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Exploitation of Arctic Fishes

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ABSTRACT

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Fisheries in the Arctic can be divided into three competing types: domestic fisheries for local consumption, commercial fisheries in which the fish are exported to southern markets, and sport fisheries, for resident and non-resident fishermen. Of these fisheries, the domestic fishery takes precedence, giving Inuit and Indian fishermen priority in usage, when fishing for their own needs. The domestic fishery is also the most poorly understood, owing largely to the lack of data describing catch and effort values.

The major commercial fisheries of Great Slave Lake, the Mackenzie Delta, Cambridge Bay, the West Coast of Hudson Bay, and eastern Hudson Strait are each discussed in some detail. The first two fisheries are primarily for whitefish: lake whitefish, Coregonus clupeaformis, in Great Slave Lake, and broad whitefish, Coregonus nasus, in the Mackenzie Delta. Cambridge Bay and West Coast Hudson Bay fisheries are dependent on anadromous Arctic char. The fisheries in eastern Hudson Strait and Baffin Island are the only significant marine fisheries in the Arctic.

The problems of management of these diverse types of fishery are discussed with particular emphasis on the employment of innovative management techniques. Commercial fishery management problems are compounded by the existence of competing sport and domestic fisheries. A great increase in sport fishing in the Northwest Territories is documented by the increase in licenses issued: 5586 in 1968/69 and 16,061 in 1985/86.

The potential for development of marine fisheries is examined, species by species. While there are certain areas of potential, immediate prospects are captial intensive enterprise, not the low budget, labor intensive efforts which derive most benefit to northern communities.

The report concludes with a summary of the principle changes in the domestic, sport and commercial fisheries in the N.W.T. in recent years. The replacement of dog-teams by snow-machines has apparently reduced domestic fishing activities, although there is little data to support this generalization. The reduction of fishing for dog food may have been offset by a greater demand for fresh fish by an increasing human population.

N.W.T. commercial fishery catches are now about 50% of their peak which occurred in 1950. Their contribution to the total Canadian commercial fishery is about 3 %. Most readily exploitable stocks now appear to be exploited near their natural limits. There appear to be few economically attractive opportunities for new fishery development, although there is some potential for eastern Arctic Greenland halibut, shrimp and Iceland scallop. In all cases, exploitation will demand a high level of technology and involve significant transportation costs.

There has been a significant increase in the sport fishery, largely owing to an increase in the N.W.T. resident population. However, since 1980, sport catches of lake trout, northern pike, Arctic grayling and Arctic char have declined, while only walleye catches have increased.

Key words: Arctic; anadromous; commercial; fresh water; invertebrates; management; marine; overfishing; legislation; sport fishing statistics; artisanal fishing.

RÉSUMÉ

Crawford, R. 1989. Exploitation of Arctic fishes. Can. Manuscr. Rep. Fish. Aquat. Sci. 2002: v + 43 p.

Dans l'Arctique, les pêches peuvent être classées dans trois catégories concurrentielles: la pêche familiale axée sur la consommation locale, la pêche commerciale axée sur l'exportation des poissons vers les marchés du sud, et la pêche sportive pratiquée par les pêcheurs résidents et non résidents. La pêche familiale vient au premier rang, et permet aux pêcheurs inuit et indiens d'avoir accès en priorité aux ressources halieutiques lorsqu'ils pêchent pour répondre à leurs propres besoins. Elle est également la plus méconnue, en raison de l'absence de données sur la valeur des prises et des efforts de pêche.

Les principales pêcheries commerciales du Grand lac des Esclaves, du delta du Mackenzie, de la baie Cambridge, de la côte ouest de la baie d'Hudson et du secteur oriental du détroit d'Hudson sont décrites de façon assez détaillée. Les deux premières pêcheries sont axées principalement sur le corégone: le grand corégone Coregonus clupeaformis dans le Grand lac des Esclaves, et le corégone tschir Coregonus nasus dans delta du Mackenzie. Les pêcheries de la baie Cambridge et de la côte ouest de la baie d'Hudson sont tributaires de l'omble chevalier anadrome. Les pêcheries du secteur oriental du détroit d'Hudson et de l'île Baffin sont les seules pêcheries maritimes importantes dans l'Arctique.

Les problèmes de gestion des pêches sont analysés, et un intérêt particulier est accordé à l'utilisation de techniques de gestion novatrices. Les problèmes de gestion des pêches commerciales sont aggravés par l'existence de pêches familiales et sportives concurrentielles. La pêche sportive a pris beaucoup d'ampleur dans les Territoires du Nord-Ouest comme en témoigne l'augmentation du nombre de permis accordés: 5 586 en 1968-1969 comparativement à 16 061 en 1985-1986.

Les possibilités de mise en valeur des pêches maritimes sont examinés pour chaque espèce. Certains secteurs offrent un potentiel, mais les projets immédiats sont à forte

intensité de capital et non à forte intensité de main-d'oeuvre, laquelle bénéficie le plus aux collectivités nordiques.

Enfin, les grands changements qui ont touché les pêches commerciales, sportives et familiales dans les Territoires du Nord-Ouest au cours des dernières années sont résumés. La substitution des traîneaux à chiens aux motoneiges a apparemment entraîné une réduction de la pêche familiale, bien que les données soient insuffisantes pour appuyer une telle généralisation. Cette réduction peut avoir été compensée par la demande accrue de poissons frais pour répondre aux besoins d'une population toujours croissante.

À l'heure actuelle, les prises commerciales dans les Territoires du Nord-Ouest représentent près de 50 % des prises effectuées en 1950 et 3 % environ des prises commerciales totales au Canada. Les stocks les plus facilement exploitables ont apparemment été exploités près de leurs seuils d'équilibre. Le développement de nouvelles pêcheries semble offrir peu de possibilités économiques intéressantes, bien que le flétan du Groenland, la crevette et le pétoncle d'Islande présentent un certain potentiel dans l'est de l'Atlantique. Dans tous les cas, l'exploitation des ressources nécessitera l'utilisation de techniques de pointe et impliquera d'énormes coûts de transport.

La pêche sportive a connu un essor considérable en raison surtout de l'accroissement de la population résidente des Territoires du Nord-Ouest. Les prises sportives du touladi, du grand brochet, de l'ombre arctique et de l'omble chevalier ont toutefois décliné depuis 1980, et seules les prises de doré ont augmenté.

Mots-clés: Arctique; anadrome; commercial; eaux douces; invertébrés; aménagement; marin; pêche excessive; loi; statistiques sur la pêche sportive; pêche artisanal.

INTRODUCTION

Awareness of an overall general decline in Canadian fish landings has generated official concern for the health and direction of our fisheries (Beamish et al. 1986). In 1982 the Department of Fisheries and Oceans began to expand its Arctic fisheries programs and in 1985 the Arctic Fisheries Science Advisory Committee (AFSAC) was created to ensure that quality scientific information is available for the development of management plans for Arctic fisheries. This paper, prepared for AFSAC, is intended to be a brief synopsis of the present status of fish exploitation in northern Yukon, the Northwest Territories (N.W.T.) and northern Quebec. It begins with a brief historical perspective and an overview of northern Canada's fish resources. These are followed by considerations of the three northern fisheries: domestic, commercial and sport. Because of regional differences, important commercial fisheries are considered separately (Fig. 1). Statistics indicating estimates of past and present levels of exploitation are included for those species where such data are available. Compared with freshwater and anadromous species, marine fishes are relatively unexploited in the Canadian Arctic. The domestic and commercial use and potential of some of these are considered next in this review. This is followed by a summary which includes a comparison of data in a search for trends in the landings of some of these fisheries. The paper concludes with an assessment of the current state of affairs in the Arctic fisheries.

HISTORICAL PERSPECTIVE

Recent identification of late Pleistocene fish fossils from Northern Yukon (Cumbra et al. 1981) indicate that much of the present ichthyofauna of the western Arctic has inhabited that area for a long time. It also has been postulated that early pre-Dorset nomadic northern peoples may have occupied this area as many as 27,000 years ago (Harington 1978). Fish constituted one of the few resources at their disposal and freshwater and anadromous species were likely an important component of their diet. It is not until the Dorset era, however, that fishing implements become common artifacts in the archeological record left from those early times (Bandi 1969).

The Dorset culture flourished in northern Canada from perhaps as early as 800 B.C. until about 1200 A.D. (Bandi 1969). Nomads, they hunted caribou and fished the lakes and rivers of the North and its interior lands. These people were followed by the Thule who also fished but probably less than did their predecessors. Unlike the Dorsets, the Thule people were whale hunters settling principally along the Arctic coast. During the Thule period, freshwater fish resources of the interior were exploited by ancestors of the Athabascan, Algonkian and Cree Indians who live there today (Bandi 1969).

It was not until the 16th century, when large whales were less common along the coastal areas of the Arctic Archipelago, possibly due to a cooling climatic trend, that the Thule began to rely more heavily on the fish resources at hand. In the absence of the great whales, fishes such as Arctic char, lake trout, and various coregonids often represented the most readily procurable source of protein for these people's diet and were their principal source of dog food (Beamish et al. 1986). Their descendants, the Inuit, followed this tradition; fish are still an important food source for natives of the Arctic.

Northern fish stocks began facing new pressures as events of the 20th century thrust change into the lives of northern people. World War II defense and supply operations and the establishment of the Distant Early Warning Line across the Arctic in the 1950's did much to introduce aspects of modern civilization to the north. Awareness of northern mineral, hydrocarbon and fish resources increased dramatically in the 1960's and new routes of access to these once remote lands forever altered northern life. These events presented the opportunity for development of commercial and sport fisheries in many northern areas.

Concomitant with the increased awareness and accessibility of northern resources, fish stocks in the south, such as lake whitefish in lakes Winnipeg and Huron, were impacted by overfishing and pollution. The relatively unexploited resources of the north became economic assets and targets for development. As a result, since the late 1940's lake whitefish from Great Slave Lake, N.W.T. have been supplied to markets which have felt the impact of declining southern resources. In the mid 1960's, entrepreneurs also developed successful commercial fisheries for Arctic char. Likewise, today's successful northern sport fishing-lodge industry was developed during this period.

With the establishment of economic activity in the North, a wage economy was introduced to the natives' way of life. With wages came snowmachines and southern foodstuffs. These decreased the need for fish as food or dog food (Beamish et al. 1986). But this decrease in domestic utilization has been accompanied by the simultaneous expansion of the commercial and sport fisheries. In some instances, these new fisheries have placed additional pressure on stocks which continue to be relied upon as important traditional food resources. In other cases, they have created pressure on some remote and possibly previously unexploited fish stocks. Because of these developments, the domestic, commercial, and sport fisheries of northern Canada will be considered separately in this report.

OVERVIEW OF THE RESOURCE

SPECIES DISTRIBUTION

Freshwater and anadromous species

Zoogeographically, the Canadian Arctic is not complex; species diversity throughout the north is low. There is a pattern to the distri-

bution of species, however, and it apparently has been influenced by the nature and extent of post-glacial dispersion. In general, diversity is lowest in the higher latitudes and is lower in the east than in the west.

In the eastern Arctic, Arctic char and lake trout (Table 1) predominate but there are exceptions. Trout have not been identified on Ellesmere Island and Arctic char are not common in James Bay. In northern Quebec, Atlantic salmon can be more abundant than Arctic char. Coastal marine resources in the east are comparatively diverse, however, especially along Hudson and Davis Straits where Greenland cod, Arctic cod and sculpins are common in these waters. Atlantic cod appear seasonally along east Baffin Island and in Hudson Strait. Lumpfish and sometimes capelin occur throughout Hudson Bay. Marine invertebrates are also locally abundant and some are occasionally used as food in certain areas.

Much of the lands of the east and east-central Arctic are remnants of the Precambrian Shield, granitic formations whose inland waters are frequently oligotrophic. The environment is harsh, the growing season short, and production of less than 0.5 kg/ha/y can be anticipated (Beamish et al. 1986). Estuarine production in the eastern Arctic, although higher than freshwater production, is also lower than in more southern areas (Martini 1986).

Moving westward, lands on the west shore of Hudson Bay and inland (District of Keewatin) support a more diverse ichthyofauna and productivity may be greater. Arctic char, lake trout, northern pike, lake cisco, Arctic grayling, lake whitefish and round whitefish occur in this area. All are used for human consumption and/or dog food, but to varying degrees based on their abundance and/or local preferences. Arctic char, trout and lake whitefish are the major species in the domestic fishery here, and char are exploited commercially.

Diversity increases as one moves further westward into the District of MacKenzie. Here, lands are predominantly sedimentary and suspended solids and nutrients in the waters are relatively higher than in the eastern Arctic. The treeline extends further north than in the east, and lakes of the boreal forest can yield between 0.5 and 7.6 kg/ha/y (Beamish et al. 1986). Although productivity is higher than in the east, it is still very low on the oligotrophic scale. As a result, all freshwater Arctic fishes are characterized by slow growth, longevity, late age of first maturity, and limited reproductive potential. Although game fish can reach trophy size, these represent many years of accumulated production and they are vulnerable to overexploitation (Beamish et al. 1986). Recovery from overexploitation is generally slow although there are exceptions, notably with Arctic char (Johnson 1976).

A dominant feature in the District of Mackenzie is the Mackenzie River, the largest river in Canada. Its delta at the edge of the Beaufort Sea is comprised of a series of channels and interconnected lakes totalling about 9,500 square kilometers in area, exclusive of land masses. The delta is heavily utilized by large populations of anadromous coregonids (Bond 1982). Lakes of the delta support the summer feeding of some of these fish which spawn in the Mackenzie River system. These lakes are shallow and although they have a low phytoplankton productivity (4-10 $g \cdot cm^{-2}$), many have productive aquatic macrophyte communities (e.g. 30 $g \cdot cm^{-2}$ in South Lake, N.W.T.) (Bodaly et al. in press). It is postulated that macrophyte production plays an important role in the trophic chain of these lake ecosystems.

There is a relatively large domestic fishery for coregonids in the Mackenzie Delta. Arctic char, lake trout, northern pike, burbot, and longnose sucker are also found in lakes and channels of this area but are often of secondary importance in the domestic fishery due to limited distribution and/or difficulties in reaching suitable fishing sites when compared with the availability of the migrating coregonids (Bissett 1974). Commercial exploitation of Mackenzie River Delta fishes has been erratic and largely unsuccessful. However, the fisheries in the rivers and lakes of the Mackenzie River Valley to the south have been quite successful, especially the lake whitefish fishery of Great Slave Lake. Examples of different Mackenzie Valley fisheries are summarized separately below.

Along the Arctic coasts of Yukon and the N.W.T., as well as in the Arctic Archipelago, the principal and sometimes only freshwater species are Arctic char and lake trout. Because of energetic gains of anadromy, sea-run Arctic char dominate in biomass and are an important food of these regions.

Marine species

In general, the marine fish resources of the Canadian Arctic are relatively unexploited. They are also largely unknown. To date, 135 marine fish species have been identified, 35 of these since the late 1970's (McAllister et al. 1985). Their biology and numbers have been little studied. Because many villages in the Archipelago are government relocations of Inuit from other places, utilization of local fish resources is largely affected by traditions and habits developed at earlier homesites. As a result, the dietary importance of marine resources to northern inhabitants can vary significantly from area to area. Also, Inuit do not often fish with the type of gear required to successfully exploit marine resources in locations offshore from the immediate coast and few marine species are captured.

Gill nets used in coastal Arctic char fisheries frequently capture sculpins, especially fourhorn sculpin, but these are often used only as dog food and sometimes as fox bait. In northern Quebec, staghorn sculpin is a desirable food fish and is often caught with hook and line. Other fishes such as Greenland cod in the east and Saffron cod in the west, are also sometimes utilized as food and dog food. Pacific herring are a by-catch of the Mackenzie Delta

coregonid fishery and they are occasionally dried for food or frozen for dog food. The commercial potential of herring in this area has not gone unnoticed and the history of this enterprise is presented in the marine resources section devoted to this species.

OVERVIEW OF THE FISHERIES

Native residents of northern Yukon and interior central and western N.W.T. are Indians of the Athabascan group, such as the Louchex, Hare and Slave Indians who live along the Mackenzie River. Other Athabascans live on the shores of Great Slave and Great Bear Lake, along the Liard and Slave Rivers, and in the Keewatin District along the eastern shores of Hudson Bay. Cree Indians occupy the shores of James Bay and nearby Hudson Bay (Canada, DEMR 1974). Inuit inhabit northern Quebec, the coastal mainland of the N.W.T., and islands in the Arctic Archipelago.

The location of some Inuit villages, established after the relatively recent transformation from nomadic hunting to settlement living, was influenced by the availability of flowing rivers as sources of drinking water. Proximity to these rivers often resulted in proximity to Arctic char stocks which now are important in the local domestic fisheries. In fact, some villages were developed at historic summer fishing camp sites which have been used for centuries. For example, Cambridge Bay is known as Ikaluktutiak, "the fair fishing place" (GNWT 1984). Iqaluit, once the community called Frobisher Bay, is a traditional name meaning "place of the fish."

