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KUUJJUAQ RESEARCH CENTRE

Inland Fisheries Development in Nunavik (Northern Québec): a preliminary assessment.

Report prepared for the
Economic Regional Development Agreement Committee

Réjean Dumas
Kuujjuaq Research Centre
Makivik Corporation
Kuujjuaq, Nunavik (Qc.)
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PRELIMINARY

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Acknowledgements

The synthesis of information pertinent to the commercial development of our inland fisheries has been a task much longer than anticipated. Access to this information has been possible only through the collaboration of many individuals among our staff, governments and people of the industry.

First I would like to thank Dave Gillis for his assistance and ideas when this project was just hatching and for coordinating opinions between E.R.D.A. representatives and our group. Louis Roy (M.L.C.P.), Camille Choquette (M.A.P.A.Q.) and Fritz Axelsen (M.A.P.A.Q.) have contributed to this report, through hours of discussions. Staff from the Renewable Resource Development Department (Marc allard, Tom Boivin, Alix H. Gordon, Peter May and Stas Olpinski) provided multiple advices.

Morrie Portnoff and Ulaayu Qissiq have put much effort into preparing creative maps and illustrations. Word processing was diligently done by Mae Saunders which has shown endless patience throughout the numerous revisions brought to the text.

INTRODUCTION

Economic development in Arctic regions is often synonymous of natural resource exploitation; we import modern technology and we export products from the land. This land is remote, clean and these products come with a taste of adventure. Atlantic salmon *Salmo Salar* and arctic char *Salvelinus alpinus* have been the object of many commercial fisheries since the late 1800's. Among these ventures, some were successes, many were failures, usually due to poor management and overfishing. Because of the quality and exotic value of northern fish products, many enterprises have shown interest in developing this industry. However, few have delivered the expected high quality product.

Unlike anadromous fish, the freshwater fish sector has never been exploited commercially in Nunavik (Inuit territory in Northern Québec). On the other hand, they constitute an important part of Inuit subsistence especially during winter and spring months when lakes are more easily accessible by snowmobile or dog teams. In decreasing order of importance to the wildlife harvest (by weight) the major species are: lake trout *Salvelinus namaycush*, brook trout *Salvelinus fontinalis*, whitefishes (mainly *coregonus clupeaformis* but also *prosopium cylindraceum* and *coregonus artedii)* and land-locked arctic char *Salvelinus alpinus* (figure 1) . These species contributed to 9% (in edible weight) of the wildlife harvest by Québec Inuit in 1979 and 1980 (J.B.N.Q.N.H.R.C. 1982).

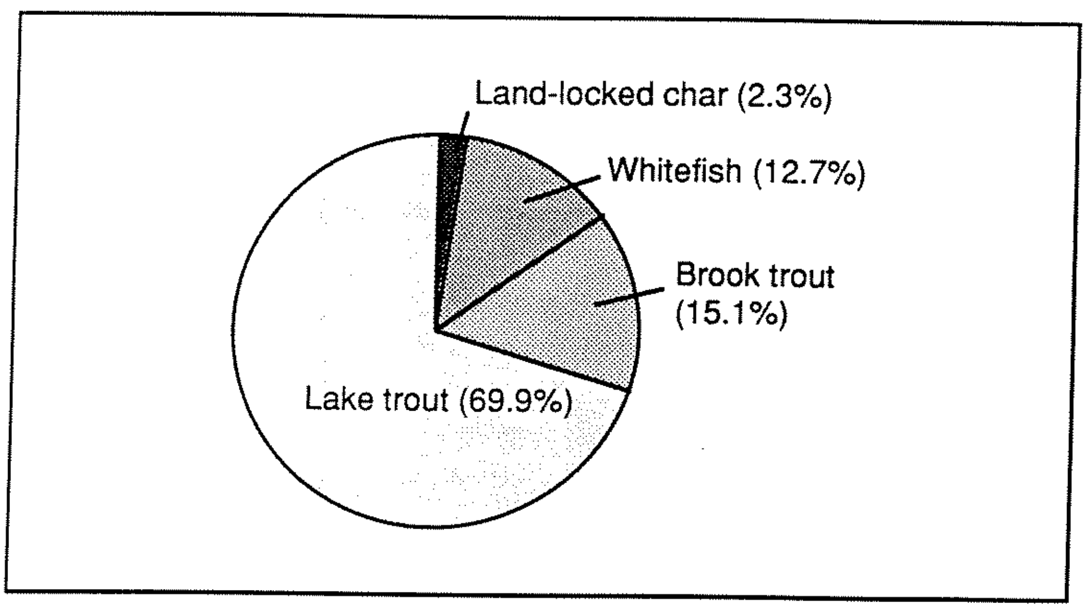


Figure 1. Proportion of different freshwater fish species (by edible weight) in the subsistence economy of Québec Inuit.

In general, freshwater fish are harvested within a 150 kilometer band from the sea coast (figure 2). This leaves a large territory in Nunavik's interior densely drained by underutilized freshwater systems. The objective of this assessment is to review biological and economic aspects of the freshwater fish resource sector and to examine the feasability of commercially exploiting it.

