crew costs for new collectors.

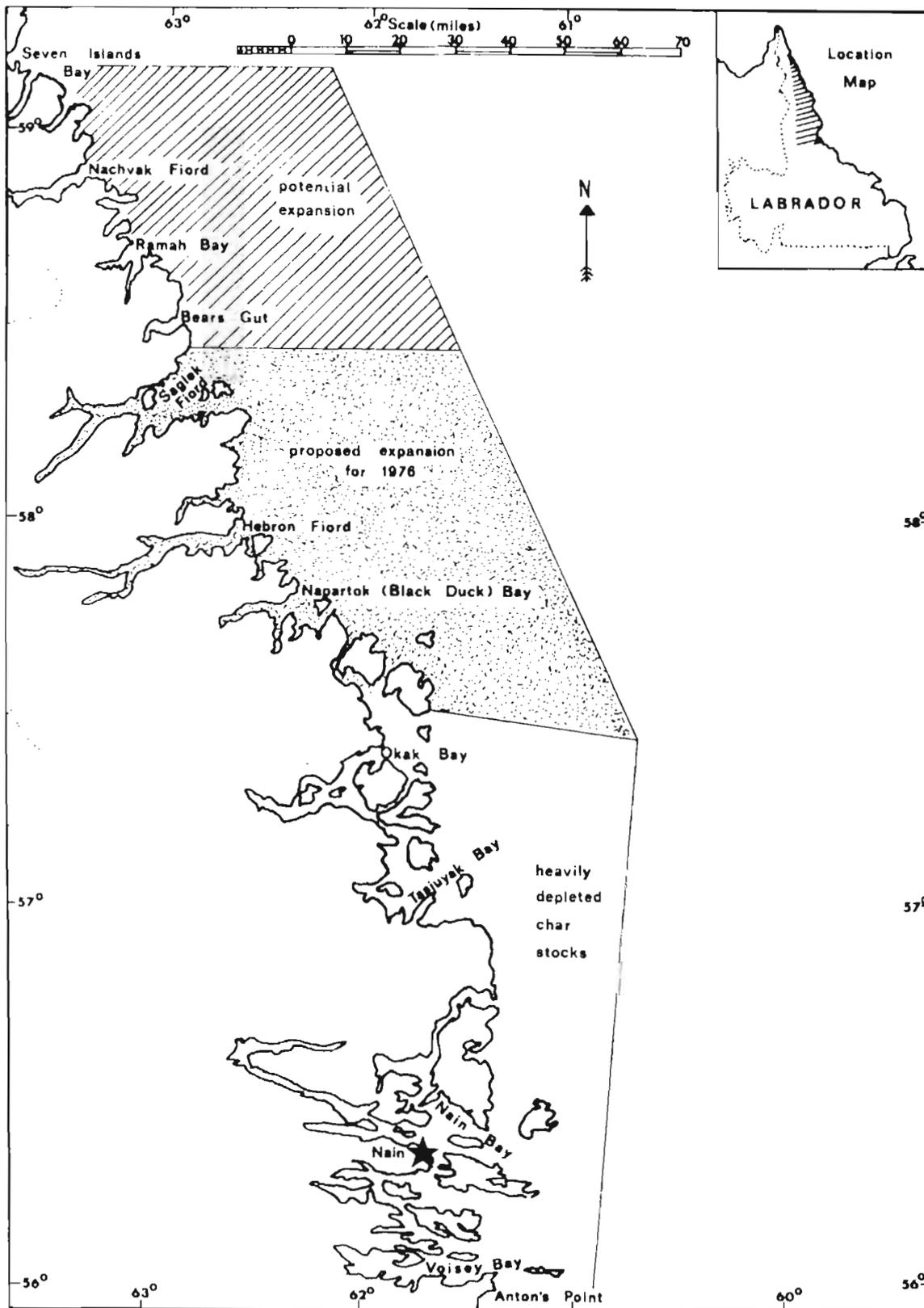


Fig. 24. Proposed and potential expansion areas for the Nain char fishery.

With the recent emphasis on salmon, fishermen may prove reluctant to return to northern berths where salmon fishing is poor. Salmon prices remain significantly higher than those of char, so that fishermen will feel inclined to return south at the first indications of good salmon fishing mid-way through the season.

Understandably, certain fishermen will wish to remain in areas close to Nain while others will be equally interested in returning to traditional berths farther north. Co-ordination of activities will rest largely with the Nain Fisheries Committee and Labrador Services Division. Eventual decisions on the suitability of such management controls as quotas or closures will be made pending final productivity estimates by research workers. Optimal levels of exploitation are as yet unknown. Expected harvest on the basis of defined levels of effort is predictable but, while this and the effects of overfishing have been documented, immediate solution of current problems in the Nain fishery will depend on the direct response of fishermen and industry to recommended controls. The probable advantages of restricting the fishery through further regulatory measures are slight.

SUMMARY

- 1) Biological and management investigations of the commercial Arctic char fishery at Nain, Labrador, were undertaken from 1973 to 1975. These studies are ongoing.
- 2) With the decline of the Labrador inshore cod fishery in the late sixties, commercial emphasis at Nain has focused on Arctic char and Atlantic salmon resources in the area.
- 3) The alteration of traditional fishing patterns associated with the shift from salted to fresh frozen char products in 1970 resulted in a concentration of fishing effort in areas close to Nain.
- 4) Since 1970, the average size (dressed weight) of char landed at the Nain fish plant has declined steadily.
- 5) The catch success of char fishermen on a unit effort basis (man-weeks and net-weeks fished) has declined in recent years.
- 6) The interrelationship of the char and salmon fisheries at Nain is complex. Commercial activities are characterized by a geographic separation of char and salmon berths and seasonal shifts in effort from one species to the other. Total char landings are lowest in years of salmon abundance.
- 7) A total of 2071 char from nine locations; 3+ to 19+ in age; 11.0 to 82.7 cm fork length; .016 to 5.77 kg dressed weight were sampled for growth evaluation and comparison.
- 8) Age determinations from the scales of Arctic char averaged 1.5 years less than readings from the corresponding otolith pair.
- 9) Each set of otoliths was examined independently by two readers. Approximately 20% of all age determinations were considered unreliable and subsequently rejected.
- 10) Char growth was exceedingly slow in all areas and progressively slower in more northern regions of the Labrador coast. Labrador stocks are variably slower or faster growing than other anadromous populations throughout northern Canada and Alaska.
- 11) Growth proceeds at a faster rate in younger fish; commercial size (> 1 kg) is commonly reached by age 7+; growth rates slow with a considerable overlap of length ranges in older age groupings.
- 12) Total annual mortalities of char in major fishing areas were high in 1973 and 1974, ranging from 44 to 59%. Of major concern is the heavy cropping of pre-spawning and maturing fish.

- 13) Distinct differences in the age, length and weight characteristics of char from separate sampling areas imply a minimal overlap of individual stocks.
- 14) Evidence exists of alterations in growth rate in areas currently exploited. In a 20-year period between independent analyses growth rates have increased markedly.
- 15) Age at first downstream migration in Nain Bay char varied from 3+ to 7+ years.
- 16) The mathematical relationship between length and G.H.On (gutted, head on) weight, as determined from a combined sample of 2071 char, may be expressed as follows:

$$W = 0.00000751 L^{3.0627}$$

- 17) The mathematical relationship between round (Y) and dressed (X) weight as determined from 332 char sampled in Nain Bay may be defined as follows:

$$Y = -0.0323 + 1.2150 X$$

- 18) Of 600 Arctic char sexed at sea, 272 (45.3%) were male and 328 (54.7%) female. Year-classes 4+ to 11+ were represented in the data.
- 19) While growth (age/length) proceeds at a similar rate in male and female char, males were proportionately larger at a given length.
- 20) 4058 upstream migrant char were recorded at the Fraser River counting fence between July 28 and September 7, 1975. Initial runs are thought to occur earlier and a fuller evaluation will be made in 1976.
- 21) Few indications of advancing maturation were evident in adult char sampled at sea or taken during the upstream run. Observations will be expanded in 1976 to include early-run fish.
- 22) Major upstream movements of Arctic char from the sea were found to coincide with spring tide conditions at the river mouth. The average size of upstream migrants decreased as the season progressed.
- 23) Immediate steps should be taken to offset localized overfishing in areas close to Nain by the establishment of a workable operation in unfished areas farther north. Revamping of current collection practices will be prerequisite.

REFERENCES

- Allen, K. R. 1966. A method of fitting growth curves of the von Bertalanffy type to observed data. J. Fish. Res. Board Can. 23: 163-179.
- Andrews, C. W. and E. Lear. 1956. The biology of Arctic char (*Salvelinus alpinus* L.) in northern Labrador. J. Fish. Res. Board Can. 13: 843-860.
- Bertalanffy, L. von. 1938. A quantitative theory of organic growth. Hum. Biol. 10(2): 181-213.
- Bond, W. A. 1974. The commercial fishery at Sandy Point, District of Keewatin, N.W.T. in 1972. Data Report Series No. CEN/D-74-2, Fisheries and Marine Service, Central Region. 16 p.
- Coady, L. 1974. The Arctic char fishery of northern Labrador. Progress Report No. 104, Resource Development Branch, Newfoundland Region. 31 p.
- DeVries, A. L. 1971. Freezing resistance in fishes. Fish Physiology. Hoar and Randall Vol. 6: 157-190; Academic Press, New York and London.
- Grainger, E. H. 1953. On the age, growth, migration, reproductive potential and feeding habits of Arctic char (*Salvelinus alpinus*) of Frobisher Bay, Baffin Island. J. Fish. Res. Board Can. 10: 326-370.
- Gullestad, N. 1974. On lack of winter zones in the centre of scales from Arctic char (*Salmo alpinus* L.). Norw. J. Zool. 22: 141-143.
- Healey, M. C. 1975. Dynamics of exploited whitefish populations and their management with special reference to the Northwest Territories. J. Fish. Res. Board Can. 32: 427-448.
- Hubbs, C. L. and C. Hubbs. 1953. An improved graphical analysis and comparison of series of samples. J. Syst. Zool. 2(2): 49-56.
- Hunter, J. G. 1970. Production of Arctic char (*Salvelinus alpinus* Linnaeus) in a small Arctic lake. Fish. Res. Board Can. Tech. Rep. 231: 190 p.
- Lantz, A. W. 1966. Eutectic brine freezer for Eskimo fishermen. Canadian Fisheries Reports 6: 33-38.
- Lee, R.L.G. 1969. The ecology of the Arctic char *Salvelinus alpinus* L., the brook trout *Salvelinus fontinalis* Mitchill, and the Atlantic salmon *Salmo salar* L., in the Leaf River, Ungava. M.Sc. Thesis, University of Waterloo, Ontario. 147 p.
- LeJeune, R. 1967. L'omble chevalier anadrome du Kagnersoulard-jovark. Service de la Faune du Quebec Bull. No. 10: 45 p.

