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Broad Whitefish (Coregonus nasus) of the Lower Mackenzie River: Biological Characteristics, Commercial and Subsistence Harvest Trends, and Local Management Issues

by

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Broad Whitefish (Coregonus nasus) of the Lower Mackenzie River: Biological Characteristics, Commercial and Subsistence Harvest Trends, and Management Issues

By

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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfilment of the requirements of the degree of Master of Natural Resources Management.

ABSTRACT

Anadromous broad whitefish from the lower Mackenzie River region may be comprised of several discrete stocks with mature fish migrating from the Beaufort Sea coast to upstream locations to spawn. People from the communities of Tuktoyaktuk, Aklavik, Inuvik, Ft. McPherson, Tsiigehtchic and Ft. Good Hope harvest broad whitefish for subsistence and commercial purposes from camps scattered throughout the region. Three aspects of broad whitefish management were examined to assist in the formulation of a fishery management strategy: 1) Biological samples from 1984 to 1989 from the Delta were examined for within-year and/or between-year heterogeneity; 2) Subsistence and commercial harvests were examined, and current harvest levels were estimated; and 3) Local harvesters were interviewed to gain insight into management issues. Differences were observed in certain biological parameters, particularly age- and length- frequency distributions. This variability may be due to the existence of discrete stocks or may be an artifact of small sample sizes and gear selectivity. The annual broad whitefish harvest was estimated to be between 100,000 and 300,000 kg. The subsistence portion was found to comprised 62% to 98% of the total harvest for 1983 to 1990. Commercial fisheries for the local market are small (approximately 5,000 kg), and export fisheries have operated only sporadically. Communities with easy road access were interested in examining the potential for commercial development. Most people interviewed thought the population(s) could support an increased harvest, although there was concern expressed by some who suggested development should proceed cautiously in order to protect the subsistence fishery. Management is the responsibility of the Department of Fisheries and Oceans in partnership with the Inuvialuit Fisheries Joint Management Committee and the Gwich'in and Sahtu Renewable Resources Boards. These groups are advised to develop a management plan jointly, and to co-ordinate research activities and commercial development for this shared resource. An adaptive management strategy is proposed in light of the limited biological information available.

ACKNOWLEDGEMENTS

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I am thankful to the representatives of the Hunters and Trappers Committees and Renewable Resources Councils as well as others in the communities of Tuktoyaktuk, Inuvik, Aklavik, Ft. McPherson, Tsiigehtchic and Ft. Good Hope who shared their knowledge and concerns about broad whitefish fisheries with me, their hospitality was very much appreciated. Thanks also to Mr. B. Day of Inuvik for providing the samples of broad whitefish used in this study. The support of the Department of Fisheries and Oceans staff in Inuvik (R. Allen, L. Dahlke, W. Day, V. Gillman, L. Harwood, P. Lemieux, N. Robinson and B. Webster) was greatly appreciated. The assistance provided by staff at the Freshwater Institute, particularly the Arctic Fisheries Ecology and Assessment Research Section was also appreciated. A special thanks to: Laura Anderson and Colette Craig who provided harvest information; Ron Lypka who provided computer programming advice; Ken Mills, John Babaluk and Rick Wastle who taught me how to prepare and age fin-rays and otoliths; Laura Heuring who helped prepare the fin-rays for aging; and Ross Tallman who made it possible for me to visit the above communities.

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At the Natural Resources Institute I met many interesting people with a variety of different backgrounds who gave me a wider perspective on resource issues. Friends like Sherri Dangerfield and Carl Hrenchuk made it easier to get through the tough times and Chris McDonald and Judy Zieske were there to offer advice or help with administration.

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INTRODUCTION

1.1 BACKGROUND INFORMATION

The Mackenzie River, located in the western Canadian Arctic (Fig. 1), drains a total area of 1.8 x 10^6 km^2 and is the fourth largest river flowing into the Arctic Ocean (Rosenburg and Barton 1986). The river covers 15° of latitude and therefore includes many diverse habitats, used by a variety of economically important fishes, one of which is the broad whitefish (<u>Coregonus</u> <u>nasus</u> (Pallas)).

Hydrocarbon exploration and development during the early 1970's prompted several studies on the natural resources of the Mackenzie River basin which included the fisheries of the delta region. Work has continued and recent studies have shown that the Mackenzie Basin broad whitefish represent a discrete population, genetically different from other anadromous broad whitefish found in rivers to the east and west (Reist 1987). Also, there is evidence suggesting the existence of separate sub-populations or stocks within the lower Mackenzie River region[1] broad whitefish (Dr. J. Reist, DFO-Winnipeg, personal communication).

The term "stock" may take on a different meaning depending on who is using it and in what context it is used. For example, to a fish harvester a stock may refer to a group of fish from a particular region which are vulnerable to the gear used. This "fishery stock" may or may not include several different species, populations, or sub-populations (Gauldie 1991). A genetic stock is defined as a genetically isolated group of individuals which are not intrinsically reproductively isolated from other stocks but maintain genetic distinctness through spatial and/or temporal separation of spawning (Bailey and Smith 1981). The

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[1]Here the lower Mackenzie River region includes that portion of the Mackenzie River downstream of the Ramparts Rapids near Ft. Good Hope, the Mackenzie Delta, the Peel River, the Arctic Red River, and the nearshore waters of the Beaufort Sea.

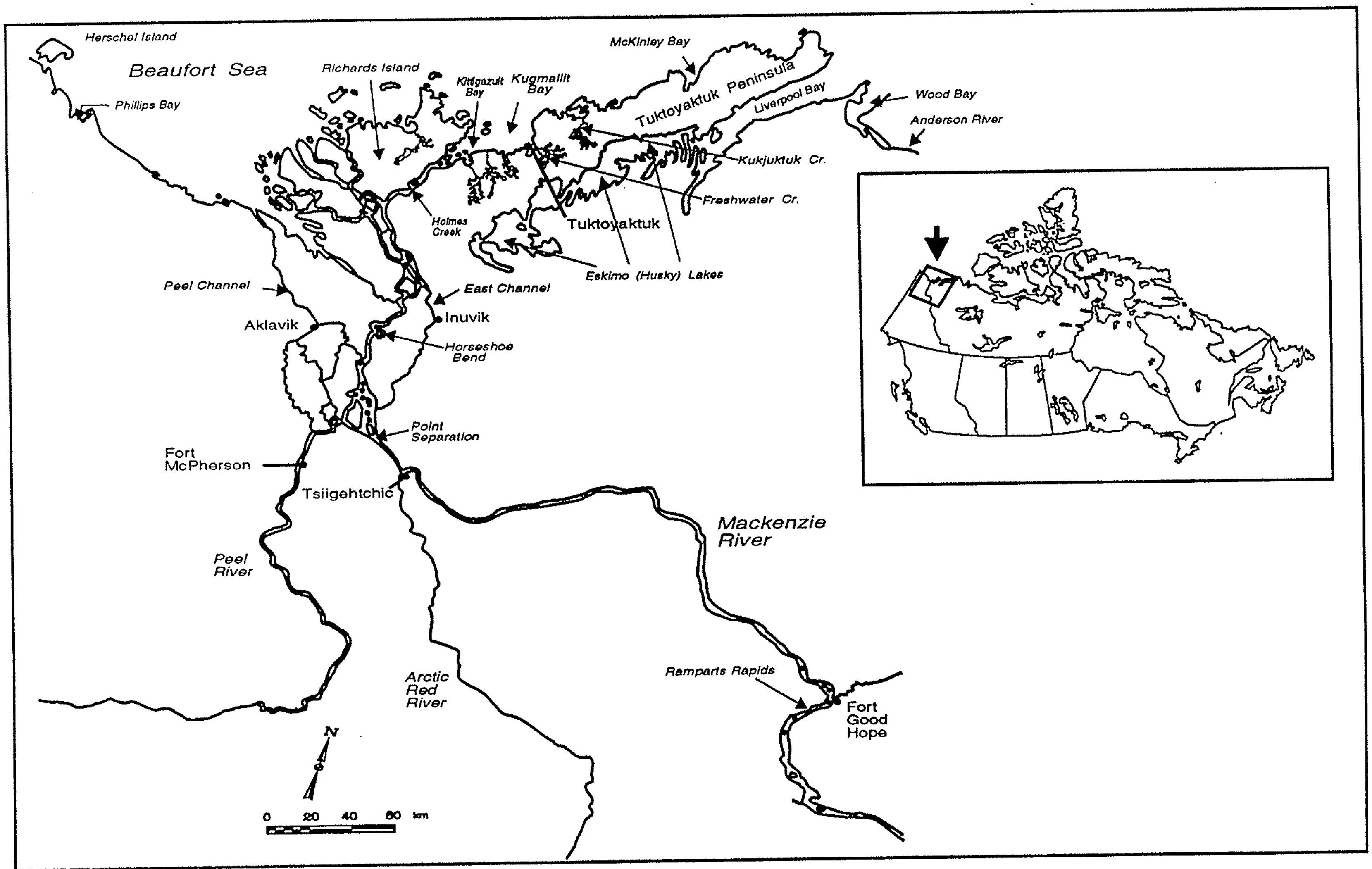


Figure 1. The Lower Mackenzie River region with the location of communities and other pertinent areas. (Base map was provided by Ken Chang-Kue, Department of Fisheries and Oceans, Winnipeg, Manitoba).

latter definition can also be referred to as a biological population and is the definition of stock which will be used in this practicum.

It is important from a management perspective to determine whether separate stocks exist, and if so, do they exhibit different values for typical population parameters of relevance in the determination of abundance of the stock. Fishery modelling techniques used by fisheries scientists and managers to determine abundance assume that the parameters of reproduction, growth, mortality, etc. are homogenous throughout the stock in question. If this assumption is incorrect or if a mixture of stocks are being harvested, then the models and their predictions of abundance become invalid. Some fisheries scientists and managers advocate what is called adaptive management (Walters 1986). They feel that traditional fisheries models are unable to predict abundance and yields on a consistent basis even when they are dealing with a known stock because of the lack of sufficient data and the dynamic nature of fish populations and their environment.

There are two and possibly three life history types or groups of broad whitefish within the lower Mackenzie River basin that have distinct life history characteristics (Reist 1987; Reist and Bond 1988). The anadromous life history type moves between upstream spawning areas in rivers and possibly lakes, and feeding and overwintering areas in the nearshore marine environment during their life cycle. The lacustrine life history type is characterized by fish that remain in lakes and associated river environments for their entire life-cycle. Fish of the riverine life history type, which have not been confirmed as being present in the Mackenzie River, restrict movement and migration to the river environment. It is likely that several stocks exist within each of the above life history types but this has not been demonstrated conclusively (Reist, at review); some spawning areas have been located (Chang-Kue and Jessop 1983; 1992; 1994) and several mark/recapture programs have been undertaken to document the spatial and temporal distribution of the broad whitefish of the lower Mackenzie River region (Stein et al. 1973a, 1973b; Bond and Erickson 1982, 1985; Chang-Kue and Jessop 1983, 1992, 1994; Babaluk et al. at review). The extent to which stock mixing might occur is not known. Mixing of stocks may or may not occur prior to spawning during the pre-spawning feeding and migratory phases of their life-cycle. Therefore, the life-cycle of broad whitefish from the Mackenzie River is extremely complex. Fisheries managers must recognize this and adjust management policies accordingly.

The lower Mackenzie River region supports important subsistence and commercial fisheries for broad whitefish of the various life history types. They are harvested by people from Inuvik, Aklavik, Tuktoyaktuk, Fort McPherson, Tsiigehtchic (formerly Arctic Red River), and Fort Good Hope (Fig. 1). Fishing pressure is most intensive during the fall and early winter when the fish are gathering in pre-spawning aggregations, migrating to spawning sites, and during spawning.

In the past, the commercial fishery has been responsible for only a small portion of the total whitefish harvest. From 1972 to 1989 commercial sales in this region were to the small local market only. The majority of the total harvest goes to subsistence consumption. With the introduction of snow machines, the need for fish for dog food was reduced considerably. Also, the increased dependence on a wage economy reduced the time available for subsistence fishing. However, country foods are still very popular and frequently consumed by most households (Wein and Freeman 1992; Lutra Associates 1989) so wage earners who previously caught their own fish may now be buying fish from commercial fish harvesters or receiving fish in trade or as gifts from relatives and friends.

In 1989 the Inuvialuit HTC in Inuvik and the Government of the Northwest Territories (GNWT) Economic Development and Tourism Department began investigating the possibility of establishing an export commercial fishery along a stretch of the Middle Channel north of Horseshoe Bend in the central delta of the Mackenzie River (Fig. 1). The Department of Fisheries and Oceans responded by issuing an exploratory fishery licence for each of the years 1989 to 1993. In addition to broad whitefish, inconnu (Stenodus leucichthys (Guldenstadt)) and northern pike (Esox lucius (Linnaeus)) were harvested and sold. Lake whitefish (Coregonus clupeaformis (Mitchell)) were only harvested and sold to the FFMC in 1989 because they were found to be of poor quality due to the high cyst count of the tapeworm Triaenophorus crassus.

Improved processing facilities and refrigerated transport trucks have helped improve the feasibility of a commercial fishery in the Mackenzie Delta. However, at this time the price of whitefish is low and markets are weak. Better prices, more and/or larger markets and an increased quota are all required for this fishery to be economically sustainable (RT and Assoc. 1994; Anderson 1995).

The Department of Fisheries and Oceans (DFO) is responsible for fisheries management in the Northwest Territories (NWT) under section 43 of the Fisheries Act. Specifics are stipulated in the Northwest Territories Fishery Regulations. In December 1975, five commercial fisheries management areas were created in the Mackenzie Delta (Government of Canada 1975). Broad whitefish harvests from the communities of Ft. McPherson and Ft. Good Hope, which lay outside the area boundaries were reported separately. In 1991 the boundaries were realigned and Area Five was extended upstream to include the community of Ft. Good Hope (Government of Canada 1991) (Fig. 24). Each area is assigned a commercial harvest quota for various species. The Fisheries Act quotas do not differentiate between broad whitefish and lake whitefish at this time, but variation notices and exploratory fishery licences issued since 1990 have. There is no consideration of the potential for separate stocks in the current management policy. Thus, broad whitefish from one biological stock may be subject to numerous fisheries during their migration between feeding habitats and spawning areas. Conversely, local fisheries may exploit a number of biological stocks either as mixed-stock groups or sequentially if they migrate separately.

Recent land claims settlements have created co-management arrangements which give local resource users influence and control over the management of fisheries resources in their regions. The Inuvialuit Final Agreement (IFA), Gwich'in Comprehensive Land Claim Agreement, and the Sahtu Dene and Metis Comprehensive Land Claim Agreement were enacted by the Government of Canada in 1984, 1992, and 1993, respectively (Fig. 2).

The Inuvialuit Hunters and Trappers Committees (HTC) represent local resource harvesters in all the Inuvialuit communities including Tuktoyaktuk, Inuvik, and Aklavik. A co-management board called the Fisheries Joint Management Committee is comprised of an equal number of Inuvialuit and Government representatives. The FJMC holds community consultations on a regular basis and advises the Minister of Fisheries and Oceans on management decisions and policy recommendations relating to fisheries in the Inuvialuit Settlement Region (Department of Indian Affairs and Northern Development 1984).

The Gwich'in have a similar co-management system. There are Renewable Resources Councils (RRC) in each community - Inuvik, Aklavik, Tsiigehtchic and Ft. McPherson - that are consulted by and advise a Renewable Resources Board (RRB) which deals with fisheries, wildlife, and forestry management issues. The RRB is comprised of an equal number of Gwich'in and Government representatives. All management decisions, policy recommendations, etc. made by the RRB are forwarded to the respective government departments for final approval (Department of Indian Affairs and Northern Development 1992).

The Sahtu Dene and Metis co-management system is identical to that described above for the Gwich'in. There are RRC's in all the communities, including Ft. Good Hope.

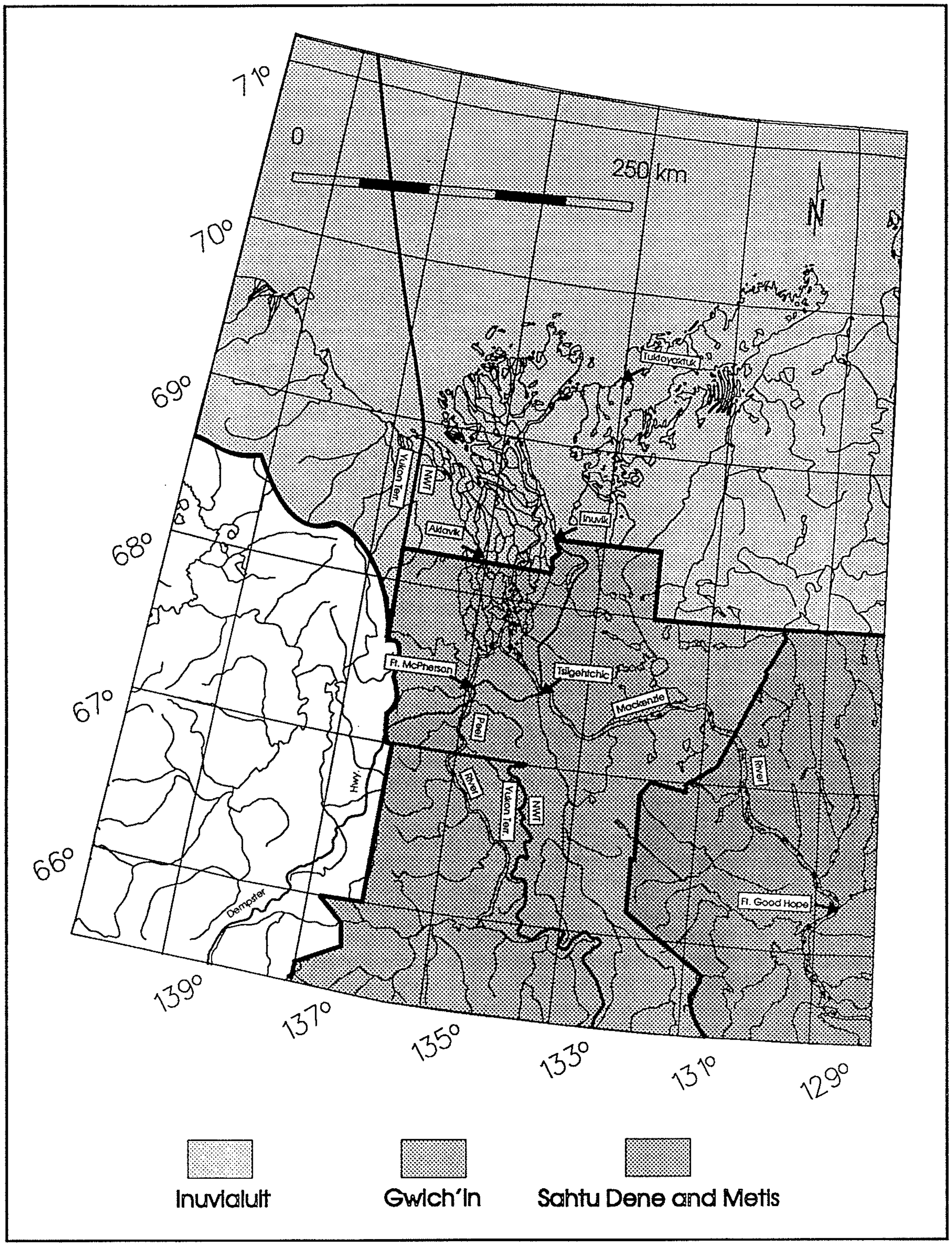


Figure 2. Comprehensive land claim regions covering the lower Mackenzie River region.

1.2 ISSUE STATEMENT

As stated earlier, correct application of current fisheries science techniques and models requires that individual stocks be identifiable. Failure to correctly identify stocks and properly apply the models may cause differential rates of impact between stocks. This potentially results in underharvest of abundant stocks and overharvest of stocks that are less abundant. Such overharvest may in turn result in the loss of genetic variability, poor management and the possible collapse of the stock and the fishery relying upon it (Bodaly et al. 1989).

The anadromous broad whitefish of the lower Mackenzie River region are likely comprised of multiple stocks that are harvested in several fisheries as they migrate through the delta to upstream spawning grounds. Therefore, the fishery managers are presented with several questions that should be addressed:

1. At which point and time are fishermen exploiting mixed-stock or unit-stock assemblages?

2. Are some stocks being exploited by more than one community or fishery spatially or temporally as they move upstream to their spawning grounds?

3. Is the stock(s) capable of sustaining the exploitation?

A sound understanding of biological parameters and how they vary between samples and locations is one of the requirements in determining whether or not stocks exist. However, in addition to the biological problems outlined above, the fishery managers must also consider the current harvest level and the potential for resource user conflicts between subsistence and commercial fishermen as well as between communities and land claim groups, that is:

1. What are the current subsistence and commercial harvest levels?

2. Can historical estimates be used to determine current harvest potential?

3. What is the best management strategy?

4. Is co-management working? How could it be improved upon to avert potential conflicts between resource users?

The Inuvialuit, Gwich'in and Sahtu co-management boards will be looking for advice and information to assist them in addressing these and other issues concerning the management of broad whitefish in the Mackenzie River.

1.3 <u>OBJECTIVES</u>

This research examined biological parameters of broad whitefish collected from what was believed to be a mixture of stocks from the Middle Channel downstream of Horseshoe Bend in the Mackenzie River Delta of the Northwest Territories (Fig. 3). The samples used were captured over a span of six years (1984 to 1989) and include a temporal series of four samples taken from September to November 1984. In addition, the past and present subsistence and commercial harvest of broad whitefish by local people were investigated and management issues explored.

Three specific objectives were investigated.

1. The biological parameters of samples from the Middle Channel downstream of Horseshoe Bend were examined for evidence of temporal variation within a year (1984) or between years (1984-1989) which may be reflective of heterogeneity within the broad whitefish of the Mackenzie River. The null hypothesis was that within the biological parameters examined, there are no between-year or within-year biological differences in fish captured at this Middle Channel location.

2. The past and present subsistence and commercial harvest levels for broad whitefish in the lower Mackenzie River region were

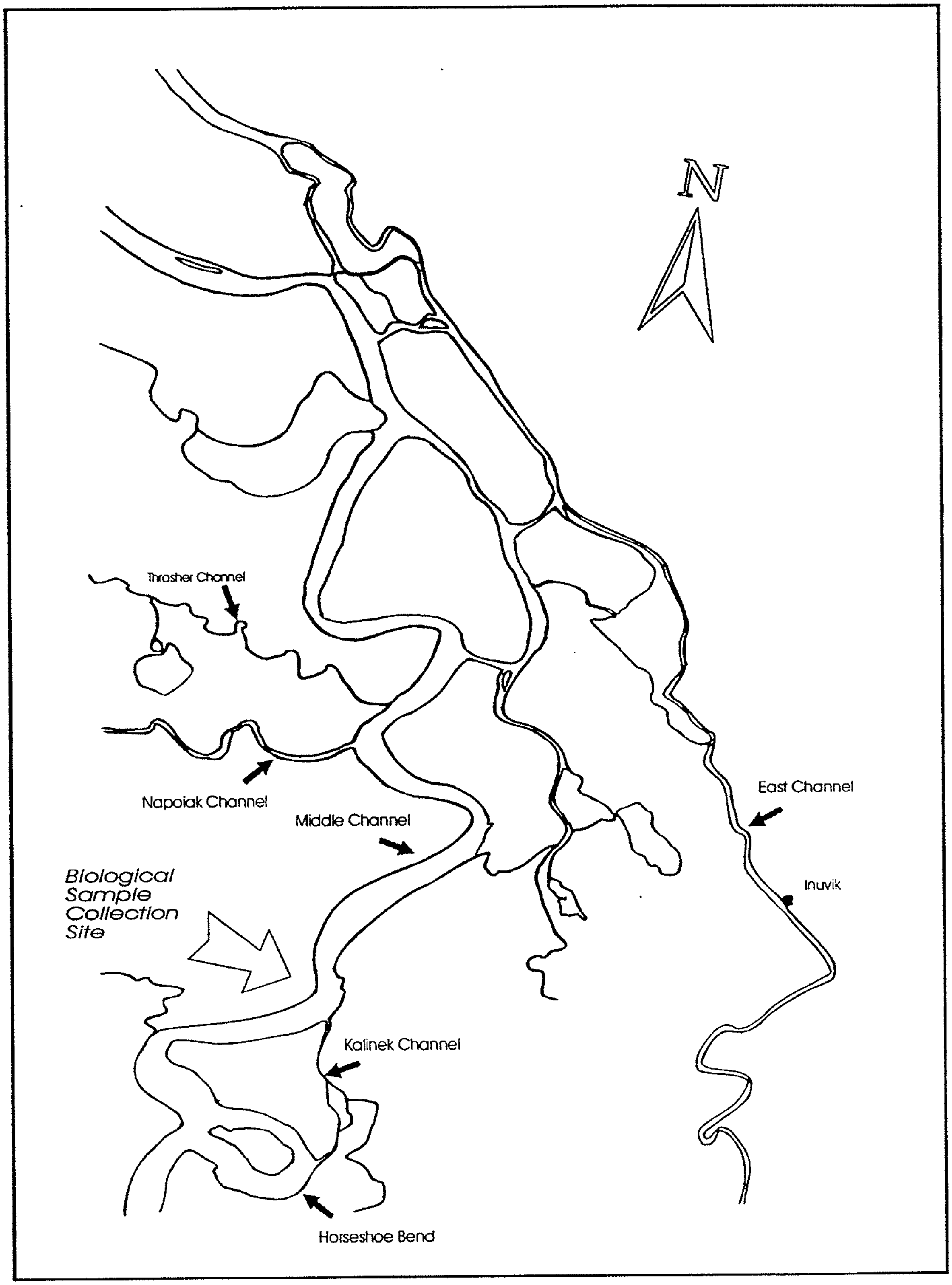


Figure 3. The 1984 to 1989 broad whitefish samples were collected from an area of the Middle Channel near Kalinek Channel by Mr. Billy Day.

compared, examined for trends, and the current total combined harvest estimated.

3. The management issues for broad whitefish were examined with input from all stake holders, including the resource harvesters, through the use of informal interviews.

1.4 SCOPE AND LIMITATIONS

Although the larger stock identification problem is an important issue, the biological aspect of this study has been limited to a description and comparative analysis of broad whitefish samples from the Horseshoe Bend area, for 1984 to 1989, immediately preceding the development of the latest commercial exploratory fishery (1989 to 1993). Samples exist for other areas within the Delta but the examination of all samples is a separate study in itself, beyond the scope of this study. The exploratory commercial fishery was to be located in the Middle Channel downstream of Horseshoe Bend. There were both within-year temporal samples available for 1984 and single samples for 1985 to 1989 from this location. Also, it is believed that the Middle Channel acts as a conduit through which most anadromous broad whitefish stocks move on the way to their spawning grounds. Thus, these samples provide the opportunity to examine stock parameters for variation between and within years. It should be noted that these samples do not include the early life history stages because they were caught using nets comprised of a single large mesh size, 139 mm (5.5") (however, immature fish are not known to inhabit this area), thus some biases exist in the data.

The past harvest information and the management issues extend to the entire area; therefore, these aspects of the study will encompass the entire lower Mackenzie River region rather than just the Middle Channel area near Horseshoe Bend.

1.5 STUDY IMPORTANCE

Management of broad whitefish of the lower Mackenzie River region is difficult with the current information base. Despite the lack of information, subsistence and commercial fisheries continue. These may have resulted in some stocks being exploited to a greater degree than others. This study will provide some information on the biological characteristics of broad whitefish, trends in subsistence and commercial fisheries and insight into local management issues to assist resource users in formulating management decisions.

Information from this study will also be useful in assessing the effects to the fishery of future developments such as the construction of roads, dams, oil pipelines and other industrial activities in the Mackenzie Valley.

The primary client for this study is the Federal Department of Fisheries and Oceans. However, the DFO's mandate is to co-manage with the resource users, therefore, this study will also be of interest to the Inuvialuit as represented by community Hunters and Trappers Committees, the Fisheries Joint Management Committee, and the Inuvialuit Game Council and the Gwich'in and Sahtu Dene/Metis resource users as represented by community Renewable Resources Councils and the respective Renewable Resources Boards. Other interested parties include the Northwest Territorial Government Departments of Economic Development and Tourism, and Renewable Resources.

Chapter II

LIFE-HISTORY AND BIOLOGICAL CHARACTERISTICS

2.1 INTRODUCTION

The data set utilized in the biological analysis presented here exists as part of a broad whitefish genetics and stock identification project being conducted by Dr. J. D. Reist of the Department of Fisheries and Oceans, Freshwater Institute Science Laboratory, Winnipeg, Manitoba. Data were collected for samples of broad whitefish caught by Mr. Billy Day in the Middle Channel of the Mackenzie River Delta, near Horseshoe Bend (Fig. 3) in six consecutive years (1984 to 1989). Biological analysis of population parameters such as growth and mortality require sample sizes larger than those available here which were collected for genetics research. However, given our limited knowledge of the broad whitefish of the lower Mackenzie River region it is important to examine the available biological information.

The purpose of this chapter as stated in Chapter I, Objective 1, is to present analyses of data from the 1984 to 1989 samples and to test the null hypothesis that within the biological parameters examined there are no between-year (1984-1989) or within-year (1984) differences in fish captured at the Middle Channel location. Heterogeneity in the samples would suggest that stock structuring is occurring within the anadromous broad whitefish of the lower Mackenzie River region. A summary of the information known to date on broad whitefish of the lower Mackenzie River region and of other systems will provide a context within which the data presented here can be interpreted.

2.2 DESCRIPTION OF THE STUDY AREA

The Mackenzie River discharges 333 km^3 of water and 118 million tonnes of sediment into the Beaufort Sea on an annual basis (Brunskill 1986). Of the rivers flowing into the Arctic Ocean it is ranked fourth in size behind three Russian rivers, the Yenisey, Lena, and Ob rivers

(Todd 1970, cited in Rosenberg and Barton 1986). The Mackenzie River lies between latitude 54 ^{o}N and 69 ^{o}N (Reist and Bond 1988) but it is the lower Mackenzie, downstream of Ramparts Rapids near Fort Good Hope (about 66 ^{o}N), that is utilized by anadromous broad whitefish and of interest in this study (Fig. 1).

The more southerly boreal forest climate zone extends northward following the Mackenzie Valley to the delta. The sub-arctic and tundra climate zones which surround much of the lower Mackenzie River valley are moderated by the sheer size of the Mackenzie River and Mackenzie River Valley (Rosenburg and Barton 1986). The lower Mackenzie River basin is located in the permafrost zone with mean daily temperatures varying from 10 ^{o}C to 16 ^{o}C in July to -23 ^{o}C to -29 ^{o}C in January (Bodaly et al. 1989).

The ice-free season for the lower Mackenzie River is late June to early October whereas in the upper Mackenzie, break-up occurs in late April and freeze-up in the middle of November. Peak flows occur in the spring with a June maximum of about 2.3 x 10^4 $m^3 \cdot sec^{-1}$ (Reist and Bond 1988) and mean annual flow of 0.95-1.1 x 10^4 $m^3 \cdot sec^{-1}$ at the delta (Bodaly et al. 1989).

The Coriolis effect and prevailing winds deflect most of the water from the Mackenzie River east along the Tuktoyaktuk Peninsula. This creates a zone of brackish water which is much less saline than the waters to the west of the delta (Reist and Bond 1988). However, a narrow brackish corridor does develop along the west coast as far as Point Barrow, Alaska during high spring flows and break up of the sea ice (Craig 1984).

Broad whitefish and other coregonid species are known to tolerate low salinity levels (de March 1989); therefore, the flow regimes of the Mackenzie River and other freshwater rivers and streams along the Beaufort Sea coast affect their distribution. Broad whitefish from the lower Mackenzie River region have been found along the Tuktoyaktuk

Peninsula east as far as McKinley Bay (Lawrence et al. 1984; Bond and Erickson 1985), and some young-of-the-year and mature fish have been observed as far west as Phillips Bay (Bond and Erickson 1989).

A large delta, 12,170 km^2, has formed at the mouth of the Mackenzie River (Brunskill 1986). This delta is comprised of many small channels, shallow lakes (<3 m) and ponds. A majority of delta lakes are flood plain lakes that experience varied degrees of annual flooding depending on their levee height or connection to the river channels (Taylor et al. 1982; Marsh and Hey 1989). Flooding provides these lakes with additional water and important nutrients. However, the sediment loading can affect primary and secondary productivity (Taylor et al. 1982).

Primary production in the Mackenzie River Delta lakes is low (4-10 $g\ C\cdot m^{-2}\cdot yr^{-1}$) (Bodaly et al. 1989) and is primarily light-limited due to the high suspended sediment concentrations in the spring and summer and low incident radiation and snow cover in the winter (Taylor et al. 1982; Bodaly et al. 1989). However, low availability of phosphorus may be a significant secondary factor in some lakes; particularly those that do not experience high sediment inputs due to their limited connectedness with river channels (Taylor et al. 1982; Bodaly et al. 1989). Fee et al. (1988) found that phytoplankton productivity levels in lakes of the Mackenzie Delta and lakes in the Kukjuktuk Creek drainage on the Tuktoyaktuk Peninsula were similar. Data from a study of the macrophyte and algal communities of selected lakes in the Mackenzie Delta and Tuktoyaktuk Peninsula are presented by Ramlal et al. (1991).

Benthic organisms may represent the largest fraction of invertebrate secondary production in delta lakes, as standing crops were found by Taylor et al. (1982) to be orders of magnitude greater than those for zooplankton.

2.3 DISTRIBUTION AND LIFE HISTORY OF ANADROMOUS BROAD WHITEFISH WITHIN THE STUDY AREA

Broad whitefish (Fig. 4a) occupy fresh and brackish waters of the arctic drainages of northwestern North America and northern Eurasia (Scott and Crossman 1973). In North America they are found in many Alaskan rivers, the head waters of the Yukon River in the Yukon Territory and west from Perry River, NWT, to the Mackenzie River and its tributaries (Scott and Crossman 1973) (Fig. 4b).

In Chapter I the existence of three life history types was discussed. There is genetic evidence that the anadromous and lacustrine life-history types exist in the lower Mackenzie River region that supports observations made by the resource users. Broad whitefish with a slightly darker dorsal colour, yellowish/golden ventral colour and often smaller size have been caught in Mackenzie River Delta channels and adjacent lakes (E. McCleod, Aklavik, personal communication). The local people differentiate these fish from other broad whitefish and refer to them as "lake-fish". The colouring may be an adaptation to, or a result of, having spent time foraging in the humic delta lakes. These fish may be lacustrine forms that have entered the river channels to overwinter or feed, anadromous forms that have spent time in the Delta lakes, or a riverine form. Very little information is available for this group of broad whitefish. The life history information presented below applies to anadromous broad whitefish only.

A general life history of anadromous broad whitefish in the lower Mackenzie River region can be divided into two components, those fish that are maturing and mature adults that have spawned previously (Fig. 5) (Reist and Bond 1988). The fish that make up these two groups tend to occupy different habitats and behave differently, although some overlap is evident.

Anadromous broad whitefish spawn primarily upstream in the mainstem and major tributaries of the Mackenzie River. Movements of

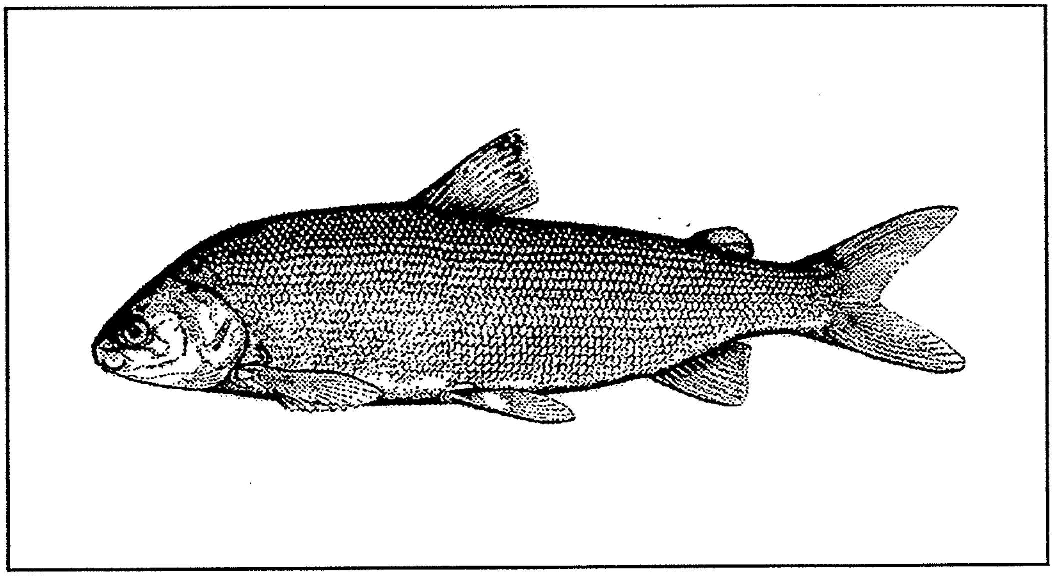


Figure 4a. Broad whitefish, *Coregonus nasus* (Pallus).

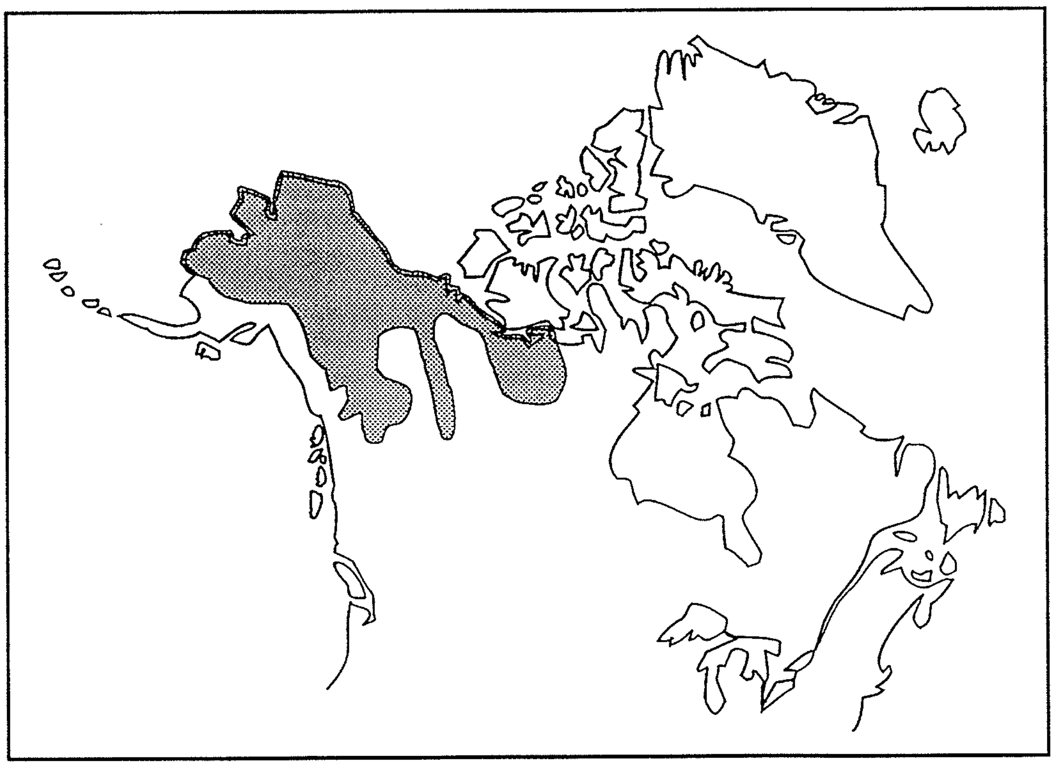


Figure 4b. Broad whitefish North American distribution, after Scott and Crossman (1973).

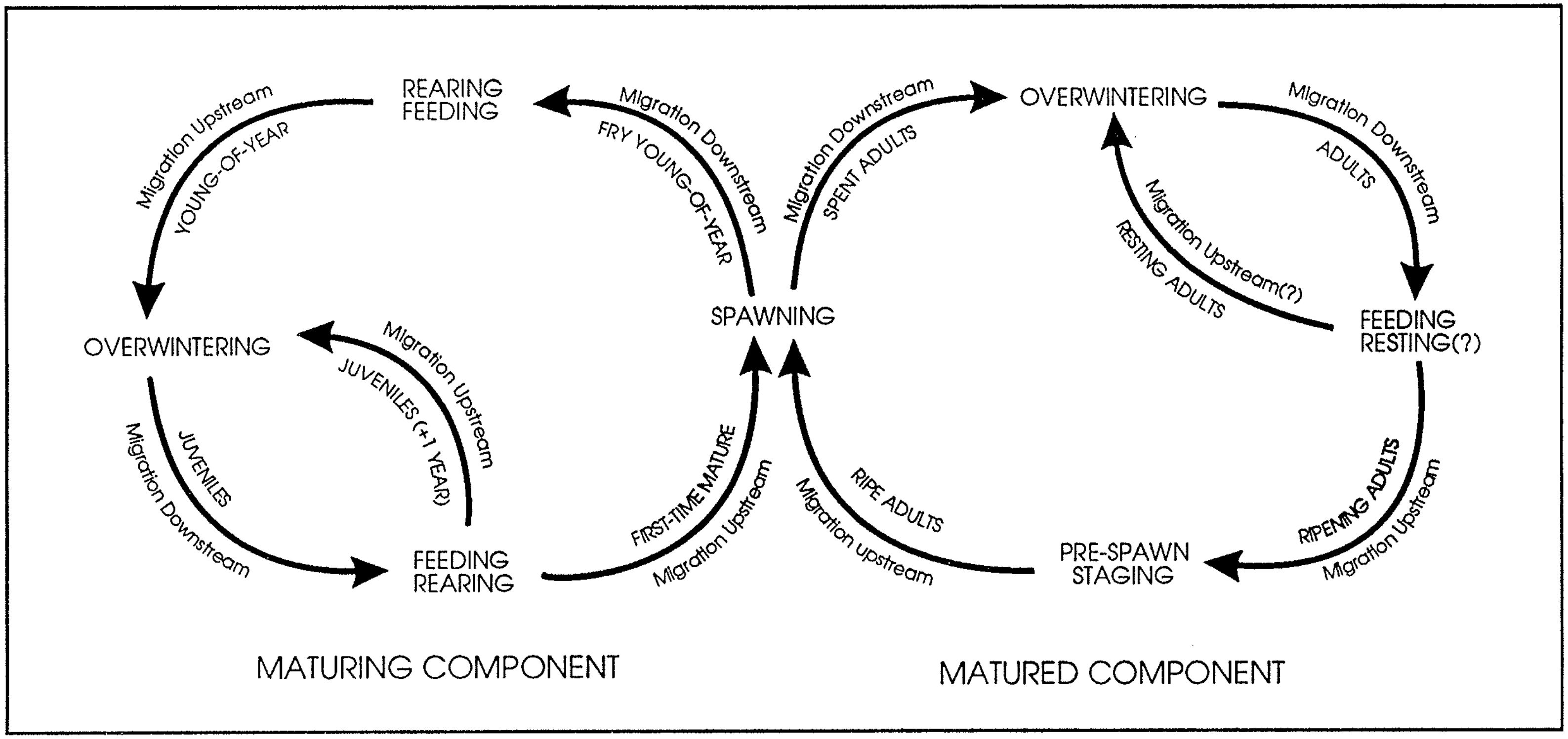


Figure 5. Generalized life history of anadromous broad whitefish from the Mackenzie River, exhibiting repeat spawning, after Reist and Bond (1988).

radio-tagged fish suggest possible spawning sites at Point Separation near the beginning of the delta, back eddies near the confluence of the Mackenzie and Arctic Red Rivers, and the Ramparts Rapids area near Fort Good Hope (Fig. 1) (Chang-Kue and Jessop 1983). Ripe and/or spent fish have been caught in the Peel and Arctic Red rivers as well as Campbell and Travaillant lakes (Fig. 1). This suggests spawning may also occur in these areas, although fish that are spawning in the lakes may represent the lacustrine life history type. (Dr. J. Reist, DFO-Winnipeg, personal communication).

Broad whitefish spawn under the ice during late October and early November when the water temperature is approximately 0 °C. Eggs hatch in the spring and larvae are believed to be carried downstream with the flood waters, dispersing into delta lakes, coastal nearshore areas and lake systems on the Tuktoyaktuk Peninsula (Chang-Kue and Jessop 1992; Bond and Erickson 1985). However, some may go west as far as Phillips Bay (Bond and Erickson 1987; 1989).

The Tuktoyaktuk Peninsula and delta lakes are believed to be important summer feeding areas and possibly overwintering habitat for young-of-the-year and juvenile broad whitefish. Newly hatched young may be swept into small delta lakes with the spring flood waters (Taylor et al. 1982) where they may or may not become isolated, once the flood waters recede. Very few of these lakes provide suitable over-wintering habitat because they are very shallow. Taylor et al. (1982) noticed migrations of yearling and mature broad whitefish into several delta lakes and a significant net migration out in early September possibly triggered by decreased flow in connecting channels, temperature and/or day length. Broad whitefish were found primarily in lakes connected to the main river; very few fish and almost no broad whitefish were found in unconnected delta lakes. However, lake whitefish and least cisco (Coregonus sardinella Valenciennes) were more abundant than broad whitefish in all but one of the study lakes (Taylor et al. 1982).

Northern pike have the potential to impact significantly on the immature coregonid populations. Taylor et al. (1982) found that pike consumed four, 10 and 50 times the fish biomass that migrated through their weirs into the main channel from three study lakes.

Young-of-the-year (YOY) and juvenile broad whitefish have been found to dominate the ichthyofauna found in Tuktoyaktuk Peninsula lakes and streams (Chang-Kue and Jessop 1992; Bond and Erickson 1985) and are also found in lakes on Richards Island (Lawrence et al. 1984). Mid-summer catches in 19 of 23 lakes sampled from Tuktoyaktuk Peninsula and Richards Island in 1978-1980, were dominated by juvenile and immature adult broad whitefish with maximum catches coming from the shallow lakes with little or no overwintering capacity (Lawrence et al. 1984). Bond and Erickson (1985) and Chang-Kue and Jessop (1992) observed juvenile broad whitefish moving up-stream immediately after ice out (mid June) in several streams on the Tuktoyaktuk Peninsula. Downstream movement of adult broad whitefish in these streams was also noted as early as June 29th but remained infrequent until the end of August with the peak occurring on September 28th (Bond and Erickson 1985). There is a notable size difference between the fish involved in the upstream and downstream runs, indicating that young fish (0+ to four years) may remain in the upstream lakes for several years while larger, older fish (five to 12 years) may prefer to move into these freshwater systems for summer feeding and move to deeper outer delta lakes, nearshore areas, Kugmallit Bay, or the lower East Channel for overwintering prior to reaching maturity and spawning condition (Lawrence et al. 1984; Bond and Erickson 1985; Chang-Kue and Jessop 1992).

Sexual maturation occurs between seven and nine years of age at a minimum size of 420-450 mm (Bond 1982). Current-year spawners spend the summer prior to spawning feeding in the delta or Tuktoyaktuk Peninsula lakes. In September they begin congregating at sites within the inner delta (Chang-Kue and Jessop 1993). When the water temperature drops near to 1 °C they begin the upstream migration to spawning grounds from these aggregation sites. The spawning run is separated by sex, with the male broad whitefish moving first followed in approximately a week by the females (George Niditchie, Tsiigehtchic, personal communication). Spent adults migrate back downstream to spend the winter in the outer delta (Chang-Kue and Jessop 1983). Mature broad whitefish may spawn several times during their lives (i.e., they are iteroparous fish). However, because the large energy reserves required to produce eggs and sperm, especially the former, cannot be obtained in one summer of foraging it is likely that individuals do not spawn in sequential years and instead rest for one or more years to acquire sufficient energy reserves. Also, the long migration to spawning grounds may require considerable energy expenditure and likely contribute to the preclusion of annual spawning migrations (Craig 1989).

2.4 BIOLOGICAL CHARACTERISTICS OF BROAD WHITEFISH WITHIN THE STUDY AREA

Prior to the survey work of the 1970's, little information was available on the life history and biology of Mackenzie River broad whitefish. Wynne-Edwards (1952) had reviewed the available life history information and Muth (1969) compared age and growth data for samples collected from the Mackenzie and Coppermine rivers in 1956, 1957, and 1961. Since then there have been several studies within the lower Mackenzie River region that have provided data on size and age distributions, growth, weight-length relationships, and maturity indices. The data from some of these surveys have been summarized in Tables 1 and 2 and Figure 6. This information will be reviewed below and examined for evidence of stock structuring given the general life history of broad whitefish, the locations and time they were sampled, and the gear used.

Data which may be representative of discrete broad whitefish stocks from other river systems will also be examined (Table 3 and

Table 1. A summary of biological data for broad whitefish collected from several areas within the lower Mackenzie River region using gear designed to select a complete size range.

Location	Source	Date Collected	Gear Used	Sample Size	Length Range (mm)	Length Mode (mm)	Age [1] Range (yrs)	Age Mode (yrs)	Age at Maturity
Freshwater Cr. upstream	Bond and Erickson (1985)	June-Oct. 1982	2-way counting fence	100,178	51-546	90; 230	0-18	0; 3-4	10
downstream				91,000	68-634	275		5-6	
Mayogiak Cr. upstream	Bond and Erickson (1982)	June-August 1981	"	24,626	31-450	50; 200	0-7	2-3	no mature fish
downstream				2,892	69-490	325		4-7	caught
Kukjuktuk Cr. upstream	Chang-Kue and Jessop (1992)	June-Sept. 1979	"	1,097,481	50-553	75; 375	0-13	0-1; 7-8	7
downstream				85,503	62-557	375		7-8	
Tuktoyaktuk Harbour	Bond (1982)	July 1979-March 1981	var. mesh 10-60mm [2]	549	34-530	125; 325	0-13	8	female=7, male=8
Richards Island Lakes	Lawrence et al. (1984)	June-Sept. 1980	" 10-60mm	344	76-575	425	1-16	9	9
Tuktoyaktuk Pen. Lakes	"	June-Sept. 1979	" 10-60mm	336	76-525	163; 425	0-15	1; 10	9
Outer Delta	Percy (1975)	June-Sept. 1974	" 38-140mm	354	141-655	490	0-15	8	3-4
Outer Delta	de Graaf and Machniak (1977)	July-Sept. 1975	" 25-89mm	133	39-632	75; 325	1-19	4; 6; 9	7
West Delta Channels	Stein et al. (1973b)	June-Oct. 1972	" 38-140mm	1,090	110-600	431-510	1-15	9	
Middle Channel	Treble and Tallman (at review)	Sept. 1989-93	"	267	142-617	495-525	2-25	9-13	6
Mackenzie River [3]	Stein et al. (1973b)	June-Oct. 1972	"	1,307	110-690	461-540	1-14	9-10	
Mackenzie River [3]	Hatfield et al. (1972)	June-Oct. 1971	"	682	230-670	510	2-16	9	
Mackenzie River	Muth (1969)	1956, 1957, 1961	"	564	60-500		2-15	7	

[1] Scales were used to age most of the samples except for de Graaf and Machniak (1977) who used otoliths and Treble and Tallman (at review) who used fin-rays.

[2] Single mesh nets of 51mm and 70mm, and seine nets were also used.

[3] Areas sampled are near Tsiigehtchic.

Table 2. A summary of biological data for broad whitefish collected from several areas within the lower Mackenzie River region using large mesh nets.

Location	Source	Date Collected	Gear Used	Sample Size	Length Range (mm)	Length Mode (mm)	Age[1] Range (yrs)	Age Mode (yrs)	Age at Maturity	Mortality
Middle Channel	Treble and Tallman (at review)	Sept. 1989-93	139mm mesh net	3,358	305-651	475-515	3-30	8-12	female=5-6; male=4-5	0.24-0.44
Thrasher Channel	"	Sept. 1992-93	"	653	253-685	465	4-20	6	female=7; male=5-6	0.25-0.27
East Channel[2]	Percy (1975)	1973	"	149	462-553		6-13	9		
Barge Lake	Treble and Read (1994)	Aug.-Sept. 1993	"	247	390-610	455	5-16	7		0.30
East Channel[3]	"	Aug.-Sept. 1993	"	51	410-540	465	5-16	7		
Peel River	"	Sept.-Oct. 1993	114mm and 159mm	283	390-600	475	4-18	7		0.31
Peel Channel	"	October 1993	139mm mesh nets	300	412-656	475	5-23	9		0.34
Mackenzie River[4]	"	Oct.-Nov. 1993	"	299	430-625	485	5-23	8		0.30

[1] Fin-rays were used to age the fish except for Percy (1975) who used scales.
[2] Areas sampled are near Holmes Creek.
[3] Areas sampled are near Inuvik.
[4] Areas sampled are near Tsiigehtchic.

Table 3. A summary of biological data for broad whitefish collected from different river systems in Canada (C), Alaska (A), and Russia (R).

Location	Source	Date Collected	Gear Used	Sample Size	Length Range (mm)	Length Mode (mm)	Age [1] Range (yrs)	Age Mode (yrs)	Age at Maturity
Mackenzie River [2] (C)	Stein et al. (1973b)	June-Oct. 1972	var. mesh 38-140mm	37	110-420	161-170	0-13	2	
Anderson River (C)	Bond and Erickson (1991)	July-Sept. 1989	trap nets	5,380	45-599	75	0-16	0	female=13; male=9
Anderson River (C)	Bond and Erickson (1992a)	July-Aug. 1990	trap nets	2,249	50-622	75; 245; 355	0-28	0; 9; 17	female=13; male=16
Colville River [3] (A)	Alt and Kogl (1973)	June-Sept. 1970	var. mesh 14-64mm	153	335-670		0-15		7,8
Porcupine River (A)	Alt (1976)	1970 and 1971	" 19-64mm; 64 and 74mm	32	470-600		4-8	5-7	female=5-6; male=5
Minto Flats (A)	"	"	"	79	400-640		5-11	6-8	5
Holitna River (A)	"	"	"	73	360-560		4-8	5-7	female=6-7; male=5,6
Imuruk Basin (A)	"	"	"	53	230-450		3-8	5-8	female=7-8; male=6-8
Sagavanirktok River (A)	"	"	"	104	140-530		2-13	7-10	female=8-10; male=7-9
Karbey River (R)	Prasolov (1989)	Sept.-Nov. 1983	nets 45, 50, and 60mm	360	380-600	440	5-13	8	4
Tanama River (R)	Popov (1976)	1973 and 1974		800			0-13	6-7 [4]	7-8

[1] Scales were used to age the fish except for Bond and Erickson (1991 and 1992a) who used otoliths.
[2] Areas sampled are near Norman Wells.
[3] Areas sampled are near Umiat.
[4] These ages dominated the commercial catch.

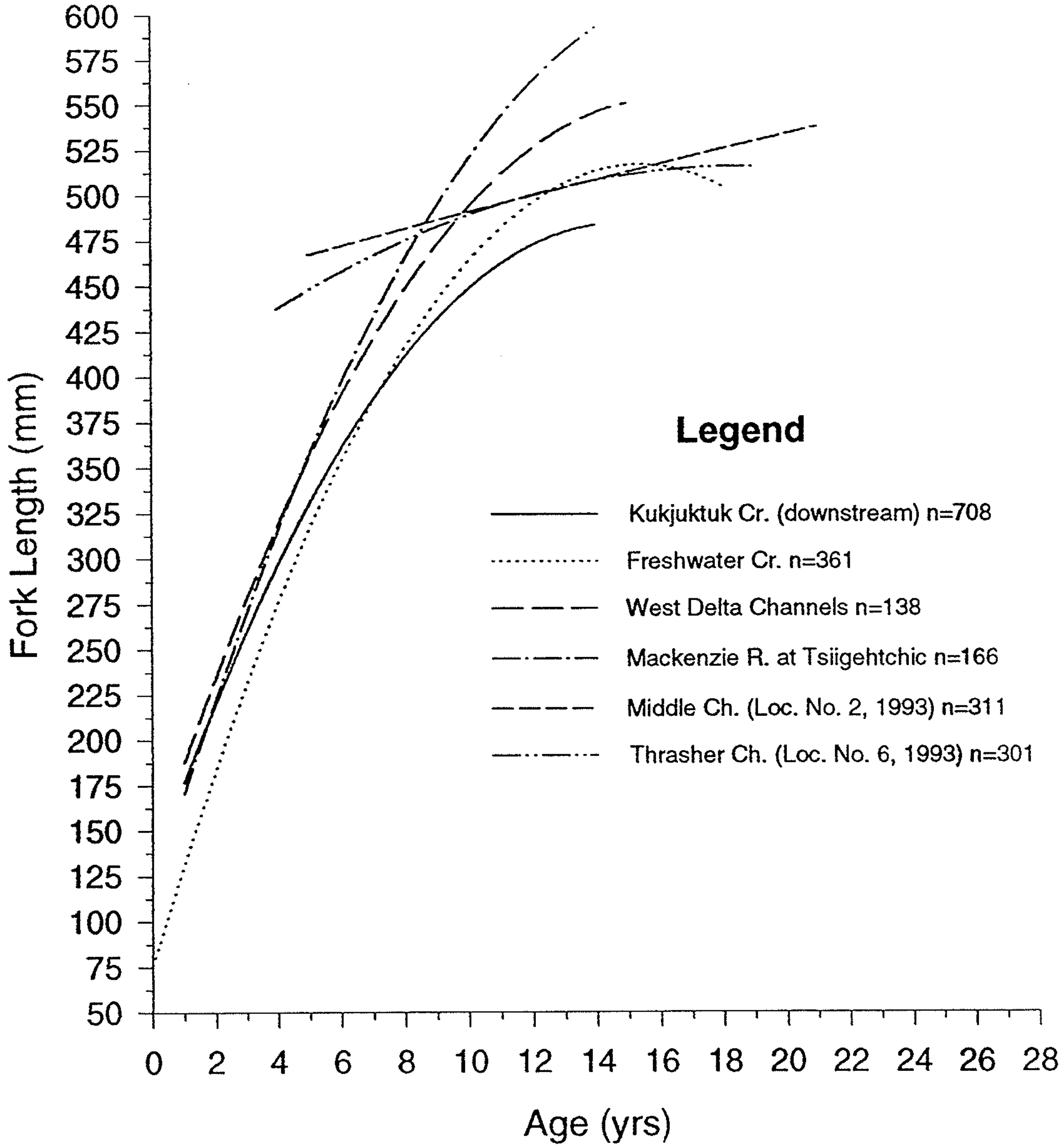


Figure 6. Length-at-age growth curves for broad whitefish from five areas within the lower Mackenzie River region. Data from Middle and Thrasher Channels are from 139mm mesh nets used in the UDC Exploratory Fishery in 1993 (Treble et al. in prep.). The growth curve for Freshwater Creek broad whitefish beyond age 16 is not likely representative because it is based on only four fish aged 17 and 18 years. See Tables 1 and 2 for additional information.