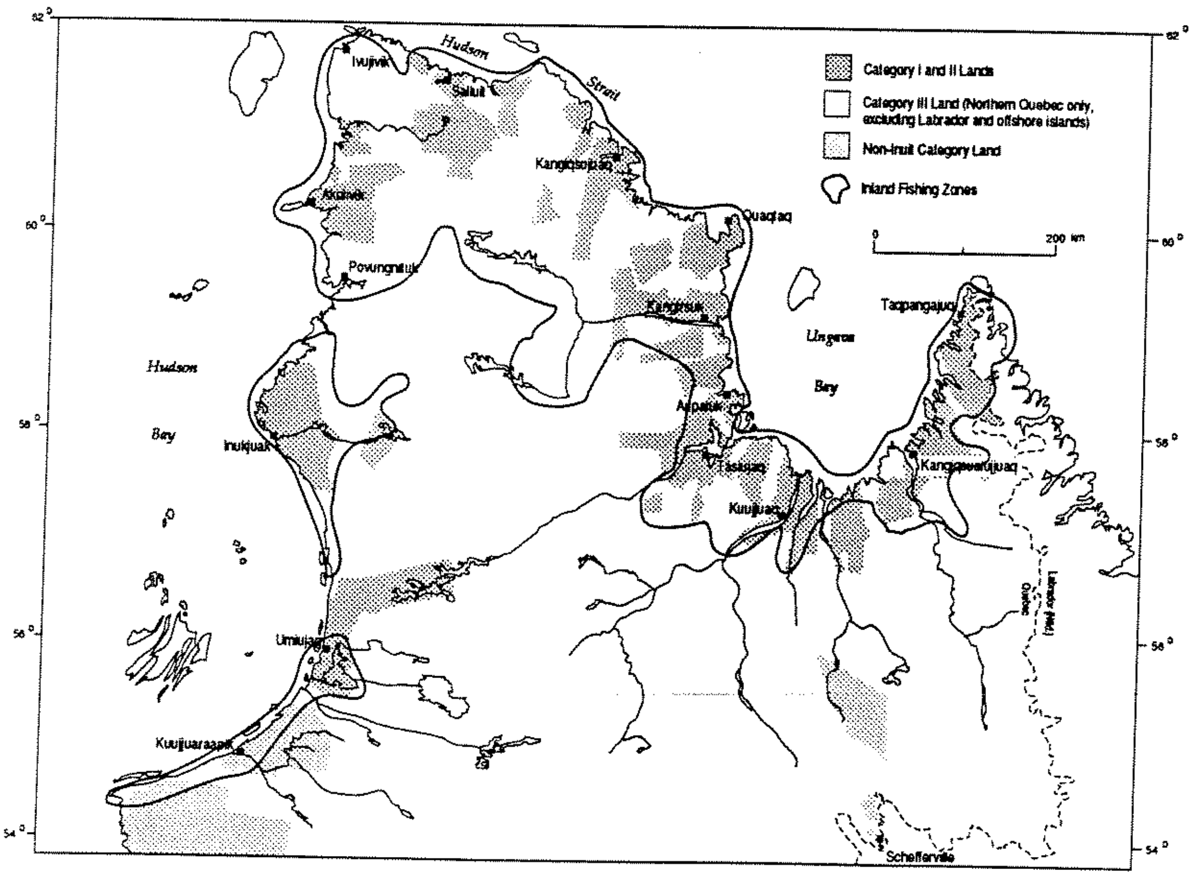


Figure 2. Land category selection and fishing zones used by Inuit in Québec.

OBJECTIVES and GUIDING PRINCIPLES

The assessment of the potential of freshwater resources is a vast field which we can divide into three major levels:

1. Fishing operations and marketing of dressed fish.
2. Transformation into secondary products (smoked, fillets, canned, caviar, etc.)
3. Enhancement of fish stocks and aquaculture.

This study adresses objectives related to the first level. Other project also mandated under the Economic Regional Development Agreement (E.R.D.A.) are adressing levels 2 and 3.

<u>Study objectives</u>

i. Identify commercial target species and their potential relative abundance in Nunavik's interior lakes.

ii. Examine fishing operation scenarios and potential sites for the commercial exploitation of freshwater resources in Nunavik.

iii. Review biological considerations related to fishing yields, fish quality and the management of freshwater fisheries.

iv. Identify freshwater fish markets, optimal access routes and revenues from non-processed (dressed) freshwater fish products.

In order to achieve these objectives a set of guiding principles were necessary in the selection of proper scenarios:

i. To protect present and future subsistence needs, potential commercial zones should be beyond the presently used areas.

ii) Systems used by anadromous fish stocks (Atlantic salmon and arctic char) have suffered from over-exploitation in many areas. They require a specific management and these systems should be excluded from potential freshwater commercial areas.

iii) Fishing operation scenarios should follow the more restrictive alternatives to avoid too optimistic predictions. Commercialization proceeding, restrictions can be lifted when appropriate, as additional information on fish stocks will become available and product development proceeds.

Note: Choosing between metric and standard was difficult. Though scientific literature is consistantly using kilograms. The fish insdustry is based on the pound. Thoughout the text both systems are used but the final analyses were done in kilos.

THE FRESHWATER FISH SECTOR IN THE CANADIAN FISHERY

National perspective

In Canada, freshwater fish comprise a small portion of the total commercial fish landings: 44 000 tons or 3% in 1986 (figure 3, Department of Fisheries and Oceans 1987 a). Freshwater fish are better known for their value as a sport catch. In Atlantic and Pacific provinces, the marine sector is so important that freshwater commercial fisheries are virtually non-existant. These fisheries however play a key role in the economy of many communities in northern Manitoba, Saskatchewan and in the great lakes area. Ontario, by itself, catches nearly half of the national total (figure 4).

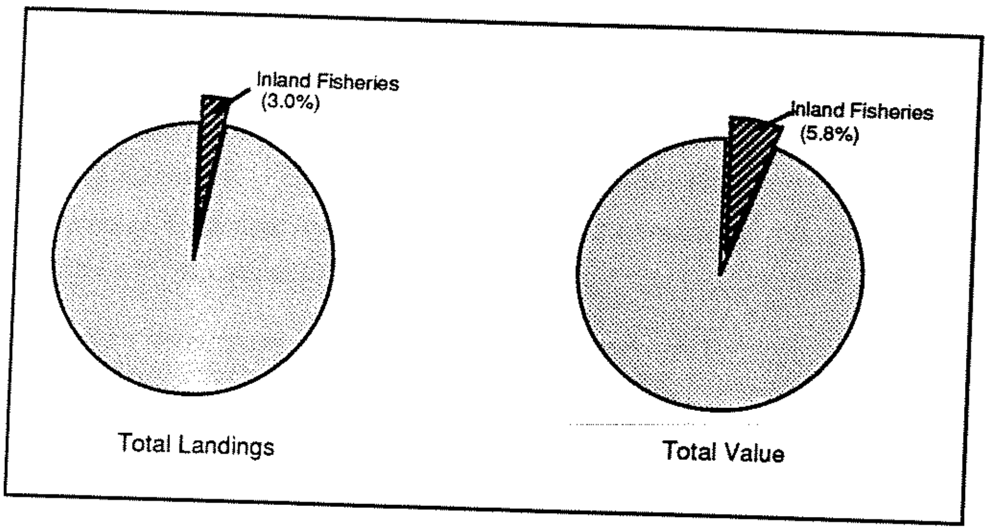


Figure 3. Contribution of the inland sector to the canadian commercial fisheries in landings and value (data source: D.F.O. 1987 a).