- May, A. 1967. The effects of offshore fishing on the inshore Labrador codfishery. ICNAF Res. Bull. 4: 67-75.
- McCart, P., P. Craig and H. Bain. 1972. Report on fisheries investigations in the Sagavanirktok River and neighboring drainages. Alyeska Pipeline Service Company. 168 p.
- McPhail, J. D. 1961. A systematic study of the *Salvelinus alpinus* complex in North America. J. Fish. Res. Board Can. 18: 793-816.
- Moravian Records - Handwritten accounts, diaries, etc., of the Moravian dealings on the Labrador coast 1771-1920. Available on microfilm - Memorial University Library, St. John's, Nfld.
- Murphy, H. P. and T. R. Porter. 1974. Stream surveys of 31 rivers in Labrador. Vol. I - English River to Fraser River. Vol. II - Kamaratsuk Brook to Eclipse River. Int. Rep. Ser. No. NEW/i-74-8, Resource Development Branch, Newfoundland Region.
- Northern Labrador Services Division
Annual Reports, Government of Newfoundland and Labrador.
Northern Labrador Trading Operations - Dept. of Natural Resources, 1942-1951.
Division Northern Labrador Affairs - Dept. Public Welfare, 1952-1967.
Northern Labrador Services Division - Dept. Public Welfare, 1968-1970.
Northern Labrador Services Division - Dept. Social Services and Rehabilitation, 1971-1975.
- Nordeng, H. 1961. On the biology of char (*Salvelinus alpinus* L.) in Salangen, North Norway. Zoologi 10: 67-121.
- Peet, R. 1971. A report on the counting trap and reconnaissance surveys conducted in central coastal Labrador during 1967. Progress Report No. 68, Resource Development Branch, Newfoundland Region. 286 p.
- Pritchard, H. H. 1911. Through trackless Labrador. Sturgis and Walton Publishers, New York and London. 244 p.
- Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Bull. Fish. Res. Board Can. 119: 300 p.
1973. Linear regressions in fishery research. J. Fish. Res. Board Can. 30: 409-434.
- Sandeman, E. J. 1969. Age determination and growth rate of redfish, *Sebastes* sp., from selected areas around Newfoundland. ICNAF Res. Bull. 6: 79-106.

- Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184: 966 p.
- Sollows, G. C., J. A. Dalziel, G. Smith and N. Steele. 1954. Salmon Investigations - Preliminary survey of the rivers and commercial fishery of northern Labrador. Part 2. Progress Report No. 2, Resource Development Branch, Newfoundland Region. 22 p.
- Sprules, W. M. 1952. The Arctic char of the west coast of Hudson Bay. J. Fish. Res. Board Can. 9: 1-15.
- Thompson, J.A.G. 1957. On the ecology of the Arctic char (*Salvelinus alpinus* (L.)) of Nettilling Lake, Baffin Island, N.W.T. McGill University, M.Sc. Thesis. 58 p.

Appendix I

Arctic char, Atlantic salmon and cod exports
from the northern Labrador coast, 1942-75.



Appendix I.

| Year | Arctic char | | | Atlantic salmon | | | Cod | | | |
|------|-----------------|---------------------------|--------------------------------------|--------------------------------------|---------------------------|--------------------------------------|--------------------------------------|-----------------|--------------------------------------|--------------------------------------|
| | Pickled (lb) | Frozen G.H.On* (lb) | Estimated whole weight (lb) | Estimated whole weight (kg) | Frozen G.H.On* (lb) | Estimated whole weight (lb) | Estimated whole weight (kg) | Pickled (lb) | Estimated whole weight (lb) | Estimated whole weight (kg) |
| 1942 | 32,340 | | 54,331 | 24,612 | | | | 782,096 | 2,111,659 | 956,582 |
| 1943 | | | | | | | | 868,784 | 2,345,718 | 1,062,610 |
| 1944 | 24,200 | | 40,656 | 18,417 | | | | 1,047,648 | 2,828,650 | 1,281,378 |
| 1945 | 56,540 | | 94,987 | 43,029 | | | | 973,840 | 2,629,368 | 1,191,104 |
| 1946 | 72,600 | | 121,968 | 55,252 | | | | 849,184 | 2,292,796 | 1,038,637 |
| 1947 | 142,340 | | 239,131 | 108,326 | | | | 999,376 | 2,698,315 | 1,222,337 |
| 1948 | 268,400 | | 450,912 | 204,263 | | | | 925,680 | 2,499,336 | 1,132,199 |
| 1949 | 99,000 | | 166,320 | 75,343 | | | | 1,061,088 | 2,864,938 | 1,297,817 |
| 1950 | 98,560 | | 165,581 | 75,008 | | | | 1,147,328 | 3,097,786 | 1,403,297 |
| 1951 | 72,380 | | 121,598 | 55,084 | | | | 1,674,736 | 4,521,787 | 2,048,370 |
| 1952 | 185,020 | | 310,834 | 140,808 | | | | 1,246,896 | 3,366,619 | 1,525,078 |
| 1953 | 224,620 | | 377,362 | 170,945 | | | | 669,424 | 1,807,445 | 818,773 |
| 1954 | 160,160 | | 269,069 | 121,888 | | | | 892,864 | 2,410,733 | 1,092,062 |
| 1955 | 168,520 | | 283,114 | 128,251 | | | | 455,280 | 1,229,256 | 556,853 |
| 1956 | 99,000 | | 166,320 | 75,343 | | | | 94,752 | 255,830 | 115,891 |
| 1957 | 126,500 | | 212,520 | 96,272 | | | | 714,448 | 1,929,010 | 873,842 |
| 1958 | 170,060 | | 285,701 | 129,423 | | | | 1,304,800 | 3,522,960 | 1,595,901 |
| 1959 | 149,600 | | 251,328 | 113,852 | | | | 1,592,192 | 4,298,918 | 1,947,410 |
| 1960 | 115,720 | 5,850 | 201,664 | 91,354 | | | | 1,642,816 | 4,435,603 | 2,009,328 |
| 1961 | 166,320 | 30,000 | 316,618 | 143,428 | | | | 1,831,424 | 4,944,845 | 2,240,015 |
| 1962 | 208,120 | 9,000 | 360,802 | 163,443 | | | | 1,695,120 | 4,576,824 | 2,073,301 |
| 1963 | 217,910 | | 366,089 | 165,838 | | | | 1,724,800 | 4,656,960 | 2,109,603 |
| 1964 | 203,830 | | 342,434 | 155,123 | | | | 1,306,704 | 3,528,101 | 1,598,230 |
| 1965 | 120,560 | | 202,541 | 91,751 | | | | 1,881,040 | 5,078,808 | 2,300,700 |
| 1966 | 93,500 | | 157,080 | 71,157 | | | | 1,572,368 | 4,245,394 | 1,923,163 |
| 1967 | 193,820 | | 325,618 | 147,505 | | | | 1,622,768 | 4,381,474 | 1,984,808 |
| 1968 | 181,830 | | 305,474 | 138,380 | | | | 1,478,288 | 3,991,378 | 1,808,094 |
| 1969 | 241,670 | 33,173 | 447,140 | 202,554 | 16,481 | 18,129 | 8,212 | 202,496 | 546,739 | 247,673 |
| 1970 | 211,420 | 75,000 | 448,186 | 203,028 | 53,000 | 58,300 | 26,410 | 289,856 | 782,611 | 354,523 |
| 1971 | 106,700 | 190,019 | 414,880 | 187,941 | 111,828 | 123,011 | 55,724 | 22,400 | 60,480 | 27,397 |
| 1972 | 186,780 | 156,051 | 507,294 | 229,804 | 93,630 | 102,993 | 46,656 | 22,400 | 60,480 | 27,397 |
| 1973 | 71,280 | 235,953 | 412,332 | 186,786 | 221,209 | 243,330 | 110,228 | 97,328 | 262,786 | 119,042 |
| 1974 | | 264,449 | 327,917 | 148,546 | 104,275 | 114,703 | 51,960 | | | |
| 1975 | | 95,529 | 118,456 | 53,661 | 193,248 | 212,572 | 96,295 | 18,250 | 49,275 | 22,322 |

*G.H.On = Gutted, head on



Appendix II

Summary of age, length and weight data
for Arctic char; nine sampling locations.

- (i) Anton's Point
- (ii) Voisey Bay
- (iii) Unity Bay
- (iv) Nain-Unity Bays
- (v) Nain Bay
- (vi) Tikkoatokak Bay
- (vii) Tasiuyak Bay
- (viii) Okak-Cutthroat
- (ix) Okak Bay



Appendix II ... (i). Age, length and weight data for Arctic char sampled at Anton's Point, August 1, 1974.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 6 ⁺ | 1 | - | 44.90 | - | - | - | 1.03 | - | - |
| 7 ⁺ | 22 | 43.1-59.0 | 49.69 | 4.70 | 1.00 | 0.91-2.38 | 1.37 | 0.38 | 0.08 |
| 8 ⁺ | 65 | 45.2-66.5 | 52.46 | 4.56 | 0.57 | 1.01-3.71 | 1.65 | 0.49 | 0.06 |
| 9 ⁺ | 49 | 47.1-72.2 | 55.31 | 4.81 | 0.69 | 1.02-3.97 | 1.85 | 0.56 | 0.08 |
| 10 ⁺ | 15 | 47.0-65.2 | 55.57 | 5.54 | 1.43 | 0.97-3.48 | 1.96 | 0.71 | 0.18 |
| 11 ⁺ | 9 | 48.5-65.9 | 56.59 | 6.06 | 2.02 | 1.04-3.38 | 2.03 | 0.76 | 0.25 |
| SUMMARY: 161 | | 43.1-72.2 | 53.59 | 5.17 | 0.41 | 0.91-3.97 | 1.73 | 0.57 | 0.05 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 43.0-44.9 | 7 | 0.81-1.03 | 0.96 | 0.94 |
| 45.0-46.9 | 10 | 0.91-1.29 | 1.09 | 1.08 |
| 47.0-48.9 | 25 | 0.97-1.38 | 1.22 | 1.22 |
| 49.0-50.9 | 25 | 1.04-1.68 | 1.33 | 1.38 |
| 51.0-52.9 | 29 | 1.26-2.11 | 1.55 | 1.56 |
| 53.0-54.9 | 30 | 1.02-2.07 | 1.71 | 1.75 |
| 55.0-56.9 | 27 | 1.60-2.45 | 1.92 | 1.95 |
| 57.0-58.9 | 21 | 2.01-2.40 | 2.18 | 2.16 |
| 59.0-60.9 | 10 | 1.78-2.71 | 2.29 | 2.40 |
| 61.0-62.9 | 7 | 2.50-2.70 | 2.58 | 2.65 |
| 63.0-64.9 | 2 | 3.32-3.49 | 3.41 | 2.91 |
| 65.0-66.9 | 5 | 3.04-3.71 | 3.38 | 3.20 |
| 67.0-68.9 | - | - | - | - |

Appendix II ... (i) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Mean | Mean | |
| 69.0-70.9 | 1 | - | 3.62 | 3.82 |
| 71.0-72.9 | 1 | - | 3.97 | 4.16 |

SUMMARY: N = 200 Regression Equation: $\text{Log } W = 3.0131 \text{ Log } L - 4.9768$
 Correlation Coefficient = 0.9933

Appendix II ... (ii). Age, length and weight data for Arctic char sampled at Voisey Bay, July 31, 1974.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 7 ⁺ | 5 | 45.4-48.8 | 47.42 | 1.38 | 0.62 | 1.15-1.40 | 1.22 | 0.10 | 0.05 |
| 8 ⁺ | 39 | 43.0-62.0 | 51.30 | 4.30 | 0.69 | 0.88-2.93 | 1.66 | 0.52 | 0.08 |
| 9 ⁺ | 59 | 45.4-62.3 | 53.33 | 4.49 | 0.59 | 0.99-3.14 | 1.82 | 0.57 | 0.07 |
| 10 ⁺ | 41 | 44.8-67.1 | 55.05 | 5.30 | 0.83 | 1.06-4.02 | 2.00 | 0.64 | 0.10 |
| 11 ⁺ | 14 | 49.9-65.7 | 56.69 | 4.71 | 1.26 | 1.37-3.41 | 2.11 | 0.69 | 0.18 |
| 12 ⁺ | 9 | 49.6-65.0 | 58.13 | 4.76 | 1.59 | 1.31-3.46 | 2.50 | 0.66 | 0.22 |
| 13 ⁺ | 3 | 53.0-63.1 | 57.37 | 5.19 | 2.99 | 1.70-2.67 | 2.14 | 0.49 | 0.28 |