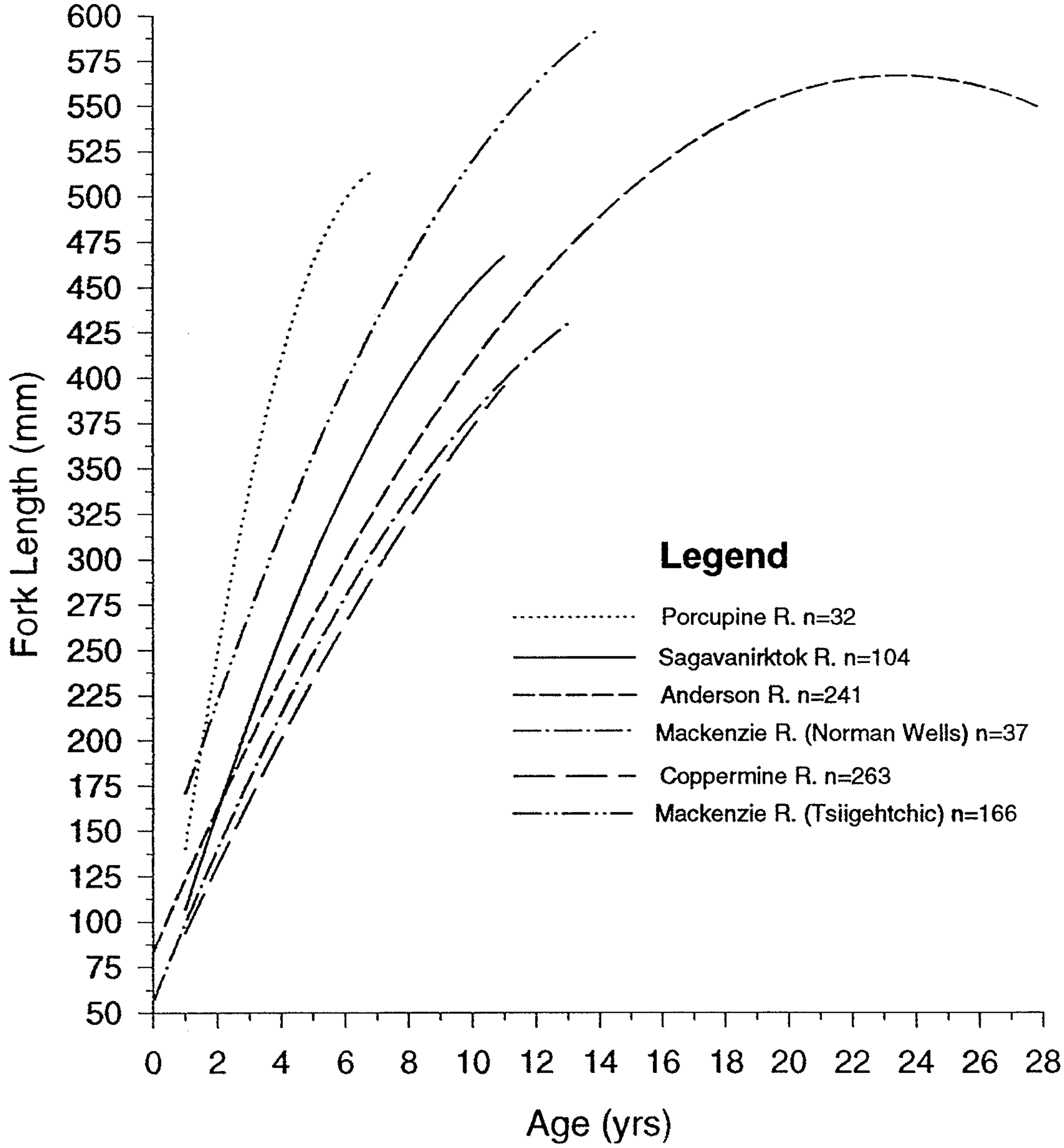


Figure 7. Length-at-age growth curves for broad whitefish from different river systems including a representative of the Mackenzie River from Figure 6. The growth curve for Anderson River broad whitefish beyond age 24 is not likely representative because it is based on only four fish aged 26, 27, and 28 years. See Tables 1 and 3 for additional information.

Figure 7) as a comparison to broad whitefish from the Mackenzie River.

2.4.1 Tuktoyaktuk Peninsula, Richards Island and Outer Delta

Size and Age

Few immature broad whitefish were found in surveys of the Mackenzie Delta conducted in the early 1970's and fish from the size range 200 mm to 450 mm appeared to be "missing" or rare. These fish were later located by researchers working on the Tuktoyaktuk Peninsula and Richards Island creeks and lakes and nearshore coastal areas (Chang-Kue and Jessop 1992; Bond and Erickson 1982 and 1985; Lawrence et al. 1984).

Broad whitefish migrating up Tuktoyaktuk creeks were less than seven years old and the most abundant age classes were young-of-the-year (0+), yearlings (1+) and fish three to four years old (Chang-Kue and Jessop 1992; Bond and Erickson 1982; 1985). However, downstream migrants were on average older (only a few fish younger than three or four years) and larger (only 2% were <225 mm) (Bond and Erickson 1985). For example 88% of the upstream migrants in Kukjuktuk Creek in 1979 were 0+ and 1+ with a modal length of 75 mm but there was a second peak at 375 mm (Chang-Kue and Jessop 1992) (Table 1). Bond and Erickson (1982) and (1985) found the majority of upstream migrants at Freshwater Creek were also less than three years old and the size distribution was bi-modal, one peak at 50-99 mm and a second at 225-249 mm (Table 1). Downstream migrants at Freshwater Creek, Mayogiak Creek and Kukjuktuk Creek had modal lengths of 275 mm, 325 mm, and 375 mm, respectively (Bond and Erickson 1982 and 1985) (Table 1).

Lawrence et al. (1984) surveyed several streams and lakes on Tuktoyaktuk Peninsula and Richards Island as well as coastal areas. Although ages ranged from 0-13 years for fish collected along the coast few fish were mature. The size-range for fish from lakes on the Tuktoyaktuk Peninsula and Richards Island were similar (Table 1).

However, lakes on the Tuktoyaktuk Peninsula had a larger proportion of young fish which resulted in a marked bi-modal size and age distribution.

Percy (1975) sampled broad whitefish from lakes and channels in the outer delta and found a size range of 141 mm to 655 mm with the majority falling between 350 mm and 530 mm and an age range of zero to 15 years with a mode of eight years (Table 1). Along the "cross delta pipeline route" de Graaf and Machniak (1977) also found that the majority of broad whitefish fell in the length range 300 mm to 550 mm with a few falling between 39 mm and 186 mm (Table 1). They reported otolith ages of one to 19 years with strong year classes at age four, six and nine. Percy (1975) used scales to age the fish, had slightly different mesh sizes and a larger sample size than de Graaf and Machniak (1977) which could explain the differences between these two groups of samples.

Growth

No difference in growth rates between males and females was found by de Graaf and Machniak (1977), Bond (1982), and Chang-Kue and Jessop (1992). A mean annual increase in length of 35 mm for immature and 20 mm for mature broad whitefish was reported by Taylor et al. (1982) using data from de Graaf and Machniak (1977) and Hatfield et al. (1972).

Growth was similar for Kukjuktuk Creek upstream and downstream migrants (Chang-Kue and Jessop 1992). Length at age data for the Kukjuktuk Creek downstream migrants and Freshwater Creek (both upstream and downstream samples combined) have been plotted in Figure 6. It appears that Kukjuktuk Creek fish grow faster than Freshwater Creek fish until age eight when the curves cross and Kukjuktuk Creek fish grow more slowly at a given age than Freshwater Creek fish. This pattern was also seen in a plot of length at age for Kukjuktuk Creek and Tuktoyaktuk Harbour broad whitefish, (Freshwater Creek flows into Tuktoyaktuk

Harbour), although the cross-over occurred at approximately three years of age (Bond 1982).

Growth for fish from the "cross delta pipeline route" in the outer delta was below that reported for the Mackenzie River (Muth 1969) and outer delta (Percy 1975) which were similar (de Graaf and Machniak 1977). Bond (1982) reported a growth rate for Tuktoyaktuk Harbour fish that was intermediate between rates for broad whitefish from the Mackenzie River at Tsiigehtchic (Hatfield et al. 1972) and from the outer delta (de Graaf and Machniak 1977). The growth curve for fish from the west delta channels was similar to that for the outer delta samples collected by de Graaf and Machniak (1977) and lies between the curve for the Mackenzie River at Tsiigehtchic (Stein et al. 1973b) and those for Kukjuktuk and Freshwater Creeks (Figure 6).

Weight-Length Relationship and Condition Factor (K)

There were no significant differences between the slopes and intercepts of the weight-length regressions for male and female broad whitefish collected from Freshwater Creek (Bond and Erickson 1982; 1985). However, they did find differences between time periods in condition factors (K) for the pooled sample (male and female combined) of immature fish. Downstream migrants moving in September had a larger K (1.309) than did downstream migrants in July (1.253) and upstream migrants in June (1.208). Chang-Kue and Jessop (1992) also reported a higher K value for downstream (1.400-1.500) versus upstream (1.150-1.300) migrants and a significant difference in both slope and intercept between upstream (slope=3.125, intercept=0.077) and downstream (slope=3.250, intercept=0.075) males. For all fish 57 mm to 557 mm sampled by Chang-Kue and Jessop (1992), the slope was 3.226 and the intercept -5.461.

Percy (1975) split his sample (slope=2.929) into mature and immature components which had slopes of 3.263 and 2.862, respectively.

Sex Ratio, Age-at-Maturity and Gonadosomatic Index

The female to male (F/M) sex ratio for broad whitefish sampled from Tuktoyaktuk Harbour was 0.46 (Bond 1982). The F/M sex ratio for the Rat River area on the west side of the delta ranged from 0.75 to 1.5 (Jessop et al. 1973). de Graaf and Machniak (1977) found a F/M ratio of 0.51 along the "cross delta pipeline route" and Percy (1975) reported that there were only slightly more females than males in the lakes and channels of the outer delta.

Percy (1975) reported finding mature broad whitefish with scale ages of three to four years. Chang-Kue and Jessop (1992) reported broad whitefish mature at approximately age seven (scales) with a fork length of 377 ± 22 mm. Bond (1982) found the youngest mature male and female were aged eight and seven (scales), respectively, with a fork length range of 420 mm to 450 mm. The age-at-maturity reported by de Graaf and Machniak (1977) using otoliths was seven years, with all fish mature by age 10.

The gonadosomatic index (GSI) for immature and resting females collected from Tuktoyaktuk Harbour during July to September was 0.4 to 0.6 and 0.8 to 0.9, respectively, while the GSI for mature females ranged from five to 10 (Bond 1982). Immature and resting males had a mean GSI of 0.1 and mature males had a mean GSI of 1.0 (Bond 1982).

Reproduction

Fecundity for broad whitefish of the Mackenzie River was reported as 26,922-65,798 eggs per female (fork length ranging from 451 mm-568 mm) with a mean of 39,721 eggs (de Graaf and Machniak 1977).

2.4.2 Mackenzie River Mainstem

Size, Age and Growth

Hatfield et al. (1972) and Stein et al. (1973b) report data for the Mackenzie River near Tsiigehtchic for 1971 and 1972 that are comparable (Table 1). Stein et al. (1973b) found that scale ages nine and 10 comprised 44.7% and 50.9% of the samples from Aklavik and Tsiigehtchic, respectively, with few fish less than four years. Muth (1969) did not give specific sampling locations but reported an age range for broad whitefish of the Mackenzie River similar to that reported by Hatfield et al. (1972) and Stein et al. (1973). However, the modal age for Muth's data was seven years and the lengths were somewhat smaller covering a range of 60 to 500 mm (Table 1). Also, broad whitefish collected from the Middle Channel during the 1989 to 1993 Uummarmiut Development Corporation (UDC) exploratory fishery (Treble and Tallman at review) had age and length data similar to those reported by Hatfield et al. (1972) and Stein et al. (1973b). Pelvic fin-rays were used to age the Middle Channel fish and this likely explains the greater age range (Table 1). Length-at-age data for the Middle Channel fish were not plotted but it was similar to that for the West Delta Channels and slightly less than that for the Mackenzie River at Tsiigehtchic reported by Stein et al. (1973b) (Figure 6).

Broad whitefish samples (all locations) from the 139 mm (5.5") mesh nets used in the UDC exploratory fishery had a fin-ray age range of three to 30 years with a mean of 11.5 years and a length range of 253 mm to 685 mm with a mean of 500 mm (Table 2). A comparison of samples from side channels and connected lakes with samples from the larger Middle Channel suggests size, age and maturity differences exist between these locations (Treble and Tallman at review; Treble et al. in prep.; Treble and Read 1994). More younger and smaller fish were found to be present in the side-channels and lakes than in the main channel and the majority of these fish were not in spawning condition. Figure 6 contains length at age plots for two locations, the Middle Channel and Thrasher Channel which is representative of the side channels and lakes. Growth appears to differ for the younger year classes but the curves come together at approximately age nine. These data are all from a single, large mesh net and differ considerably from data that are collected using variable mesh nets. Slaney (1974) in de Graaf and Machniak (1977) was quoted as stating that broad whitefish from land-locked lakes had a faster growth rate than broad whitefish from the channels of the Mackenzie River. Slow- and fast-growing forms have also been reported by Russian scientists (Berg 1948 in de Graaf and Machniak 1977).

Broad whitefish samples collected from the 1973 Holmes Creek commercial fishery which also used 139 mm mesh gillnets (Percy 1975) were similar to those from the 1989 to 1993 Middle Channel exploratory fishery (Treble and Tallman at review) (Table 2).

Weight-Length Relationship and Condition Factor (K)

Muth (1969), Stein et al. (1973b), de Graaf and Machniak (1977), and Bond (1982) all reported no difference between sexes for the weight-length relationship. Muth (1969) reported a slope of 3.41, Stein et al. (1973b) reported a range in slope of 3.15 to 3.27 and de Graaf and Machniak (1977) found a slope of 3.155 and an intercept of -5.276. However, Hatfield et al. (1972) reported that males were heavier than females and gave a combined slope of 3.008. Also, Jessop et al. (1973) reported that for broad whitefish collected from the Rat River on the west side of the delta, males were heavier than females with slopes for the weight-length regression of 3.032 and 1.867, respectively.

Females were significantly heavier than males for ten of 16 samples collected using 139 mm mesh nets during the Middle Channel exploratory fishery. Males had a slope and intercept that ranged from 2.488 to 3.070 and -3.139 to -5.013, respectively, while females had a slope that ranged from 2.511 to 2.879 and an intercept that varied between -3.500 to -4.474 (Treble and Tallman at review).

Sex Ratio, Age-at-Maturity and Gonadosomatic Index

The ratio of female to male broad whitefish in the Middle Channel was approximately equal during each year the UDC exploratory fishery operated (Treble and Tallman at review).

Hatfield et al. (1972) found that all fish greater than 400 mm were mature (approximately age five to six), with only a few mature individuals as small as 300 mm (approximately age three to four). The youngest confirmed age-at-maturity for broad whitefish from the Middle Channel exploratory fishery was four to five years for males and five to six years for females, with the majority mature at age eight to nine (Treble and Tallman at review).

Samples of mature females from the Middle Channel exploratory fishery had a mean GSI of approximately 15.0 to 20.0 while the GSI for mature males varied from 0.86 to 1.44.

Mortality and Survival

Using catch-curve analysis on samples collected from the 1989 to 1993 UDC exploratory fishery, Treble and Tallman (at review) found that the instantaneous mortality rate, annual mortality rate, and survival rate varied from 0.24 to 0.44, 0.22 to 0.35 and 0.65 to 0.78, respectively. Similar data were found for broad whitefish from Barge Lake, Peel Channel, Peel River, and the Mackenzie River at Tsiigehtchic (Treble and Read 1994) (Table 2).

2.4.3 Summary

Broad whitefish from different locations within the lower Mackenzie River appear to vary in certain key characteristics such as size, age, growth and age-at-maturity. For example Tuktoyaktuk Peninsula and outer delta fish seem to be smaller on average than fish from the mainstem Mackenzie River (Table 1 and Figure 6) and fish from the side channels and lakes within the delta may also be smaller than fish in the main channel. Age-at-maturity seems to vary from a low of three to four to a high of nine or ten. Mortality does not appear to vary significantly between locations. Some factors which might contribute to the differences observed above are: 1) different gear has been used to collect the samples (e.g., counting fences and different choice of mesh sizes for the experimental net gangs); 2) broad whitefish prefer certain environments over others at different stages in their life history; or 3) there may be different stocks present that tend to have different age structure, growth and maturity rates. How much each of these factors contributes to the observed differences is difficult to ascertain at this time.

2.5 BIOLOGICAL CHARACTERISTICS OF BROAD WHITEFISH FROM OTHER LOCATIONS

2.5.1 Anderson and Coppermine Rivers, Northwest Territories

Samples were collected from the Anderson River in 1989 and 1990 by Bond and Erickson (1991; 1992a; 1992b). They found lengths ranged from 45 mm to 599 mm in 1989 and 50 mm to 622 mm in 1990 (Table 3). Otolith ages ranged from 0 to 16 years and 0 to 28 years in 1989 and 1990 respectively. Young-of-the-year (0+) and yearling (1+) fish had lengths ranging from 40-69 mm and 70-109 mm, respectively. Large juveniles were 300-429 mm and spawners were greater than 429 mm. The growth rate for these fish is less than that for the Mackenzie River at Tsiigehtchic (Figure 7). The minimum age-at-maturity for males was nine in 1989 and 16 in 1990 and 13 years for females in both years. These ages-at-maturity are considerably higher than those for the Mackenzie River samples given in Table 1 as well as for other locations summarized in Table 3. Slope and intercept of the weight-length regression line varied between years, 3.150 and -5.326, respectively, in 1989 and 3.249 and -5.578, in 1990. Seventy percent and 53% of the 1989 and 1990 samples, respectively, were female. Mean GSI for females ranged from 5.28 to 12.57 and from 2.07 to 11.08 in 1989 and 1990, respectively.

Mean GSI for males was 1.02 to 1.7 in 1989 and 0.88 to 1.30 in 1990.

Muth (1969) sampled broad whitefish from the Coppermine River in 1956, 1957, and 1961 and found scale ages ranged from four to 18 years. Coppermine fish were older at a given length than Mackenzie River fish (Figure 7) and Muth (1969) suggested it may be due to environmental factors such as water temperature and food availability. Also, another factor that affects growth and age-at-maturity that could be considered here is fishing pressure. The population(s) of the Mackenzie River may have been more heavily exploited than the Coppermine population. There were no differences between sexes in the weight-length relationship.

2.5.2 Alaskan Rivers

Griffiths et al. (1992) reported an otolith age range of 0 to 12 years for broad whitefish from Prudhoe Bay. These samples exhibited increased growth to age four years (approximately 250 mm) and decreased growth after age four, similar to the pattern found in two studies of broad whitefish from the Mackenzie River (Bond 1982) and Chang-Kue and Jessop (1992).

Five rivers in Alaska were studied by Alt (1976). These broad whitefish could be split into two groups with similar biological characteristics based on location and length of growing season. The Porcupine, Minto Flats, and Holitna Rivers of central Alaska were in one group and the Imuruk and Sagavanirktok Rivers of northern Alaska were in the second (Table 3). Alt (1976) suggests that despite having similar growth curves fish in these two groups are likely from different stocks because the salinity levels found in the Bering, Chukchi, and Beaufort Seas acts as a barrier to broad whitefish from the four river systems; at least two genetic stocks could exist in each of the two groups. In Figure 7 the Porcupine River represents the faster growing group and the Sagavanirktok River represents the slower growing group.

Alt and Kogl (1973) sampled the Colville River and Colville River

Delta areas. Fork lengths for samples from the delta ranged from 105 mm to 630 mm with a mean of 375 mm (37% were spawners). Samples from upstream on the river had a length ranging from 335 mm to 670 mm and a mean of 530 mm (86% spawners). Ages ranged from 0 to 15 years, with maturity reached at age seven or eight. Growth was considered to be slow with a mean length of 390 mm at age eight years. Broad whitefish have been harvested commercially from the delta since 1950. The mean length and weight for the commercial catch (127 mm (5") mesh gillnet) is 550 mm and 2300 g, respectively.

2.5.3 Russian Rivers

Popov (1976) reported scale ages ranging from 0 to 13 years with an age-at-maturity of seven to eight years for broad whitefish from the Tanama River, a tributary of the Yenisey (Table 3). Fish aged six and seven years (397 mm to 448 mm) dominated the commercial catch.

The lower Ob River region resembles the lower Mackenzie River region in that they are both very complex with several interconnecting rivers and channels with the potential of producing several different stocks. Broad whitefish from the lower Ob River Basin had scale ages ranging from three to 13 years, fork lengths ranging from 373 mm to 496 mm and a weight range of 520 g to 2020 g (Prasolov 1989) (Table 3). The majority of Kharbey River spawners were aged seven to nine years with the youngest recorded mature at age four. Further south in the Manya River a gradually increasing age range was observed for spawners. In 1978 the majority of spawners were aged three to six and in 1983 the majority were aged six to eight. Despite differences in age-at-maturity between rivers in the lower Ob River region the spawning populations of different tributaries had a similar age structure and Prasolov (1989) concluded that the existence of different stocks within the system could not be shown.

Broad whitefish of the Mackenzie River compared well with fish from some Russian rivers for growth to age seven (Muth 1969). Hatfield et al. (1972) and Stein et al. (1973b) reported a growth rate for broad whitefish from the Mackenzie River that was similar to that reported for several Russian rivers including the Kolyma River (Berg 1949 in Stein et al. 1973b) in Siberia.

2.6 METHODS USED FOR THE MIDDLE CHANNEL BIOLOGICAL SAMPLE

Biological parameters of importance to fisheries managers include size, age, and maturity distributions; gonadosomatic index; length-weight relationship; condition factor; and length-age relationship. These analyses were performed on the 1984 to 1989 dataset (Appendix A) discussed previously.

2.6.1 Sampling Methods

Mr. Billy Day, an Inuvik fish harvester under contract to DFO, used 139 mm mesh gillnets to catch the fish samples analyzed here. All samples were collected in the fall from approximately the same location on the Middle Channel, near Horseshoe Bend (Fig. 3). In 1984, samples were collected at four different intervals over three months (early September, mid September, mid October, and early November). Whole fish were shipped south to Dr. Reist's lab in Winnipeg for data collection and tissue sampling. Detailed fish processing and data collection methods are described in Reist (1987).

Sample codes and collection dates are given in Table 4. The collection dates for 1984-5-1 and 1984-6-1 were similar to the collection dates for samples from other years so they were combined (to provide a larger sample) for use in the between-year comparative analysis. More specific collection dates for the 1987 and 1989 samples were not available.

Table 4. Sample code, sampling date and sample size for broad whitefish collected from the Middle Channel, Mackenzie River Delta, 1984 to 1989.

Sample Code	Sampling Date	Sample Size		
		Male	Female	Total
1984-5-1	early September	30	27	57
1984-6-1	middle of September	17	18	35
1984-7-1	middle of October	20	6	26
1984-8-1	November 7 to 11	21	30	51
1985-38-1	middle of September	14	21	35
1986-69-1	September 20 to 26	29	21	50
1987-84-1	fall	6	44	50
1988-49-1	September 22	19	11	30
1988-49-2	October 5	6	4	10
1988-49-3	October 10	6	4	10
1989-36-1	fall	31	19	50

2.6.2 Biological Methods

Round weight was recorded to the nearest gram and fork length to the nearest millimetre. Sex and maturity (the degree of gonad development) were determined and gonad weight was measured to the nearest 0.1 g. Scales and pelvic fin rays were removed for aging purposes.

Table 5. Maturity code and criteria used for 1984 to 1987 broad whitefish samples (Reist 1987).

(.)	- missing value, i.e. datum not collected
00	- too young to be sexed
01	- **immature (virgin) female**, granular ovaries, membrane firm
02	- **resting female**, ovaries 40-50% of body cavity, membrane thin and loose, healed from spawning
03	- **mature female**, current-year spawner with ovaries filling body cavity, eggs not loose
04	- **ripe female**, eggs full-size and loose, expelled by slight pressure
05	- **spent female**, ovaries ruptured and flaccid, some eggs retained in body cavity
06	- **immature male**, testes long, thin and firm
07	- **resting male**, testes tubular, healed from spawning, mottled and purplish in colour
08	- **mature male**, testes large, lobate, white to purplish with fluid centres
09	- **ripe male**, testes full size, white and lobate, milt expelled by slight pressure
10	- **spent male**, testes flaccid, violet-pink, blood vessels visible

Maturity codes were used, along with the GSI, to classify the maturity state of the broad whitefish samples. Table 5 contains the code used for the 1984 to 1987 samples only (Reist 1987). The lab switched codes in 1988 and there were inconsistencies between the maturity code and the GSI data which resulted in some uncertainty as to whether the code had been properly assigned for the 1988 and 1989 samples. The gonad weight and GSI data indicated that all of the 1988 and 1989 data were current-year spawners. Therefore, the mean GSI has been calculated but no data using the maturity code have been presented for these years.

After becoming familiar and confident with scale, fin-ray and otolith aging methodology, age data from these structures were compared for 100 broad whitefish (Treble and Reist 1993). The pelvic fin-ray age range for these samples was three to 17 years. Scales were found to consistently underestimate the age of fish older than six years. The mean scale age (7.84 years) differed significantly from the mean fin-ray and otolith ages (9.80 and 8.91 respectively).

Fin rays were more readily available for the 1984 to 1989 samples and are the age structure of choice for monitoring commercial fisheries at this time. Therefore, the pelvic fin-ray was the age structure chosen for use in this study.

The first three fin-rays were removed close to the body. They were dipped in epoxy resin and after the epoxy had hardened (approximately 24 hours) thin sections measuring 0.40 mm and 0.50 mm were cut using a low speed saw with a diamond tipped blade. Sections were mounted on glass microscope slides using a clear mounting medium and covered with plastic cover slips. A compound microscope with a dark field condenser and transmitted light was used to magnify the sections. Annuli appeared as dark bands (opaque) between white (translucent) growth zones.

An annulus is a feature laid down on hard parts (bones, scales and otoliths) on an annual basis as a result of a slowing of the growth rate brought on by factors such as cold winter temperatures (Jearld 1983). For broad whitefish of the Mackenzie River, Bond and Erickson (1982) noted that the previous years' annulus had not been laid down or was not visible until the middle of July and therefore they credited fish caught in June and early July with an additional annulus.

2.6.3 Dataset Preparation

The Statistical Analysis System (SAS) on a VAX mainframe computer was used to analyze the data and graphics and tables were created using a personal computer.

The age data, determined as above, were added to the original dataset available from Dr. J. Reist. Condition factor and (GSI) were calculated and appended to the dataset using the SAS (see formulae below). Plots of length vs. age, weight vs. age, weight vs. length were produced for each set of samples and were examined for outlying or erroneous data points. Errors due to incorrect data entry were corrected and extreme outliers discarded as bad data before the analyses were performed.

Summary tables containing age and length class data were produced using programs developed by Dale McGowan of the Department of Fisheries and Oceans Freshwater Institute, Winnipeg, Manitoba and can be found in Appendix B (Tables 1 to 20).

2.7 <u>RESULTS</u> <u>AND</u> <u>DISCUSSION</u>

2.7.1 Comparison of Male and Female Broad Whitefish

There were no significant differences in mean age for any samples (two sample t-test, α=0.05) or for all samples combined (Table 6). The October 1984 sample (1984-7-1) and the 1988 sample were the only samples that showed a significant difference in length between sexes, P=0.0012 and P=0.0462, respectively (Table 7). However, the post-hoc power tests (the probability of rejecting the null hypothesis when in fact it is false) were very poor for both age and length analyses, likely a result of small sample sizes, therefore we can not fully trust these results.

None of the Kolmogorov-Smirnov (K-S) tests for equality of distribution of ages between male and female broad whitefish were significant (Table 8) and only the October 1984 sample was significant (P=0.0425) for the comparison of length distributions (Table 9).

The weight-length relationships for male and female broad whitefish were tested using analysis of covariance (Table 10). The early September sample (1984-5-1) showed a significant difference

Table 6. Two sample t-tests (α=0.05) of mean age for male and female broad whitefish. A positive mean difference indicates females are older than males.

Sample Code	Degrees of Freedom	P-value	Mean Difference (yrs)	Post-Hoc Power (%)
1984-5-1	18	0.2974	1.63	18
1984-6-1	31	0.1692	1.27	28
1984-7-1	24	0.8854	-0.18	3
1984-8-1	45	0.8435	0.17	4
1985-38-1	17.7	0.1346	1.50	*
1986-69-1	48	0.8768	-0.15	3
1987-84-1	47	0.3450	-1.26	17
1988-49-all	48	0.9172	0.11	11
1989-36-1	47	0.9766	0.02	3
All Samples	357	0.3723	0.28	14

* Sample variance was not equal so power analysis was not carried out.

Table 7. Two sample t-tests (α=0.05) of mean length for male and female broad whitefish. A positive mean difference indicates females are larger than males.

Sample Code	Degrees of Freedom	P-value	Mean Difference (mm)	Post-Hoc Power (%)
1984-5-1	52	0.7299	2.45	5
1984-6-1	28	0.4805	-8.00	10
1984-7-1	20	0.0012*	-32.84	**
1984-8-1	23	0.1921	12.65	22
1985-38-1	32	0.3666	7.43	17
1986-69-1	45	0.2727	-7.49	17
1987-84-1	33	0.2637	13.83	17
1988-49-all	46	0.0462*	-16.97	51
1989-36-1	48	0.1897	-8.23	25
All Samples	343	0.7802	-0.80	4

* Significant result, mean lengths are different
** Sample variance was not equal so power analysis was not carried out.

Table 8. Kolmogorov-Smirnov tests of equal distribution (α=0.05) for ages between male and female broad whitefish sampled.

Sample Code	Sample Size Male, Female	D Statistic	P-value
1984-5-1	12,8	0.4583	0.2656
1984-6-1	16,17	0.2680	0.5928
1984-7-1	20,6	0.3667	0.5642
1984-8-1	19,28	0.2594	0.4315
1984-all	67,59	0.1121	0.8256
1985-38-1	14,21	0.4048	0.1275
1986-69-1	29,21	0.1445	0.9611
1987-84-1	6,43	0.2868	0.7793
1988-49-all	31,19	0.1273	0.9910
1989-36-1	31,18	0.2007	0.7486

Table 9. Kolmogorov-Smirnov tests of equal distribution (α=0.05) for length between male and female broad whitefish sampled.

Sample Code	Sample Size Male, Female	D Statistic	P-value
1984-5-1	29,25	0.1310	0.9753
1984-6-1	15,15	0.2667	0.6604
1984-7-1	17,5	0.7059	0.0425*
1984-8-1	12,13	0.4359	0.1866
1984-all	73,58	0.0909	0.9521
1985-38-1	13,21	0.2527	0.6841
1986-69-1	27,20	0.2222	0.6217
1987-84-1	5,30	0.4333	0.3968
1988-49-all	30,18	0.3333	0.1641
1989-36-1	31,19	0.2122	0.6636

* Significant result, length frequencies differ

Table 10. Analysis of covariance for the weight-length relationship between male and female broad whitefish (α=0.05).

Sample Code	Sample Size	Homogeneity of Slope P-value	Ancova P-value	Common Slope	Estimate Male-Female
1984-5-1	54	0.9870	0.0135*	2.82	-0.056
1984-6-1	30	0.8656	0.0603	3.30	-0.062
1984-7-1	22	0.0588	0.2206	2.54	-0.048
1984-8-1	25	0.6610	0.3260	2.00	-0.050
1984-all	131	0.8553	0.0087*	2.74	-0.019
1985-38-1	34	0.7647	0.5962	3.15	-0.022
1986-69-1	47	0.3942	0.3188	3.24	-0.029
1987-84-1	35	0.4460	0.1023	2.61	0.076
1988-49-all	48	0.2188	0.2370	2.40	-0.049
1989-36-1	50	0.3164	0.0006*	2.45	-0.081

* Significant result, sexes differ.

between the sexes (P=0.0135), and contributed to the significant P-value (0.0087) for the 1984 sample combined. The 1989 sample was also significantly different (P=0.0006). The estimated difference in population means of weight adjusted for length using analysis of covariance between male and female fish showed that females were larger than males for all but one sample (1987). There may be differences in the weight-length relationship between sexes at this time of year because female gonads become considerably larger and heavier than the male gonads as spawning time approaches.

Given that previous researchers have observed no sex differences in length-frequency distributions (Hatfield et al. 1972; Bond 1982), mean length-at-age (de Graaf and Machniak 1977) and the weight-length relationship (Muth 1969; Stein et al. 1973b; de Graaf and Machniak 1977; and Bond 1982), it is concluded that the differences noted here are minimal and these data could be combined for further analysis despite the above significant results.

2.7.2 Sex Ratio

The ratio of female to male broad whitefish in any given sample provides information on the distribution of sexes within a population at the time the sample was collected, if sampling was done in a random manner. The sex ratio may vary from population to population and fluctuations in the ratio within a population over time may indicate changes in sex-specific mortality rates which could affect overall population numbers in the future. However, the applicability of this statistic for discerning the presence or absence of discrete stocks in this instance is questionable given the dynamic nature of broad whitefish movements. The data are presented below for informational purposes only.

Sex ratios for the 1984 temporal series are plotted in Figure 8a. The ratio was near 1.0 for the September sample, dropped to below one

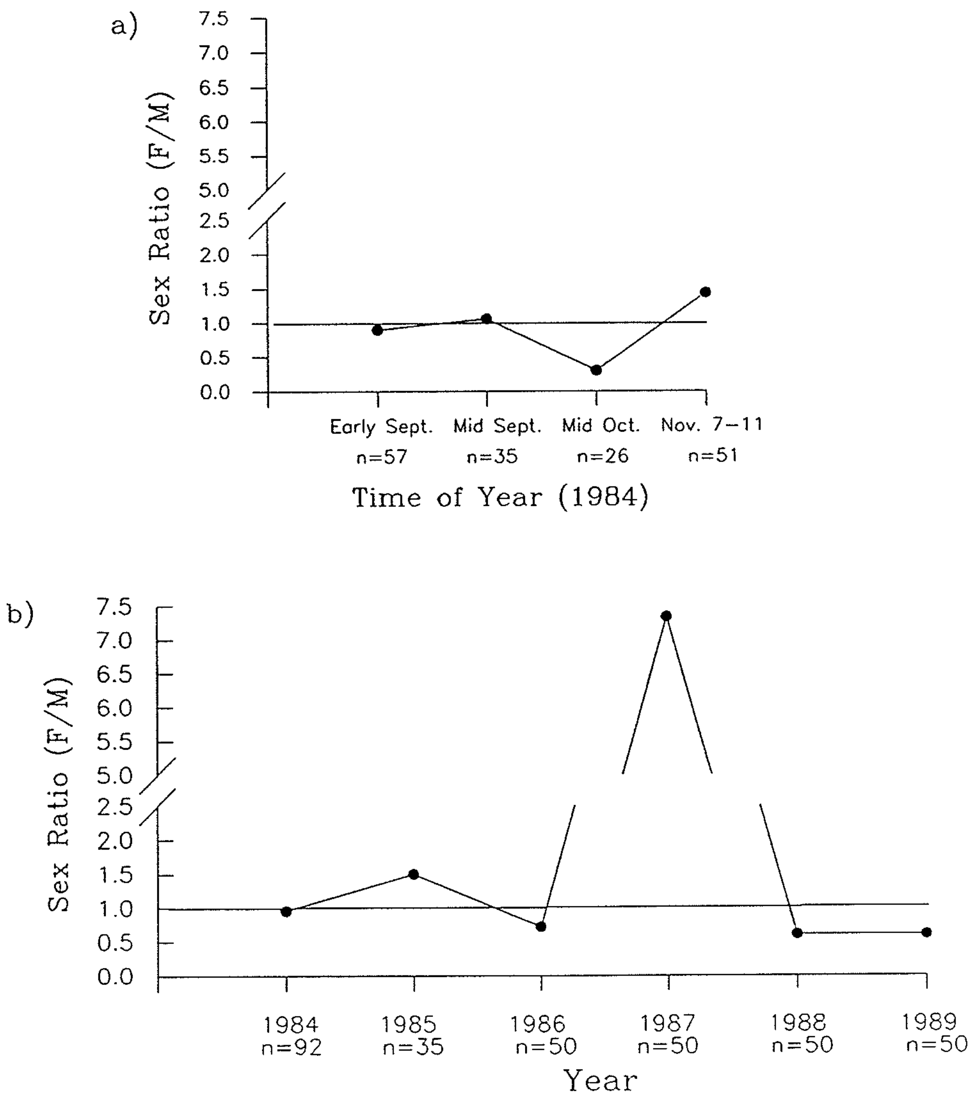


Figure 8. Sex ratio data: a) within–1984 temporal series; b) between–year comparison.

for the October sample and rose above one for the early November sample. These data seem to support the observation that the sexes are evenly distributed prior to the spawning migration and then in late fall they segregate for the run to and from upstream spawning grounds. Depending on when the samples are collected, females or males would dominate the catch. However, these data are not sufficient to substantiate this characteristic of the life history. The sample sizes are small and were collected over a very short time period, therefore this information should be used cautiously.

The sex ratio (female/male) fluctuates around 1.0 (50% male and 50% female) for all but the 1987 sample (Fig. 8b). The ratio was very high in this year (7.33) because it was comprised almost entirely of female broad whitefish. This may not be due to any gear or sample selectivity but could represent the true situation at the time the sample was collected as broad whitefish are known to partition their movements during the spawning migration on the basis of sex.

2.7.3 Maturity Frequency, Gonadosomatic Index and Age-at-Maturity

In the 1984 temporal series, female broad whitefish appear to ripen before males (Fig. 9a). In the November sample the majority of females are spent, while the majority of males are still ripe. This progression from mature to spent over the two months which sampling occurred was to be expected given what we know of broad whitefish biology.

The GSI was calculated to provide a more quantitative assessment of the degree of sexual development. The following formula from Snyder (1983) was used: GSI = gonad weight (g) * 100/round weight (g). The mean GSI for spawners, non-spawners and spent fish was calculated separately for females (Fig. 10) and males (Fig. 11). Gonadosomatic index values for fish collected from the Mackenzie River prior to spawning have not been reported previously. Therefore, the values

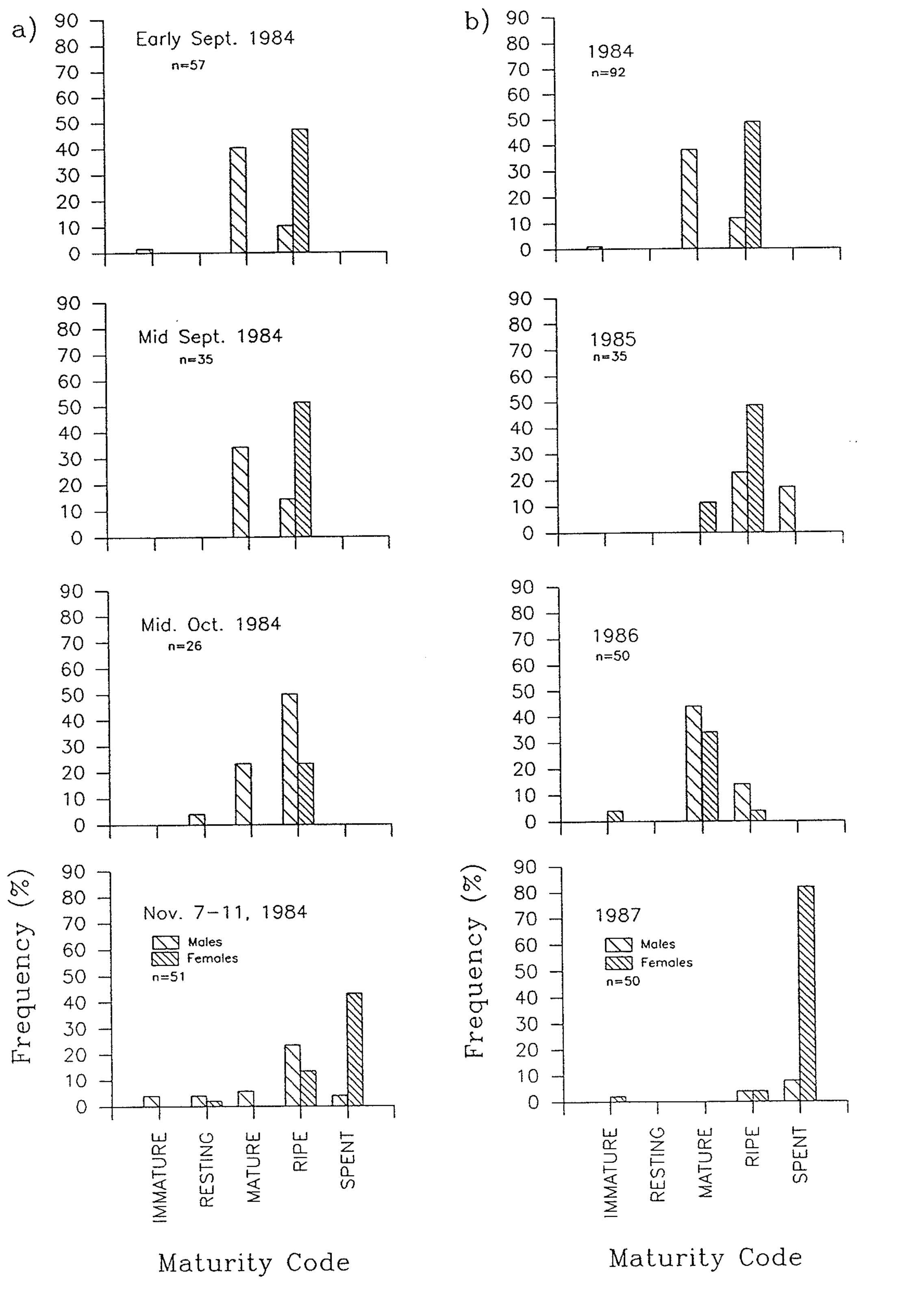
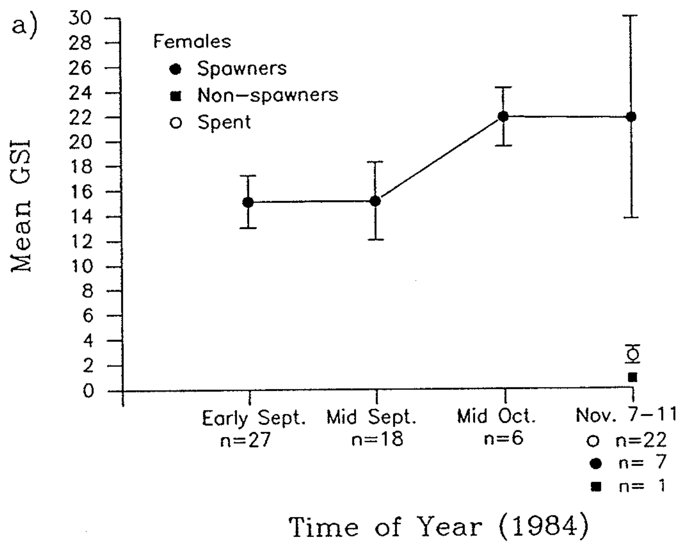


Figure 9. Maturity data: a) within-1984 temporal series; b) between-year comparison.



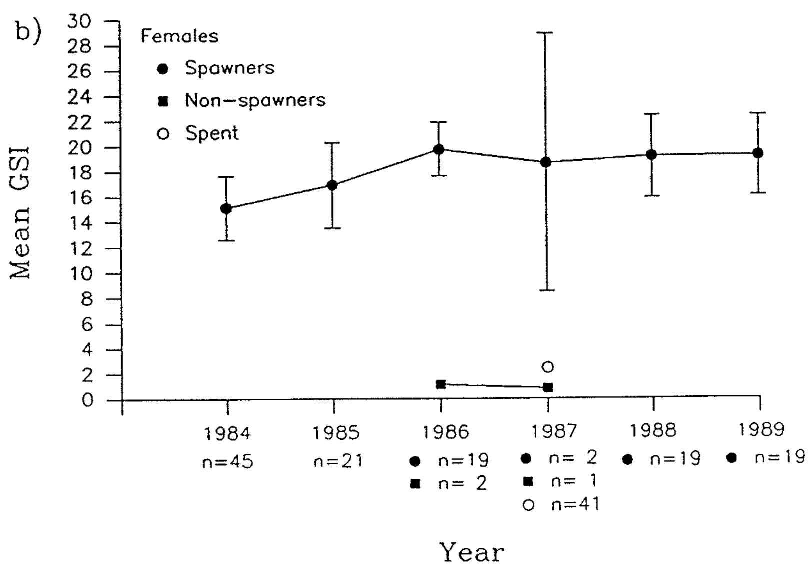


Figure 10. Mean gonadosomatic index (GSI) ± one standard deviation for female Broad whitefish: a) within-1984 temporal series; b) between-year comparison.

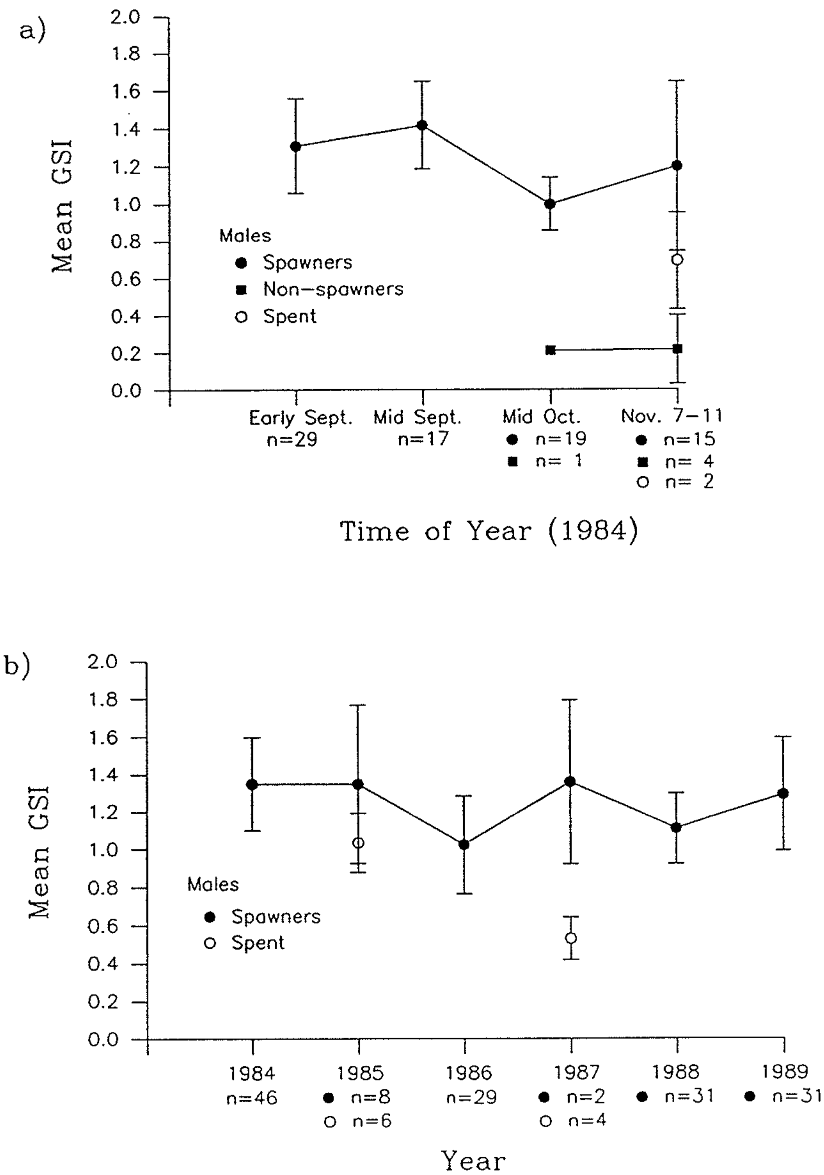


Figure 11. Mean gonadosomatic index (GSI) ± one standard deviation for male broad whitefish: a) within-1984 temporal series; b) between-year comparison.

reported here can be used to complement those reported by Bond (1982) for male and female broad whitefish sampled from Tuktoyaktuk Harbour during their July to September sampling program.

Figure 10a shows how the mean GSI for female spawners increased within the season from 15.10 for early September to 21.82 for early November while Figure 11a shows the mean GSI for males fluctuated from a low of 1.00 to a high of 1.42. Egg mass likely increased more rapidly than sperm mass so the above trends were to be expected. For the male broad whitefish there was one non-spawner in the October sample and four in the November sample with mean GSIs of approximately 0.20. Two spent males in the November sample had a mean GSI of 0.69.

In 1985 the majority of males and females were ripe with a few spent males whose mean GSI was 1.04 (Fig. 9b and 11b). Bond (1982) found that the mean GSI for immature and spent male broad whitefish was 0.1 and the mean GSI for mature males was 1.0. Therefore, there may have been an error in the coding of these samples. There may have been some confusion between the resting and spent classifications in the maturity coding for this 1985 sample. They may in fact be resting fish (mature fish that will not spawn in the current year).

The 1987 sample is almost entirely females (Fig. 9b) and the mean GSI for the majority of this sample is very low, confirming that they are spent fish (Fig. 10b). An exact collection date was not available for these data (Table 4) and the fact that they compare more favourably with the November 1984 sample (Fig. 9a and 10a) than with the other September samples suggests they may have been collected in late October or early November.

The maturity code data presented here are not a reliable tool for predicting the presence or absence of discrete stocks given the inconsistency and uncertainty in the time of data collection and the inconsistency between maturity codes and GSI.

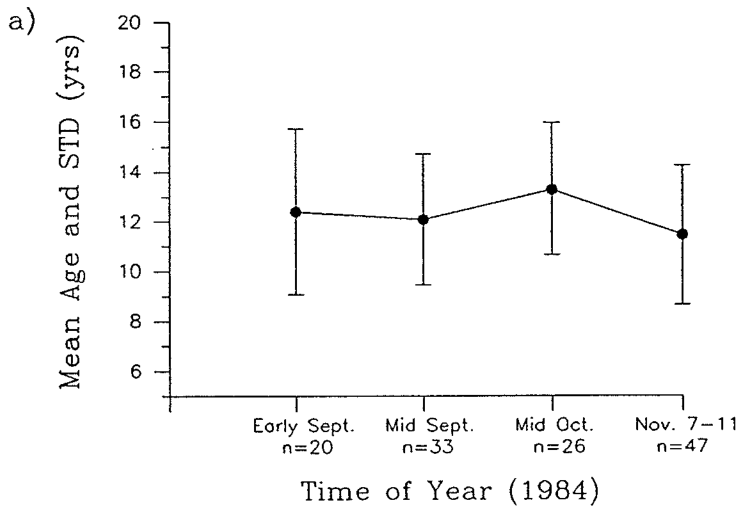
The GSI for female spawners in the between-year comparison ranged from 15.01 to 19.72 (Fig. 10b). The high standard deviation associated with the 1987 mean is likely due to the small sample size. Mean GSI for non-spawners and spent females was less than 2.60. For male spawners the mean GSI ranged from 1.03 to 1.35 (Fig. 11b). Four of the six samples in 1987 were classified as spent males and had a mean GSI of 0.53. Unlike the 1985 sample this value was much lower than the value for spawning males and is more similar to the November 1984 value for spent males. The variability observed in the mean GSI for spawners could be due to: 1) year-to-year variability in sampling time; 2) year-to-year variability in environmental factors that influence the onset of maturity; or 3) variability in maturity rates of different broad whitefish stocks that may be located in this area at the time of sampling.

Age-at-maturity can be used as one of the indicators of stock differences and may also be used to monitor the effects of mortality due to environmental and/or fishing pressures. Of all the samples examined from 1984 to 1989, the youngest mature male was five years old and all males aged 10 or older were mature (Appendix B, Tables 1 to 10). No females younger than age seven years were caught and they were all mature. There was one 14 year old female classified as immature that may in fact have been resting, but most females aged 10 or older were mature (Appendix B, Tables 1 to 10). No patterns or trends in age-at-maturity were discernable from these samples.

2.7.5 Mean Age and Age-Frequency Distribution

Analysis of variance was used to test for differences in mean age between years (1984-1989), and between times within 1984.

Mean ages for the 1984 temporal series fluctuated around 12 years (Fig. 12a). The mean for the October sample (13.31 years) was greater than that for the other time periods. However, the difference was not significant (P=0.0679) (Table 11). There was variability in the



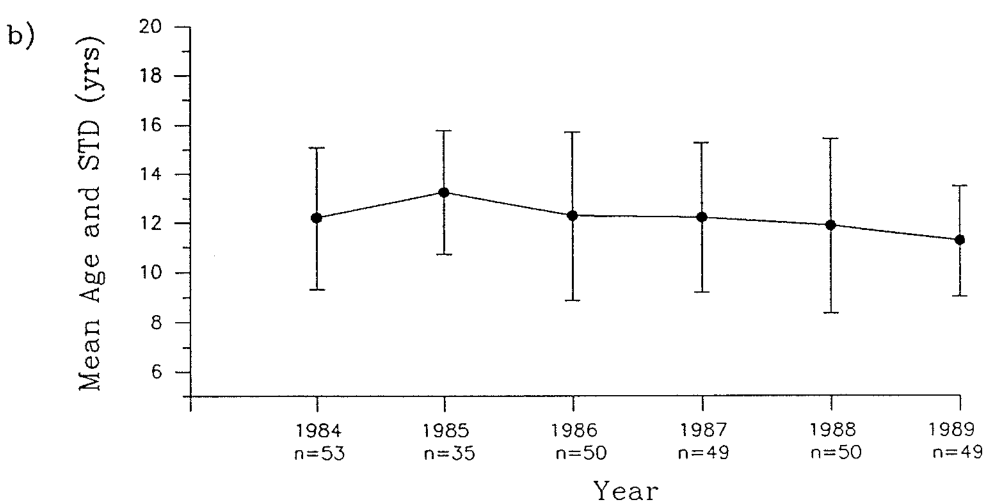


Figure 12. Mean ages ± one standard deviation: a) within-1984 temporal series; b) between-year comparison.

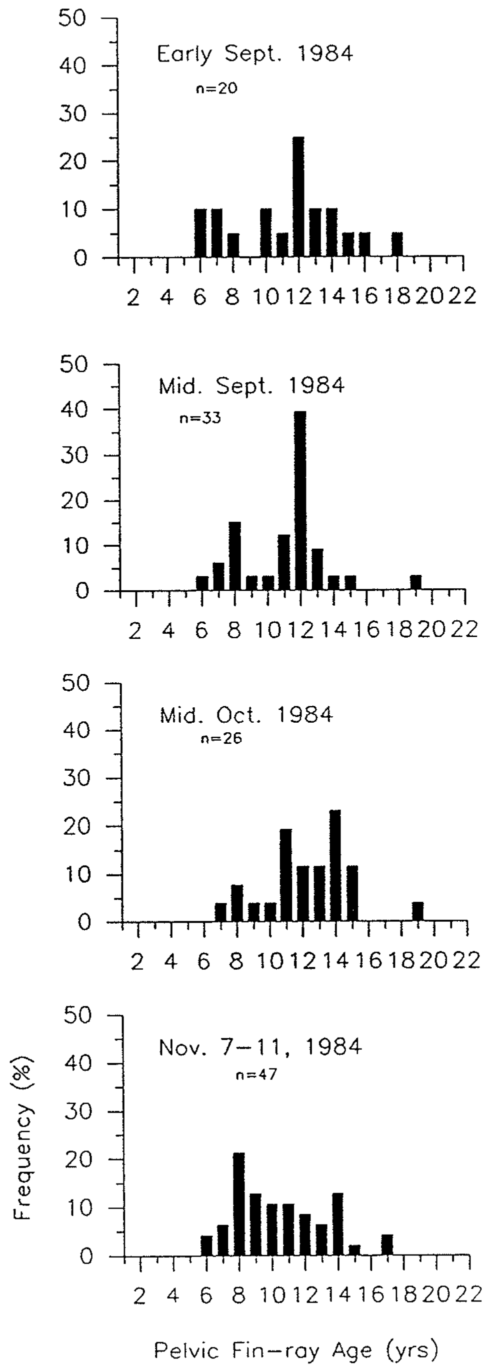


Figure 13. Age frequency data for the within-1984 temporal series.

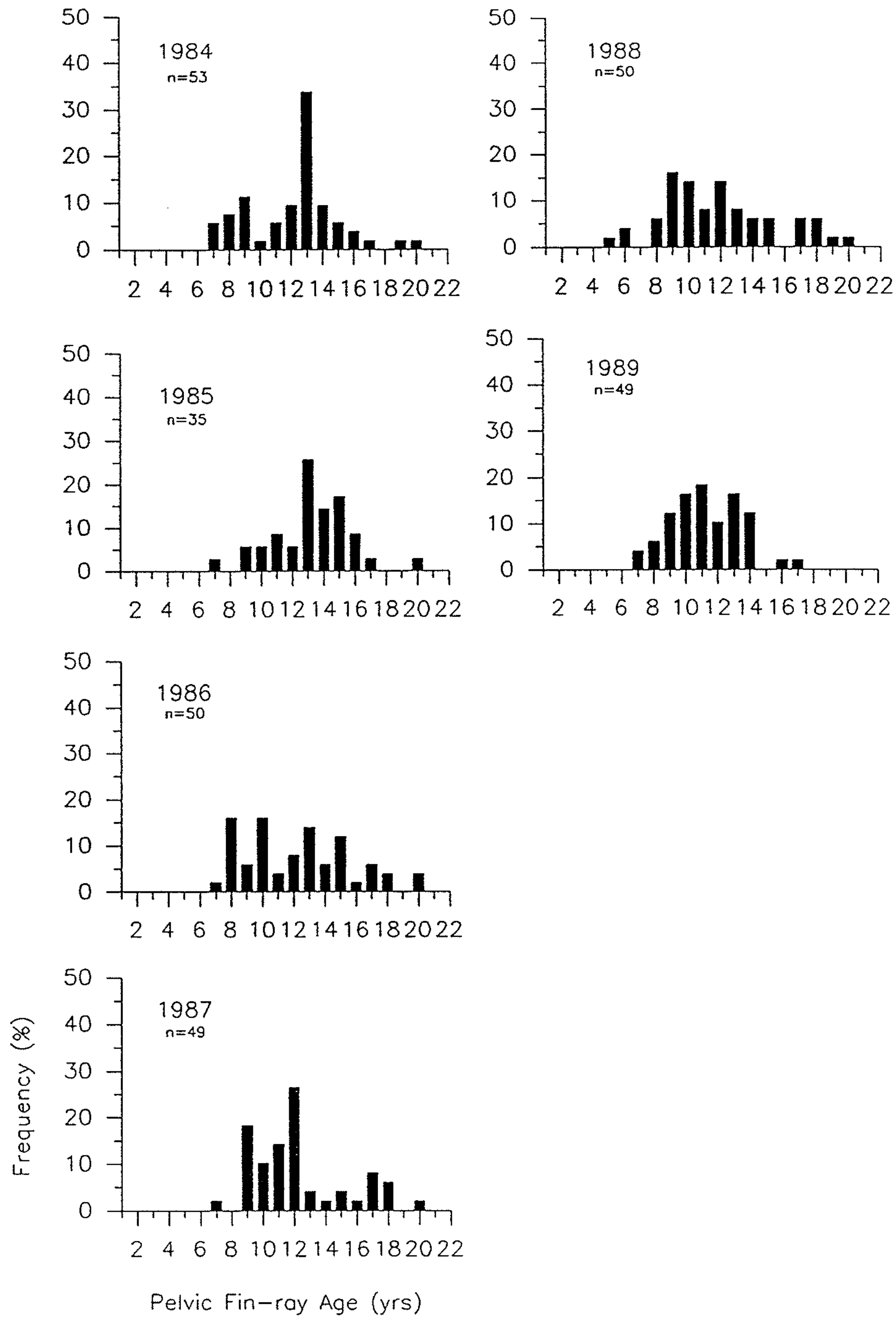


Figure 14. Age frequency data for the between-year comparison.