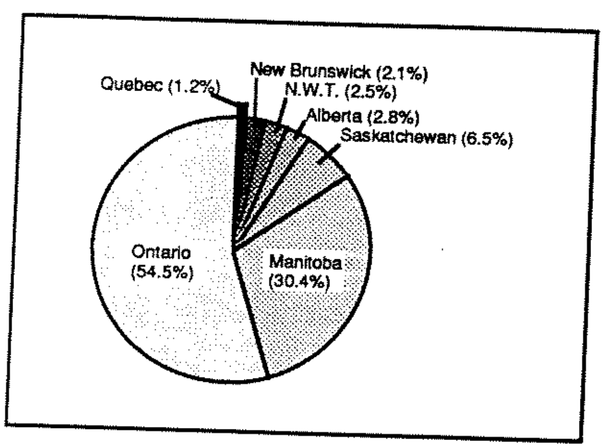


Figure 4. Contribution of canadian provinces to the national commercial freshwater fish catch, 1983- 84 average (data source: D.F.O. 1987 b).

The main freshwater commercial species are smelt, yellow perch and lake whitefish, other species of importance being northern pike, yellow perch, suckers, cisco (tullibee) and sauger. Lake trout and arctic char account for less than 2% of the freshwater fish landings (Department of Fisheries and Oceans, 1987 b). Freshwater fish are usually fished for by gillnet and pound net, except for smelt which are largely caught by otter trawls. Whitefish are also caught by trap and occasionally by hook.

Québec perspective

Québec's commercial freshwater fisheries are of marginal importance compared to sport fishing. Among the seven concerned provinces Québec ranks last in annual freshwater fish production averaging 570 tons in 1983 - 84 for a landed value of $1.2 million. The most important fisheries are located along the St-Lawrence River , and target eel, perch and minnows. These three species account for two thirds of the total revenues from all catches. Whitefish fisheries are reduced to two lakes with assigned commercial quotas in Québec (Ministère du Loisir, de la Chasse et de la Pêche, 1986).

Lake	Quota (kg)	Fishing gear
Témiscamingue	*6 500	gill net
Champlain	12 000	seine

* includes cisco

A number (14) of other lakes in the Abilibi - Temiscamingue area and sections on the St-Lawrence River are open to commercial fisheries for many species including lake whitefish, cisco and suckers. These are registered to the Plan de Pêche as unlimited harvest in the understanding that quotas will be established if there are indications that whitefish and cisco stocks are being depleted. Experimental fisheries are also under way in a few areas, namely in lakes surrounding Waswanipi where the Cree Regional Authority is exploring commercial possibilities for sturgeon, whitefish and cisco.

Also worth mentions are the testing of a whitefish trap in Kippawa lake and the only commercial operation for lake trout in Québec: Manicouagan Reservoir (figure 5).

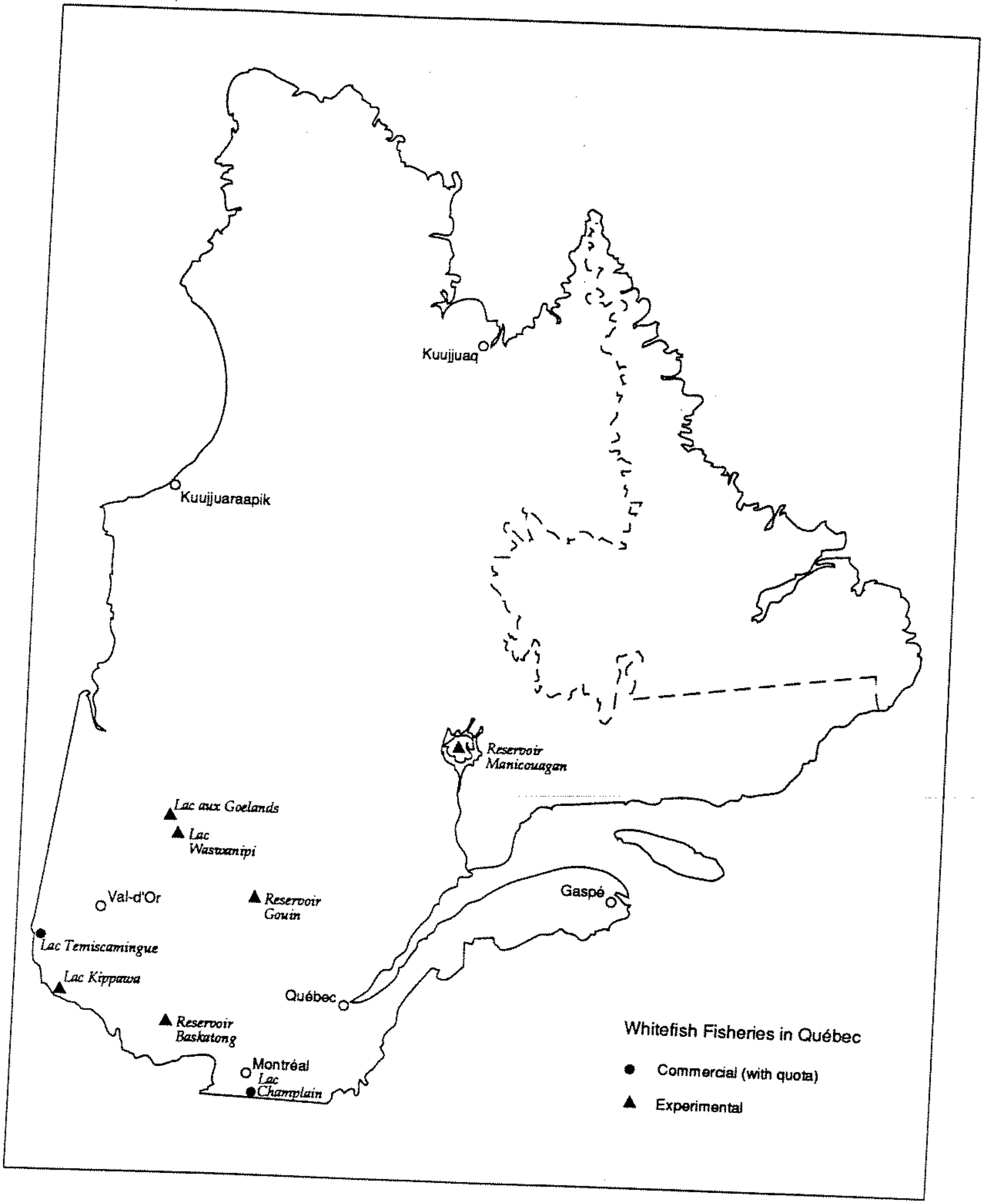


Figure 5. Location of commercial and experimental fisheries in Québec (data source: M.L.C.P. 1988 and Louis Roy, pers. comm.).