DOMESTIC FISHERY

There are three types of fish exploitation in the Arctic: domestic, commercial and sport. Section 22 of the N.W.T. Fishery Regulations defines domestic fishing as: an Indian, Inuk, or person of mixed blood (at least one-quarter Indian or Inuk) fishing by angling or by means of gill nets, set lines, spears, snares or dip nets, for food for himself, his family, or his dogs. This fishery is unregulated and unlicensed access to it has been deemed a right of these people (G. Yaremchuk and B. Wong, DFO Winnipeg, unpublished data). Present fisheries policy recognizes that domestic fishing takes precedence over other types of exploitation. In addition, protection of domestic fishing areas and stocks from possible habitat disturbance has highest priority with northern fishery regulatory agencies (R. Peet, DFO Winnipeg, unpublished data).

The character of domestic fishing in the Canadian Arctic is related to the background of the indigenous population. The main fishing gear used by Athabascans and Cree is the gill net. Inuit use gill nets too but they also catch their fish by jigging a hook and line and with a leister (a spear typically with three barbed prongs) (Martini 1986). Fish weirs of stone or branches have been used by Inuit since prerecorded history, but their use as legal fishing gear for domestic harvests is restricted and very limited (Davies et al. 1986). Escapement through a weir must be allowed or there is danger of seriously impacting an entire anadromous spawning run. There are advantages to a weir when used judiciously and these are presently being exploited by limited weir use in the Cambridge Bay commercial Arctic char fishery (Kristofferson et al. 1986). Species harvested in the domestic fisheries are listed in Table 1.

In general, the tradition of fish exploitation is stronger in Inuit and Indians of northern Quebec than for natives elsewhere in Canada's north. That this is so is largely a function of opportunity, for in northern Quebec stocks of Atlantic salmon, brook trout and large sculpins are available for exploitation, as well as many of those species found elsewhere in the north. Given this region's relative smaller number of marine mammals, fish provide a larger portion of dietary protein to these people than fish generally do elsewhere in the north.

There is also a much more extensive history of commercial fish exploitation in northern Quebec than in the western Arctic. For example, there has been a sea run Atlantic salmon fishery on the Koksoak River (Ungava Bay) intermittantly since 1869 (Makivik Corp. 1986).

What could be the single most significant unresolved aspect of all northern fisheries is the fact that the size of the annual domestic harvest is unknown in spite of a number of efforts to derive estimates. What little is known is largely a result of localized efforts.

One study of a domestic fishery on the Yukon's North Slope indicated that marine mammals and caribou have traditionally provided the brunt of the domestic food base there, Arctic char being supplementary. The North Slope native population dwindled from perhaps 3000 at the turn of the century, when the bowhead whaling industry was thriving, to less than 20 individuals in 1973. Although no data exist to record landings at the beginning of this period, Steigenberger et al. (1975) estimated that the 1972-73 domestic fishery there harvested 1000-2750 fish weighing a total of 610-2060 kg(1350-4550 pounds). The catch consisted of Arctic char for human consumption and Arctic cisco, least cisco, broad whitefish and inconnu for dog food. Since then, hydrocarbon exploitation has swelled the North Slope's population but the most significant impact on local fisheries has been the expansion of the area's sport fishery (see below).

Other notable studies of domestic fisheries are those which were focused on the Mackenzie Valley area (summarized by Corkum and McCart 1981), the Keewatin (Gamble 1984), and the Baffin Region (J. Pattimore, Baffin Region Inuit Association, Iqaluit, unpublished data). All concluded that the lack of accurate statistics makes reliable estimation of the overall domestic harvest impossible. In spite of this limitation, there have been attempts to describe the relative size of the northern domestic fishery.

In their review of the domestic fishery in the Northwest Territories, G. Yaremchuk and B. Wong (DFO Winnipeg, unpublished data) state that approximately 40% (by weight) of the total annual Northwest Territories fish harvest may be accounted for by the domestic fishery. Others suggest that on a local scale, the relative significance of domestic exploitation may be considerably greater. For example, Corkum and McCart (1981) cautiously estimated that the 1980 domestic harvest in the Mackenzie River Delta totalled about 80% of the annual catch for that area. There is a great degree of variability and uncertainty in such approximations, but all agree that the size of the domestic harvest is relatively large. G. Yaremchuk and B. Wong (DFO Winnipeg, unpublished data) point out that this harvest is the aggregate yield of a diffuse fishery with a large number of participants taking small catches from a large number of stocks. They also intimate (perhaps naively) that in the absence of other types of fishery exploitation there is little danger of overexploitation by the domestic fishery.

However, A. Kristofferson (DFO Winnipeg, personal communication) suggests that local populations of lake trout and Arctic char have been impacted by long-term domestic fishing. When Inuit habits were nomadic, domestic fishing pressure on specific stocks was likely only significant when large numbers of hunters were occupying the same area. After permanent villages were established, domestic fishing pressure on local stocks became more consistent. At some locations such as Rankin Inlet, landings declined. It is also likely that human populations in and near these settlements are increasing, which tends to magnify the long-term effect domestic fishing has on these stocks.

Several factors make quantification of domestic landings difficult. Duration of individual domestic fisheries can vary from a few days to several months, depending on things such as location, species sought, availability of fish, and the number of middle to older age groups in the community following traditional activities (Bissett 1974). Also, fishing camps are often distributed over wide distances and there is little reason for fishermen to quantify production either by species or by pounds harvested (Bissett 1974).

Studies to estimate domestic harvest levels have rarely used statistically similar designs; results are not often comparable. Furthermore, funding for such work has been limited and efforts to date consist of studies focused at selected communities or areas. Finally, extrapolation is often used to compensate for the general lack of record keeping in the fishery and to adjust estimates to include participants who have not contributed data to a survey. There are known to be extreme variations in the domestic harvest by individual families and this variation could significantly affect extrapolated estimates. For example, the 1973 Fort McPherson domestic fishery survey results ranged from 135-2,270 kg (300 to 5,000 pounds) of fish per family per year (Bissett 1974). The 1973 Mackenzie delta fishery survey estimated between 900-7,250 kg (2,000-16,000 pounds) per family.

The only broad based effort to gather fish landings data in the N.W.T. is done by an annual commercial fishery questionnaire whereby all commercial license holders are required to report all catches. Estimates of commercial and commercial plus domestic harvests are extrapolated from this questionnaire but for the above reasons, results are rough approximations. This is especially so when fishermen are responding to an annual questionnaire most often from memory rather than a set of records.

Thus, if Yaremchuk and Wong (DFO, unpublished data) are correct, almost half of all fish landed in the northern Canadian fisheries (domestic, commercial and sport) go unreported. This makes management of these fisheries especially difficult. For example, there are no data to compare current with past harvests. There are also no meaningful numbers for generating estimates of the impacts these harvests have had or will have on northern fish stocks.

COMMERCIAL FISHERY

Commercial fishing in Canada is defined as "all fishing for purposes of sale or barter" (Canada, DFE 1977). Commercial fishing in the Arctic is strictly regulated by species, mesh sizes, gear, closed seasons, and quotas. While it is the intent of these regulations to allocate commercial exploitation without overfishing, they have frequently been unsuccessful because of the difficulty to control commercial exploitation in concert with a simultaneous unregulated domestic fishery. As a result, examples of overexploitation where commercial fishing is allowed are common.

Commercial fishing activity in the N.W.T. is extensive (Table 2) and has been recently reviewed by Davies et al. (1986) but in northern Yukon proper, there is little if any commercial exploitation of fish stocks. Yukon fish stocks which spawn in the Peel River or its tributaries are more frequently exploited by the Mackenzie Delta fisheries when these fish migrate from waters in the Yukon to the Beaufort Sea. In northern Quebec, there is a long tradition of commercial fishing. Atlantic salmon and Arctic char were traded by the Hudson Bay Company beginning in the mid-1800's and these species continue to support commercial enterprise in that area. There has been a commercial marine fishery at Killiniq Island; the potential of this fishery and others directed at Quebec's northern marine and anadromous resources are being evaluated. The Killiniq fishery will be discussed elsewhere in this report.

A major management problem regarding commercial fish exploitation in the Arctic is how to harvest the sparse production of a large area, where stocks consist of old fish available in large and conveniently fishable units, but where the rate of renewability of the resource is low (Martini 1986). Solutions to this problem have been pursued in various ways and new strategies continue to evolve. For example, the largest fishery in the Canadian Arctic, located on Great Slave Lake, was originally a mixed fishery based on species of differing harvest

potential (lake whitefish and lake trout). The differing responses of these species to exploitation resulted in "compromise" management whereby harvest levels of one species (lake whitefish) were allocated at the expense of the other species (lake trout). In smaller lakes of the N.W.T., a system of rotating pulse fisheries has been established. For anadromous coastal fisheries, annual quotas derived from test fishing results are utilized. Each of these schemes to promote yet control commercial exploitation is briefly discussed below.

Great Slave Lake commercial fishery

Great Slave Lake (Fig. 1) is the fifth largest lake in North America. It contains the largest and most productive fishery in the N.W.T. Begun in 1945, there are now two fishing seasons: summer season extending between 16 May and 25 September (approx.), and winter season extending between 1 December and 31 March (approx.). Although it was originally an open fishery, there is now a policy of limited entry to regulate both the number of boats fishing the summer season and the number of snow machines operating during the winter season. Sinking gill nets are the principal gear used in both seasons. Mesh restrictions apply but previous limitations on net length, number of nets, and time between lifts are no longer in effect. Since 1948, a major and unique asset to this northern fishery has been the proximity of the Mackenzie Highway, a major transportation link with southern markets.

Great Slave Lake is oligotrophic, especially in the east arm area (Keleher 1972). Of the 56 freshwater fish species recorded in the Canadian Arctic, 25 are known to occur in the lake. Of these, five are commonly sold (Table 3), two others less frequently. In order of recent importance they are: lake whitefish, northern pike, lake trout, inconnu, walleye, longnose sucker, and burbot (Davies et al. 1986). Ciscoes (Coregonus spp.), burbot and longnose sucker may constitute 40% of a fisherman's catch: all but the burbot are frequently discarded on the lake due to lack of market demand (Roberge et al. 1982).

Most of the fish caught in the lake are destined for export sales to southern Canada, U.S.A. or Europe. Fish for export sale are required to be shipped first to the Freshwater Fish Marketing Corporation (FFMC) in Winnipeg, Manitoba. The FFMC is a government owned corporation and is the only body licensed to sell export catches of freshwater fish from the region. As such, the magnitude of these catches is one of the better documented aspects of northern fisheries.

In 1945, when the fishery opened, lake trout and lake whitefish comprised 64% and 30% respectively of the total annual catch of 0.75 million kg (1.7 million pounds) (Table 3). By 1949, the quota had been increased and landings reached 4.5 million kg (9.9 million pounds). The proportions of trout and whitefish had shifted to 39% and 56%. During this five-year period, lake trout landings dominated the summer fishery and peaked at about 1.4 million kg (3 million pounds) in 1949 (Table 4). Winter landings were predominantly whitefish.

To manage the rapidly expanding fishery and to attempt to prevent local overfishing, Great Slave Lake was divided in 1949 into six administrative areas, each with a separate composite quota. Lake trout predominated in the east part of the lake and whitefish predominated in the west. The fishery was managed for high sustained yield even though it was a mixed fishery supported by species of significantly different levels of productivity (McCart and Den Beste 1979). When lake trout landings declined, fishing effort concentrated on the more productive whitefish population in the west.

In 1950, for the first time more lake whitefish than lake trout were caught in the summer fishery. Annual lake trout landings were on the decline, a trend that has continued to this day (Fig. 2, Table 4). In spite of quotas and fishing regulations intended to provide annual sustained yield of both species, lake trout were overfished (Keleher 1972).

The East Arm of Great Slave Lake was closed to all commercial fishing in 1974. It has since been managed exclusively for domestic and sport fishing. The remaining portion of the lake, except area closures near settlements, is now managed as a commercial whitefish fishery. Lake trout are said to have been "unable to withstand commercial gillnetting" (Moshenko et al. 1981). In contrast, exploitation of lake whitefish populations appears to have been successful and continued sustained landings are expected (Beamish et al. 1986).

As of 1972 there had been no apparent increase in the numbers of other fishes in Great Slave Lake in response to the over harvesting of lake trout, a major predator in the lake (Keleher 1972).

Inland Lake commercial fisheries

In the Arctic, small oligotrophic lakes are very numerous. The growing season is short and productivity in these lakes is low. As a result, fish stocks are characterized by slow growth and they are vulnerable to overexploitation. Transportation links to most of these places are undeveloped and travel by aircraft is the major mode of access. Because of the lack of inexpensive transportation, successful commercial exploitation requires either a premium price for the fish or large amounts of product. Southern markets have resisted awarding a premium price so the fishery relies on a large catch to generate a profit.

In these circumstances it has been found to be challenging to manage the fisheries in these lakes for a commercially viable yield on an annual basis. In the Mackenzie Valley, a pulsed fishery was adopted in the 1950's and utilized a six-year rotating cycle. The commercial quota for these lakes was adapted from Rawson (1960) who determined that eleven of twelve lakes in northern Saskatchewan were capable of sustained annual fish production of 0.5

lb per acre (0.56 kg/ha). To allow sufficient profit to the fishery, six years of this annual quota were taken from a given lake within two years. Thereafter, the fishery in this lake was closed for four years and the stocks were allowed to recover before repeating the cycle. This program was also adopted for certain lakes in the Keewatin. An historical record of lakes fished and their annual harvest has been compiled by Davies et al. (1986). These data are summarized in Table 5.

When the cyclic quota program began in the Mackenzie Valley, it incorporated a system of six control areas. Lakes within a control area were on the same cycle and categorized according to three types of use: 1. commercial fishing exclusively, 2. commercial fishing and research, and 3. sport and domestic fishing (Davies et al. 1986). By 1966, it had been determined that the commercial fishing industry was unable to establish suitable infrastructure for processing and transportation within the confines of rotating control areas. The fishing cycles for these lakes were then considered individually and the control area concept was abandoned.

In spite of these efforts to address problems with this management program, fishermen continued to be dissatisfied with the cyclic quota system. By the early 1970's, the cyclic system was abandoned in favor of a return to an annual quota system (Roberge et al. 1986).

The inland lake fishery saw its peak of activity between 1962 and 1972 (Fig. 3; Davies et al. 1986). A maximum of 30 lakes were fished in one year (1970) and a maximum of 650,000 kg (1.4 million pounds) round weight were reported harvested in 1962. Lake whitefish was the dominant species but lake trout, walleye and northern pike were also harvested in large numbers.

Transportation expenses for a fishery exploiting a resource scattered in remote areas are predictably high. The decline of fishing effort in this fishery coincided with rising fuel costs in the 1970's, a phenomenon which impacted all fisheries.

Mackenzie River Delta commercial fisheries

Fishing within the Mackenzie River Delta (Fig. 1) is predominantly confined to river channels and lakes. Unlike the inland and coastal fisheries which have been monitored throughout much of their development, data for the fisheries of the delta have only been sporadically reported (Table 6). A review of these data was presented by Corkum and McCart (1981) and is summarized here. For the purposes of this report, the Mackenzie Delta fisheries include the delta proper, the Peel, Hornaday and Arctic Red rivers, and the area lakes.

Several anadromous species are extremely abundant in the delta area. They pass through the delta on their way to feeding grounds in the coastal Beaufort Sea and return in the fall, migrating upriver to yet-undefined spawning grounds. During these migrations they represent high concentrations of easily exploitable fish.

Broad whitefish has been the species of major importance here. Lake whitefish are also very abundant but heavy incidence of tapeworms (Triaenophorus crassus) often precludes their utilization for anything but dogfood. There are few char in the Mackenzie River proper but the Peel River run is exploited. The Hornaday River to the east is occasionally productive too. Other species exploited commercially are: lake trout, northern pike, Arctic cisco, least cisco, inconnu, burbot, and longnose sucker (Corkum and McCart 1981).

Between 1957 and 1980, broad whitefish constituted roughly three fourths of the Mackenzie Delta commercial landings sold to southern markets (Corkum and McCart 1981). During their 1978-1980 survey of Mackenzie Delta domestic and commercial fish exploitation, these authors estimated that 81% of all fish caught during that time went to domestic consumption. They also estimated that more than 62% of this domestic harvest was comprised of broad and lake whitefish (225,000 kg or 500,000 lb). During this time, 11% (31,500 kg or 70,000 lb) of the total Mackenzie River Delta catch was exported to southern markets through the Freshwater Fish Marketing Corporation, and 8% (22,500 kg or 50,000 lb) was sold locally. These were years of burgeoning oil development in the area and the local market was quite active. Since the reduction in oil industry activity in 1986, the local market is now likely smaller but the domestic fishery is probably about the same.