Table 11. Analysis of variance statistics for age and length (α=0.05).

Location Codes	Variable	Degrees of Freedom	Type III SS F-value	P-value	Normality Test P-value
1984-5 to 8	Age	3	2.44	0.0679	0.0378*
	Length	3	1.49	0.2208	0.0912
1984 to 1989	Age	5	1.91	0.0920	0.0001*
	Length	5	6.55	0.0001*	0.3143

* Significant result

Table 12. Coefficient of variation for age and length distributions.

	Within-1984				Between-years					
	Early Sept.	Mid Sept.	Mid Oct.	Nov. 7 to 11	1984	1985	1986	1987	1988	1989
Age	0.266	0.215	0.203	0.243	0.238	0.188	0.276	0.246	0.294	0.195
Length	0.051	0.060	0.065	0.048	0.055	0.047	0.047	0.050	0.059	0.044

distribution of ages over the sampling period (Fig. 13). The coefficient of variation (CV=standard deviation/mean) ranged from .203 to .266 (Table 12). None of the samples were normally distributed P=0.0378 (Table 11), for example the positive skewness of the November sample was quite noticeable (Fig. 13).

For 1984-1989 ages ranged from five to 20 years with the modal age fluctuating from eight to 14 years (Fig. 14). Age-frequency distributions were not normally distributed for the between-year samples either (P=0.0001) (Table 11). There are shifts in age distribution to younger year classes for 1986, 1987 and 1989 and fish greater than 17 years are present from 1984 to 1988 but not 1989 (Fig. 14). The mean ages were not significantly different between-years (P=0.0920) (Fig. 12b) (Table 8) and the CV varied from .188 to .294 (Table 12).

There is variability in age distributions within and between years that may not be entirely explained by small sample size. There could be more than one homogeneous stock, or broad whitefish movements into and/or through the sampling area could be structured according to age.

2.7.6 Mean Length and Length-Frequency Distribution

Analysis of variance was used to test for differences in mean length between years (1984-1989), and between times within 1984.

Unlike age, the lengths were normally distributed for the within-year temporal series (Table 11). Mean length was approximately 500 mm (Fig. 15a) and analysis of variance was not significant (P=0.2208) (Table 11). Lengths fell between 436 mm and 573 mm and the modal range was again 463 mm to 512 mm. Although the mode did vary somewhat there was no noticeable trend over time (Fig. 16) and the CV was much lower than that for age, ranging from .048 to .065 (Table 12).

Mean length varied from a high of 505.9 mm in 1987 to a low of 482.77 in 1988 (Fig. 15b) with no observed trend over time but the analysis of variance showed that at least one mean was significantly

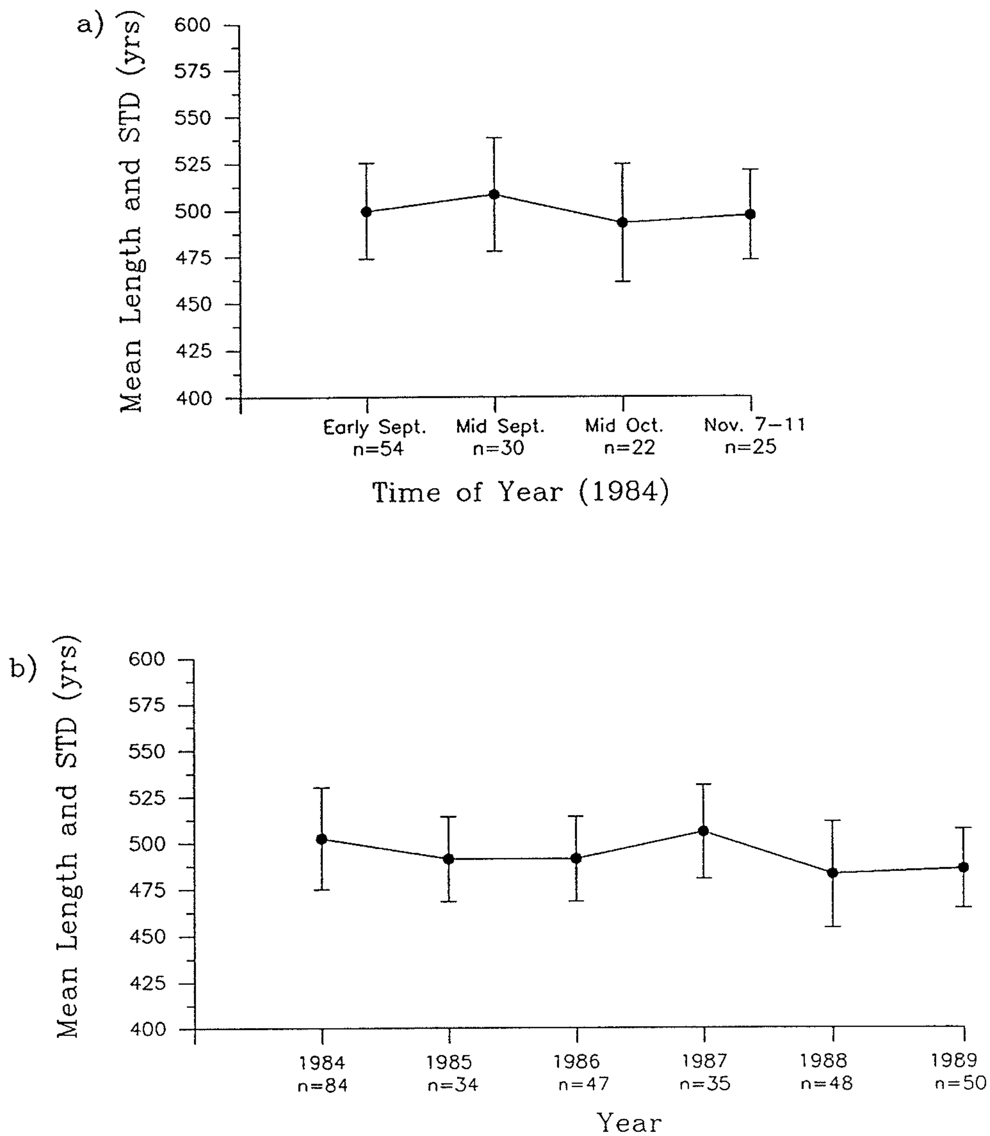


Figure 15. Mean length data ± one standard deviation: a) within-1984 temporal series; b) between-year comparison.

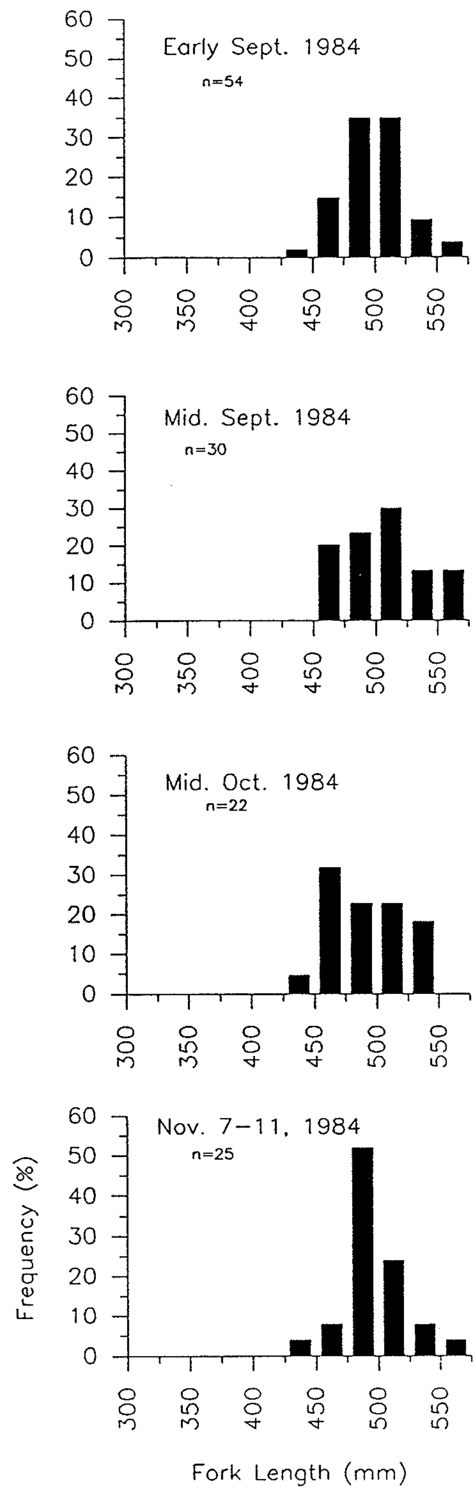


Figure 16. Length frequency data in 25 mm length classes for the within-1984 temporal series.

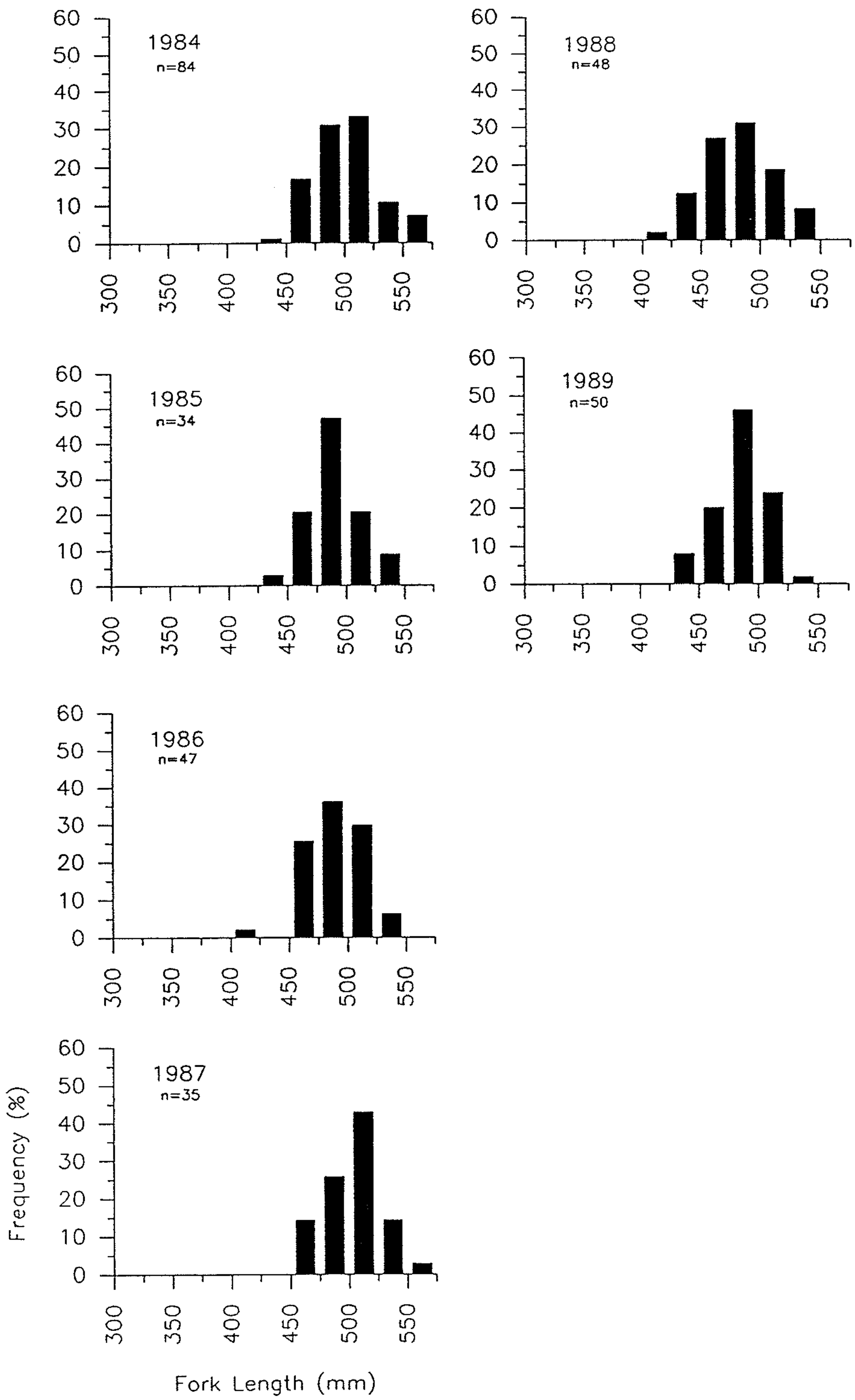


Figure 17. Length frequency data in 25 mm length classes for the between-year comparison.

different (P=0.0001) (Table 11). Fishers Least Significant Difference (LSD) multiple-comparison procedure showed that 1984 and 1987 were similar but different from the other years. Length-frequency distributions were normally distributed between years (Table 11). Lengths ranged from 418 mm to 574 mm and modal lengths varied between 463 mm and 512 mm (Figure 17). There was some evidence of heterogeneity in the length-frequency distributions between years, although it was not as marked as it was for the age distributions. The CV was small with values ranging from .044 to .059 (Table 12). The selectivity of a single mesh net might reduce observed differences in length-frequency distributions which could be caused by influxes of different stocks or different size classes of a single stock as was discussed above for age.

2.7.7 Length-at-Age

Growth curves of length plotted against age were produced but no comparative analyses were performed. It was difficult to interpret these data because small sample sizes for each age class result in a highly variable, uneven growth pattern. However, there does not appear to be significant differences in the age at length curves for the segment of the population(s) sampled using 139 mm gillnets for the 1984 temporal series (Fig. 18) or for 1984 to 1989 (Fig. 19).

2.7.8 Weight-Length Regression and Condition Factor (K)

Weight-length regression analysis and Fulton's K were used to evaluate fish condition. The weight-length relationship was described by the equation $\log_{10} W = a + b(\log_{10} L)$ where W=weight (g), L=fork length (mm) a = y-intercept and b=slope of the regression line. Fulton's K, a condition factor, was calculated using the formula: $K = \text{weight (g)} * 10^5 / \text{length}^3 \text{ (mm)}$ (Anderson and Gutreuter 1983). Cone (1989) suggests that using estimates of the weight-length regression parameters is a better method for evaluating fish condition. However,

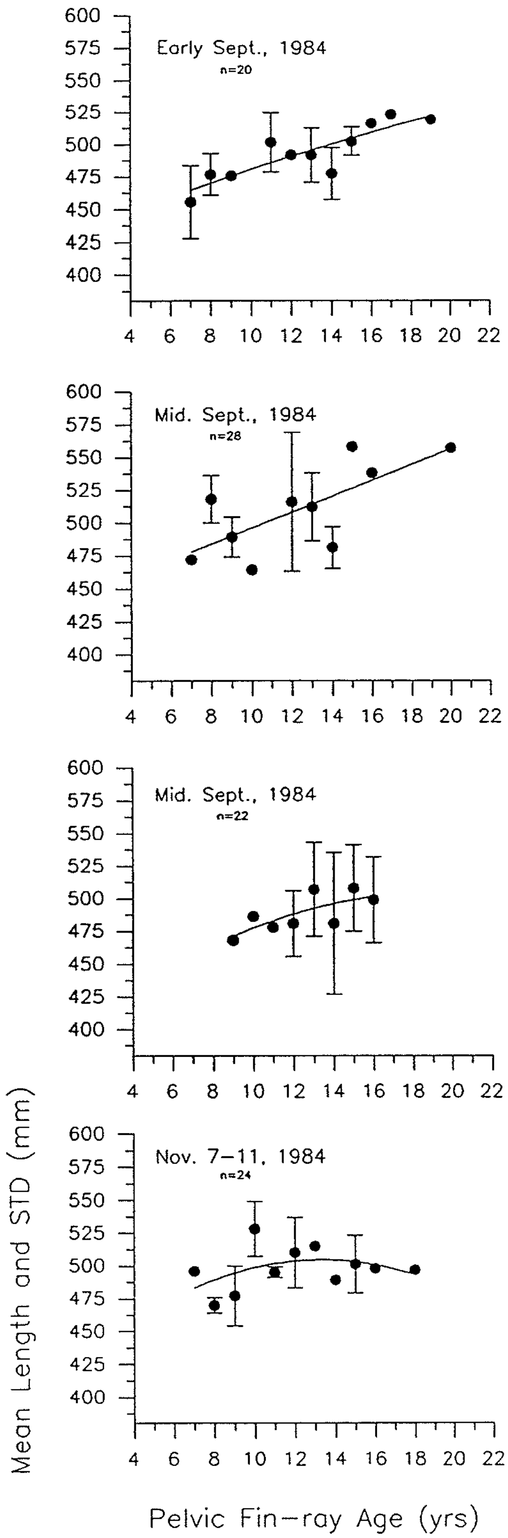


Figure 18. Length versus age growth curves for the within-1984 temporal series.

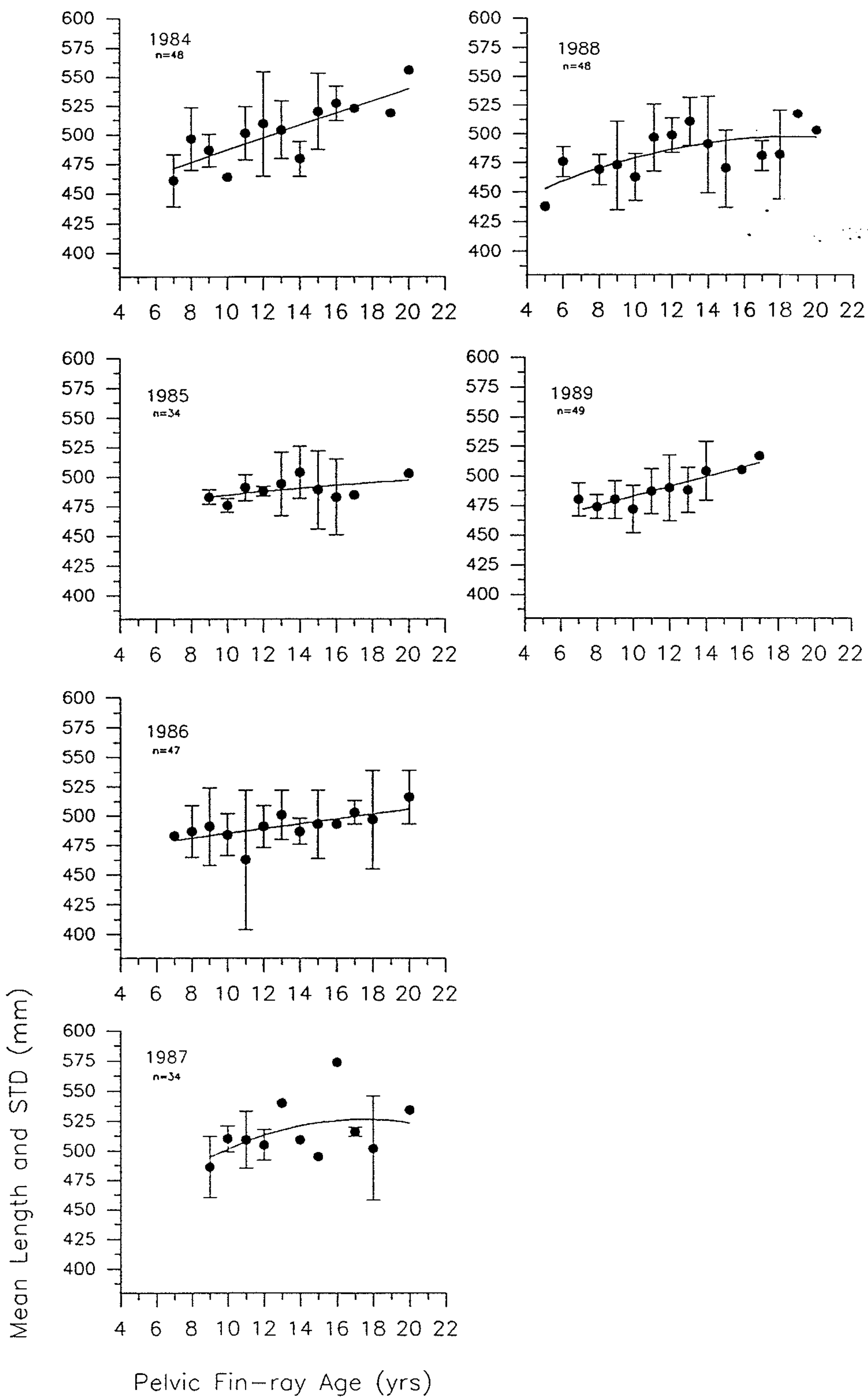


Figure 19. Length versus age growth curves for the between-year comparison.

Fulton's condition factor (K) has been calculated and can be found in both the age and length class tables located in Appendix A. Analysis of covariance was used to compare the slopes of the weight-length regression lines between times within 1984 and between years.

Tables 13 and 14 contain the weight-length regression estimates for slope and intercept, r^2, total degrees of freedom (sample size (n)-1), F statistic, and P-value for each group of samples.

There was a trend in the slope (downwards from the September sample on) and intercepts (upwards from the September sample on) for the 1984 temporal series (Table 13). Slope varied between 3.22 in mid September and 2.15 in November; while the intercept varied between -5.43 in mid September and -2.54 in November. The r^2 ranged from 0.44 to 0.84. However, analysis of covariance showed no significant difference in slopes (P=0.1839) (Table 15). The slope of the weight-length relationship will change during transition periods such as from spawning condition to non-spawning condition. Although this change was not significant it was reflected in the 1984 temporal series.

Differences were observed in the 1984 to 1989 between-year comparison for the weight-length relationship (Table 14). Slope and intercept varied between 3.02 and 3.19 and -4.88 to -5.30, respectively, for 1984 to 1986. For 1988 and 1989 slope and intercept changed to approximately 2.30 and -2.90, respectively. There was a significant difference in the analysis of covariance between years (P=0.0477) (Table 15). Estimates for pair-wise combinations of all years showed the following similarities and differences; 1985, 1986, and 1988 were similar; 1988 and 1989 were similar but 1989 was different from 1985 and 1986; 1984 and 1987 were different from all years and from each other. The weight-length relationship is so dependent on external factors such as environmental conditions that it is not a reliable indicator of stock differences. For example the slope of the weight-length relationship for a stock may be high one year as a result of a very good growing

Table 13. Parameters for the weight-length relationship for the within-1984 temporal series (α=0.05).

Year	Time of Year	Slope	Intercept	R-Square	Total DF	F-value	P-value
1984	Early September	2.852	-4.427	0.751	53	157.202	0.0001
1984	Mid September	3.223	-5.426	0.822	29	129.360	0.0001
1984	Mid October	2.395	-3.176	0.842	21	106.239	0.0001
1984	Nov. 7-11	2.151	-2.542	0.435	24	17.724	0.0003

Table 14. Parameters for the weight-length relationship for the between-year comparison (α=0.05).

Year	Slope	Intercept	R-square	Total DF	F-value	P-value
1984	3.021	-4.880	0.786	83	300.798	0.0001
1985	3.191	-5.313	0.633	33	55.163	0.0001
1986	3.187	-5.297	0.709	46	109.793	0.0001
1987	2.506	-3.532	0.646	34	60.287	0.0001
1988	2.282	-2.853	0.527	47	51.333	0.0001
1989	2.286	-2.850	0.599	49	71.575	0.0001

Table 15. Analysis of covariance statistics for the weight-length relationship (α=0.05).

Location Codes	Sample Size	Homogeneity of Slope p-value	Ancova p-value	Common Slope
1984-5 to 8	131	0.0930	0.1839	2.76
1984 to 1989	298	0.0477*	0.0001*	2.75

* Significant result.

season but the following year it may be much lower depending on the temperature, food availability, etc. The differences observed here between 1984 and 1989 likely reflect differences in growing season and/or differences in the state of readiness for spawning rather than differences in stock characteristics.

Fulton's condition factor ranged from an average of 1.5 to 1.71 for 1984 to 1989 and from 1.50 to 1.57 for the 1984 temporal series (Appendix B, Tables 11 to 20).

2.8 SUMMARY AND CONCLUSIONS

Information from the literature presented earlier in this chapter illustrates how the parameters of age, length, age-at-maturity and growth can vary for broad whitefish from different river systems. These differences may be attributable to a combination of genetic and environmental factors as suggested by Alt (1976) and possibly human factors such as harvesting rates. The lower Mackenzie River region is very complex with the potential to support several distinct populations of one or more life history types. If environmental conditions are assumed to be similar for all anadromous broad whitefish of the lower Mackenzie River region then differences in the above biological parameters between locations may indicate the existence of separate stocks. An examination of the literature does show differences between locations but inconsistency in the aging structure used, gear type, sampling period and sample sizes makes it difficult to make any definite conclusions.

The samples examined here were collected with other purposes in mind using a single-sized gillnet mesh (139 mm) that selects only large mature fish. Most fisheries science methods require a representative cross section of all age and size classes in order to make comparisons between stocks or predictions as to the state or condition of a stock. Also, small sample sizes may have affected the reliability of the data.

Therefore, the null hypothesis presented earlier, (within the biological parameters examined, there are no between-year or within-year biological differences in fish captured at the Middle Channel location), cannot be accepted or rejected given the data limitations. The data do show variability within and between years for some analyses, particularly the length- and age-frequency plots. Mean age and length were relatively stable at 12 yrs and 500 mm, respectively, but the modal age and length ranged between eight and 14 yrs, and 463 and 512 mm, respectively. There is no particular trend to these data but they are quite variable from year to year. Similar variability in age and length distributions were observed by Treble et al. (in prep.), but whether or not this variability is due to genetic variation between distinct stocks is not certain.

The management of broad whitefish on a stock-by-stock basis is not possible at this time. We have data that suggest distinct stocks of anadromous broad whitefish exist but these data are not conclusive. Therefore, broad whitefish harvest levels should be monitored closely and appropriate measures taken to collect biological data on a regular basis. Fishery managers would be advised to consider an adaptive management approach (this is discussed further in Chapter IV), but in order to increase their understanding of the system and improve management policies they are also encouraged to support research to determine if more than one anadromous stock exists and to answer questions such as: Are there also riverine stocks? What is the difference between the lake form "lake-fish" and the anadromous form? What role if any do Delta lakes, ponds and side-channels play in broad whitefish life-history?

Chapter III

COMMERCIAL AND SUBSISTENCE HARVESTS: PAST AND PRESENT

3.1 INTRODUCTION

The lower Mackenzie River region supports important subsistence and commercial fisheries for anadromous broad whitefish. These fisheries consist of three types: export commercial (fish produced for sale outside the region), local commercial (fish produced for local sale), and subsistence (fish produced for community use). Subsistence fishing is defined as non-commercial fishing for the purposes of local food use by the harvesters, their families and community (Berkes 1988; 1990). Subsistence fishing can further be divided into non-licensed fishing by Aboriginal people and licensed fishing by non-Aboriginal people.

Fisheries are carried out primarily by Aboriginal peoples: Inuvialuit, Dene, and Metis who live in the communities of Tuktoyaktuk, Inuvik, Aklavik, Fort McPherson, Tsiigehtchic, and Fort Good Hope (Fig. 1). These people consider fishing a cultural tradition and not just an economic activity. Commercial and subsistence fishing activities are closely related since they are often conducted by the same people at the same time. Fishing begins in the spring once flood waters recede, and intensifies during the fall and early winter when the broad whitefish are gathering in pre-spawning aggregations, and migrating to spawning sites. Portions of a given catch may either be sold commercially or used for subsistence (Bodaly et al. 1989).

Export commercial fisheries have been attempted in the Mackenzie River Delta in the past without success. The high cost of producing and transporting fish to southern markets and the difficulty in keeping fish fresh were key problems for commercial ventures and broad whitefish was unable to compete successfully with lake whitefish produced nearer to southern markets (Davies et al. 1987; Anderson 1995). Only a combination fishery, subsistence/local commercial, occurred in the

Mackenzie River Delta from 1972 to 1989 at which time an exploratory fishery was initiated.

Several agencies including the RCMP, Government of the NWT Department of Economic Development and Tourism and the Department of Renewable Resources, as well as the federal Department of Fisheries and Oceans (DFO) have reported or collected commercial and subsistence harvest statistics for the NWT. However, comprehensive records are not available for some years and harvests have gone unreported (Yaremchuk et al. 1989). In 1988 the Department of Fisheries and Oceans established a computerized commercial fisheries statistics reporting system to provide annual harvest reports. These reports provide data on commercial harvest sales and exploratory fisheries by management area and water body for the entire NWT. Local commercial sales data for the Mackenzie River Delta, Region I, are collected using an annual survey sent to all commercially licensed fish harvesters.

Subsistence harvest monitoring programs have been developed by Aboriginal groups as part of the recent comprehensive land claim settlements. The Inuvialuit program began in July 1986, the Gwich'in program in August 1995 and the Sahtu program will be established soon. All hunters, trappers and fish harvesters who reside in the Inuvialuit Settlement Region (ISR) are interviewed on a monthly basis by community monitors. There may be slight differences in organization and data collection between each land claim group but essentially the location and numbers of species harvested are recorded on a regular basis. The data can be used by fish and wildlife managers, and provide evidence as to the value of these natural resources to the people in the communities.

The purpose of this chapter as stated in Chapter I, Objective 2 is to compare and examine for trends the past subsistence and commercial harvest levels and to estimate the present harvest of broad whitefish in the lower Mackenzie River region. Past and present commercial and subsistence fisheries will be reviewed below and broad whitefish harvest levels estimated where necessary. The Department of Fisheries and Oceans uses the government fiscal year, April 1 to March 31, for reporting annual harvests and setting quotas while the Inuvialuit Harvest Monitoring Program uses a calendar year. Because very little fishing occurs during the months of January, February and March in this region (Fabijan 1991a; 1991b; 1991c) these two reporting formats are directly comparable.

3.2 A HISTORY OF FISHERIES IN THE LOWER MACKENZIE RIVER REGION

3.2.1 Commercial Fisheries

A chronology of commercial fishing and exploratory or test fishing ventures is given in Figure 20. Barlishen and Webber (1973) and Davies et al.(1987) reviewed the history of commercial fishing in the Mackenzie Delta and noted that the Anglican and Roman Catholic Missions and the Royal Canadian Mounted Police (RCMP) were the first groups to purchase fish from Native and Inuvialuit fish harvesters. These groups also hired fish harvesters to catch fish for them. Subsistence fishing occurred during the summer and winter at hunting and trapping camps located on lakes outside the delta (Hunter 1975), and in 1950 a Ft. McPherson trader used a ski-plane to commercially fish some of these outlying lakes (Bissett 1967).

In 1960 the Department of Northern Affairs and National Resources (DNANR) set up fisheries at Aklavik, Kittigazuit, and the mouth of the Peel River. Poor equipment and lack of storage and freezing space ended the fishery shortly after it was begun (Barlishen and Webber 1973). In 1963 and 1964, the Department of Indian Affairs and Northern Development (DIAND) established a small whitefish and inconnu fishery at Holmes Creek, about 195 km north of Inuvik on the East Channel (Bissett 1967; Barlishen and Webber 1973). Approximately 9,000 kg of dressed fish, mostly whitefish (broad and lake whitefish), were harvested in 1963.

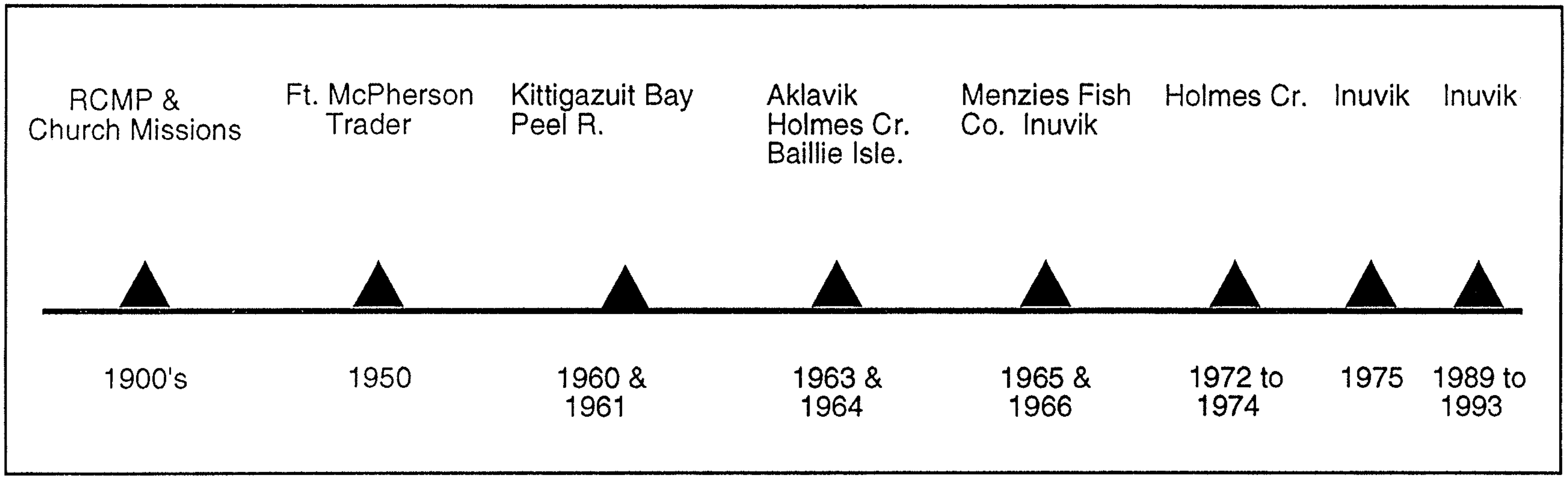


Figure 20. Commercial fishing and test fishing ventures in the lower Mackenzie River region from the early 1900's to 1993.

However, high costs and a poor local market resulted in its termination following the 1964 summer harvest and a small winter fishery (Barlishen and Webber 1973). Also in 1964 a request by the McInnis Fish Co. for a licence for 455,000 kg[2] of fish was denied by the DFO on the grounds that the resources should be reserved for subsistence use or for commercial development for the benefit of local people (Barlishen and Webber 1973).

In 1965 and 1966 the Menzies Fish Co. of Edmonton hired local fish harvesters and operated a commercial whitefish fishery out of Inuvik (Bissett 1967; Barlishen and Webber 1973). That year, 9,000 kg of whitefish were harvested. Technical and mechanical problems combined to discourage the company from returning after the 1966 season (Barlishen and Webber 1973).

From 1967 to 1971 there were no attempts made to fish commercially for export and by 1972 the Government of the Northwest Territories (GNWT) had decided to emphasize domestic fishing and local commercial fishing only. The Holmes Creek fishery was re-opened in 1972 with the intent of supplying the Inuvik area. A total of 39,814 kg of whitefish were harvested over a three year period (Yaremchuk et al. 1989). In 1973 approximately 22,226 kg of whitefish were harvested at the Holmes Creek fishery. Some of the 15,876 kg harvested in 1974 (Yaremchuk et al. 1989) were sold to the Freshwater Fish Marketing Corporation (FFMC) (Davies et al. 1987). In 1975 the whitefish species harvest (a mix of broad whitefish and lake whitefish) was processed out of a plant in Inuvik but it was still uneconomical and the fishery was closed (Davies et al. 1987).

There was no formal commercial fishery between 1975 and 1989. During this period some subsistence fish harvesters purchased commercial licences so they could sell surplus fish in the local market. Fisheries

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[2]All weights are given as round or whole weights unless otherwise indicated.

officers began to survey these commercial fish harvesters in 1977 (Corkum and McCart 1981). The Tsiigehtchic fishery reviewed by Bodaly et al. (1989) for the years 1979 to 1984 is an example of this type of combination subsistence/local commercial fishery. The fishery is conducted from late summer to early winter and is primarily directed towards broad whitefish migrating upstream for spawning. There were 3-12 commercial licence holders and an unknown number of subsistence fish harvesters. The reported commercial catch varied from 700-6,550 kg of broad whitefish (assuming 1 kg/fish) and the estimated total community harvest was 14,581 kg of broad whitefish in 1984 (D.V. Gillman and A.H. Kristofferson unpublished data in Bodaly et al. 1989).

The Inuvik Hunters and Trappers Committee (HTC) initiated an exploratory fishery in 1989 which ran for five years. For the first four years the fish were exported from the NWT through the FFMC. In 1993 they were marketed with minimal success in the NWT and Yukon Territory by the Uummarmiut Development Corporation (UDC), a subsidiary of the Inuvik Community Corporation.

For the period 1957 to 1986, there were only four years in which sales of broad whitefish were differentiated from lake whitefish in the commercial harvest reports for Schedule V - Region I (Mackenzie Delta); 308 kg in 1957, 5,514 kg in 1961, 16,834 kg in 1981, and 23,374 kg in 1982 (Yaremchuk et al. 1989). This problem was corrected in 1988 when the DFO began publishing an annual summary of fish and marine mammal harvests for the Northwest Territories.

Commercial licence holders do not always return their harvest surveys and therefore, the numbers reported by the DFO are minimum values for commercial harvest and sales. For example in the 1989 fishing season approximately 45% of the commercial licence holders from five delta communities (Aklavik, Tsiigehtchic, Fort McPherson, Inuvik and Tuktoyaktuk) responded to the DFO harvest survey questionnaire. A harvest of 28,108 kg of broad whitefish was reported of which 8,039 kg

($9,325 value) were sold (Department of Fisheries and Oceans 1992a). In 1993, 55% of the commercial licence holders responded to the survey and reported a catch of 8,246 kg of which 897 kg were sold ($1,675 value) (Department of Fisheries and Oceans 1995).

3.2.2 Subsistence Fisheries

In general, subsistence harvest has been affected by human population changes, gear changes and life-style changes. Key factors which have affected subsistence harvests over time in the lower Mackenzie River region are given in Fig. 21.

The population in the area increased with the arrival of the whalers at the turn of the century. They set up camps on Herschel Island and along the Beaufort Sea coast (Wolforth 1966). Whaling was short lived but was followed closely by an increase in trapping activity throughout the delta in the early 1900's (Wolforth 1966). The first trading post located in the lower Mackenzie River region was established at Ft. Good Hope in 1836, it was followed by Ft. McPherson in 1840, Tsiigehtchic in 1901 and Aklavik in 1912 (Usher 1971). Many other temporary trading posts were also established throughout the Delta between 1912 and 1950 (Usher 1971). By the 1950's the fur trade was in decline. Fewer people were able to make a living trapping and communities grew as more and more people moved in from camps on the delta in search of work. As community living and wage employment increased, subsistence activity decreased, particularly in the 1960's and early 1970's with the boom in oil and gas exploration.

Changes in technology and equipment have also affected subsistence harvests. Nylon nets began to replace cotton nets in the late 1950's (Hunter 1975; Sinclair et al. 1967). The nylon nets were stronger, and more durable than cotton and therefore more efficient at catching fish. The widespread use of monofilament mesh nets has not occurred in this region yet, but may have an impact in the future. The amount of broad

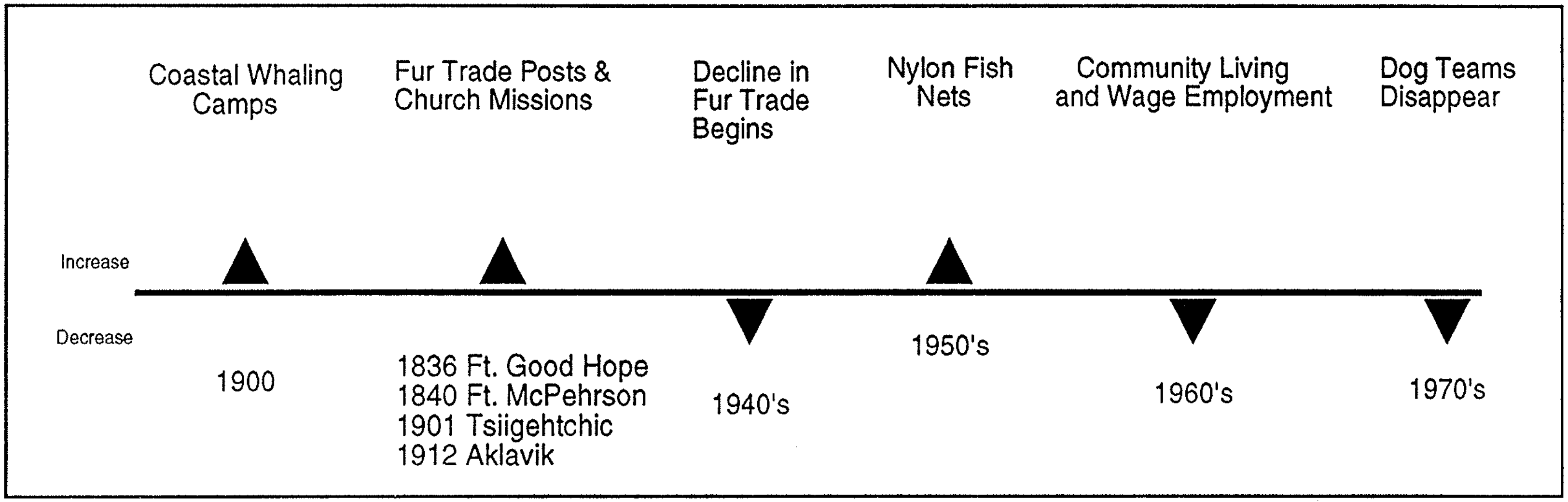

Figure 21. Events which have had an effect on subsistence fish harvests in the lower Mackenzie River region from the late 1800's to the 1990's.

whitefish used for dog food gradually declined through the 1970's and 1980's as snow machines replaced dog teams. Jessop et al. (1974) estimated that 62% of the broad whitefish harvested were used to feed dogs in the community of Aklavik in 1973. In 1981 Sparling and Sparling (1988b) estimated that 47% was used for dog food and in 1988 Lutra Assoc. (1989) indicated that 0%, 6%, and 22% of the broad whitefish harvest was used for dog food in the communities of Tsiigehtchic, Ft. McPherson and Ft. Good Hope, respectively. Many people prefer to feed fish other than broad whitefish to their dogs if enough is available. In the 1990's only one or two people in each community ran dog teams, usually for sport or recreation. With the reduced need for dog food an individual fish harvester's catch has significantly decreased.

Human consumption of broad whitefish and other country foods does not appear to be in decline for people living in the lower Mackenzie River region. Wein and Freeman (1992) studied food use and preferences for Inuvialuit in Aklavik. They found that country foods were quite highly preferred and quite frequently consumed (approximately twice a day), with broad whitefish first for fish species and fifth overall behind caribou, beluga, hares and muskrat. Inuvialuit living in Aklavik consumed country foods twice as often as Native people living near Wood Buffalo National Park (Wein and Freeman 1992). Country foods comprised 3/4 or more of the foods consumed for 90%, 92% and 63% of the people living in the communities of Tsiigehtchic, Ft. McPherson and Ft. Good Hope, respectively (Lutra Associates 1989). Of all country foods consumed, 1/4 to 1/2 was fish for 100% of households in Tsiigehtchic, 1/2 to 3/4 was fish for 79% of households in Ft. McPherson and 1/4 to 1/2 was fish for 62% of households in Ft. Good Hope (Lutra Associates 1989).

Only total estimates of all fish species harvested for subsistence were reported prior to 1973 with values ranging from 682,500 kg in 1963 (Sinclair et al. 1967) to 1,005,550 kg in 1965 (Wolforth 1966) for the

Mackenzie Delta, Ft. McPherson and Tsiigehtchic.

Baker and Reist (1988) estimated that at least 63,750 kg of broad whitefish were harvested domestically in 1972. Their estimate was based on 1972 survey data from the Department of Indian Affairs and Northern Development that estimated a total harvest (all species) of 255,000 kg for the Mackenzie Delta, Ft. McPherson and Tsiigehtchic and a 1973 survey in Aklavik (Jessop et al. 1974) that found 33,034 kg of broad whitefish comprised 25% of the total fish harvested. Jessop et al. (1974) also surveyed fish harvesters in Tsiigehtchic in 1973 and reported a harvest of 10,678 kg of broad whitefish.

In 1981, Sparling and Sparling (1988a and b) surveyed fish harvesters from Inuvik and Aklavik between July 6 and August 25 and from Ft. McPherson and Tsiigehtchic from July 6 to November 20. They extrapolated to all fish harvesters observed to be fishing and estimated a harvest of approximately 44,508 kg of broad whitefish for the two and five month periods for these four communities.

In July 1986 the Inuvialuit Subsistence Harvest Monitoring Program was initiated by the Inuvialuit Game Council and the DFO continued to monitor non-Inuvialuit communities although not on an annual basis. Inuvialuit hunters (also Dene and Metis hunters who live in the ISR) were interviewed each month by a community harvest monitor. The number of each species harvested and the location of the harvest was recorded and totalled by community. Harvests for July 1986 through to December 1990 have been published by the Inuvialuit Game Council. Harvest data for 1991 to 1994 have been collected and should be available in January 1996. The Gwich'in initiated a similar program in August 1995 and a Sahtu harvest monitoring program was also being developed as of 1995.

In 1989 the Inuvialuit communities of Tuktoyaktuk, Inuvik, and Aklavik reported a harvest of 30,803 kg (Fabijan 1991b). A DFO survey of communities outside the ISR, (Ft. McPherson, Tsiigehtchic and Ft. Good Hope) reported 45,278 kg (Dahlke, unpublished report). Together these subsistence harvests total 76,081 kg of broad whitefish for 1989 (assuming 2.3 kg/fish, the standard used by the DFO since 1988). However, in 1988 Lutra Associates (1989) surveyed a majority of active fish harvesters in Ft. McPherson, Tsiigehtchic, and Ft. Good Hope, and report an average fish harvest per week in each of four fishing seasons (spring, summer, fall and winter).[3] Using the raw data tabulated in Volume II of the report, the number of broad whitefish harvested by each community could be calculated (see section 3.3.1 below) and the total harvest was found to be 229,382 kg of broad whitefish (assuming 2.3 kg/fish). Adding this to the 1988 harvest reported in the ISR (Fabijan 1991a) gives a total broad whitefish harvest of 293,502 kg for 1988, almost four times that reported in 1989. This discrepancy is discussed below in section 3.4.2.

The DFO issues domestic fishing licences to non-aboriginal people who wish to harvest fish for subsistence purposes. They must report their harvests the same way that commercial fish harvesters do, by filling out an annual harvest survey. Records on domestic licence harvests are available since 1979 and annual harvests have ranged from 322 kg to 29,859 kg (Department of Fisheries and Oceans, unpublished data).

Dr. M. Freeman (at review) has estimated broad whitefish harvests may have varied between 224,000 and 945,000 kg for Inuvialuit fish harvesters located in the Mackenzie Delta in the early 1950's, based on a traditional knowledge survey conducted in 1993. Broad whitefish were estimated to comprise 50 to 75% of the total fish harvest. These estimates were for Inuvialuit harvests only and do not include fish taken prior to the fall fishery, fish caught to feed RCMP dogs and the dogs used at Reindeer Station, or fish sold to mission schools,

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[3]It should be noted that the summary tables for the average of all fish species harvested, consumed, given away, fed to dogs and stored in each season, found in Volumes I and II of this report are misleading. The values given are an average of the averages for each species, not a sum of the averages for each species.

hospitals and a mink farm (Freeman, at review).

3.2.3 Exploratory Fishery - 1989 to 1993

The Department of Fisheries and Oceans issues an exploratory fishery licence prior to issuing a full commercial licence for areas not listed in the GNWT Fisheries Regulations (Schedule V) or for areas like the Mackenzie Delta, where large organized commercial fisheries have not occurred for some time and where little or no previous data exist on which to base management decisions (Kristofferson and McGowan 1981; Yaremchuk et al. 1989). The exploratory licence provides a provisional quota, lists species, mesh size, and season. Fish harvesters are supervised by GNWT Renewable Resource Officers or DFO Fishery Officers and are requested to provide catch and effort data and, when required, biological samples. The exploratory fishery is used to gather baseline data, including biological samples, during the first year or two of fishing to assess the fish stocks. Fishing generally continues for the next 3-5 years to harvest the provisional quota, with accurate harvest and effort statistics being recorded. At the end of this time a final biological sample is collected and compared with the initial one. If there are no significant changes in population parameters or effort, it is assumed that the harvest level is sustainable and the fishery is then submitted for inclusion in Schedule V as a commercial fishery (Yaremchuk et al. 1989).

An exploratory fishery took place in the Mackenzie River, Middle Channel, near Inuvik from 1989 to 1993 under license to the Inuvik Hunters and Trappers Committee (HTC) and later the Uummarmiut Development Corporation (UDC). The quota was set at 16,000 kg for broad whitefish in 1989 and increased to 20,450 kg in 1991 (Department of Fisheries and Oceans 1991; 1993). Ice was supplied to each fishing enterprise enabling the fish to be iced immediately following cleaning, prior to the trip to the fish plant located in the community of Inuvik.

The fish were weighed, classified according to size and re-iced for transport by refrigerated truck to the Freshwater Fish Marketing Corporation (FFMC) processing plant in La Ronge, Saskatchewan in 1989 and to Winnipeg, Manitoba in 1990 to 1992. The UDC purchased the broad whitefish and inconnu caught in 1993 but did not sell to the FFMC, they attempted to market the fish themselves but had limited success. A small amount of fish were filleted or cut into steaks for sale locally and in 1992 and 1993 whitefish species roe (eggs) were collected for sale on the local market. These eggs are a highly sought after delicacy for many local Aboriginal people.

The fishery was conducted during the month of September when the water and air temperatures were beginning to decrease and the fish quality could be better maintained. Also, broad whitefish are more concentrated at this time of year as they gather together prior to making their spawning migration. The number of fish camps, licensed fish harvesters and helpers varied slightly from year to year but on average there were six camps, with six to nine licensed fish harvesters who had one to four helpers each. In 1989 a total of twenty people including helpers participated in the fishery (Polakoff 1989). Unfortunately the first shipment of lake whitefish was not of high quality, it was classified as cutter grade whitefish and valued at only \$0.40 kg^{-1} due to high cyst counts of the cestode parasite _Trianophorus crassus_ (Polakoff 1989). It was no longer economical to ship them south so no lake whitefish were sold after 1989. All broad whitefish were graded as export and sold for \$0.66 to \$1.19 kg^{-1} depending on their size (Polakoff 1989). Eighteen percent were classed as jumbo size, worth \$1.19 kg^{-1} in 1989 (Polakoff 1989).

Of the five years the exploratory fishery was conducted the broad whitefish quota was only filled in 1991. Polakoff (1989) indicated that the 1989 quota could have easily been met if there had been no equipment failure or if the fishing had continued past September 9^{th}. This was born out when the quota was met in 1991 following an increase of 4,450 kg. However, equipment problems and/or early inclement fall weather contributed to poor harvests the following two years.

This exploratory fishery was heavily subsidized by government and not sustainable given the current quota level, low market prices and demand (both local and export) for fresh, frozen and processed products (Anderson 1995). Given 1991 prices for a value added product (fillets and steaks), a quota of 626,063 kg was calculated as being necessary to break-even with respect to costs and revenue. This is approximately 26 times the current quota (Anderson 1995) and it is unclear as to whether the resource base is available to sustain such a level of exploitation. On the other hand neither the export nor local markets could provide the increase in prices and sales that would be required in order to break-even at the current harvest level (Anderson 1995).

Often government subsidies to northern development projects are looked upon as an investment in the local economy and a better means of supporting subsistence activities than other types of transfer payments. However, in this case most of the government support went towards the cost of acquiring and maintaining the capital equipment required to produce fish for the export market and Anderson (1995) concludes that local commercial sales of surplus subsistence harvests is the best fishery development option for the Mackenzie Delta.

3.3 METHODS USED FOR DATA EVALUATION

3.3.1 Data Tabulation

Commercial and subsistence harvest information were collected from a review of the literature as well as from unpublished sources within the Department of Fisheries and Oceans and can be found in Appendix D and E, respectively. These data were tabulated by community or management area (depending on how they were reported), by year and by species. Harvests of coregonid species have been listed separately.

Other fish species have been combined and the harvest reported as "other", although sometimes other economic and socially important species such as Arctic char (Salvelinus alpinus (Linnaeus)), lake trout (Salvelinus namaycush (Walbaum)), northern pike and burbot or loche (Lota lota (Linnaeus)) have also been listed.

The data sources have been matched as best as possible to get the most accurate representation of past harvests - both commercial (local and export) and subsistence (including domestic licence harvests). Differences between sources do exist and have been indicated using footnotes in the tables of Appendix D and E.

Where two separate surveys or estimates were conducted in a single year, each producing a different value, both have been reported but the larger value was used in further estimates of broad whitefish harvest unless the differences could be explained. Where harvest data were reported in pounds (lb) it was converted to kilograms (kg)[4]. Sometimes harvest was reported as numbers of fish caught. In these cases the numbers caught were converted to kg using the DFO's standard conversion factors found in Table 16.

The report, "A survey of fish users in Dene and Metis communities in and near the Mackenzie River watershed. Vol. II" by Lutra Associates (1989) contains data on fish harvests for the communities of Ft. Good Hope, Ft. McPherson, and Tsiigehtchic, as well as others. The survey included questions on the average duration of subsistence fishing activities by household and season (spring, summer, fall and winter), the average weekly household harvest by species, season and by periods within a season (start, middle, end, and an average for the whole season). The amount of each species harvested has been calculated here by multiplying the average harvested per household per week per season, reported by survey respondents, by the number of weeks in each season and the number of households reporting a harvest in that season. The

[4]Pounds were converted to kilograms by multiplying by .455.

Table 16. Average weights for species used to convert numbers of fish harvested to kilograms harvested. (Source: Department of Fisheries and Oceans 1991, unless otherwise indicated).

Species		Average Weight
Common Name	Scientific Name	(kg)
broad whitefish	*Coregonus nasus*	2.3
lake whitefish	*Coregonus clupeaformis*	1.3
inconnu	*Stenodus leucichthys*	4.5
cisco/herring sp.	-	0.4
northern pike	*Esox lucius*	2.3
burbot/loche	*Lota lota*	3.0
arctic char	*Salvelinus alpinus*	1.3
lake trout	*Salvelinus namaycush*	4.0
salmon sp.	-	3.0
grayling [1]	*Thymallus arcticus*	1.0
sucker sp.	-	1.0
other sp.	-	2.0

[1] Weight for grayling from Great Bear Lake taken from Scott and Crossman, 1973.

totals for each season were added to give a total annual harvest by species.

3.3.2 Broad Whitefish Harvest Estimation

Once all harvest statistics were tabulated the commercial and subsistence harvest of broad whitefish could be estimated for the lower Mackenzie River region. Broad whitefish harvests have not been presented here for individual management areas or communities; primarily because the data have not been consistently reported by management area and harvests reported by community are not as helpful to managers as harvests reported by water body or catch location. The data are available in Appendices D and E for those interested in specific locations and years.

Where commercial harvest data were reported as total fish or whitefish species, broad whitefish commercial harvest (sales) have been estimated based on average sales by weight of 67% of all fish species and 88% of whitefish species (Table 17). Lake whitefish harvests reported in Yaremchuk et al. (1989) are believed to be a mix of broad whitefish and lake whitefish (Corkum and McCart 1981) for the following years: 1960, 1962-1966, 1972-1975, 1979, 1980 and 1983 and were treated as whitefish species (see above).

Dahlke (unpublished report) contains commercial harvest and sales data for 1978 to 1988 which were based on DFO surveys returned from commercial licence holders. Corkum and McCart (1981) mention the establishment of these surveys in 1978 and report the results for 1978 to 1980. The Department of Fisheries and Oceans, Economics Branch in Winnipeg, Manitoba, also has harvest records based on these surveys for 1982 to the present. Yaremchuk et al. (1989) report fisheries harvests for 1945 to 1987 based on historical records from DFO, GNWT Departments of Economic Development and Renewable Resources and the FFMC. These were the primary sources used to determine the broad whitefish harvests

Table 17. Commercial licence sales of broad whitefish as a percentage of the whitefish species sold (kg) and the total sold (kg) (Appendix D, Table 3).

	Year												
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Mean
% of whitefish sp.	73.2		92.3	87.8	94.2	94.4	84	92.5	96.1	74.8	95.2	85.4	88.2
% of total	64.9		71.4	74.8	74.1	71.8	74	65.9	60.5	61.0	63.2	63.9	67.8

Table 18. Commercial licence total harvest of broad whitefish as a percentage of the whitefish species harvest (kg) and the total harvest (kg) (Appendix D, Table 5).

	Year												
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Mean
% of whitefish sp.	65.7	65.9	71.3	76.5	75.8	72.7	78.9	71.7	69.5	56.8	63.3	71.6	70.0
% of total	40.3	39.7	36.7	48.7	44.7	38.7	52.6	42.5	43.5	42.4	33.0	35.2	41.5

Table 19. Domestic licence harvest of broad whitefish as a percentage of the whitefish species harvest (kg) and the total harvest (kg) (Appendix E, Table 6).

	Year												
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Mean
% of whitefish sp.	65.7	45.4	70.5	64.6	74.2	97.4	44.3	13.8	50.1	66.2	84.4	77.7	62.9
% of total	40.3	20.1	30.7	40.1	43.8	55.9	38.7	10.5	30.5	21.5	47.8	39.2	34.9

Table 20. Subsistence harvest of broad whitefish as a percentage of the whitefish species harvest (kg) and the total harvest (kg)(Appendix E, Tables 2 and 4).