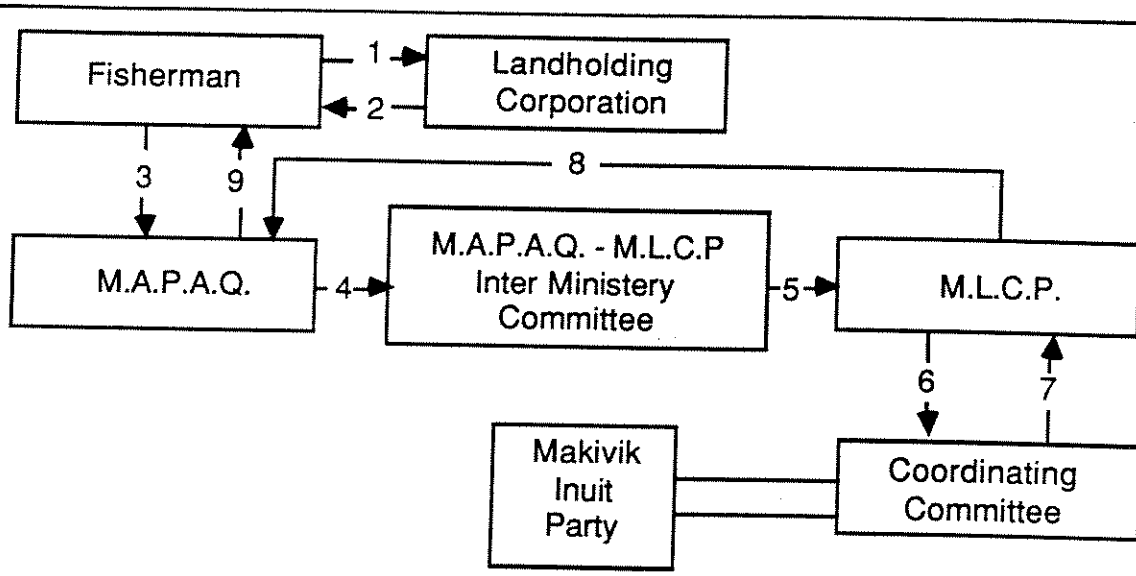
TARGET SPECIES AND LEGAL ASPECTS

Commercial fishing activities and fish sales are regulated under different legislations in Québec. Fishing activities on one hand are covered under the "Règlement de pêche du Québec", an edited version of the federal regulations. The sale of fish products, on the other hand, is regulated under the "Loi sur la conservation de la faune" (C-61 and C-61.1). For commercial activities operated in Nunavik, additional regulations apply under the James Bay and Northern Québec Agreement. This agreement gives native people the exclusive right to operate and establish commercial fisheries or category I and II lands defined by the said Agreement (figure 2). On category III land, these exclusive rights apply only for certain species, namely non-anadromous whitefishes, suckers and burbot *lotta lotta.*

Any commercial fisheries for freshwater species (including anadromous and catadromous ones) must be operated under the proper permit. Such permits are issued by the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (M.A.P.A.Q.). There are three types of permits. Exploratory and experimental permits are allocated when sustainable yields, fishing sites, fish products need to be evaluated. These permits are usually short-term until the potential of the fishery is assessed. When conclusive, a commercial fishing license is allocated. Before any permit is issued, M.A.P.A.Q. consults with the Ministère du Loisir de la Chasse et de la Pêche (M.L.C.P.), responsible for management aspects of the resource, to insure that the proposed commercial activities will not endanger the concerned fish stocks.

All applications for commercial fisheries permits in Northern Québec (category I, II and III lands) must be submitted to the Hunting, Fishing and Trapping Coordinating Committee. This committee must adress to the responsible minister, recommendations based on potential impacts of the proposed fishery, particularly on subsistence and recreational fishing (Editeur officiel du Québec, 1976). Figure 6 summarizes the path which must be followed by commercial permit applications in order to be approved in Nunavik.

In Québec, certain fish species cannot be sold unless they are caught under a commercial fishing permit. Some other fish species, can simply not be commercially fished for in Quebec. They can however be sold in Québec when they come from outside the province (in areas where they are legally fished for). Table 1 reviews the commercial status of the major freshwater and anadromous fish species present in Nunavik.



Steps:

1. Fisherman presents his application to LHC for support resolution if fishery is on category I or II lands, and for community approval if on category III.

2. LHC provides relevant papers of support to the fisheman.

3. Fisherman sends his application to M.A.P.A.Q.

4. M.A.P.A.Q. presents the application to a joint committee, between M.A.P.A.Q. and M.L.C.P. which reviews the application from a biological point of view.

5,6,7. Application goes to M.L.C.P. which presents it to the Coordinating Committee for approval

8, 9. Application to M.A.P.A.Q. which issues the appropriate permit.

Note: At any one point in this process, the application can be refused and returned to the fisherman. Also, if the application is accepted, restrictions are usually put on the application and in most cases we would expect that an experimental permit will be issued for the first year (s).

Figure 6. Path required for the approval of a commercial permit application in Nunavik.

In Nunavik, the whitefish and lake trout are the main target species for inland commercial operations. Northern pike, round whitefish, suckers and cisco are potential by-catches which can be marketed in different forms. Lake trout will most certainly be predominant in fishing lakes and can legally be sold in Québec. However M.L.C.P.is revising biological and management legislation of this species and there are indications that it could be put on the non-commercial list in future years (Louis Roy, pers. comm.). Land-locked char is also an expected by-catch from a whitefish fishery, but a non-commercial one.