The data describing landings for local sale are not entered into the FFMC record keeping process but are derived from the questionably accurate annually-distributed commercial fisheries questionnaire described earlier. As with the questionnaire, the FFMC data are also subject to estimation and omission (Bodaly et al. 1986). Accordingly, Corkum and McCart (1981) acknowledge their figures are approximations but the relative size of the various Mackenzie River Delta fisheries is clear. At the present time, the commercial fish harvest in the delta is much smaller than the domestic harvest.

The growth of the delta commercial fisheries has not often been limited by the abundance of exploitable resources in the region. Commercial fisheries have failed for a myriad of reasons. A history of these efforts was presented by Davies et al. (1986). These authors acknowledged the negative impact of high transport and processing costs to these fisheries but suggested another reason for failures has been the lack of proper freezing and storage facilities. They noted that seven of eight attempts to establish a commercial fishery in the Delta between 1960-1972 failed for this reason.

Corkum and McCart (1981) cited three more reasons for the failure of Mackenzie Delta commercial fisheries besides the two noted above: limited local markets, a lack of skilled shoreside facility maintenance personnel, and conflicts between domestic and commercial fisheries. However, they expressed optimism that oil industry development in Inuvik and Tuktoyaktuk

might expand local demand for supplies of fresh fish. They also suggested oil industry support services might enhance the quality of support available to commercial fishery operations. They did not predict the eventual decline in oil industry activity.

There have been occasional attempts to commercially exploit Pacific herring in the Beaufort Sea near the Tuktoyaktuk Peninsula. Presently, there is interest in a Pacific herring roe fishery. This species and its fisheries will be discussed in the section on marine resources (see below).

Coastal Arctic char commercial fishery

Arctic char is recognized as a polymorphic species complex. In the Canadian Arctic there are two recognized forms. The smaller Western Arctic-Bering Sea Form is faster growing but in Canada is limited to the western portion of the Mackenzie Delta, its tributaries, and drainages to the Beaufort Sea in the Yukon. Only one lake resident population is known (McPhail 1961).

The Eastern Arctic Form ranges east of the Mackenzie River drainage. It grows to a larger size than the Western Form and occurs widely as freshwater-resident and anadromous populations. Freshwater-resident eastern Arctic char are extremely slow growing and, although abundant, are too small for practical commercial fishery development. Anadromous char, on the other hand, are often sufficiently abundant to support commercial exploitation. Their larger size promotes satisfactory economic return for the fishery but their slow growth results in slow recruitment to an economically harvestable size (Johnson 1976).

Arctic char is the principal species taken in coastal commercial fisheries of the Canadian Arctic (Fig. 1, Table 7). The first recorded instance of its commercial exploitation occurred in 1932 along the Keewatin Coast but it was not until the 1960's that successful long-term commercial operations were implemented (Fig. 4). In 1960, a successful char fishery was established at Cambridge Bay. In 1962, commercial fishing for Arctic char began along the Keewatin coast. This former fishery, with a total 26 year production of over 1.1 million kg (2.4 million pounds) and a current annual production of approximately 62,000 kg (136,000 pounds) ranks number one in Canadian Arctic char landings (Davies et al. 1986).

Initially, the char fishery was essentially unregulated and abuses of the resource occurred. For example, in spite of a recommended quota of 909 kg (2,000 pounds) for a proposed char fishery on Herschel Island in the Beaufort Sea (Currie 1964, as cited in Steigenberger et al. 1975), in 1965 the Menzie Fish Company took 5363-7311 kg (11,804-16,084 pounds) from the area. The following year their efforts yielded 101-545 kg (222-1,200 pounds). Although economics and weather played a part in this decrease, possible overfishing cannot be ignored (Steigenberger et al. 1975).

The char fishery is now managed by a system of annual quotas. Quotas are established in two ways. If a stock is presently unexploited, its suitability for commercial exploitation is evaluated by the use of a test fishery program (Kristofferson and McGowan 1981). A limited fishery is allowed for a minimum of two years (usually three or four) and the size and age of fish in the stock are determined from samples of the catch. Managers then evaluate the potential of the stock to support commercial fishing pressure. If the stock already supports a domestic and/or sport fishery, samples from these catches are used to evaluate commercial potential. If evaluation indicates the stock can accommodate commercial exploitation at levels suggesting potential economic success, harvest levels are limited to quotas. If subsequent evaluation determines detrimental impact from this new fishery, quotas are reduced or abolished, in deference to a domestic fishery if one is present.

In practice, this system has not always prevented overfishing. Cases of sudden declines in fish abundance have been reported, even though quotas were not exceeded. While the evaluation program attempts to allocate the resource among the domestic, commercial, and sport user groups, the size of the domestic harvest is usually unknown. As noted above, this portion of the harvest can be considerable. Without this information, assessing fishing pressure and allocating commercial quotas is difficult and understandably inaccurate. In some instances, stocks which have been sustaining domestic and sport fishing pressure cannot sustain the additional harvest allocated to a commercial fishery.

An example of this problem occurred with the char fishery on the Sylvia Grinnell River near Iqaluit (Kristofferson and Sopuck 1983). This river, the site of a traditional Inuit domestic fishery and a more recently established sport fishery, first attracted commercial fishing activity between 1947 and 1950. Examination of the stock in 1958, when the commercial fishery was reactivated, suggested that previous commercial exploitation did not have long-term impact. The Sylvia Grinnell River stock was judged to be capable of sustaining domestic, sport and commercial harvests and commercial fishing resumed.

During this latter phase of this fishery's development (late 1950's and early 1960's) landings and catch per unit of effort for all avenues of exploitation declined steadily. In 1966, commercial fishing was banned in an effort to protect the domestic harvest and to allow the population to recover. (Johnson (1976) has shown that impacted char stocks can recover rapidly if all exploitation ceases.) Domestic and recreational fishing was allowed to continue on the Sylvia Grinnell River and the stock has yet to return to pre-commercial fishing levels.

A similar scenario also occurred with the Diana River Arctic char stock in Rankin Inlet (A. Kristofferson, personal communication). As with the Sylvia Grinnell River fishery, commercial landings were set by quota and monitored by tally. Recreational landings were monitored by creel census. The magnitude of the domestic

harvests was unknown. When fishery managers allocated commercial quotas to the fishery they followed conservative guidelines. But when commercial landings were superimposed on the unknown quantity of the domestic catch, the fishery eventually collapsed due to overfishing. Management in these circumstances is certainly a trial-and-error process.

Arctic char stocks of the Kellett, Becker and Arrowsmith Rivers near Pelly Bay and in the Ekalluk River near Cambridge Bay have suffered similar fate. Kristofferson et al. (1982) recommended that all exploitation be banned in these Pelly Bay rivers to allow recovery of the stocks. Because of the priority assigned to domestic fishing rights and the basic need for food, complete fishing closures have been rare and are very unpopular. Char stocks in these particular rivers are an important local source of food and domestic exploitation has continued. These stocks have not yet recovered from earlier overfishing (A. Kristofferson, personal communication).

A further complication to effective Arctic char management is the fact that unregulated domestic fishermen sometimes use smaller mesh nets than are allowed in the commercial fishery. Use of these nets has been implicated as impacting the average size of Arctic char in the Rat River, for example. Some domestic fishermen hold commercial fishing licenses and sell part of their catch in the commercial fishery. It is difficult to enforce mesh size regulations when both small and large-mesh nets can be legally in use at the same location (Corkum and McCart 1981).

Additional management problems arise if char fishing takes place along the coast in the summer when anadromous stocks are at sea. Stocks from various rivers may mix together when on their way to or while they are at summer feeding grounds. Fishing at this time may impact several stocks at once. And these stocks may face fishing pressure again when they return to their separate home streams at summer's end. Arctic char caught in the summer in Mangles Bay and in the Kingark River near Gjoa Haven are believed to be a mixture of stocks which come from several nearby rivers where there are also char fisheries. Kristofferson et al. (1982) recommended completely excluding commercial fishing from these summer feeding areas but fishing continues.

Port Burwell/Killiniq commercial fishery

In the Canadian Arctic there is little history of fishing directed toward commercial exploitation of strictly marine species. Most efforts have been or are artisanal-type fisheries such as the Atlantic cod fishery of Frobisher Bay. These will be mentioned anecdotally in the synopsis of exploited marine species later in this report. The fishery at Killiniq Island, off northern Quebec (Fig. 1) is unique and will be highlighted here separately.

Between 1947 and 1950, studies by Fisheries Research Board of Canada personnel aboard the FRV Calanus revealed an abundance of Atlantic cod in Ungava Bay near Killiniq Island. As a result of this work, experimental fisheries to provide cod as food for northern Quebec Inuit were established on the island at Port Burwell in 1950 and 1951 (Gillis and Allard 1984). Data from these efforts are scarce but Davies et al. (1986) indicated 6,347 cod were taken in 1950 (no weight given). This author has found no reference to 1951 catches but Gillis and Allard (1984) noted that not much effort was directed toward utilizing this resource after the experimental fisheries ended.

In 1959, the Department of Indian Affairs and Northern Development (DIAND) began an economic development project at Port Burwell which included the establishment of a fish freezing facility. It was DIAND's intent to assist in the development of an Atlantic cod fishery to bridge the resource gap between the summer Arctic char fishery and the October harp seal harvest (Gillis and Allard 1984).

In spite of limitations in freezer plant design and capacity, this operation prospered during the 1960's although accurate records are scarce. Gillis and Allard (1984) report the following catches:

1966	3 682 kg	(8 100 pounds)
1968	27 273 kg	(60 000 pounds)
1969	3 636 kg	(B 000 pounds)
1972	1 364 kg	(3 000 pounds)

Davies et al. (1986) reported landings in 1969 were 17,447 kg (38,384 pounds)and stated that the 1972 quota was 30,000 kg (66,000 pounds) but have no catch data for that year. Although these data don't always agree, it is apparent that landings fluctuated significantly, a portent of future efforts to establish an Atlantic cod fishery in this area.

Logistic resupply of Killiniq Island/Port Burwell was extremely difficult (Gillis and Allard 1984). For reasons not related to the fishery, Port Burwell was gradually abandoned by its inhabitants during the 1970's. The fishery closed around 1975 due to insufficient labor force and in 1978, the townsite was officially closed.

The people of Killiniq Island were dispersed among various northern Quebec communities fringing Ungava Bay. In spite of relocation, these people have not given up their ambition to exploit the abundant marine resources of the area. They have joined with Makavik Corporation, which represents the Inuit of northern Quebec and Labrador, and have taken steps to reactivate the fishery using the fleet from Port Burwell and some refurbished processing facilities there. They have renamed it the Killiniq fishery and it has been under development and evaluation since 1983.

Vessels in the present Killiniq fishery are multi-purpose longliners in the 13-14.5 meter (40-45 feet) range. They have been engaged in exploratory fishing along the Labrador coast and in Ungava Bay. Atlantic cod are known to occur in these waters typically for a three to five week period in the summer, as a result

of this species' annual inshore migration along the Canadian Atlantic seaboard. In 1983, Killiniq catches of Atlantic cod were excellent. Quality was reported to be exceptional and salted fillets exported to southern markets returned top prices. Early optimism about the re-establishment of a successful commercial fishery waned in 1984 and 1985 when the migration of Atlantic cod into Ungava Bay was weak and 439 kg (976 pounds) and 704 kg (1,564 pounds) respectively were taken (Allard and Gillis 1986). The potential of this species as a dependable source of product to the Killiniq fishery remains questionable.

Arctic char stocks of Killiniq Island and the vicinity were heavily exploited during peak of commercial fishing activity in the 1960's and early 1970's. After the people of Port Burwell were relocated, local fishing pressure on this species effectively ceased. When these char stocks were examined in 1984 and 1985, they appeared fully recovered and showed no effects of earlier exploitation (D. Gillis, Makivik Corp., Fort Chimo, Que., personal communication). The potential for a char trap fishery in this area is presently under evaluation (Allard and Gillis 1986).

Other species harvested in the by-catch of the recent Killiniq fishery include: Greenland cod, American plaice, shorthorn sculpin, Greenland halibut, polar eelpout, Arctic eelpout, scallops, crab and shrimp. The status of some of these species will be considered below.

SPORT FISHERIES

The potential of northern resources for recreational fishing was apparently realized in the 1940's when surveys of Great Slave, Great Bear, and Teslin lakes revealed an abundance of trophy-size fish in these waters (Rawson 1959). Early sport fishing participants travelled northward in search of trophy lake trout and Arctic grayling. The expansion of this fishery into an activity which requires careful monitoring and control has been relatively recent.

The sport fishery represents an important source of employment and income to the N.W.T. In particular, two service groups there benefit from expenditures made by sport fishers persuing their recreational activity. First, there is the direct service sector which provides access to the fish resources. Examples are fishing camps, lodges and outfitters located throughout the north. (In 1982, there were 41 fishing lodges in the N.W.T. offering a total bed capacity of 780 units (D. Topolniski, DFO Winnipeg, unpublished data).) Second, there is the indirect service sector consisting of northern hotels and restaurants whose businesses benefit from but are not wholly dependent upon the sport fishery (Canada DFO 1981).

There are now two kinds of sportfishing licenses in the N.W.T. (a third kind, a short-term license, was discontinued in 1977). A resident sportfishing license is available to all persons who have resided in Canada for a period of not less than six months. Non-residents are issued a separate license. No license is required by children under the age of 16, by residents over the age of 65, or by persons qualifying for the domestic fishery.

During the 1968-69 fishing season, a total of 5,586 N.W.T. sport fishing licenses were sold. Only 20% of these were issued to N.W.T. residents (Table 8). By 1985, 54% of a total of 16,019 N.W.T. sportfishing licenses were sold to residents. This interval was a period of increased activity in the north and fishing effort and N.W.T. resident participation increased dramatically. Population changes and enhanced access to resources by a developing transportation system account for a large part of this increase in local resource utilization.

Since 1970, license sales to non-residents have been rather constant (Fig. 5). Comparable sales for residents increased more than 275% (Table 8). The 1985 survey indicated that 55% of sport fishing effort was expended in the Hay River, Fort Smith and Yellowknife areas, population centres of the N.W.T. (GNWT 1986).

The Canadian sport fishery was first surveyed in 1961 but the survey was incomplete. In 1975, the first nationally-coordinated set of angling surveys was conducted across Canada and the magnitude of the sport fishing harvest in the N.W.T. became known. Similar surveys have been and are scheduled to be repeated on a five-year cycle.

In 1985, resident anglers preferred walleye, lake trout and Arctic char. Non-residents preferred lake trout, Arctic char and Arctic grayling but this preference has changed with time (Tables 10 and 11). Lake trout were the most commonly caught species in 1985 but only 20% of those caught were reportedly taken (Table 12). Angler interest and management programs for this species are directed at trophy-size fish and releases are common (catch and possession limits for lake trout in N.W.T. are three and five, respectively except for designated trophy-waters where only two may be in possession and only one of these can be over 28 inches (70 cm) fork length).

On the other hand, 61% of the walleye caught in 1985 were taken (Table 12), a harvest which had increased 90% since 1975. During this same 10 year period, the number of Arctic char reported harvested by the N.W.T. sport fishery increased 88% (Table 9). Landings for other species also increased, most notably those of walleye. Catches of northern pike declined overall during this period. During this time there was a 50% increase in the number of licenses sold (Table 8).

As mentioned earlier, enhanced access to remote areas of the N.W.T. has been a key development in the expansion of the sport fishery. Because of this, fishery managers now draw distinctions between real or potential fishing intensity at sites near population centres, where service roads are available, and more remote sites serviced by aircraft. Ground-access fisheries are considered to have an undefined and uncontrolled user population. Remote access

sites, such as lodges and camps are considered to have a well defined and controlled sport fishery user population. From these considerations, fishery managers have developed a classification of N.W.T. sport fisheries based on three levels:

1. Intensive fisheries - those which a) sustain harvest levels which are straining the capacity of a resource, b) which sustain fishing pressure which could overfish a resource, or c) where a serious use conflict exists,
2. Intensive/extensive fisheries - those in which current use does not strain the resource and where user conflicts do not exist, but where anticipated increases are perceived to exceed the resource capacity,
3. Extensive fisheries - those which do not appear to have problems and where none are anticipated within the next 5-10 years.

All three types consider the cumulative effects of domestic, commercial and/or sport fishing and are judged to require different levels of management and information (Jacobsen et al. 1983).

This priorization of management and the need for research for fisheries management purposes is necessary due to the extensive area of jurisdiction and the large number of lakes supporting the N.W.T. sport fishery. As a result, efforts to obtain biological information on the status of stocks supporting sport fishing vary according to perceived needs or concerns (Jacobsen et al. 1983). Areas where impacts or conflicts are judged to be the greatest receive the most attention.

Studies have shown that sport fishing has impacted populations of Arctic grayling near Hay River (Gillman and Dahlke 1973; Falk and Gillman 1974, 1980) and at Providence Creek, N.W.T. (Falk et al. 1982). Similarly, the size of lake trout in Great Bear Lake has significantly decreased since the advent of a lodge-based trophy fishery there (Falk et al. 1973). These experiences have shown that careful management of sport fisheries is as important as management of commercial fisheries.