SUMMARY: 170 43.0-67.1 53.73 5.09 0.39 0.88-4.02 1.88 0.62 0.05

Appendix II ... (ii) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 1 | - | 1.40 | 1.00 |
| 43.0-44.9 | 4 | 0.88-1.11 | 1.01 | 1.13 |
| 45.0-46.9 | 10 | 1.13-1.28 | 1.19 | 1.27 |
| 47.0-48.9 | 22 | 0.99-1.52 | 1.26 | 1.41 |
| 49.0-50.9 | 22 | 1.05-1.60 | 1.41 | 1.57 |
| 51.0-52.9 | 31 | 1.27-2.54 | 1.65 | 1.74 |
| 53.0-54.9 | 30 | 1.17-2.21 | 1.81 | 1.91 |
| 55.0-56.9 | 30 | 1.12-2.49 | 2.05 | 2.10 |
| 57.0-58.9 | 12 | 2.00-2.87 | 2.32 | 2.30 |
| 59.0-60.9 | 16 | 1.62-3.01 | 2.61 | 2.51 |
| 61.0-62.9 | 12 | 2.61-3.41 | 2.93 | 2.73 |
| 63.0-64.9 | 4 | 2.67-3.35 | 2.85 | 2.96 |
| 65.0-66.9 | 3 | 3.41-3.54 | 3.47 | 3.21 |
| 67.0-68.9 | 2 | 3.59-4.02 | 3.81 | 3.47 |
| 69.0-70.9 | 1 | - | 3.95 | 3.73 |
| 71.0-72.9 | 1 | - | 3.52 | 4.01 |
| 73.0-74.9 | 2 | 4.32-4.45 | 4.39 | 4.31 |

SUMMARY: N = 203 Regression Equation: $\log W = 2.5719 \log L - 4.1725$
Correlation Coefficient = 0.9710

Appendix II ... (iii). Age, length and weight data for Arctic char sampled at Unity Bay from July 17 to August 15, 1974.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 3 ⁺ | 8 | 12.8-16.5 | 14.45 | 1.16 | 0.41 | .016-.036 | 0.02 | 0.01 | 0.00 |
| 4 ⁺ | 43 | 14.1-25.0 | 19.25 | 2.08 | 0.32 | .021-.110 | 0.05 | 0.02 | 0.00 |
| 5 ⁺ | 34 | 17.9-30.8 | 20.85 | 2.86 | 0.49 | .038-.220 | 0.07 | 0.04 | 0.01 |
| 6 ⁺ | 24 | 17.3-42.9 | 31.47 | 10.42 | 2.13 | .043-.830 | 0.42 | 0.35 | 0.07 |
| 7 ⁺ | 89 | 19.4-58.1 | 44.57 | 6.21 | 0.66 | .051-1.77 | 0.95 | 0.29 | 0.03 |
| 8 ⁺ | 140 | 36.2-63.1 | 47.94 | 4.99 | 0.42 | .530-3.02 | 1.20 | 0.44 | 0.04 |
| 9 ⁺ | 67 | 40.2-62.9 | 49.61 | 5.52 | 0.67 | .660-2.82 | 1.36 | 0.50 | 0.06 |
| 10 ⁺ | 11 | 43.9-62.9 | 49.95 | 5.60 | 1.69 | .880-2.90 | 1.33 | 0.60 | 0.18 |
| 11 ⁺ | 2 | 50.7-67.1 | 58.90 | 11.60 | 8.20 | 1.05-1.55 | 1.28 | 0.33 | 0.23 |
| SUMMARY: 418 | | 12.8-67.1 | 40.86 | 12.81 | 0.63 | .016-3.02 | 0.90 | 0.62 | 0.03 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|-------|------------------------|
| | | Range | Mean | |
| 11.0-12.9 | 1 | - | 0.017 | 0.014 |
| 13.0-14.9 | 10 | 0.016-0.050 | 0.025 | 0.022 |
| 15.0-16.9 | 3 | 0.025-0.036 | 0.030 | 0.034 |
| 17.0-18.9 | 33 | 0.032-0.063 | 0.045 | 0.049 |
| 19.0-20.9 | 44 | 0.042-0.080 | 0.057 | 0.068 |
| 21.0-22.9 | 24 | 0.065-0.093 | 0.078 | 0.092 |
| 23.0-24.9 | 5 | 0.109-0.113 | 0.111 | 0.121 |
| 25.0-26.9 | 3 | 0.093-0.142 | 0.126 | 0.155 |
| 27.0-28.9 | 4 | 0.162-0.179 | 0.171 | 0.196 |

Appendix II ... (iii) cont'd

| Length Category (cm) | Number of fish | G.H. On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|---------------------|-------|------------------------|
| | | Range | Mean | |
| 29.0-30.9 | 2 | 0.220-0.261 | 0.241 | 0.244 |
| 31.0-32.9 | | | | |
| 33.0-34.9 | 2 | 0.277-0.395 | 0.336 | 0.362 |
| 35.0-36.9 | 1 | - | 0.53 | 0.434 |
| 37.0-38.9 | 1 | - | 0.60 | 0.514 |
| 39.0-40.9 | 18 | 0.63-0.87 | 0.71 | 0.604 |
| 41.0-42.9 | 62 | 0.63-1.38 | 0.80 | 0.705 |
| 43.0-44.9 | 67 | 0.71-1.43 | 0.92 | 0.816 |
| 45.0-46.9 | 67 | 0.80-1.90 | 1.05 | 0.939 |
| 47.0-48.9 | 50 | 0.80-1.38 | 1.17 | 1.07 |
| 49.0-50.9 | 41 | 1.05-1.67 | 1.28 | 1.22 |
| 51.0-52.9 | 27 | 1.17-1.80 | 1.50 | 1.38 |
| 53.0-54.9 | 20 | 1.23-1.94 | 1.72 | 1.56 |
| 55.0-56.9 | 17 | 0.95-2.32 | 1.66 | 1.74 |
| 57.0-58.9 | 16 | 0.94-3.07 | 1.97 | 1.95 |
| 59.0-60.9 | 8 | 1.36-3.15 | 2.51 | 2.17 |
| 61.0-62.9 | 8 | 2.20-2.90 | 2.52 | 2.40 |
| 63.0-64.9 | 2 | 2.00-3.02 | 2.51 | 2.66 |
| 65.0-66.9 | | | | |
| 67.0-68.9 | 1 | - | 1.51 | 3.22 |
| 69.0-70.9 | | | | |
| 71.0-72.9 | 1 | - | 4.53 | 3.85 |

SUMMARY: N = 538

Regression Equation: $\log W = 3.1473 \log L - 5.2591$
 Correlation Coefficient = 0.9928

Appendix II ... (iv). Age, length and weight data for Arctic char sampled at Nain and Unity Bays from August 3 to August 20, 1973.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 4 ⁺ | 1 | - | 15.30 | - | - | - | 0.04 | - | - |
| 5 ⁺ | 5 | 16.1-25.8 | 20.02 | 5.23 | 2.34 | 0.04-0.16 | 0.08 | 0.06 | 0.03 |
| 6 ⁺ | 5 | 32.6-46.7 | 41.44 | 5.43 | 2.43 | 0.31-1.15 | 0.82 | 0.34 | 0.15 |
| 7 ⁺ | 30 | 36.0-48.8 | 42.11 | 3.03 | 0.55 | 0.45-1.43 | 0.80 | 0.20 | 0.04 |
| 8 ⁺ | 50 | 37.4-54.1 | 43.69 | 3.95 | 0.56 | 0.48-1.74 | 0.91 | 0.30 | 0.04 |
| 9 ⁺ | 26 | 40.1-53.0 | 44.59 | 2.94 | 0.58 | 0.66-1.30 | 0.93 | 0.18 | 0.03 |
| 10 ⁺ | 11 | 40.0-59.3 | 48.17 | 5.36 | 1.62 | 0.81-2.19 | 1.19 | 0.43 | 0.13 |
| 11 ⁺ | 5 | 46.8-58.7 | 52.34 | 4.47 | 2.00 | 0.86-2.21 | 1.54 | 0.61 | 0.27 |
| SUMMARY: 133 | | 16.1-59.3 | 43.02 | 6.80 | 0.59 | 0.04-2.21 | 0.90 | 0.36 | 0.03 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 15.0-16.9 | 4 | 0.02-0.042 | .031 | 0.032 |
| 17.0-18.9 | | | | |
| 19.0-20.9 | | | | |
| 21.0-22.9 | | | | |
| 23.0-24.9 | | | | |
| 25.0-26.9 | 2 | 0.12-0.16 | 0.14 | 0.159 |
| 27.0-28.9 | | | | |
| 29.0-30.9 | | | | |
| 31.0-32.9 | 1 | - | 0.31 | 0.313 |
| 33.0-34.9 | | | | |
| 35.0-36.9 | 2 | 0.45-0.62 | 0.54 | 0.460 |

Appendix II ... (iv) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 37.0-38.9 | 3 | 0.48-0.60 | 0.61 | 0.548 |
| 39.0-40.9 | 27 | 0.58-0.97 | 0.72 | 0.648 |
| 41.0-42.9 | 29 | 0.62-0.98 | 0.78 | 0.760 |
| 43.0-44.9 | 21 | 0.81-1.12 | 0.90 | 0.885 |
| 45.0-46.9 | 27 | 0.80-1.46 | 1.02 | 1.02 |
| 47.0-48.9 | 15 | 1.06-1.43 | 1.23 | 1.18 |
| 49.0-50.9 | 5 | 1.22-1.32 | 1.23 | 1.34 |
| 51.0-52.9 | 4 | 1.23-1.73 | 1.47 | 1.53 |
| 53.0-54.9 | 6 | 1.25-2.16 | 1.62 | 1.73 |
| 55.0-56.9 | | | | |
| 57.0-58.9 | 1 | - | 2.21 | 2.18 |
| 59.0-60.9 | 1 | - | 2.19 | 2.44 |

SUMMARY: N = 148

Regression Equation: $\log W = 3.2611 \log L - 5.4110$
 Correlation Coefficient = 0.9974

Appendix II ... (v). Age, length and weight data for Arctic char sampled at Nain Bay, July 30, 1974.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 7 ⁺ | 6 | 43.8-53.2 | 47.53 | 3.53 | 1.44 | 0.95-1.91 | 1.26 | 0.36 | 0.15 |
| 8 ⁺ | 38 | 42.6-60.3 | 50.56 | 4.47 | 0.73 | 0.80-2.62 | 1.37 | 0.34 | 0.06 |
| 9 ⁺ | 61 | 44.5-59.7 | 51.13 | 3.72 | 0.48 | 0.94-2.49 | 1.50 | 0.37 | 0.05 |
| 10 ⁺ | 48 | 44.2-60.9 | 53.50 | 3.29 | 0.48 | 0.94-2.36 | 1.71 | 0.34 | 0.05 |
| 11 ⁺ | 17 | 46.7-62.9 | 53.71 | 4.76 | 1.16 | 1.00-3.07 | 1.71 | 0.54 | 0.13 |