Table 1. Commercial status of major fish species present in Nunavik freshwater systems

Status	Species	Note
Non-commercial:	Atlantic salmon (ouananiche) *Salmo salar*	
	Land-locked arctic char *Salvelinus alpinus*	
	Brook trout (freshwater form) *Salvelinus fontinalis*	
Commercial:	Atlantic salmon (anadromous) *Salmo salar*	Tags required
	Arctic char (anadromous) *Salvelinus alpinus*	Tags required
	Brook trout (anadromous) *Salvelinus fontinalis*	
	Lake whitefish *Coregonus clupeaformis*	
	Round Whitefish *Prosopium cylindraceum*	
	Cisco *Coregonus artidii*	
	Lake trout *Salvelinus namaycush*	Status being revised
	Northern Pike *Esox lucius*	
	Long nose sucker *Catostomus catostomus*	
	White sucker *Catostomus commersoni*	

As will be discussed in the next section, lake trout and land-locked arctic char are commercially the most valuable resources present in northern lakes. Exploratory and experimental permits provide more latitude in the target species than does a regular commercial one. The possibility of including these two species in the experimental fishery stage are conditional on the scientific opinion which will be provided by M.L.C.P. Biological factors on which this opinion will be based will be discussed in the an ulterior section.

The above commercial regulations concerns the sale or trade of fish to non-natives, in other words people or organizations which are not beneficiary of the James Bay and Northern Québec Agreement. The gift, exchange and sale of all fish products between Natives (or beneficiaries of the Agreement) are allowed under the " community use" concept of the said Agreement, but subject to the principle of conservation, that is, as long as these fish species or stocks are not endangered.

FISH PRODUCTS AND MARKETS

Markets perspective

In general, freshwater fish have a lower market value than anadromous and marine ones. To identify product forms and prices, fourteen (14) whole sale fish buyers in the Montréal-Québec region and in Boston were contacted. They are generally interested in arctic fish products because of its appeal as coming from a "clean " environment. They however indicated that they are interested in long-term agreements with serious fishermen which will guarantee them high quality products in regular shipments. This section deals mainly with dressed fish products. Although there are markets for transformed products such as canned, pickled and smoked freshwater fish, the potential of these products and the required technology need to be covered in a specific assessment beyond the scope of this report.

In most regions where freshwater commercial fisheries are operated (northwest Ontario, Manitoba, Saskatchewan, Alberta and N.W.T.). The Freshwater Fish Marketing Corporation (a Winnipeg-based crown corporation) has exclusive whole selling rights. In Québec however, the F.F.M.C. does not operate and fishermen can sell to the buyer of their choice.

There are several buyers interested in freshwater species. They are usually buying those fish gutted, head-on, gills in (a product form known as dressed) preferably fresh but can also deal with frozen fish. A good portion of Canadian freshwater fish are exported, mainly to the United States but also to Finland, France and Sweden. In 1983 and 1984, 62% of the catch was exported mostly as dressed fish, fresh or frozen, but also as fillets and fish blocks (figure 7).

All statistics on fish production and exports in this section come from an annual statistic review of the 1983 and 1984 Canadian fisheries prepared by Fisheries and Oceans (D.F.O. 1987 b).

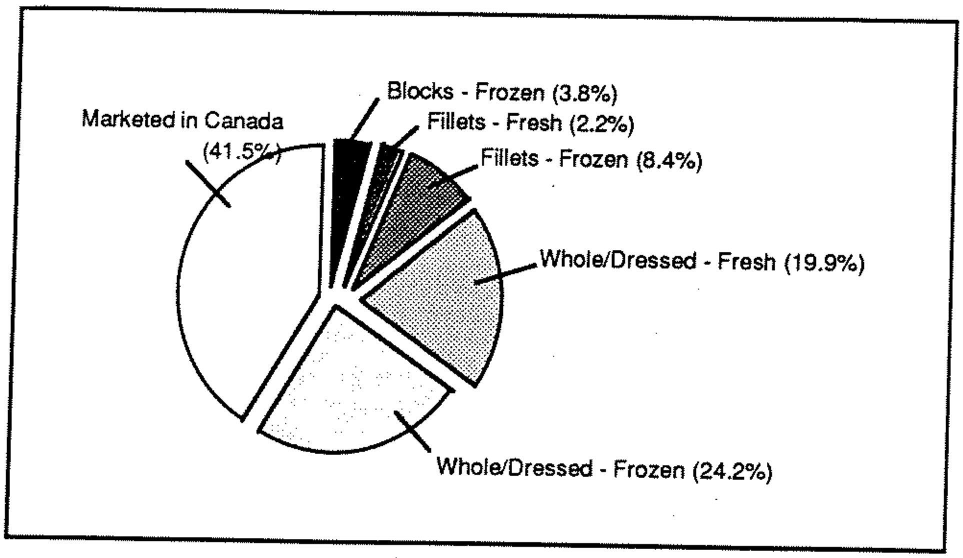


Figure 7. Canadian freshwater fish exports by product form, 1983-84 (data source: D.F.O. 1987).

Whitefishes

Most of the Canadian whitefish is exported to the U.S. (72% of the total production), largely as dressed, head-on fresh fish (figure 8). The Jewish communities of the Eastern states are major consumers of this species. It is a preferred ethnic dish specially during Jewish holidays: September, October, December and April (Morrie Portnoff, pers, comm.). New York and Boston are the major wholesale fish centres for the U.S Atlantic coast. In the case of whitefish, New York in the major trade centre.

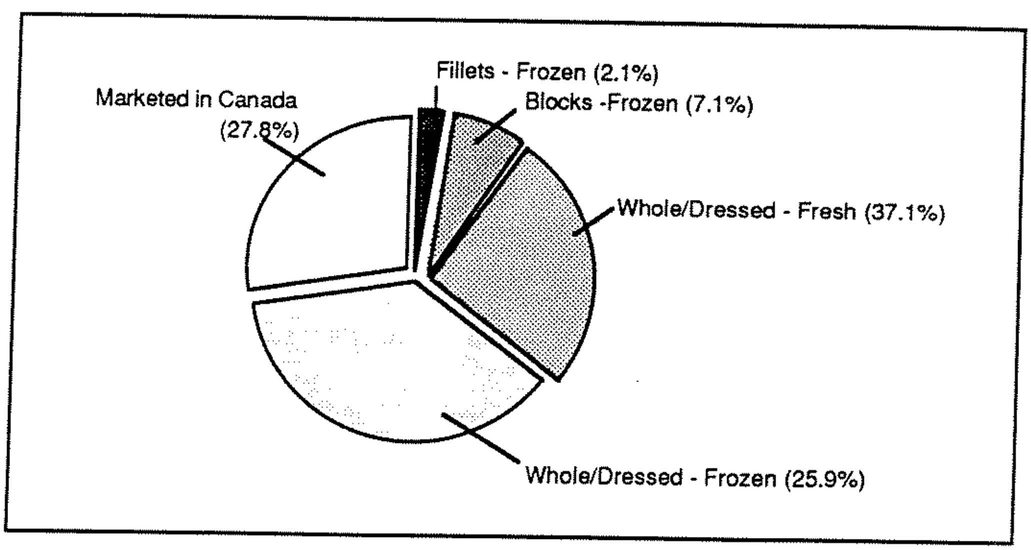


Figure 8. Canadian whitefish exports by product form, 1983-84 (data source: D.F.O. 1987 b).