	Year														
	1973	1978	1979	1980	1980	1980	1981	1981	1986	1987	1988	1988	1989	1990	Mean
% of whitefish sp.	39.5	52.6	47.7	57.7	62.8	52.3	57.7	50.1	80.1	83.9	71.0	58.1	71.7	79.3	61.8
% of total	25.7	38.1	31.5	32.6	44.6	35.5	32.8	28.1	23.7	38.8	41.8	31.3	30.2	30.0	33.2

for the lower Mackenzie River region. The source reporting the larger value for broad whitefish commercial harvest sales was used in the following instances where conflicts arose:

1) Corkum and McCart (1981) differentiate between local and export harvests for 1978 to 1980. In 1978 the sum of the export and local harvest values reported for the Mackenzie Delta, excluding the Peel and Arctic Red Rivers, coincided with the harvest reported by Yaremchuk et al. (1989). This is not the case for 1979 and 1980 where only Corkum and McCart's (1981) export harvest values for the Mackenzie Delta coincide with values reported by Yaremchuk et al. (1989). The local harvest values reported by Dahlke (unpublished report) differ from those reported by Corkum and McCart (1981) for most species in 1978 and 1980. Therefore, the export harvest values from Corkum and McCart (1981), and the local harvest values from Dahlke (unpublished report) for 1978 and 1980 and from Corkum and McCart (1981) for 1979, have been summed to give a total commercial harvest for 1978 to 1980.

2) Dahlke (unpublished report), Yaremchuk et al. (1989), and DFO-Winnipeg (unpublished data) each report the larger broad whitefish harvest for 1981, 1982, and 1983, respectively. The UDC exploratory harvest, 1989 to 1993, has been added to the local commercial harvest sales, to give a total commercial harvest for these years.

Where subsistence harvest data were reported as total fish or whitefish species, broad whitefish subsistence harvest has been estimated based on an average harvest by weight of 35% and 65% broad whitefish respectively (Tables 18, 19, 20).

Harvest reported on commercial licence survey forms that was excess of sales was considered to be used for subsistence purposes and included as such in the total subsistence harvest estimates. The amount of broad whitefish sold on the local market by commercial licence holders is on average 18% (excluding an unusually high value of 86% for 1982) of the total amount of broad whitefish harvested by those licence

Table 21. Broad whitefish local commercial harvest and sales (kg) and percent sold for commercial licence holders in the lower Mackenzie River region, 1978 to 1993. (Appendix D, Tables 1c, 3, 5, and 6, unless otherwise indicated).

Year	Total Harvest	Amount Sold	Percent Sold
1978	16,914*	2,871	17
1979	53,466	7,843**	15
1980	59,137	6,197	10
1981	69,734	17,528	25
1982	27,304	23,374**	86
1983	31,372	5,525	18
1984	60,683	5,640	9
1985	31,771	2,544	8
1986	43,125	3,497	8
1987	39,114	5,314	14
1988	29,240	5,759	20
1989	28,109	8,039	29
1990	13,761	7,626	55
1991	4,691	342	7
1993	8,246	897	11

*Includes domestic licence harvest
**Source: Appendix D, Table 1b

holders (Table 21).

Double counting has likely occurred for some fish harvesters in the ISR since 1986. These fish harvesters would be surveyed for both commercial harvest and sales by DFO and for subsistence harvest by the Inuvialuit monitors. Therefore, the subsistence portion of the commercial harvest for the communities of Inuvik, Aklavik, and Tuktoyaktuk has not been included in the estimates for 1986 and 1987 and the subsistence portion of the commercial harvest for all communities was omitted from the estimates for 1988 and 1989 because subsistence surveys were also carried out in Tsiigehtchic, Ft. McPherson and Ft. Good Hope for these years. In 1990 the DFO reported harvest by management area making it more difficult to separate ISR and non-ISR harvests and only one of the three communities outside the ISR was surveyed for subsistence harvest. Therefore, no adjustments were made for double counting in 1990.

The only subsistence harvest information available beyond 1990 is from the subsistence portion of the DFO commercial harvest surveys. The Inuvialuit harvest monitoring program data were not available for these years. Therefore, broad whitefish harvest estimates beyond 1990 are incomplete. The following are notes with regards to the data used to determine broad whitefish subsistence harvests:

1) Olesh (1979) reports a value for the Mackenzie Delta that is identical to the harvest Sinclair et al. (1967) report for fish harvests from Ft. Smith to Inuvik. The harvests reported by Sinclair et al. (1967) for the communities of Inuvik, Aklavik, Ft. McPherson, Tsiigehtchic, and Ft. Good Hope, are believed to be more accurate and were used to determine the harvest level for 1961.

2) In 1963 the sum of the harvest reported by Olesh (1979) and Abramson (1963) in Bissett (1967), less the lake herring from Toker and Atkinson Point, was used because it was larger than the value reported by Sinclair et al. (1967) for Aklavik/Mackenzie River delta).

3) The Banks Island data reported in 1970 are most likely Arctic char and have not been included.

4) In 1972 the harvest values reported by DIAND/MPS (1973) in Corkum and McCart (1981) for the Mackenzie Delta, Tuktoyaktuk, Ft. McPherson and Tsiigehtchic were used along with data for the Peel River from Stein et al. (1973). Data for the Big Fish River, Fish Hole and the Rat River from Hunt (1973) in Corkum and McCart (1981) have not been included because they are most likely char.

5) The value from Hunt (1973) in Corkum and McCart (1981) was used because it was larger than the estimate from Jessop et al. (1974) for Aklavik in 1973.

6) In 1975 only the estimate for the Mackenzie Delta, excluding Tuktoyaktuk was used. It was not possible to separate the Tuktoyaktuk harvests from the other locations reported by Olesh (1979).

7) In 1980 data from Area I to IV (Corkum and McCart 1981) were added to the GNWT data reported by Sparling and Sparling (1988a) for Tsiigehtchic and Ft. McPherson.

8) Harvest data reported by Dahlke (unpublished report) for Tsiigehtchic and Ft. McPherson in 1988 were not used as they were less than the harvest calculated from data in the report by Lutra Associates (1989).

3.4 RESULTS AND DISCUSSION

3.4.1 Commercial Broad Whitefish Harvests in the Lower Mackenzie River Region

The commercial sales of broad whitefish estimated (1955 to 1980) and actual (1981 to 1993) have fluctuated between approximately 0 and 37,500 kg over the 38 years for which records are available (Table 22 and Figure 22) (Appendix D, Tables 1 to 7). Peaks generally occurred when export commercial fishing ventures were being conducted: 1960 and 1961, 1963 to 1966, 1972 to 1975, 1989 to 1993. Corkum and McCart

Table 22. Subsistence, domestic licence, commercial sales (including exploratory fisheries) and total combined broad whitefish harvest (kg), reported and estimated based on data available from the lower Mackenzie River region, 1955 to 1993.

Year	Subsistence Harvest	Domestic Licence Harvest	Total Subsistence Harvest	Commercial Sales	Total Combined Harvest
1955				505	505
1956				5,700	5,700
1957				3,235	3,235
1958				13	13
1959					
1960	268,336		268,336	8,798	277,134
1961	165,738		165,738	19,590	185,328
1962				7,714	7,714
1963	311,353		311,353	5,730	317,083
1964	318,500		318,500	27,584	346,084
1965	352,739		352,739	7,955	360,694
1966				37,399	37,399
1967					
1968					
1969					
1970	26,436		26,436		26,436
1971	7,963		7,963		
1972	100,454		100,454	1,507	101,961
1973	218,282		218,282	20,417	238,699
1974				13,971	13,971
1975	109,946		109,946	9	109,955
1976				14,223 *	14,223
1977				460	460
1978	25,436		25,436	5,273	30,709
1979	79,829	3,410	83,239	13,285	96,524
1980	136,591	9,297	145,888	16,485	162,373
1981	96,714	1,628	98,342	17,528	115,870
1982	34,880	29,859	64,739	23,374	88,113
1983	25,847	405	26,252	5,525	31,777
1984	55,043	1,785	56,828	5,640	62,468
1985	29,227	322	29,549	2,544	32,093
1986	48,506	3,448	51,954	3,497	84,246
1987	100,919	1,571	102,490	5,187	107,677
1988	295,693	3,685	299,378	5,759	305,137
1989	84,695	1,581	86,276	13,820	100,096
1990	55,566		55,566	20,727	76,293
1991	4,349		4,349	19,576	23,925
1992				17,797	17,797
1993	7,349		7,349	12,718	20,067

* This harvest may have been taken in 1975 (see text, section 3.4.1).

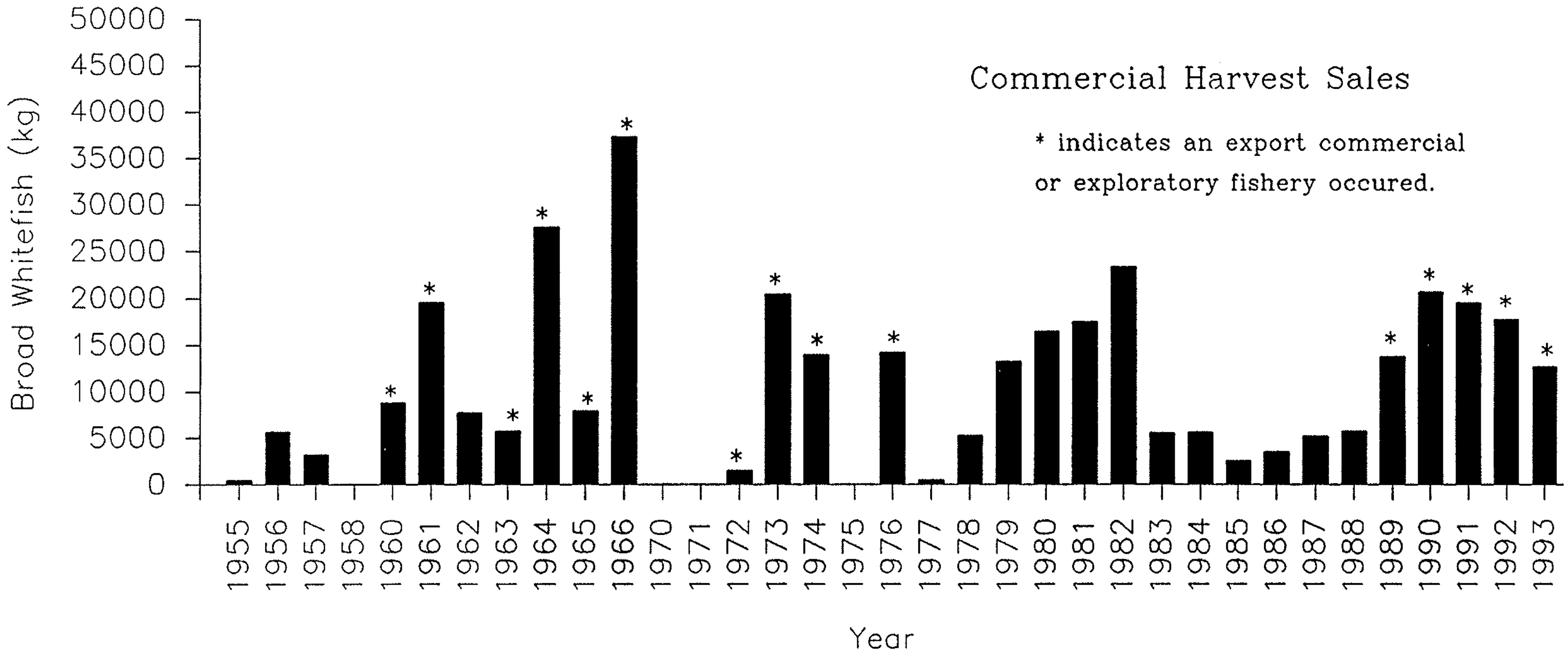

Figure 22. Broad whitefish commercial and exploratory fishery harvest sales, reported and estimated, for lower Mackenzie River region communities, 1955–1993. These data include both local and export sales for the year in which both occurred. Sales of 13 kg and 9 kg were reported in 1958 and 1975, respectively, and no sales were reported for 1970 and 1971. The harvest reported for 1976 may in fact have been taken in 1975 (see text, section 3.4.1).

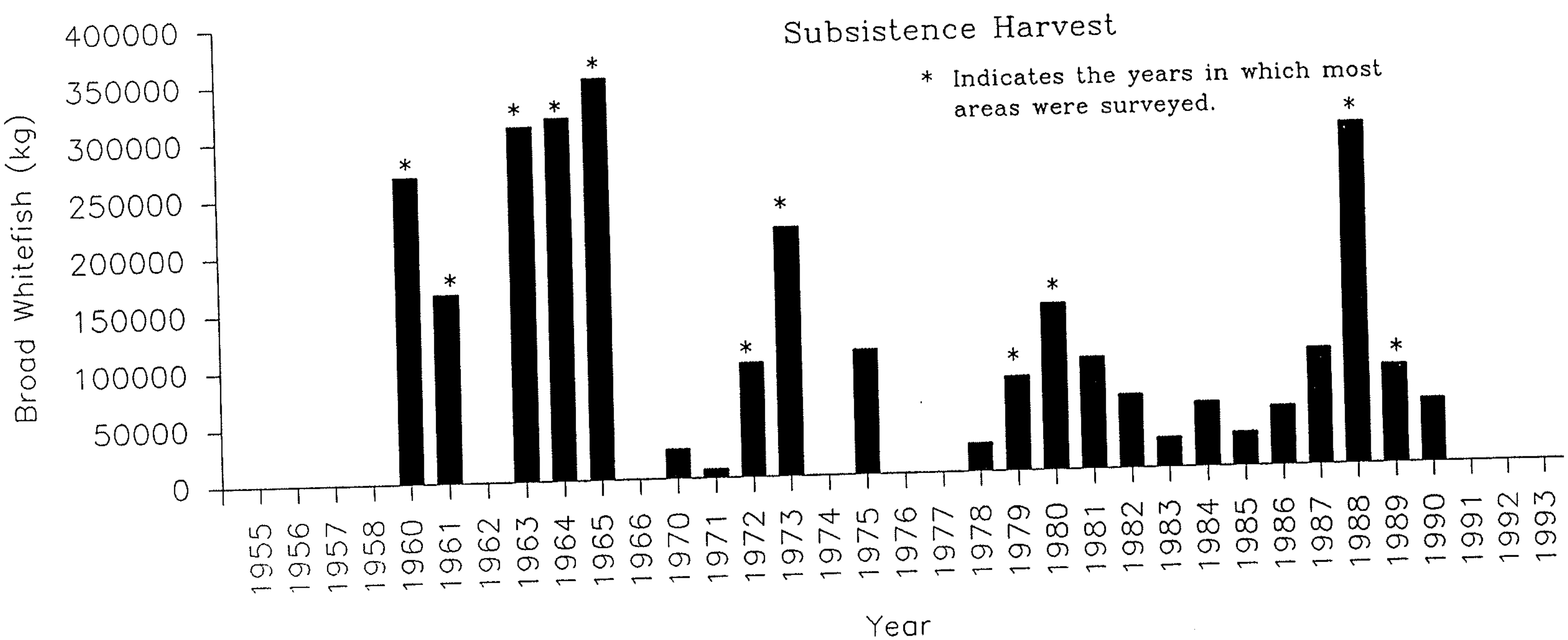

Figure 23. Broad whitefish subsistence harvest, reported and estimated, for lower Mackenzie River region communities, 1960–1990. Subsistence harvest was never zero; data for all communities/regions were not available for all years. Note that the y-axis is eight times larger than the y-axis for the commercial harvest plotted in Figure 22.

(1981) indicated that Bissett (1967) may have incorrectly reported a harvest of 35,196 kg in 1964 because the DFO records indicated this harvest had occurred in 1963. However, the DFO has since published this data and it is in agreement with Bissett (1967); the peak harvest for the 1963 to 1964 fishery occurred in 1964. Davies et al. (1987) reported that whitefish had been harvested in 1975, the final year of a four year commercial fishery development period. However, Corkum and McCart (1981) and Yaremchuk et al. (1989) report no whitefish species harvest for 1975, but do report a harvest in 1976 that compares with that taken during the commercial fishery operating in 1973 and 1974. Therefore, the harvest recorded for 1976 likely represents 1975 harvest that was mis-assigned to 1976 (Fig. 22). The peak in harvests from 1979 to 1982 does not correspond to any export commercial sales and may be reflective of strong local sales or more comprehensive harvest surveys.

The number of commercially licensed fish harvesters in the lower Mackenzie River region has varied between 22 and 77 for the years 1982 to 1993 (Appendix D, Tables 1c and 2). However, not all of these fish harvesters completed harvest surveys. The surveys are not always returned, possibly because the fish harvesters; a) decided not to fish that year, b) did not sell any fish, or c) did not want to or forgot to complete the survey. Therefore, the above harvests are minimum values based on reports from as few as 27% of commercial fish harvesters to as many as 80% (Appendix D, Tables 1c and 2).

This does not necessarily mean that commercial sales are going unreported. Many subsistence fish harvesters purchase licences to enable them to sell surplus fish to friends, and depending on the circumstances (e.g., a good or poor year for fishing) they may not sell any fish and do not fill out the survey. Also, people who fish a lot may be more likely to fill out the survey and report their catch than people who purchase a licence but fish infrequently (L. Anderson, DFO-Winnipeg, personal communication).

Exploratory fishery data for 1989 to 1993 can be found in Appendix D, Table 7. The broad whitefish harvested in this fishery ranged from 5,781 kg to 19,234 kg and was approximately three times the average commercial harvest reported in the six years previously (4,692 kg), but was comparable to export fishery harvests of the past (Table 22).

3.4.2 Subsistence Broad Whitefish Harvests in the Lower Mackenzie River Region

Subsistence harvest estimates for the lower Mackenzie River region were not made or data collected consistently across all fish harvesters in all communities each year. As a result the actual reported (1978-81 and 1983-85) and estimated (all other years) broad whitefish harvest found in Table 22 and Figure 23 is spotty. For most years the harvest estimates or surveys covered only certain locations or communities within the larger lower Mackenzie River region. However, for the following years, most if not all areas were covered by one or more surveys:

1) For 1960, 1961, 1963 and 1964 various sources estimated harvests for the Mackenzie Delta (Appendix E, Table 1); estimates of broad whitefish harvests varied from 165,738 to 318,500 kg (Table 22).

2) In 1965 Wolforth (1966) covered all areas but Ft. Good Hope and of the 1,005,550 kg of total fish harvested (Appendix E, Table 1), it was estimated that 352,739 kg were broad whitefish (Table 22);

3) A combination of surveys in 1972 and 1973 covered most areas (Appendix E, Table 1) and broad whitefish harvests of 100,454 kg and 218,282 kg were estimated, respectively (Table 22);

4) In 1979 and 1980 surveys that covered most of the region (Appendix E, Tables 2 and 4) produced broad whitefish harvest estimates that ranged from 79,829 to 136,591 kg, respectively (Table 22);

5) In 1988 and 1989 fish harvesters in all six communities along the lower Mackenzie River region were surveyed (Appendix 2, Table 4) and

the estimated broad whitefish harvest was 295,693 kg and 84,695 kg, respectively (Table 22). More recent harvest estimates for the entire lower Mackenzie River region are not yet available.

When harvest from non-native domestic licence fish harvesters is included the current level of subsistence harvest for broad whitefish from the lower Mackenzie River region ranges between 51,954 kg, (recorded in 1986) and 299,378 kg (recorded in 1988) (Table 22) (Appendix E, Tables 3 to 6).

There appears to be a downward trend in broad whitefish subsistence harvests from a high of 352,739 kg in 1965 to a low of 86,276 kg in 1989, if one ignores the 1988 estimate. The survey method used by Lutra Associates (1989) in 1988 produced a much higher estimated harvest than that used by the DFO for both 1988 and 1989 (Appendix E, Table 3 and 4). The harvests estimated by these two sources are quite different and bring into question the reliability of subsistence harvest estimates. How do we choose between the two?

There are problems inherent in most surveys. The results of two surveys could differ for a number of reasons, some of which are: 1) where did the survey originate; 2) who is administering the survey; 3) what questions are asked; and 4) how and when the questions are asked. Surveys that are community driven, such as the Inuvialuit, Gwich'in and Sahtu harvest monitoring programs or those commissioned by a local government or agency are more likely to have the co-operation of all fish harvesters and therefore produce better more reliable results than a survey originating from a federal or territorial government.

In 1988 the DFO initiated what was to be a three year subsistence fisheries monitoring program. They contracted community monitors to survey subsistence fish harvesters in Ft. McPherson (1988 and 1989), Tsiigehtchic (1988 to 1990) and Ft. Good Hope (1989). In 1988, 35 camps based in and near Tsiigehtchic and Ft. McPherson were visited on a bi-weekly basis by the monitor and a DFO employee between August and

November (12 weeks) (Dahlke, unpublished report). Individuals who were missed were contacted at a later date. The survey asked: How many of each species were caught?; Where were they caught?; What size of gillnet was used?; How were the fish used?; How big is the family?; How many dogs are there?; and other questions relating to fishing success. There was no information available as to how many camps were surveyed in 1989, although all three communities were covered. Data for only two fish harvesters were available for 1990 (Appendix E, Table 3 and 4).

Lutra Associates (1989) hired and trained people from each community to conduct their survey. Ninety-six households located in all three communities were each visited once and the survey took an average of 1.5 hrs to complete. The survey included questions concerning fish harvesting, use and quality, and harvest estimates were given separately for each fishing season (spring, summer, fall and winter). The method used to estimate the total harvest has been given previously in section 3.3.1. They reported a high level of interest in the survey for these communities and were able to cover approximately 33% of all households, including a high percentage of active fish harvesters in the communities of Ft. Good Hope (73%), Ft. McPherson (82%) and Tsiigehtchic (100%).

The DFO survey made more frequent visits and had fewer questions but the Lutra Associates (1989) survey included more people and covered the whole fishing season, approximately 18 weeks (Tsiigehtchic) to 29 weeks (Ft. Good Hope) depending on the location. The Lutra Associates survey may have elicited better cooperation from the respondents than did the DFO survey because it was commissioned by the Dene Nation and conducted almost entirely by local people. Also, a general rule of thumb is to use the higher of two values when dealing with estimates of fish harvests based on survey or recall data because of the tendency to underestimate the true harvest. Therefore, the harvest data estimated from the Lutra Associates (1989) survey is believed to be the more reliable of the two survey estimates and has been used here in the calculations of total harvest found in Table 22 and Figure 23.

The commercial, subsistence and total combined harvest for broad whitefish and the total combined harvest for all species on a per capita basis for the years for which we have the best information are compared (Table 23). This allows for a comparison of these data with other data for subsistence fisheries in Canada, specifically those found in Berkes (1990). Exact comparisons are not possible given differences in surveys and data collection. Also, the population statistics used here include non-natives. However, the per capita estimates for the total combined harvest can serve as a check on the validity of the reported harvests. The 109 kg fish/capita and 41 kg fish/capita, for the 1988 and 1989 estimates, respectively, fall within the range of 26 to 148 kg fish/capita reported by Berkes (1990) for other regional studies. The values calculated for 1961 and 1965 (223 and 240 kg fish/capita) may reflect the larger harvests required to feed dogs and the greater reliance on fish for food at that time.

The subsistence harvest estimates for 1972 from Ft. McPherson and Tsiigehtchic, the Mackenzie Delta and Tuktoyaktuk, and Ft. Good Hope and Colville Lake, are based on surveys of 52, 50, and 52 families, respectively, for a total of 154 families (Department of Indian Affairs and Northern Development and MPS Associates 1973 in Withler 1975). Other reports of fish harvests prior to 1981 sometimes included population estimates for the area at the time the estimate was made but did not break it down any further to number of fish harvesters or number of households included in the survey. Since 1981 data on the number of surveys (individual or households) from which the harvest estimates have been made are available on a more consistent basis (Appendix E, Tables 3 and 4). For the period 1986 to 1990 there were between 100 and 183 active fish harvesters in total from the ISR communities of Inuvik, Aklavik and Tuktoyaktuk (Appendix E, Tables 3 and 4). Lutra Associates (1989) identified a total of 43 active fish harvesters from the

Table 23. Total harvest and harvest per capita for broad whitefish and all species combined (Appendix D and E), for the lower Mackenzie River region for selected years.

Year	Number of Commercial Fishermen [1]	Commercial Sales Broad Whitefish (kg)	Subsistence Harvest Broad Whitefish (kg)	Total Harvest Broad Whitefish (kg)	Communities Surveyed [2]	Total Population [3]	Broad Whitefish Harvest per capita	Total Harvest All Species (kg) [4]	All species Harvest Per Capita
1961		19,590	165,738	185,328	3,4,5,6	2,230	83.1	497,730	223.2
1965	8	7,955	351,943	359,898	1,2,3,4,5	4,253	84.6	1,022,136	240.3
1979	58	13,358	83,239	96,524	1,2,3,5	4,760	20.3	246,727	51.8
1980	71	16,485	145,888	162,373	1,2,3,4,5	5,392	30.1	381,162	70.7
1986	43 (77%)	3,497	51,954	84,246	1,2,3	5,081	16.6	230,507	45.4
1988	28 (67%)	5,759	299,378	305,137	1,2,3,4,5,6	6,511	46.9	714,598	109.8
1989	27 (45%)	13,820	86,276	100,096	1,2,3,4,5,6	6,511	15.4	267,034	41.0

1 Per cent of license sales reporting is in brackets.

2 1=Tuktoyaktuk, 2=Inuvik, 3=Aklavik, 4=Ft. McPherson, 5=Tsiigehtchic, 6=Ft. Good Hope

3 Sources for population estimates are as follows:

1961 - Estimates from Sinclair et al. (1967) for Ft. McPherson, Tsiigehtchic and Ft. Good Hope, 1963 and Wolforth (1966) for Aklavik and Reindeer Station, 1958.
1965 - Bissett (1967) estimates for 1966.
1979 - Statistics Canada (1987) estimates for 1981.
1980 - as above.
1986 - Statistics Canada (1987) estimates for 1986.
1988 - as above
1989 - as above.

4 Data source: Appendix D and E. Data treatment followed methods used for broad whitefish as discussed in the methods section above.

communities of Tsiigehtchic, Ft. McPherson and Ft. Good Hope in 1988 (the 96 households surveyed include a majority of these fish harvesters) for a total of approximately 150 to 230 active fish harvesters in the lower Mackenzie River region (Appendix E, Tables 3 and 4).

3.5 SUMMARY AND CONCLUSIONS

The variability in subsistence and commercial harvest estimates of broad whitefish in the lower Mackenzie River region over the years can be partially attributed to the type of survey used and the fact that not all areas have been surveyed each year and not all fish harvesters are surveyed or choose to respond to surveys. Often the surveys have been based on the recall of harvests that occurred over a period of weeks, months or often a full year, and the unit of measure (kg, lb, or numbers of fish) and the conversion factors used have not been consistent. As a result the accuracy of these harvest estimates is questionable, and they may be underestimates of the true harvest (Withler 1975; Crawford 1989).

Freeman (at review) suggests that prior to 1955, Inuvialuit subsistence harvest of broad whitefish could have ranged between 224,000 and 945,000 kg although he used a larger value to calculate the proportion of broad whitefish in the total catch (50% to 75%) than was used in this study (35%). Subsistence harvests for the early 1960's estimated here for the entire lower Mackenzie River region (including the commercial harvest sales) ranged between 165,738 and 352,739 kg (Table 22). This downward trend in subsistence harvests was to be expected given the changes in lifestyle and technologies that occurred through the 1950's and 1960's. If the 1988 estimate is ignored, this downward trend seems to continue through the 1970's and 1980's when harvests fell from approximately 220,000 kg in 1973 to 86,000 kg in 1989. During this time fewer and fewer people were making their living from the land as the region slowly entered the wage economy. Therefore, it might be expected that subsistence harvests would continue to fall.

However, we are assuming that these data are accurate estimates of the subsistence harvest. Given the variability between the two estimates discussed above this may not be a valid assumption. For reasons mentioned previously, the 1988 estimate (based on the survey by Lutra Associates (1989)) is considered to be more reliable than the 1989 estimate (based on the DFO survey). If this is true then the subsistence harvest is currently quite substantial and we could conclude that: 1) fish harvest may not have declined significantly since the 1960's; or 2) subsistence harvests are on the rise due to a renewed interest in country foods, living on the land (if only part of the year) and an increase in population.

The largest commercial harvests occurred in the years in which export or exploratory fisheries were conducted; except for a period between 1979 and 1982 when relatively large local commercial harvests of 13,285 to 23,374 kg were recorded. Since 1982 local harvest sales have fallen to approximately 5,000 kg. This decrease in sales may be real and due to a loss in market or it may be due to a lack of reporting on the part of the licence holders. Data on the number of surveys returned as a percent of the licences sold have been available since 1982 and the percent of licence holders who have reported harvests has varied from 26% to 80%. However, it is possible that those licence holders who are not reporting are not catching many fish or did not sell any fish and do not feel it is necessary to return the surveys. There is no obvious correlation between the numbers of fish sold and the number of surveys returned. For example, the 1982 harvest is based on only 38% of the licence holders and is much higher than the 1984 harvest which is based on 80% of the licence holders (Table 22) (Appendix D, Table 3).

The subsistence fishery continues to be very important to the people in this region and as a result it is a much larger fishery than the commercial fishery. Approximately 78-83% of all fish caught were used for subsistence purposes in 1978 to 1980 (Corkum and McCart 1981) and for 1983 to 1990, 62% to 98% of the broad whitefish caught were used for subsistence (Table 22). However, the importance of the commercial fishery should not be discounted as it provides the cash needed by many people to support their subsistence activities.

Despite their shortcomings, data from the surveys and harvest estimates presented here are all that are available to fisheries managers with which they can form an opinion as to previous and current broad whitefish harvest levels. There has been interest in developing large scale export commercial fisheries in the past to help improve the local economy and this is likely to be pursued again sometime in the future. Information about subsistence requirements and broad whitefish population production capabilities will be required in order to properly gauge the extent to which a commercial fishery could be developed. It is concluded that the 1988 total harvest estimate of 305,137 kg is reasonable, and may be closer to the true harvest than estimates for other recent years. Further, the data presented here suggest the annual broad whitefish harvest falls within a range of approximately 100,000 kg to 300,000 kg. The lower figure may not be representative due to a lack of reporting or poor coverage of all active fish harvesters. Assuming this is the case, then the upper figure may be more representative. These estimates provide what may be a more realistic range within which the broad whitefish harvests fall until more data become available.

Chapter IV

BROAD WHITEFISH MANAGEMENT ISSUES

4.1 INTRODUCTION

Fisheries management in the lower Mackenzie River region used to be the sole responsibility of the Department of Fisheries and Oceans. However, as a result of the settlement of comprehensive land claims, local resource users now have co-management systems in place and are able to participate directly in decision-making processes (Fig. 2) (Department of Indian Affairs and Northern Development 1984, 1992, 1993). Representation on the co-management boards is split equally between government appointees and the local user groups with a mutually agreed upon chairperson. The Inuvialuit were the first Aboriginal group in this area to become empowered through the establishment of a co-management system when the signing of their comprehensive land claim agreement resulted in the formation of the Fisheries Joint Management Committee (FJMC) (Department of Indian Affairs and Northern Development 1984). Renewable Resource Boards (RRB) were established following the implementation of the Gwich'in and Sahtu Dene and Metis land claims signed in 1992 and 1993, respectively (Department of Indian Affairs and Northern Development 1992, 1993). Therefore, the political environment within which the management issues for broad whitefish are embedded is complex, involving six communities - Tuktoyaktuk, Inuvik, Aklavik, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope; three land claim groups - Inuvialuit, Gwich'in and Sahtu Dene and Metis; as well as the Northwest Territorial and Federal Governments.

The allocation of the broad whitefish of the lower Mackenzie River region between commercial and subsistence use, between communities, and between the Inuvialuit, Gwich'in and Sahtu people has not been an issue until recently, following a renewed interest in commercial development. Are there enough fish to support commercial harvests as well as maintain subsistence harvest levels? How important is the development of commercial fisheries to the people in these communities? Are there real financial gains to be made? Are there any concerns with regards to the management of broad whitefish? The determination and documentation of local harvester opinions concerning broad whitefish use and management can help to determine priorities and put into perspective the management issues of concern to both the resource and the resource users.

The purpose of this chapter as specified in Chapter I, Objective 3, is to examine management issues with input from all stake holders, including resource harvesters. With this in mind informal interviews were conducted with fish harvesters and other interested parties, in each of the lower Mackenzie River region communities. Comments and concerns raised during these interviews are presented here following some general background information concerning the science of fisheries management in general and the lower Mackenzie River region specifically; and details of the co-management institutions created under the Inuvialuit, Gwich'in and Sahtu Dene and Metis comprehensive land claim agreements.

4.2 FISHERIES SCIENCE AND THE CONCEPT OF ADAPTIVE MANAGEMENT

It is not the intention here to discuss or describe in detail the theories and models used by fisheries scientists and managers but to describe the background to one pertinent resource management concept, adaptive management.

The discipline of fisheries science is fairly young as compared to others in the natural science field; its theories and applications began influencing fisheries management practices following World War II and gained in popularity in the 1950's and 1960's (Larkin 1978). Ricker developed his stock and recruitment model in 1954 and Beverton and Holt developed their population dynamics model in 1957 based on data from the North Sea fishery (Larkin 1978).

Techniques for collecting data for stock or population statistics such as age, growth, mortality (both fishing and natural), and recruitment were developed along with the models used to analyze and interpret these data (Ricker 1975; Gulland 1969) - the objective being to estimate or predict the maximum equilibrium yield for the population. Unfortunately the assumptions on which the models are based do not always hold true in the real world and have not been proven for many arctic species, including broad whitefish. Larkin (1978) states that most of the contemporary theory on regulation of fish populations is based on data from catch statistics only, which are not representative of the entire population. Larkin (1978, p. 67) also suggests one of the problems with traditional models is that they "... assume for convenience, that aggregate fishing effort is applied to a stock of fishes in such a way that, thanks either to the movements of fish or the movements of fishermen or both, the net result is a random removal of fish from the fishable population(s) in which the catch is proportional to abundance." Also, factors other than fishing, (e.g., environmental factors), can affect mortality, growth and reproduction. Fish stocks cannot necessarily be maintained at a stable equilibrium given these types of external influences. Therefore, the prediction of maximum sustainable harvest levels and equilibrium yields is very difficult and sometimes impossible.

Fisheries scientists are working to solve the problems associated with the earlier models and some are suggesting modifications to our approach to fisheries management. For example Hilborn (1987) suggests that the following uncertainties in resource management exist and that we will never be able to overcome them. We will have to learn to deal with: 1) uncertain productive potential;

2) uncertain consequences of resource exploitation;

3) uncertain budgets for management; and

4) uncertain political decisions.

One way of dealing with these uncertainties is to use management itself, as a tool for learning about the system or stock in question and/or changing management policies on a regular basis to adjust to ever-changing circumstances; an adaptive learning process or "adaptive management" (Holling 1978; Hilborn 1987). An example would be the exploratory fishery process described in Chapter III. Adaptive management assumes that management involves a continual learning process that cannot be broken down into separate units, one for research and one for regulatory activities. It further assumes that a state of equilibrium or optimum productivity (e.g., maximum sustainable yield) and complete knowledge of the resource is not attainable (Holling 1978; Walters 1986).

The implementation of an adaptive management strategy does not necessarily preclude the use of other fisheries science theories or models, but recognizes their deficiencies and the need to continually adjust management policies based on monitoring, evaluation and experimentation. The use of computers and the development of more sophisticated modelling of single, multi-stock, and multi-species fisheries can be utilized to assist in the planning and evaluation of management policy but should not be relied upon to provide definitive results (McDonald 1988).

Adaptive management generally implies that quotas and economic returns will vary depending on the state of the population. The degree to which these factors vary is the key to whether or not an adaptive management strategy is likely to be adopted by a management agency because most fish harvesters would prefer a stable economic return and the markets would prefer stable inputs. Therefore, fishery managers have generally preferred a conservative management strategy based on long-term average survival that will likely suit a range of possible population states (Hilborn 1987). In this way they are more likely to achieve stable populations, harvests and economic returns. However, they may not know enough about how the population(s) respond to increases or decreases in fishing mortality to be as prepared as they could be to deal with surprise events that cause shifts in the population state beyond what was previously considered to be the average fluctuation range (Hilborn 1987; Holling 1986).

The implementation of an adaptive management strategy requires a good biological monitoring system in order to detect changes in population parameters as well as flexibility in management to allow for quick decision making as problems arise (Hilborn 1987). It is also important for the management agency to ensure that what is learned over time is retained and passed on to new staff (Hilborn 1992). This is important under any circumstances but doubly so under an adaptive management strategy where learning and adapting policy to what is learned are key components.

Fisheries management used to be the domain of government scientists, biologists and technicians trained in the collection, analysis and interpretation of biological data and fisheries models. Policy recommendations would be made to senior management and politicians based on these data. They would then weigh the social, economic, political and biological inputs prior to formulating official policy. Over the last fifteen to twenty years governments have been pressured by Aboriginal people and other resource users to share some of the decision-making power with regards to the management of fishery resources (Pinkerton 1989; Berkes et al. 1991). This is particularly true with regards to the management of fish and wildlife resources in the comprehensive land claim areas of Canada's North (MacLachlan 1994). The co-management arrangements that have developed vary from location to location in terms of how the boards or committees are structured and what degree of decision-making power they have (Pinkerton 1989; Haugh 1994; Berkes 1994).

In general there are representatives from government as well as from the fish harvesters. The board solicits input from other fish harvesters and local stakeholders as well as from government. The board has a certain amount of decision-making power, may formulate policy and regulations, and/or advise government on legislation. Often the government still holds the final decision-making responsibility over management issues. Some boards may have small budgets to cover their operational expenses while others have larger budgets that allow them to carry out research. Co-management boards established under comprehensive claims agreements fall into the latter category. Most of these co-management boards are striving to integrate western-based scientific management with the local or traditional knowledge held by fish harvesters (Berkes 1994).

Many people feel that fisheries science is not able to answer their questions, has not been able to consistently predict yields, or will never have enough data or information on which to base sound conclusions (McDonald 1988). They conclude that science alone is inadequate to properly manage resources and suggest that the inclusion of traditional knowledge in an adaptive management framework will result in better, more-informed management decisions (McDonald 1988). Some people might also suggest that an "adaptive" approach to natural resource management has gone on in subsistence based societies that hunt and harvest natural resources. Traditional environmental knowledge (TEK) is "a body of knowledge built up by a group of people through generations of living in close contact with nature." and is "... both cumulative and dynamic, building upon the experience of earlier generations and adapting to the new technological and socioeconomic changes of the present." (Johnson 1992, p.4). Subsistence harvesters typically adjusted their harvesting practices based on observed changes in the state of the environment around them and likely experimented with different techniques or approaches in the process of developing a management system that worked for them and their community at that given place and time.

Fisheries science and TEK are both evolving and changing. As more information is gathered and evaluated, practices are modified or new ones developed. With the development of the co-management process to include more TEK, fisheries science and TEK concepts will become more familiar to fish harvesters and scientists, alike. They will effect changes in each other and in the approach to fisheries management.

4.3 FISHERIES MANAGEMENT IN THE LOWER MACKENZIE RIVER REGION

The subsistence fishery is self-regulated with limited government interference (Yaremchuk and Wong 1989). Subsistence fish harvesters are not allowed to sell their catch, or give it to non-natives. Rivers or channels cannot be completely blocked with nets, nor can nets be abandoned or left unattended for more than a few days. There is no control over mesh size, length of net, or the number of nets and only Area VI, has ever been closed to subsistence fishing and that was with the full cooperation of local subsistence fish harvesters. Subsistence harvest surveys have been carried out periodically by various agencies. More recently, regular subsistence harvest monitoring programs have been implemented following the signing of comprehensive land claims and the development of co-management bodies (see Chapter III).

Commercial fishery regulation has been carried out by the Department of Fisheries and Oceans (DFO) and includes the use of regulations covering harvest, mesh size, quotas, licences, and management areas. In 1954 the Northwest Territories Regulations were developed and included in the Government of Canada's Fisheries Act (Government of Canada 1954). At that time there was no specific mention of the Mackenzie Delta or other locations within the lower Mackenzie River region. A minimum mesh size of 114 mm (4.5") for commercial whitefish fishing in the Mackenzie Delta was introduced in December, 1966 (Government of Canada 1966). It was not until May, 1974 that revisions to the regulations included commercial quotas for the

Mackenzie Delta (whitefish species), Eskimo (Husky) Lakes (inconnu and whitefish, herring and cisco species) and for Liverpool Bay (trout species). The regulations and quotas did not differentiate between broad whitefish and lake whitefish (Table 24).

Revisions to the NWT Fishery Regulations made in December, 1975 divided the Mackenzie Delta into five management areas (Fig. 24) with the following whitefish species quotas assigned to each area:

Area I (5,000 lbs or 2,275 kg);

Area II (20,000 lb or 9,100 kg);

Area III (30,000 lb or 13,650 kg);

Area IV (75,000 lb or 34,125 kg);

Area V (10,000 lb or 4,550 kg) (Government of Canada 1975), (Table 24). The total whitefish species quota for the Mackenzie Delta area was 140,000 lbs or 63,770 kg as compared to the 33,197 kg set previously. There was also a Peel River quota of 5,000 lbs or 2,275 kg of whitefish species (Table 24). Also, the minimum mesh size was increased to 139 mm (5.5") for whitefish species (Government of Canada 1975).

No changes were made to the management area boundaries until August 1987 when a sixth management area was added to control the Big Fish River char harvests (Fig. 25) (Government of Canada 1987)[5]. It was subsequently closed to gillnet fishing for five years to allow the char populations to recover from over-harvesting (Bell and Gillman 1991; Binder and Hanbidge 1993).

The quotas were converted from pounds to kilograms in June, 1981 (Government of Canada 1981) and the whitefish quota adjusted for Areas III and IV; Area III was increased by an amount approximately equal to that by which Area IV was decreased. The total whitefish quota for the

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[5]The management boundaries found in Corkum and McCart (1981) were draft boundaries only, not actual boundaries (N. Robinson, DFO-Inuvik, personal communication).

Table 24. Quotas (kg) for commercial species by fisheries management area 1974-1993. Source: Gov. of Canada Gazette Schedule V (1974, 1975, 1978, 1981, 1987, and 1991), (1 lb = .455 kg). Beginning in 1990, the quotas set in Schedule V have been adjusted using a variation notice (Department of Fisheries and Oceans 1992b, 1993, 1994, and 1995); where the quota has been changed it is shown in brackets. The most recent management area boundary changes were made in 1991 (Fig. 26).

Location	Species	Year								
		1974	1975	1976[1]	1977	1978	1981[2]	1987[3]	1990[4]	1993
Mackenzie Delta										
Area I	Broad Whitefish	NQ[5]	NQ	-	-	-	-	-	(2,000)	(2,000)
	Whitefish Sp.[6]			2,275	2,275	2,275	2,300	2,300	(-)	(-)
	Cisco Sp.[7]			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Lake Trout			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Arctic Char			910	910	910	900	900	900	900
	Burbot & N. Pike			4,550	4,550	4,550	4,600	4,600	4,600	4,600
Area II	Broad Whitefish	NQ	NQ	-	-	-	-	-	(3,000)	(2,000)
	Whitefish Sp.			9,100	9,100	9,100	9,100	9,100	(-)	(-)
	Cisco Sp.			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Lake Trout			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Burbot & N. Pike			4,550	4,550	4,550	4,600	4,600	(4,500)	(4,500)
Area III	Broad Whitefish	NQ	NQ	-	-	-	-	-	(1,000)	(1,000)
	Whitefish Sp.			13,650	13,650	13,650	45,500	45,500	(-)	(-)
	Cisco Sp.			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Lake Trout			2,275	2,275	2,275	2,300	2,300	2,300	2,300
	Burbot & N. Pike			4,550	4,550	4,550	4,600	4,600	4,600	4,600
Area IV	Broad Whitefish	NQ	NQ	-	-	-	-	-	(1,000)	(1,000)
	Whitefish Sp.			34,125	34,125	34,125	4,600	4,600	(-)	(-)
	Inconnu			4,550	4,550	4,550	4,600	4,600	4,600	4,600
	P. Herring			227,500	227,500	227,500	227,300	227,300	(500)	(500)
	Lake Trout			2,275	2,275	2,275	2,300	2,300	2,300	2,300
Area V	Broad Whitefish	NQ	NQ	-	-	-	-	-	(1,000)	(1,000)
	Whitefish Sp.			4,550	4,550	4,550	4,600	4,600	(-)	(-)
	P. Herring			-	-	-	500	500	500	500
	Cisco Sp.			-	-	-	500	500	500	(600)
Area VI[8]	Arctic Char	NQ	NQ	NQ	NQ	NQ	NQ	NO[9]	NO	NO
Total	Whitefish Sp.	33,197	33,197							
Ft. McPherson Area										
Peel River[10]	Broad Whitefish	ND[11]	ND	-	-	-	-	-	(1,500)	(2,300)
	Whitefish Sp.			2,275	2,275	2,275	2,300	2,300	(-)	(-)

Table 24. Continued.

Location	Species	Year 1974	1975	1976[1]	1977	1978	1981[2]	1987[3]	1990[4]	1993
Tuktoyaktuk Area										
Eskimo (Husky) Lakes[10]	Broad Whitefish	-	-	-	-	-	-	-	-	-
	Whitefish Sp.	11,375	11,375	11,375	11,375	11,375	11,400	11,400	11,400	11,400
	Inconnu	910	910	1,138	1,138	1,138	1,200	1,200	1,200	1,200
	Cisco Sp.	22,750	22,750	11,375	11,375	11,375	11,400	11,400	11,400	11,400
	P. Herring	227,500	227,500	-	-	-	-	-	-	-
	Lake Trout	-	-	11,375	11,375	11,375	11,400	11,400	11,400	11,400
Liverpool Bay[10]	Whitefish Sp.	-	-	-	-	-	-	-	-	-
	Inconnu	-	-	1,138	1,138	1,138	1,200	1,200	1,200	1,200
	Cisco Sp.	-	-	11,375	11,375	11,375	11,400	11,400	11,400	(2,400)
	P. Herring	-	-	227,500	227,500	227,500	227,300	227,300	20,000	(2,000)
	Trout	11,375	11,375	-	-	-	-	-	-	-
Ft. Good Hope Area										
Manuel Lake[10]	Broad Whitefish	ND	ND	-	-	-	-	-	-	-
	Lake Whitefish & Lake Trout			4,550	4,550	4,550	800	800	800	800
Rorey Lake[10]	Broad Whitefish	ND	ND	-	-	-	-	-	-	-
	Lake Whitefish & Lake Trout			4,550	4,550	4,550	800	800	800	800
Other Areas										
Sitidgi Lake[10]	Broad Whitefish	ND	ND	-	-	-	-	-	-	-
	Lake Whitefish & Lake Trout			1,365	1,365	1,365	300	300	300	300
TOTAL[12]	Broad Whitefish	-	-	-	-	-	-	-	(9,500)	(9,300)
	Whitefish Sp.	44,572	44,572	77,350	77,350	77,350	79,800	79,800	11,400	11,400
	Lake Whitefish & Lake Trout	-	-	10,465	10,465	10,465	1,900	1,900	1,900	1,000
	Inconnu	910	910	6,826	6,826	6,826	7,000	7,000	7,000	7,000
	Cisco Sp.	22,750	22,750	29,575	29,575	29,575	30,200	30,200	30,200	(21,300)
	P. Herring	227,500	227,500	455,000	455,000	455,000	455,100	455,100	(21,000)	(3,000)
	Lake Trout	11,375	11,375	20,475	20,475	20,475	20,600	20,600	20,600	20,000
	Arctic Char	-	-	910	910	910	900	900	900	900
	Burbot & N. Pike	-	-	13,650	13,650	13,650	13,800	13,800	(13,700)	(13,700)

Table 24. Continued.

[1]Management boundaries created (Fig. 24).
[2]Quota adjusted from pounds to kilograms.
[3]Management Area VI added to the northwest cornor of the delta and closed to fishing from Aug. 1-31, 1987-1992. Areas I-V remained unchanged (Fig. 25).
[4]The number in brackets is the operating quota established by way of a variation notice.
[5]Management areas I to V were created in December 1975 and management area VI was created in 1987.
[6]Includes lake whitefish and broad whitefish.
[7]Includes least cisco and arctic cisco.
[8]Area VI was created in 1987 to better manage Big Fish River arctic char. Quota levels were not set, the area was closed to fishing (Canada Gazette 1987).
[9]This area was not open to commercial fishing.
[10]Additional areas where commercial quotas have been set.
[11]No quota was listed at this time.
[12]Total for all areas in the lower Mackenzie River region where broad whitefish are harvested.

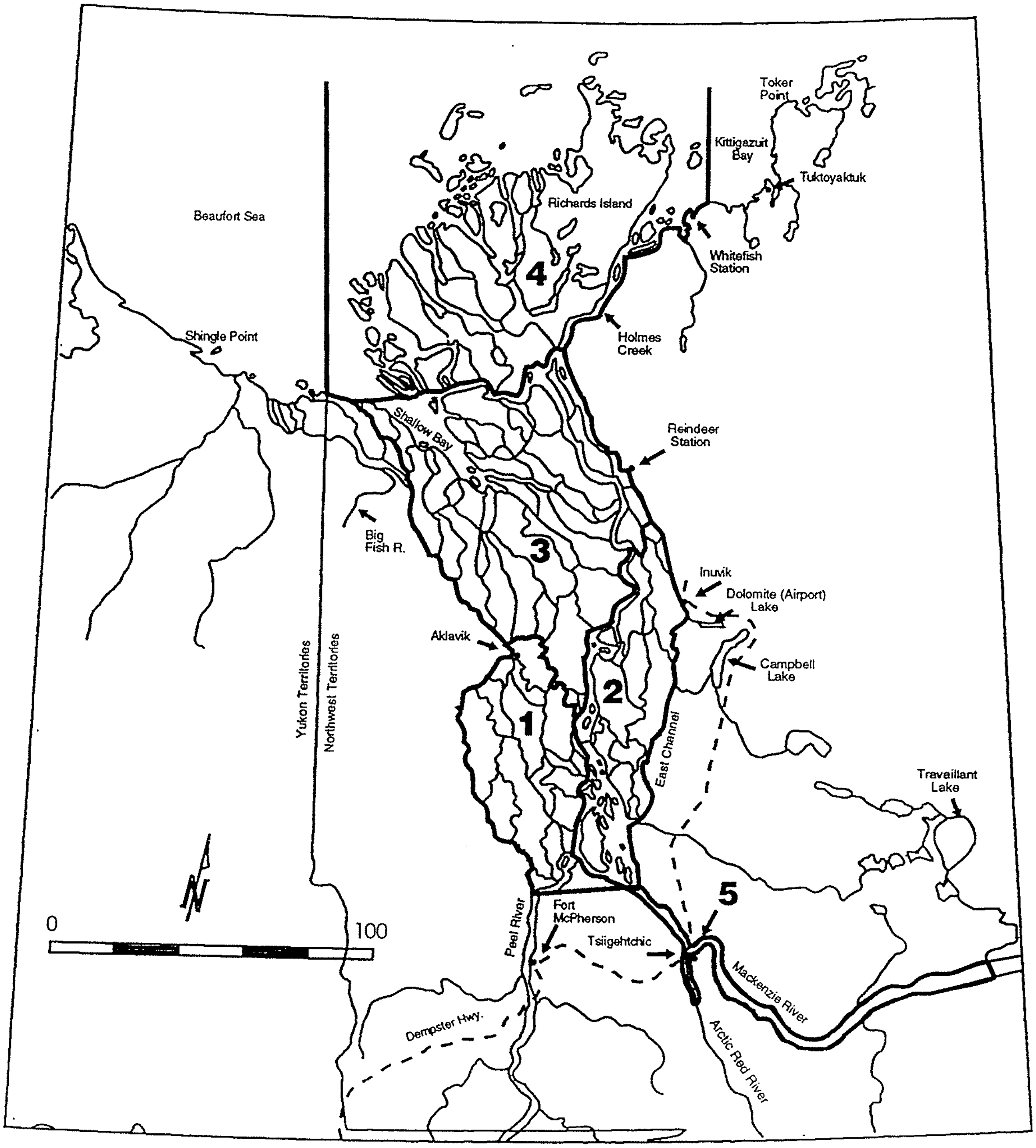

Figure 24. Fisheries Management Areas for the Mackenzie River Delta, NWT, from 1976 to 1986.

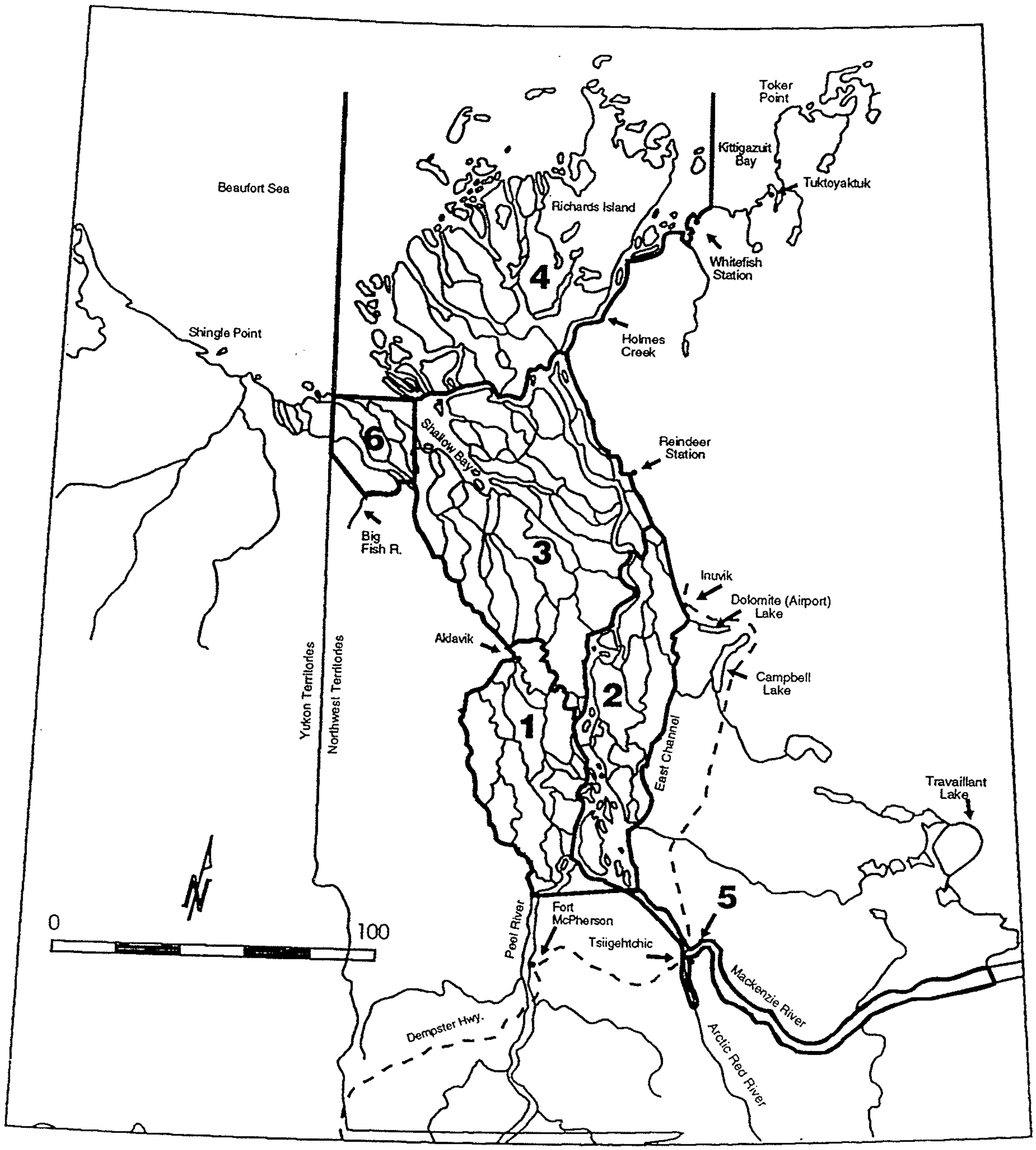

Figure 25. Fisheries Management Areas for the Mackenzie River Delta, NWT, from 1987 to 1990.

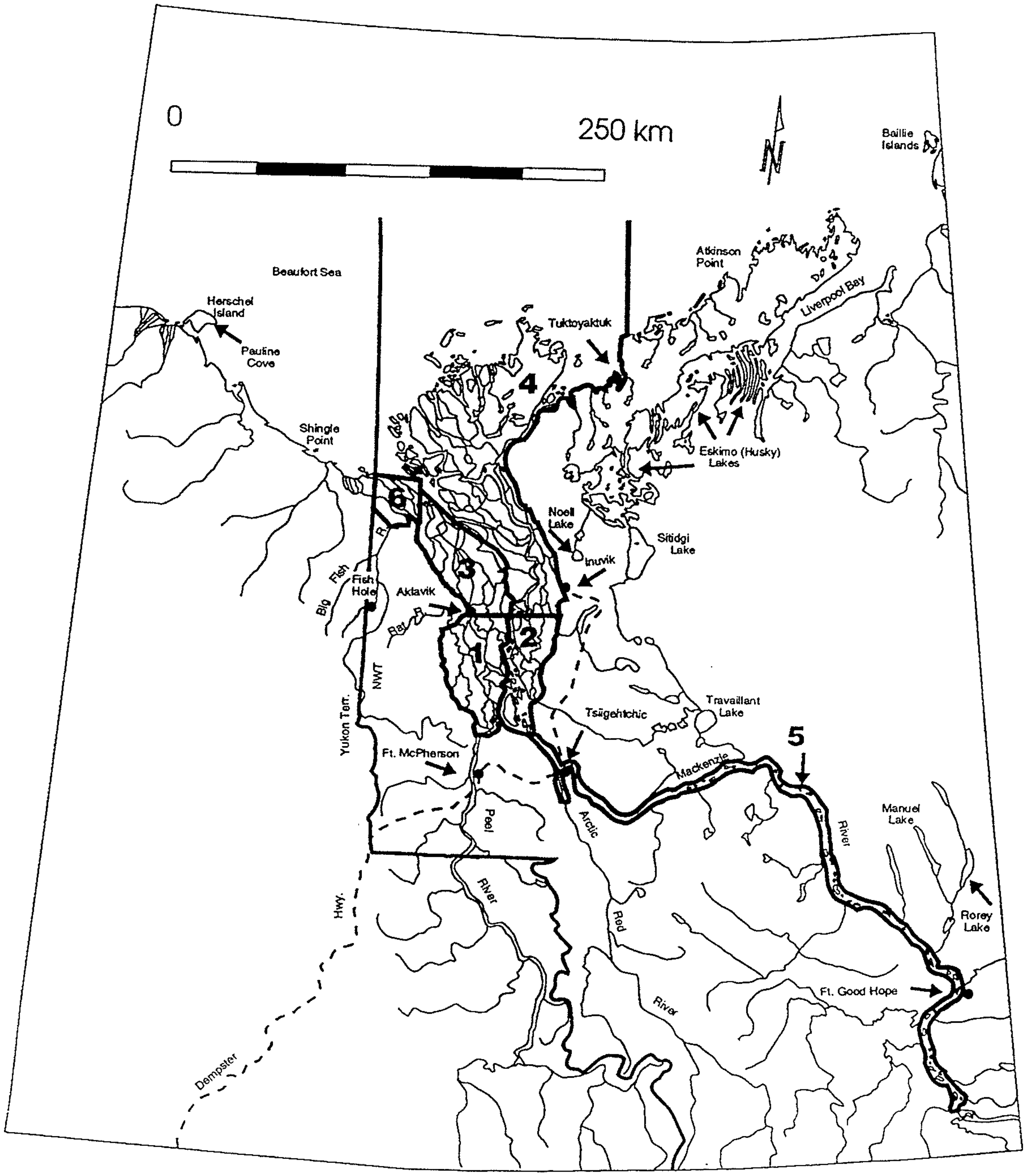

Figure 26. Fisheries Management Areas for the Lower Mackenzie River and Delta, NWT, from 1991 to present.