Appendix II ... (v) cont'd

| Number of annuli | Number of fish | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
|------------------|----------------|-----------|-------|--------------|--------------|-----------|------|--------------|--------------|
| 12 ⁺ | 6 | 52.1-57.7 | 54.28 | 2.06 | 0.84 | 1.58-2.59 | 1.83 | 0.38 | 0.16 |
| 13 ⁺ | 4 | 50.5-64.2 | 56.40 | 5.99 | 2.99 | 1.47-2.95 | 2.09 | 0.74 | 0.37 |
| 14 ⁺ | 1 | - | 47.50 | - | - | - | 1.14 | - | - |
| SUMMARY: 181 | | 42.6-64.2 | 51.96 | 4.18 | 0.31 | 0.80-3.07 | 1.56 | 0.42 | 0.03 |

| Length Category (cm) | Number of fish | G.H.O _n Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 1 | - | 0.80 | 0.83 |
| 43.0-44.9 | 8 | 0.94-1.12 | 1.02 | 0.95 |
| 45.0-46.9 | 17 | 0.94-1.19 | 1.07 | 1.08 |
| 47.0-48.9 | 25 | 1.00-1.50 | 1.21 | 1.23 |
| 49.0-50.9 | 36 | 1.12-1.91 | 1.40 | 1.38 |
| 51.0-52.9 | 33 | 1.28-1.84 | 1.54 | 1.55 |
| 53.0-54.9 | 37 | 1.37-2.11 | 1.72 | 1.72 |
| 55.0-56.9 | 25 | 1.15-2.25 | 1.83 | 1.92 |
| 57.0-58.9 | 18 | 1.22-2.59 | 2.08 | 2.12 |
| 59.0-60.9 | 5 | 2.25-2.62 | 2.42 | 2.34 |
| 61.0-62.9 | 2 | 2.58-3.07 | 2.83 | 2.57 |
| 63.0-64.9 | 3 | 2.43-2.95 | 2.62 | 2.82 |

SUMMARY: N = 210 Regression Equation: $\log W = 2.8930 \log L - 4.7740$
 Correlation Coefficient = 0.9929

Appendix II ... (vi). Age, length and weight data for Arctic char sampled at Tikkoatokak Bay on July 29 and August 3, 1974.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 7 ⁺ | 7 | 44.0-53.2 | 48.11 | 2.97 | 1.12 | 0.88-1.54 | 1.29 | 0.22 | 0.08 |
| 8 ⁺ | 38 | 43.4-60.7 | 50.06 | 3.97 | 0.64 | 0.90-2.89 | 1.41 | 0.46 | 0.07 |
| 9 ⁺ | 53 | 41.3-59.4 | 51.92 | 4.60 | 0.63 | 0.95-2.82 | 1.59 | 0.47 | 0.06 |
| 10 ⁺ | 43 | 45.2-62.8 | 53.73 | 4.29 | 0.65 | 0.95-2.99 | 1.72 | 0.48 | 0.07 |
| 11 ⁺ | 13 | 46.2-64.1 | 55.18 | 6.16 | 1.71 | 1.02-3.42 | 1.86 | 0.74 | 0.21 |
| 12 ⁺ | 12 | 48.5-62.9 | 56.45 | 3.84 | 1.11 | 1.42-2.90 | 2.15 | 0.47 | 0.13 |
| 13 ⁺ | 3 | 60.2-61.7 | 60.83 | 0.78 | 0.45 | 2.36-3.46 | 2.86 | 0.56 | 0.32 |
| 14 ⁺ | 2 | 49.8-61.4 | 55.60 | 8.20 | 5.80 | 1.27-2.80 | 2.04 | 1.08 | 0.77 |
| SUMMARY: 171 | | 41.3-64.1 | 52.58 | 4.94 | 0.38 | 0.88-3.46 | 1.66 | 0.55 | 0.04 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 2 | 0.92-1.17 | 1.05 | 0.86 |
| 43.0-44.9 | 4 | 0.88-1.00 | 0.92 | 0.99 |
| 45.0-46.9 | 21 | 0.93-1.34 | 1.09 | 1.12 |
| 47.0-48.9 | 31 | 0.95-1.90 | 1.25 | 1.27 |
| 49.0-50.9 | 26 | 1.11-1.73 | 1.34 | 1.43 |
| 51.0-52.9 | 22 | 1.02-1.87 | 1.50 | 1.60 |
| 53.0-54.9 | 22 | 1.31-2.15 | 1.71 | 1.79 |
| 55.0-56.9 | 17 | 1.42-2.60 | 1.97 | 1.99 |
| 57.0-58.9 | 26 | 1.36-2.90 | 2.17 | 2.20 |
| 59.0-60.9 | 12 | 1.67-2.82 | 2.33 | 2.43 |

Appendix II ... (vi) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 61.0-62.9 | 7 | 2.30-3.46 | 2.82 | 2.67 |
| 63.0-64.9 | 2 | 3.11-3.42 | 3.27 | 2.93 |

SUMMARY: N = 192

Regression Equation: $\log W = 2.8990 \log L - 4.7683$
 Correlation Coefficient = 0.9799

Appendix II ... (vii). Age, length and weight data for Arctic char sampled at Tasiuyak Bay on July 29, 1974.

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 8 ⁺ | 10 | 51.0-58.8 | 53.43 | 2.27 | 0.72 | 1.31-2.08 | 1.55 | 0.22 | 0.07 |
| 9 ⁺ | 25 | 42.9-68.0 | 55.30 | 6.28 | 1.26 | 1.18-3.84 | 2.00 | 0.71 | 0.14 |
| 10 ⁺ | 21 | 47.8-74.4 | 58.12 | 6.40 | 1.40 | 0.90-4.96 | 2.11 | 0.96 | 0.21 |
| 11 ⁺ | 17 | 52.5-71.2 | 59.90 | 5.81 | 1.41 | 1.35-4.39 | 2.24 | 0.78 | 0.19 |
| 12 ⁺ | 9 | 49.6-77.9 | 64.33 | 8.13 | 2.71 | 1.24-4.80 | 2.72 | 1.00 | 0.33 |
| 13 ⁺ | 3 | 47.5-79.0 | 61.87 | 15.93 | 9.20 | 1.41-5.11 | 2.93 | 1.94 | 1.12 |
| 14 ⁺ | 3 | 58.4-72.8 | 66.10 | 7.25 | 4.19 | 1.82-3.86 | 3.00 | 1.06 | 0.61 |
| 15 ⁺ | 1 | - | 71.50 | - | - | - | 3.80 | - | - |
| SUMMARY: | 89 | 42.9-79.0 | 58.31 | 7.33 | 0.78 | 0.90-5.11 | 2.18 | 0.91 | 0.10 |

Appendix II ... (vii) cont'd

| Length Category (cm) | Number of fish | G.H.O _n Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 1 | | 1.30 | 0.97 |
| 43.0-44.9 | 1 | | 1.47 | 1.09 |
| 45.0-46.9 | | | | |
| 47.0-48.9 | 4 | 0.90-1.41 | 1.19 | 1.36 |
| 49.0-50.9 | 9 | 1.10-1.39 | 1.24 | 1.50 |
| 51.0-52.9 | 13 | 1.31-1.80 | 1.46 | 1.66 |
| 53.0-54.9 | 15 | 1.35-1.83 | 1.57 | 1.82 |
| 55.0-56.9 | 19 | 1.27-2.02 | 1.72 | 2.00 |
| 57.0-58.9 | 14 | 1.59-2.93 | 2.07 | 2.18 |
| 59.0-60.9 | 11 | 2.05-2.53 | 2.21 | 2.37 |
| 61.0-62.9 | 13 | 2.15-3.16 | 2.46 | 2.58 |
| 63.0-64.9 | 7 | 2.69-2.94 | 2.78 | 2.79 |
| 65.0-66.9 | 6 | 2.14-3.22 | 2.72 | 3.01 |
| 67.0-68.9 | 6 | 2.62-3.84 | 3.22 | 3.24 |
| 69.0-70.9 | 1 | - | 3.80 | 3.49 |
| 71.0-72.9 | 4 | 3.10-4.39 | 3.79 | 3.74 |
| 73.0-74.9 | 3 | 4.36-4.96 | 4.44 | 4.01 |
| 75.0-76.9 | 1 | - | 5.19 | 4.28 |
| 77.0-78.9 | 1 | - | 4.80 | 4.57 |
| 79.0-80.9 | 1 | - | 5.11 | 4.87 |

SUMMARY: N = 130

Regression Equation: $\log W = 2.4975 \log L - 4.0647$
 Correlation Coefficient = 0.9596

Appendix II ... (viii). Age, length and weight data for Arctic char sampled at Okak Bay and Cutthroat from August 3 to 18, 1973.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 6 ⁺ | 1 | - | 49.70 | - | - | - | 1.47 | - | - |
| 7 ⁺ | 7 | 44.9-52.3 | 48.07 | 2.82 | 1.06 | 1.05-1.52 | 1.26 | 0.18 | 0.07 |
| 8 ⁺ | 23 | 43.4-59.9 | 49.80 | 4.04 | 0.84 | 0.85-2.98 | 1.42 | 0.46 | 0.10 |
| 9 ⁺ | 49 | 44.4-61.3 | 52.12 | 4.09 | 0.58 | 1.10-2.66 | 1.63 | 0.39 | 0.06 |
| 10 ⁺ | 42 | 43.5-60.3 | 52.53 | 3.88 | 0.60 | 0.96-3.12 | 1.69 | 0.43 | 0.07 |
| 11 ⁺ | 41 | 47.8-63.0 | 55.79 | 4.32 | 0.67 | 1.14-2.90 | 1.91 | 0.48 | 0.07 |
| 12 ⁺ | 11 | 48.0-63.6 | 54.41 | 4.86 | 1.46 | 1.13-3.19 | 1.70 | 0.61 | 0.18 |
| 13 ⁺ | 14 | 51.0-66.5 | 59.66 | 5.54 | 1.48 | 1.42-2.95 | 2.33 | 0.54 | 0.14 |
| 14 ⁺ | 1 | - | 56.50 | - | - | - | 2.02 | - | - |
| 15 ⁺ | 2 | 55.8-60.9 | 58.35 | 3.61 | 2.55 | 1.82-2.47 | 2.15 | 0.46 | 0.33 |
| SUMMARY: 191 | | 43.4-66.5 | 53.32 | 4.98 | 0.36 | 0.85-3.19 | 1.73 | 0.50 | 0.04 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 1 | - | 0.92 | 0.89 |
| 43.0-44.9 | 5 | 0.96-1.45 | 1.13 | 1.01 |
| 45.0-46.9 | 8 | 0.85-1.23 | 1.09 | 1.14 |
| 47.0-48.9 | 38 | 1.04-1.89 | 1.28 | 1.28 |
| 49.0-50.9 | 31 | 1.16-1.87 | 1.40 | 1.43 |
| 51.0-52.9 | 50 | 1.31-2.45 | 1.59 | 1.59 |
| 53.0-54.9 | 29 | 1.31-2.02 | 1.67 | 1.76 |
| 55.0-56.9 | 23 | 1.41-2.76 | 1.91 | 1.94 |
| 57.0-58.9 | 21 | 1.63-2.98 | 2.05 | 2.14 |

Appendix II ... (viii) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 59.0-60.9 | 18 | 1.77-2.85 | 2.33 | 2.34 |
| 61.0-62.9 | 9 | 1.56-2.90 | 2.37 | 2.56 |
| 63.0-64.9 | 8 | 2.06-3.19 | 2.79 | 2.79 |
| 65.0-66.9 | 7 | 2.26-3.75 | 2.99 | 3.03 |
| 67.0-68.9 | 2 | 3.43-3.69 | 3.56 | 3.28 |
| 69.0-70.9 | 1 | - | 3.61 | 3.55 |
| 71.0-72.9 | | | | |
| 73.0-74.9 | | | | |
| 75.0-76.9 | 1 | - | 4.30 | 4.43 |
| 77.0-78.9 | | | | |
| 79.0-80.9 | | | | |
| 81.0-82.9 | 1 | - | 5.77 | 5.44 |

SUMMARY: N = 253

Regression Equation: $\log W = 2.6984 \log L - 4.4278$
 Correlation Coefficient = 0.9957

Appendix II ... (ix). Age, length and weight data for Arctic char sampled at Okak Bay on July 31, 1974.