Details of the sport fisheries in the Arctic drainages of the Yukon and northern Quebec are not included in this report. Canada sport fishery survey data are aggregated at the provincial level and hence are not readily available for these component areas. Very few Arctic char are reported taken in the Yukon sport fishery and none are reported by Quebec, although some are likely taken.

EXPLOITABLE ARCTIC MARINE FISHERY RESOURCES

There have not been many examinations of the marine ichthyofauna in the Canadian Arctic. The few that have been done were scattered widely over the years. For example, quantitative demersal sampling in Hudson Bay was not reported prior to 1978 but qualitative studies were recorded as long ago as 1930 (Martini 1986). Limited quantitative and qualitative surveys by Arctic Biological Station personnel and others have been conducted in the Arctic since the 1950's but knowledge of these resources remains infinitesimal.

Interest in Arctic marine resources has recently increased due to hydrocarbon exploitation activity. Of the 135 fish species presently known to exist in these waters, the Arctic cod is considered most important in the context of its utilization as a food resource by marine mammals, birds and fish. As such it has recently become the focus of a DFO program to study its abundance, distribution and productivity. No other marine fish species is presently under similar investigation in the Canadian Arctic.

The contribution of marine fish species to the domestic harvest is largely unknown. A few studies such as the Keewatin wildlife harvest study (Gamble 1984) have attempted to estimate the use of marine fish, but available information is often anecdotal. Nevertheless, generalizations can be made.

Throughout the arctic, fourhorn sculpin often occur as by-catch in gill nets set along the coast in the fishery for anadromous species such as Arctic char and coregonids. Another welcomed marine species in the by-catch along the Beaufort Sea coast is the Pacific herring.

The status of these and other species will be discussed in the following synopsis of Arctic marine fish resources. Its purpose is to catalogue those marine species found in Arctic waters which are exploited or have potential for fishery exploitation, either domestic, commercial, or sport. It is assumed a priori that little is known about this subject. The synopsis includes anecdotal information and is intended to form the basis of an elementary understanding of the use or potential use of these resources.

PACIFIC HERRING

Pacific herring have been caught frequently in the nearshore Beaufort Sea. They are reported to be more abundant to the east of the Mackenzie Delta than to the west. Occasionally they enter freshwater and they are known to spawn in bays and inlets of the Tuktoyaktuk Peninsula and elsewhere (Gillman and Kristofferson 1984).

In 1963, an experimental fishery was conducted near Baille Island and about 8,000 kg of Pacific herring were harvested (Davies et al. 1986). In spite of promising catches, high costs for processing and transportation rendered the product non-competitive in southern markets and the fishery was abandoned.

In 1980, the Inuvialuit Development Corporation sought funding to investigate the development of commercial fisheries in the Mackenzie Delta and coastal Beaufort Sea. Pacific herring in mature and post-spawning condition in spring and fall runs had been found along the Tuktoyaktuk Peninsula, and in Mason Bay, Kugmallit Bay

(Corkum and McCart 1981), Liverpool Bay, and as far east as the Coppermine River (Gillman and Kristofferson 1984). The Minister of Renewable Resources for the Government of the N.W.T. requested and received DFO involvement.

In 1980, a feasibility study for the establishment of a herring roe fishery in the Beaufort Sea was initiated. Although previous failures of commercial fishery development in this area were recognized and acknowledged, participants in this latest effort hoped to take advantage of Japanese markets recently developed for southwestern Canada's successful roe fishery. Also, improvements to transportation links meant enhanced access of the proposed fishery to southern and oversea markets (A. Kristofferson and V. Gillman, DFO Winnipeg, unpublished data).

Test fishing for Pacific herring was conducted in Tuktoyaktuk Harbor (1981 and 1982) and the Liverpool Bay area (1981, 1982 and 1983). Results suggested mature herring could be safely caught through melting ice in the Fingers area of Liverpool Bay. In 1983, 4,580 kg (10,100 lb) of herring yielded 398 kg (877 lb) of processed roe which was deemed marketable after shipment to Vancouver. Smoked male carcasses also were potentially marketable (A. Kristofferson and V. Gillman, DFO Winnipeg, unpublished data).

To generate sufficient product to justify investment and development of a Beaufort Sea Pacific herring roe fishery, it has been estimated that a spawning stock biomass of 1,000 tonnes is required (A. Kristofferson, DFO Winnipeg, personal communication). To date, no such stock has been found. As yet unanswered is the disposition of the huge quantities of carcasses generated by such a fishery. Furthermore, herring appear in the stomachs of lake trout in the Eskimo Lakes area. These trout support a small sport fishery and are taken for domestic consumption. Local fishermen are concerned that exploitation of Pacific herring may impact this locally important lake trout resource (A. Kristofferson, DFO Winnipeg, personal communication).

Gutted and dried Pacific herring are occasionally utilized as food by inhabitants of Tuktoyaktuk, Aklavik and Inuvik. Exploitation appears to be light and sporadic. They have also been infrequently observed to be the focus of a small dogfood fishery in Tuktoyaktuk Harbor (W. Bond, DFO Winnipeg, personal communication).

ARCTIC COD

This species is widely dispersed throughout the global northern high latitudes and is believed to be the most abundant marine fish in the Arctic. Occasionally, dense shoals of Arctic cod are observed near a landfast ice edge or in bays during the open-water season. Large shoals have also been observed beneath ice, most recently by using hydroacoustic techniques. A remarkable siting of a shoal "several" miles long and presumably of Arctic cod was reported by the captain of the nuclear submarine USS Skate as it cruised beneath the polar ice cap in the Arctic Basin (Ley 1971). Other shoal sightings have been less spectacular but this species is known to occur from 84°42'N to the Gulf of St. Lawrence (Andriashev 1980).

A pivotal component of the Arctic food chain, Arctic cod is eaten by birds, marine mammals, fishes such as Arctic char, and Inuit and their dogs. Because Arctic cod consume vast quantities of small crustaceans such as copepods and amphipods, the importance of its food chain-role in rendering the abundance of these small units of energy to a form more available to larger Arctic predators cannot be overstated. It is commercially exploited in the north Atlantic by Russia and others but not in the Arctic. As a food resource to the Inuit it is often ignored even though shoaling Arctic cod are sometimes stranded on beaches in great numbers. These strandings are conjectured to be the result of flight behavior in response to the presence of large predators such as beluga. At Grise Fiord, stranded cod are harvested for local consumption but this is apparently the exception. More frequently, this species is caught in the domestic fishery on hook-and-line by jigging in ice cracks.

GREENLAND COD

This species is apparently also quite abundant in the eastern Arctic archipelago and in Hudson Bay. Its biology was recently the topic of a study by Mikhail (1985) and in 1965, an Arctic Biological Station tagging study estimated 12,000 were in Cambridge Bay (Hunter 1967).

This species is frequently harvested in the domestic fishery by jigging in ice cracks. Larger than the Arctic cod, it sometimes appears in the by-catch of the char fishery. In 1985 and 1986 there was a small commercial fishery for this species by fishermen from Lake Harbor, Baffin Island. Poor acceptance of this fishery's product in Iqaluit has since curtailed fishing effort to meet only the demand of the lake Harbour community. (R. Allen, DFO Iqaluit, personal communication).

In the Belcher Islands it can be a seasonally important food resource and is eaten raw, sometimes with berries. As with Arctic cod, this species is not a major food item of the Inuit, but it is utilized as dogfood.

SAFFRON COD

This species has similar importance in the western Arctic as does Greenland cod in the east. Larger than Greenland cod, it occurs in the by-catch of the Mackenzie River Delta anadromous fishery. It is occasionally used as food and dogfood.

POLAR COD

This species' distribution is circumpolar in the High Arctic. Apparently less abundant in the coastal areas of the Canadian Arctic archipelago than either Arctic or Greenland cod, it is infrequently caught by jigging in ice cracks.

ATLANTIC COD

There is a history of commercial exploitation of this species in the South Baffin/Hudson Strait area. In northern Quebec, there is a commercial fishery at Port Burwell, once abandoned but now called the Killiniq Fishery and operated by the Makivik Corporation. A more complete description of this fishery is included in the Commercial Fisheries section of this paper (see above).

In Frobisher Bay and Cumberland Sound, Atlantic cod are found in one or two deep bays which have entrances blocked by tidally-washed bars (Patriquin 1967; L. Dahlke, DFO Yellowknife, personal communication). The cod in these bays are abundant, appear to have normal growth rates when compared to fish from southern areas, and can exceed 15 kg (33 pounds) in weight. There is a commercial market for them in Iqaluit and a sport camp fishery on Lake Ogac, Frobisher Bay has been considered. The extent of this resource and appropriate fishing levels are unknown.

This species is presently a focus of a GNWT-sponsored exploratory fishery in its early phases of development in Cumberland Sound.

CAPELIN

Capelin are infrequently utilized as food and/or dogfood in the Hudson Bay/Hudson Strait region. They have been commercially harvested in the Churchill area and by the Port Burwell fishery but these efforts were short-lived. There is interest in establishing a capelin fishery in Coppermine but nothing has developed in this context to date.

GREENLAND HALIBUT/TURBOT

There is a GNWT-sponsored exploratory fishery for this species in Cumberland Sound. Inuit at Pangnirtung have received instruction on long-line fishing through sea ice from Greenland Inuit and initial Cumberland Sound catches in the spring of 1985 had commercial potential (over 200 fish of about 5-6 kg (11-13 pounds) each were landed in a few days of fishing: L. Dahlke, DFO Yellowknife, personal communication). By 1988, landings had increased to 5000 kg (11,000 pounds) round weight. Initial fishing methods involved the use of a manually operated line hauler but a recent innovation for the fishery has been the introduction of a hydraulically powered unit (R. Allen, DFO Iqaluit, personal communication).

Catches in the summer from a long-line vessel have not been as good because weather and developmental problems have hampered an active fishing effort. There is indication that this fish leaves Cumberland Sound in the summer and does not return until the fall (L. Dahlke, DFO Yellowknife, personal communication).

There has been some limited success with domestic fishing for Greenland halibut at Pond Inlet. There is also interest at Grise Fiord but fishing efforts there have yet to produce this species. However, halibut remains near seal holes have reportedly been sighted by Grise Fiord hunters. There are large stocks of Greenland halibut in Davis Strait and they are exploited commercially by boats from the south. The extent of their habitation of Lancaster Sound or Jones Sound is unknown.

In 1965 there was a very brief experimental halibut fishery at Port Burwell. In one night, 185 kg (400 pounds) of halibut and 2015 kg (4450 pounds) of sea catfish and roughhead grenadier were harvested (Davies et al. 1986). Recent efforts by the Killiniq fishery have determined that harvesting halibut in this area is best undertaken offshore which is beyond the capability of vessels presently available to this fishery (D. Gillis, Makivik Corp., Fort Chimo, Que., personal communication).

STARRY FLOUNDER

In the western Arctic this species is locally distributed and not very abundant. It is known to be highly edible and frequents shallow brackish waters. Exploitation of this species is unreported but domestic use is considered to be likely, if only infrequent.

ARCTIC FLOUNDER

Smaller than the starry flounder, it is widely distributed and very abundant. It is also edible but has little meat. If exploited at all, it would likely be used as dogfood.

SCULPINS

In northern Quebec, sculpins are considered a predictable food resource (Dumas et al. 1985). Many are taken in nets as by-catch but the most are taken by hook and line. The shorthorn sculpin is the most important species, but fourhorn and Arctic staghorn sculpins are also harvested. In the Belcher Islands, sculpins are often broiled and eaten with berries.

Elsewhere they are rarely exploited. Occasionally they are fed to dogs although some species are sometimes considered to be poisonous. Fourhorn sculpin are the most common species in the western Arctic where they are occasionally used as fox bait.

LUMPFISH

Rarely exploited, this fish is frequently observed in the Hudson Bay/Hudson Strait area. It is infrequently eaten but may be used as dogfood.

GREENLAND SHARK

These animals are frequently observed at whale-slaughter sites in the eastern Arctic. They are believed to be abundant in the North and are harvested by Greenland Inuit for dogfood

and for their abrasive skin. This large shark once supported a Greenland fishery for liver oil but there is no history of its exploitation by Canadians. Greenland sharks attracted to whaling sites in the Canadian Arctic are considered nuisances and are frequently killed and discarded.

SHRIMPS

There are two commercially exploited species of shrimp in eastern Canadian waters. In Davis Strait, the northern shrimp (Pandalus borealis) supports a large fishery and the less abundant striped pink shrimp (Pandalus montagui) is sometimes landed as by-catch. While it has been known for some time that huge stocks of northern shrimp occur in Davis Strait, concentrations of striped pink shrimp in eastern Hudson Strait and Ungava Bay were unknown until the 1970's (Parsons 1984).

The Canadian shrimp fishery has been managed since 1979 by the Northern Shrimp Advisory Committee (NSAC), which formulates annual northern shrimp management plans. NSAC grants licences to harvest the shrimp resource in the Canadian Northwest Atlantic. During the initial development of this fishery, licensees were allowed to charter foreign vessels to gain sufficient experience to permit the purchase and operation of Canadian vessels. Under this temporary arrangement, the Canadian licensee received royalty revenues from the foreign vessel (DFO Briefing Note 01/08/86).

In 1980, three shrimp fishery management zones were established for the eastern Hudson Strait area. They were: 1) west of Resolution Island, 2) west of Killiniq Island (Ungava Bay), and 3) other areas outside the former two. For that year, NSAC set quotas of 100 mt (110 t) for each zone (300 mt or 331 t total). About 240 mt (265 t) were taken, primarily from zone 1 (CAFSAC Advisory Document 88/9).

Because of the proximity of this unexploited resource to eastern Arctic communities, three Inuit Groups, Baffin Region Inuit, Northern Quebec Inuit and the Labrador Inuit Association, applied to NSAC in 1980 for a license to harvest striped pink shrimp stocks in eastern Hudson Strait and Ungava Bay with a chartered Danish vessel from Greenland. Although this first request was not approved, the groups were encouraged to continue their endeavours to enter this fishery (D. Gillis, Makivik Corp., Fort Chimo, Que., personal communication).

In 1982, a southern vessel conducted exploratory fishing in zones 2 and 3 for a total catch of only 12.8 mt (14.1 t). Commercial fishing did not resume until October, 1986 when one vessel representing some of the Inuit groups caught 482 mt (532 t), primarily from the grounds near Resolution Island where the average catch rate was 8.3 mt/h (9.2 t/h). For 1987-88, NSAC established a total allowable catch (TAC) of 1000 mt (1104 t) for the Resolution Island area and 200 mt (220 t) for Ungava Bay. The Inuit and others participated in this fishery and catches totalled 1,063 mt (1173 t) and 12 mt (13.2 t), for the two areas respectively (CAFSAC Advisory Document 88/89).

A separate experimental fishery for northern shrimp was conducted in Cumberland Sound, Baffin Island during the summer of 1986. A test quota of 1,000 kg (2,200 pounds) round weight was granted to the permittee but few shrimp were caught (L. Dahlke, DFO Yellowknife, personal communication). This was a limited effort employing a few shrimp traps rather than the conventional commercial shrimp nets used in the Davis Strait and Hudson Strait fisheries. This fishery was undertaken by Inuit fishermen of Pangnirtung in an effort to commercially exploit local resources. They directed most of their effort toward scallops and had some success with that species (see below).

Interest in shrimp fishing in the Arctic continues. Although the size of the striped pink shrimp resource is unknown, there is likely to be more requests to NSAC from operators of offshore trawlers/processors for licenses to fish this species in eastern Hudson Strait. As well, there is considerable interest within several Inuit communities to pursue shrimp in an inshore fishery. However, the extent and in many instances even the existence of an inshore shrimp resource is also unknown at this time (R. Allen, DFO Iqaluit, personal communication).

ICELAND SCALLOPS

Iceland scallop stocks (Chlamys islandica) occur in coastal Canada from Davis Strait to the Gulf of St. Lawrence (Naidu et al. 1982). Although they are fished along the Labrador coast, e.g. near Nain and West St. Modeste (Naidu et al. 1982), interest in this species in Arctic waters is a recent phenomenon. Northern investigations of this resource have centered in several areas and are considered separately below.

Northern Labrador Coast, Ungava Bay and Hudson Strait

In 1983, the Killiniq fishery found scallops along the northern Labrador and Quebec coasts. Subsequent exploratory fishing in 1984 and 1985 indicated widespread occurrence westward into Ungava Bay. Indigenous fisherman along Hudson Strait also reported the occurrence of scallops into Hudson Bay as far as Rankin Inlet but their abundance there is unknown (D. Gillis, Makivik Corp., Fort Chimo, Que., personal communication). An experimental fishery conducted from Killiniq Island in 1985 produced an average of 5.4 kg (11.9 pounds) of scallop meats per hour, approximately 80% of a southern Canadian fishing operation's break-even rate. Because expenses for northern operations are much higher, this proportion for a Killiniq fishery would be lower. The meats were consumed locally where Inuit demonstrated a preference for whole live scallops rather than the shucked meats preferred in southern markets (Gillis et al. 1987).