The fish prices vary greatly according to the season. The latest Economic and Commercial Analysis Directorate (D.F.O., January 1989) reports a price range between Canadian $1.10 per pound for frozen F.F.M.C. Whitefish and U.S. $2.00 per pound for fresh, boxed whitefish (F.O.B. Mid- Atlantic) from the New-York Fulton Fish market. The table below shows December 1988 prices for different product form. These are selling prices. A profit in the order of 15% is uaually taken every time fish change hands.

Product	Price (Can. $) per kilo
F.F.M.C., frozen, head-on, dressed	2.20
F.F.M.C. frozen, fillets	5.50
Great Lakes, fresh head-on, dressed	6.56

Among contacted fish buyers, the most interested in whitefish were Capital Fish (Ottawa) and Reine de la Mer (Montréal) which respectively gave November prices of $1.25 - $1.75 and $1.00 per pound (F.O.B. Montréal) for regular shipments in the order of 500 to 1000 pounds per week. Fish size and color also affect the price; larger or silver fish (over two pounds) will get a better price, than small or dark ones. Prices to the fishermen can however go as low as Canadian $0.60 per pound. Current prices for frozen dressed are presently at $2,35 per pound ($5.17 per kg). Therefore a commercial fishery based on whitefish only must be able to survive through the market price fluctuations. As of December 1988. F.F.M.C. reported that production was still low this year and that the demand for whitefish as strong.

There are also markets for whitefish roe are sold fresh, a small experimental fishery/fish store type from Fabre, Qc. indicated they would buy up to 100 pounds @ $4.00 per pound. It is difficult to find markets for fresh roe because it needs to be processed and salted within 24 hours after the catch.

Arctic char

Although arctic char has been commercially marketed for decades, it remains among consumers an exotic product. Fish buyers are aware and interested in it, but the relative low production of arctic char in the west keeps the supplies sporadic. At present, there is only one arctic char commercial fishery in Québec. It operates between November and April and last year produced 10,000 pounds of dressed frozen fish (Boivin et al, 1988). In November 1988, F.F.M.C. was selling frozen, head-on dressed arctic char for $4.80 per pound. The demand was for both fresh and frozen fish.

Lake trout

Lake trout is a less popular fish product. Most of the Canadian trout production are rainbow's exported to the U.S. (90% in 1983 - 84). The lake trout is then in direct competition with cultured trout coming from Ontario and with Pacific salmon. The F.F.M.C. reported a selling price of $1.20 per pound for frozen, head-on, dressed fish. On the other hand, an Ottawa fish buyer considered a price of $3.00 to $3.75 per pound (F.O.B., Montréal) to the fishermen as realistic for fresh fish and $1.85 per pound for frozen.

Market prospects for arctic char (in its land-locked form) and lake trout suffer from restrictions of management order in Québec. M.L.C.P. considers that these populations cannot sustain large harvests and therefore should not be targetted by any commercial fishing effort (Louis Roy, pers comm.). They therefore recommend that products from these fish species be marketed strictly in the north under the community use concept tof the James Bay and Northern Québec Agreement, which means sold only to beneficiaries of the said Agreement.

Northern pike

Canadian pike is largely exported (59%) to France and to the U.S. Frozen skinless fillets are sold by F.F.M.C. at $2.25 (August 1988). Pike is also available from the New-York Fulton fish market at $1.31 per pound. One Montréal fish buyer offered $0.50 - $0.60 per pound but only for fresh and whole fish and in large quantities. March prices for dressed frozen pike was at $1.85 per pound.

Suckers

Suckers, commercially referred to as mullets, also have a place in the Canadian freshwater fish market. In Québec, one group from Fabre, operator of an experimental fishery for whitefish, is transforming the white sucker by-catch into sausages and ground meat patties which they sell through their store.

Northern markets

Kuujjuaq and Kuujjuaraapik are the two largest communities in Nunavik. Combined, they host nearly 2500 inhabitants, out of which about 30% are non-beneficiaries , in other words people with limited fishing rights. These communities have relatively high employment rates i.e. people having less free time to go fishing or hunting for themselves, thus potential fish buyers. Additionally, they benefit from daily flights, bringing in good number of travellers eager to go south with northern foods. Both communities have a Co-op and a Hudson Bay store selling fresh and frozen goods. Soon Kuujjuaq will also see the first country food store in Nunavik. These stores would be the logical local market outlets.

Preliminary discussions with the HBC store manager in Kuujjuaq and Johnny Peters (owner of the country food store) indicated an interest in selling fish locally. Although it is difficult for them to evaluate the quantities they would buy, they said they would be interested in trying some on an experimental basis. The HBC needs would be around 1000 - 2000 pounds per year, filleted and tray-packed. The country food store will be equipped with a vaccuum packer and freezers, so they are possibilities fo attractive presentation of the product.

BIOLOGICAL ASPECTS

Several authors have reviewed biological information pertaining to exploitation of freshwater fish namely whitefish and lake trout (Healey 1975, Johnson 1976, Power 1978, Cloutier 1988). Additional data is available from work conducted for the Caniapiscau-Koksoak Joint Study Group in the Caniapiscau drainage basin (SAGE 1981) and studies done by Hydro-Québec. This section reviews key aspects of the dynamics of fish populations: species composition, biomass, exploitation rates, sustainable yields and response to exploitation.

Species composition and biomass

The proportion between target species and by-catches is among the main problems which inland fisheries are faced with. Difficulties in adjusting the gear selectivity to meet the marketable volumes of each species are likely to result in excess catches for the fish products which have limited demand. Legendre and Legendre (1984) describe dispersal pattern hypotheses for freshwater species in Québec. They conclude that following the Wisconsin glaciation, fish species dispersed through isobars movements and river head water connections, resulting in a wide distribution of species like lake trout, lake whitefish and longnose suckers. Looking more closely at the areas of concern for inland fisheries: southern Ungava and south-eastern Hudson Bay we can expect the presence of whitefish (figure 9) throughout these water system and lake trout (figure 10) in most of it, except for the coastal zone near Kuujjuaraapik. The absence of lake trout in this area is of particular interest because of the anticipated market limitations for this species. Arctic char (figure 11), in its land-locked form, is expected to be present in most of the concerned areas where as northern pike (figure 12) occurs only in the southern parts of Nunavik.