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 7 ⁺ | 1 | - | 52.00 | - | - | - | 1.55 | - | - |
| 8 ⁺ | 1 | - | 55.10 | - | - | - | 1.80 | - | - |
| 9 ⁺ | 14 | 47.5-67.5 | 52.94 | 5.32 | 1.42 | 1.30-3.90 | 1.81 | 0.69 | 0.18 |
| 10 ⁺ | 33 | 49.0-65.0 | 55.66 | 4.66 | 0.81 | 1.22-3.24 | 1.94 | 0.56 | 0.10 |

Appendix II ... (ix) cont'd

| Number of annuli | Number of fish | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
|------------------|----------------|-----------|-------|--------------|--------------|-----------|------|--------------|--------------|
| 11 ⁺ | 37 | 47.4-67.6 | 55.42 | 5.81 | 0.96 | 1.14-3.72 | 1.87 | 0.67 | 0.11 |
| 12 ⁺ | 28 | 49.7-76.2 | 57.11 | 6.31 | 1.19 | 1.35-4.81 | 2.21 | 0.81 | 0.15 |
| 13 ⁺ | 22 | 48.0-72.6 | 57.33 | 5.79 | 1.23 | 1.08-4.14 | 2.23 | 0.72 | 0.15 |
| 14 ⁺ | 18 | 46.7-75.7 | 59.54 | 7.37 | 1.74 | 1.14-3.84 | 2.35 | 0.81 | 0.19 |
| 15 ⁺ | 5 | 51.5-70.9 | 61.74 | 9.00 | 4.03 | 1.78-4.21 | 2.79 | 1.02 | 0.46 |
| 16 ⁺ | 3 | 61.9-70.4 | 65.33 | 4.48 | 2.59 | 3.10-4.67 | 3.62 | 0.91 | 0.52 |
| 17 ⁺ | 1 | - | 69.70 | - | - | - | 4.35 | - | - |
| 18 ⁺ | 1 | - | 48.50 | - | - | - | 1.45 | - | - |
| 19 ⁺ | 1 | - | 54.50 | - | - | - | 1.84 | - | - |
| SUMMARY: 165 | | 46.7-76.2 | 56.63 | 6.27 | 0.49 | 1.08-4.81 | 2.11 | 0.78 | 0.06 |

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 45.0-46.9 | 1 | - | 1.14 | 1.125 |
| 47.0-48.9 | 7 | 1.08-1.45 | 1.27 | 1.271 |
| 49.0-50.9 | 29 | 1.15-1.67 | 1.37 | 1.429 |
| 51.0-52.9 | 24 | 1.42-1.97 | 1.65 | 1.599 |
| 53.0-54.9 | 29 | 1.37-2.01 | 1.73 | 1.782 |
| 55.0-56.9 | 17 | 1.64-2.49 | 1.87 | 1.978 |
| 57.0-58.9 | 25 | 1.15-2.57 | 2.09 | 2.187 |
| 59.0-60.9 | 13 | 2.22-2.87 | 2.50 | 2.411 |
| 61.0-62.9 | 19 | 2.12-3.14 | 2.65 | 2.648 |
| 63.0-64.9 | 12 | 2.85-3.48 | 3.12 | 2.901 |
| 65.0-66.9 | 5 | 2.77-3.99 | 3.22 | 3.168 |
| 67.0-68.9 | 4 | 3.10-3.90 | 3.64 | 3.451 |

Appendix II ... (ix) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 69.0-70.9 | 6 | 3.20-4.78 | 4.14 | 3.751 |
| 71.0-72.9 | 3 | 4.14-4.22 | 4.18 | 4.066 |
| 73.0-74.9 | | | | |
| 75.0-76.9 | 3 | 3.48-4.81 | 3.98 | 4.748 |

SUMMARY: N = 197 Regression Equation: $\text{Log } W = 2.8651 \text{ Log } L - 4.7114$
Correlation Coefficient = 0.9891



Appendix III

Summary of age, length and weight data
for Arctic char; major fishing areas.

- (i) Voisey Area
- (ii) Nain Area
- (iii) Okak Area



Appendix III ... (i). Voisey Area.

=====

| | | Sexes Combined | | | | | | | |
|------------------|----------------|------------------|-------|--------------|--------------|---------------------|------|--------------|--------------|
| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H. On Weight (kg) | | | |
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 6 ⁺ | 1 | - | 44.90 | - | - | - | 1.03 | - | - |
| 7 ⁺ | 27 | 43.1-59.0 | 49.27 | 4.36 | 0.84 | 0.91-2.38 | 1.34 | 0.35 | 0.07 |
| 8 ⁺ | 104 | 43.0-66.5 | 52.02 | 4.48 | 0.44 | 0.88-3.71 | 1.66 | 0.50 | 0.05 |
| 9 ⁺ | 108 | 45.4-72.2 | 54.23 | 4.72 | 0.45 | 0.99-3.97 | 1.84 | 0.57 | 0.05 |
| 10 ⁺ | 56 | 44.8-67.1 | 55.19 | 5.32 | 0.71 | 0.97-4.02 | 1.99 | 0.65 | 0.09 |
| 11 ⁺ | 23 | 48.5-65.9 | 56.65 | 5.14 | 1.07 | 1.04-3.41 | 2.08 | 0.70 | 0.15 |
| 12 ⁺ | 9 | 49.6-65.0 | 58.13 | 4.76 | 1.59 | 1.31-3.46 | 2.50 | 0.66 | 0.22 |
| 13 ⁺ | 3 | 53.0-63.1 | 57.37 | 5.19 | 2.99 | 1.70-2.67 | 2.14 | 0.49 | 0.28 |
| SUMMARY: | 331 | 43.0-72.2 | 53.57 | 5.16 | 0.28 | 0.88-4.02 | 1.81 | 0.60 | 0.03 |

Appendix III ... (i) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 1 | - | 1.40 | 0.97 |
| 43.0-44.9 | 11 | 0.81-1.11 | 0.98 | 1.09 |
| 45.0-46.9 | 20 | 0.91-1.29 | 1.14 | 1.23 |
| 47.0-48.9 | 47 | 0.97-1.52 | 1.24 | 1.38 |
| 49.0-50.9 | 47 | 1.04-1.68 | 1.37 | 1.53 |
| 51.0-52.9 | 60 | 1.26-2.54 | 1.60 | 1.70 |
| 53.0-54.9 | 60 | 1.02-2.21 | 1.76 | 1.88 |
| 55.0-56.9 | 57 | 1.12-2.49 | 1.99 | 2.07 |
| 57.0-58.9 | 33 | 2.00-2.87 | 2.23 | 2.27 |
| 59.0-60.9 | 26 | 1.62-3.01 | 2.49 | 2.48 |
| 61.0-62.9 | 19 | 2.50-3.41 | 2.80 | 2.70 |
| 63.0-64.9 | 6 | 2.67-3.49 | 3.04 | 2.94 |
| 65.0-66.9 | 8 | 3.04-3.71 | 3.41 | 3.19 |
| 67.0-68.9 | 2 | 3.59-4.02 | 3.81 | 3.45 |
| 69.0-70.9 | 2 | 3.62-3.95 | 3.79 | 3.73 |
| 71.0-72.9 | 2 | 3.52-3.97 | 3.75 | 4.01 |
| 73.0-74.9 | 2 | 4.32-4.45 | 4.39 | 4.31 |

SUMMARY: N = 403

Regression Equation: $\log W = 2.6380 \log L - 4.2954$
 Correlation Coefficient = 0.9716

Appendix III ... (ii). Nain Area.

=====

| | | Sexes Combined | | | | | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 3 ⁺ | 8 | 12.8-16.5 | 14.45 | 1.16 | 0.41 | .016-.036 | 0.02 | 0.01 | 0.00 |
| 4 ⁺ | 44 | 14.1-25.0 | 19.25 | 2.08 | 0.32 | .021-.110 | 0.05 | 0.02 | 0.00 |
| 5 ⁺ | 39 | 16.1-30.8 | 20.74 | 3.17 | 0.51 | .038-.220 | 0.07 | 0.04 | 0.01 |
| 6 ⁺ | 29 | 17.3-46.7 | 33.61 | 10.47 | 1.91 | .043-1.15 | 0.49 | 0.37 | 0.07 |
| 7 ⁺ | 132 | 19.4-58.1 | 44.14 | 5.98 | 0.52 | .051-1.91 | 0.94 | 0.30 | 0.03 |
| 8 ⁺ | 266 | 36.2-63.1 | 47.84 | 5.13 | 0.32 | .480-3.02 | 1.21 | 0.45 | 0.03 |
| 9 ⁺ | 207 | 40.1-62.9 | 49.98 | 5.06 | 0.35 | .660-2.82 | 1.41 | 0.47 | 0.03 |
| 10 ⁺ | 113 | 40.0-62.9 | 52.72 | 4.50 | 0.42 | .810-2.99 | 1.62 | 0.47 | 0.04 |
| 11 ⁺ | 37 | 46.2-67.1 | 54.04 | 5.74 | 0.93 | .860-3.42 | 1.70 | 0.62 | 0.10 |
| 12 ⁺ | 18 | 48.5-62.9 | 55.73 | 3.45 | 0.81 | 1.42-2.90 | 2.04 | 0.46 | 0.11 |
| 13 ⁺ | 7 | 50.5-64.2 | 58.30 | 4.87 | 1.84 | 1.47-3.46 | 2.42 | 0.74 | 0.28 |
| 14 ⁺ | 3 | 47.5-61.4 | 52.90 | 7.45 | 4.30 | 1.14-2.80 | 1.74 | 0.92 | 0.53 |
| SUMMARY: | 903 | 12.8-67.1 | 45.52 | 11.00 | 0.36 | .016-3.46 | 1.18 | 0.64 | 0.02 |

Appendix III ... (ii) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 11.0-12.9 | 1 | - | .017 | 0.014 |
| 13.0-14.9 | 10 | .016-.050 | .025 | 0.022 |
| 15.0-16.9 | 7 | .020-.042 | .031 | 0.034 |
| 17.0-18.9 | 33 | .032-.063 | .045 | 0.049 |
| 19.0-20.9 | 44 | .042-.080 | .057 | 0.069 |
| 21.0-22.9 | 24 | .065-.093 | .078 | 0.093 |
| 23.0-24.9 | 5 | .109-.113 | .111 | 0.122 |
| 25.0-26.9 | 5 | .093-.160 | .140 | 0.158 |
| 27.0-28.9 | 4 | .162-.179 | .171 | 0.200 |
| 29.0-30.9 | 2 | .220-.261 | .241 | 0.248 |
| 31.0-32.9 | 1 | - | 0.31 | 0.304 |
| 33.0-34.9 | 2 | .277-.395 | .336 | 0.369 |
| 35.0-36.9 | 3 | 0.45-0.62 | 0.54 | 0.442 |
| 37.0-38.9 | 4 | 0.48-0.60 | 0.61 | 0.525 |
| 39.0-40.9 | 45 | 0.58-0.97 | 0.72 | 0.617 |
| 41.0-42.9 | 94 | 0.62-1.38 | 0.80 | 0.720 |
| 43.0-44.9 | 100 | 0.71-1.43 | 0.92 | 0.834 |
| 45.0-46.9 | 132 | 0.80-1.90 | 1.05 | 0.960 |
| 47.0-48.9 | 121 | 0.80-1.90 | 1.21 | 1.098 |
| 49.0-50.9 | 108 | 1.05-1.91 | 1.33 | 1.250 |
| 51.0-52.9 | 86 | 1.02-1.87 | 1.51 | 1.415 |
| 53.0-54.9 | 85 | 1.23-2.16 | 1.71 | 1.594 |
| 55.0-56.9 | 59 | 0.95-2.60 | 1.82 | 1.789 |
| 57.0-58.9 | 61 | 0.94-3.07 | 2.09 | 1.999 |
| 59.0-60.9 | 26 | 1.36-3.15 | 2.40 | 2.225 |
| 61.0-62.9 | 17 | 2.20-3.46 | 2.68 | 2.468 |
| 63.0-64.9 | 7 | 2.00-3.42 | 2.77 | 2.729 |
| 65.0-66.9 | | | | |
| 67.0-68.9 | 1 | - | 1.51 | 3.305 |
| 69.0-70.9 | | | | |
| 71.0-72.9 | 1 | - | 4.53 | 3.960 |