In 1987, a joint-venture exploratory Iceland scallop survey was conducted in the immediate offshore area of the southeast Canadian Arc-

tic. This survey found no scallops along the northern Labrador coast or in Davis Strait near south Baffin Island. It did find them along the north shore of the eastern Hudson Strait and near Killiniq Island, especially near Akpatok Island in Ungava Bay. Three areas of Akpatok Bank contained an estimated trawlable biomass of 4266 mt (4702 t) whole scallops or 544 mt (600 t) shucked meats, the largest concentration of Iceland scallops found in this area of the Arctic at that time. However, peak catch rates during this survey did not reach levels required to sustain operations of a typical Canadian offshore scallop vessel (D. Gillis, Seaku Fisheries Inc., and M. Allard, Makivik Corp., Que., unpublished report).

Also in 1987, an offshore scallop dragger explored the Labrador coast for scallops north of 52° N latitude. The vessel's permit excluded operations in Canada's Territorial Sea (within the 12-mile limit). No scallops were caught during this survey (M. Karlsen, Karlsen Shipping Co. Ltd., Halifax, N.S., unpublished data).

Although Gillis et al. (1987) determined the Iceland scallop resource to be closest to full commercial status within the Killiniq fishery resource pool, it has been recommended that more and improved exploratory surveys be done in the Ungava Bay/Hudson Strait area before serious consideration is given to implementing commercial enterprise toward harvesting this resource (D. Gillis, Seaku Fisheries Inc., and M. Allard, Makivik Corp., Que., unpublished report). Toward this end, a joint-venture scallop survey was undertaken in 1988 to further delineate the abundance and distribution of Iceland scallops in the inshore waters of eastern Hudson Strait (R. Allen, DFO Iqaluit, Personal communication).

Cumberland Sound

In 1983 and 1984, the Pangnirtung Hunters and Trappers Association observed scallops on lines they had set during exploratory groundfishing operations. During the summer of 1985 and using their own fishing vessel, the HTA caught Iceland scallops during a preliminary investigation of the Cumberland Sound scallop resource.

In 1986, they were granted a test fishery permit for the experimental harvest of up to 2,000 kg (4,400 pounds) round weight from Cumberland Sound. A fishing consultant from New Brunswick was contracted to assist the test fishery. Three scallop beds were found near the mouth of Pangnirtung Fiord and at least one was considered to have yields with economic potential (L. Dahlke, DFO Yellowknife, personal communication).

In 1987, the HTA obtained another permit for iceland scallop fishing operations in Cumberland Sound. This permit stipulated a quota of 100,000 kg (220,000 pounds) round weight. Their boat worked with a local scallop dragger and the two vessels shared the quota together. Results for this first year's effort were limited, but valuable experience was gained toward processing and marketing scallops from Cumberland Sound (R. Allen, DFO Iqaluit, personal communication).

In 1988 the search for commercial quantities of Iceland scallops in Cumberland Sound continued. Granted another 100,000 kg (220,000 pounds) quota, the two vessels conducted another exploratory survey and test commercial fishery. They searched many areas of Cumberland Sound and although they found several previously unknown scallop beds, the area with the most promising potential as a Pangnirtung fishery resource was the beds near the mouth of Pangnirtung Fiord which were discovered in 1986.

Initial yields averaged 680 kg (1500 pounds) per vessel per day (R. Allen, DFO Iqaluit, personal communication).

Frobisher Bay

Also in 1988, DFO conducted an exploratory survey of scallops on and near the bank in southeastern Frobisher Bay. They found few scallops and concluded that beds in that area would not support commercial fishing activity (R. Crawford, DFO Winnipeg, unpublished data).

Lake Harbour

There has been some exploration of the waters near Lake Harbour for Iceland scallops (1987 and 1988) but no commercial quantities have been discovered to date (R. Allen, DFO Iqaluit, personal communication).

GREEN SEA URCHIN

The green sea urchin, Strongylocentrotus droebachiensis, is common along the eastern Canadian coast, the Arctic Archipelago, and within Hudson Bay. It is frequently observed in the littoral zone and is known to occur to depths of 1,150 m (Gosner 1971). Raw sea urchin roe is considered a delicacy in many areas of the world. Eastern Canadian Inuit harvest the green sea urchin with dip nets or collect them from beaches after storms and remove the roe for local consumption.

In 1984, the Northwest Territories Economic Development Agreement funded a study to investigate the potential for commercial exploitation of this resource near Sanikiluaq, Belcher Islands. The goal of this pilot study was to explore the local commercial market for sea urchin roe and investigate the potential for marketing product in Toronto and Quebec Province.

The results of the 1984 study were considered promising (J. Jamieson, Sanikiluaq, N.W.T., personal communication). However, further exploration of this potential required the implementation of a test fishery. The principals behind the study chose not to follow through with the test fishery and this investigation was abandoned. The Sanikiluaq sea urchin resource continues to supply the local domestic fishery.

CLAMS

The bivalve Mya truncata occurs from the High Arctic southward to the Gulf of Maine (Gosner 1971). A staple in the diet of walrus, this shellfish is savored by Inuit throughout the eastern and central Arctic. Clam siphons found in the stomachs of freshly-killed walrus are considered a delicacy. Whole clams are also eagerly sought in the beach strand after a storm. While their use in the domestic fishery is widely reported, there is presently no commercial exploitation of this species in the Arctic. However, in 1988 DFO successfully utilized a hydraulic clam dredge during a study of walrus food resources, particularly Mya truncata and Serripes groenlandicus. The potential of this device for the establishment of an artesanal shellfish fishery in the north is under evaluation (H. Welch, DFO Winnipeg, personal communication).

BLUE MUSSEL

The shores of south Baffin Island, northern Quebec and Hudson Bay are replete with the blue mussel (Mytelus edulis). This species is consumed in the domestic fishery but on a limited basis and only where it is particularly abundant.

Occasional interest has been expressed by local Baffin Inuit groups regarding the potential of this species for commercial exploitation (L. Dahlke, DFO Yellowknife, personal communication). Local markets supported by larger population centers such as Iqaluit appear to have the best potential for supporting commercial development of this fishery. In 1987, price to Prince Edward Island mussel fishermen in southern Canadian markets was about $1.20/kg ($0.55/pound). Export price was about $2.20/kg ($1.00/pound). It is not likely a northern fishery could compete in southern markets due to comparatively higher transportation costs. The development of shucked smoked mussel meats packed in jars may have the greatest promise of economic return for a northern export fishery but southern markets will require extensive development (Canada, DFO 1985).

SEA CUCUMBERS, BRITTLE STARS AND MARINE ALGAE

These items are all identified in the diet of Belcher Islands Inuit (J. Jamieson, Sanikiluaq, N.W.T., personal communication). They are also consumed elsewhere but infrequently at best. Kelp constitutes about 2% of the diet of Broughton Island residents (J. Pattimore, Baffin Region Inuit Association, Iqaluit, unpublished data).

SUMMARY

DOMESTIC FISHERY

Although there are little data to support comparisons and define trends, the utilization of fish in the Arctic domestic fishery appears to have decreased since the early 1970's. Snow machines have replaced dogs as the principal mode of transportation and dogfood requirements are less. Southern foodstuffs have become more available and have probably diminished the utilization of fish because diets have changed. A new wage economy has created a labor force composed of individuals with less time to fish, but with more money to spend buying fish from the commercial fishery as their needs require. Although undefined, the expansion of the northern population may be offsetting the effect of this perceived decrease in per capita utilization of Arctic fishes.

COMMERCIAL FISHERY

Between 1945 and 1983, the commercial freshwater fisheries of N.W.T., Ontario, Ontario, Manitoba, Saskatchewan, and Alberta harvested an aggregate total of almost 1.8 billion kg (3.9 billion pounds) of fish (Table 13). Five percent of this total were harvested in the N.W.T. On an annual basis, the N.W.T. proportion of these landings peaked at 12% in 1950 when the Great Slave Lake fishery was at its maximum (Table 14). Thereafter, this annual proportion of Canadian commercial freshwater fisheries declined steadily until it leveled out at about 3% in 1974. It has remained near that figure since.

N.W.T. commercial fishery landings are now about 50% of their peak historical levels, which were reached around 1950, and have remained fairly steady since the early 1970's (Table 13). This performance is a reflection of the landings of whitefish (lake, broad and round), the principal species landed (Table 14). Catches of lake trout have also stabilized since the early 1970's, but they are less than 10% of their peak level.

Catches of Arctic char have generally increased since 1970, with some fluctuation. Char landings typically represent about 6% of the total N.W.T. commercial harvest (Table 2). In 1980, they equalled about 0.126% of total Canadian freshwater commercial fishery landings (Table 15). Statistically, char catches are reported as a sea fishery. In 1980, they represented only 0.008% of the combined total of all Canadian sea fisheries (Table 16, Fig. 6). However, their value to the Arctic fisheries is significant. The 1985-86 nominal landed value of Arctic char was $4.70/kg ($2.14/pound) while whitefish were worth $0.92/kg ($0.42/pound), a difference of more than 500%. Comparable values for other species were: lake trout at $1.07/kg ($0.49/pound), walleye at $2.19/kg ($1.00/pound) and northern pike at $0.73/kg ($0.33/pound) (Canada, DFO 1986).

Most easily accessible high-value Arctic fish resources appear to be presently exploited near their natural limits. There are few economically sound opportunities for significant expansion of Arctic fish commercial exploitation. Exceptions are marine species such as Greenland halibut, Iceland scallop and striped pink shrimp near Baffin Island. However, immediate prospects for successful exploitation of these re-

sources, specially shrimp, is capital intensive enterprise, not the artisanal, labor intensive type of fishery which derives most benefit to northern communities. In this regard, the scallop and turbot fisheries present the best model of hope for new avenues of fish exploitation elsewhere in the Arctic. These fisheries are based on resources that are easily accessible and require relatively modest harvesting capability to generate sufficient quantity of product to sustain shoreside processing facilities. But this model is not without its limits. At present, the east is the only region in the Arctic where such unexploited resources are known to exist. Also, because the growth rate of northern species is typically slow, it is critical that these fisheries operate at rates of harvest which provide sustained yields. Managers require detailed information to determine what those harvest rates should be. In spite of the facts that very little is known about the Baffin Island Iceland scallop resource and much work remains to be done before appropriate harvest levels can be accurately projected, plans for expanding the scope of this fishery are under development. Unfortunately, this is typical in the history of Arctic fisheries and certainly should not be included in a model for future fisheries development.

SPORT FISHERY

Sport fishing effort in northern Canada has increased significantly since 1970, largely due to resident population growth of the N.W.T. Non-resident participation has remained fairly level throughout this period, apparently due to limited accommodations available in the lodge fishery. Unlike the domestic and commercial fisheries, the potential for growth of the sport fisheries is real and likely to be realized. Many areas suitable for sport fishing are underutilized and are available to the fly-in fisherman. The potential for growth of this fishery has been recognized by the GNWT and is being promoted by them because of the economic benefits to the N.W.T.

Sport fishing catches, on the other hand, were less in 1985 than in 1980 (Table 9). Of the species identified in sport fishing survey results, catches of lake trout, northern pike, Arctic grayling, and Arctic char declined for this latter period. The single noted exception was walleye, which experienced a 26% increase in harvest. The sport fishery survey data base contains estimates for only three years of fishing (1975, 1980, 1985) and is too small to allow accurate interpretation of trends. However, angling overfishing of Arctic grayling and other species has been demonstrated in the past. The 41% decline in landings of Arctic grayling between 1980 and 1985 could be significant, especially if this trend was to contine. This situation suggests that creel censuses of popular fishing areas should be conducted more frequently than the present 5-year interval to derive more timely interpretations of sport fishery trends for input to fishery managment decisions.

CONCLUSIONS

Accurate assessment of Arctic fish exploitation is made difficult by the lack of accurate statistics for these fisheries. This is particularly true for the domestic fishery where essentially no comprehensive data describing landings or fishing effort are available. Catch statistics for the commercial and sport fisheries are better but are replete with omissions and often contain approximations. Commercial fisheries data originate from operators of freezers and canneries as well as from shippers. These sources have been known to be delinquent in their record keeping and local commercial sales often go unreported (McCart and Den Beste 1979). Sport fishery statistics are derived from surveys. Such data are subject to recall bias, under and over estimation by respondants, species identification errors, etc. Until a more complete set of accurate data becomes available, assessments of Arctic fisheries will be broad in scope and general in focus.

The future of Arctic fisheries and Arctic fishery management depends on the acquisition of a much larger data base describing these fisheries and their resources than presently exists. Consideration of the health and migration pattern of Northern fish stocks can only rarely be attempted because we have practically no information on this subject except in those few cases where stocks define themselves (e.g. the Sylvia Grinnell River stock) or where tagging studies have been done (e.g. Cambridge Bay). Examination of genetic differences indicating stock separation in the Arctic has been only recently initiated. Other information such as the productivity and population dynamics of Arctic fishes is also extremely limited and yet is required if we are to make meaningful assessments of the future of these resources.

There is also the need for new avenues of communication between fishery managers and fisheries researchers. Fishery managers need to define their management goals and make these known to the researchers. Managers must also identify and priorize their needs for supplemental information required for management purposes. Researchers can contribute more effectively to the management process if they consider research problems in the context of generating information needed by fishery managers. For problematic fisheries, managers and researchers should actively interact through the development of multidisciplinary programs such as experimental management studies. In brief, managers and researchers must enhance their efforts to communicate and share information through a forum such as AFSAC to maximize their efforts toward improving the management of Arctic fisheries.

Fish exploitation in the Arctic has been poorly monitored, documented and studied in the past. As a result, our capability to manage present levels of harvest of these resources is limited, as is our efficacy in developing meaningful strategies for the future. Our efforts toward understanding how our northern fish stocks are utilized must increase as should our resolve to learn what the effects of this utilization are. Failure to do so now, in a world

of ever-increasing demand with diminishing supplies, could mean future regret for lost opportunity. We may never again have the chance to contribute so much toward the future health of our northern fish stocks as we do at present.

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Table 1. Principal fish species of N.W.T. domestic fisheries.

Western and central inland Arctic (includes District of Mackenzie):
broad whitefish, lake whitefish, lake trout, inconnu, northern pike, burbot, lake cisco, Arctic grayling, walleye, and longnose sucker.

Western coastal Arctic (includes Mackenzie Delta area):
broad whitefish, lake whitefish, lake trout, inconnu, northern pike, Arctic char, Arctic cisco, least cisco, burbot, longnose sucker, Arctic cod, saffron cod, polar cod, Pacific herring, fourhorn sculpin, flatfishes(?).

North-central coastal Arctic and Archipelago:
Arctic char, lake trout, Arctic cod, Greenland cod, polar cod, sculpins, invertebrates.

Hudson Bay/Foxe Basin (includes District of Keewatin):
Arctic char, lake trout, lake whitefish, round whitefish, lake cisco, northern pike, Arctic grayling, longnose sucker, Greenland cod, capelin, lumpfish, sculpins, invertebrates.

Baffin area:
Arctic char, lake trout, Greenland cod, Atlantic cod, Arctic cod, Greenland halibut, sculpins, invertebrates.

Northern Quebec:
Arctic char (except James Bay), lake trout, brook trout, lake whitefish, northern pike, Atlantic salmon, Atlantic cod, Greenland cod, sculpins, invertebrates.

Note: Invertebrates include green sea urchin, clams, crabs, scallops, mussels, shrimps, and brittle stars where/when available.

Table 2. Northwest Territories commercial fish landings, 1945-1984, in thousands of kg round weight. Source: Davies et al. 1986.

Year	White-fish*	Lake trout	Walleye	N. pike	Inconnu	Arctic char	Mixed**	Total
1945	227	499			40			766
1946	590	726			51			1367
1947	907	771			39			1717
1948	2177	997	2		102			3278
1949	2449	1814		18	163			4444
1950	2585	1134	1	51	124			3895
1951	1905	1270	1	33	146			3355
1952	1633	1361	3	33	90			3120
1953	1769	1089	17	31	91			2997
1954	1814	1089	34	29	78			3044
1955	1950	1270	56	30	75		1	3382
1956	1860	1179	32	27	76		8	3182
1957	1996	907	27	42	97		4	3073
1958	1497	953	57	71	99			2677
1959	1588	783	51	120	141			2683
1960	1724	508	114	114	78	24	17	2579
1961	1722	511	29	183	135	23	31	2634
1962	2106	608	6	125	125	53	493	3516
1963	2078	343	54	140	156	51	316	3138
1964	2072	429	11	80	133	42	258	3033
1965	1812	441	16	108	139	74	406	3000
1966	1266	282	14	149	98	76	311	2198
1967	1089	345	16	212	111	48	153	1974
1968	1454	126	11	162	84	48	146	2030
1969	1375	160	7	133	80	91	356	2202
1970	1728	329	42	135	58	51	30	2373
1971	1533	197	68	103	62	114	12	2089
1972	1442	173	66	91	79	97	10	1963
1973	1065	272	47	155	104	135	1	1779
1974	771	318	45	111	100	166	1	1512
1975	726	318	46	96	95	154	4	1439
1976	862	181	32	103	77	80		1335
1977	1176	181	30	119	87	138	5	1734
1978	1113	318	15	158	153	108	1	1866
1979	1076	363	31	131	154	103		1862
1980	1203	363	52	205	65	105		2003
1981	1097	181	55	151	43	102		1631
1982	1124	89	17	139	18	86		1553
1983			40			85	6	1277
1984			26			143	4	1226

*Includes lake whitefish, broad whitefish and round whitefish.
**Includes aggregated data for which species were not identified.