Mackenzie Delta was now 66,100 kg.

Yaremchuk et al. (1989) report quota levels that are slightly different to those quoted here for the years prior to 1981 likely because the conversion factor used to convert lbs to kg was slightly different. They also report the switch to metric in 1982 not 1981.

In 1991 the management area boundaries were modified (Fig. 26) to coincide with the ISR boundary and to extend Area V past the community of Tsiigehtchic to include fishing locations in and around Ft. Good Hope. The quotas were not adjusted to reflect the new boundaries. The management boundary for Area V may soon be adjusted northward to coincide with the Gwich'in and Sahtu Settlement Area boundaries (D. Moshenko, DFO-Winnipeg, personal communication).

The commercial harvest sales in each of the management areas seldom reached the quota limits prior to 1990 (Table 22 and 24). The total sales for all areas has never exceeded 40,000 kg and averages approximately 20,000 kg (Table 22), while the total quota for whitefish species went from 44,572 kg to 79,800 kg between 1974 and 1990 (Table 24). The quotas did not differentiate between lake whitefish and broad whitefish but very few lake whitefish are sold commercially due to their poor quality so it is inferred that the broad whitefish commercial harvest sales could have reached these levels.

In the absence of complete biological data, commercial quotas for the NWT have been set using yield indices such as Ryder's Morphoeadaphic Index (MEI) or a comparison of yield from rivers of similar size (Clarke 1993). However, the MEI was developed for use in lakes; it is a trophic state model that provides an index of lake fertility and potential fish production but it does not account for other factors that affect fish production such as pH or the availability of reproductive sites (Hayes et al. 1993). Therefore, its applicability to the Mackenzie River Delta is questionable.

In 1990 the quotas set in 1981 were modified using variation notices. The variation notice is a management tool that can be used to change certain Fisheries Act Regulations such as quotas. Broad whitefish are now differentiated from lake whitefish for most areas and the quotas are significantly reduced (Department of Fisheries and Oceans 1992a; 1992b; 1993; 1994; 1995) (Table 24). Low commercial sales levels and uncertainty with regards to subsistence harvest and true production potential may have caused fishery managers to have second thoughts with regards to the previous quotas. Thus, recently set quotas more closely reflect the true level of commercial sales rather than the biological potential of the resource.

A more recent management tool that has been used in the Mackenzie Delta is the exploratory or test fishery policy. A five year exploratory fishery that targeted broad whitefish in the Middle Channel of the Mackenzie River Delta, was completed in 1993, see Chapter III for a more detailed discussion.

Fish harvesters interested in selling fish from their subsistence catch or who participate in commercial fishery ventures are required to purchase a licence from the DFO. Since 1978 these fish harvesters have been surveyed at the end of the fishing season. The survey format has been modified over the years but essentially they have been asked to record how much of each species they caught, how much they sold, and where these catches were made. The survey data are compiled and reported by management area but prior to 1990 it was reported primarily by community (see Chapter III).

Non-native fish harvesters who wish to catch fish for subsistence purposes are required to purchase a domestic fishing licence from the DFO. These fish harvesters are also sent survey forms similar to the ones used for commercial fish harvesters so that the DFO is able to estimate harvests for this component of the total harvest.

In 1986, following the signing of the Inuvialuit Final Agreement (IFA) the DFO no longer had the sole responsibility over the management of fish resources in the Mackenzie Delta (Department of Indian Affairs and Northern Development 1984). An Inuvialuit Game Council (IGC) was formed to deal with collective interests and advise government on policy, legislation, regulations and administration dealing with renewable resources either directly or through co-management bodies one of which is the FJMC (Fig. 27) (Doubleday 1989; Bell and Gillman 1991; Robinson and Binder 1991; Binder and Hanbidge 1993). Similar bodies called Renewable Resources Boards were set up under the Gwich'in and Sahtu Dene and Metis comprehensive land claims (Fig. 28) (Department of Indian Affairs and Northern Development 1992; 1993). These RRBs have both decision making and advisory powers. Provisions of these land claim agreements are protected under the Canadian Constitution and where they conflict with other Federal or Territorial legislation, the agreements prevail (MacLachlan 1994).

4.3.1 The Inuvialuit Fisheries Joint Management Committee

Information presented below is from the Inuvialuit Final Agreement (IFA) published by the Department of Indian and Northern Development (1984) unless otherwise noted. The renewable resources co-management structure created under the IFA is given in Fig. 27.

The Fisheries Joint Management Committee (FJMC) is responsible for advising the Minister of the Department of Fisheries and Oceans on regulations, research policies and management of fish and marine mammal resources within the Inuvialuit Settlement Region (ISR). Responsibilities include the determination of harvest levels and subsistence quotas, the regulation of public fishing on certain Inuvialuit lands as may be required, the allocation of any subsistence quotas among communities, and the allocation of commercial fishing licences and quotas as specified in the IFA.

There are four voting members and a chairperson selected by those members. The Inuvialuit Game Council (IGC) and the government each

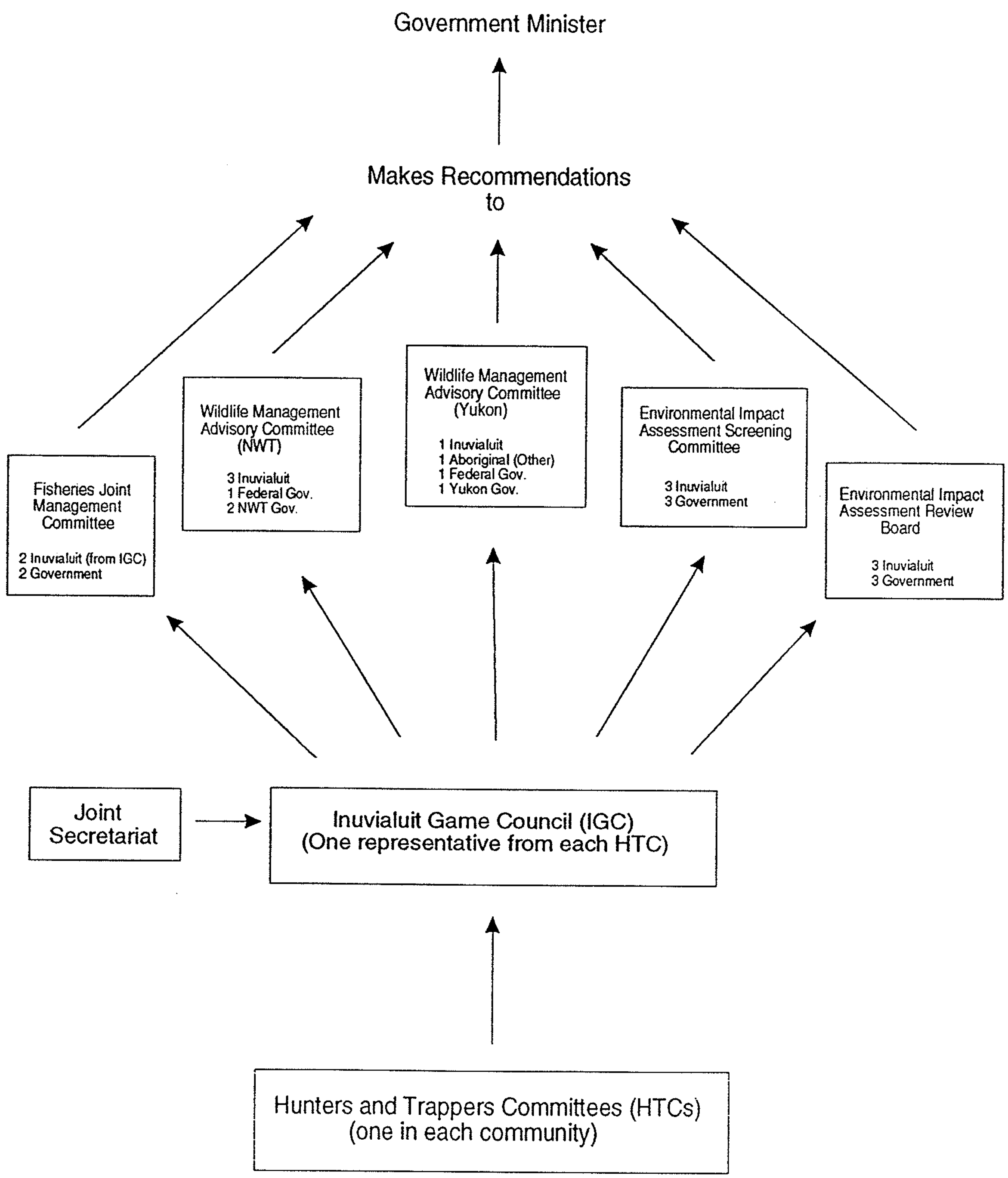

Figure 27. Structure of the Inuvialuit renewable resources co-management system.

select two of the four voting members. The IGC is comprised of at least one representative from the Hunters and Trappers Committees (HTC) located in each community plus a chairperson. It is responsible for: 1) appointing Inuvialuit members to all joint government and Inuvialuit bodies responsible for fish and wildlife management; 2) advising the appropriate government authority about legislation, regulations, and policies involving fish and wildlife; 3) assigning community hunting and trapping areas and sub-allocating Inuvialuit harvest quotas among the six communities; 4) representing Inuvialuit interests in any other Canadian or international group concerned with wildlife issues in the ISR. The IGC also oversees the subsistence harvest monitoring program conducted by Joint Secretariat staff.

The HTCs in each community are responsible for advising the IGC and FJMC about the subsistence use and requirements of their people and sub-allocating quotas. They also play a role in identifying research needs and encourage Inuvialuit involvement in conservation, and management of fish and wildlife resources in the ISR.

Technical and administrative support is provided to the FJMC and three other Inuvialuit co-management bodies by the Joint Secretariat (Binder and Hanbidge 1993). Community meetings are organized on an annual basis in order to determine or better understand individual community needs and requirements with regards to their fisheries resources. They also hold regular meetings with the DFO and others who conduct research on their behalf. Annual reports are prepared which give brief descriptions of the committees activities and the research projects carried out by Joint Secretariat staff and other agencies funded by the FJMC.

The IFA requires the Government of Canada to ensure that management plans are developed for migratory species to ensure acceptable population levels are maintained in all jurisdictions and to coordinate research objectives and related matters. The management of migratory species is made easier by the provision that allows other Aboriginal groups who have recognized traditional interests in the ISR, to have membership on the FJMC and other co-management boards provided equal representation between government and native members is maintained. However, this membership is limited to the time spent resolving mutual issues only and is conditional on Inuvialuit being extended a similar offer by the other groups co-management board (Binder and Hanbidge 1993).

Overlap agreements may be created between the Inuvialuit and neighbouring land claim groups to deal with resource use and management issues on lands that have been traditionally used by more than one Aboriginal people (Binder and Handidge 1993). For example an overlap agreement was signed in 1984 that dealt with wildlife harvesting by Gwich'in within the ISR and by Inuvialuit south of the ISR (Binder and Hanbidge 1993). Keith et al. (1987) describe the concerns of northerners with the state of fisheries management in the early 1980's. Since then the situation has improved and the DFO is cooperating fully with the FJMC. Very few, if any, of their recommendations have been rejected by the Minister (Bell and Gillman 1991; Binder and Hanbidge 1993).

4.3.2 The Gwich'in and Sahtu Dene and Metis Renewable Resources Boards

Information presented below is from the Gwich'in comprehensive land claim agreement and the Sahtu Dene and Metis comprehensive land claim agreement published by the Department of Indian Affairs and Northern Development (1992 and 1993) unless otherwise noted.

The Gwich'in and Sahtu Dene and Metis comprehensive land claim agreements are similar in many ways because both developed out of the comprehensive land claim agreement in principle between Canada, the Dene and Metis Nation, and the Metis Association of the Northwest Territories (Department of Indian Affairs and Northern Development 1988). As a result the renewable resource co-management structure is identical for these two groups (Fig. 28).

Public management boards called Renewable Resources Boards (RRBs) have been created which are comprised of six members and six alternates appointed jointly by the Governor in Council and the Executive Council of the Government of the Northwest Territories. Both Governments and the Tribal Council[6] put forward a list of nominations and from each list three members and three alternates are selected. At least one member must be a resident of the Northwest Territories who is not a participant in the land claim agreement. The members nominate a chairperson who must be from the settlement area.

The RRB is the main instrument of wildlife management in the settlement area and as such has decision-making powers subject only to conservation, public health and safety (D. Moshenko, DFO-Winnipeg, personal communication). The RRB has an Executive Director and staff to carry out board responsibilities and conduct independent research. The RRB consults with government, communities, the public, and Renewable Resource Councils (RRC) which are established in each community and were formerly known as Hunters and Trappers Associations (HTAs). There is no direct link between the RRB and the RRCs as is the case between the Inuvialuit's IGC and HTCs. Decisions, policies, and regulations pertaining to the harvesting and management of fish, wildlife and forestry may be established by the board and sent to the Minister for review and approval. Any regulations or legislation proposed by government must be reviewed prior to approval by the RRB.

The RRB will oversee a Settlement Harvest Study that will provide data to be used in determining a Gwich'in/Sahtu minimum needs level (MNL). After five years, the MNL will be determined using the following

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[6]The Sahtu Tribal Council has been re-named the Sahtu Secretariat Incorporated since the land claim was signed in 1993 (D. Moshenko, DFO-Winnipeg, personal communication).

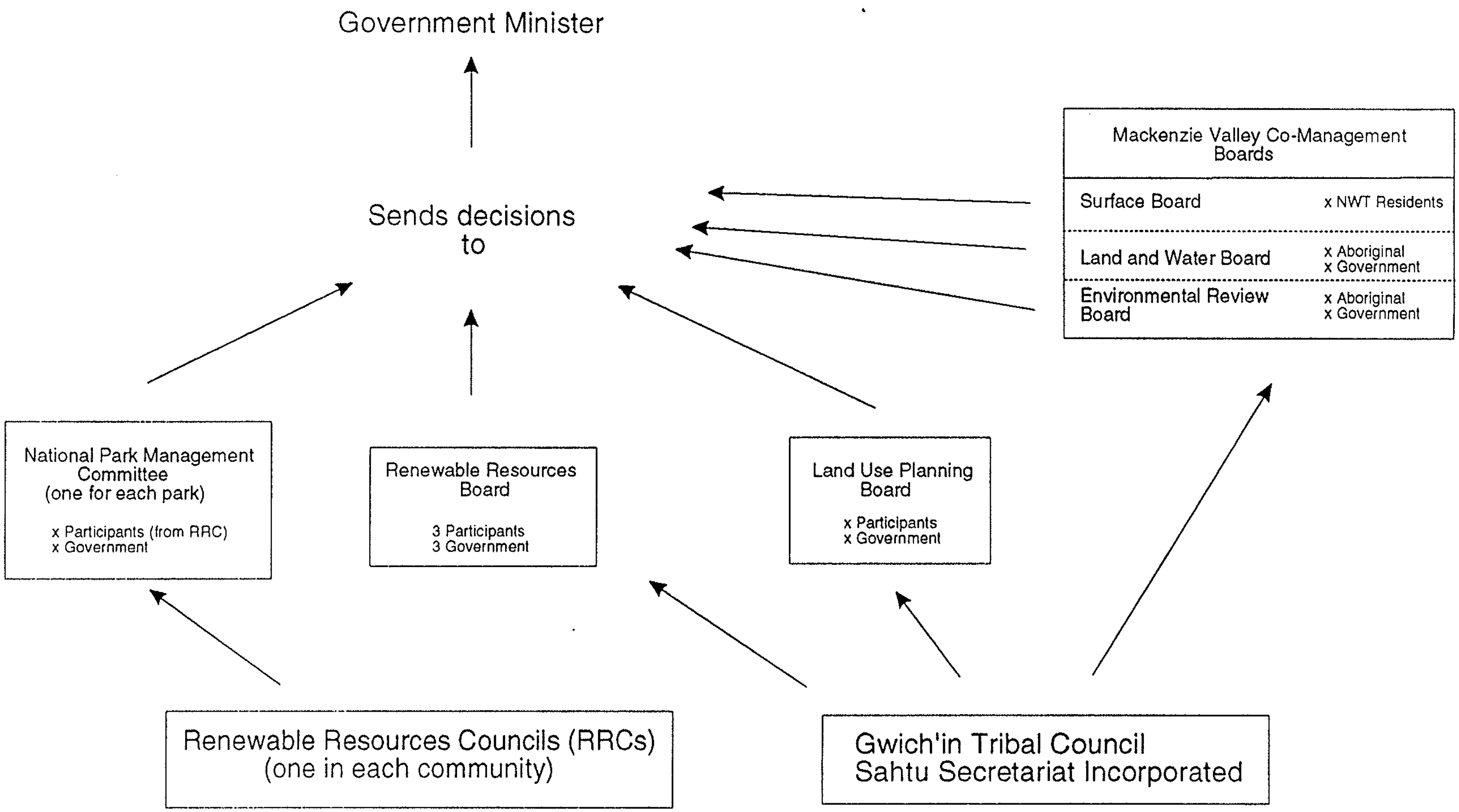

Figure 28. Structure of the Gwich'in and Sahtu Dene, and Metis renewable resources co-management system.

formula: $MNL=1/2*(h1+h2+h3+h4+h5+hmax)$; where h1 to h5 equal the average harvest in years one to five and hmax equals the maximum harvest taken in any one of the previous five years. A Gwich'in/Sahtu needs level may be set at or above the MNL and may be adjusted at any time after consulting with the RRC. A RRC or the Gwich'in/Sahtu Tribal Council may advise the RRB to reallocate any portion of the needs level not required at any given time.

The allocation of the total allowable harvest, beyond the needs level, is done in no particular order: 1) to long-term residents who are not participants in the agreement; 2) to personal consumption needs of other aboriginal people who have harvesting rights in the settlement area; 3) to sport hunting and fishing; and 4) to commercial demands.

The RRB will determine if commercial harvesting is to be allowed in Gwich'in/Sahtu lands and may set terms and conditions for such harvesting. The agreement stipulates that the harvesting needs of the participants will have first priority if for any reason harvesting quotas are set. Participants have exclusive rights to a licence for fishing in waters overlying Gwich'in/Sahtu lands. Non-participants to the land claim who had a licence to fish in waters overlying Gwich'in/Sahtu lands at the time of the agreement may continue to fish as long as they renew the licence each and every year following the agreement.

For other waters in the settlement area, participants will be offered a number of licences equal to the number held by participants in either the first or second year prior to the signing of the agreement, which ever is larger. These licences are offered first to the individual fish harvesters and then to the Tribal Council. The Tribal Council has the first right of refusal to one half of any new licences, licences not renewed, or not re-issued. Once the participants have been offered or issued 50% of the licences for any fishery they are treated on the same terms as any other applicant.

The RRC in each community oversees resource use and issues access permits for all lands within their area. They will also allocate the needs level for their community among participants of the agreement, establish group trapping areas, advise the RRB on issues of importance to them, and encourage local involvement in conservation, research and other fish and wildlife management activities.

The government is to work with the RRB, other management bodies including foreign governments and users, to establish management agreements and plans that will maintain and enhance population levels for migratory species. The Gwich'in/Sahtu are to be provided the opportunity to be represented in any Canadian discussions with regards to migratory species located in the settlement area. The agreements address the possibility that regional resource management boards could be established in the future that would cover all or parts of the respective land claim areas. If this occurs, the agreements specify that the new board would assume the powers of the RRBs and the RRBs would become regional panels of the new board. These regional panels would be reduced to five members and would exercise the powers of the new board except in areas which may affect regions outside their respective settlement areas.

One clause unique to the Sahtu Dene and Metis claim under the section on wildlife harvesting and management requires the RRB to determine if a Great Bear Lake Committee should be created. No additional details are available but this committee would likely report to the RRB and might be responsible for resource harvesting and management issues on Great Bear Lake.

4.4 INTERVIEW METHODS USED TO DOCUMENT LOCAL HARVESTER OPINIONS

Based on a general understanding of potential management issues a series of questions were developed that served as an outline or interview guide for informal interviews with representatives of both

Inuvialuit HTCs and Dene/Metis RRCs in each community (Appendix C, Tables 1 and 2). In some interviews, the interview guide was followed closely while in others it was used only as a reference to lead conversation. In some cases, only the president of the HTC or RRC was interviewed, in others there were two or more people present. In some communities both part-time and full-time fish harvesters were present. Some of the interviews were taped; for others it was not possible or the participants preferred not to have the interview taped. Information derived from these interviews has been summarized and grouped into three categories: subsistence fishery issues, commercial fishery and resource allocation issues, and management issues.

It is important to recognize that no two interviews were the same. The opinions and comments were from individuals, thus they do not necessarily represent the views of the organization or community. It is also important to note that organizations or communities may not hold uniform views. There were in fact instances in which opinions differed within and between communities and land claim groups. Also, views can change; some of the comments attributed to a specific community or group may not hold true at a later date. Therefore, it is difficult to generalize, and attempts at such may not always be entirely appropriate. However, generalizations have been made here in an attempt to illustrate the key local issues involving the management of broad whitefish in the lower Mackenzie River region.

4.5 RESULTS OF INTERVIEWS AND DISCUSSION

A summary of the issues raised and comments provided during the interviews can be found in Table 25. These will be discussed in general terms below.

4.5.1 Subsistence Fishery Issues

Everyone agreed that the fishing effort had been much greater in

Table 25. Commercial and subsistence fisheries management issues which were raised and comments that were made in interviews with members of each community.

✓ Agree with this comment/issue

✗ Disagree with this comment/issue

✓✗ Opinions on this issue differed

☐ No comment made or issue not discussed

	Inuvik HTC	Aklavik HTC	Tuktoyaktuk HTC	Inuvik RRC	Aklavik RRC	Tsiigehtchic RRC	Ft. McPherson RRC	Ft. Good Hope RRC
Subsistence Fishery Issues								
1) Fishing effort was much higher in the past	✓	✓	✓	✓	✓	✓	✓	✓
2) There are fewer fish now than in the past	✗	✓✗		✗		✗	✓✗	✗
3) There has been no noticeable change in catch per net	✓	✓	✓	✓	✓	✓	✓	✓
4) There has been no noticeable change in the size of the fish caught	✓	✓	✓	✓	✓	✓	✓	✓
5) There are concerns with fish quality	✓					✓	✓	✓
Commercial Fishery Issues								
1) Caution/concern expressed over commercial development	✗	✓	✓	✓✗	✓	✗	✓✗	✗
2) No conflict between commercial and subsistence harvesting	✓	✓✗	✓	✓	✓	✓	✓✗	✓
3) Would like to see a commercial fishery developed	✓	✓✗	✓✗	✓		✓	✓	
4) Would like to explore the possibility of a joint venture				✓	✓	✓	✓	
Fishery Management Issues								
1) The co-management system is working well	✓	✓	✓	—	—	—	—	—
2) Land claim and co-management should bring positive changes	—	—	—	✓	✓	✓	✓	✓
3) Traditional knowledge is being lost	✓	✓✗	✗	✓				✓
4) Traditional knowledge should be incorporated into the management system	✓	✓	✓	✓				
5) Harvest monitoring should continue	✓	✓		✓			✓	
6) A management plan should be developed which will include input from all parties	✓	✓		✓	✓			
7) Areas were mentioned where scientific research should be focused	✓	✓	✓					
8) The importance of receiving information from researchers was stressed	✓		✓				✓	

the past, prior to and including the 1950's and 1960's. At that time more people were living off the land, fishing to feed themselves and their dogs. One estimate put harvest for the 1990's at 1/10 what it was in the past. Broad whitefish harvests for the ISR for 1987 and 1988 were approximately 1/10 of the estimates for Inuvialuit harvests prior to 1955 made by Freeman (at review). However, estimates for the entire region in 1988 and 1989 are approximately eight times and two times greater, respectively, than 1/10 of the estimates made from surveys done in the 1960's (Appendix D, Table 4). Past broad whitefish harvests for the lower Mackenzie River region would have ranged between 860,000 and 2.9 million kg if the 1988 and 1989 estimates found in Table 22 were multiplied by 10.

No one had noticed any changes in the size of the fish caught or in the numbers they were catching per net. However, some of the Aklavik HTC and Ft. McPherson RRC members interviewed felt there may be fewer fish now than there were 10 to 15 years ago. It was noted that on average, fish from the Peel Channel seemed to be smaller and catches were less than what you would find in the Middle Channel or mainstem Mackenzie River. Fish harvesters in Tuktoyaktuk commented that "jumbo" broad whitefish are most common in Tuktoyaktuk Harbour in July and that juvenile broad whitefish are often caught along with "herring" in 89 mm (3.5") mesh nets.

Members of the Inuvik HTC, Tsiigehtchic RRC, Ft. McPherson and Ft. Good Hope RRCs expressed concern over fish quality. People from several communities mentioned that they preferred broad whitefish caught in the lakes ("lake-fish") to those caught in the Mackenzie River ("whitefish"). These lake-fish are sometimes caught alongside other broad whitefish in the delta channels in the fall but do not appear to be in spawning condition. In this instance they are still considered to be of better quality because the flesh is richer and less "watery". One person felt that the quality of broad whitefish caught on the coast was similar to that for broad whitefish from the lakes and both were better than broad whitefish from the river. Lipids or fats found in the muscle tissues of fish are replaced by water as the gonads begin to ripen. Differences in maturity may explain the differences in taste and quality between fish from these locations. Some people were also concerned about the potential cumulative effects of hydrocarbon exploration and development upstream on the Mackenzie River as well as upstream hydroelectric development on Mackenzie River tributaries such as the Liard River.

4.5.2 Commercial Fishery and Resource Allocation Issues

The majority of people interviewed saw no conflict between commercial and subsistence harvesting. Some felt fish harvesters involved in a commercial fishery would just put in an extra net or two to meet their subsistence needs. Most felt the broad whitefish populations could support both subsistence and commercial fisheries in more than one community. All communities were interested in economic development opportunities in general and fisheries development in particular.

Both Inuvialuit and Gwich'in from the communities of Inuvik, Tsiigehtchic and Ft. McPherson felt there could be some potential for commercial development in their communities and would like to pursue this further. The Inuvialuit in Inuvik have already taken steps in that direction with their exploratory fishery on the Middle Channel north of Horseshoe Bend which was conducted between 1989 and 1993 (Fig. 1).

People interviewed in Tuktoyaktuk, Aklavik and Ft. Good Hope pointed out that the potential for commercial fishery development in their communities was limited, given that they had no road access and would have to send fish out by air. Also, some people in Aklavik suggested that the best fishing was to be found in the Middle Channel where the fish were on average larger and more plentiful, than in the smaller channels near Aklavik. Therefore an export commercial fishery would be less likely to succeed in their community.

The pooling of resources through the establishment of a joint fishery operation between communities was suggested as one way to overcome some of the difficulties in securing capital and supplying fish. For example, Gwich'in from Tsiigehtchic and Ft. McPherson felt a joint fishery between these two communities might be an option worth investigating.

There also was some concern expressed over the development of large export fisheries by some people. They stressed that the subsistence fishery was of primary importance and that commercial development should be approached cautiously. One individual emphasized that any commercial development should be for the benefit of Aboriginal fish harvesters only.

4.5.3 Other Fishery Management Issues

The Inuvialuit have had approximately ten years of experience with their co-management system and everyone was very pleased with how it was developing. Through their HTCs and the FJMC they have been able to identify areas of concern and influence policy decisions.

It was noticed that the size and degree of isolation of the community may have an influence on the transfer of traditional knowledge to the younger generations. In Inuvik (a larger regional centre) several people commented that traditional knowledge was being lost because young people were not taking an interest in traditional activities; they did not like spending time in the bush. While similar comments were made by some people in Aklavik there was also a feeling there and particularly in Tuktoyaktuk that young people were interested and did have opportunities to learn traditional hunting and fishing skills, that they were becoming more respectful of elders, and that traditional management tools such as elder and peer pressure were being revived.

Many people expressed the desire to have traditional knowledge included along with scientific knowledge in the decision making process, but how this might be achieved was not discussed further. Some Inuvialuit mentioned having their elders' committees act as advisors to the management committees. At the moment these committees have no formal input into resource management decisions.

The Gwich'in and Sahtu communities have not had the same opportunities to influence fisheries management as the Inuvialuit have in recent years. No one pointed to any significant problems with how broad whitefish fisheries were being managed in their communities but they were looking forward to gaining control over their resources through the establishment of Renewable Resource Councils and Boards following the implementation of their land claims. Some felt that having control or ownership over their resources might help to reduce some of the over-harvesting and waste that has occurred at times and that young people may begin to pay more attention to how their resources are used.

Most people agreed that harvest monitoring was important and should continue in order to determine basic subsistence use of fish resources. This would not only document the importance of the fisheries resource in case of some environmental threat but would also assist in the determination of commercial harvest potentials.

Most groups recognized that the broad whitefish were a shared resource and that a management plan should be developed with input from all parties. However, it was not necessarily a priority for some communities where issues concerning other species were more pressing than issues concerning broad whitefish.

4.6 SUMMARY AND CONCLUSIONS

To date, management intervention in broad whitefish populations of the lower Mackenzie River region has been minimal, compared to some char populations in the area, because broad whitefish have not exhibited any signs that they are in decline. Management areas have been established that divide the region into smaller units primarily to facilitate the management of the commercial fisheries. Commercial quotas were established in 1974 and the combined quota for all areas has been as high as 79,800 kg, but since 1983 reported sales were closer to 5,000 kg (20,000 kg if you include the exploratory harvests for 1989 to 1993) (Table 22). Recently, the combined commercial quota for broad whitefish from all areas was set somewhat arbitrarily at 9,300 kg; a level which more closely reflects the local commercial sales (excluding exploratory fisheries). The subsistence fishery was known to be much larger than the commercial fishery but often good estimates were not available. In Chapter III the subsistence harvest is estimated to be between 100,000 and 300,000 kg.

Local fish harvesters felt that the broad whitefish populations of the lower Mackenzie River region have remained fairly stable. Some noted localized fluctuations in quantity and quality, but generally it was felt that the quantity, size, and quality of the broad whitefish were unchanged and that the resource was not in any danger of being over-harvested. The level of effort expended, and the amount of fish harvested in the subsistence fishery is believed to have decreased since the 1950's and 1960's when more people were making a living off the land and more fish were required to feed dog teams.

There was general interest expressed in several communities to look into the commercial development of the broad whitefish resource. This was somewhat expected, as most northern communities are looking for development opportunities and the development of natural resources is often the most feasible. However, people in the communities of Tuktoyaktuk, Aklavik and Ft. Good Hope recognized the difficulties that the lack of road access would impose on such a project. The importance of the subsistence harvest was noted by people in all communities and some individuals suggested that any commercial development should proceed with caution.

The Inuvialuit were pleased with their co-management system and how it was developing, although they felt TEK was not being incorporated into management decisions as well as it could be. One suggestion was to involve an elders committee in the management process at an advisory level. Another might be to include TEK in the harvest monitoring studies. Stevenson (1995) discusses the value of incorporating TEK into the co-management process and provides guidelines for its collection as one component of a harvest study. As a result, observations relating to abundance trends, fish health and behaviour, etc., are collected and recorded on a regular basis. It is important to remember to take direction from the communities with regards to the type of information and data to be collected and how best to collect it (Stevenson 1995). This information might be harder to collate than harvest numbers and location but would provide a means through which TEK could be transferred to the co-management board and/or fisheries researchers on an ongoing basis.

The need for a broad whitefish management plan was recognized but was not necessarily a priority given that there were no pressing harvesting or allocation issues. However, this may not always be the case. To date, the stocks have been able to support subsistence harvesting and a limited amount of commercial fishing. Sustaining the subsistence harvest is of primary concern to most resource users but the potential to capitalize on and provide a cash income from the excess through the development of commercial fisheries is attractive to some. Therefore, there is potential for conflict not only in terms of resource allocation between commercial and subsistence interests within communities and land claim groups but also between communities and land claim groups, particularly if large export commercial fisheries are developed.

The co-management arrangement developed by the IFA has worked well. The DFO is working cooperatively with the FJMC to ensure their concerns, and recommendations are addressed and fisheries researchers are ensuring their work is reported back to the community through more creative and informative means such as posters, meetings, and workshops. The other two land claim agreements (Gwich'in and Sahtu Dene and Metis) are expected to produce similar results.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

5.1 BIOLOGICAL ANALYSIS

Ideally fisheries scientists would like to have complete knowledge with which to confidently apply population models developed for predicting stock size and sustainable yields. Unfortunately this is often not possible and the broad whitefish of the lower Mackenzie River region is one such example. Also, even if full population data were available, it is questionable that yield estimates that would be reliable year after year could be established (Larkin 1978; Holling 1986).

There is incomplete life history information for broad whitefish from the lower Mackenzie River region. We know there are two and possibly three life history types, anadromous, lacustrine, and riverine. The existence of separate stocks within these life history types has been hypothesized but has not yet been demonstrated. The extent to which stock mixing might occur is not known. Mixing of stocks may or may not occur prior to spawning during the pre-spawning feeding and migratory phases of their life history. The determination of population size(s) for such a complex resource is very difficult and has not yet been achieved for broad whitefish from the lower Mackenzie River region.

Objective 1, stated in Chapter I, was to examine biological data from broad whitefish collected from the Middle Channel for temporal differences within 1984 and between 1984 and 1989 that may be evidence of heterogeneity within broad whitefish of the Mackenzie River. Samples collected from this location and time are believed to be a mixture of stocks that are gathering just prior to beginning their spawning migration. Differences within- and between-years were observed, particularly in length and age distributions but whether or not this variability is due to genetic variation between discrete stocks is not certain. The data are limited for this type of analysis by small sample sizes and the fact they are from a single mesh size (139 mm). Therefore, the null hypothesis associated with Objective 1 could neither be accepted or rejected with confidence. The existence of discrete stocks of anadromous broad whitefish in the lower Mackenzie River region remains a hypothesis and management on a stock-by-stock basis is not possible at this time.

The biological data presented in this practicum when combined with data from the 1989 to 1993 exploratory fishery, provide managers with eleven years of information on broad whitefish from a single location and will assist in the formulation of a management plan. The data presented here show that many age groups were represented in the population(s). Ages ranged from five to 20 years, the mean age (12 years) and age at maturity (seven years) were relatively high and constant over the study period. The mean length was almost constant at 500 mm across years. The population(s) sampled appear to be strong and stable. However, the population or stock structure is a "black box". If it is a true complex of stocks, then the typical response associated with a high or increasing level of mortality in any one stock may be masked by the presence of other stocks. On the other hand, anadromous broad whitefish may not respond to increases in fishing mortality in the way typically expected because of the nature of its life-cycle; broad whitefish are found in an open system (river, lakes and coastal habitat) as opposed to a closed system (lake, river or marine habitat) on which most of the scientific models are based.

There is evidence that suggests that anadromous broad whitefish might be comprised of different stocks. If these stocks have different population parameters then they may respond differently to an increase in fishing mortality and multi-stock fisheries models would be more appropriate than unit-stock models. However, the application of these models requires complete knowledge of the existing stocks and their population parameters. These data do not yet exist and monitoring data from the mixed-stock commercial and subsistence fisheries will not provide it.

Adaptive management strategies can be applied in situations such as this one, where there is limited information with which to apply traditional fisheries science methods and management policies (Chapter IV, Section 4.2). Fisheries managers may use the exploratory fishery concept as an adaptive management strategy. A quota would be based on information from the previous five year exploratory fishery, and subsequently, quotas would be increased or decreased after each three-to- five year exploratory cycle, depending on how certain key indicator variables responded. This would require an extensive biological and harvest monitoring program in order to detect crucial changes or trends in these variables. Monitoring may help us determine how broad whitefish react to increases and decreases in fishing mortality, but research projects designed to answer basic questions such as stock discrimination are also important in assisting managers in the interpretation of monitoring data and formulation of management policy.

5.2 HARVEST STATISTICS

Objective 2, as stated in Chapter I, was to examine past and present subsistence and commercial harvest and to estimate the current total harvest for broad whitefish within the lower Mackenzie River region.

Commercial harvest estimates were available from 1955 to the present. However, for most years there were no export harvests and local commercial sales data were based on annual recall surveys that were not always completed by every licence holder. Therefore, these data are minimum estimates of the total commercial harvest. The highest harvests occurred for the years in which export fisheries operated: 1960 and 1961; 1963 to 1966; 1972 to 1975; and 1989 to 1993. These fisheries were generally not successful due to a lack of market, and competition with lower priced fish from southern fisheries. Some subsistence fish harvesters purchase a commercial licence which allows them to supply the local market with fresh, dried, or smoked fish in excess of their subsistence needs. These combination subsistence/local commercial fisheries have operated since the trading posts were established in the region in the late 1800's and harvests appear to have dropped off from a high of 23,374 kg in 1982 to approximately 5,000 kg in the early 1990's.

The subsistence fishery was, and continues to be, a large and extremely important fishery in the lower Mackenzie River region. Broad whitefish are very abundant and continue to be a staple of the subsistence diet for many Aboriginal people as well as an important part of their culture and tradition. Estimates of the subsistence fishery harvests go back as far as 1960 but are spotty. Like the local commercial harvest estimates mentioned above, the subsistence harvest estimates are based on survey data that may not have covered all active fish harvesters and may be more or less reliable. Recent estimates covering all communities in the lower Mackenzie River region are available for 1988 (299,378 kg) and 1989 (86,276 kg) only. The 1988 harvest estimate is high and goes against the general downward trend in harvests observed for estimates from the 1960's to the 1980's. However, this 1988 value was considered to be reliable. The estimates for 1960 to 1965 varied between 165,738 and 352,739 kg. Assuming they were reasonably accurate, this suggests that subsistence harvests may not have decreased to the extent previously thought by fisheries managers and fish harvesters. They may even be on the increase following a period of decrease in the late 1960's and 1970's. Country foods, particularly broad whitefish, comprise a considerable portion of the diet for Aboriginal people in the lower Mackenzie River region, so it is not unrealistic to suggest that broad whitefish harvests are high and possibly increasing.

It was estimated that the total annual broad whitefish harvest falls between 100,000 and 300,000 kg. Beginning in 1996, there will be data available from the Gwich'in harvest study and soon after, from the Sahtu Dene and Metis study. When these data are combined with the Inuvialuit study, we will have data from all communities in the lower Mackenzie River region where broad whitefish are harvested. At that point, better estimates of total broad whitefish harvests for the entire lower Mackenzie River region should be possible.

5.3 FISHERIES MANAGEMENT ISSUES

Objective 3, as stated in Chapter I, was to examine management issues for broad whitefish from the lower Mackenzie River region with input from resource users and other stake-holders.

The broad whitefish populations of the lower Mackenzie River region are considered to be healthy and stable by most local harvesters. Most people interviewed for this study believed that the number of full-time fish harvesters had decreased (although many continue to fish part-time), and the harvest had also decreased because few people have dog teams to feed. Therefore, it was felt that there are not as many broad whitefish being harvested in the 1990's as in the 1950's. This may be true, although data presented here suggest that the subsistence harvest is high and possibly comparable to what was being harvested in the 1960's and 1970's. A reduction in harvest from a 1950's level may mean there is room for the expansion of commercial fisheries for broad whitefish but it was made clear that the subsistence fishery was of primary importance.

The allocation of fish between subsistence and commercial fisheries was not considered to be a problem at this time, as most people felt there were enough fish in the system to support commercial development. What may be an issue is where a commercial fishery is located and who benefits from it. Broad whitefish are a resource which is shared by six communities, and three land claim groups. The relatively small exploratory fishery which operated out of Inuvik from 1989 to 1993 had the support and cooperation of other groups and communities, but an expanded operation in the same or any other location may not, unless opportunities are provided for others to become involved and benefit from such a development.

There is a need for a broad whitefish management plan, developed jointly by all parties. Such a plan should be completed before any further decisions are made regarding the development of commercial fisheries in general, and export commercial fisheries in particular. The status quo (limited management intervention) could continue in the absence of commercial development, although regular biological monitoring of the populations, possibly every two to three years, is necessary in order to keep baseline data up-to-date. This would entail the collection of biological data from cooperating fish harvesters who would be trained to collect the data or who would allow someone to sample their catch. Ideally these cooperating fish harvesters would be from several different locations (Tuktoyaktuk Harbour and/or Kugmallit Bay, East, Middle and West delta channels, Tsiigehtchic, Peel River, and Ft. Good Hope). Covering all locations in one year might be difficult and costly. The number of monitoring locations could be reduced or they could be grouped together and the groups could be monitored on a rotational basis; e.g., group 1 the first year, group 2 the second year, group 3 the third year, back to group 1 the fourth year, and so on. Data that should be collected include: date and location of the catch; mesh size used; length of the fish; round or whole weight; sex; gonad weight; maturity code; and pelvic or pectoral fin rays and otoliths for age determination. Such a program could be coordinated by a fisheries biologist and carried out by local people trained in fisheries sampling techniques.

It would be difficult to determine potential yields on which to base a quota level if commercial fishing was to be expanded beyond the current subsistence/local commercial level given the current scientific and traditional knowledge base. Therefore, if an export commercial fishery was to be developed monitoring efforts would need to be intensified (i.e., both the subsistence and commercial fisheries monitored on an annual basis) and adaptive management strategies are recommended as discussed in section 5.1 above.

The Department of Fisheries and Oceans has adjusted to the new cooperative management system created under the Inuvialuit Final Agreement; few if any recommendations provided to the Minister have been rejected. The Inuvialuit partners interviewed were pleased with the current management situation although some felt that local or traditional knowledge was not being utilized to the extent possible.

5.4 RECOMMENDATIONS

The following recommendations arise from my review of the material presented in the preceding chapters and summarized briefly above.

1) A lower Mackenzie River region broad whitefish management plan is needed to guide research activities and commercial development. Without one, there is the potential for management policies regarding broad whitefish to conflict between land claim groups and communities. Also, scarce resources, both time and money, could be wasted if efforts are not coordinated under a management plan. (Chapter IV).

2) The rights and responsibilities of each land claim group to the broad whitefish resource should be established. This is an essential part of any management plan, particularly now that the previous federal government-based management system has been superseded by co-management under the comprehensive land claim agreements. (Chapter IV).

3) <u>Co-management boards should continue working towards a system that utilizes both science and local or traditional knowledge</u>. Three ways to assist in the incorporation and utilization of TEK are: a) have an elders committee that would be available to act in an advisory capacity on a regular or as needed basis; b) conduct surveys of community members, specifically elders to document their knowledge and provide historical information; and c) provide a means by which current qualitative information and observations related to fish abundance, and behaviour, etc. can be regularly collected to complement the harvest data already required by fisheries managers. (Chapter IV).

4) <u>The existence and/or boundaries of DFO management areas needs to be assessed</u>. The Inuvialuit harvest study collects location information along with harvest numbers. However, the data are reported by community, not by management area. Also, commercial and subsistence harvest data have been collected and/or reported by DFO by community only for 1978 to 1989. People often fish at summer camps that are located quite a distance from their home community. This makes it very difficult to determine subsistence and total broad whitefish harvest levels for DFO fisheries management areas. The fisheries management areas are based somewhat on broad whitefish biology and were established to control commercial fisheries. However, it is almost impossible to base any commercial management decisions for these areas in the absence of total harvest information. Therefore, the DFO and the co-management boards should: a) make a request to the Inuvialuit, Gwich'in and Sahtu harvest coordinators to provide them with data based on management area and water body; or alternatively, b) eliminate the use of the current management areas for the compilation and reporting of harvest data (except for area VI created to specifically manage char), and instead use the land claim boundaries until such time as the commercial fisheries warrant closer regulation. (Chapter III and IV).

5) <u>Subsistence harvest data collection needs to continue in the Inuvialuit and Gwich'in settlement areas at least until the Sahtu have completed their five year Settlement Harvest Study</u>. At that point there would be five consecutive years of broad whitefish harvest data for the entire lower Mackenzie River region that would enable a better approximation of the total broad whitefish harvest. Ideally the harvest surveys should be continued after the five year Settlement Harvest Studies are completed. Fish harvest surveys must be able to provide specific harvest location information because two adjacent rivers or lakes may contain separate stocks that are subject to differing amounts of harvest and may therefore require different approaches to management. The time of the harvest should also be indicated in order to determine when harvesting is most intense. The number of fish caught has been the unit of measure most often used in recent subsistence harvest surveys. This practice could continue as long as an average weight is also determined on a regular basis for each species caught in each area. This would enable better estimates of the amount of fish harvested by weight. (Chapter III and IV).

6) <u>Continue to conduct both pure and applied research in order to provide the information needed to improve management decisions</u>. The primary focus of the co-management boards should be applied research and monitoring activities that can provide information that is immediately useful in addressing management questions. However, these boards also have a need for pure research that may provide insight over the longer term into issues such as stock identification and life history characteristics and therefore should also make research funds available for this purpose. (Chapter II).

7) An "adaptive management strategy" should be implemented before establishing an export commercial fishery in the lower Mackenzie River region. The anadromous broad whitefish population(s) appear to be stable at this time and would likely require little management intervention if the current subsistence/local commercial fisheries remain unchanged. The economic feasibility of an export fishery is doubtful given current market conditions. However, this may not always be the case, and managers should be prepared to respond to fisheries development initiatives. Sufficient data do not yet exist (and may never exist) that will allow conventional fishery population models, based on unit-stock or multi-stock concepts, to predict fishery yields with confidence. An adaptive management approach is therefore recommended, one that would rely on learning-by-doing and using management policy as "experiments", as in the application of the current exploratory fishery concept on an on-going basis. A conservative quota based on information from the previous five-year exploratory fishery could be established and subsequent quotas adjusted up or down after each five-year cycle, depending on how certain key indicator variables responded. Extensive monitoring on an annual basis of, not only the commercial fishery but several other harvest locations within the region, would be required and models could be applied to guide decisions if data become available. (Chapter II and III).

8) Ecologically sensitive areas for broad whitefish should be identified and protected from future developments. For example spawning grounds on the Mackenzie River and its tributaries, nursery areas located on the Tuktoyaktuk Peninsula and outer Delta Islands, and nearshore migratory corridors are all important for the overall health of the broad whitefish resource and its environment. This is one area where local or traditional knowledge can be utilized both in the identification and protection of these areas. (Chapter II).

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APPENDIX A

Biological data collected from the Mackenzie River, Middle Channel, near Horseshoe Bend 1984 to 1989 are listed in Table 1. The variables, their definitions, and any codes used are as follows:

1) OBS1 = observation number for this dataset (n=404);
2) OBS2 = observation number for Dr. J. Reist's larger dataset;
3) SPECIMEN = individual identification number assigned to each fish sampled;
4) YEAR = the year the sample was collected;
5) LOC = the location and/or time of year the sample was collected. In the following cases it applies to the 1984 samples:
   - 5 = Horseshoe Bend, early September
   - 6 = Horseshoe Bend, mid September
   - 7 = Horseshoe Bend, mid October
   - 8 = Horseshoe Bend, November 7 to 11;

   In these cases it corresponds to the other years:
   - 38 = Horseshoe Bend, mid September, 1985
   - 69 = Horseshoe Bend, 20^{th}-26^{th} September, 1986
   - 84 = Horseshoe Bend, fall, 1987
   - 49 = Horseshoe Bend, 1988
   - 36 = Horseshoe Bend, fall, 1989
6) SLOC = the sub-location and/or time of year the sample was collected. In the following cases it applies to the 1988 sample which was collected at three different times:
   - 1 = September 22, 1988
   - 2 = October 5, 1988
   - 3 = October 10, 1988
7) SEX = the sex code for the fish, male=1 and female=2;
8) RDWT = the whole or round weight in grams (g);
9) STL = the standard length in millimetres (mm);
10) FRL = the fork length in millimetres (mm);
11) MAT = sexual maturity codes (see Table 2 in the text);
12) GWT = the gonad weight in grams (g);
13) F_AGE = the pelvic fin-ray age in years;
14) DATE = the date samples were collected;
15) NET = the gillnet type used, C=commercial size 139 mm (5.5") mesh;
16) MESH = the gillnet mesh size in which the fish was caught (139 mm);
17) K_FACTOR = Fulton's condition factor (see methods in text for the formula used);
18) GSI = the gonadosomatic index (see methods in the text for the formula used);
19) . = missing value;

Appendix A1. Biological data for broad whitefish collected from the Mackenzie River, Middle Channel, near Horseshoe Bend, 1984 to 1989.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
1	168	16101	1984	5	1	2	1941	441	488	4	296.0	8	E_Sept	C	5.5	1.67	15.2499
2	138	16102	1984	5	1	1	2137	441	524	8	30.3	17	E_Sept	C	5.5	1.485	1.4179
3	169	16103	1984	5	1	2	2142	481	520	4	251.1	19	E_Sept	C	5.5	1.523	11.7227
4	170	16104	1984	5	1	2	1745	451	492	4	254.0	14	E_Sept	C	5.5	1.465	14.5559
5	139	16105	1984	5	1	1	1761	440	485	8	23.6	11	E_Sept	C	5.5	1.544	1.3401
6	171	16106	1984	5	1	2	1473	427	464	4	203.8	14	E_Sept	C	5.5	1.475	13.8357
7	140	16107	1984	5	1	1	1191	396	436	8	12.2	7	E_Sept	C	5.5	1.437	1.0243
8	141	16108	1984	5	1	1	1417	421	465	6	.	8	E_Sept	C	5.5	1.409	.
9	142	16109	1984	5	1	1	1668	431	475	8	19.2	13	E_Sept	C	5.5	1.556	1.1511
10	256	16122	1984	8	1	1	2008	438	498	8	29.4	16	7-11_Nov	C	5.5	1.626	1.4641
11	257	16123	1984	8	1	1	1596	423	466	10	8.1	8	7-11_Nov	C	5.5	1.577	0.5075
12	258	16124	1984	8	1	1	1533	409	.	6	1.3	9	7-11_Nov	C	5.5	.	0.0848
13	259	16125	1984	8	1	1	1786	443	485	8	25.6	9	7-11_Nov	C	5.5	1.566	1.4334
14	260	16126	1984	8	1	1	1748	442	489	8	20.6	14	7-11_Nov	C	5.5	1.495	1.1785
15	261	16127	1984	8	1	1	1224	403	440	6	1.0	9	7-11_Nov	C	5.5	1.437	0.0817
16	262	16128	1984	8	1	1	2016	446	492	9	26.4	11	7-11_Nov	C	5.5	1.693	1.3095
17	278	16129	1984	8	1	2	2060	447	480	5	31.9	12	7-11_Nov	C	5.5	1.863	1.5485
18	279	16165	1984	8	1	2	.	.	.	5	88.9	10	7-11_Nov	C	5.5	.	4.8315
19	263	16166	1984	8	1	1	1784	473	517	9	39.2	10	7-11_Nov	C	5.5	1.291	2.1973
20	280	16167	1984	8	1	2	.	474	.	5	54.9	15	7-11_Nov	C	5.5	.	2.9002
21	281	16168	1984	8	1	2	.	503	.	5	54.5	13	7-11_Nov	C	5.5	.	2.5587
22	282	16169	1984	8	1	2	.	453	.	5	30.9	11	7-11_Nov	C	5.5	.	1.806
23	283	16170	1984	8	1	2	.	442	.	4	297	10	7-11_Nov	C	5.5	.	18.0547
24	264	16171	1984	8	1	1	.	473	.	9	12.2	18	7-11_Nov	C	5.5	.	0.7683
25	265	16172	1984	8	1	1	.	444	.	9	7.9	9	7-11_Nov	C	5.5	.	0.4725
26	284	16212	1984	8	1	2	2919	495	.	4	897.4	13	7-11_Nov	C	5.5	.	30.7434
27	285	16213	1984	8	1	2	1606	426	.	5	35.6	9	7-11_Nov	C	5.5	.	2.2167
28	266	16214	1984	8	1	2	1748	476	.	5	42.4	15	7-11_Nov	C	5.5	.	2.4256
29	267	16215	1984	8	1	1	1771	.	.	9	15.4	15	7-11_Nov	C	5.5	.	0.8696
30	286	16216	1984	8	1	2	2035	463	497	4	392.9	11	7-11_Nov	C	5.5	1.658	19.3071
31	287	16217	1984	8	1	2	2391	489	515	4	527.2	10	7-11_Nov	C	5.5	1.75	22.0494
32	268	16218	1984	8	1	1	2149	475	517	10	18.8	15	7-11_Nov	C	5.5	1.555	0.8748
33	288	16258	1984	8	1	2	1807	472	515	5	43.3	13	7-11_Nov	C	5.5	1.323	2.3962
34	289	16259	1984	8	1	2	.	.	.	4	678.4	10	7-11_Nov	C	5.5	.	28.7458
35	269	16260	1984	8	1	1	2138	486	.	9	22.2	13	7-11_Nov	C	5.5	.	1.0384
36	290	16261	1984	8	1	2	2369	507	553	5	54.4	10	7-11_Nov	C	5.5	1.401	2.2963
37	291	16262	1984	8	1	2	1897	459	496	5	53.2	7	7-11_Nov	C	5.5	1.555	2.8044
38	270	16263	1984	8	1	1	1414	417	.	7	6.7	7	7-11_Nov	C	5.5	1.95	0.4738

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
39	292	16264	1984	8	1	2	1933	483	527	5	49.2	12	7-11_Nov	C	5.5	1.321	2.5453
40	293	16265	1984	8	1	2	1532	463	.	5	31.5	9	7-11_Nov	C	5.5	.	2.0561
41	294	16304	1984	8	1	2	2044	449	480	2	15.5	9	7-11_Nov	C	5.5	1.848	0.7583
42	271	16305	1984	8	1	1	1778	500	538	7	3.9	12	7-11_Nov	C	5.5	1.142	0.2193
43	295	16306	1984	8	1	2	1649	443	.	5	34.5	14	7-11_Nov	C	5.5	.	2.0922
44	296	16307	1984	8	1	2	1810	467	502	5	38.9	9	7-11_Nov	C	5.5	1.431	2.1492
45	272	16308	1984	8	1	1	1212	385	.	9	22.2	9	7-11_Nov	C	5.5	.	1.8317
46	297	16309	1984	8	1	2	1393	441	474	5	39.8	8	7-11_Nov	C	5.5	1.308	2.8571
47	298	16310	1984	8	1	2	1415	460	.	5	33.3	14	7-11_Nov	C	5.5	.	2.3534
48	273	16311	1984	8	1	1	1533	443	480	9	9.0	9	7-11_Nov	C	5.5	1.386	0.5871
49	274	16353	1984	8	1	1	1729	451	488	9	20.6	.	7-11_Nov	C	5.5	1.488	1.1914
50	299	16354	1984	8	1	2	2527	469	.	4	665.0	11	7-11_Nov	C	5.5	.	26.3158
51	275	16355	1984	8	1	1	1483	438	476	9	20.0	15	7-11_Nov	C	5.5	1.375	1.3486
52	300	16356	1984	8	1	2	1974	463	495	5	50.6	12	7-11_Nov	C	5.5	1.628	2.5633
53	301	16357	1984	8	1	2	1546	461	.	5	40.2	11	7-11_Nov	C	5.5	.	2.6003
54	276	16358	1984	8	1	1	2309	494	.	9	30.8	.	7-11_Nov	C	5.5	.	1.3339
55	302	16359	1984	8	1	2	1635	457	.	5	32.9	12	7-11_Nov	C	5.5	.	2.0122
56	303	16360	1984	8	1	2	1808	467	.	4	121.4	.	7-11_Nov	C	5.5	.	6.7146
57	304	16361	1984	8	1	2	2237	489	.	5	82.7	.	7-11_Nov	C	5.5	.	3.6969
58	305	16397	1984	8	1	2	1599	463	497	5	36.7	18	7-11_Nov	C	5.5	1.303	2.2952
59	277	16398	1984	8	1	1	1523	436	.	9	14.0	8	7-11_Nov	C	5.5	.	0.9192
60	306	16399	1984	8	1	2	1679	475	510	5	54.4	15	7-11_Nov	C	5.5	1.266	3.24
61	172	16587	1984	5	1	2	1714	442	485	4	218.3	.	E_Sept	C	5.5	1.502	12.7363
62	143	16588	1984	5	1	1	1894	479	514	9	26.2	.	E_Sept	C	5.5	1.395	1.3833
63	144	16589	1984	5	1	1	2077	467	516	9	32.1	.	E_Sept	C	5.5	1.512	1.5455
64	145	16590	1984	5	1	1	2000	476	514	9	34.1	.	E_Sept	C	5.5	1.473	1.705
65	173	16591	1984	5	1	2	1863	494	542	4	198.3	.	E_Sept	C	5.5	1.17	10.6441
66	146	16592	1984	5	1	1	1546	457	498	8	26.2	.	E_Sept	C	5.5	1.252	1.6947
67	147	16593	1984	5	1	1	2145	478	520	8	24.9	.	E_Sept	C	5.5	1.526	1.1608
68	174	16594	1984	5	1	2	2216	460	495	4	417.2	.	E_Sept	C	5.5	1.827	18.8267
69	148	16595	1984	5	1	1	2630	502	547	8	37.3	.	E_Sept	C	5.5	1.607	1.4183
70	149	16596	1984	5	1	1	1354	422	461	9	10.8	.	E_Sept	C	5.5	1.382	0.7976
71	175	16597	1984	5	1	2	1684	423	.	4	248.1	.	E_Sept	C	5.5	.	14.7328
72	176	16598	1984	5	1	2	1807	463	510	4	317.4	.	E_Sept	C	5.5	1.362	17.565
73	177	16599	1984	5	1	2	1641	426	467	4	226.5	.	E_Sept	C	5.5	1.611	13.8026
74	150	16600	1984	5	1	1	1396	425	464	8	15.6	13	E_Sept	C	5.5	1.397	1.1175
75	151	16601	1984	5	1	1	1974	469	518	8	23.5	11	E_Sept	C	5.5	1.42	1.1905
76	152	16602	1984	5	1	1	1678	459	501	8	19.1	13	E_Sept	C	5.5	1.334	1.1383