SUMMARY: N = 1,088

Regression Equation: $\log W = 3.1601 \log L - 5.2707$
 Correlation Coefficient = 0.9931

Appendix III ... (iii). Okak Area.

| | | Sexes Combined | | | | | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 6 ⁺ | 1 | - | 49.70 | - | - | - | 1.47 | - | - |
| 7 ⁺ | 8 | 44.91-52.3 | 48.56 | 2.95 | 1.04 | 1.05-1.55 | 1.30 | 0.20 | 0.07 |
| 8 ⁺ | 34 | 43.4-59.9 | 51.02 | 3.95 | 0.68 | 0.85-2.98 | 1.47 | 0.40 | 0.07 |
| 9 ⁺ | 88 | 42.9-68.0 | 53.16 | 5.13 | 0.55 | 1.10-3.90 | 1.76 | 0.57 | 0.06 |
| 10 ⁺ | 96 | 43.5-74.4 | 55.14 | 6.38 | 0.65 | 0.90-4.96 | 1.88 | 0.65 | 0.07 |
| 11 ⁺ | 95 | 47.4-71.2 | 56.37 | 5.42 | 0.56 | 1.14-4.39 | 1.95 | 0.63 | 0.06 |
| 12 ⁺ | 48 | 48.0-77.9 | 57.85 | 7.09 | 1.02 | 1.13-4.81 | 2.19 | 0.86 | 0.12 |
| 13 ⁺ | 39 | 47.5-79.0 | 58.52 | 6.67 | 1.07 | 1.08-5.11 | 2.32 | 0.79 | 0.13 |
| 14 ⁺ | 22 | 46.7-75.7 | 60.30 | 7.42 | 1.58 | 1.14-3.86 | 2.42 | 0.83 | 0.18 |
| 15 ⁺ | 8 | 51.5-71.5 | 62.11 | 8.06 | 2.85 | 1.78-4.21 | 2.76 | 0.94 | 0.33 |
| 16 ⁺ | 3 | 61.9-70.4 | 65.33 | 4.48 | 2.59 | 3.10-4.67 | 3.62 | 0.91 | 0.52 |
| 17 ⁺ | 1 | - | 69.70 | - | - | - | 4.35 | - | - |
| 18 ⁺ | 1 | - | 48.50 | - | - | - | 1.45 | - | - |
| 19 ⁺ | 1 | - | 54.50 | - | - | - | 1.84 | - | - |
| SUMMARY: | 445 | 42.9-79.0 | 55.53 | 6.30 | 0.30 | 0.85-5.11 | 1.95 | 0.73 | 0.03 |

Appendix III ... (iii) cont'd

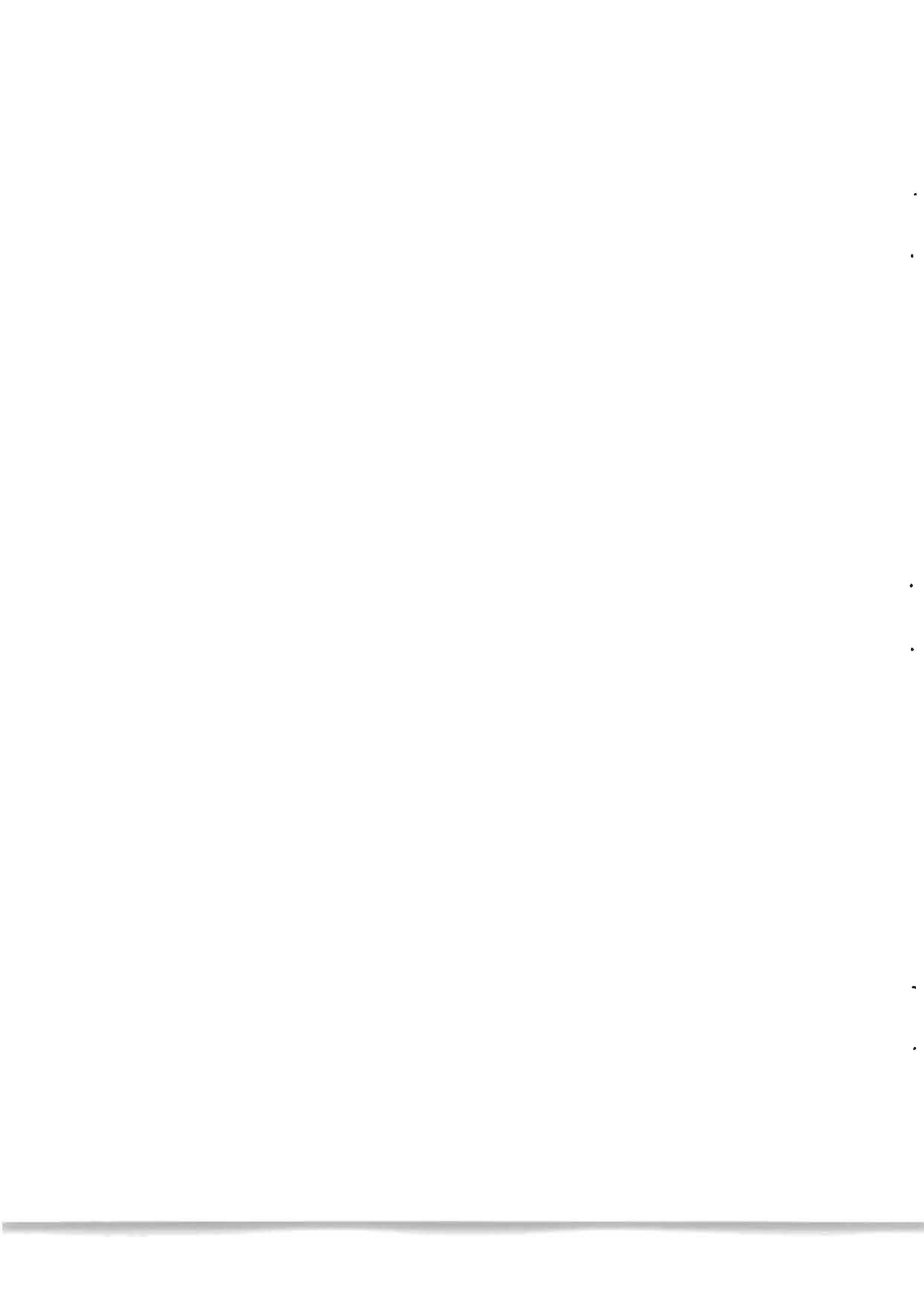
| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 41.0-42.9 | 2 | 0.92-1.30 | 1.11 | 0.93 |
| 43.0-44.9 | 6 | 0.96-1.47 | 1.19 | 1.05 |
| 45.0-46.9 | 9 | 0.85-1.23 | 1.10 | 1.19 |
| 47.0-48.9 | 49 | 0.90-1.89 | 1.27 | 1.33 |
| 49.0-50.9 | 69 | 1.10-1.87 | 1.37 | 1.48 |
| 51.0-52.9 | 87 | 1.31-2.45 | 1.59 | 1.64 |
| 53.0-54.9 | 73 | 1.31-2.02 | 1.67 | 1.81 |
| 55.0-56.9 | 59 | 1.27-2.76 | 1.85 | 2.00 |
| 57.0-58.9 | 60 | 1.15-2.98 | 2.07 | 2.19 |
| 59.0-60.9 | 42 | 1.77-2.87 | 2.35 | 2.40 |
| 61.0-62.9 | 41 | 1.56-3.16 | 2.53 | 2.62 |
| 63.0-64.9 | 27 | 2.06-3.48 | 2.93 | 2.84 |
| 65.0-66.9 | 18 | 2.14-3.99 | 2.96 | 3.09 |
| 67.0-68.9 | 12 | 2.62-3.90 | 3.42 | 3.34 |
| 69.0-70.9 | 8 | 3.20-4.78 | 4.03 | 3.61 |
| 71.0-72.9 | 7 | 3.10-4.39 | 3.96 | 3.89 |
| 73.0-74.9 | 3 | 4.36-4.96 | 4.44 | 4.18 |
| 75.0-76.9 | 5 | 3.48-5.19 | 4.29 | 4.49 |
| 77.0-78.9 | 1 | - | 4.80 | 4.81 |
| 79.0-80.9 | 1 | - | 5.11 | 5.14 |
| 81.0-82.9 | 1 | - | 5.77 | 5.49 |

SUMMARY: N = 580

Regression Equation: $\log W = 2.6480 \log L - 4.3278$
 Correlation Coefficient = 0.9916

Appendix IV

Summary of age, length and weight data
for Arctic char; combined data.



Appendix IV. Combined age, length and weight data for Arctic char sampled at Nain, northern Labrador.

=====

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 3 ⁺ | 8 | 12.8-16.5 | 14.45 | 1.16 | 0.41 | .016-.036 | 0.02 | 0.01 | 0.00 |
| 4 ⁺ | 44 | 14.1-25.0 | 19.25 | 2.08 | 0.32 | .021-.110 | 0.05 | 0.02 | 0.00 |
| 5 ⁺ | 39 | 16.1-30.8 | 20.74 | 3.17 | 0.51 | .038-.220 | 0.07 | 0.04 | 0.01 |
| 6 ⁺ | 31 | 17.3-49.7 | 34.47 | 10.69 | 1.89 | .043-1.47 | 0.55 | 0.41 | 0.07 |
| 7 ⁺ | 167 | 19.4-59.0 | 45.21 | 5.96 | 0.46 | .051-2.38 | 1.04 | 0.36 | 0.03 |
| 8 ⁺ | 404 | 36.2-66.5 | 49.19 | 5.22 | 0.26 | .480-3.71 | 1.35 | 0.49 | 0.02 |
| 9 ⁺ | 403 | 40.1-72.2 | 51.81 | 5.32 | 0.26 | .660-3.97 | 1.61 | 0.56 | 0.03 |
| 10 ⁺ | 265 | 40.0-74.4 | 53.98 | 5.07 | 0.31 | .810-4.96 | 1.78 | 0.58 | 0.04 |
| 11 ⁺ | 155 | 46.2-71.2 | 55.67 | 5.49 | 0.44 | .860-4.39 | 1.91 | 0.65 | 0.05 |
| 12 ⁺ | 75 | 48.0-77.9 | 57.47 | 6.19 | 0.71 | 1.13-4.81 | 2.20 | 0.76 | 0.09 |
| 13 ⁺ | 49 | 47.5-79.0 | 57.68 | 6.20 | 0.94 | 1.08-5.11 | 2.26 | 0.77 | 0.12 |
| 14 ⁺ | 25 | 46.7-75.7 | 60.02 | 7.27 | 1.35 | 1.14-3.86 | 2.40 | 0.81 | 0.15 |
| 15 ⁺ | 8 | 51.5-71.5 | 62.11 | 8.06 | 2.85 | 1.78-4.21 | 2.76 | 0.94 | 0.33 |
| 16 ⁺ | 3 | 61.9-70.4 | 65.33 | 4.48 | 2.59 | 3.10-4.67 | 3.62 | 0.91 | 0.52 |
| 17 ⁺ | 1 | - | 69.70 | - | - | - | 4.35 | - | - |
| 18 ⁺ | 1 | - | 48.50 | - | - | - | 1.45 | - | - |
| 19 ⁺ | 1 | - | 54.50 | - | - | - | 1.84 | - | - |
| SUMMARY | 1679 | 12.8-79.0 | 49.73 | 10.12 | 0.25 | .016-5.11 | 1.50 | 0.75 | 0.02 |