Table 3. Great Slave Lake commercial fish harvest, 1945-1985, in thousands of kg round weight. Source: Davies et al. 1986.

Year	Whitefish	Lake trout	N. pike	Inconnu	Walleye	Total
1945	227	499		40		766
1946	590	726		51		1367
1947	907	771		39		1717
1948	2177	997		102	2	3278
1949	2449	1814	18	163		4444
1950	2585	1134	51	124	1	3895
1951	1905	1270	33	146	1	3355
1952	1633	1361	33	90	3	3120
1953	1769	1089	31	91	1	2981
1954	1814	1089	29	78	1	3011
1955	1950	1270	30	75	5	3330
1956	1860	1179	27	76	2	3144
1957	1996	907	42	97	1	3043
1958	1497	953	71	99	3	2623
1959	1588	771	114	141	10	2624
1960	1724	499	110	78	5	2416
1961	1678	499	175	135	10	2497
1962	2041	499	123	125	5	2793
1963	2041	318	139	156	6	2660
1964	1724	272	80	133	10	2219
1965	1678	363	108	139	14	2302
1966	1225	227	149	98	14	1713
1967	1089	272	212	111	16	1700
1968	1406	91	162	84	11	1754
1969	1361	136	133	80	7	1717
1970	1451	227	134	58	8	1878
1971	1361	136	99	62	15	1673
1972	1043	91	90	79	7	1310
1973	862	272	155	104	17	1410
1974	771	318	111	100	45	1345
1975	726	318	96	95	10	1245
1976	862	181	103	77	9	1232
1977	1089	181	119	87	11	1487
1978	862	318	158	153	13	1504
1979	862	363	130	154	6	1515
1980	953	363	200	65	19	1600
1981	363	181	151	43	4	742
1982	1124	81	138	18		1361
1983						1096
1984						1056
1985						1157

Table 4. Great Slave Lake commercial landings of whitefish and lake trout, 1945-1985, in thousands of kg round weight. Source: Davies et al. 1986.

	Whitefish			Lake Trout			Both		
	Summer	Winter	Annual	Summer	Winter	Annual	Summer	Winter	Annual
1945	227	0	227	499	0	499	726	0	726
1946	454	91	590	726	0	726	1179	91	1315
1947	408	499	907	680	91	771	1089	590	1633
1948	454	1724	2177	635	363	997	1089	2087	3175
1949	1043	1406	2449	1361	454	1814	2404	1860	4264
1950	1043	1542	2585	907	272	1134	1950	1814	3765
1951	953	953	1905	997	272	1270	1950	1225	3175
1952	726	907	1633	1134	227	1361	1860	1134	2994
1953	680	1089	1769	862	227	1089	1542	1315	2858
1954	1043	771	1814	862	227	1089	1905	997	2903
1955	1089	862	1950	1089	181	1270	2177	1043	3220
1956	1043	816	1860	953	227	1179	1996	1043	3039
1957	1225	771	1996	771	136	907	1996	907	2903
1958	816	680	1497	816	136	953	1633	816	2449
1959	907	680	1588	635	136	771	1542	816	2359
1960	1134	590	1724	408	91	499	1542	680	2223
1961	907	771	1678	408	91	499	1315	862	2177
1962	1225	816	2041	408	91	499	1633	907	2540
1963	1179	862	2041	272	45	318	1451	907	2359
1964	1043	680	1724	272	0	272	1315	680	1996
1965	907	771	1678	318	45	363	1225	816	2041
1966	635	590	1225	227	0	227	862	590	1451
1967	590	499	1089	227	45	272	816	544	1361
1968	816	590	1406	91	0	91	907	590	1497
1969	816	544	1361	136	0	136	953	544	1497
1970	862	590	1451	136	91	227	997	680	1678
1971	862	499	1361	92	45	136	953	544	1497
1972	726	363	1043	46	45	91	771	408	1134
1973	771	45	862	272	45	272	997	91	1089
1974	726	45	771	272	45	318	953	91	1089
1975	590	91	726	318	0	318	907	91	997
1976	771	91	862	181	0	181	953	91	1043
1977	953	91	1089	181	0	181	1179	91	1270
1978	771	91	862	318	0	318	1089	91	1225
1979	726	91	862	318	0	363	1043	136	1179
1980	816	91	953	363	0	363	1179	136	1315
1981	318	0	363	181	0	181	499	45	544
1982							885	328	1213
1983							661	299	960
1984							694	219	913
1985							645	341	986

Table 5. Summary of commercial harvest for the Inland Lakes fishery of the Northwest Territories, 1953-1984, in kg round weight. Source: Davies et al. 1986.

Year	Lakes Fished	Whitefish	Lake trout	Walleye	Northern pike	Mixed*	Total
1953	1			16286			16286
1954	1			32563			32563
1955	1			5095			5095
1956	1			29616			29616
1957	1			25884			25884
1958	1			54300			54300
1959	3	3016	7965	41014	6101		58096
1960	9	5746	9917	109436	3795	10616	139510
1961	10	26158	25259	18573	8211	26185	104386
1962	9	55679	62425	582	107	488850	607643
1963	14	29887	20857	47619	820	310563	409746
1964	19	272756	118501	733		258332	650322
1965	10	94272	71647	1947		402481	570347
1966	26	7458	14132			311174	332764
1967	19	7364	905			152728	160997
1968	13	302	421	60		146490	147273
1969	16	6818	24475			355836	387129
1970	30	254439	99449	34274	604	29690	418456
1971	14	157552	46293	53117	4082	11777	272821
1972	12	373649	75464	59455	6732	9623	524923
1973	15	36937	31806	29887	281	838	99749
1974	6	1992	1600	27995	216	953	32756
1975	8	15150	11005	35991		3558	65704
1976	4			23123			23123
1977	4	98	68	18577	3	909	19655
1978	4	1048	683	1885	78	888	4582
1979	5	2995	73	25474	267		28809
1980	10	14130	7639	33385	5102		60256
1981	2	81	226	50897			51204
1982	5	2850	8457	46689	1308	6	59310
1983	5	3312	1971	40275	904		46462
1984	2	53		26329	92	200	26674

*Includes aggregated data for which species were not identified.

Table 6. Summary of commercial fish landings from the Mackenzie Delta area, 1955-1980. Harvest volumes in kg round weight. Source: Davies et al. 1986.

Year	Whitefish	Arctic char	Inconnu	Northern pike	Others	Mixed**	Total
1955							752
1956							8500
1957	611		8	62			681
1958						13	13
1959							
1960	5445					5976	11431
1961	18204		968			5000	24172
1962	8784		1614	2376	4262		17036
1963	6516				1851		8401
1964	35161		4036			34	42566
1965	9059	7311				3369	16370
1966	28235	364			101		28700
1967							
1968							
1969							
1970							
1971							
1972	1715						1715
1973	22273		409				22682
1974	15909						15909
1975							
1976	16145						16145
1977	523						523
1978	2727	1136					3863
1979	6198	639	2375	364		182	9758
1980	9045	4723	2388			3459	19615

*Includes broad whitefish and lake whitefish.
**Includes aggregated data for which species were not identified.

Table 7. Summary of commercial fish landings from the coastal Arctic area*, 1960-1984, in kg round weight. Source: Davies et al. 1986.

Year	Searun A. char	Landlocked A. char	Whitefish	Lake trout	Mixed**	Total
1960	24225					24225
1961	23303					23303
1962	53312			12563	113	65988
1963	51318			4794	3329	59441
1964	41891		489	7829	18	50227
1965	74361					74361
1966	76219					76219
1967	48342			41199		89541
1968	48241		12394	2663		63298
1969	91056					91056
1970	51236		4088	6756		62080
1971	103216	10315	455	5000		118986
1972	81647	15195		11521		108678
1973	125218	9921				135139
1974	163999	1850				165849
1975	153187	1255				154442
1976	80438					80438
1977	138094				4163	142257
1978	107809					107809
1979	103349					103789
1980	105465					105465
1981	102563					102563
1982	85646					85646
1983	84748					84748
1984	143329					143329

*Includes data from fisheries at Rankin Inlet, Cambridge Bay, Pelly Bay, Iqaluit, Mackenzie Delta, and other places.
**Includes aggregated data for which species were not identified.

Table 8. Northwest Territories sport fishing licence sales for the period 1954-1985.

Year	Total licences	Resident licences	Short-term***	Non-resident licences
1954-1955	133	27		106
1955-1956	270	106		164
1956-1957	743	120		623
1957-1958	839	126		713
1958-1959	1 100	229		871
1959-1960	1 204	407		797
1960-1961	1 406	504		902
1961-1962	1 605	810		795
1962-1963	2 153	928		1 225
1963-1964	2 381	985		1 396
1964-1965*	-	-		-
1965-1966*	-	-		-
1966-1967	4 529	1 218		3 311
1967-1968	5 133	1 508		3 625
1968-1969	5 586	1 630		3 956
1969-1970	5 209	1 355		3 854
1970-1971	5 900	1 439		4 461
1971-1972**	6 584	3 346	483	2 755
1972-1973	7 972	4 625	560	2 787
1973-1974	9 607	5 770	793	3 044
1974-1975	10 655	6 584	690	3 381
1975-1976	11 256	7 650	570	3 036
1976-1977	11 071	7 491	489	3 091
1977-1978	13 365	9 242		4 123
1978-1979	11 716	8 695		3 021
1979-1980	15 806	11 056		4 750
1980-1981	15 124	10 656		4 468
1981-1982	15 446	11 484		3 962
1982-1983	14 669	11 391		3 278
1983-1984	14 263	10 842		3 421
1984-1985	16 019	12 656		3 363

* No data available.
** Definition of resident changed to include all Canadians.
*** Short-term licences issued between 1971-1977.

Sources: 1954/55 to 1969/70 - D. Topolniski, DFO Winnipeg, unpublished data.
1970/71 to 1984/85 - Anderson 1986.

Table 9. Number of fish retained* by licensed anglers in the Northwest Territories 1975, 1980 and 1985.

Species	Resident			Non-resident			Total		
	1975	1980	1985	1975	1980	1985	1975	1980	1985
Lake trout	23 802	27 148	34 500	23 409	29 445	16 688	47 211	56 593	51 188
Northern pike	26 640	46 200	28 281	16 991	11 772	7 351	43 631	57 972	35 632
Arctic grayling	18 709	18 945	12 761	12 010	16 205	7 830	30 719	35 150	20 591
Walleye	14 193	28 129	36 733	8 131	5 602	5 844	22 324	33 731	42 577
Whitefish	8 021	NA	NA	800	NA	NA	8 821	NA	NA
Arctic char	6 198	22 727	9 955	2 529	4 635	6 460	8 727	27 362	16 415
Other	6 802	16 724	12 236	611	1 018	2 045	7 413	17 712	14 281
TOTAL SPECIES	104 365	159 873	134 466	64 481	68 677	46 218	168 846	228 550	180 648

*Does not include fish caught and released. See Table 10.

Sources: DFO/GNWT sportfishing surveys; 1976 (unpublished data), 1981, 1986.

Table 10. Ranking of species preferred by anglers in the Northwest Territories, 1980.

Species Preference	Resident	Nonresident	
		Canadian	Other
1	Arctic grayling	Lake trout	Lake trout
2	Walleye	Arctic grayling	Arctic grayling
3	Trout (general)	Arctic char	Northern pike
4	Lake trout	Northern pike	Arctic char
5	Northern pike	Walleye	Walleye
6	Arctic char	Trout (general)	Trout (general)
7	Lake whitefish	Rainbow trout	Rainbow trout

Table 11. Distribution of species preference indicated by anglers in the Northwest Territories in 1985.

Species	Resident %	Nonresident %	All Anglers %
Lake trout	15.8	28.8	21.9
Other trout	18.8	7.9	13.6
Arctic char	16.0	20.0	17.9
Arctic grayling	15.7	19.7	17.6
Walleye	23.4	8.7	16.5
Northern pike	6.6	14.0	10.1
Lake whitefish	2.9	0.4	1.7
Other species	0.8	0.5	0.7
TOTAL	100.0	100.0	100.0

Table 12. Estimated weight in kg by species of fish landed in 1985 by resident and non-resident anglers in the N.W.T. sport fishery. Includes numbers and weight of fish caught and fish retained.

	Resident				Non- resident				Total			
Fish Species	# Caught	Wt.	# Retained	Wt.	# Caught	Wt.	# Retained	Wt.	# Caught	Wt.	# Retained	Wt.
N. pike	109185	99249	28281	25707	55228	50202	7351	6682	164413	149451	35632	32389
Lake trout	83761	304555	34500	125442	165107	600329	16688	60678	248868	904884	51188	186120
Grayling	23345	21221	12761	11600	65271	59331	7830	7117	88616	80552	20591	18717
Walleye	54856	49864	36733	33390	15005	13640	5844	5312	69861	63504	42577	38702
Char	12422	45166	9955	36196	22302	81090	6460	23489	34724	126256	16415	59685
Other species	18416	16740	12236	11123	3819	3471	2045	1859	22235	20212	14281	12981
Total	301985	536795	134466	243458	326732	808063	46218	105137	628717	1344859	180684	348594
Weight of Fish Retained* (in kg)			243 458				105 137				348 594	
(in lbs)			535 608				538 232				766 907	

* Weights were estimated by applying the following average unit weight conversion factors (in pounds) to the numbers of each species retained: pike = 2.0, lake trout = 8.0, grayling = 2.0, walleye = 2.0, char = 8.0, other species = 2.0 (D. Topolniski, personal communication).

Source: DFO/GNWT 1986.

Table 13. Total commercial landings, by province, for the major Canadian freshwater fisheries, 1945-1983 (thousands of kg round weight). Source: Davies et al. 1986.

Year	Ontario	Manitoba	Saskatchewan	Alberta	NWT
1945	12717	13794	3919	3622	1496
1946	14999	13044	3544	5032	3018
1947	11327	13608	3645	4499	1581
1948	13228	14331	3671	3283	3548
1949	11014	13411	3396	2865	4137
1950	10164	14304	3969	3212	3576
1951	14077	16125	5233	3818	3399
1952	17293	14245	4824	4390	3201
1953	20381	10617	3855	4927	3054
1954	21673	12930	4784	3984	3192
1955	20699	15847	4605	3961	3558
1956	27084	13788	4282	4373	3153
1957	23183	14321	5019	4724	2993
1958	21398	14483	5715	5208	2680
1959	22219	14085	5693	5744	2613
1960	21591	14490	6591	7190	2548
1961	24926	13906	6584	5133	2595
1962	28930	16377	6804	4094	2811
1963	24649	16211	6391	3860	2739
1964	19735	12989	6489	5784	2690
1965	23807	13421	6774	3862	2599
1966	25557	13578	6253	4947	1993
1967	24792	9453	5318	4497	1763
1968	25269	11673	4976	5390	1975
1969	28670	9702	6312	4985	2110
1970	20902	7379	5540	3128	2138
1971	19411	6763	5309	1231	1768
1972	19593	10225	5053	1210	1630
1973	23895	10601	5021	1267	1539
1974	24143	11409	5630	698	1435
1975	20576	12215	4884	874	1143
1976	18645	10832	5104	1020	1283
1977	23529	12540	5214	1131	1376
1978	25413	12830	3748	997	1496
1979	25087	14556	4484	1019	1446
1980	26701	18086	5336	1213	1651
1981	28071	13734	3460	1101	1444
1982	34110	15454	3801	1106	1585
1983	27538	15005	2542	1135	1137
TOTALS	846996	512351	193772	130514	90093

Table 14. Total whitefish landings, by province, for the major Canadian commercial freshwater fisheries, 1945-1983 (thousands of kg round weight). (In the N.W.T., whitefish are taken primarily from Great Slave Lake. These data allow comparison of the production of that fishery with the aggregate yields of fisheries elsewhere.) Source: Davies et al. 1986.