Between 1978 and 1984, the Société d'Energie de la Baie James (S.E.B.J.) monitored the fish resources in reservoirs, rivers and control lakes of the James Bay and Ungava drainage basins. This program , taken over by Hydro-Québec in 1987, provides catch per unit of effort (c.p.u.e.) data in number of fish and in biomass. (Boucher et Roy 1985; Therrien et Belzile 1988). Experimental (gang-mesh 2.5 to 10.2 cm), 7.6 cm (3 inch) and 10.2cm (4 inch) nets were used in each site for 24 or 48 hours per month (June - October). A summary of c.p.u.e. and average weights recorded for whitefish and lake trout is presented in table 2. Arctic char and northern pike accounted for respectively 0.3% and 1.3% of lake catches in the sampled areas.

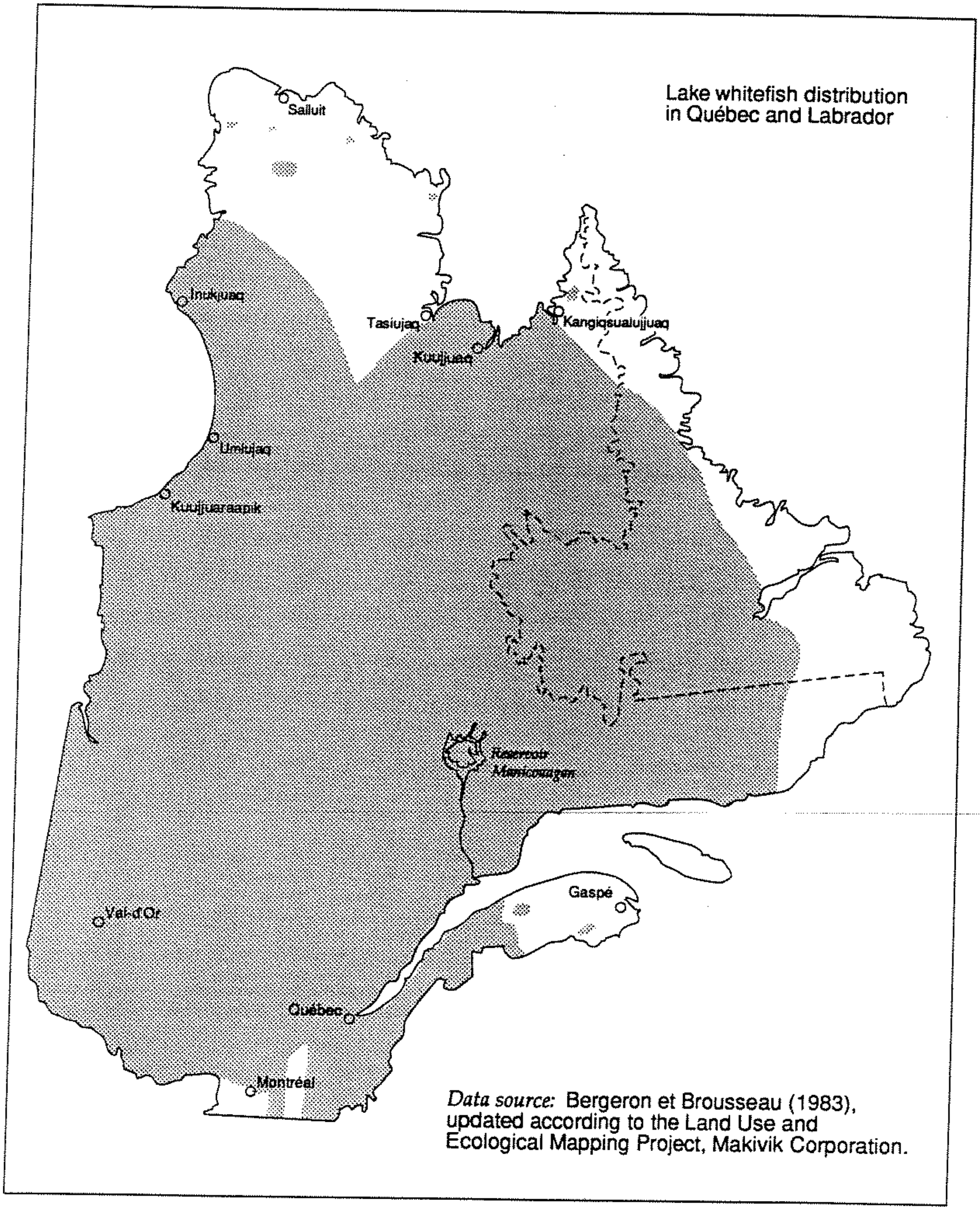


Figure 9. Lake whitefish distribution in Québec and Labrador.