=====

Appendix IV cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------------|----------------------|--------------------|------|------------------------------|
| | | Range | Mean | |
| 11.0-12.9 | 1 | - | .017 | .015 |
| 13.0-14.9 | 10 | .016-.050 | .025 | .024 |
| 15.0-16.9 | 7 | .020-.042 | .031 | .036 |
| 17.0-18.9 | 33 | .032-.063 | .045 | .052 |
| 19.0-20.9 | 44 | .042-.080 | .057 | .072 |
| 21.0-22.9 | 24 | .065-.093 | .078 | .096 |
| 23.0-24.9 | 5 | .109-.113 | .111 | .126 |
| 25.0-26.9 | 5 | .093-.160 | .140 | .161 |
| 27.0-28.9 | 4 | .162-.179 | .171 | .202 |
| 29.0-30.9 | 2 | .220-.261 | .241 | .250 |
| 31.0-32.9 | 1 | - | 0.31 | .304 |
| 33.0-34.9 | 2 | .277-.395 | .336 | .367 |
| 35.0-36.9 | 3 | 0.45-0.62 | 0.54 | .437 |
| 37.0-38.9 | 4 | 0.48-0.60 | 0.61 | .516 |
| 39.0-40.9 | 45 | 0.58-0.97 | 0.72 | .604 |
| 41.0-42.9 | 97 | 0.62-1.40 | 0.81 | .701 |
| 43.0-44.9 | 117 | 0.71-1.47 | 0.94 | .809 |
| 45.0-46.9 | 161 | 0.80-1.90 | 1.06 | .927 |
| 47.0-48.9 | 217 | 0.80-1.90 | 1.23 | 1.06 |
| 49.0-50.9 | 224 | 1.04-1.91 | 1.35 | 1.20 |
| 51.0-52.9 | 233 | 1.02-2.54 | 1.56 | 1.35 |
| 53.0-54.9 | 218 | 1.02-2.21 | 1.71 | 1.51 |
| 55.0-56.9 | 175 | 0.95-2.76 | 1.89 | 1.69 |
| 57.0-58.9 | 154 | 0.94-3.07 | 2.11 | 1.89 |
| 59.0-60.9 | 94 | 1.36-3.15 | 2.40 | 2.09 |
| 61.0-62.9 | 77 | 1.56-3.46 | 2.63 | 2.31 |
| 63.0-64.9 | 40 | 2.00-3.49 | 2.92 | 2.55 |
| 65.0-66.9 | 26 | 2.14-3.99 | 3.10 | 2.80 |
| 67.0-68.9 | 15 | 1.51-4.02 | 3.34 | 3.07 |
| 69.0-70.9 | 10 | 3.20-4.78 | 3.98 | 3.36 |
| 71.0-72.9 | 10 | 3.10-4.53 | 3.98 | 3.66 |
| 73.0-74.9 | 5 | 4.32-4.96 | 4.42 | 3.98 |
| 75.0-76.9 | 5 | 3.48-5.19 | 4.29 | 4.32 |
| 77.0-78.9 | 1 | - | 4.80 | 4.68 |
| 79.0-80.9 | 1 | - | 5.11 | 5.05 |
| 81.0-82.9 | 1 | - | 5.77 | 5.45 |

SUMMARY: N = 2,071

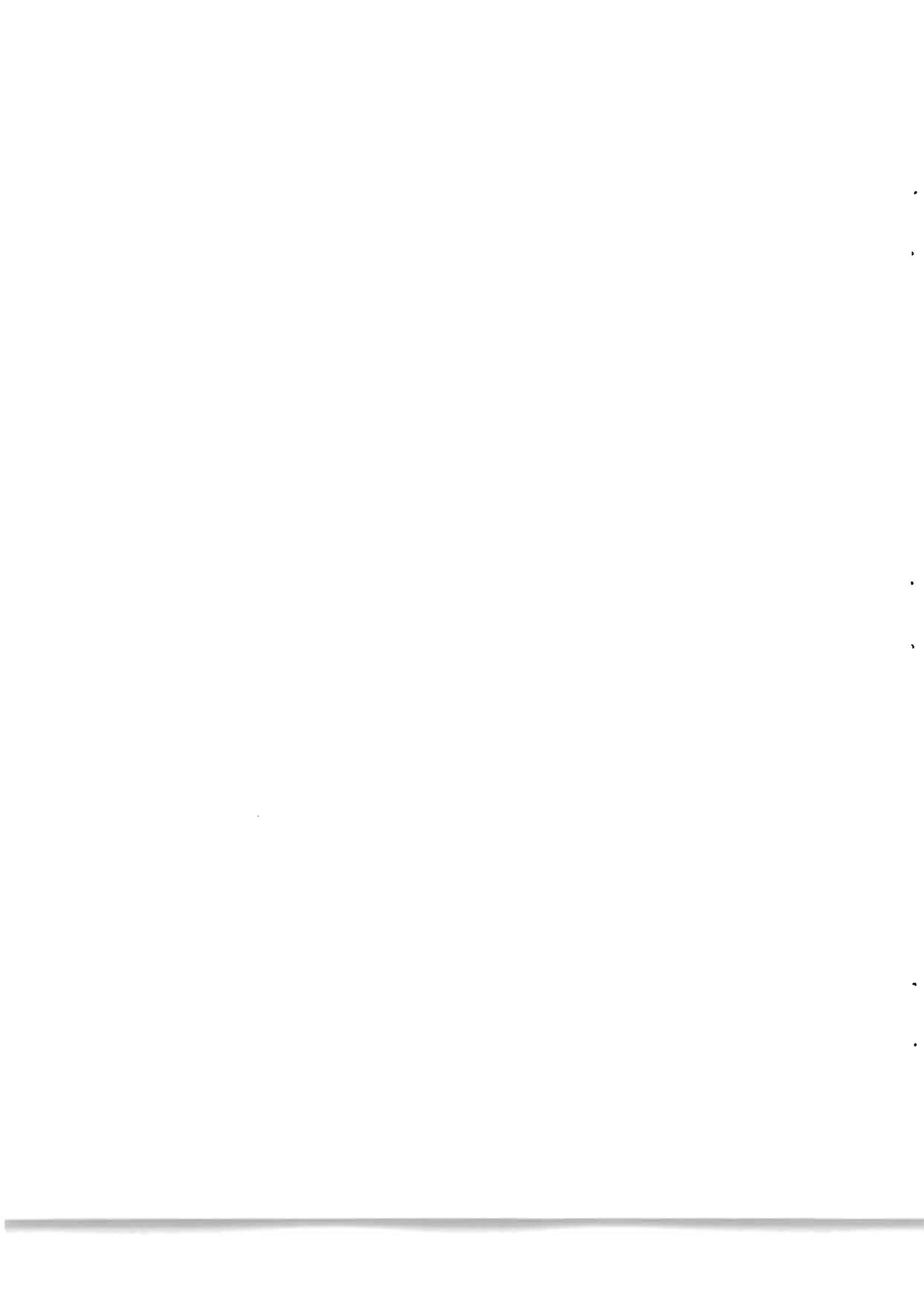
Regression Equation: $\log W = 3.0627 \log L - 5.1242$
 Correlation Coefficient = 0.9823

Appendix V

Comparison of age, length and weight data
for male and female Arctic char sampled at Unity Bay.

(i) males

(ii) females



Appendix V ... (i). Age, length and weight data for male Arctic char sampled at Unity Bay, July-August 1973, and 1974.

Sexes Combined

| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 4 ⁺ | 12 | 15.3-23.2 | 19.93 | 2.24 | 0.65 | .031-.110 | 0.06 | 0.02 | 0.01 |
| 5 ⁺ | 13 | 16.1-28.1 | 20.81 | 3.25 | 0.90 | .030-.166 | 0.07 | 0.04 | 0.01 |
| 6 ⁺ | 11 | 17.3-46.7 | 34.01 | 11.24 | 3.39 | .043-1.15 | 0.53 | 0.43 | 0.13 |
| 7 ⁺ | 49 | 36.0-58.1 | 44.88 | 4.67 | 0.67 | 0.45-1.87 | 0.95 | 0.31 | 0.04 |
| 8 ⁺ | 88 | 37.4-63.1 | 47.75 | 5.55 | 0.59 | 0.56-3.02 | 1.23 | 0.52 | 0.06 |
| 9 ⁺ | 42 | 40.2-62.3 | 48.59 | 6.06 | 0.94 | 0.66-2.82 | 1.32 | 0.55 | 0.08 |
| 10 ⁺ | 3 | 53.3-62.9 | 58.50 | 4.85 | 2.80 | 1.62-2.90 | 2.24 | 0.64 | 0.37 |
| 11 ⁺ | 1 | - | 54.20 | - | - | - | 2.16 | - | - |
| | 219 | 15.3-63.1 | | | | .030-3.02 | | | |

Appendix V ... (i) cont'd

| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 13.0-14.9 | 2 | .011-.025 | .018 | .018 |
| 15.0-16.9 | 2 | - | .030 | .028 |
| 17.0-18.9 | 8 | .038-.052 | .045 | .042 |
| 19.0-20.9 | 9 | .044-.065 | .056 | .060 |
| 21.0-22.9 | 12 | .065-.093 | .080 | .083 |
| 23.0-24.9 | 1 | - | .110 | .111 |
| 25.0-26.9 | 1 | - | .120 | .146 |
| 27.0-28.9 | 2 | .166-.174 | .170 | .187 |
| 29.0-30.9 | - | - | - | - |
| 31.0-32.9 | 1 | - | .310 | .293 |
| 33.0-34.9 | - | - | - | - |
| 35.0-36.9 | 1 | - | .450 | .436 |
| 37.0-38.9 | 3 | .560-.600 | .587 | .522 |
| 39.0-40.9 | 15 | .600-.810 | .675 | .621 |
| 41.0-42.9 | 43 | .620-1.38 | .776 | .731 |
| 43.0-44.9 | 30 | .710-1.43 | .908 | .855 |
| 45.0-46.9 | 34 | .800-1.46 | 1.06 | .993 |
| 47.0-48.9 | 27 | .800-1.41 | 1.17 | 1.15 |
| 49.0-50.9 | 17 | 1.06-1.62 | 1.33 | 1.31 |
| 51.0-52.9 | 12 | 1.40-1.80 | 1.59 | 1.50 |
| 53.0-54.9 | 18 | 1.39-2.16 | 1.76 | 1.70 |
| 55.0-56.9 | 8 | 1.80-2.22 | 2.00 | 1.92 |
| 57.0-58.9 | 10 | 1.12-2.58 | 2.02 | 2.16 |
| 59.0-60.9 | 8 | 1.36-3.15 | 2.43 | 2.43 |
| 61.0-62.9 | 6 | 2.20-2.90 | 2.49 | 2.71 |
| 63.0-64.9 | 2 | 2.00-3.02 | 2.51 | 3.01 |

SUMMARY: N = 272

Regression Equation: $\log W = 3.3580 \log L - 5.5850$
 Correlation Coefficient = 0.9987

Appendix v ... (ii). Age, length and weight data for female Arctic char sampled at Unity Bay, July-August 1973, and 1974.