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
77	178	16603	1984	5	1	2	1584	433	476	4	252.2	9	E_Sept	C	5.5	1.469	15.9217
78	153	16604	1984	5	1	1	1838	446	492	8	18.3	12	E_Sept	C	5.5	1.543	0.9956
79	179	16605	1984	5	1	2	2165	467	510	4	341.7	15	E_Sept	C	5.5	1.632	15.7829
80	180	16606	1984	5	1	2	2187	483	527	4	341.7	.	E_Sept	C	5.5	1.494	15.6241
81	181	16607	1984	5	1	2	1937	483	504	4	268.4	.	E_Sept	C	5.5	1.513	13.8565
82	182	16608	1984	5	1	2	2243	495	535	4	389.7	.	E_Sept	C	5.5	1.465	17.3741
83	154	16609	1984	5	1	1	1801	448	487	8	24.3	.	E_Sept	C	5.5	1.559	1.3493
84	155	16610	1984	5	1	1	1713	455	496	8	23.2	.	E_Sept	C	5.5	1.404	1.3543
85	183	16611	1984	5	1	2	2902	511	554	4	449.7	.	E_Sept	C	5.5	1.707	15.4962
86	156	16612	1984	5	1	1	1715	466	512	9	27.7	.	E_Sept	C	5.5	1.278	1.6152
87	184	16613	1984	5	1	2	1551	425	465	4	243.8	.	E_Sept	C	5.5	1.543	15.7189
88	157	16614	1984	5	1	1	1650	442	484	8	24.0	.	E_Sept	C	5.5	1.455	1.4545
89	185	16615	1984	5	1	2	1985	464	508	4	341.8	.	E_Sept	C	5.5	1.514	17.2191
90	158	16616	1984	5	1	1	1938	434	480	8	23.6	.	E_Sept	C	5.5	1.752	1.2178
91	159	16617	1984	5	1	1	1612	468	.	8	23.1	.	E_Sept	C	5.5	.	1.433
92	186	16618	1984	5	1	2	1984	444	491	4	237.5	.	E_Sept	C	5.5	1.676	11.9708
93	187	16619	1984	5	1	2	1446	425	466	4	237.5	.	E_Sept	C	5.5	1.429	16.4246
94	160	16620	1984	5	1	1	2388	515	564	8	38.3	.	E_Sept	C	5.5	1.331	1.6039
95	188	16621	1984	5	1	2	2324	480	529	4	395.7	.	E_Sept	C	5.5	1.57	17.0267
96	189	16622	1984	5	1	2	1702	442	476	4	253.2	.	E_Sept	C	5.5	1.578	14.8766
97	161	16623	1984	5	1	1	1741	443	489	8	28.1	.	E_Sept	C	5.5	1.489	1.614
98	190	16624	1984	5	1	2	1955	457	498	4	298.4	.	E_Sept	C	5.5	1.583	15.2634
99	162	16625	1984	5	1	1	1952	479	520	8	22.2	.	E_Sept	C	5.5	1.388	1.1373
100	191	16626	1984	5	1	2	2093	466	510	4	322.1	.	E_Sept	C	5.5	1.578	15.3894
101	163	16627	1984	5	1	1	1760	444	485	8	14.7	.	E_Sept	C	5.5	1.543	0.8352
102	192	16628	1984	5	1	2	1672	449	.	4	198.2	.	E_Sept	C	5.5	.	11.8541
103	164	16629	1984	5	1	1	1982	467	504	8	28.9	.	E_Sept	C	5.5	1.548	1.4581
104	165	16630	1984	5	1	1	1810	456	507	9	16.0	13	E_Sept	C	5.5	1.389	0.884
105	193	16631	1984	5	1	2	2375	471	512	4	444.8	13	E_Sept	C	5.5	1.77	18.7284
106	194	16632	1984	5	1	2	1761	451	495	4	274.5	15	E_Sept	C	5.5	1.452	15.5877
107	166	16633	1984	5	1	1	1614	433	476	8	22.8	7	E_Sept	C	5.5	1.497	1.4126
108	167	16634	1984	5	1	1	1900	469	517	8	28.3	16	E_Sept	C	5.5	1.375	1.4895
109	213	16635	1984	6	1	2	2981	514	557	4	465	20	M_Sept	C	5.5	1.725	15.5988
110	195	16636	1984	6	1	1	2429	493	538	8	35.2	16	M_Sept	C	5.5	1.56	1.4492
111	214	16637	1984	6	1	2	2150	470	512	4	414.0	13	M_Sept	C	5.5	1.602	19.2558
112	215	16638	1984	6	1	2	1671	436	474	4	140.9	13	M_Sept	C	5.5	1.569	8.4321
113	196	16639	1984	6	1	1	2035	461	510	8	25.8	9	M_Sept	C	5.5	1.534	1.2678
114	216	16640	1984	6	1	2	1714	430	470	4	294.1	14	M_Sept	C	5.5	1.651	17.1587

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
115	197	16641	1984	6	1	1	1706	461	505	9	19.4	8	M_Sept	C	5.5	1.325	1.1372
116	198	16642	1984	6	1	2	2189	487	521	4	335.4	13	M_Sept	C	5.5	1.548	15.3221
117	217	16643	1984	6	1	2	3276	529	573	4	477.1	13	M_Sept	C	5.5	1.741	14.5635
118	199	16644	1984	6	1	1	2493	506	558	8	27.1	15	M_Sept	C	5.5	1.435	1.087
119	200	16645	1984	6	1	1	2161	469	.	8	36.7	14	M_Sept	C	5.5	.	1.6983
120	201	16646	1984	6	1	1	3085	516	568	9	48.6	12	M_Sept	C	5.5	1.683	1.5754
121	202	16647	1984	6	1	1	1725	470	518	8	23.8	12	M_Sept	C	5.5	1.241	1.3797
122	203	16648	1984	6	1	1	2469	494	.	8	32.2	12	M_Sept	C	5.5	.	1.3042
123	218	16649	1984	6	1	2	1877	456	504	4	340.2	13	M_Sept	C	5.5	1.466	18.1247
124	219	16650	1984	6	1	2	1949	485	528	4	200.9	.	M_Sept	C	5.5	1.324	10.3079
125	220	16651	1984	6	1	2	1822	445	483	4	287.8	9	M_Sept	C	5.5	1.617	15.7958
126	221	16652	1984	6	1	2	1706	435	.	4	290.8	13	M_Sept	C	5.5	.	17.0457
127	222	16653	1984	6	1	2	1586	437	.	4	206.7	13	M_Sept	C	5.5	.	13.0328
128	223	16654	1984	6	1	2	1858	448	.	4	331.6	11	M_Sept	C	5.5	.	17.8471
129	204	16655	1984	6	1	1	1594	442	490	8	24.5	13	M_Sept	C	5.5	1.355	1.537
130	224	16656	1984	6	1	2	2510	490	533	4	499.8	13	M_Sept	C	5.5	1.658	19.9124
131	225	16657	1984	6	1	2	1667	425	464	4	214.0	10	M_Sept	C	5.5	1.669	12.8374
132	226	16658	1984	6	1	2	1984	469	515	4	240.5	13	M_Sept	C	5.5	1.453	12.122
133	227	16659	1984	6	1	2	1715	450	492	4	250.0	14	M_Sept	C	5.5	1.44	14.5773
134	205	16660	1984	6	1	1	2243	487	530	9	36.7	8	M_Sept	C	5.5	1.507	1.6362
135	206	16661	1984	6	1	1	1970	467	510	9	25.2	.	M_Sept	C	5.5	1.485	1.2792
136	207	16662	1984	6	1	1	1832	466	508	9	29.2	13	M_Sept	C	5.5	1.397	1.5939
137	228	16663	1984	6	1	2	1475	430	474	4	185.7	9	M_Sept	C	5.5	1.385	12.5898
138	229	16664	1984	6	1	2	1464	416	463	4	254.4	12	M_Sept	C	5.5	1.475	17.377
139	208	16665	1984	6	1	1	1677	456	498	8	22.3	13	M_Sept	C	5.5	1.358	1.3298
140	209	16666	1984	6	1	1	1668	444	500	8	23.8	13	M_Sept	C	5.5	1.334	1.4269
141	210	16667	1984	6	1	1	1655	438	472	8	16.2	7	M_Sept	C	5.5	1.574	0.9789
142	211	16668	1984	6	1	1	2017	454	498	8	32.5	9	M_Sept	C	5.5	1.633	1.6113
143	212	16669	1984	6	1	1	1789	433	480	8	32.8	9	M_Sept	C	5.5	1.618	1.8334
144	230	16670	1984	7	1	1	1589	424	.	8	18.4	9	M_Oct	C	5.5	.	1.158
145	249	16671	1984	7	1	2	1671	431	472	4	333.5	12	M_Oct	C	5.5	1.589	19.9581
146	231	16672	1984	7	1	1	1576	410	456	9	14.4	14	M_Oct	C	5.5	1.662	0.9137
147	232	16673	1984	7	1	1	1962	454	.	8	22.7	8	M_Oct	C	5.5	.	1.157
148	233	16674	1984	7	1	1	1535	429	476	9	11.3	12	M_Oct	C	5.5	1.423	0.7362
149	234	16675	1984	7	1	1	2497	490	541	7	5.3	15	M_Oct	C	5.5	1.577	0.2123
150	235	16676	1984	7	1	1	1604	410	445	8	17.5	14	M_Oct	C	5.5	1.82	1.091
151	236	16677	1984	7	1	1	1778	440	486	8	15.1	10	M_Oct	C	5.5	1.549	0.8493
152	237	16678	1984	7	1	1	1594	428	471	8	14.9	13	M_Oct	C	5.5	1.526	0.9348

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
153	238	16679	1984	7	1	1	1865	438	484	9	17.5	15	M_Oct	C	5.5	1.645	0.9383
154	250	16680	1984	7	1	2	1715	456	.	4	396.4	20	M_Oct	C	5.5	.	23.1137
155	239	16681	1984	7	1	1	2099	464	516	9	18.6	15	M_Oct	C	5.5	1.528	0.8861
156	251	16682	1984	7	1	2	1719	426	468	4	322.2	9	M_Oct	C	5.5	1.677	18.7435
157	240	16683	1984	7	1	1	2025	471	522	9	21.4	12	M_Oct	C	5.5	1.424	1.0568
158	252	16684	1984	7	1	2	1667	410	456	4	392.7	12	M_Oct	C	5.5	1.758	23.5573
159	253	16685	1984	7	1	1	1721	463	.	9	19.4	15	M_Oct	C	5.5	.	1.1273
160	241	16686	1984	7	1	1	1942	464	508	9	16.6	13	M_Oct	C	5.5	1.481	0.8548
161	242	16687	1984	7	1	1	2094	478	522	9	19.4	16	M_Oct	C	5.5	1.472	0.9265
162	254	16688	1984	7	1	2	1815	424	463	4	451.2	15	M_Oct	C	5.5	1.829	24.8595
163	243	16689	1984	7	1	1	2479	487	535	8	29.6	15	M_Oct	C	5.5	1.619	1.194
164	244	16690	1984	7	1	1	2182	472	515	9	21.2	16	M_Oct	C	5.5	1.597	0.9716
165	245	16691	1984	7	1	1	2196	501	542	9	27.5	13	M_Oct	C	5.5	1.379	1.2523
166	246	16692	1984	7	1	1	1695	439	481	9	15.2	12	M_Oct	C	5.5	1.523	0.8968
167	247	16693	1984	7	1	1	1417	421	461	9	12.5	16	M_Oct	C	5.5	1.446	0.8821
168	248	16694	1984	7	1	1	2487	494	543	9	27.3	14	M_Oct	C	5.5	1.553	1.0977
169	255	16695	1984	7	1	2	1633	437	478	4	337.5	11	M_Oct	C	5.5	1.495	20.6675
170	1081	18567	1985	38	1	1	1246	422	468	9	16.0	13	M_Sept	C	5.5	1.216	1.2841
171	1095	18568	1985	38	1	2	1789	435	479	4	267.0	11	M_Sept	C	5.5	1.628	14.9245
172	1096	18569	1985	38	1	2	2067	449	485	3	360.0	17	M_Sept	C	5.5	1.812	17.4165
173	1097	18570	1985	38	1	2	2249	452	491	4	448.0	12	M_Sept	C	5.5	1.9	19.92
174	1082	18571	1985	38	1	1	2709	446	.	9	36.0	7	M_Sept	C	5.5	.	1.3289
175	1098	18572	1985	38	1	2	1788	447	485	4	367.0	12	M_Sept	C	5.5	1.567	20.5257
176	1099	18573	1985	38	1	2	2192	463	511	3	314.0	14	M_Sept	C	5.5	1.643	14.3248
177	1083	18574	1985	38	1	1	2371	460	500	10	26.0	11	M_Sept	C	5.5	1.897	1.0966
178	1100	18575	1985	38	1	2	2032	451	499	4	458.0	15	M_Sept	C	5.5	1.635	22.5394
179	1101	18576	1985	38	1	2	1904	452	498	3	364.0	13	M_Sept	C	5.5	1.542	19.1176
180	1102	18577	1985	38	1	2	1908	433	471	3	308.0	10	M_Sept	C	5.5	1.826	16.1426
181	1084	18578	1985	38	1	1	1999	453	495	10	15.0	11	M_Sept	C	5.5	1.648	0.7504
182	1103	18579	1985	38	1	2	2851	488	538	4	625.0	15	M_Sept	C	5.5	1.831	21.9221
183	1104	18580	1985	38	1	2	1731	426	465	4	276.0	13	M_Sept	C	5.5	1.722	15.9445
184	1085	18700	1985	38	1	1	2011	431	480	9	25.0	10	M_Sept	C	5.5	1.818	1.2432
185	1105	18701	1985	38	1	2	1794	442	490	4	380.0	13	M_Sept	C	5.5	1.525	21.1817
186	1106	18702	1985	38	1	2	1923	460	512	4	306.0	15	M_Sept	C	5.5	1.433	15.9126
187	1086	18703	1985	38	1	1	1569	421	469	9	18.0	13	M_Sept	C	5.5	1.521	1.1472
188	1107	18704	1985	38	1	2	1472	438	485	4	209.0	14	M_Sept	C	5.5	1.29	14.1984
189	1087	18705	1985	38	1	1	1637	454	503	9	16.0	20	M_Sept	C	5.5	1.286	0.9774
190	1108	18706	1985	38	1	2	1898	464	506	4	294.0	13	M_Sept	C	5.5	1.465	15.49

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
191	1088	18707	1985	38	1	1	2005	470	522	9	47.0	13	M_Sept	C	5.5	1.41	2.3441
192	1109	18708	1985	38	1	2	2652	491	538	4	306.0	14	M_Sept	C	5.5	1.703	11.5385
193	1110	18709	1985	38	1	2	1965	442	483	4	356.0	14	M_Sept	C	5.5	1.744	18.117
194	1111	18710	1985	38	1	2	2249	464	505	4	444.0	16	M_Sept	C	5.5	1.746	19.7421
195	1089	18711	1985	38	1	1	1465	411	451	10	14.0	15	M_Sept	C	5.5	1.597	0.9556
196	1090	18712	1985	38	1	1	1799	449	487	9	24.0	9	M_Sept	C	5.5	1.558	1.3341
197	1112	18713	1985	38	1	2	1501	410	463	4	215.0	15	M_Sept	C	5.5	1.512	14.3238
198	1091	18714	1985	38	1	1	1845	439	483	10	21.0	13	M_Sept	C	5.5	1.637	1.1382
199	1092	18715	1985	38	1	1	2553	495	543	10	28.0	13	M_Sept	C	5.5	1.595	1.0967
200	1113	18716	1985	38	1	2	1764	454	502	4	287.0	14	M_Sept	C	5.5	1.394	16.2698
201	1093	18728	1985	38	1	1	1956	439	478	9	22.0	9	M_Sept	C	5.5	1.791	1.1247
202	1094	18729	1985	38	1	1	1368	402	447	10	16.0	16	M_Sept	C	5.5	1.532	1.1696
203	1114	18730	1985	38	1	2	1451	426	471	4	134.0	15	M_Sept	C	5.5	1.389	9.235
204	1115	18731	1985	38	1	2	1931	456	498	4	304.0	16	M_Sept	C	5.5	1.563	15.7431
205	1257	22005	1986	69	1	2	2183	451	488	3	394.8	12	20-26_Sept	C	5.5	1.878	18.0852
206	1228	22006	1986	69	1	1	2387	452	500	8	30.1	14	20-26_Sept	C	5.5	1.91	1.261
207	1258	22007	1986	69	1	2	2008	440	.	3	391.5	10	20-26_Sept	C	5.5	.	19.497
208	1259	22008	1986	69	1	2	1596	441	481	3	291.7	14	20-26_Sept	C	5.5	1.434	18.2769
209	1229	22009	1986	69	1	1	2585	476	515	8	31.1	8	20-26_Sept	C	5.5	1.893	1.2031
210	1260	22010	1986	69	1	2	2222	477	511	3	440.3	10	20-26_Sept	C	5.5	1.665	19.8155
211	1230	22011	1986	69	1	1	1767	431	474	9	18.9	8	20-26_Sept	C	5.5	1.659	1.0696
212	1261	22012	1986	69	1	2	2377	460	497	3	541.7	8	20-26_Sept	C	5.5	1.936	22.7892
213	1231	22013	1986	69	1	1	1686	422	462	8	18.0	10	20-26_Sept	C	5.5	1.71	1.0676
214	1262	22014	1986	69	1	2	2696	474	514	3	512.9	9	20-26_Sept	C	5.5	1.985	19.0245
215	1232	22015	1986	69	1	1	2119	475	517	8	14.0	15	20-26_Sept	C	5.5	1.533	0.6607
216	1263	22016	1986	69	1	2	1525	422	464	1	12.5	8	20-26_Sept	C	5.5	1.527	0.8197
217	1233	22017	1986	69	1	1	1884	445	493	8	18.6	17	20-26_Sept	C	5.5	1.572	0.9873
218	1264	22018	1986	69	1	2	1838	444	483	3	379.9	7	20-26_Sept	C	5.5	1.631	20.6692
219	1234	22020	1986	69	1	1	1744	449	497	9	16.1	13	20-26_Sept	C	5.5	1.421	0.9232
220	1265	22021	1986	69	1	2	1287	382	421	4	273.4	11	20-26_Sept	C	5.5	1.725	21.2432
221	1235	22022	1986	69	1	1	2330	475	517	8	22.1	12	20-26_Sept	C	5.5	1.686	0.9485
222	1266	22023	1986	69	1	2	1593	446	486	3	258.7	13	20-26_Sept	C	5.5	1.388	16.2398
223	1236	22024	1986	69	1	1	2047	474	512	8	16.2	13	20-26_Sept	C	5.5	1.525	0.7914
224	1267	22025	1986	69	1	2	1861	454	493	3	375.7	16	20-26_Sept	C	5.5	1.553	20.1881
225	1268	22026	1986	69	1	2	2151	472	512	4	471.7	17	20-26_Sept	C	5.5	1.603	21.9293
226	1237	22027	1986	69	1	1	2140	465	513	9	20.1	15	20-26_Sept	C	5.5	1.585	0.9393
227	1238	22028	1986	69	1	1	1673	439	478	9	22.7	13	20-26_Sept	C	5.5	1.532	1.3568
228	1269	22029	1986	69	1	2	1471	440	480	1	20.4	14	20-26_Sept	C	5.5	1.33	1.3868

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
229	1239	22030	1986	69	1	1	2161	459	500	8	19.8	13	20-26_Sept	C	5.5	1.729	0.9162
230	1240	22031	1986	69	1	1	2248	462	507	8	25.8	10	20-26_Sept	C	5.5	1.725	1.1477
231	1241	22032	1986	69	1	1	1827	454	.	8	10.9	15	20-26_Sept	C	5.5	.	0.5966
232	1242	22033	1986	69	1	1	1630	453	483	8	14.2	12	20-26_Sept	C	5.5	1.447	0.8712
233	1243	22034	1986	69	1	1	1477	423	460	8	20.1	8	20-26_Sept	C	5.5	1.517	1.3609
234	1244	22035	1986	69	1	1	1710	432	.	8	20.3	9	20-26_Sept	C	5.5	.	1.1871
235	1270	22036	1986	69	1	2	1921	437	473	3	440.8	10	20-26_Sept	C	5.5	1.815	22.9464
236	1245	22037	1986	69	1	1	1493	426	469	8	16.5	15	20-26_Sept	C	5.5	1.447	1.1052
237	1246	22038	1986	69	1	1	1739	435	475	8	19.5	12	20-26_Sept	C	5.5	1.623	1.1213
238	1247	22039	1986	69	1	1	1552	408	455	8	12.1	15	20-26_Sept	C	5.5	1.648	0.7796
239	1271	22040	1986	69	1	2	1501	428	468	3	294.0	9	20-26_Sept	C	5.5	1.464	19.5869
240	1248	22041	1986	69	1	1	2523	500	542	9	48.3	13	20-26_Sept	C	5.5	1.585	1.9144
241	1249	22042	1986	69	1	1	2142	458	506	8	21.4	8	20-26_Sept	C	5.5	1.653	0.9991
242	1272	22043	1986	69	1	2	1519	432	467	3	338.2	18	20-26_Sept	C	5.5	1.491	22.2646
243	1250	22044	1986	69	1	1	1674	439	475	8	17.6	10	20-26_Sept	C	5.5	1.562	1.0514
244	1251	22045	1986	69	1	1	2511	487	527	8	21.6	18	20-26_Sept	C	5.5	1.716	0.8602
245	1273	22046	1986	69	1	2	2097	465	505	3	469.0	17	20-26_Sept	C	5.5	1.628	22.3653
246	1274	22047	1986	69	1	2	2288	466	510	3	407.7	15	20-26_Sept	C	5.5	1.725	17.8191
247	1252	22048	1986	69	1	1	1686	427	470	8	19.3	8	20-26_Sept	C	5.5	1.624	1.1447
248	1275	22049	1986	69	1	2	2296	468	506	3	410.5	8	20-26_Sept	C	5.5	1.772	17.8789
249	1253	22050	1986	69	1	1	1766	448	493	8	17.9	13	20-26_Sept	C	5.5	1.474	1.0136
250	1254	22051	1986	69	1	1	2007	487	532	8	14.5	20	20-26_Sept	C	5.5	1.333	0.7225
251	1276	22052	1986	69	1	2	1950	454	499	3	341.3	20	20-26_Sept	C	5.5	1.569	17.5026
252	1277	22053	1986	69	1	2	1997	444	484	3	331.5	10	20-26_Sept	C	5.5	1.761	16.5999
253	1255	22054	1986	69	1	1	1784	460	504	9	17.7	11	20-26_Sept	C	5.5	1.393	0.9922
254	1256	22055	1986	69	1	1	1821	436	478	9	13.8	10	20-26_Sept	C	5.5	1.667	0.7578
255	1306	25267	1987	84	1	2	1751	461	.	5	40.8	11	Sept	C	5.5	.	2.3301
256	1307	25268	1987	84	1	2	1138	432	.	5	37.6	12	Sept	C	5.5	.	3.304
257	1308	25269	1987	84	1	2	1419	450	490	5	31.2	.	Sept	C	5.5	1.206	2.1987
258	1309	25270	1987	84	1	2	1449	425	462	5	31.2	9	Sept	C	5.5	1.469	2.1532
259	1310	25271	1987	84	1	2	1964	462	.	5	49.5	15	Sept	C	5.5	.	2.5204
260	1300	25272	1987	84	1	1	2050	463	512	9	34.1	11	Sept	C	5.5	1.527	1.6634
261	1311	25273	1987	84	1	2	1748	483	525	5	32.9	12	Sept	C	5.5	1.208	1.8822
262	1312	25274	1987	84	1	2	1372	428	465	5	42.9	9	Sept	C	5.5	1.365	3.1268
263	1313	25275	1987	84	1	2	1934	480	526	5	34.0	12	Sept	C	5.5	1.329	1.758
264	1314	25276	1987	84	1	2	1496	440	.	5	43.0	12	Sept	C	5.5	.	2.8743
265	1315	25277	1987	84	1	2	1521	450	.	5	29.0	7	Sept	C	5.5	.	1.9066
266	1316	25278	1987	84	1	2	1990	466	513	5	41.0	11	Sept	C	5.5	1.474	2.0603

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
267	1317	25279	1987	84	1	2	1787	477	517	5	40.0	9	Sept	C	5.5	1.293	2.2384
268	1318	25280	1987	84	1	2	1465	428	465	5	28.2	9	Sept	C	5.5	1.457	1.9249
269	1319	25281	1987	84	1	2	2325	467	506	4	601.0	12	Sept	C	5.5	1.795	25.8495
270	1301	25282	1987	84	1	1	1581	466	498	9	16.6	18	Sept	C	5.5	1.28	1.05
271	1320	25283	1987	84	1	2	1405	433	472	5	32.8	9	Sept	C	5.5	1.336	2.3345
272	1321	25284	1987	84	1	2	1318	415	.	1	10.2	9	Sept	C	5.5	.	0.7739
273	1322	25285	1987	84	1	2	1687	458	495	5	44.4	15	Sept	C	5.5	1.391	2.6319
274	1323	25286	1987	84	1	2	1803	490	.	5	51.9	17	Sept	C	5.5	.	2.8785
275	1324	25287	1987	84	1	2	2202	493	540	5	51.0	13	Sept	C	5.5	1.398	2.3161
276	1325	25288	1987	84	1	2	1864	477	519	5	43.3	17	Sept	C	5.5	1.333	2.323
277	1326	25289	1987	84	1	2	1643	463	504	5	48.4	12	Sept	C	5.5	1.283	2.9458
278	1327	25290	1987	84	1	2	2158	499	548	5	49.0	18	Sept	C	5.5	1.311	2.2706
279	1328	25291	1987	84	1	2	2014	472	513	5	45.5	9	Sept	C	5.5	1.492	2.2592
280	1329	25292	1987	84	1	2	2207	530	574	5	72.4	16	Sept	C	5.5	1.167	3.2805
281	1330	25293	1987	84	1	2	1336	431	.	5	31.6	12	Sept	C	5.5	.	2.3653
282	1331	25294	1987	84	1	2	2041	492	534	5	57.0	20	Sept	C	5.5	1.34	2.7927
283	1332	25295	1987	84	1	2	1675	473	510	5	42.3	10	Sept	C	5.5	1.263	2.5254
284	1333	25296	1987	84	1	2	1325	436	477	5	34.3	11	Sept	C	5.5	1.221	2.5887
285	1334	25297	1987	84	1	2	1710	456	500	5	37.4	10	Sept	C	5.5	1.368	2.1871
286	1335	25298	1987	84	1	2	1332	447	.	5	27.9	17	Sept	C	5.5	.	2.0946
287	1336	25299	1987	84	1	2	1712	462	506	5	46.2	12	Sept	C	5.5	1.321	2.6986
288	1337	25300	1987	84	1	2	1071	401	.	5	17.8	11	Sept	C	5.5	.	1.662
289	1302	25301	1987	84	1	1	1307	424	460	10	5.6	18	Sept	C	5.5	1.343	0.4285
290	1338	25302	1987	84	1	2	1665	450	496	5	37.6	12	Sept	C	5.5	1.364	2.2583
291	1339	25303	1987	84	1	2	1595	447	490	5	35.7	12	Sept	C	5.5	1.356	2.2382
292	1340	25304	1987	84	1	2	1757	472	.	5	40.1	10	Sept	C	5.5	.	2.2823
293	1341	25305	1987	84	1	2	1698	475	513	5	34.4	17	Sept	C	5.5	1.258	2.0259
294	1342	25306	1987	84	1	2	1774	463	.	5	40.6	13	Sept	C	5.5	.	2.2886
295	1343	25307	1987	84	1	2	1713	468	502	5	38.5	12	Sept	C	5.5	1.354	2.2475
296	1344	25308	1987	84	1	2	1479	465	.	5	34.7	9	Sept	C	5.5	.	2.3462
297	1345	25309	1987	84	1	2	1719	476	521	5	42.1	10	Sept	C	5.5	1.216	2.4491
298	1303	25310	1987	84	1	1	2154	455	490	10	14.9	12	Sept	C	5.5	1.831	0.6917
299	1346	25311	1987	84	1	2	1703	462	500	5	45.4	11	Sept	C	5.5	1.362	2.6659
300	1304	25312	1987	84	1	1	2207	500	.	10	11.0	12	Sept	C	5.5	.	0.4984
301	1347	25313	1987	84	1	2	1706	476	509	5	38.2	14	Sept	C	5.5	1.294	2.2392
302	1348	25314	1987	84	1	2	1227	421	.	4	140.7	10	Sept	C	5.5	.	11.467
303	1349	25315	1987	84	1	2	2090	502	543	5	55.8	11	Sept	C	5.5	1.305	2.6699
304	1305	25316	1987	84	1	1	1833	461	510	10	9.4	9	Sept	C	5.5	1.382	0.5128

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
305	1449	26913	1988	49	1	1	1453	432	472	8	12.7	17	22_Sept	C	5.5	1.382	0.8741
306	1450	26914	1988	49	1	1	2314	474	526	9	30.0	18	22_Sept	C	5.5	1.59	1.2965
307	1451	26915	1988	49	1	1	2067	472	517	8	23.4	19	22_Sept	C	5.5	1.496	1.1321
308	1452	26916	1988	49	1	1	2182	475	519	9	26.4	12	22_Sept	C	5.5	1.561	1.2099
309	1453	26917	1988	49	1	1	1323	419	457	8	12.3	18	22_Sept	C	5.5	1.386	0.9297
310	1454	26918	1988	49	1	1	2035	448	493	8	18.8	13	22_Sept	C	5.5	1.698	0.9238
311	1455	26919	1988	49	1	1	1454	401	430	8	21.8	9	22_Sept	C	5.5	1.829	1.4993
312	1468	26920	1988	49	1	2	1695	410	443	3	292.3	10	22_Sept	C	5.5	1.95	17.2448
313	1469	26921	1988	49	1	2	1810	433	466	3	311.3	15	22_Sept	C	5.5	1.789	17.1989
314	1470	26922	1988	49	1	2	1534	432	455	3	230.8	10	22_Sept	C	5.5	1.629	15.0456
315	1471	26923	1988	49	1	2	2042	459	499	3	373.8	13	22_Sept	C	5.5	1.643	18.3056
316	1456	26924	1988	49	1	1	1915	432	466	7	20.5	6	22_Sept	C	5.5	1.892	1.0705
317	1457	26925	1988	49	1	1	2594	495	540	8	26.5	13	22_Sept	C	5.5	1.647	1.0216
318	1472	26926	1988	49	1	2	2310	475	510	3	367.8	12	22_Sept	C	5.5	1.741	15.9221
319	1458	26927	1988	49	1	1	2126	428	473	8	27.6	9	22_Sept	C	5.5	2.009	1.2982
320	1473	26928	1988	49	1	2	2335	436	472	3	569.9	11	22_Sept	C	5.5	2.221	24.4069
321	1459	26929	1988	49	1	1	2120	471	528	8	19.3	11	22_Sept	C	5.5	1.44	0.9104
322	1460	26930	1988	49	1	1	1998	461	500	8	18.8	9	22_Sept	C	5.5	1.598	0.9409
323	1461	26931	1988	49	1	1	2283	462	509	7	20.3	12	22_Sept	C	5.5	1.731	0.8892
324	1462	26932	1988	49	1	1	2069	457	495	7	23.1	12	22_Sept	C	5.5	1.706	1.1165
325	1463	26933	1988	49	1	1	1341	398	438	7	17.1	5	22_Sept	C	5.5	1.596	1.2752
326	1474	26934	1988	49	1	2	1792	419	455	3	353.7	10	22_Sept	C	5.5	1.902	19.7377
327	1464	26935	1988	49	1	1	1668	430	.	8	17.6	9	22_Sept	C	5.5	.	1.0552
328	1479	26936	1988	49	2	1	1953	435	480	8	24.2	10	5_Oct	C	5.5	1.766	1.2391
329	1485	26937	1988	49	2	2	1103	380	418	3	198.4	9	5_Oct	C	5.5	1.51	17.9873
330	1480	26938	1988	49	2	1	1574	435	475	8	14.7	17	5_Oct	C	5.5	1.469	0.9339
331	1481	26939	1988	49	2	1	2182	465	511	8	33.8	13	5_Oct	C	5.5	1.635	1.549
332	1482	26940	1988	49	2	1	2146	450	497	8	20.6	12	5_Oct	C	5.5	1.748	0.9599
333	1483	26941	1988	49	2	1	1250	442	485	8	17.6	6	5_Oct	C	5.5	1.096	1.408
334	1486	26942	1988	49	2	2	2030	400	440	3	368.4	15	5_Oct	C	5.5	2.383	18.1478
335	1484	26943	1988	49	2	1	1651	424	471	8	21.3	8	5_Oct	C	5.5	1.58	1.2901
336	1487	26944	1988	49	2	2	1908	437	479	3	433.4	9	5_Oct	C	5.5	1.736	22.7149
337	1488	26945	1988	49	2	2	1644	462	503	3	202.6	20	5_Oct	C	5.5	1.292	12.3236
338	1489	26946	1988	49	3	1	2009	465	501	7	21.5	14	10_Oct	C	5.5	1.598	1.0702
339	1490	26947	1988	49	3	1	2184	445	490	7	19.7	11	10_Oct	C	5.5	1.856	0.902
340	1491	26948	1988	49	3	1	1997	450	490	8	19.8	10	10_Oct	C	5.5	1.697	0.9915
341	1492	26949	1988	49	3	1	2226	473	525	8	23.5	9	10_Oct	C	5.5	1.538	1.0557
342	1495	26950	1988	49	3	2	1845	467	505	3	288.2	15	10_Oct	C	5.5	1.433	15.6206

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
343	1493	26951	1988	49	3	1	1627	432	480	9	20.2	10	10_Oct	C	5.5	1.471	1.2415
344	1496	26952	1988	49	3	2	1847	432	.	3	432.0	11	10_Oct	C	5.5	.	23.3893
345	1497	26953	1988	49	3	2	2245	484	528	3	494.4	14	10_Oct	C	5.5	1.525	22.0223
346	1498	26954	1988	49	3	2	1999	452	487	3	466.7	9	10_Oct	C	5.5	1.731	23.3467
347	1494	26955	1988	49	3	1	1407	408	445	9	18.0	14	10_Oct	C	5.5	1.597	1.2793
348	1475	26956	1988	49	1	2	1618	407	439	3	337.6	10	22_Sept	C	5.5	1.912	20.8653
349	1465	26957	1988	49	1	1	1902	458	495	8	19.2	17	22_Sept	C	5.5	1.568	1.0095
350	1476	26958	1988	49	1	2	1805	428	455	3	364.7	8	22_Sept	C	5.5	1.916	20.205
351	1466	26959	1988	49	1	1	2303	448	495	8	26.5	12	22_Sept	C	5.5	1.899	1.1507
352	1477	26960	1988	49	1	2	1518	431	464	3	270.2	18	22_Sept	C	5.5	1.52	17.7997
353	1467	26961	1988	49	1	1	1995	434	471	8	18.2	12	22_Sept	C	5.5	1.909	0.9123
354	1478	26962	1988	49	1	2	2028	450	481	3	427.6	8	22_Sept	C	5.5	1.822	21.0848
355	1507	28761	1989	36	1	1	2494	510	550	8	34.4	14	Sept	.	.	1.499	1.3793
356	1538	28762	1989	36	1	2	2164	455	490	3	339.3	7	Sept	.	.	1.839	15.6793
357	1508	28763	1989	36	1	1	1874	460	495	8	19.7	10	Sept	.	.	1.545	1.0512
358	1539	28764	1989	36	1	2	1878	445	480	3	359.1	14	Sept	.	.	1.698	19.1214
359	1509	28765	1989	36	1	1	1952	472	500	9	17.4	10	Sept	.	.	1.562	0.8914
360	1510	28766	1989	36	1	1	1889	457	488	8	21.1	14	Sept	.	.	1.625	1.117
361	1511	28767	1989	36	1	1	2277	465	507	9	40.2	11	Sept	.	.	1.747	1.7655
362	1540	28768	1989	36	1	2	1637	443	470	4	311.5	7	Sept	.	.	1.577	19.0287
363	1512	28769	1989	36	1	1	1425	405	442	9	17.8	12	Sept	.	.	1.65	1.2491
364	1541	28770	1989	36	1	2	1833	435	470	4	393.1	8	Sept	.	.	1.766	21.4457
365	1513	28771	1989	36	1	1	1868	422	466	9	30.0	8	Sept	.	.	1.846	1.606
366	1514	28772	1989	36	1	1	1872	448	489	9	16.6	14	Sept	.	.	1.601	0.8868
367	1515	28773	1989	36	1	1	2020	445	490	9	26.3	11	Sept	.	.	1.717	1.302
368	1542	28774	1989	36	1	2	1799	411	445	4	368.2	10	Sept	.	.	2.042	20.4669
369	1516	28775	1989	36	1	1	1913	438	478	9	31.9	10	Sept	.	.	1.752	1.6675
370	1543	28776	1989	36	1	2	1770	419	456	4	397.5	11	Sept	.	.	1.867	22.4576
371	1517	28777	1989	36	1	1	2039	451	485	9	27.8	8	Sept	.	.	1.787	1.3634
372	1544	28778	1989	36	1	2	2399	472	510	4	457.3	13	Sept	.	.	1.809	19.0621
373	1545	28779	1989	36	1	2	2311	466	510	4	592.0	12	Sept	.	.	1.742	25.6166
374	1546	28780	1989	36	1	2	2203	448	487	4	395.7	13	Sept	.	.	1.907	17.9619
375	1518	28781	1989	36	1	1	1664	412	455	8	22.3	10	Sept	.	.	1.767	1.3401
376	1547	28782	1989	36	1	2	2671	462	501	4	449.6	13	Sept	.	.	2.124	16.8326
377	1519	28783	1989	36	1	1	1841	439	470	8	22.5	11	Sept	.	.	1.773	1.2222
378	1548	28784	1989	36	1	2	1797	431	468	4	247.4	11	Sept	.	.	1.753	13.7674
379	1520	28785	1989	36	1	1	1926	430	469	9	26.4	10	Sept	.	.	1.867	1.3707
380	1521	28786	1989	36	1	1	2038	469	512	9	16.1	14	Sept	.	.	1.518	0.79

Appendix A1. Continued.

OBS 1	OBS 2	SPECIMEN	YEAR	LOC	SLOC	SEX	RDWT	STL	FRL	MAT	GWT	F_AGE	DATE	NET	MESH	K_FACTOR	GSI
381	1549	28787	1989	36	1	2	2144	465	502	3	527.3	13	Sept	.	.	1.695	24.5942
382	1550	28787	1989	36	1	2	1989	440	478	3	403.9	9	Sept	.	.	1.821	20.3067
383	1551	28789	1989	36	1	2	1931	444	483	3	313.1	13	Sept	.	.	1.714	16.2144
384	1522	28790	1989	36	1	1	1995	470	517	9	22.8	17	Sept	.	.	1.444	1.1429
385	1523	28791	1989	36	1	1	2047	457	500	9	23.7	12	Sept	.	.	1.638	1.1578
386	1552	28792	1989	36	1	2	1741	412	449	3	263.2	13	Sept	.	.	1.923	15.1177
387	1553	28793	1989	36	1	2	2225	444	490	3	499.9	12	Sept	.	.	1.891	22.4674
388	1554	28794	1989	36	1	2	1814	444	480	3	321.2	13	Sept	.	.	1.64	17.7067
389	1555	28795	1989	36	1	2	2274	460	490	3	452.7	11	Sept	.	.	1.933	19.9077
390	1524	28796	1989	36	1	1	2435	470	510	8	30.8	12	Sept	.	.	1.836	1.2649
391	1525	28797	1989	36	1	1	1937	455	480	8	17.3	9	Sept	.	.	1.751	0.8931
392	1526	28798	1989	36	1	1	1724	450	480	8	17.3	9	Sept	.	.	1.559	1.0035
393	1527	28799	1989	36	1	1	2091	470	490	8	28.1	11	Sept	.	.	1.777	1.3439
394	1528	28800	1989	36	1	1	2020	465	505	8	38.5	14	Sept	.	.	1.568	1.9059
395	1529	28801	1989	36	1	1	1926	470	500	8	31.1	11	Sept	.	.	1.541	1.6147
396	1530	28802	1989	36	1	1	1938	465	505	9	27.2	16	Sept	.	.	1.505	1.4035
397	1531	28803	1989	36	1	1	1685	445	480	9	26.0	9	Sept	.	.	1.524	1.543
398	1532	28804	1989	36	1	1	1674	405	450	9	33.3	10	Sept	.	.	1.837	1.9892
399	1533	28805	1989	36	1	1	1723	450	480	9	18.7	10	Sept	.	.	1.558	1.0853
400	1534	28806	1989	36	1	1	1912	455	490	8	25.5	13	Sept	.	.	1.625	1.3337
401	1535	28807	1989	36	1	1	1964	460	505	8	18.1	9	Sept	.	.	1.525	0.9216
402	1536	28808	1989	36	1	1	1423	420	455	8	15.4	9	Sept	.	.	1.511	1.0822
403	1537	28809	1989	36	1	1	2316	480	515	9	31.3	11	Sept	.	.	1.696	1.3515
404	1556	28810	1989	36	1	2	1692	435	475	3	288.7	.	Sept	.	.	1.579	17.0626

APPENDIX B

Biological data for individual samples of broad whitefish collected from the Mackenzie River, Middle Channel near Horseshoe Bend, 1984 to 1989, by age (Tables B1 to B9) and length class (Tables B11 to B19). The abbreviations in all tables are N=the number of samples, STD=standard deviation, K=Fulton's condition factor, MAT=mature, and YR=year.

Appendix B1. Biological data by age class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, 1984 temporal series.

YEAR=1984 LOC=5 (early September)

AGE	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	2	456	26	1403	299	1.47	100	.	.	.	.	.	.	.	2	456	28	1403	299	1.47	100
8	1	465	.	1417	.	1.41	0	1	488	.	1941	.	1.67	100	2	477	16	1679	371	1.54	50
9	.	.	.	.	.	.	.	1	476	.	1584	.	1.47	100	1	476	.	1584	.	1.47	100
11	2	502	23	1868	151	1.48	100	.	.	.	.	.	.	.	2	502	23	1868	151	1.48	100
12	1	492	.	1838	.	1.54	100	.	.	.	.	.	.	.	1	492	.	1838	.	1.54	100
13	4	487	21	1638	174	1.42	100	1	512	.	2375	.	1.77	100	5	492	21	1785	362	1.49	100
14	.	.	.	.	.	.	.	2	478	20	1609	192	1.47	100	2	478	20	1609	192	1.47	100
15	.	.	.	.	.	.	.	2	503	11	1963	286	1.54	100	2	503	11	1963	286	1.54	100
16	1	517	.	1900	.	1.38	100	.	.	.	.	.	.	.	1	517	.	1900	.	1.38	100
17	1	524	.	2137	.	1.49	100	.	.	.	.	.	.	.	1	524	.	2137	.	1.49	100
19	.	.	.	.	.	.	.	1	520	.	2142	.	1.52	100	1	520	.	2142	.	1.52	100
TOTAL	12							8							20						
MEAN		488	26	1699	267	1.45			495	19	1898	312	1.56			491	23	1779	295	1.49	
AGE N	12							8							20						
MEAN	11.8							13.4							12.4						
STD	3.2							3.5							3.3						

YEAR=1984 LOC=6 (mid September)

AGE	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	1	472	.	1655	.	1.57	100	.	.	.	.	.	.	.	1	472	.	1655	.	1.57	100
8	2	518	18	1975	380	1.42	100	.	.	.	.	.	.	.	2	518	18	1975	380	1.42	100
9	3	496	15	1947	137	1.60	100	2	479	6	1649	245	1.50	100	5	489	15	1828	226	1.56	100
10	.	.	.	.	.	.	.	1	464	.	1667	.	1.67	100	1	464	.	1667	.	1.67	100
11	.	.	.	.	.	.	.	.	.	.	1858	.	.	100	.	.	.	1858	.	.	100
12	2	543	35	2426	681	1.46	100	1	463	.	1464	.	1.48	100	3	516	53	2186	735	1.47	100
13	4	499	7	1693	100	1.36	100	7	519	30	2105	528	1.58	100	11	512	26	1978	477	1.50	100
14	.	.	.	2161	.	.	100	2	481	16	1715	1	1.55	100	2	481	16	1863	258	1.55	100
15	1	558	.	2493	.	1.44	100	.	.	.	.	.	.	.	1	558	.	2493	.	1.44	100
16	1	538	.	2429	.	1.56	100	.	.	.	.	.	.	.	1	538	.	2429	.	1.56	100
20	.	.	.	.	.	.	.	1	557	.	2981	.	1.73	100	1	557	.	2981	.	1.73	100
TOTAL	14							14							28						
MEAN		512	28	2036	418	1.47			503	35	1979	511	1.57			507	31	2007	462	1.52	
AGE N	16							17							33						
MEAN	11.4							12.7							12.1						
STD	2.7							2.4							2.6						

Appendix B1. Con't.

YEAR=1984 LOC=7 (mid October)

AGE	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
8	.	.	.	1962	.	.	100	.	.	.	.	.	.	.	.	.	.	1962	.	.	100
9	.	.	.	1589	.	.	100	1	468	.	1719	.	1.68	100	1	468	.	1654	92	1.68	100
10	1	486	.	1778	.	1.55	100	.	.	.	.	.	.	.	1	486	.	1778	.	1.55	100
11	.	.	.	.	.	.	.	1	478	.	1633	.	1.50	100	1	478	.	1633	.	1.50	100
12	3	493	25	1752	250	1.46	100	2	464	11	1669	3	1.67	100	5	481	25	1719	182	1.54	100
13	3	507	36	1911	302	1.46	100	.	.	.	.	.	.	.	3	507	36	1911	302	1.46	100
14	3	481	54	1889	518	1.68	100	.	.	.	.	.	.	.	3	481	54	1889	518	1.68	100
15	4	519	26	2132	352	1.59	100	1	463	.	1815	.	1.83	100	5	508	33	2079	340	1.64	100
16	3	499	33	1898	419	1.51	100	.	.	.	.	.	.	.	3	499	33	1898	419	1.51	100
20	.	.	.	.	.	.	.	.	.	.	1715	.	.	100	.	.	.	1715	.	.	100
TOTAL	17							5							22						
MEAN		500	32	1917	335	1.54			467	8	1703	64	1.67			493	32	1868	308	1.57	
AGE N	20							6							26						
MEAN	13.4							13.2							13.3						
STD	2.3							3.9							2.7						

YEAR=1984 LOC=8 (November 7 to 11)

AGE	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	.	.	.	1414	.	1.95	100	1	496	.	1897	.	1.56	100	1	496	.	1656	342	1.75	100
8	1	466	.	1560	52	1.58	100	1	474	.	1393	.	1.31	100	2	470	6	1504	103	1.44	100
9	3	468	25	1458	242	1.46	67	2	491	16	1748	230	1.64	100	5	477	23	1587	269	1.53	80
10	1	517	.	1784	.	1.29	100	2	534	27	2380	16	1.58	100	3	528	21	2181	344	1.48	100
11	1	492	.	2016	.	1.69	100	1	497	.	2036	491	1.66	100	2	495	4	2031	401	1.68	100
12	1	538	.	1778	.	1.14	100	3	501	24	1901	185	1.60	100	4	510	27	1876	169	1.49	100
13	.	.	.	2138	.	.	100	1	515	.	2363	786	1.32	100	1	515	.	2288	571	1.32	100
14	1	489	.	1748	.	1.50	100	.	.	.	1532	165	.	100	1	489	.	1604	171	1.50	100
15	2	497	29	1801	334	1.47	100	1	510	.	1714	49	1.27	100	3	501	22	1766	242	1.40	100
16	1	498	.	2008	.	1.63	100	.	.	.	.	.	.	.	1	498	.	2008	.	1.63	100
18	.	.	.	.	.	.	100	1	497	.	1599	.	1.30	100	1	497	.	1599	.	1.30	100
TOTAL	11							13							24						
MEAN		491	27	1688	286	1.51			503	21	1889	385	1.51			497	24	1802	356	1.51	
AGE N	19							28							47						
MEAN	11.4							11.5							11.5						
STD	3.3							2.5							2.8						

Appendix B2. Biological data by age class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, the 1984 September samples combined.

YEAR=1984 LOC=5 AND 6

MALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	3	461	22	1487	257	1.50	100
8	3	500	33	1789	419	1.41	67
9	3	496	15	1947	127	1.60	100
10	.	.	.	.	.	.	.
11	2	502	23	1868	151	1.48	100
12	3	526	39	2279	629	1.49	100
13	8	493	16	1665	135	1.39	100
14	.	.	.	2161	.	.	100
15	1	558	.	2493	.	1.44	100
16	2	528	15	2165	374	1.47	100
17	1	524	.	2137	.	1.49	100
19	.	.	.	.	.	.	.
20	.	.	.	.	.	.	.
TOTAL	26						
MEAN		501	29	1892	394	1.46	
AGE N	28						
MEAN	11.6						
STD	2.9						

FEMALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	.	.	.	.	.	.	.
8	1	488	.	1941	.	1.67	100
9	3	478	5	1627	177	1.49	100
10	1	464	.	1667	.	1.67	100
11	.	.	.	1858	.	.	100
12	1	463	.	1464	.	1.48	100
13	8	518	28	2132	505	1.60	100
14	4	480	15	1662	127	1.51	100
15	2	503	11	1963	286	1.54	100
16	.	.	.	.	.	.	.
17	.	.	.	.	.	.	.
19	1	520	.	2142	.	1.52	100
20	1	557	.	2981	.	1.73	100
TOTAL	22						
MEAN		500	30	1953	451	1.57	
AGE N	25						
MEAN	12.9						
STD	2.8						

COMBINED

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	3	461	22	1487	257	1.50	100
8	4	497	27	1827	351	1.48	75
9	6	487	14	1787	225	1.54	100
10	1	464	.	1667	.	1.67	100
11	2	502	23	1864	107	1.48	100
12	4	510	45	2116	656	1.49	100
13	16	505	25	1925	447	1.50	100
14	4	480	15	1762	249	1.51	100
15	3	521	33	2140	367	1.51	100
16	2	528	15	2165	374	1.47	100
17	1	524	.	2137	.	1.49	100
19	1	520	.	2142	.	1.52	100
20	1	557	.	2981	.	1.73	100
TOTAL	48						
MEAN		501	29	1921	419	1.51	
AGE N	53						
MEAN	12.2						
STD	2.9						

Appendix B3. Biological data by age class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, 1984 to 1989.

YEAR=1984 (all samples)

AGE	MALES							FEMALES							COMBINED						
	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	3	461	22	1469	213	1.61	100	1	496	.	1897	.	1.56	100	4	470	25	1554	266	1.60	100
8	4	492	32	1741	308	1.45	83	2	481	10	1667	387	1.49	100	6	488	26	1723	301	1.47	88
9	6	482	24	1635	301	1.53	80	6	481	12	1699	188	1.57	100	12	481	18	1665	248	1.55	89
10	2	502	22	1781	4	1.42	100	3	511	45	2142	412	1.61	100	5	507	34	1998	352	1.53	100
11	3	498	17	1917	137	1.55	100	2	488	13	1920	390	1.58	100	5	494	15	1919	304	1.56	100
12	7	514	33	2019	515	1.43	100	6	482	26	1772	218	1.61	100	13	499	33	1904	411	1.51	100
13	11	497	22	1766	232	1.41	100	9	518	26	2171	522	1.57	100	20	506	25	1968	446	1.48	100
14	4	483	44	1915	396	1.63	100	4	480	15	1619	140	1.51	100	8	481	30	1753	311	1.57	100
15	7	518	30	2062	376	1.53	100	4	495	22	1834	191	1.54	100	11	510	29	1980	334	1.54	100
16	6	509	27	2005	339	1.51	100	.	.	.	.	.	.	.	6	509	27	2005	339	1.51	100
17	1	524	.	2137	.	1.49	100	.	.	.	.	.	.	.	1	524	.	2137	.	1.49	100
18	.	.	.	.	.	.	100	1	497	.	1599	.	1.30	100	1	497	.	1599	.	1.30	100
19	.	.	.	.	.	.	.	1	520	.	2142	.	1.52	100	1	520	.	2142	.	1.52	100
20	.	.	.	.	.	.	.	1	557	.	2348	895	1.73	100	1	557	.	2348	895	1.73	100
TOTAL	54							40							94						
MEAN		499	30	1846	358	1.50			497	27	1898	400	1.56			498	29	1870	377	1.52	
AGE N	67							59							126						
MEAN	12.0							12.3							12.2						
STD	2.9							2.8							2.9						

YEAR=1985

AGE	MALES							FEMALES							COMBINED						
	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%
(YR)	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	.	.	.	2709	.	.	100	.	.	.	.	.	.	.	.	.	.	2709	.	.	100
9	2	483	6	1878	111	1.67	100	.	.	.	.	.	.	.	2	483	6	1878	111	1.67	100
10	1	480	.	2011	.	1.82	100	1	471	.	1908	.	1.83	100	2	476	6	1960	73	1.82	100
11	2	498	4	2185	263	1.77	100	1	479	.	1789	.	1.63	100	3	491	11	2053	295	1.72	100
12	.	.	.	.	.	.	.	2	488	4	2019	326	1.73	100	2	488	4	2019	326	1.73	100
13	5	497	34	1844	490	1.48	100	4	490	18	1832	84	1.56	100	9	494	27	1838	351	1.51	100
14	.	.	.	.	.	.	.	5	504	22	2009	446	1.55	100	5	504	22	2009	446	1.55	100
15	1	451	.	1465	.	1.60	100	5	497	31	1952	563	1.56	100	6	489	33	1871	542	1.57	100
16	1	447	.	1368	.	1.53	100	2	502	5	2090	225	1.65	100	3	483	32	1849	446	1.61	100
17	.	.	.	.	.	.	.	1	485	.	2067	.	1.81	100	1	485	.	2067	.	1.81	100
20	1	503	.	1637	.	1.29	100	.	.	.	.	.	.	.	1	503	.	1637	.	1.29	100
TOTAL	13							21							34						
MEAN		487	27	1895	432	1.58			494	20	1958	347	1.61			491	23	1933	378	1.60	
AGE N	14							21							35						
MEAN	12.4							13.9							13.3						
STD	3.3							1.7							2.5						

Appendix B3. Con't.

YEAR=1986

MALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	.	.	.	.	.	.	.
8	5	485	24	1931	437	1.67	100
9	.	.	.	1710	.	.	100
10	4	481	19	1857	269	1.67	100
11	1	504	.	1784	.	1.39	100
12	3	492	22	1900	377	1.59	100
13	6	504	22	1986	325	1.54	100
14	1	500	.	2387	.	1.91	100
15	4	489	31	1826	304	1.55	100
16	.	.	.	.	.	.	.
17	1	493	.	1884	.	1.57	100
18	1	527	.	2511	.	1.72	100
20	1	532	.	2007	.	1.33	100
TOTAL	27						
MEAN		495	23	1935	321	1.60	
AGE N	29						
MEAN	12.3						
STD	3.2						

FEMALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	1	483	.	1838	.	1.63	100
8	3	489	22	2066	470	1.75	67
9	2	491	33	2099	845	1.72	100
10	3	489	20	2037	129	1.75	100
11	1	421	.	1287	.	1.73	100
12	1	488	.	2183	.	1.88	100
13	1	486	.	1593	.	1.39	100
14	2	481	1	1534	88	1.38	50
15	1	510	.	2288	.	1.73	100
16	1	493	.	1861	.	1.55	100
17	2	509	5	2124	38	1.62	100
18	1	467	.	1519	.	1.49	100
20	1	499	.	1950	.	1.57	100
TOTAL	20						
MEAN		487	22	1923	365	1.64	
AGE N	21						
MEAN	12.2						
STD	3.8						

COMBINED

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	1	483	.	1838	.	1.63	100
8	8	487	22	1982	421	1.70	88
9	2	491	33	1969	638	1.72	100
10	7	484	18	1947	218	1.70	100
11	2	463	59	1536	351	1.56	100
12	4	491	18	1971	339	1.66	100
13	7	501	21	1930	332	1.52	100
14	3	487	11	1818	497	1.56	67
15	5	493	29	1903	331	1.59	100
16	1	493	.	1861	.	1.55	100
17	3	503	10	2044	141	1.60	100
18	2	497	42	2015	701	1.60	100
20	2	516	23	1979	40	1.45	100
TOTAL	47						
MEAN		491	23	1930	337	1.62	
AGE N	50						
MEAN	12.3						
STD	3.4						

YEAR=1987

MALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	.	.	.	.	.	.	.
9	1	510	.	1833	.	1.38	100
10	.	.	.	.	.	.	.
11	1	512	.	2050	.	1.53	100
12	1	490	.	2181	37	1.83	100
13	.	.	.	.	.	.	.
14	.	.	.	.	.	.	.
15	.	.	.	.	.	.	.
16	.	.	.	.	.	.	.
17	.	.	.	.	.	.	.
18	2	479	27	1444	194	1.31	100
20	.	.	.	.	.	.	.
TOTAL	5						
MEAN		494	21	1855	354	1.47	
AGE N	6						
MEAN	13.3						
STD	3.8						

FEMALES

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	.	.	.	1521	.	.	100
9	6	482	26	1536	239	1.40	88
10	3	510	11	1618	220	1.28	100
11	4	508	28	1655	391	1.34	100
12	8	507	13	1664	306	1.38	100
13	1	540	.	1988	303	1.40	100
14	1	509	.	1706	.	1.29	100
15	1	495	.	1826	196	1.39	100
16	1	574	.	2207	.	1.17	100
17	2	516	4	1674	238	1.30	100
18	1	548	.	2158	.	1.31	100
20	1	534	.	2041	.	1.34	100
TOTAL	29						
MEAN		508	26	1688	296	1.35	
AGE N	43						
MEAN	12.1						
STD	2.9						

COMBINED

AGE (YR)	LENGTH (MM) N	LENGTH (MM) MEAN	LENGTH (MM) STD	WEIGHT (G) MEAN	WEIGHT (G) STD	K	% MAT
7	.	.	.	1521	.	.	100
9	7	486	26	1569	244	1.40	89
10	3	510	11	1618	220	1.28	100
11	5	509	24	1711	387	1.38	100
12	9	505	13	1744	341	1.43	100
13	1	540	.	1988	303	1.40	100
14	1	509	.	1706	.	1.29	100
15	1	495	.	1826	196	1.39	100
16	1	574	.	2207	.	1.17	100
17	2	516	4	1674	238	1.30	100
18	3	502	44	1682	434	1.31	100
20	1	534	.	2041	.	1.34	100
TOTAL	34						
MEAN		506	26	1708	305	1.37	
AGE N	49						
MEAN	12.2						
STD	3.0						

Appendix B3. Con't.