Year	Ontario	Manitoba	NWT	Saskatchewan	Alberta
1945	1939	2043	984	2057	1476
1946	2023	2260	1663	1503	1205
1947	2246	1718	864	1610	808
1948	2941	1526	2251	1462	800
1949	3210	1918	2617	1610	831
1950	2995	2826	2836	1995	1096
1951	3264	2784	2082	2660	1229
1952	4285	2617	1741	2563	1436
1953	4643	2063	1757	1768	1373
1954	3111	2408	1827	2362	1445
1955	2023	2356	2091	2276	1221
1956	1840	2511	1805	2379	1847
1957	1466	2946	1955	2920	1801
1958	1490	2854	1536	5727	1920
1959	1447	3135	1573	5705	1965
1960	1752	2805	1729	3537	2465
1961	1776	3180	1829	3453	2081
1962	1655	3675	2051	3359	1254
1963	1616	3578	2077	3245	926
1964	1468	3310	1842	2868	698
1965	1470	3388	1823	3520	762
1966	1279	2743	1276	3026	949
1967	1271	2565	1059	2491	943
1968	1321	2404	1458	2195	917
1969	1344	2459	1570	2852	1090
1970	1304	2203	1598	2769	1055
1971	1068	2521	1304	2913	992
1972	1000	2541	1141	2553	1003
1973	902	2427	1094	1862	990
1974	1072	2335	1019	2222	1075
1975	1113	2757	783	2175	1039
1976	1374	3037	950	2052	1161
1977	*	*	1020	*	*
1978	1747	3665	1091	*	*
1979	1345	4544	1066	1819	703
1980	1771	4527	1208	1913	837
1981	1800	3391	1102	1203	770
1982	1814	2976	1166	693	919
1983	2271	3361	886	919	834

*Data not available.

Table 15. Freshwater commercial fisheries catches by species and by province (thousands of kg live weight), 1980.

Species	N.W.T.	N.B.	Que.	Ont.	Alta.	Man.	Sask.
Whitefish	1 208	-	7	1 771	837	4 527	1 913
Lake trout	134	-	-	280	-	60	740
Walleyeye	44	0	4	1 353	60	3 316	756
N. pike	184	-	3	269	248	2 562	1 035
Sucker	-	-	-	572	-	4 721	231
Arctic char	81	-	-	-	-	-	-
Alewife	-	522	-	-	-	-	-
Tomcod	-	-	80	-	-	-	-
Eel	-	16	176	169	-	-	-
Salmon	-	0	-	16	-	-	-
Shad	-	9	6	2	-	-	-
Smelt	-	-	0	11 426	-	-	-
White bass	-	-	-	911	-	-	-
Sturgeon	-	22	70	22	-	-	-
Catfish	-	-	137	328	-	-	-
Burbot	-	-	-	109	-	-	-
Tullibee*	-	-	-	1 926	43	306	50
Perch	-	-	113	6 344	4	65	-
Carp	-	-	36	122	-	778	586
Sauger	-	-	-	17	-	1 708	-
Rock bass	-	-	0	49	-	-	-
Sunfish	-	-	7	119	-	-	-
Others	66	7	29	896	21	41	25

* Includes lake herring, chub and cisco.

Source: DFO Canadian Fisheries Annual Statistical Review 1980.

Table 16. Summary of Canadian commercial fish catches for 1980 (thousands of kg round weight).

Regions and Provinces	Nominal Catches	Percent Total
A. All Fisheries		
By Region		
Atlantic Coast	1 156 088	86
Pacific Coast	129 926	10
Inland Region	54 297	4
CANADA	1 340 311	
B. Sea Fisheries*		
By Province - Sea Fisheries*		
Northwest Territories	105**	.008
Nova scotia	436 822	34
New Brunswick	105 356	8
Prince Edward Island	33 463	2
Quebec	81 248	6
Newfoundland	499 199	39
British Columbia	129 926	10
SEA FISHERIES	1 286 119	
C. Freshwater Fisheries		
By Province - Freshwater Fisheries		
Northwest Territories	1 717	3
New Brunswick	576	1
Quebec	668	1
Ontario	26 701	49
Manitoba	18 086	33
Saskatchewan	5 336	10
Alberta	1 213	2
FRESHWATER FISHERIES	54 297	

* Includes catches by foreign vessels under cooperative arrangements.
** NWT searun Arctic char caught in the Arctic coastal fishery.

Source: DFO Canadian Fisheries Annual Statistical Review 1980; Davies et al. 1986.

Table 17. Number of fish (000's) caught and retained by sportfishers, by species and by province, 1980.

Species	N.W.T.	Yukon	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Can.
Arctic char	27.3	1.4	2.4					N/A				10.5	41.6
Arctic grayling	35.1	82.9	50.8	158.0	8.5	3.1	0.7	N/A					339.1
Bass			41.5			136.3	10059.9	N/A	113.4	34			10387.0
N. pike	58.0		2.1	2808.0	1921.6	1733.5	5639.6	N/A			1.4		12164.2
Walleye	33.7		.7	891.4	1602.3	2510.1	14958.9	N/A	60.5	0.7			205B.3
Perch			12.6	2995.1	1634.5	474.6	22442.4	N/A	169.4	0.8	0.3		27729.7
Smelt			88.0			9.3	24414.9	N/A	1503.9	2541.7	82.3	13.7	28653.8
Salmonids													
Pacific			1935.2					N/A					1935.2
Atlantic								N/A	45.9	18.6	0.4	123.7	188.6
Freshwater		10.7	1522.5	0.3	2.9		313.1	N/A	51.1	1.3		81.9	1983.8
Trouts													
Brook			432.0	117.6	26.6	48.2	2417.8	N/A	3387.8	2009.4	539.7	6032.1	15011.2
Lake	55.4	37.8	380.1	197.0	144.7	128.5	1317.6	N/A					2261.1
Rainbow		7.0	4176.7	1422.6	54.2	65.8	1064.0	N/A		244.9	25.3	378.7	7439.2
Others	5.2	1.1	1067.2	506.7	21.1	3.5	834.3	N/A	216.7	63.4	111.3	688.9	3519.4
Whitefish	5.9	3.8	288.1	1264.5	25.1	57.4	513.7	N/A					2158.5
Other	7.6	2.0	7560.3	226.6	61.5	410.0	9586.0	N/A	191.2	139.0	87.7	22.4	18294.4

Source: DFO National Angling Survey, 1980.

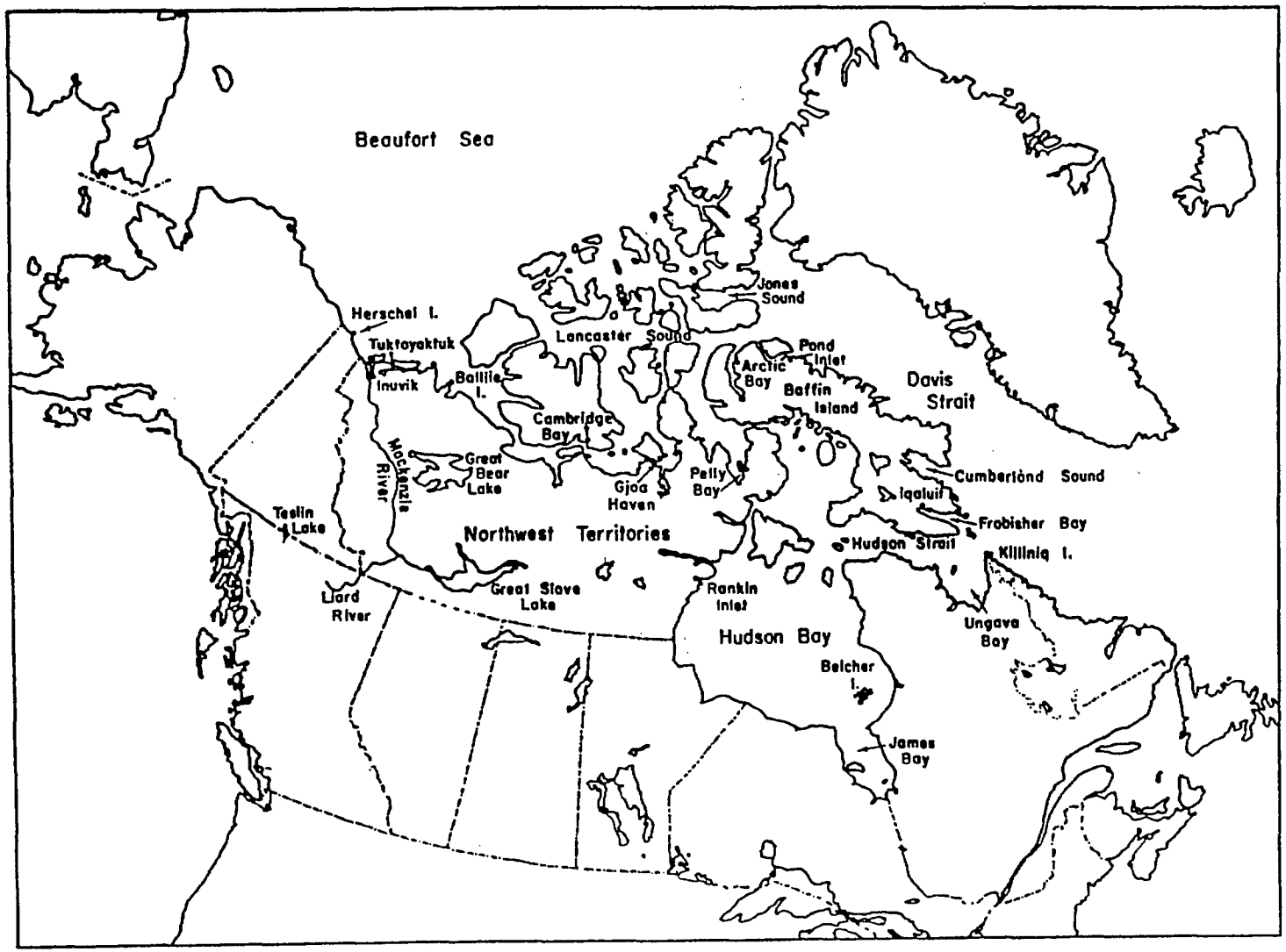


Figure 1. Map of area under consideration showing place names of pertinent areas or locations mentioned in this report.

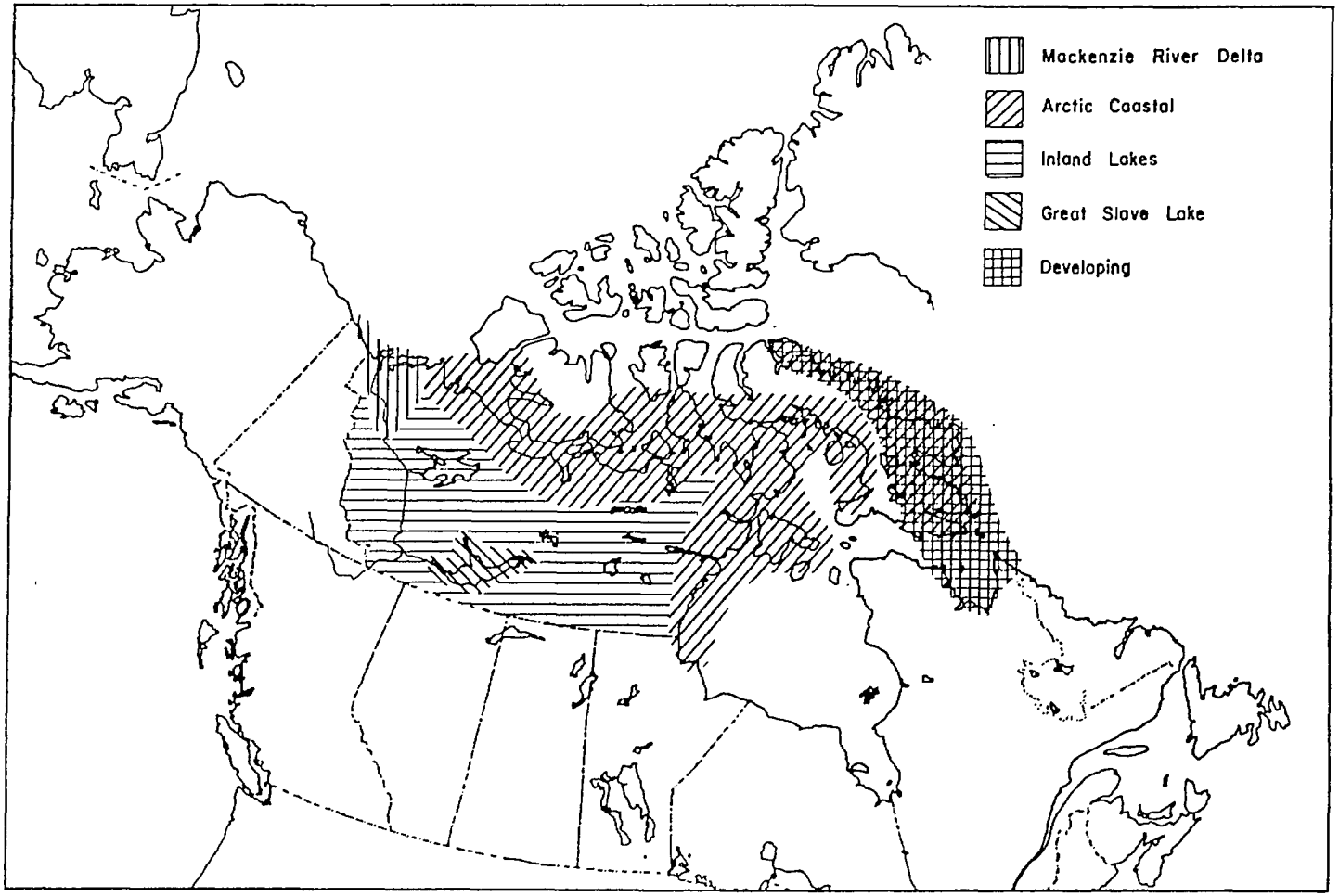


Figure 2. Generalized boundaries of principal north Canadian commercial fisheries considered in this report.

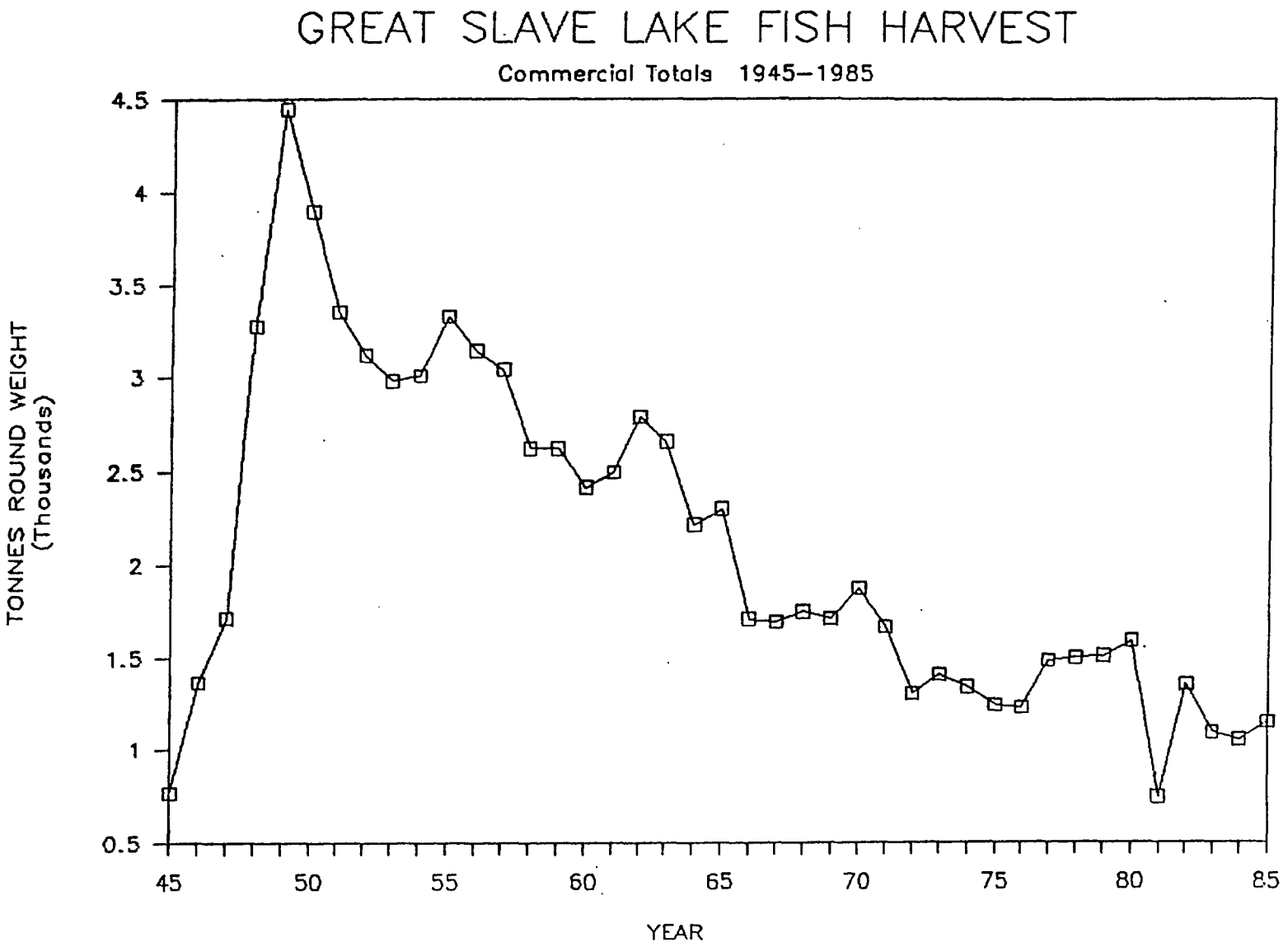


Figure 3. Total commercial landings for all species from Great Slave Lake, 1945-1985. Data from DFO, Data Reports.