=====

| | | Sexes Combined | | | | | | | |
|------------------|----------------|------------------|-------|--------------|--------------|--------------------|------|--------------|--------------|
| Number of annuli | Number of fish | Fork Length (cm) | | | | G.H.On Weight (kg) | | | |
| | | Range | Mean | s.d. of mean | s.e. of mean | Range | Mean | s.d. of mean | s.e. of mean |
| 4 ⁺ | 16 | 14.7-21.4 | 18.79 | 1.73 | 0.43 | .021-.072 | 0.05 | 0.01 | 0.00 |
| 5 ⁺ | 16 | 16.4-30.8 | 21.51 | 3.77 | 0.94 | .038-.220 | 0.09 | 0.06 | 0.01 |
| 6 ⁺ | 16 | 18.2-42.9 | 34.26 | 9.63 | 2.41 | .048-.830 | 0.52 | 0.34 | 0.08 |
| 7 ⁺ | 62 | 19.1-56.7 | 42.43 | 6.90 | 0.88 | .045-1.43 | 0.90 | 0.30 | 0.04 |
| 8 ⁺ | 88 | 36.2-58.7 | 45.90 | 4.61 | 0.49 | .480-2.14 | 1.03 | 0.30 | 0.03 |
| 9 ⁺ | 45 | 40.1-56.1 | 47.20 | 4.19 | 0.62 | .710-1.67 | 1.10 | 0.25 | 0.04 |
| 10 ⁺ | 18 | 40.0-55.2 | 47.49 | 3.91 | 0.92 | .810-1.89 | 1.11 | 0.30 | 0.07 |
| 11 ⁺ | 7 | 46.8-67.1 | 52.71 | 7.86 | 2.97 | .860-2.21 | 1.35 | 0.47 | 0.19 |
| 268 | | 14.7-67.1 | | | | .021-2.21 | | | |

Appendix v... (ii) cont'd

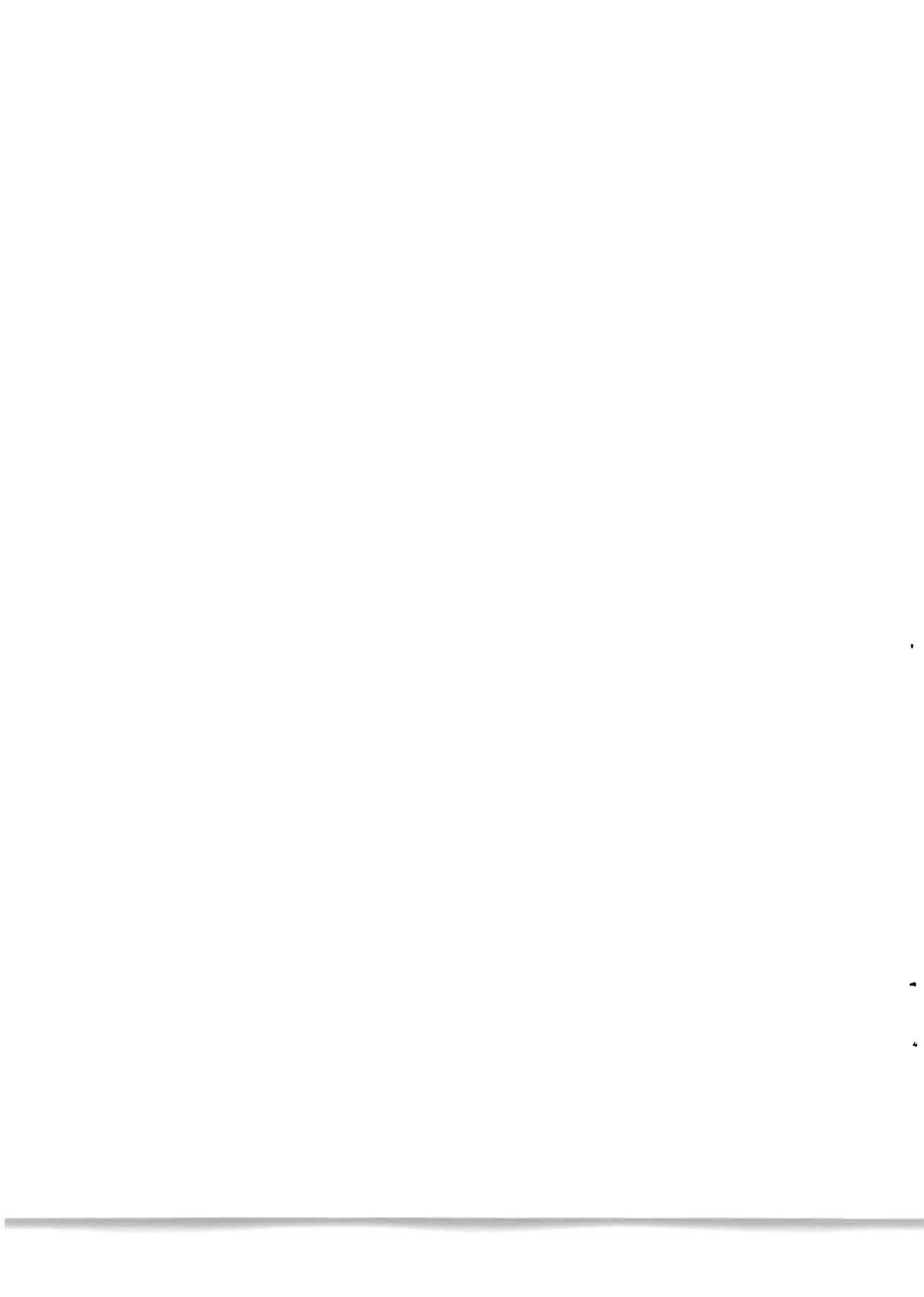
| Length Category (cm) | Number of fish | G.H.On Weight (kg) | | Calculated Weight (kg) |
|----------------------|----------------|--------------------|------|------------------------|
| | | Range | Mean | |
| 13.0-14.9 | 2 | .021-.023 | .022 | 0.023 |
| 15.0-16.9 | 1 | - | .042 | 0.034 |
| 17.0-18.9 | 12 | .032-.053 | .044 | 0.050 |
| 19.0-20.9 | 19 | .042-.075 | .057 | 0.069 |
| 21.0-22.9 | 10 | .066-.089 | .078 | 0.092 |
| 23.0-24.9 | 3 | .109-.113 | .111 | 0.120 |
| 25.0-26.9 | 3 | .142-.160 | .148 | 0.154 |
| 27.0-28.9 | 2 | .162-.179 | .171 | 0.193 |
| 29.0-30.9 | 2 | .220-.261 | .241 | 0.239 |
| 31.0-32.9 | - | | | |
| 33.0-34.9 | 2 | .277-.395 | .336 | 0.352 |
| 35.0-36.9 | 2 | .530-.620 | .575 | 0.420 |
| 37.0-38.9 | 1 | - | .480 | 0.496 |
| 39.0-40.9 | 29 | .580-.870 | .721 | 0.580 |
| 41.0-42.9 | 47 | .650-1.34 | .814 | 0.674 |
| 43.0-44.9 | 53 | .750-1.09 | .907 | 0.778 |
| 45.0-46.9 | 48 | .800-1.26 | 1.02 | 0.892 |
| 47.0-48.9 | 31 | .900-1.43 | 1.18 | 1.02 |
| 49.0-50.9 | 24 | 1.05-1.67 | 1.29 | 1.15 |
| 51.0-52.9 | 16 | 1.17-1.60 | 1.40 | 1.30 |
| 53.0-54.9 | 7 | 1.23-1.79 | 1.51 | 1.46 |
| 55.0-56.9 | 7 | 0.95-1.89 | 1.33 | 1.64 |
| 57.0-58.9 | 6 | 1.30-3.07 | 2.09 | 1.82 |
| 59.0-60.9 | 0 | - | - | - |
| 61.0-62.9 | 0 | - | - | - |
| 63.0-64.9 | 0 | - | - | - |
| 65.0-66.9 | | | | |
| 67.0-68.9 | 1 | - | 1.51 | 2.97 |

SUMMARY: N = 328

Regression Equation: $\log W = 3.0757 \log L - 5.1621$
 Correlation Coefficient = 0.9891

Appendix VI

Round/Dressed (G.H.On) weight relationship
in Arctic char sampled at Nain Bay.



Appendix VI. Round/Dressed (G.H.On) weight relationship.

| Dressed Wt. Category | Number of fish | Round Wt. Range | Round Wt. Mean | Calculated Weight |
|----------------------|----------------|-----------------|----------------|-------------------|
| 0.80 - 0.89 | 76 | 0.91 - 1.31 | 1.02 | 1.00 |
| 0.90 - 0.99 | 39 | 1.04 - 1.22 | 1.16 | 1.12 |
| 1.00 - 1.09 | 32 | 1.13 - 1.82 | 1.29 | 1.24 |
| 1.10 - 1.19 | 46 | 0.96 - 1.53 | 1.36 | 1.37 |
| 1.20 - 1.29 | 26 | 1.55 - 1.65 | 1.56 | 1.49 |
| 1.30 - 1.39 | 26 | 1.47 - 1.76 | 1.61 | 1.61 |
| 1.40 - 1.49 | 11 | 1.70 - 1.87 | 1.77 | 1.73 |
| 1.50 - 1.59 | 15 | 1.48 - 2.09 | 1.85 | 1.85 |
| 1.60 - 1.69 | 7 | 1.85 - 2.09 | 1.95 | 1.97 |
| 1.70 - 1.79 | 9 | 2.03 - 2.34 | 2.19 | 2.09 |
| 1.80 - 1.89 | 8 | 1.94 - 2.30 | 2.19 | 2.22 |
| 1.90 - 1.99 | 4 | 2.22 - 2.37 | 2.31 | 2.34 |
| 2.00 - 2.09 | 6 | 2.40 - 2.56 | 2.47 | 2.46 |
| 2.10 - 2.19 | 3 | 1.39 - 2.64 | 2.20 | 2.58 |
| 2.20 - 2.29 | 5 | 2.42 - 2.75 | 2.61 | 2.70 |
| 2.30 - 2.39 | 4 | 2.74 - 2.91 | 2.82 | 2.82 |
| 2.40 - 2.49 | 1 | 2.96 | 2.96 | 2.94 |
| 2.50 - 2.59 | 5 | 2.95 - 3.11 | 3.02 | 3.07 |
| 2.60 - 2.69 | 2 | 3.15 - 3.35 | 3.25 | 3.19 |
| 2.70 - 2.79 | 1 | 3.59 | 3.59 | 3.31 |
| 2.80 - 2.89 | 2 | 3.32 - 3.47 | 3.40 | 3.43 |
| 2.90 - 2.99 | 1 | 3.61 | 3.61 | 3.55 |
| 3.00 - 3.09 | 1 | 3.52 | 3.52 | 3.67 |
| 3.10 - 3.19 | 2 | 3.70 - 3.97 | 3.84 | 3.80 |

Predictive Regression
Slope (b) Intercept (a)

1.2047 -0.0114

Functional Regression
Slope (v) Intercept (u)

1.2150 -0.0323

r N
.99 332