YEAR=1988 (all samples)

AGE (YR)	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
5	1	438	.	1341	.	1.60	100	.	.	.	.	.	.	.	1	438	.	1341	.	1.60	100
6	2	476	13	1583	470	1.49	100	.	.	.	.	.	.	.	2	476	13	1583	470	1.49	100
8	1	471	.	1651	.	1.58	100	2	468	18	1917	158	1.87	100	3	469	13	1828	190	1.77	100
9	4	482	41	1894	324	1.74	100	3	461	38	1670	493	1.66	100	7	473	38	1810	378	1.71	100
10	3	483	6	1859	202	1.64	100	4	448	8	1660	110	1.85	100	7	463	20	1745	176	1.76	100
11	2	509	27	2152	45	1.65	100	1	472	.	2091	345	2.22	100	3	497	29	2122	204	1.84	100
12	6	498	16	2163	120	1.76	100	1	510	.	2310	.	1.74	100	7	499	15	2184	123	1.76	100
13	3	515	24	2270	290	1.66	100	1	499	.	2042	.	1.64	100	4	511	21	2213	263	1.66	100
14	2	473	40	1708	426	1.60	100	1	528	.	2245	.	1.53	100	3	491	42	1887	432	1.57	100
15	.	.	.	.	.	.	.	3	470	33	1895	118	1.87	100	3	470	33	1895	118	1.87	100
17	3	481	13	1643	232	1.47	100	.	.	.	.	.	.	.	3	481	13	1643	232	1.47	100
18	2	492	49	1819	701	1.49	100	1	464	.	1518	.	1.52	100	3	482	38	1718	525	1.50	100
19	1	517	.	2067	.	1.50	100	.	.	.	.	.	.	.	1	517	.	2067	.	1.50	100
20	.	.	.	.	.	.	.	1	503	.	1644	.	1.29	100	1	503	.	1644	.	1.29	100
TOTAL	30							18							48						
MEAN		489	27	1914	346	1.63			472	29	1848	300	1.76			483	29	1889	328	1.68	
AGE N	31							19							50						
MEAN	11.8							11.9							11.9						
STD	3.7							3.4							3.5						

YEAR=1989

AGE (YR)	MALES							FEMALES							COMBINED						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT	N	MEAN	STD	MEAN	STD	K	MAT
7	.	.	.	.	.	.	.	2	480	14	1901	373	1.71	100	2	480	14	1901	373	1.71	100
8	2	476	13	1954	121	1.82	100	1	470	.	1833	.	1.77	100	3	474	10	1913	110	1.80	100
9	5	480	18	1747	219	1.57	100	1	478	.	1989	.	1.82	100	6	480	16	1787	220	1.62	100
10	7	475	19	1818	126	1.70	100	1	445	.	1799	.	2.04	100	8	472	20	1816	117	1.74	100
11	6	495	16	2079	189	1.71	100	3	471	17	1947	284	1.85	100	9	487	19	2035	216	1.76	100
12	3	484	37	1969	509	1.71	100	2	500	14	2268	61	1.82	100	5	490	28	2089	397	1.75	100
13	1	490	.	1912	.	1.63	100	7	487	20	2129	332	1.83	100	8	488	19	2102	317	1.80	100
14	5	509	25	2063	252	1.56	100	1	480	.	1878	.	1.70	100	6	504	25	2032	238	1.58	100
16	1	505	.	1938	.	1.51	100	.	.	.	.	.	.	.	1	505	.	1938	.	1.51	100
17	1	517	.	1995	.	1.44	100	.	.	.	.	.	.	.	1	517	.	1995	.	1.44	100
TOTAL	31							18							49						
MEAN		489	23	1932	241	1.65			481	19	2032	278	1.82			486	22	1969	257	1.71	
AGE N	31							18							49						
MEAN	11.3							11.3							11.3						
STD	2.3							2.2							2.2						

Appendix B4. Biological data by length class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, 1984 samples 5 to 8.

YEAR=1984 LOC=5 (early September)

LENGTH INTERVAL (MM)	MALES						FEMALES						COMBINED					
	LENGTH (MM)		WEIGHT (G)				LENGTH (MM)		WEIGHT (G)				LENGTH (MM)		WEIGHT (G)			
	N	MEAN	MEAN	STD	K	% MAT	N	MEAN	MEAN	STD	K	% MAT	N	MEAN	MEAN	STD	K	% MAT
430	1	436	1191	.	1.44	100	.	.	.	.	.	.	1	436	1191	.	1.44	100
460	3	463	1389	32	1.40	67	4	466	1528	88	1.51	100	7	465	1468	98	1.46	86
470	2	476	1641	38	1.53	100	2	476	1643	83	1.52	100	4	476	1642	53	1.53	100
480	6	485	1775	94	1.56	100	2	487	1828	161	1.59	100	8	485	1788	103	1.56	100
490	3	495	1699	147	1.40	100	5	494	1932	192	1.60	100	8	495	1845	205	1.53	100
500	3	504	1823	152	1.42	100	2	506	1961	34	1.51	100	5	505	1878	133	1.46	100
510	6	515	1927	124	1.41	100	4	511	2110	235	1.59	100	10	513	2000	189	1.48	100
520	3	521	2078	109	1.47	100	3	525	2218	95	1.53	100	6	523	2148	119	1.50	100
530	.	.	.	.	.	.	1	535	2243	.	1.47	100	1	535	2243	.	1.47	100
540	1	547	2630	.	1.61	100	1	542	1863	.	1.17	100	2	545	2247	542	1.39	100
550	.	.	.	.	.	.	1	554	2902	.	1.71	100	1	554	2902	.	1.71	100
560	1	564	2388	.	1.33	100	.	.	.	.	.	.	1	564	2388	.	1.33	100
TOTAL	29						25						54					
MEAN		498	1816	302	1.46			501	1949	332	1.54			499	1878	320	1.50	
STD		26.6						24.9						25.6				

YEAR=1984 LOC=6 (mid September)

LENGTH INTERVAL (MM)	MALES						FEMALES						COMBINED					
	LENGTH (MM)		WEIGHT (G)				LENGTH (MM)		WEIGHT (G)				LENGTH (MM)		WEIGHT (G)			
	N	MEAN	MEAN	STD	K	% MAT	N	MEAN	MEAN	STD	K	% MAT	N	MEAN	MEAN	STD	K	% MAT
460	.	.	.	.	.	.	2	464	1566	144	1.57	100	2	464	1566	144	1.57	100
470	1	472	1655	.	1.57	100	3	473	1620	127	1.54	100	4	473	1629	105	1.54	100
480	1	480	1789	.	1.62	100	1	483	1822	.	1.62	100	2	482	1806	23	1.62	100
490	3	495	1763	224	1.45	100	1	492	1715	.	1.44	100	4	495	1751	185	1.45	100
500	3	504	1735	86	1.35	100	1	504	1877	.	1.47	100	4	504	1771	100	1.38	100
510	3	513	1910	163	1.42	100	2	514	2067	117	1.53	100	5	513	1973	156	1.46	100
520	.	.	.	.	.	.	2	525	2069	170	1.44	100	2	525	2069	170	1.44	100
530	2	534	2336	132	1.53	100	1	533	2510	.	1.66	100	3	534	2394	137	1.58	100
550	1	558	2493	.	1.44	100	1	557	2981	.	1.73	100	2	558	2737	345	1.58	100
560	1	568	3085	.	1.68	100	.	.	.	.	.	.	1	568	3085	.	1.68	100
570	.	.	.	.	.	.	1	573	3276	.	1.74	100	1	573	3276	.	1.74	100
TOTAL	15						15						30					
MEAN		512	1995	414	1.47			504	2030	527	1.55			508	2012	466	1.51	
STD		26.7						34.1						30.4				

Appendix B4. Con't.

YEAR=1984 LOC=7 (mid October)

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
440	1	445	1604	.	1.82	100	.	.	.	.	.	.	1	445	1604	.	1.82	100
450	1	456	1576	.	1.66	100	1	456	1667	.	1.76	100	2	456	1622	64	1.71	100
460	1	461	1417	.	1.45	100	2	466	1767	68	1.75	100	3	464	1650	208	1.65	100
470	2	474	1565	42	1.47	100	2	475	1652	27	1.54	100	4	474	1608	58	1.51	100
480	3	484	1779	85	1.57	100	.	.	.	.	.	.	3	484	1779	85	1.57	100
500	1	508	1942	.	1.48	100	.	.	.	.	.	.	1	508	1942	.	1.48	100
510	2	516	2141	59	1.56	100	.	.	.	.	.	.	2	516	2141	59	1.56	100
520	2	522	2060	49	1.45	100	.	.	.	.	.	.	2	522	2060	49	1.45	100
530	1	535	2479	.	1.62	100	.	.	.	.	.	.	1	535	2479	.	1.62	100
540	3	542	2393	171	1.50	100	.	.	.	.	.	.	3	542	2393	171	1.50	100
TOTAL	17						5						22					
MEAN		500	1945	351	1.54			467	1701	71	1.67			493	1890	325	1.57	
STD		32.3						8.4						31.8				

YEAR=1984 LOC=8 (November 7 to 11)

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
440	1	440	1224	.	1.44	0	.	.	.	.	.	.	1	440	1224	.	1.44	0
460	1	466	1596	.	1.58	100	.	.	.	.	.	.	1	466	1596	.	1.58	100
470	1	476	1483	.	1.38	100	1	474	1393	.	1.31	100	2	475	1438	64	1.34	100
480	4	486	1699	113	1.48	100	2	480	2052	11	1.86	100	6	484	1817	202	1.61	100
490	2	495	2012	6	1.66	100	4	496	1876	193	1.54	100	6	496	1922	165	1.58	100
500	.	.	.	.	.	.	1	502	1810	.	1.43	100	1	502	1810	.	1.43	100
510	2	517	1967	258	1.42	100	3	513	1959	380	1.45	100	5	515	1962	298	1.44	100
520	.	.	.	.	.	.	1	527	1933	.	1.32	100	1	527	1933	.	1.32	100
530	1	538	1778	.	1.14	100	.	.	.	.	.	.	1	538	1778	.	1.14	100
550	.	.	.	.	.	.	1	553	2369	.	1.40	100	1	553	2369	.	1.40	100
TOTAL	12						13						25					
MEAN		491	1736	255	1.47			503	1922	280	1.51			497	1833	279	1.49	
STD		25.6						21.4						23.9				

Appendix B5. Biological data by length class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, the 1984 September samples combined.

YEAR=1984 LOC=5 AND 6 (early and mid September)

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
430	1	436	1191	.	1.44	100	.	.	.	.	.	.	1	436	1191	.	1.44	100
460	3	463	1389	32	1.40	67	6	465	1540	95	1.53	100	9	464	1490	108	1.49	89
470	3	474	1646	28	1.54	100	5	474	1629	100	1.53	100	8	474	1635	78	1.53	100
480	7	484	1777	86	1.57	100	3	485	1826	114	1.60	100	10	485	1792	91	1.57	100
490	6	495	1731	173	1.42	100	6	494	1896	194	1.57	100	12	495	1813	195	1.50	100
500	6	504	1779	121	1.39	100	3	505	1933	54	1.50	100	9	505	1831	125	1.42	100
510	9	514	1921	128	1.41	100	6	512	2096	191	1.57	100	15	513	1991	174	1.47	100
520	3	521	2078	109	1.47	100	5	525	2158	135	1.49	100	8	524	2128	125	1.48	100
530	2	534	2336	132	1.53	100	2	534	2377	189	1.56	100	4	534	2356	135	1.55	100
540	1	547	2630	.	1.61	100	1	542	1863	.	1.17	100	2	545	2247	542	1.39	100
550	1	558	2493	.	1.44	100	2	556	2942	56	1.72	100	3	556	2792	262	1.62	100
560	2	566	2737	493	1.51	100	.	.	.	.	.	.	2	566	2737	493	1.51	100
570	.	.	.	.	.	.	1	573	3276	.	1.74	100	1	573	3276	.	1.74	100
TOTAL	44						40						84					
MEAN		503	1877	350	1.46			502	1980	411	1.55			503	1926	381	1.50	
STD		27.2						28.3						27.6				

Appendix B6. Biological data by length class for broad whitefish from the Mackenzie River Delta Middle Channel near Horseshoe Bend, 1984 to 1989.

YEAR=1984 (all samples)

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
430	1	436	1191	.	1.44	100	.	.	.	.	.	.	1	436	1191	.	1.44	100
440	2	443	1414	269	1.63	50	.	.	.	.	.	.	2	443	1414	269	1.63	50
450	1	456	1576	.	1.66	100	1	456	1667	.	1.76	100	2	456	1622	64	1.71	100
460	5	463	1436	93	1.44	80	8	465	1597	135	1.59	100	13	464	1535	142	1.53	92
470	6	474	1592	71	1.49	100	8	474	1605	115	1.51	100	14	474	1599	96	1.50	100
480	14	485	1755	94	1.54	100	5	483	1916	148	1.70	100	19	484	1798	129	1.58	100
490	8	495	1801	196	1.48	100	10	495	1888	183	1.56	100	18	495	1849	188	1.53	100
500	7	505	1803	126	1.40	100	4	505	1902	76	1.48	100	11	505	1839	117	1.43	100
510	13	515	1962	153	1.44	100	9	512	2050	252	1.53	100	22	514	1998	199	1.47	100
520	5	522	2071	82	1.46	100	6	525	2121	152	1.46	100	11	524	2098	122	1.46	100
530	4	535	2232	319	1.46	100	2	534	2377	189	1.56	100	6	535	2280	272	1.49	100
540	4	543	2453	183	1.53	100	1	542	1863	.	1.17	100	5	543	2335	308	1.46	100
550	1	558	2493	.	1.44	100	3	555	2751	333	1.61	100	4	556	2686	301	1.57	100
560	2	566	2737	493	1.51	100	.	.	.	.	.	.	2	566	2737	493	1.51	100
570	.	.	.	.	.	.	1	573	3276	.	1.74	100	1	573	3276	.	1.74	100
TOTAL	73						58						131					
MEAN		500	1870	339	1.48			499	1943	372	1.55			500	1902	355	1.51	
STD		28.2						27.3						27.7				

YEAR=1985

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
440	1	447	1368	.	1.53	100	.	.	.	.	.	.	1	447	1368	.	1.53	100
450	1	451	1465	.	1.60	100	.	.	.	.	.	.	1	451	1465	.	1.60	100
460	2	469	1408	228	1.37	100	2	464	1616	163	1.62	100	4	466	1512	202	1.49	100
470	1	478	1956	.	1.79	100	3	474	1716	237	1.61	100	4	475	1776	228	1.66	100
480	3	483	1885	112	1.67	100	4	485	1823	261	1.60	100	7	484	1850	198	1.63	100
490	1	495	1999	.	1.65	100	5	495	1982	172	1.63	100	6	495	1985	154	1.64	100
500	2	502	2004	519	1.59	100	3	504	1970	250	1.54	100	5	503	1984	315	1.56	100
510	.	.	.	.	.	.	2	512	2058	190	1.54	100	2	512	2058	190	1.54	100
520	1	522	2005	.	1.41	100	.	.	.	.	.	.	1	522	2005	.	1.41	100
530	.	.	.	.	.	.	2	538	2752	141	1.77	100	2	538	2752	141	1.77	100
540	1	543	2553	.	1.60	100	.	.	.	.	.	.	1	543	2553	.	1.60	100
TOTAL	13						21						34					
MEAN		487	1833	378	1.58			494	1958	347	1.61			491	1910	359	1.60	
STD		26.7						20.4						22.9				

Appendix B6. Con't.

YEAR=1986

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
420	.	.	.	.	.	.	1	421	1287	.	1.73	100	1	421	1287	.	1.73	100
450	1	455	1552	.	1.65	100	.	.	.	.	.	.	1	455	1552	.	1.65	100
460	3	464	1552	116	1.56	100	3	466	1515	12	1.49	67	6	465	1534	77	1.53	83
470	6	475	1727	60	1.61	100	1	473	1921	.	1.82	100	7	475	1754	92	1.64	100
480	1	483	1630	.	1.45	100	6	484	1780	275	1.57	83	7	484	1758	257	1.55	86
490	3	494	1798	75	1.49	100	3	496	2063	276	1.69	100	6	495	1930	232	1.59	100
500	5	503	2144	223	1.68	100	2	506	2197	141	1.70	100	7	504	2159	193	1.69	100
510	5	515	2244	217	1.64	100	4	512	2339	244	1.74	100	9	513	2286	220	1.69	100
520	1	527	2511	.	1.72	100	.	.	.	.	.	.	1	527	2511	.	1.72	100
530	1	532	2007	.	1.33	100	.	.	.	.	.	.	1	532	2007	.	1.33	100
540	1	542	2523	.	1.59	100	.	.	.	.	.	.	1	542	2523	.	1.59	100
TOTAL	27						20						47					
MEAN		495	1947	329	1.60			487	1918	374	1.64			491	1935	345	1.62	
STD		23.3						22.2						22.9				

YEAR=1987

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
460	1	460	1307	.	1.34	100	3	464	1429	50	1.43	100	4	463	1398	73	1.41	100
470	.	.	.	.	.	.	2	475	1365	57	1.28	100	2	475	1365	57	1.28	100
490	2	494	1868	405	1.56	100	4	493	1592	122	1.33	100	6	493	1684	249	1.40	100
500	.	.	.	.	.	.	7	504	1787	238	1.40	100	7	504	1787	238	1.40	100
510	2	511	1942	153	1.45	100	6	514	1838	144	1.35	100	8	513	1864	143	1.38	100
520	.	.	.	.	.	.	3	524	1800	117	1.25	100	3	524	1800	117	1.25	100
530	.	.	.	.	.	.	1	534	2041	.	1.34	100	1	534	2041	.	1.34	100
540	.	.	.	.	.	.	3	544	2150	56	1.34	100	3	544	2150	56	1.34	100
570	.	.	.	.	.	.	1	574	2207	.	1.17	100	1	574	2207	.	1.17	100
TOTAL	5						30						35					
MEAN		494	1785	346	1.47			508	1767	267	1.34			506	1770	274	1.36	
STD		21.0						25.7						25.3				

Appendix B6. Con't.

YEAR=1988 (all samples)

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
410	.	.	.	.	.	.	1	418	1103	.	1.51	100	1	418	1103	.	1.51	100
430	2	434	1398	80	1.71	100	1	439	1618	.	1.91	100	3	436	1471	139	1.78	100
440	1	445	1407	.	1.60	100	2	442	1863	237	2.17	100	3	443	1711	312	1.98	100
450	1	457	1323	.	1.39	100	3	455	1710	153	1.82	100	4	456	1614	230	1.71	100
460	1	466	1915	.	1.89	100	2	465	1664	206	1.65	100	3	465	1748	206	1.73	100
470	5	472	1760	287	1.67	100	2	476	2122	302	1.98	100	7	473	1863	318	1.76	100
480	3	482	1610	352	1.44	100	2	484	2014	21	1.78	100	5	483	1771	333	1.58	100
490	7	494	2091	132	1.74	100	1	499	2042	.	1.64	100	8	494	2085	124	1.73	100
500	3	503	2097	161	1.64	100	2	504	1745	142	1.36	100	5	504	1956	235	1.53	100
510	3	516	2144	66	1.56	100	1	510	2310	.	1.74	100	4	514	2185	99	1.61	100
520	3	526	2220	97	1.52	100	1	528	2245	.	1.53	100	4	527	2226	80	1.52	100
540	1	540	2594	.	1.65	100	.	.	.	.	.	.	1	540	2594	.	1.65	100
TOTAL	30						18						48					
MEAN		489	1923	349	1.63			472	1848	309	1.76			483	1895	333	1.68	
STD		26.9						29.3						28.7				

YEAR=1989

LENGTH INTERVAL (MM)	MALES LENGTH (MM) N	MALES LENGTH (MM) MEAN	MALES WEIGHT (G) MEAN	MALES WEIGHT (G) STD	MALES K	MALES % MAT	FEMALES LENGTH (MM) N	FEMALES LENGTH (MM) MEAN	FEMALES WEIGHT (G) MEAN	FEMALES WEIGHT (G) STD	FEMALES K	FEMALES % MAT	COMBINED LENGTH (MM) N	COMBINED LENGTH (MM) MEAN	COMBINED WEIGHT (G) MEAN	COMBINED WEIGHT (G) STD	COMBINED K	COMBINED % MAT
440	1	442	1425	.	1.65	100	2	447	1770	41	1.98	100	3	445	1655	201	1.87	100
450	3	453	1587	142	1.71	100	1	456	1770	.	1.87	100	4	454	1633	148	1.75	100
460	2	468	1897	41	1.86	100	1	468	1797	.	1.75	100	3	468	1864	65	1.82	100
470	2	474	1877	51	1.76	100	4	473	1788	158	1.69	100	6	474	1818	132	1.71	100
480	7	483	1838	131	1.63	100	4	483	1957	171	1.74	100	11	483	1881	151	1.67	100
490	4	491	1974	99	1.67	100	3	490	2221	55	1.89	100	7	491	2080	153	1.76	100
500	7	503	2018	123	1.58	100	2	502	2408	373	1.91	100	9	503	2104	241	1.66	100
510	4	514	2196	214	1.62	100	2	510	2355	62	1.78	100	6	512	2249	187	1.67	100
550	1	550	2494	.	1.50	100	.	.	.	.	.	.	1	550	2494	.	1.50	100
TOTAL	31						19						50					
MEAN		489	1932	241	1.65			481	2014	282	1.81			486	1963	257	1.71	
STD		22.[illegible]						18.6						21.4				

APPENDIX C

A representative sample of the interview guide used to interview broad whitefish harvesters in the communities of Tuktoyaktuk, Inuvik, Aklavik, Ft. MacPherson, Tsiigehtchic, and Ft. Good Hope. The guide used for specific communities and groups may have differed from this one because each community has had different experiences with regards to certain management issues, particularly commercial fishery development and co-management.

Appendix C1. List of interviews that were conducted in 1992, when they were conducted, and who attended.

Organization Interviewed	Date of Interview	Number of People Interviewed
Tuktoyaktuk HTC	August 31	Chair, Secretary + 4 members
Inuvik HTC	August 29	President + Resource Person
Inuvik HTA	October 22	President
Aklavik HTC	October 21	3 Directors
Aklavik HTA	October 20	President + 2 members
Tsiigehtchic Band [1]	September 29	Chief + Band Manager
"	Sept. 4-Oct. 14	7 members
Ft. McPherson HTA	October 5	President + 5 members
Ft. Good Hope HTA	September 21	President + 2 members
Joint Secretariat	August 28	Harvest Study Coordinator
	September 2	Executive Director
FJMC	September 16	Inuvialuit Representative
GNWT ED&T	August 25	Economic Dev. Officer
DFO	October 22	Fisheries Biologist

[1] The Tsiigehtchic HTA was not operating at the time of my visit.

Appendix C2

Question Guide For Interviews

1) Subsistence Fishery

a) How long have you fished for broad whitefish?

b) Do you use gillnets? What size? How are they set? (shallow, deep)

c) When and where do you fish? Are there several runs or just one?

d) How many nets would you set?

e) What would your average catch be per net?

f) How is the fish used? (for human consumption or dog food)

g) How is it processed? (hung, frozen, dried)

h) Have you noticed any changes in the fishery since you started? What kind?

i) Has your catch remained about the same over the last few years? If not why? Does this worry you?

j) Have you noticed any changes in the size (length, weight) of broad whitefish over the years?

k) Are more or less people fishing for food these days? Could you say how many?

l) What are the benefits of having a subsistence fishery? Are there any costs?

m) Overall, how important is this fishery to you? Your community?

Note: *1) Rawson Academy report 1990, reported that people in communities of Arctic Red River and Ft. McPherson and Ft. Good Hope (?) were concerned that they did not have enough fish stored for the winter.*

2) Lockhart tested burbot and broad whitefish for contaminants after hearing complaints from communities about watery flesh in broad whitefish and deformed livers in burbot.

2) Commercial Fishery

a) Do you also fish commercially? When?

b) Would you hire helpers? How many?

c) Approximately how many fish would you sell? Where would you sell them?

d) How many other fishermen in your community would fish commercially?

e) Why do you fish commercially? Is it important to you?

3) Resource Allocation

a) Does the commercial fishery take time away from your subsistence fishery? Do you still have time to catch enough fish for your family?

b) Do you think a large scale export commercial fishery could be developed here? If this happened do you think more people would take up fishing?
Do you think you would still have enough time to catch fish for your family and friends?

c) Are you aware of the development of a commercial fishery for broad whitefish in Inuvik? What do you think of this?

d) Do you think that a commercial fishery for broad whitefish might affect the success of your subsistence fishery?

__Note__: *1) Subsistence fisheries are given priority over commercial fisheries in the NWT and essentially all of Canada since the* *__Sparrow__* *decision.*
2) Some scientists are concerned that an extensive commercial harvest may reduce population sizes and limit opportunity to fish for food in the future.

4) Other Management Issues

a) Do you think there is a need for a management plan for Mackenzie River broad whitefish? What should it include?

Note: Can a management plan be exclusively for broad whitefish, what about the other fish caught in the same nets?

b) Who would be responsible for implementing it? ie) organizing the monitoring programs and collection of data with which to formulate and revise the plan.
(DFO, FJMC, Dene RRB or a combination)

c) Should there be a monitoring program? If so how often?

d) Was there a traditional management system in the past? Was it effective? To what degree is it operating today?

e) Do you think it could continue to function effectively in the future, given the changes that have occurred (settlement, wage employment, etc.)?

f) Is traditional knowledge being actively passed on to younger generations by parents, elders or community/school programs? How?

g) Do you think that traditional knowledge could be incorporated into a broad whitefish management plan? In what way?

5) Co-management

a) Is the co-management idea acceptable to you? Why? Why not?

b) Could you tell me about the co-management system set up under the land claim agreement? Are you happy with it, confident that it will work better than what you had before? Why?

c) Have you had opportunities to provide your ideas and input? How often? Have they been accepted and acted upon?

d) Do you think people in upstream and downstream communities should be consulted when FJMC or anyone else makes decisions concerning broad whitefish. How do you think this could best be achieved? (via HTC's or HTA's(RRC), via FJMC and RRB's via a separate BDWF management Bd.)

Note: *In the Gwich'in land claim agreement there is: 1) reference to a Mackenzie Basin regional resources management board (would this include Inuvialuit?); 2) reference to creation of management plans for migratory species. (Government would consult RRB, other management agencies and users).*

6) Self-government

What would you do differently if you had more local control? Will the co-management boards continue to exist? Do you think they will have more decision-making power?

APPENDIX D

Commercial harvest and sales data for the lower Mackenzie River region, 1955 to 1993 (Tables D1 to D8).

Appendix D1a. Export and local commercial harvest sales (kg) reported for the Lower Mackenzie River, 1957-1974, by management area, circa 1976 (Fig. 22). Source: Yaremchuk et al. (1989), unless otherwise noted. Values for lake whitefish recorded in Yaremchuk et al. (1989) may include broad whitefish; Corkum and McCart (1981) reported similar values under the term whitefish and note that most of these were thought to be broad whitefish. Also, Corkum and McCart (1981) reported similar values (1 lb=.455 kg) to Yaremchuk et al. unless otherwise noted. A small harvest of 13 kg of fish sp. was reported for 1958 by Corkum and McCart (1981) but has not been included in this table.

Location	Species	Year 1955	1956	1957	1960	1961	1962	1963	1964	1965	1966	1972	1973	1974
Mackenzie Delta														
Area I	Broad Whitefish	ND[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Area II	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND	ND
	Lake Whitefish										-			
	Fish Sp.[2]										5,460[3]			
	TOTAL										5,460			
Area III	Broad Whitefish	ND	ND	308	ND	ND	-	ND	ND	-	-	ND	ND	ND
	Lake Whitefish			302			8,278			9,040[5]	28,176[6]			
	Inconnu			8			-			-	-			
	Northern Pike			62			-			-	-			
	Fish sp.			3,971[4]			-			-	1,411[7]			
	TOTAL			4,651			8,278			9,040	29,587			
Area IV	Broad Whitefish	ND	ND	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND
	Lake Whitefish						488	-						
	Inconnu						1,611	4,028						
	Northern Pike						2,371	5,435						
	Other[8]						4,266[9]	3,372[9]						
	TOTAL						8,736	12,835						
Area V	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Lake Whitefish													
Unkown[10]	Broad Whitefish	-	-	ND	-	-	-	ND	ND	-	-	ND	ND	ND
	Lake Whitefish	-	-		-	-	488			-	-			
	Whitefish sp.[11]	-	-		-	12,185[12]	-			-	-			
	Northern Pike	-	-		-	-	237,131			-	-			
	Arctic Char	-	-		-	-	-			7,296[13]	363			
	Other	-	-		-	-	-			-	101[9]			
	Fish Sp.	753[4]	8,508[4]		5,982[4]	5,005[4]	-			-	-			
	TOTAL	753	8,508		5,982	17,190	237,619[14]			7,296	464			

Appendix D1a. Continued.

Location	Species	1955	1956	1957	1960	1961	1962	Year 1963	1964	1965	1966	1972	1973	1974
Ft. McPherson Area														
Peel River[15]	Broad Whitefish	ND	ND	-	-	5,514	ND	ND	ND	ND	-	ND	ND	ND
	Lake Whitefish			-	5,443	523					-			
	Inconnu			-	-	966					-			
	Cisco Sp.[16]			1,606	-	-					-			
	Fish Sp.			-	-	-					4,277[17]			
	TOTAL			1,606	5,443	7,003					4,277			
Tsiigehtchic[15]	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND	ND
	Lake Whitefish										-			
	Inconnu										-			
	Fish sp.										683[18]			
	TOTAL										683			
Tuktoyaktuk Area														
Eskimo (Husky) Lakes[15]	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND	-
	Lake Whitefish										5,224			-
	Lake Whitefish & Lake Trout													1,149[9]
	Inconnu										-			-
	Lake Trout										839			-
	TOTAL										6,063			1,149
Holmes Creek[19]	Broad Whitefish	ND	ND	ND	ND	ND	ND	-	-	ND	ND	-	-	-
	Lake Whitefish							6,511	19,255			1,712	22,226	15,876
	Inconnu							-	-			-	408	-
	Other							-	15,881[20]			-	-	-
	TOTAL							6,511	35,136			1,712	22,634	15,876
Ft. Good Hope Area														
Manuel Lake[15]	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Lake Whitefish												907	
	TOTAL												907	
Sitidgi Lake[15]	Lake Whitefish & Lake Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,149
	TOTAL													1,149

Appendix D1a. Continued.

Location	Species	1955	1956	1957	1960	1961	1962	1963	1964	1965	1966	1972	1973	1974
Other														
Shingle Point[15]	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND	ND
	Lake Whitefish										-			
	Inconnu										910			
	P. Herring										910			
	TOTAL										1,820[21]			
Pauline Cove[15]	Broad Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	-	-	ND	ND	ND
	Lake Whitefish									-	-			
	Whitefish sp.									-	91			
	P. Herring									-	273			
	Arctic Char									250	455			
	TOTAL									250[22]	819[21]			
Dolomite Lake[15]	Lake Whitefish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	68	ND
	Inconnu												9	
	Northern Pike												5	
	Lake Trout												23	
	TOTAL												105	
TOTAL[23]	Broad Whitefish	-	-	308	-	5,514	-	-	-	-	-	-	-	-
	Lake Whitefish	-	-	302	5,443	523	8,766	6,511	19,255	9,040	33,400	1,712	23,201	15,876
	Lake Whitefish & Lake Trout	-	-	-	-	-	-	-	-	-	-	-	-	2,298
	Whitefish Sp.	-	-	-	-	12,185	-	-	-	-	91	-	-	-
	Inconnu	-	-	8	-	966	1,611	4,028	-	-	910	-	417	-
	Cisco Sp.	-	-	1,606	-	-	-	-	-	-	-	-	-	-
	P. Herring	-	-	-	-	-	-	-	-	-	1,183	-	-	
	Northern Pike	-	-	62	-	-	2,371	5,435	-	-	-	-	5	-
	Arctic Char	-	-	-	-	-	-	-	-	7,296	818	-	-	-
	Lake Trout	-	-	-	-	-	-	-	-	-	839	-	23	-
	Other	-	-	-	-	-	4,266	3,372	-	16,586	101	-	-	-
	Fish Sp.	753	8,508	3,971	5,982	5,005	-	-	15,881	-	11,831	-	-	-
	TOTAL	753	8,508	6,257	11,425	24,193	17,014	19,346	35,136	16,586	49,173	1,712	23,646	18,174

[1] No fishing occured or no data collected for this year and location.
[2] Harvest was not differentiated according to species. Corkum and McCart (1981) reported values for mixed fish that could include broad whitefish, lake whitefish, inconnu, lake herring, lake trout, arctic char, grayling, northern pike, burbot, smelt, herring, sucker, lamprey, cod, arctic sole, starry flounder and fourhorn sculpin.
[3] Bissett (1967), fish sales from subsistence harvest for Inuvik area.
[4] Corkum and McCart (1981) reported data for "mixed" fish.
[5] Bissett (1967) reported a similar value for whitefish sp. (9,068 kg) for the 1965 central delta fishery that covered fisheries management area II and parts of areas I, III and IV (based on 1991 boundaries).

Appendix D1a. Continued.

[6] This value is similar to the sum of local commercial sales for fish (sp.) (11,830 kg) and the central delta export commercial sales for whitefish sp. (9,680 kg) reported in Bissett (1967). Bissett's data covered fisheries management areas I, II, III, and IV (based on 1991 boundaries).

[7] Bissett (1967), local fish sales from subsistence harvest for Aklavik area.

[8] Corkum and McCart (1981), includes species other than broad whitefish, lake whitefish, inconnu and northern pike.

[9] Corkum and McCart (1981), reported a similar total Mackenzie Delta harvest but also included this value for "other" fish sold.

[10] Unidentified Mackenzie Delta location.

[11] Includes both lake whitefish and broad whitefish.

[12] The value reported here is the difference between the total whitefish sp. reported by Corkum and McCart (1981) and the sum of broad whitefish and lake whitefish reported for the Peel River by Yaremchuk et al. (1989).

[13] Bissett (1967), reported a harvest of 7,068 kg of arctic char from Ptarmigan Bay and 250 kg from Pauline Cove for a total of 7,318 kg.

[14] These data resemble data listed for Area IV and could be duplicate, with the larger value given for pike being a data entry error. Therefore these values were not included in the yearly total.

[15] These areas are not included in the management areas.

[16] Includes least cisco and arctic cisco.

[17] Bissett (1967), fish sales from subsistence harvest for Ft. McPherson.

[18] Bissett (1967), fish sales from subsistence harvest for Tsiigehtchic.

[19] Holmes Creek enters the East Channel of the Mackenzie River in fisheries management area IV.

[20] Culled fish reported in Bissett (1967) and Corkum and McCart (1981). The sum of lake whitefish from Yaremchuk et al. (1989) and culled fish from Bissett (1967) match the data reported as whitefish in Corkum and McCart (1981).

[21] Bissett (1967), fish caught and purchased by RCMP detachment.

[22] Bissett (1967), samples from Pauline Cove and Ptarmigan Bay reported by Bissett (1967) match the value recorded under unknown, therefore this data was not included in the yearly total calculation.

[23] Sum of data from the above management areas and fishing locations.

Appendix D1b. Export and local commercial harvest sales (kg) reported for the Lower Mackenzie River, NWT, 1975-1983, by management area (1 lb=.455 kg). Source: 1975-1983 from Yaremchuk et al. (1989) unless otherwise noted. Local harvest data for 1978-1989 were recorded primarily by community and are in Appendices D2 to D5. Values for lake whitefish recorded in Yaremchuk et al. (1989) for 1975, 1979 and 1983 may include broad whitefish. The number of commercial fishing licenses sold in each community can be found in Appendix D4 for 1982 to 1989.

		Year									
Location	Species	1975	1976[1]	1977	1978	1979[2]	1979	1980[3]	1981	1982	1983
Area I	Broad Whitefish	ND[4]	ND	ND	ND	705	-	146	ND	ND	ND
	Arctic Char					683	638	-			
	Lake Trout					-	181	346			
	TOTAL					1,388	819	492			
Area II	Broad Whitefish	ND	ND	ND	ND	4,213	-	591	16,773	ND	ND
	Lake Whitefish					910	5,504	-	4,923		
	Inconnu					1,320	-	63	434		
	Other[5]					364	-	-	-		
	TOTAL					6,807	5,504	654	22,130		
Area III	Broad Whitefish	ND	ND	ND	ND	1,524	-	2,293	-	ND	ND
	Lake Whitefish					-	680	-	-		
	Inconnu					250	-	55	-		
	Arctic Char					-	-	1,494	357		
	TOTAL					1,774	680	3,842	357		
Area IV	Broad Whitefish	ND	ND	ND	ND	ND	-	ND	ND	ND	ND
	Inconnu						2,370				
	TOTAL						2,370				
Area V	Broad Whitefish	ND	ND	ND	ND	ND	-	ND	ND	ND	ND
	Other						363				
	TOTAL						363				

Appendix D1b. Continued.

Location	Species	1975	1976[1]	1977	1978	1979[2]	1979	1980[3]	1981	1982	1983
						Year					
Unkown[6]	Broad Whitefish	ND	-	-	569	ND	-	-	ND	23,374	ND
	Lake Whitefish		-	-	-		6,185	-		122	
	Whitefish Sp.[7]		16,162	523	2,730		-	9,054		-	
	Inconnu		-	-	-		2,370	2,391		347	
	Arctic Char		-	-	1,297		640	4,727		816	
	Lake Trout		-	-	-		181	-		-	
	Other		-	-	-		363	-		54	
	Fish Sp.		-	-	-		-	3,463		-	
	TOTAL		16,162[8]	523[8]	4,596[9]		9,739[10]	19,635[11]		24,713	
Peel River[12]	Broad Whitefish	ND	ND	ND	1,201	ND	ND	ND	ND	ND	-
	Lake Whitefish				182						2,560
	Inconnu				46						-
	Arctic Char				109						-
	Other				155						-
	TOTAL				1,693[2]						2,560
Tsiigeht-chic[12]	Broad Whitefish	ND	ND	ND	910	855	ND	1,300	ND	ND	ND
	Lake Whitefish				546	-		637			
	Inconnu				-	455		57			
	TOTAL				1,456[2]	1,310		1,994			
Tuktoyuktuk Area[13]	Broad Whitefish	-	ND	ND	ND	546	ND	91	ND	ND	ND
	Lake Whitefish	10				-		-			
	Inconnu	-				-		91			
	Cisco Sp.	-				-		91			
	TOTAL	10				546		273			
Sitidgi Lake[12]	Broad Whitefish	-	ND	-	ND	-	ND	46	61	ND	-
	Lake Whitefish	-		-		-		23	90		-
	Lake Whitefish & Lake Trout	-		907		-		-	264		360
	Lake Trout	971		-		73		273	454		-
	TOTAL	971		907		73		342[11]	869		360
Noell Lake[12]	Broad Whitefish	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
	Lake Whitefish					119					
	TOTAL					119					

Appendix D1b. Continued.

Location	Species	1975	1976[1]	1977	1978	1979[2]	1979	1980[3]	1981	1982	1983
							Year				
TOTAL[14]	Broad Whitefish	-	-	-	2,680	7,843	-	4,467	16,834	23,374	-
	Lake Whitefish	10	-	-	728	1,484	6,184	660	5,013	122	2,560
	Whitefish Sp.	-	16,162	523	2,730	-	-	9,054	-	-	-
	Inconnu	-	-	-	46	1,570	2,370	2,657	434	347	-
	Cisco Sp.	-	-	-	-	-	-	91	-	-	-
	Arctic Char	971	-	-	1,406	683	638	6,221	357	816	-
	Lake Trout	-	-	-	-	73	181	619	454	-	-
	Lake Whitefish & Lake Trout	-	-	907	-	-	-	-	264	-	360
	Other	-	-	-	155	364	363	-	-	54	-
	Fish Sp.	-	-	-	-	-	-	3,463	-	-	-
	Total	981	16,162	1,430	7,745	12,017	9,736	27,232	23,356	24,713	2,920
	License Numbers[15]				-	-	-	-	-	74	57
	# Surveys[16]				25	58	-	71	-	28	34
	% of Sales[17]				-	-	-	-	-	38	60

[1]Management area boundaries created, see Fig. 22.

[2]Corkum and McCart (1981), local sales only. Local sales reported by Corkum and McCart (1981) for 1978 were less than those reported by Dahlke (unpublished report) found in Appendix D3. Also, the management area boundaries reported in Corkum and McCart were only proposed boundary areas. Data reported as coming from management area V actually came from the Tuktoyaktuk Peninsula area and has been recorded as such here.

[3]Corkum and McCart (1981), local sales only unless indicated. Data were reported only as number of fish sold. Reported values were based on the following conversion factors; herring or cisco = 1 lb (.455 kg), all other fish = 4 lb (1.8 kg). Dahlke (unpublished report) reported a greater number of fish sold in 1980 than did Corkum and McCart (1981) (Appendix D3). See footnote number 2 for information concerning fisheries management area V.

[4]No data collected or no sales occured for this year and location.

[5]Includes northern pike, burbot, sucker sp. (mullet), and others.

[6]Fishing location was not indicated.

[7]Primarily broad whitefish but does include lake whitefish.

[8]Corkum and McCart (1981), commercial harvest exported from the Mackenzie Delta.

[9]Corkum and McCart (1981), export and local sales combined. Similar data is reported in Yaremchuk et al. (1989).

[10]These values match those found in fisheries management areas I-V above, and could be duplicates. Therefore, they have not been used to calculate the yearly total. The arctic char harvest was added from Corkum and McCart (1981) who reported a similar total Mackenzie Delta export harvest (9,767 kg).

Appendix D1b. Continued.

[11]Corkum and McCart (1981), commercial harvest exported from the Mackenzie Delta. Yaremchuk et al. (1989) reported similar values.
[12]These areas are not included in any of the above fisheries management areas.
[13]Tuktoyaktuk Harbour was included in fisheries management area IV in 1991. Areas on or near the Tuktoyaktuk Peninsula (eg. Eskimo (Husky) Lakes and Liverpool Bay) are reported seperately.
[14]Sum of data from the above management areas and fishing locations.
[15]Total number of commercial fishing licenses sold for the above areas from Department of Fisheries and Oceans (1992, 1993, 1994, and unpublished data).
[16]Number of surveys returned.
[17]Number of surveys returned as a per cent of the total licenses sold.

Appendix D1c. Export and local commercial harvest sales (kg) reported for the Lower Mackenzie River, NWT, 1990-1993, by management area (1 lb=.455 kg). Source: Department of Fisheries and Oceans (1992b, 1993 and 1994). Local sales data for 1978-1989 were recorded primarily by community and are in Appendices D2 and D3. The number of commercial fishing licenses sold in each community can be found in Appendix D8 for 1990 to 1993.

Location	Species	Year 1990	1991[1]	1992	1993
Area I	Broad Whitefish	NS[2]	ND[3]	ND	ND
	TOTAL				
Area II	Broad Whitefish	6,325	318	ND	552
	Inconnu	154	-		68
	TOTAL	6,479[4]	318		620
Area III	Broad Whitefish	ND	NS	ND	ND
	TOTAL				
Area IV	Broad Whitefish	NS	ND	ND	NS
	TOTAL				
Area V	Broad Whitefish	460	ND	ND	345
	Inconnu	-			225
	TOTAL	460			570
Area VI[5]		NO[6]	NO	NO	NO
Tuktoyuktuk Area[7]	Broad Whitefish	690			
	Inconnu	54			
	Cisco Sp.[8]	40			
	TOTAL	784			
Peel River[9]	Broad Whitefish	15	24	ND	NS
	Inconnu	18	-		
	Arctic Char	75	-		
	Other[10]	5	-		
	TOTAL	113	24		
Sitidgi Lake[9]	Broad Whitefish	-	-	ND	-
	Lake Trout	117	22		48
	TOTAL	117[3]	22		48

Appendix D1c. Continued.

Location	Species	1990	Year 1991[1]	1992	1993
Manuel Lake[9]	Broad Whitefish	136	ND	ND	ND
	Lake Trout	100			
	TOTAL	236			
TOTAL[11]	Broad Whitefish	7,626	342	ND	897
	Inconnu	226	-		293
	Cisco Sp.	40	-		-
	Arctic Char	75	-		-
	Lake Trout	217	22		48
	Other	5	-		-
	TOTAL	8,189	364		1,238
	License Numbers[12]	54	31	33	22
	# Surveys[13]	18	8	0	12
	% of Sales[14]	33	26	0	55

[1]Management area boundaries changed, see Fig. 24.
[2]Fish harvests were reported but no sales were made for this year and location.
[3]No data were reported for this year and location.
[4]Original data sheets used; errors were found in the Department of Fisheries and Oceans 1992 report.
[5]Management area VI created in 1987 and closed to fishing Aug. 1-31, 1987-1992.
[6]This area was not open to commercial fishing.
[7]Tuktoyaktuk Harbour was included in fisheries management area IV in 1991. Areas on or near the Tuktoyaktuk Peninsula (eg. Eskimo (Husky) Lakes and Liverpool Bay) are reported seperately.
[8]Includes least and arctic cisco.
[9]These areas are not included in any of the above management areas.
[10]May include herring, salmon, sucker sp. (mullet), and others.
[11]Sum of data from the above management areas and fishing locations.
[12]Total number of commercial fishing licenses sold for the above areas: Department of Fisheries and Oceans (1992b, 1993, 1994, and 1995). See Appendix D8 for a break down of licenses sold by community.
[13]Number of surveys returned.
[14]Number of surveys returned as a per cent of the total licenses sold.

Appendix D2. Commercial license holders reported sales (# fish) for coregonid species, by community. Sources: 1978-1981 from Dahlke (unpublished report), and 1982 to 1989 from the Department of Fisheries and Oceans (1991, 1992a, 1992b, and unpublished data).

Location	Species	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[1]	1988	1989
								Year					
Aklavik	Broad Whitefish	660	ND[5]	405	1,130	191	217	502	415	475	250	340	320
	Lake Whitefish	110		15	150	250	-	-	-	-	-	-	-
	Inconnu	25		30	50	45	55	20	20	60	50	175	50
	Cisco Sp.[2]	-		-	-	-	-	-	50	-	-	-	-
	Other[3]	165		55	620	780	735	100	100	70	14	240	75
	TOTAL	960		505	1,950	1,266	1,007	622	585	605	314	755	445
	License Numbers[4]					21	20	17	19	19	13	11	19
	No. Surveys[4]					7	13	15	16	17	7	11	12
	% of Sales					33	65	88	84	89	54	100	63
Inuvik	Broad Whitefish	313	ND	969	5,071	3,933	1,545	1,550	441	395	1,445	850	2,850
	Lake Whitefish	-		30	1,419	65	-	750	9	-	830	160	1,060
	Inconnu	-		140	300	39	8	-	100	10	15	10	3
	Other	-		-	48	549	65	150	9	85	150	130	1,020
	TOTAL	313		1,139	6,838	4,586	1,618	2,450	559	490	2,440	1,150	4,933
	License Numbers					35	23	33	24	16	21	16	32
	No. Surveys					11	13	33	18	5	12	10	9
	% of Sales					31	57	100	75	31	57	63	28
Tuktoy-uktuk	Broad Whitefish	NS[6]	ND	50	71	25	-	-	50	50	NS	-	75
	Lake Whitefish			-	-	7	-	-	-	-		-	-
	Inconnu			32	14	14	5	15	40	-		-	15
	Cisco Sp.			-	-	-	-	-	-	100		800	1,000
	P. Herring			200	100	-	-	-	-	-		-	-
	TOTAL			282	185	46	5	15	90	150		800	1,090
	License Numbers					4	6	14	7	10	5	2	2
	No. Surveys					1	3	5	6	10	4	1	2
	% of Sales					25	50	36	86	100	80	50	100

Appendix D2. Continued.

Location	Species	1978	1979	1980	1981	1982	1983	Year 1984	1985	1986	1987[1]	1988	1989
Tsiigeht-chic	Broad Whitefish	275	ND	970	957	1,106	100	400	190	600	515	550	250
	Lake Whitefish	700		350	300	254	200	75	150	110	550	-	-
	Inconnu	15		25	49	123	-	50	8	300	150	50	-
	Cisco	-		-	-	-	150	-	-	-	-	-	-
	Other	-		55	-	179	50	-	-	-	-	-	-
	TOTAL	990		1,400	1,306	1,662	500	525	348	1,010	1,215	600	250
	License Numbers					7	2	6	6	8	7	7	4
	No. Surveys					5	2	5	4	8	7	2	4
	% of Sales					71	100	83	67	100	100	29	100
Ft. McPherson	Broad Whitefish	ND	ND	300	392	24	540	NS	10	NS	100	764	ND
	Lake Whitefish			-	-	-	50		-		-	65	
	Inconnu			10	85	50	-		-		-	84	
	Cisco Sp.			-	-	-	50		-		-	-	
	Other			267	-	-	-		-		-	100	
	TOTAL			577	477	74	640		10		100	1,013	
	License Numbers					7	8	6	4	3	9	6	3
	No. Surveys					4	3	2	4	3	7	4	0
	% of Sales					57	38	33	100	100	78	67	0
Ft. Good Hope	Broad Whitefish	NS	ND	ND	ND	NF[7]	NF	ND	ND	NF	NF	NF	NF
	License Numbers					0	0	1	1	0	0	0	0
	No. Surveys					-	-	0	0	-	-	-	-
	% of Sales					-	-	0	0	-	-	-	-
TOTAL[8]	Broad Whitefish	1,248	ND	2,694	7,621	5,279	2,402	2,452	1,106	1,520	2,310	2,504	3,495
	Lake Whitefish	810		395	1,869	576	250	825	159	110	1,380	225	1,060
	Inconnu	40		237	498	271	68	85	168	370	215	319	68
	Cisco Sp.	-		-	-	-	200	-	50	100	-	800	1,000
	P. Herring	-		200	100	-	-	-	-	-	-	-	-
	Other	165		377	668	1,508	850	250	109	155	164	470	1,095
	TOTAL	2,263		3,903	10,756	7,634	3,770	3,612	1,592	2,255	4,019	4,318	6,718
	License Numbers	-		-	-	74	57	77	62[9]	56	55	42	60
	No. Surveys	25		71	-	28	34	60	48	43	37	28	27
	% of Sales	-		-	-	38	60	80	77	77	67	67	45

[1]Management area boundaries changed, see Fig. 23.
[2]Includes least cisco and arctic cisco.

Appendix D2. Continued.

[3]Includes arctic char, salmon sp., northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
[4]Source:DFO economics branch for 1982 to present.
[5]No data reported for this year and location.
[6]Fish harvest reported but no sales made.
[7]No commercial fishing occured for this year and location.
[8]Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.
[9]One license sold for the community identified as Mackenzie Delta.

Appendix D3. Commercial license holders reported sales (kg) for coregonid species and total sales (all species) by Community. Data from Appendix D2 has been converted to kilograms using the following conversion factors; broad whitefish 2.3 kg, lake whitefish 1.3 kg, inconnu 4.5 kg, cisco sp. and pacific herring 0.4 kg, arctic char 1.3 kg, northern pike 2.3 kg, burbot 3.0 kg, sucker sp. 1.0 kg, chum salmon 3.0 kg, lake trout 4.0 kg (Department of Fisheries and Oceans 1991), and a mean value of 1.4 kg for arctic grayling (Scott and Crossman 1973).

		Year											
Location	Species	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[1]	1988	1989
Aklavik	Broad Whitefish	1,518	ND[5]	932	2,599	439	499	1,155	955	1,093	575	782	736
	Lake Whitefish	143		20	195	325	-	-	-	-	-	-	-
	Inconnu	113		135	225	203	248	90	90	270	225	788	225
	Cisco Sp.[2]	-		-	-	-	-	-	20	-	-	-	-
	Other[3]	318		178	1,024	1,186	956	130	300	91	42	652	98
	TOTAL	2,092		1,265	4,043	2,153	1,703	1,375	1,365	1,454	842	2,222	1,059
	License Numbers[4]					21	20	17	19	19	13	11	19
	No. Surveys[4]					7	13	15	16	17	7	11	12
	% of Sales					33	65	88	84	89	54	100	63
Inuvik	Broad Whitefish	720	ND	2,229	11,663	9,046	3,554	3,565	1,014	909	3,324	1,955	6,555
	Lake Whitefish	-		39	1,845	85	-	975	12	-	1,079	208	1,378
	Inconnu	-		630	1,350	176	36	-	450	45	68	45	14
	Other	-		-	162	815	260	394	36	340	600	520	2,352
	TOTAL	720		2,898	15,020	10,122	3,850	4,934	1,512	1,294	5,071	2,728	10,299
	License Numbers					35	23	33	24	16	21	16	32
	No. Surveys					11	13	33	18	5	12	10	9
	% of Sales					31	57	100	75	31	57	63	28
Tuktoy-uktuk	Broad Whitefish	NS[6]	ND	115	163	58	-	-	115	115	NS	-	173
	Lake Whitefish			-	-	9	-	-	-	-		-	-
	Inconnu			144	63	63	23	68	180	-		-	68
	Cisco Sp.			-	-	-	-	-	-	40		320	400
	P. Herring			80	40	-	-	-	-	-		-	-
	TOTAL			339	266	130	23	68	295	155		320	641
	License Numbers					4	6	14	7	10	5	2	2
	No. Surveys					1	3	5	6	10	4	1	2
	% of Sales					25	50	36	86	100	80	50	100
Tsiigeht-chic	Broad Whitefish	633	ND	2,231	2,201	2,544	230	920	437	1,380	1,185	1,265	575
	Lake Whitefish	910		455	390	330	260	98	195	143	715	-	-
	Inconnu	68		113	221	554	-	225	36	1,350	675	225	-
	Cisco Sp.	-		-	-	-	150	-	-	-	-	-	-
	Other	-		178	-	270	150	-	-	-	-	-	-
	TOTAL	1,611		2,977	2,812	3,698	790	1,243	668	2,873	2,575	1,490	575
	License Numbers					7	2	6	6	8	7	7	4
	No. Surveys					5	2	5	4	8	7	2	4
	% of Sales					71	100	83	67	100	100	29	100

Appendix D3. Continued.

Location	Species	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[1]	1988	1989
								Year					
Ft. McPherson	Broad Whitefish	ND	ND	690	902	55	1,242	NS	23	NS	230	1,757	ND
	Lake Whitefish			-	-	-	65		-		-	85	
	Inconnu			45	383	225	-		-		-	378	
	Cisco Sp.			-	-	-	20		-		-	-	
	Other			466	-	-	-		-		-	130	
	TOTAL			1,201	1,285	280	1,327		23		230	2,350	
	License Numbers					7	8	6	4	3	9	6	3
	No. Surveys					4	3	2	4	3	7	4	0
	% of Sales					57	38	33	100	100	78	67	0
Ft. Good Hope	Broad Whitefish	NS	ND	ND	ND	NF[7]	NF	ND	ND	NF	NF	NF	NF
	License Numbers					0	0	1	1	0	0	0	0
	No. Surveys					-	-	0	0	-	-	-	-
	% of Sales					-	-	0	0	-	-	-	-
TOTAL[8]	Broad Whitefish	2,871	ND	6,197	17,528	12,142	5,525	5,640	2,544	3,497	5,314	5,759	8,039
	Lake Whitefish	1,053		514	2,430	749	325	1,073	207	143	1,794	293	1,378
	Inconnu	181		1,067	2,242	1,221	307	383	756	1,665	968	1,436	307
	Cisco Sp.	-		-	-	-	170	-	20	40	-	320	400
	P. Herring	-		80	40	-	-	-	-	-	-	-	-
	Other	318		822	1,186	2,271	1,366	524	336	431	642	1,302	2,450
	TOTAL	4,423		8,680	23,426	16,383	7,693	7,620	3,863	5,776	8,718	9,110	12,574
	License Numbers	-	-	-	-	74	57	77	62[9]	56	55	42	60
	No. Surveys	25	58	71	-	28	33	60	48	43	37	28	27
	% of Sales	-	-	-	-	38	60	80	77	77	67	67	45

[1] Management area boundaries changed, see Fig. 23.
[2] Includes least cisco and arctic cisco.
[3] Includes arctic char, salmon sp., northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
[4] Source:DFO Economics Branch for 1982 to present and Corkum and McCart (1981) for 1978 to 1980.
[5] No data are available. However, Appendix D1b contains local sales for 1979 reported by Corkum and McCart (1981).
[6] Fish harvest reported but no sales were made.
[7] No commercial fishing occurred for this year and location.
[8] Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.
[9] One license sold for the community identified as Mackenzie Delta.

Appendix D4. Commercial license holders reported catch (# fish) for coregonid species and total catch (all species) by community. Sources: 1978-1981 from Dahlke (unpublished report), 1982-1989 from Dept. of Fisheries and Oceans (1991, 1992a, and unpublished data). Most of this catch was used for subsistence purposes, only a small fraction was sold locally, see Appendices D2 and D3 for the amount sold.