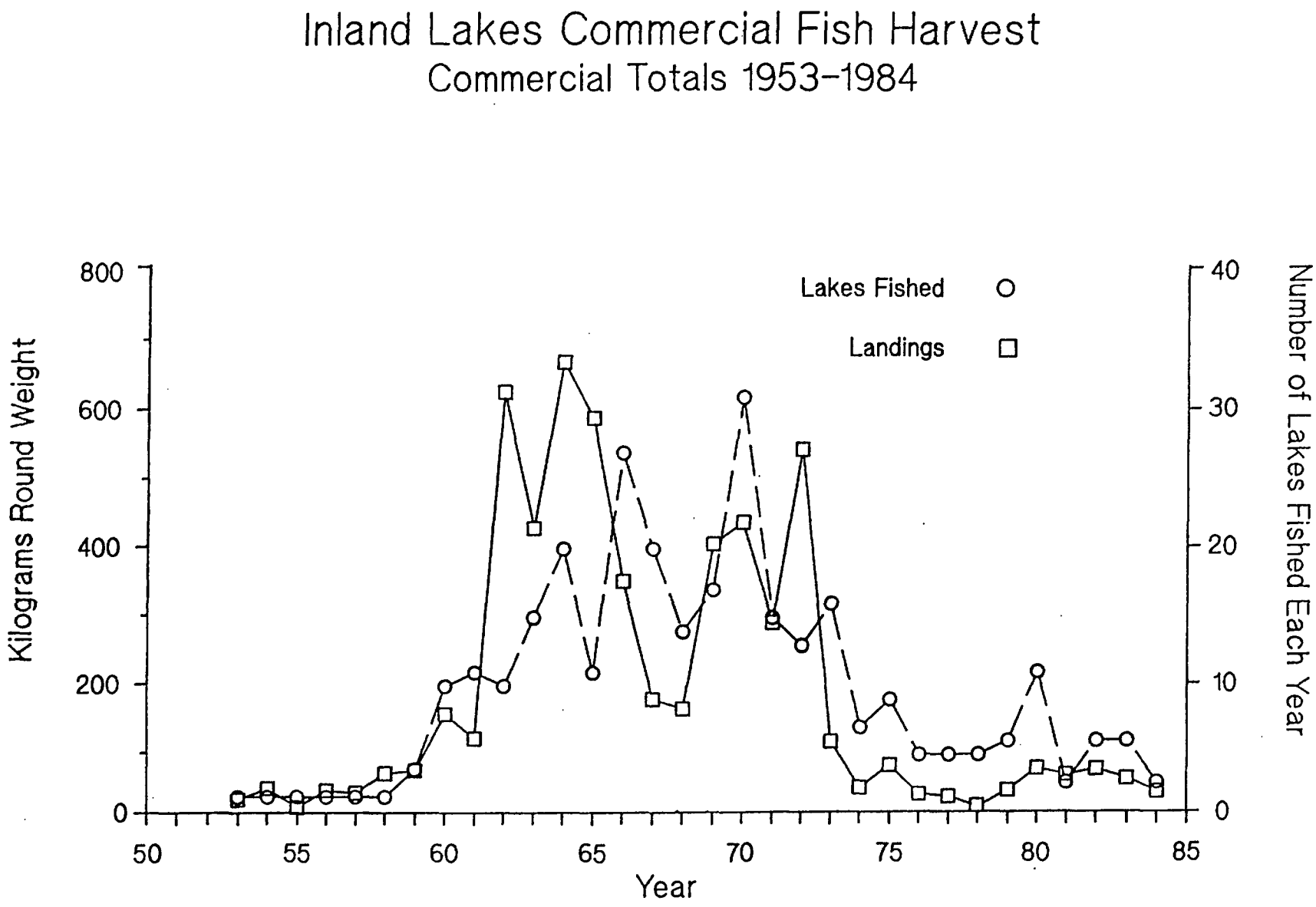


Figure 4. Total commercial landings for all species from the inland lake fisheries of N.W.T. (see Figure 2).

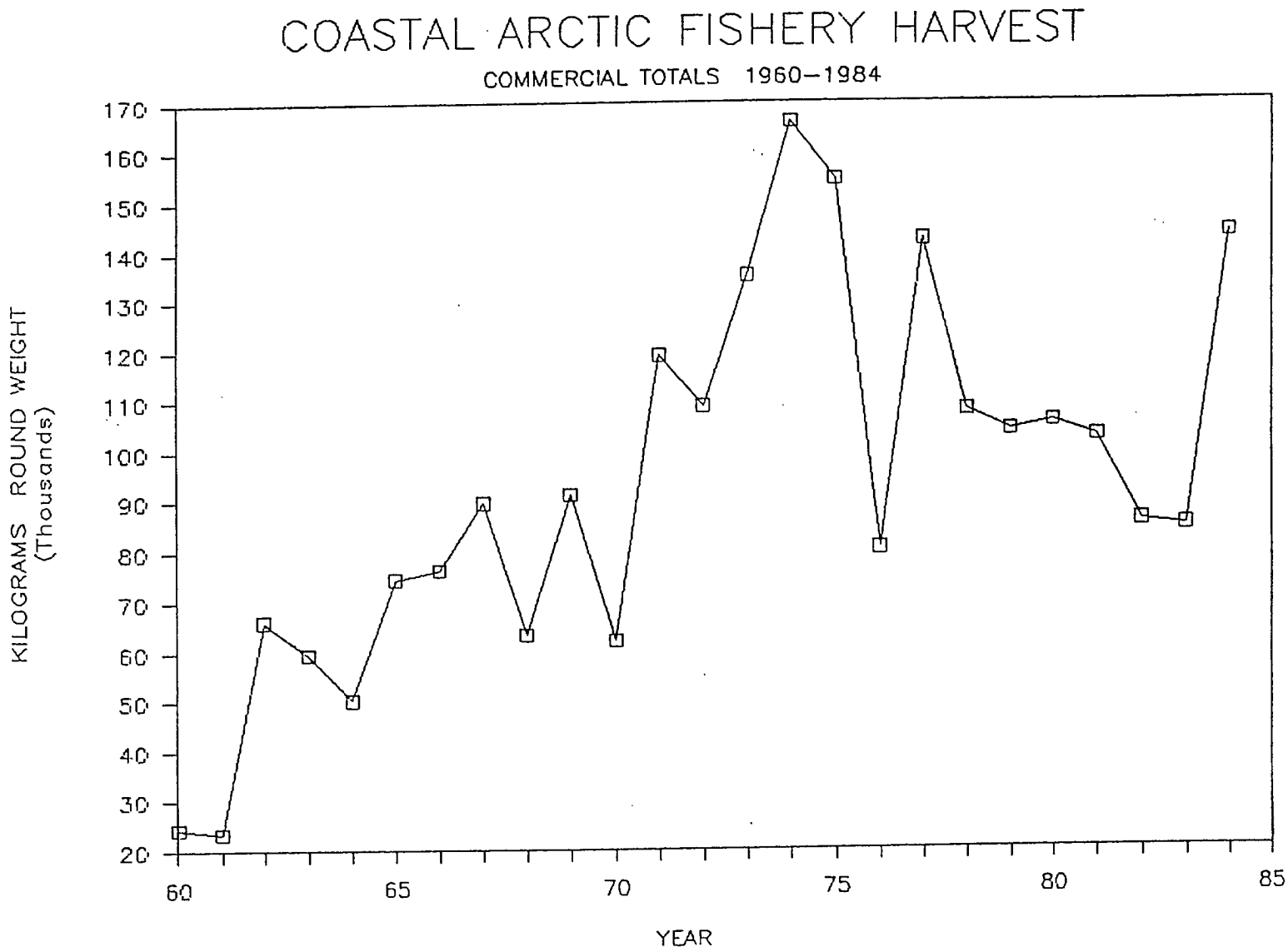


Figure 5. Total commercial landings of Arctic char by the Canadian Arctic coastal fishery (see Figure 2).

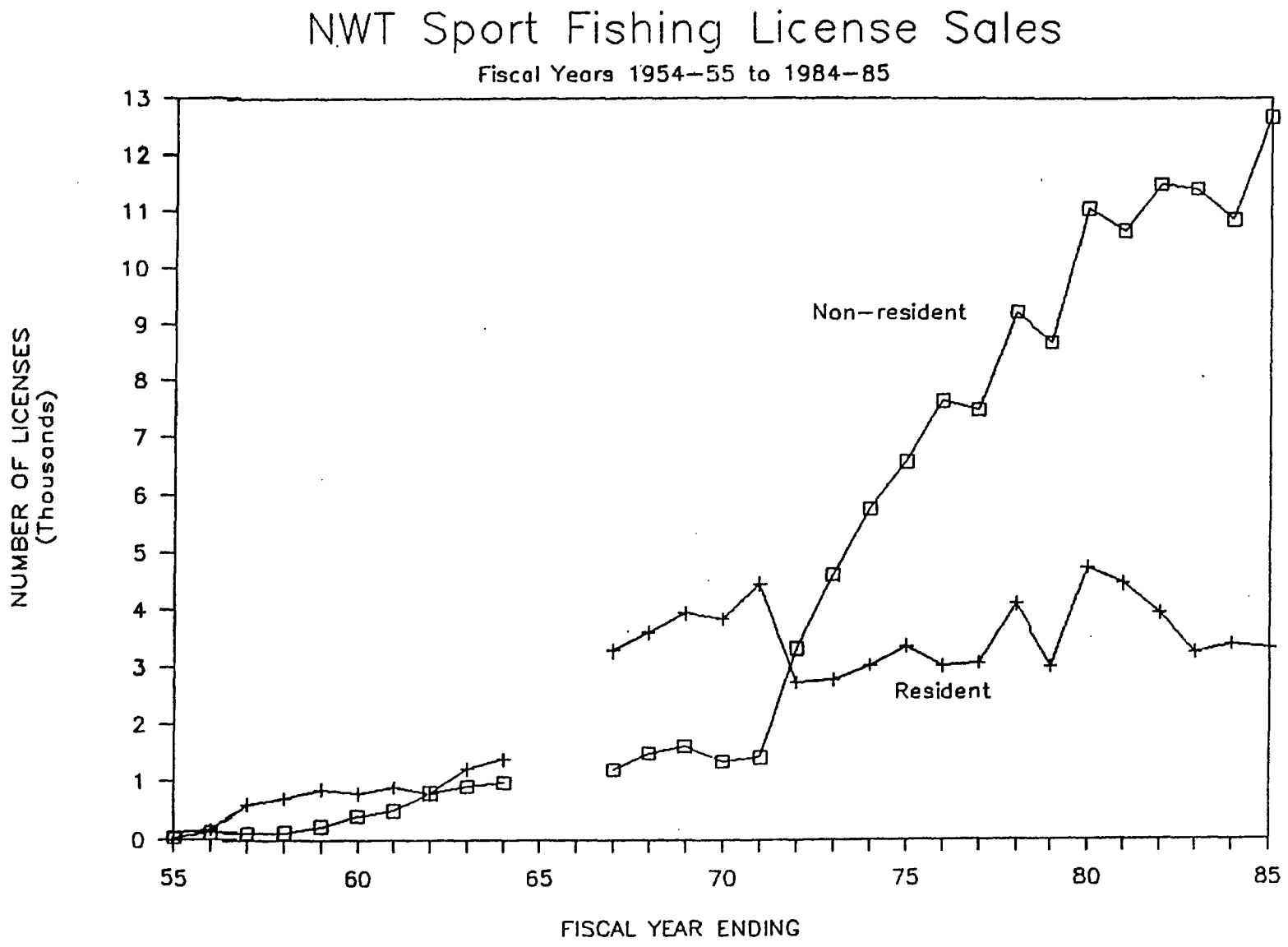
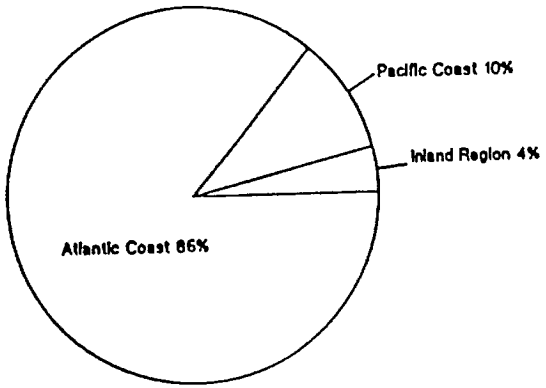


Figure 6. Number by type of sport fishing licenses sold in the N.W.T. between 1971 and 1985. Data for 1965 and 1966 is missing.

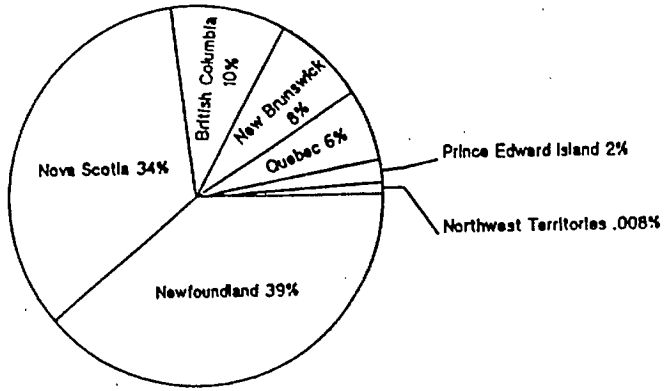
Summary of Canadian Commercial Fish Catches for 1980

(thousands of kg round weight)

All Fisheries by Region



Sea Fisheries by Province



Freshwater Fisheries By Province

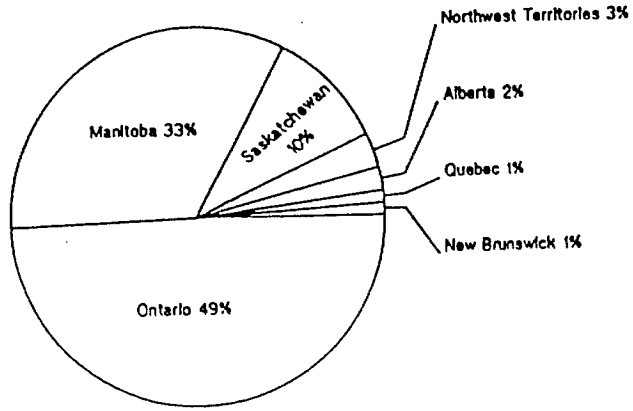


Figure 7. Relative proportions of landings by Canadian fisheries in various provinces or regions.

Appendix 1. Scientific and common names of the fish species mentioned in this report.

Squalidae	
Somniosus microcephalus	Greenland shark
Clupeidae	
Clupea harengus pallasi	Pacific herring
Salmonidae	
Coregoninae	
Coregonus autumnalis	Arctic cisco
C. sardinella	least cisco
C. clupeaformis	lake whitefish
C. nasus	broad whitefish
Prosopium cylindraceum	round whitefish
Stenodus leucichthys	inconnu
Thymallinae	
Thymallus arcticus	Arctic grayling
Salmoninae	
Salmo salar	Atlantic salmon
Salvelinus alpinus	Arctic char
S. fontinalis	brook trout
S. malma	Dolly Varden
S. namaycush	lake trout
Osmeridae	
Mallotus villosus	capelin
Esocidae	
Esox lucius	northern pike
Catostomidae	
Catostomus catostomus	longnose sucker
Gadidae	
Gadinae	
Arctogadus glacialis	polar cod
Boreogadus saida	Arctic cod
Eleginus gracilis	saffron cod
Gadus morhua	Atlantic cod
Gadus ogac	Greenland cod
Lotinae	
Lota lota	burbot
Zoarcidae	
Lycodes polaris	polar eelpout
L. reticulatus	Arctic eelpout
Percidae	
Stizostedion vitreum	walleye
Cottidae	
Icelus bicornis	twohorn sculpin
Myoxocephalus quadricornis	fourhorn sculpin
M. scorpius	short horn sculpin
Gymnocanthus tricuspis	Arctic stag-horn sculpin
Cyclopteridae	
Cyclopterus lumpus	lumpfish
Pleuronectidae	
Hippoglossoides platessoides	Canadian plaice
Liopsetta glacialis	Arctic founder
Platichthys stellatus	starry flounder
Reinhardtius hippoglossoides	Greenland halibut

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