		Year											
Location	Species	1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987[2]	1988	1989
Aklavik	Broad Whitefish	4,200	5,685	8,218	8,869	1,150	1,851	3,237	4,985	8,268	5,617	4,654	2,909
	Lake Whitefish	2,260	4,567	4,228	3,939	650	1,102	1,296	2,377	3,623	3,539	2,738	2,209
	Inconnu	1,085	1,238	1,338	1,344	710	620	482	466	991	795	1,052	2,360
	Cisco Sp.[3]	800	6,000	13,963	7,925	-	500	-	1,075	-	1,000	100	900
	P. Herring	-	-	-	-	3,000	8,300	1,325	-	8,578	115	700	15
	Other[4]	1,329	6,700	10,134	5,816	2,596	4,907	1,733	3,527	3,379	1,397	5,144	5,593
	TOTAL	9,674	24,190	37,881	27,893	8,106	17,280	8,073	12,430	24,839	12,463	14,388	13,986
	License Numbers[5]					21	20	17	19	19	13	11	19
	No. Surveys[5]					7	13	15	16	17	7	11	12
	% of Sales					33	65	88	84	89	54	100	63
Inuvik	Broad Whitefish	1,951	13,840	9,387	10,948	7,953	6,394	14,964	5,953	2,330	3,130	5,375	6,712
	Lake Whitefish	2,910	13,650	6,151	6,355	4,915	6,976	9,262	4,075	1,650	4,772	7,495	2,980
	Inconnu	162	2,188	2,077	1,046	1,240	1,231	1,991	934	185	542	665	413
	Cisco Sp.	500	2,168	1,911	586	1	6	200	-	-	22	900	-
	P. Herring	-	-	-	-	-	220	300	-	-	-	-	-
	Other	853	6,214	4,994	1,813	2,826	4,032	4,508	2,505	841	940	3,101	2,692
	TOTAL	6,376	38,060	24,520	20,748	16,935	18,859	31,225	13,467	5,006	9,406	17,536	12,797
	License Numbers					35	23	33	24	16	21	16	32
	No. Surveys					11	13	33	18	5	12	10	9
	% of Sales					31	57	100	75	31	57	63	28
Tuktoy-uktuk	Broad Whitefish	685	ND[6]	1,470	3,113	25	595	5,740	900	2,842	682	70	900
	Lake Whitefish	735		225	286	7	300	1,140	90	359	189	-	-
	Inconnu	495		360	551	14	60	150	285	455	19	1	20
	Cisco Sp.	-		-	-	-	20	1,055	2,000	3,455	532	900	1,800
	P. Herring	3,300		3,850	4,674	-	1,415	1,811	150	1,100	12	-	850
	Other	25		62	130	-	226	71	48	155	148	-	2
	TOTAL	5,240		5,967	8,754	46	2,616	9,967	3,473	8,366	1,582	971	3,572
	License Numbers					4	6	15	7	10	5	2	2
	No. Surveys					1	3	5	6	10	4	1	2
	% of Sales					25	50	36	86	100	80	50	100

Appendix D4. Continued.

Location	Species	Year 1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987[2]	1988	1989
Tsiigeht-chic	Broad Whitefish	500	1,500	3,700	5,987	2,343	700	1,807	900	5,110	3,727	1,700	1,700
	Lake Whitefish	900	75	1,620	5,115	585	600	470	550	5,953	7,450	2,500	3,400
	Inconnu	65	210	1,077	1,380	323	75	360	185	2,025	1,040	1,400	980
	Cisco	100	-	350	90	1	300	50	300	-	-	-	-
	P. Herring	-	-	-	-	-	-	-	-	250[7]	105[7]	-	160[7]
	Other	257	110	1,201	1,649	404	60	350	334	1,455	575	1,400	305
	TOTAL	1,822	1,895	7,948	14,221	3,656	1,735	3,037	2,269	14,793	12,897	7,000	6,545
	License Numbers					7	2	6	6	8	7	7	4
	No. Surveys					5	2	5	4	8	7	2	4
	% of Sales					71	100	83	67	100	100	29	100
Ft. McPherson	Broad Whitefish	ND	2,220	2,937	1,402	400	4,100	636	1,075	200	3,850	914	ND
	Lake Whitefish		2,950	6,100	765	552	100	285	2,550	3,000	6,950	305	
	Inconnu		250	648	490	375	215	340	300	200	520	337	
	Cisco Sp.		1,000	220	1,210	-	100	-	20	-	-	13	
	P. Herring		-	-	-	700[7]	-	-	-	-	300[7]	50[7]	
	Other		2,380	3,388	1,900	112	1,095	1,728	1,860	200	3,368	427	
	TOTAL		8,800	13,293	5,767	2,139	5,610	2,989	5,805	3,600	14,988	2,046	
	License Numbers					7	8	6	4	3	9	6	3
	No. Surveys					4	3	2	4	3	7	4	0
	% of Sales					57	38	33	100	100	78	67	0
Ft. Good Hope	Broad Whitefish	18	ND	ND	ND	NF[8]	NF	ND	ND	NF	NF	NF	NF
	Lake Whitefish	-											
	Inconnu	80											
	Cisco Sp.	275											
	Other	3											
	TOTAL	376											
	License Numbers					0	0	1	1	0	0	0	0
	No. Surveys					-	-	0	0	-	-	-	-
	% of Sales					-	-	0	0	-	-	-	-
TOTAL[9]	Broad Whitefish	7,354	23,245	25,712	30,319	11,871	13,640	26,384	13,813	18,750	17,006	12,713	12,221
	Lake Whitefish	6,805	21,242	18,324	16,460	6,709	9,078	12,453	9,642	14,585	22,900	13,038	8,589
	Inconnu	1,887	3,886	5,500	4,811	2,662	2,201	3,323	2,170	3,856	2,916	3,455	3,773
	Cisco Sp.	1,675	9,168	16,444	9,811	2	926	1,305	3,395	3,455	1,554	1,913	2,700
	P. Herring	3,300	-	3,850	4,674	3,700	9,935	3,436	150	9,928	532	750	1,025
	Other	2,467	15,404	19,779	11,308	5,938	10,320	8,390	8,274	6,030	6,428	10,072	8,592
	TOTAL	23,488	72,945	89,609	77,383	30,882	46,100	55,291	37,444	56,604	51,336	41,941	36,900
	License Numbers	-	-	-	-	74	57	77	62[10]	56	55	42	60
	No. Surveys	25	58	71	-	28	34	60	48	43	37	28	27
	% of Sales	-	-	-	-	38	60	80	77	77	67	67	45

Appendix D4. Continued.

[1] Includes domestic license questionaire data.
[2] Management area boundaries changed, see Fig. 23.
[3] Includes least cisco and arctic cisco.
[4] Includes arctic char, salmon sp., northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
[5] Source:DFO economics branch for 1982 to present.
[6] No Data collected for this year and location.
[7] Pacific herring are not found in the rivers and channels near the communities of Ft. McPherson or Tsiigehtchic. Therefore this harvest may be cisco sp. because herring is a local common name for least and arctic cisco.
[8] No commercial fishing occured for this year and location.
[9] Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.
[10] One license sold for the community identified as Mackenzie Delta.

Appendix D5. Commercial license holders reported catch (kg) for coregonid species and total catch (all species) by Community. Data from Appendix D4 have been converted to kilograms using the following conversion factors; broad whitefish 2.3 kg, lake whitefish 1.3 kg, inconnu 4.5 kg, cisco sp. and pacific herring 0.4 kg, arctic char 1.3 kg, northern pike 2.3 kg, burbot 3.0 kg, sucker sp. 1.0 kg, chum salmon 3.0 kg, lake trout 4.0 kg (Department of Fisheries and Oceans 1991), and a mean value of 1.4 kg for arctic grayling (Scott and Crossman 1973). Most of this catch was used for subsistence purposes, only a small fraction was sold locally, see Appendix D2 and D3 for the amount sold.

		Year											
Location	Species	1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987[2]	1988	1989
Aklavik	Broad Whitefish	9,660	13,078	18,901	20,399	2,645	4,257	7,445	11,466	19,016	12,919	10,704	6,691
	Lake Whitefish	2,938	5,937	5,496	5,121	845	1,433	1,685	3,090	4,710	4,601	3,559	2,872
	Inconnu	4,883	5,571	6,021	6,048	3,195	2,790	2,169	2,097	4,460	3,578	4,734	10,620
	Cisco Sp.[3]	320	2,400	5,585	3,170	-	200	-	430	-	400	40	360
	P. Herring	-	-	-	-	1,200	3,320	530	-	3,431	46	280	6
	Other[4]	2,830	13,405	22,428	12,837	5,186	9,509	3,710	8,400	7,970	259	12,745	14,155
	TOTAL	20,631	40,491	58,431	47,575	13,071	21,509	15,539	25,483	39,587	21,803	32,062	34,704
	License Numbers[5]					21	20	17	19	19	13	11	19
	No. Surveys[5]					7	13	15	16	17	7	11	12
	% of Sales					33	65	88	84	89	54	100	63
Inuvik	Broad Whitefish	4,487	31,832	21,590	25,180	18,292	14,706	34,417	13,692	5,359	7,199	12,363	15,438
	Lake Whitefish	3,783	17,745	7,996	8,262	6,390	9,069	12,041	5,298	2,145	6,204	9,744	3,874
	Inconnu	729	9,846	9,347	4,707	5,580	5,540	8,960	4,203	833	2,439	2,993	1,859
	Cisco Sp.	200	867	764	234	1	2	80	-	-	9	360	-
	P. Herring	-	-	-	-	-	88	120	-	-	-	-	-
	Other	2,291	14,980	12,931	4,657	5,461	10,263	12,229	6,455	2,568	2,572	8,553	7,211
	TOTAL	11,490	75,270	52,628	43,040	35,724	39,668	67,847	29,648	10,905	18,423	34,013	28,382
	License Numbers					35	23	33	24	16	21	16	32
	No. Surveys					11	13	33	18	5	12	10	9
	% of Sales					31	57	100	75	31	57	63	28
Tuktoyuktuk	Broad Whitefish	1,576	ND[6]	3,381	7,160	58	1,369	13,202	2,070	6,537	1,569	161	2,070
	Lake Whitefish	956		293	372	9	390	1,482	117	467	246	-	-
	Inconnu	2,228		1,620	2,480	63	270	675	1,283	2,048	86	5	90
	Cisco Sp.	-		-	-	-	8	422	800	1,382	213	360	720
	P. Herring	1,320		1,540	1,870	-	566	724	60	440	5	-	340
	Other	65		186	295	-	856	110	108	348	330	-	5
	TOTAL	6,145		7,020	12,177	130	3,459	16,615	4,438	11,222	2,449	526	3,225
	License Numbers					4	6	15	7	10	5	2	2
	No. Surveys					1	3	5	6	10	4	1	2
	% of Sales					25	50	36	86	100	80	50	100

Appendix D5. Continued.

Location	Species	1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987[2]	1988	1989
							Year						
Tsiigeht-chic	Broad Whitefish	1,150	3,450	8,510	13,770	5,389	1,610	4,156	2,070	11,753	8,572	3,910	3,910
	Lake Whitefish	1,170	98	2,106	6,650	761	780	611	715	7,739	9,685	3,250	4,420
	Inconnu	293	945	4,847	6,210	1,454	338	1,620	833	9,113	4,680	6,300	4,410
	Cisco Sp.	40	-	140	36	1	120	20	120	-	-	-	-
	P. Herring	-	-	-	-	-	-	-	-	100[7]	42[7]	-	64[7]
	Other	494	243	2,802	3,657	676	160	939	500	3,040	1,361	3,665	750
	TOTAL	3,147	4,736	18,405	30,323	8,281	3,008	7,346	4,238	31,745	24,340	17,125	13,554
	License Numbers					7	2	6	6	8	7	7	4
	No. Surveys					5	2	5	4	8	7	2	4
	% of Sales					71	100	83	67	100	100	29	100
Ft. McPherson	Broad Whitefish	ND	5,106	6,755	3,225	920	9,430	1,463	2,473	460	8,855	2,102	ND
	Lake Whitefish		3,835	7,930	995	718	130	371	3,315	3,900	9,035	397	
	Inconnu		1,125	2,916	2,205	1,688	968	1,530	1,350	900	2,340	1,517	
	Cisco Sp.		400	88	484	-	40	-	8	-	-	5	
	P. Herring		-	-	-	280[7]	-	-	-	-	120[7]	20[7]	
	Other		3,760	7,016	3,284	307	2,768	4,666	3,738	430	4,851	798	
	TOTAL		14,226	24,705	10,193	3,913	13,336	8,030	10,884	5,690	25,201	4,839	
	License Numbers					7	8	6	4	3	9	6	3
	No. Surveys					4	3	2	4	3	7	4	0
	% of Sales					57	38	33	100	100	78	67	0
Ft. Good Hope	Broad Whitefish	41	ND	ND	ND	NF[8]	NF	ND	ND	NF	NF	NF	NF
	Lake Whitefish	-											
	Inconnu	360											
	Cisco Sp.	110											
	Other	7											
	TOTAL	518											
	License Numbers					0	0	1	1	0	0	0	0
	No. Surveys					-	-	0	0	-	-	-	-
	% of Sales					-	-	0	0	-	-	-	-
TOTAL[9]	Broad Whitefish	16,914	53,466	59,137	69,734	27,304	31,372	60,683	31,771	43,125	39,114	29,240	28,109
	Lake Whitefish	8,847	27,615	23,821	21,400	8,723	11,802	16,190	12,535	18,961	29,771	16,950	11,166
	Inconnu	8,493	17,487	24,751	21,650	11,980	9,906	14,954	9,766	17,354	13,123	15,549	16,979
	Cisco Sp.	670	3,667	6,577	3,924	2	370	522	1,358	1,382	622	765	1,080
	P. Herring	1,320	-	1,540	1,870	1,480	3,974	1,374	60	3,971	213	300	410
	Other	5,687	32,388	45,363	24,730	11,630	23,556	21,654	19,201	14,356	9,373	25,761	22,121
	TOTAL	41,931	134,623	161,189	143,308	61,119	80,980	115,377	74,691	99,149	92,216	88,565	79,865
	License Numbers	-	-	-	-	74	57	77	62[10]	56	55	42	60
	No. Surveys	25	58	71	-	28	33	60	48	43	37	28	27
	% of Sales	-	-	-	-	38	60	80	77	77	67	67	45

Appendix D5. Continued.

[1]Includes domestic license questionaire data.
[2]Management area boundaries changed, see Fig. 23.
[3]Includes least cisco and arctic cisco.
[4]Includes arctic char, salmon sp., northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
[5]Source:DFO Economics Branch for 1982 to present.
[6]No data collected for this year and location.
[7]Pacific herring are not found in the rivers and channels near the communities of Ft. McPherson or Tsiigehtchic. Therefore this harvest may be cisco sp. because herring is a local common name for least and arctic cisco.
[8]No commercial fishing occurred for this year and location.
[9]Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.
[10]One license sold for the community identified as Mackenzie Delta.

Appendix D6. Commercial license holders reported catch (kg) for the Lower Mackenzie River, NWT, 1990-1993, by management area (1 lb=.455 kg). Source: Department of Fisheries and Oceans (1992b, 1993, 1994, and 1995). The number of commercial fishing licenses sold in each community can be found in Appendix D8.

Location	Species	Year 1990	1991[1]	1992	1993
Area I	Broad Whitefish	3,144	ND[2]	ND	ND
	Lake Whitefish	832			
	Inconnu	1,066			
	Cisco Sp.[3]	1,440			
	Northern Pike	448			
	TOTAL	6,930[4]			
Area II	Broad Whitefish	6,776	767	ND	3,128
	Lake Whitefish	789	-		73
	Inconnu	469	-		545
	P. Herring	2	-		-
	Northern Pike	257	45		283
	Burbot	105	15		600
	Other[5]	10	-		23
	TOTAL	8,408[6]	827		4,652
Area III	Broad Whitefish	ND	3,122	ND	ND
	Northern Pike		828		
	Burbot		92		
	TOTAL		4,042		
Area IV	Broad Whitefish	23	ND	ND	460
	Inconnu	23			-
	TOTAL	46			460
Area V	Broad Whitefish	1,150	ND	ND	2,300
	Lake Whitefish	-			871
	Inconnu	225			720
	Burbot	60			90
	Northern Pike	-			230
	Other	-			60
	TOTAL	1,435[6]			4,271
Area VI[7]		NO[8]	NO	NO	NO

Appendix D6. Continued.

Location	Species	1990	1991[1]	1992	1993
			Year		
Tuktoyuktuk Area[9]	Broad Whitefish	803	ND	ND	ND
	Lake Whitefish	363			
	Inconnu	58			
	Cisco Sp.	94			
	TOTAL	1,318			
Unkown[10]	Broad Whitefish	373	ND	ND	ND
	Lake Whitefish	130			
	Inconnu	225			
	Cisco Sp.	8			
	Arctic Char	5			
	Northern Pike	115			
	Burbot	90			
	Other	11			
	TOTAL	957[6]			
Peel River[11]	Broad Whitefish	1,218	802	ND	2,300
	Lake Whitefish	30	-		650
	Inconnu	500	-		450
	Arctic Char	250	-		-
	Lake Trout	3	-		-
	Northern Pike	496	-		230
	Burbot	623	-		300
	Other	176	-		22
	TOTAL	3,296[6]	802		3,952
Sitidgi Lake[11]	Broad Whitefish	136	-	ND	58
	Lake Whitefish	-	-		39
	Inconnu	-	-		-
	Lake Trout	182	299		60
	Other	-	-		3
	TOTAL	318[6]	299		160
Sam McRae Lake[11]	Broad Whitefish	2	ND	ND	ND
	Lake Whitefish	-			
	Lake Trout	64			
	Northern Pike	13			
	TOTAL	79			

Appendix D6. Continued.

Location	Species	1990	Year 1991[1]	1992	1993
Manuel Lake[11]	Broad Whitefish	136	ND	ND	ND
	Lake Whitefish	-			
	Lake Trout	100			
	TOTAL	236			
TOTAL[12]	Broad Whitefish	13,761	4,691	ND	8,246
	Lake Whitefish	2,144	-		1,633
	Inconnu	2,566	-		1,715
	P. Herring	2	-		-
	Cisco Sp.	1,542	-		-
	Arctic Char	255	-		-
	Lake Trout	349	299		60
	Northern Pike	1,329	45		743
	Burbot	878	15		990
	Other	197	920		108
	TOTAL	23,023	5,970		13,495
	License Numbers[13]	54	31	33	22
	# Surveys[14]	18	8	0	12
	% of Sales[15]	33	26	0	55

[1]Management area boundaries changed, see Fig. 24.
[2]No data collected or no sales occured for this year and location.
[3]Includes least and arctic cisco.
[4]Includes data reported from Aklavik Area (68° 15'W 135°N) which falls within Area I boundaries.
[5]May include herring, salmon, sucker sp. (mullet), and others.
[6]Data are from the original data sheets, errors were found in the Department of Fisheries and Oceans 1992 report.
[7]Management area VI created in 1987 and closed to fishing Aug. 1 - 31, 1987-1992.
[8]This area was not opened to commercial fishing.
[9]Tuktoyaktuk Harbour was included in management area IV in 1991. Areas on or near the Tuktoyaktuk Peninsula (eg. Eskimo (Husky) Lakes and Liverpool Bay) are reported seperately.
[10]Fishing location was not indicated.
[11]These areas are not included in any of the above management areas.
[12]Sum of data from the above management areas and fishing locations.
[13]Total number of commercial fishing licenses sold for the above areas: Department of Fisheries and Oceans (1992, 1993, 1994)
[14]Number of surveys returned.
[15]Number of surveys returned as a per cent of the total licenses sold.

Appendix D7. Ummarmiut Development Corporation Exploratory Fishery harvest data (rd kgs) from Department of Fisheries and Oceans (1992a, 1992b, 1993, 1994, and 1995). Fish were marketed by the Freshwater Fish Marketing Corporation for 1989 to 1992 and by the Uummarmiut Development Corporation in 1993.

Species	Year				
	1989	1990	1991	1992	1993
Broad Whitefish	5,781	13,101	19,234	17,797	11,821
Lake Whitefish	6,471	-	-	-	-
Inconnu	474	1,042	2,187	9,086	1,124
Northern Pike	1,661	7,184	8,757	2,160	-
Total	14,387	21,327	30,178	30,863	12,945

Appendix D8. Commercial fishing licenses sold, by community. Source: Department of Fisheries and Oceans 1992b, 1993, 1994, and 1995.

Community	Year			
	1990	1991	1992	1993
Aklavik	0	8	0	2
Inuvik	48	11	31	15
Tuktoyuktuk	0	2	0	2
Tsiigehtchic	5	10	2	2
Ft. McPherson	1	0	0	0
Ft. Good Hope	0	0	0	1
Holman	2	0	2	0
TOTAL	56	31	35	22

APPENDIX E

Subsistence harvest and domestic licence harvest data for the lower Mackenzie River region, 1960 to 1993 (Tables E1 to E6).

Appendix E1. Estimates of subsistence fish harvests 1960-1975, data from Corkum and McCart (1981) was confirmed and expanded upon, (1 lb = .455 kg).

Year	Location	Harvest (kg)	Source
1960-61	1) Mackenzie Delta (excluding Tuktoyuktuk)	432,250	Usher (1975)
	2) Tuktoyuktuk	334,425	Usher (1975)
	TOTAL	766,675	
1961-62	1) Inuvik and Aklavik	51,688	Sinclair et al. (1967)
	2) Ft. McPherson & Part of the Delta	230,248	Sinclair et al. (1967)
	3) Tsiigehtchic	33,943	Sinclair et al. (1967)
	4) Ft. Good Hope	157,658	Sinclair et al. (1967)
	TOTAL	473,537	
	5) Mackenzie Delta (excluding Tuktoyuktuk)	1,228,500	Olesh (1979)
	Ft. Smith to Inuvik	1,228,500	Sinclair et al. (1967)
1963	1) Mackenzie Delta (excluding Tuktoyuktuk)	796,250	Olesh (1979)
	2) Tuktoyuktuk: herring	40,950	Abramson (1963) in Bissett (1967)
	whitefish sp. and inconnu	9,100	
	3) Toker and Atkinson Pts.: lake herring	4,550	Abramson (1963) in Bissett (1967)
	4) Eskimo Lakes: trout	1,820	Abramson (1963) in Bissett (1967)
	other fish sp.	5,460	
	5) Reindeer St./Kugmallit Bay	36,000	Abramson (1963) in Bissett (1967)
	TOTAL	894,130	
	6) Aklavik (may include entire delta)	682,500	Sinclair et al. (1967)
1964	1) Mackenzie Delta (excluding Tuktoyuktuk)	910,000	Olesh (1979)
	Inuvik (may include entire delta)	910,000	Sinclair et al. (1967)
1965	1) Inuvik	159,250	Wolforth (1966)
	2) Aklavik	227,500	Wolforth (1966)
	3) Reindeer St.	45,500	Wolforth (1966)
	4) Tuktoyuktuk	273,000	Wolforth (1966)
	5) Ft. McPherson	252,525	Wolforth (1966)
	6) Tsiigehtchic	50,050	Wolforth (1966)
	TOTAL	1,007,825	
1965-66	1) Banks Island	910	Usher (1975)
1970-71	1) Banks Island	910	Usher (1975)
	2) Mackenzie Delta (excluding Tuktoyuktuk)	75,530	Usher (1975)
	TOTAL	76,440	
1971	1) Tsiigehtchic	22,750	Hunt (1972) in Corkum and McCart (1981)

Appendix E1. Continued.

1972	1) Mackenzie Delta and Tuktoyuktuk	50,505	DIAND/MPS (1973) in Corkum and McCart (1981)
	2) Ft. McPherson and Tsiigehtchic	204,750	DIAND/MPS (1973) in Corkum and McCart (1981)
	3) Peel River	42,700	Stein et al. (1973)
	4) Big Fish River	1,365-2,275	Hunt (1973) in Corkum and McCart (1981)
	5) Fish Hole	2,275-3,185	Hunt (1973) in Corkum and McCart (1981)
	6) Rat River	2,958	Hunt (1973) in Corkum and McCart (1981)
	TOTAL	263,673	
1973	1) Aklavik	452,409	Hunt (1973) in Corkum and McCart (1981)
	Aklavik	134,189	Jessop et al. (1974)
	2) Tsiigehtchic	58,907	Jessop et al. (1974)
	3) Inuvik	45,386	Olesh (1979)
	4) Tuktoyuktuk	78,670	Olesh (1979)
	TOTAL	635,372	(Using Hunt's estimate)
1975	1) Mackenzie Delta	314,132	Olesh (1979)
	2) Tuktoyuktuk, Paulatuk, Banks Island, Holman	85,995	Olesh (1979)
	TOTAL	400,127	

Appendix E2. Estimated subsistence harvest (kg) (1 lb=.455 kg), by management area as well as other locations, for the Lower Mackenzie River, NWT. Source: Corkum and McCart (1981) unless otherwise noted. Subsistence harvests have also been reported by comunity in Appendix E3 and E4. At the time Corkum and McCart prepared their report, fisheries management area V was located from Point Separation south along the Mackenzie River to just past the community of Tsiigehtchic (Fig. 22). However, they assigned harvests from the Tuktoyaktuk Peninsula to management area V and reported harvests from Tsiigehtchic seperately. This discrepancy has been accounted for in the table below; harvest from Tsiigehtchic has been included under Area V and harvest from the Tuktoyaktuk region has been identified as such.

		Year				
Location	Species	1972[1]	1973[2]	1978	1979	1980[3]
Area I	Broad Whitefish	ND[4]	ND	ND	4,426	6,967
	Lake Whitefish				1,464	8,829
	Inconnu				833	1,081
	Cisco Sp.[5]				2,958	2,677
	Other[6]				7,940	7,327
	TOTAL				17,621	26,881
Area II	Broad Whitefish	ND	ND	ND	9,598	2,055
	Lake Whitefish				19,412	3,332
	Inconnu				2,083	841
	Cisco Sp.				1,067	1,593
	Other				5,806	2,341
	TOTAL				37,966	10,162
Area III	Broad Whitefish	ND	ND	ND	10,738	16,959
	Lake Whitefish				8,600	7,204
	Inconnu				797	1,831
	Cisco Sp.				91	1,696
	Other				6,715	14,315
	TOTAL				26,941	42,005
Area IV	Broad Whitefish	ND	ND	ND	1,538	992
	Lake Whitefish				3,258	246
	Inconnu				273	575
	Cisco Sp.				68	-
	Other				997	492
	TOTAL				6,134	2,305
Area V	Broad Whitefish	ND	16,519	-	3,877	4,486
	Lake Whitefish		24,544	1,092	1,138	4,477
	Inconnu		17,357	118	610	2,351
	Cisco Sp.		-	46	91	364
	Other		487[7]	102	1,082	2,833
	TOTAL		58,907	1,358	6,798	14,511
Mackenzie Delta & Tuktoyaktuk	Broad Whitefish	ND	ND	4,859	ND	ND
	Lake Whitefish			5,178		
	Inconnu			1,417		
	Cisco Sp.			1,729		
	Other			1,601		
	TOTAL			14,784		

Appendix E2. Continued.

Location	Species	1972[1]	Year 1973[2]	1978	1979	1980[3]
Shingle Pt.	Broad Whitefish	ND	ND	ND	910	728
	Lake Whitefish				-	55
	Inconnu				-	-
	Cisco Sp.				228	-
	Other				291	-
	TOTAL				1,429	783
Tuktoyaktuk	Broad Whitefish	ND	ND	ND	3,103	1,128
	Lake Whitefish				3,039	273
	Inconnu				637	510
	Cisco Sp.				2,094	1,342
	Other				360	295
	TOTAL				9,233	3,548
Aklavik	Broad Whitefish	ND	33,067	ND	ND	ND
	Lake Whitefish		51,523			
	Inconnu		12,938			
	Cisco Sp.		15,457			
	Other		21,204			
	TOTAL		134,189			
Peel River	Broad Whitefish	-	ND	6,534	ND	ND
	Lake Whitefish	-		4,004		
	Whitefish Sp[8]	17,100		-		
	Inconnu	18,000		564		
	Cisco Sp.	7,600		410		
	Other	-		2,211		
	TOTAL	42,700		13,723		
Sitidgi L.	Broad Whitefish	ND	ND	ND	16	36
	Lake Whitefish				146	32
	Other				20	-
	TOTAL				182	68
Noell Lake	Lake Whitefish	ND	ND	ND	391	ND
	Trout				27	
	TOTAL				418	
Fish Hole	Other	ND	ND	ND	1,894	1,966
	TOTAL				1,894	1,966
TOTAL[9]	Broad Whitefish	-	49,586	11,393	34,206	33,351
	Lake Whitefish	-	76,067	10,274	37,448	24,448
	Whitefish Sp.	17,100	-	-	-	-
	Inconnu	18,000	30,295	2,099	5,233	7,189
	Cisco Sp.	7,600	15,457	2,185	6,597	7,672
	Other	-	21,691	3,914	25,132	29,569
	TOTAL	42,700	193,096	29,865	108,616	102,229

[1]Breakdown by species for the total harvest reported in Appendix E1 (Stein et al. 1973). Number of fish reported were converted to weight using the following conversion factors; whitefish sp. 1.8 kg, inconnu 4.5 kg, and cisco sp. 0.4 kg (Department of Fisheries and Oceans 1991).

Appendix E2. Continued.

[2]Breakdown by species for the total harvest reported in Appendix E1 (Jessop et al. 1974).

[3]Data was reported only as number of fish caught (both harvest number and weight were requested on the 1978 and 1979 surveys but not on the 1980 survey). Recorded weights were based on the following conversion factors: one fish (excluding herring) = 4 lb or 1.8 kg and one herring = 1 lb or .455 kg.

[4]No data are available for this year and area.

[5]Includes least cisco and arctic cisco.

[6]Includes burbot, northern pike, arctic char, lake trout, sucker sp., salmon, and arctic grayling.

[7]Includes, arctic cisco, longnose sucker, burbot and northern pike.

[8]Includes arctic cisco and least cisco.

[9]Harvest total for all management areas and locations.

Appendix E3. Estimated subsistence harvest (# of fish) by community from the Lower Mackenzie River, NWT. Sources: Sparling and Sparling (1988a) and (1988b), Lutra Associates (1989), Fabijan (1991a, 1991b, 1991c), and Dahlke (unpublished report).

Location	Species	1980[1]	1980[2]	1981[3]	1981[4]	1982	1986[5]	Year 1987[6]	1988[7]	1988[2]	1989[7]	1990[7]
Aklavik	Broad Whitefish	ND[8]	ND	239	2,400	ND	3,060	17,537	8,158	ND	8,091	6,682
	Lake Whitefish			285	5,200		1,100	7,003	3,134		4,723	2,384
	Whitefish Sp.[9]			-	-		5,321	392	858		440	15
	Inconnu			82	900		2,775	3,531	1,667		3,254	2,157
	Cisco Sp.[10]			409	-		7,395	4,828	1,884		7,034	8,254
	P. Herring			-	-		15	-	-		400	1,980
	Herring/Cisco[11]			-	-		-	-	-		-	100
	Other[12]			40	-		8,612	10,924	5,758		7,574	5,021
	TOTAL			1,055	8,500		28,278	44,215	21,459		31,516	26,593
	Fishermen[13]			16			74	82	67		35	28
Inuvik	Broad Whitefish	ND	ND	57	5,500	ND	5,684	2,210	8,345	ND	5,560	11,262
	Lake Whitefish			94	13,300		4,670	2,250	7,413		5,646	4,543
	Whitefish sp.			-	-		-	5,673	-		35	143
	Inconnu			15	1,100		1,450	1,705	1,070		1,352	3,874
	Cisco Sp.			-	-		-	1,780	898		50	100
	P. Herring			-	-		1,538	-	-		-	262
	Herring/Cisco			-	-		-	500	-		-	-
	Other			10	-		6,575	2,356	5,940		5,197	5,169
	TOTAL			176	19,900		19,917	16,474	23,666		17,840	25,353
	Fishermen			9			50	39	40		35	44
Tuktoyuktuk	Broad Whitefish	ND	ND	ND	ND	ND	4,420	13,914	11,375	ND	-	-
	Lake Whitefish						8	2,194	1,614		-	1,400
	Whitefish sp.						1,000	334	1,015		6,380	5,881
	Inconnu						1,663	4,274	1,359		1,621	1,420
	Cisco Sp.						11,240	32,217	34,352		-	-
	P. Herring						2,098	2,405	6,075		6,583	2,783
	Herring/Cisco sp.						-	-	1,940		8,689	16,521
	Other						2,890	1,195	660		467	726
	TOTAL						23,319	56,533	58,390		23,740	28,731
	Fishermen						59	59	66		24	26
Tsiigeht-chic	Broad Whitefish	10,850	5,900	104	6,600	ND	ND	ND	36,492	4,200	6,701[15]	475
	Lake Whitefish	5,700	10,850	161	14,100				49,893	11,215	6,376	200
	Inconnu	1,707	1,707	91	9,700				9,470	3,166	5,228	200
	Cisco Sp.	400	850	37	-				-	380	3	-
	Other	1,242	1,212	15	-				720	1,651	834	75
	TOTAL	19,899	20,519	408	30,400				96,575[14]	20,612	19,142[16]	950[16]
	Fishermen			30					10 Hshlds[17]	5 camps		2

Appendix E3. Continued.

Location	Species	1980[1]	1980[2]	1981[3]	1981[4]	1982	1986[5]	Year 1987[6]	1988[7]	1988[2]	1989[7]	1990[7]
Ft. McPherson	Broad Whitefish	12,970	12,770	83	5,700	ND	ND	ND	55,974	4,905	12,353	ND
	Lake Whitefish	19,300	19,300	9	850				23,940	415	2,661	
	Inconnu	2,625	2,805	42	2,600				20,400	2,235	3,598	
	Cisco Sp.	3,630	3,650	199	-				51,815	544	1,380	
	Other	4,568	6,302	-	-				6,893	1,987	2,704	
	TOTAL	43,093	44,827	333	9,150				159,022[14]	10,086	22,696[16]	
	Fishermen			16					48 Hshlds[17]	30 camps		
Ft. Good Hope	Broad Whitefish	ND	ND	ND	ND	-	ND	ND	7,265	ND	632	ND
	Lake Whitefish					-			6,036		3,676	
	Whitefish Sp.					26,453			-		-	
	Inconnu					11,192			4,766		1,451	
	Cisco Sp.					17,580			20,676		4,929	
	Other					4,572			4,415		3,261	
	TOTAL					59,797[18]			43,158[14]		13,949[16]	
	Fishermen					64 Hshlds[17]			38 Hshlds[17]			
TOTAL[19]	Broad Whitefish	23,820	18,670	483	20,200	-	13,164	33,661	127,609	9,105	33,337	18,419
	Lake Whitefish	25,000	30,150	549	33,450	-	5,778	11,447	92,030	11,630	23,082	8,527
	Whitefish Sp.	-	-	-	-	26,453	6,321	6,399	1,873	-	6,855	6,039
	Inconnu	4,332	4,512	215	14,300	11,192	5,888	9,510	38,732	5,401	16,504	7,651
	Cisco Sp.	4,030	4,500	660	-	17,580	18,635	38,825	109,625	924	13,396	8,354
	P. Herring	-	-	-	-	-	3,651	2,405	6,075	-	6,983	5,025
	Herring/Cisco	-	-	-	-	-	-	500	1,940	-	8,689	16,621
	Other	5,810	7,514	65	-	4,572	18,077	14,475	24,386	3,638	20,037	10,991
	TOTAL	62,992	65,346	1,972	67,950	59,797	71,514	117,222	402,270	30,698	128,883	81,627
	Fishermen			71		64	183	180	269	35	94	100

[1] Sparling and Sparling (1988a), GNWT Renewable Resources survey data.
[2] Dahlke (unpublished report).
[3] Sparling and Sparling (1988b), survey responses for Inuvik and Aklavik, July 6-Aug. 25 and Ft. McPherson and and Tsiigehtchic, July 6-Nov. 20, 1981.
[4] Sparling and Sparling (1988a), estimated harvest for broad whitefish, lake whitefish, and inconnu, based on survey responses and numbers of fishermen observed during the study period.
[5] Fabijan (1991a), data from July 1986-June 1987.
[6] Fabijan (1991a), data from July 1987- June 1988.
[7] Fabijan (1991a), (1991b), (1991c), data from January-December 1988, 1989, 1990 respectively.
[8] No data available for this year and location.
[9] Includes both broad whitefish and lake whitefish.
[10] Includes both least cisco and arctic cisco.
[11] Harvest could include least cisco, arctic cisco and herring since the local common name for all three is herring.
[12] Includes burbot, northern pike, arctic char, lake trout, sucker sp., salmon, arctic grayling, saffron cod, and walleye.
[13] Number of hunters who fished and/or who responded to surveys.

Appendix E3. Continued.

[14]Lutra Associates (1989).
[15]Includes 93 broad whitefish caught in nearby lakes, "lake fish" or lake "whitefish" is the local common name for these fish.
[16]DFO unpublished data.
[17]Short form for households and indicates that households not individual fishermen were surveyed.
[18]Berkes (unpublished data).
[19]Total harvest, all communities.

Appendix E4. Estimated subsistence harvest (kg) (1 lb=.455 kg), by community for the Lower Mackenzie River, NWT. Data from Appendix E3 have been converted using the following conversion factors; broad whitefish 2.3 kg, lake whitefish 1.3 kg, whitefish sp. 1.8 kg, inconnu 4.5 kg, cisco sp. and pacific herring 0.4 kg, arctic char 1.3 kg, northern pike 2.3 kg, burbot 3.0 kg, sucker sp. 1.0 kg, lake trout 4.0 kg, chum salmon 3.0 kg, walleye 1.5, saffron cod 0.4 kg, and other 2.0 kg (Deptartment of Fisheries and Oceans 1991) and a mean value of 1.0 kg for arctic grayling from Scott and Crossman (1973). Additional data is from Corkum and McCart (1981).

		Year										
Location	Species	1980[1]	1980[2]	1981[3]	1981[4]	1982	1986[5]	1987[6]	1988[7]	1988[2]	1989[7]	1990[7]
Aklavik	Broad Whitefish	ND[8]	ND	430	4,288	ND	7,038	40,335	18,763	ND	18,609	15,369
	Lake Whitefish			371	6,566		1,430	9,104	4,074		6,140	3,099
	Whitefish Sp.[9]			-	-		9,578	706	1,544		792	27
	Inconnu			328	3,626		12,488	15,890	7,502		14,643	9,707
	Cisco Sp.[10]			-	-		2,958	1,931	754		2,814	3,302
	P. Herring			-	-		6	-	-		400	792
	Herring/Cisco[11]			-	-		-	-	-		-	40
	Other[12]			90	-		19,411	27,051	15,736	ND	19,129	12,657
	TOTAL			1,219[14]	14,480		52,909	95,017	48,373		62,527	44,993
	Fishermen[13]			16			74	82	67		35	28
Inuvik	Broad Whitefish	ND	ND	125	12,250	ND	13,073	5,083	19,194	ND	12,788	25,903
	Lake Whitefish			132	18,844		6,071	2,925	9,637		7,340	5,906
	Whitefish Sp.			-	-		-	10,211	-		63	257
	Inconnu			75	5,468		6,525	7,673	4,815		6,084	17,433
	Cisco Sp.			-	-		-	712	359		20	40
	P. Herring			-	-		615	-	-		-	105
	Herring/Cisco			-	-		-	500	-		-	-
	Other			23	-		18,823	5,861	16,110		13,902	14,703
	TOTAL			355[15]	36,562		45,107	32,965	50,115		40,197	64,347
	Fishermen			9			50	39	40		35	44
Tuktoyuktuk	Broad Whitefish	ND	ND	ND	ND	ND	10,166	32,002	26,163	ND	-	-
	Lake Whitefish						10	2,852	2,098		-	1,820
	Whitefish Sp.						1,800	601	1,827		11,484	10,586
	Inconnu						7,484	19,233	6,116		7,295	6,390
	Cisco Sp.						4,496	12,887	13,741		-	-
	P. Herring						839	962	2,430		2,633	1,113
	Herring/Cisco						-	-	776		3,476	6,608
	Other						4,759	3,261	2,223		1,631	2,734
	TOTAL						29,554	71,798	55,374		26,519	29,251
	Fishermen						59	59	66		24	26

Appendix E4. Continued.

Location	Species	1980[1]	1980[2]	1981[3]	Year 1981[4]	1982	1986[5]	1987[6]	1988[7]	1988[2]	1989[7]	1990[7]
Tsiigeht-chic	Broad Whitefish	24,955	13,570	229	14,581	ND	ND	ND	83,932	9,660	15,412[18]	1,093
	Lake Whitefish	7,410	14,105	209	18,083				64,861	14,580	8,289	260
	Inconnu	7,682	7,682	464	49,095				42,615	14,247	23,526	900
	Cisco	160	340	15	-				-	152	1	-
	Other	3,064	2,980	36	-				2,160	3,180	1,918	194
	TOTAL	43,271	38,677	953[16]	81,759				193,568[17]	41,819	49,146[19]	2,447[19]
	Fishermen			30					10 Hshlds[20]	5 camps		2
Ft. McPherson	Broad Whitefish	29,831	29,371	199	13,389	ND	ND	ND	128,740	11,282	28,412	ND
	Lake Whitefish	25,090	25,090	8	769				31,122	540	3,459	
	Inconnu	11,813	12,623	185	11,545				91,800	10,058	16,191	
	Cisco Sp.	1,452	1,460	80	-				20,726	218	552	
	Other	11,421	13,771	-	-				14,268	2,967	5,611	
	TOTAL	79,607	82,315	472[21]	25,703				286,656[17]	25,065	54,225[19]	
	Fishermen			16					48 Hshlds[20]	30 camps		
Ft. Good Hope	Broad Whitefish	ND	ND	ND	ND	-	ND	ND	16,710	ND	1,454	ND
	Lake Whitefish					-			7,847		4,779	
	Whitefish Sp.					47,615			-		-	
	Inconnu					50,364			21,447		6,530	
	Cisco Sp.					7,032			8,270		1,972	
	Other					10,416			13,443		5,300	
	TOTAL					115,427[22]			67,717[17]		20,035[19]	
	Fishermen					64 Hshlds[20]			38 Hshlds[20]			
TOTAL[23]	Broad Whitefish	54,786	42,941	983	44,508	-	30,277	77,420	293,502	20,942	76,675	42,365
	Lake Whitefish	32,500	39,195	720	44,262	-	7,511	14,881	119,639	15,120	30,007	11,085
	Whitefish Sp.	-	-	-	-	47,615	11,378	11,518	3,371	-	12,339	10,870
	Inconnu	19,495	20,305	977	69,734	50,364	26,497	42,796	174,295	24,305	74,269	34,430
	Cisco Sp.	1,612	1,800	170	-	7,032	7,454	15,530	43,850	370	5,359	3,342
	P. Herring	-	-	-	-	-	1,460	962	2,430	-	3,033	2,010
	Herring/Cisco	-	-	-	-	-	-	500	776	-	3,476	6,648
	Other	14,485	16,751	149	-	10,416	42,993	36,173	63,940	6,147	47,491	30,288
	TOTAL	122,878	120,992	2,999	158,504	115,427	127,570	199,780	701,803	66,884	252,649	141,038
	Fishermen			71		64	183	180	269	35	94	100

[1] Sparling and Sparling (1988a), GNWT Renewable Resources survey data.
[2] Dahlke (unpublished report).
[3] Sparling and Sparling (1988b), survey responses for Inuvik and Aklavik July 6-Aug. 25 and Ft. McPherson and Tsiigehtchic July 6-Nov. 20, 1981.
[4] Sparling and Sparling (1988a), estimated harvest for broad whitefish, lake whitefish, and inconnu, based on survey responses and numbers of fishermen observed during the study period.
[5] Fabijan (1991a), data from July 1986-June 1987.
[6] Fabijan (1991a), data from July 1987-June 1988.

Appendix E4. Continued.

[7] Fabijan (1991a), (1991b), (1991c), data from January-December 1988, 1989, 1990.
[8] No data available for this year and location.
[9] Includes both broad whitefish and lake whitefish.
[10] Includes both least cisco and arctic cisco.
[11] Harvest could include least cisco, arctic cisco, and herring since the local common name for all three is herring.
[12] Includes burbot, northern pike, arctic char, lake trout, sucker sp., salmon, and arctic grayling, saffron cod and walleye.
[13] Number of hunters who fished and/or who responded to surveys.
[14] Sparling and Sparling (1988b), conversion factors used are unique to the Aklavik area (rounded to one decimal point): broad whitefish 1.8 kg, lake whitefish 1.3 kg, inconnu 4.0 kg, other species as given in table caption.
[15] Sparling and Sparling (1988b), conversion factors used are unique to the Inuvik area (rounded to one decimal point): broad whitefish 2.2 kg, lake whitefish 1.4 kg, inconnu 5.0 kg, other species as given in the table caption.
[16] Sparling and Sparling (1988b), conversion factors used are unique to the Tsiigehtchic area (rounded to one decimal point): broad whitefish 2.2, lake whitefish 1.3, inconnu 5.1, other species as given in the table caption.
[17] Lutra Associates (1989).
[18] Includes 93 broad whitefish caught in nearby lakes, "lake fish" or lake "whitefish" is the local common name for these fish.
[19] DFO (unpublished data).
[20] Short form for households and indicates that households, not individual fishermen were surveyed.
[21] Sparling and Sparling (1988b), conversion factors used are unique to the Ft. McPherson area (rounded to one decimal point): broad whitefish 2.4 kg, lake whitefish 0.9 kg, inconnu 4.4 kg, other species as given in the table caption.
[22] Berkes (unpublished data).
[23] Total harvest all communities.

Appendix E5. Domestic license holders reported catch (# of fish) 1978 to 1982 from Dahlke (unpublished report) and 1982 to 1993 from the Department of Fisheries and Oceans (unpublished data). No harvests were reported for 1990 to 1993.

Location	Species	Year 1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Aklavik	Broad Whitefish	4,200	150	648	40	3,490	-	257	30	NF[2]	500	700	200	ND[3]	ND	ND	ND
	Lake Whitefish	2,260	-	256	175	1,827	-	23	20		400	500	100				
	Inconnu	1,085	20	152	16	515	-	19	3		150	75	25				
	Cisco Sp.[4]	800	-	329	-	8,550	-	4	-		-	-	-				
	P. Herring	-	-	-	-	50	-	3	4		-	150	-				
	Other[5]	1,329	163	375	44	2,397	16	22	9		583	404	54				
	TOTAL	9,674	333	1,760	275	16,829	16	328	66		1,633[6]	1,829	379				
	# Surveys[7]					11	1	3	1	0	1	1	1	0[9]	0[10]		0[11]
	% of Sales[8]					100	100	100	100	-	100	100	50	0	0		0
Inuvik	Broad Whitefish	1,951	435	3,015	128	5,791	51	25	70	1,084	130	282	415	ND	ND	ND	ND
	Lake Whitefish	2,910	2,520	2,500	70	2,782	2	-	33	639	215	25	250				
	Inconnu	162	250	1,340	16	1,190	22	6	4	330	64	203	166				
	Cisco Sp.	500	150	-	10	301	-	-	-	-	5	65	50				
	P. Herring	-	-	-	-	27	-	-	-	-	-	-	-				
	Other	853	1,172	2,340	120	2,324	68	-	55	883	1,028	134	286				
	TOTAL	6,376	4,527	9,195	344	12,415	143	31	162	2,936	1,442[6]	709	1,167				
	# Surveys					20	8	7	7	8[12]	7	7	5	0[9]	0[10]		0[11]
	% of Sales					100	100	78	70	100	100	78	83	0	0		0
Tuktoyuktuk	Broad Whitefish	685	782	266	320	1,455	125	94	NF	NF	-	600	72	ND	NF	ND	NF
	Lake Whitefish	735	611	218	238	1,287	6	-			-	-	-				
	Inconnu	495	440	234	98	89	12	10			-	15	30				
	Cisco Sp.	-	-	3,500	-	780	8	-			-	900	-				
	P. Herring	3,300	5,180	-	450	237	-	-			-	-	70				
	Other	26	7	0	5	48	2	1			-	-	50				
	TOTAL	5,241	7,020	4,218	1,111	3,896	153	105			-	1,515	222				
	# Surveys					5	2	1	0	0	1	3	2	0[9]	0		0
	% of Sales					100	25	100	-	-	100	100	100	0	-		-
Tsiigeht-chic	Broad Whitefish	500	ND	ND	200	1,526	NF	NF	NF	NF	NF	NF[13]	NF	NF	NF	ND	NF
	Lake Whitefish	900			200	1,996											
	Inconnu	65			13	511											
	Cisco	100			20	7											
	P. Herring	-			-	-											
	Other	257			78	380											
	TOTAL	1,822			511	4,420											
	# Surveys					4	0	0	0	0	0	0	0	0	0		0
	% of Sales					100	-	-	-	-	-	-	-	-	-		-

Appendix E5. Continued.

Location	Species	1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Ft. McPherson	Broad Whitefish	ND	ND	ND	20	720	-	400	40	400	NF	NF	NF	NF	NF	ND	NF
	Lake Whitefish				2	78	-	1,700	1,500	2,000							
	Inconnu				1	52	-	50	90	80							
	Cisco Sp.				1	-	-	-	-								
	P. Herring				-	-	-	40[14]	30[14]	20[14]							
	Other				139	526	-	80	60	120							
	TOTAL				163	1,376	-	2,270	1,720	2,620							
	# Surveys					8	1	1	1	1	0	0	0	0	0		0
	% of Sales					100	100	50	100	100	-	-	-	-	-		-
Ft. Good Hope	Broad Whitefish	18	115	113	ND	NF	NF	NF	-	15	53	20	-	NF	ND	ND	NF
	Lake Whitefish	-	25	23					-	6	2	-	-				
	Inconnu	80	35	68					-	10	35	45	-				
	Cisco Sp.	275	228	366					-	-	-	-	-				
	Other	3	94	340					-	1	42	8	-				
	TOTAL	376	497	910					-	32	132[6]	73	-				
	# Surveys					0	0	0	1	1	2	2	1	0	0[10]		0
	% of Sales					-	-	-	100	100	100	100	50	-	0		-
TOTAL[15]	Broad Whitefish	7,354	1,482	4,042	708	12,982	176	776	140	1,499	683	1,602	687	ND	ND	ND	ND
	Lake Whitefish	6,805	3,156	2,997	685	7,970	8	1,723	1,553	2,645	617	525	350				
	Inconnu	1,887	745	1,794	144	2,357	34	85	87	420	249	338	221				
	Cisco Sp.	1,675	378	4,195	31	9,638	8	4	-	-	5	965	50				
	P. Herring	3,300	5,180	-	450	314	-	43	34	21	-	150	70				
	Other	2,468	1,436	3,055	386	5,675	86	103	124	1,035	1,653	546	390				
	TOTAL	23,489	12,377	16,083	2,404	38,936	312	2,734	1,938	5,620	3,207	4,126	1,768				
	# Surveys					48	12	12	10	10	11	13	9				
	% of Sales					100	67	80	77	100	100	87	75	0	0		0

1 Includes commercial catch questionaire data.
2 No domestic license fishing occured for this year and location.
3 No data reported for this year and location.
4 Includes least cisco and arctic cisco.
5 May include arctic char, chum salmon, northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
6 Data that did not have a name and licence number were not used.
7 Source:DFO Economics Branch, Winnipeg, MB, for 1982 to present.
8 Number of surveys returned as a per cent of the total licenses sold.
9 In 1990 two domestic licenses were sold in Aklavik, three in Inuvik, and one in Tuktoyaktuk but there were no domestic harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.
10 In 1991 one domestic license was sold in Aklavik, one in Inuvik, and one in Ft. Good Hope but there were no domestic harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.
11 In 1993 two domestic licenses were sold in Aklavik and three in Inuvik but there were no harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.

Appendix E5. Continued.

[12]This number does not include four domestic license holders who's catch was included with the commercial licence holders because they had reported fish sales.
[13]Two domestic licenses were sold but these fishermen reported fish sales so their catch has been included with the commercial license holders catch.
[14]Harvest may be cisco sp. not p. herring since herring is a local common name for least and arctic cisco.
[15]Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.

Appendix E6. Domestic license holders reported catch (kg). Data are from Appendix E5, unless otherwise noted and have been converted to kilograms using the following conversion factors; broad whitefish 2.3 kg, lake whitefish 1.3 kg, whitefish sp. 1.8 kg, inconnu 4.5 kg, cisco sp. and pacific herring 0.4 kg, arctic char 1.3 kg, northern pike 2.3 kg, burbot 3.0 kg, sucker sp. 1.0 kg, lake trout 4.0 kg, chum salmon 3.0 kg, walleye 1.5 kg, saffron cod 0.4 kg, and other 2.0 kg (Department of Fisheries and Oceans 1991) and a mean of 1.4 kg for arctic grayling (Scott and Crossman 1973).

		Year															
Location	Species	1978[1]	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Aklavik	Broad Whitefish	9,660	345	1,490	92	8,027	-	591	69	NF[2]	1,150	1,610	460	ND[3]	ND	ND	ND
	Lake Whitefish	2,938	-	333	228	2,375	-	30	26		520	650	130				
	Inconnu	4,883	90	684	72	2,318	-	86	14		675	338	113				
	Cisco Sp.[4]	320	-	132	-	3,420	-	2	-		-	-	-				
	P. Herring	-	-	-	-	20	-	1	2		-	60	-				
	Other[5]	2,830	361	911	105	5,759	17	56	19		1,310	994	138				
	TOTAL	20,631	796	3,550	497	21,919	17	766	130		3,655[6]	3,652	841				
	# Surveys[7]					11	1	3	1	0	1	1	1	0[9]	0[10]		0[11]
	% of Sales[8]					100	100	100	100	-	100	100	50	0	0		0
Inuvik	Broad Whitefish	4,487	1,001	6,935	294	13,319[12]	117	58	161	2,493	299	649	955	ND	ND	ND	ND
	Lake Whitefish	3,783	3,276	3,250	91	3,617	3	-	43	831	280	33	325				
	Inconnu	729	1,125	6,030	72	5,355	99	27	18	1,485	288	914	747				
	Cisco Sp.	200	60	-	4	120	-	-	-	-	2	26	20				
	P. Herring	-	-	-	-	11	-	-	-	-	-	-	-				
	Other	2,291	3,341	5,662	260	5,918	130	-	147	2,276	2,390	360	713				
	TOTAL	11,490	8,803	21,877	721	28,340	349	85	369	7,085	3,259[6]	1,982	2,760				
	# Surveys					20	8	7	7	8[13]	7	7	5	0[9]	0[10]		0[11]
	% of Sales					100	100	78	70	100	100	78	83	0	0		0
Tuktoyuktuk	Broad Whitefish	1,576	1,799	612	736	3,347	288	216	NF	NF	-	1,380	166	ND	NF	ND	NF
	Lake Whitefish	956	794	283	309	1,673	8	-			-	-	-				
	Inconnu	2,228	1,980	1,053	441	401	54	45			-	68	135				
	Cisco Sp.	-	-	1,400	-	312	3	-			-	360	-				
	P. Herring	1,320	2,072	-	180	95	-	-			-	-	28				
	Other	65	20	-	15	98	6	2			-	-	100				
	TOTAL	6,145	6,665	3,348	1,681	5,926	359	263			-	1,808	429				
	# Surveys					5	2	1	0	0	1	3	2	0[9]	0		0
	% of Sales					100	25	100	-	-	100	100	100	0	-		-
Tsiigeht-chic	Broad Whitefish	1,150	ND	ND	460	3,510	NF	NF	NF	NF	NF	NF[14]	NF	NF	NF	ND	NF
	Lake Whitefish	1,170			260	2,595											
	Inconnu	293			59	2,300											
	Cisco	40			8	3											
	P. Herring	-			-	-											
	Other	491			134	901											
	TOTAL	3,144			921	9,309											
	# Surveys					4	0	0	0	0	0	0	0	0	0		0
	% of Sales					100	-	-	-	-	-	-	-	-	-		-

Appendix E6. Continued.

Location	Species	1978[1]	1979	1980	1981	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Ft. McPherson	Broad Whitefish	ND	ND	ND	46	1,656	-	920	92	920	NF	NF	NF	NF	NF	ND	NF
	Lake Whitefish				3	101	-	2,210	1,950	2,600							
	Inconnu				5	234	-	225	405	360							
	Cisco Sp.				1	-	-	-	-	-							
	P. Herring				-	-	-	16[15]	12[15]	8[15]							
	Other				189	745	-	130	113	246							
	TOTAL				244	2,736	-	3,501	2,572	4,134							
	# Surveys					8	1	1	1	1	0	0	0	0	0		0
	% of Sales					100	100	50	100	100	-	-	-	-	-		-
Ft. Good Hope	Broad Whitefish	41	265	260	ND	NF	NF	NF	-	35	122	46	-	NF	ND	ND	NF
	Lake Whitefish	-	33	30					-	8	3	-	-				
	Inconnu	360	158	306					-	45	158	203	-				
	Cisco Sp.	110	91	146					-	-	-	-	-				
	Other	7	160	793					-	3	98	17	-				
	TOTAL	518	707	1,535					-	91	381[6]	266	-				
	# Surveys					0	0	0	1	1	2	2	1	0	0[10]		0
	% of Sales					-	-	-	100	100	100	100	50	-	0		-
TOTAL[16]	Broad Whitefish	16,914	3,410	9,297	1,628	29,859	405	1,785	322	3,448	1,571	3,685	1,581	ND	ND	ND	ND
	Lake Whitefish	8,847	4,103	3,896	891	10,361	11	2,240	2,019	3,439	803	683	455				
	Inconnu	8,493	3,353	8,073	649	10,608	153	383	437	1,890	1,121	1,523	995				
	Cisco Sp.	670	151	1,678	13	3,855	3	2	-	-	2	386	20				
	P. Herring	1,320	2,072	-	180	126	-	17	14	8	-	60	28				
	Other	5,684	3,880	7,366	703	13,421	153	188	279	2,525	3,798	1,371	951				
	TOTAL	41,928	16,971	30,310	4,064	68,230	725	4,615	3,071	11,310	7,295	7,708	4,030				
	# Surveys					48	12	12	10	10	11	13	9				
	% of Sales					100	67	80	77	100	100	87	75				

1 Includes commercial catch questionaire data.
2 No domestic license fishing occured for this year and location.
3 No data reported for this year and location.
4 Includes least cisco and arctic cisco.
5 May include arctic char, chum salmon, northern pike, burbot (loche), sucker sp., lake trout, arctic grayling, flounder sp., sculpin sp., rock cod and tom cod.
6 Data that did not have a name or license number were not used.
7 Source:DFO Economics Branch for 1982 to present.
8 Number of surveys returned as a per cent of the total licenses sold.
9 In 1990 two domestic licenses were sold in Aklavik, three in Inuvik, and one in Tuktoyaktuk but there were no domestic harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.
10 In 1991 one domestic license was sold in Aklavik, one in Inuvik, and one in Ft. Good Hope but there were no domestic harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.
11 In 1993 two domestic licenses were sold in Aklavik and three in Inuvik but there were no harvests reported; reported harvests associated with a domestic license may have been included in the commercial harvest reports.

[12]Harvest data from DFO Inuvik reported in Sparling and Sparling (1988a) were lower than those reported here for all but the Inuvik broad whitefish which they reported as being 22,755 kg.
[13]This number does not include four domestic license holders who sold fish and who's catch was included with the commercial licence data.
[14]Two domestic licenses were sold but these fishermen reported fish sales so their catch has been included with the commercial license holders catch.
[15]Harvest may be cisco sp. not pacific herring since "herring" is a local common name for least and arctic cisco.
[16]Sum of data from Aklavik, Inuvik, Tuktoyuktuk, Tsiigehtchic, Ft. McPherson, and Ft. Good Hope.