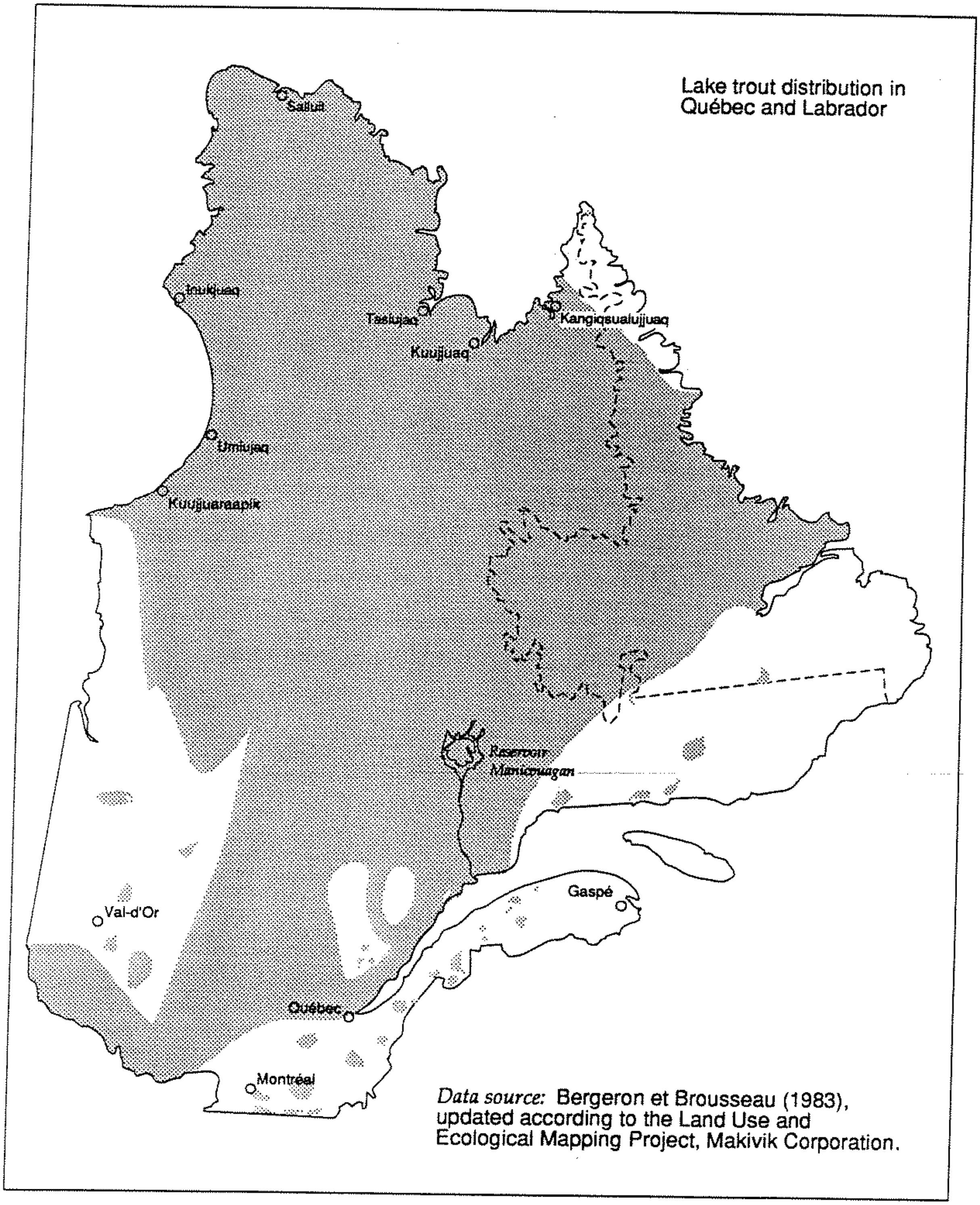


Figure 10. Lake trout distribution in Québec and Labrador.

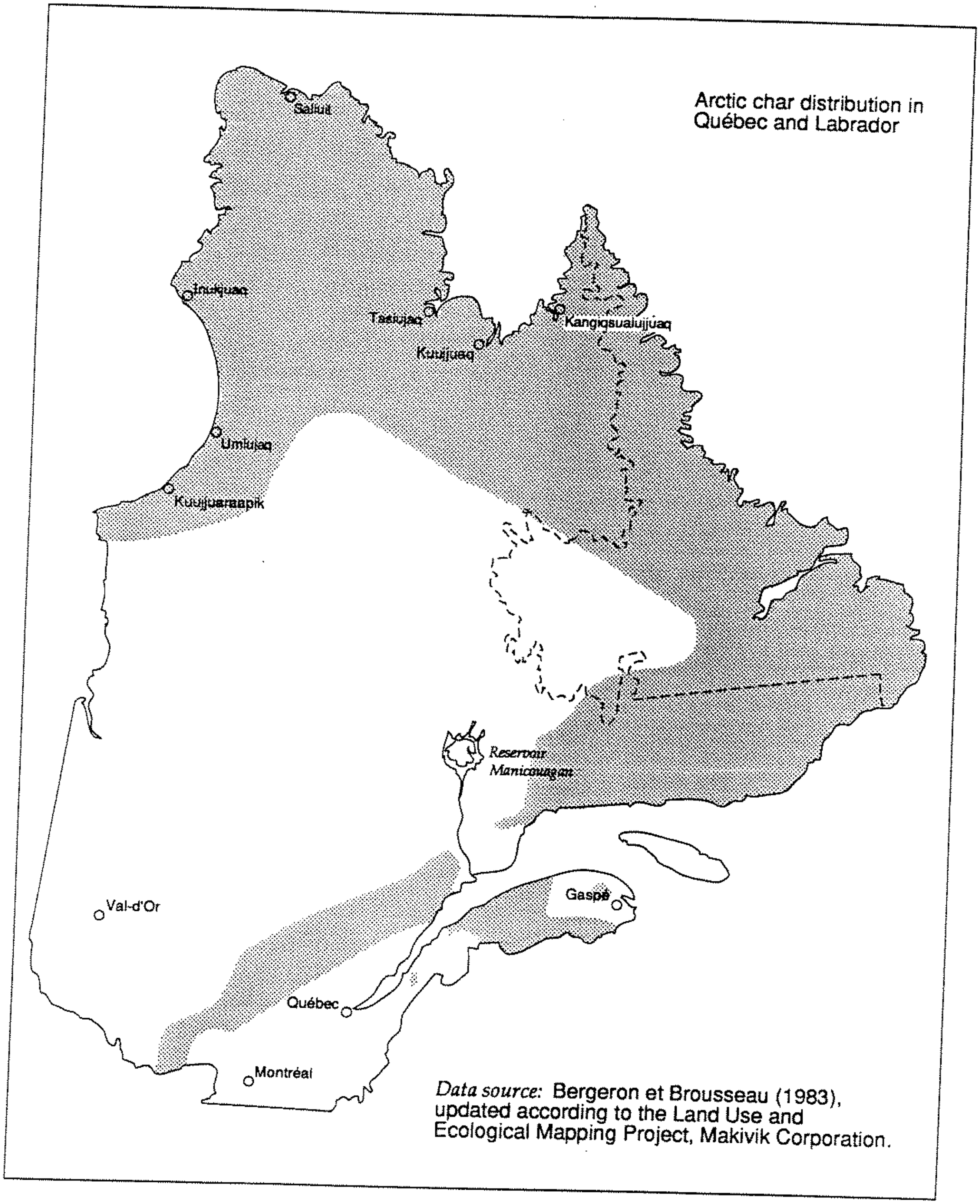


Figure 11. Arctic char distribution in Québec and Labrador.

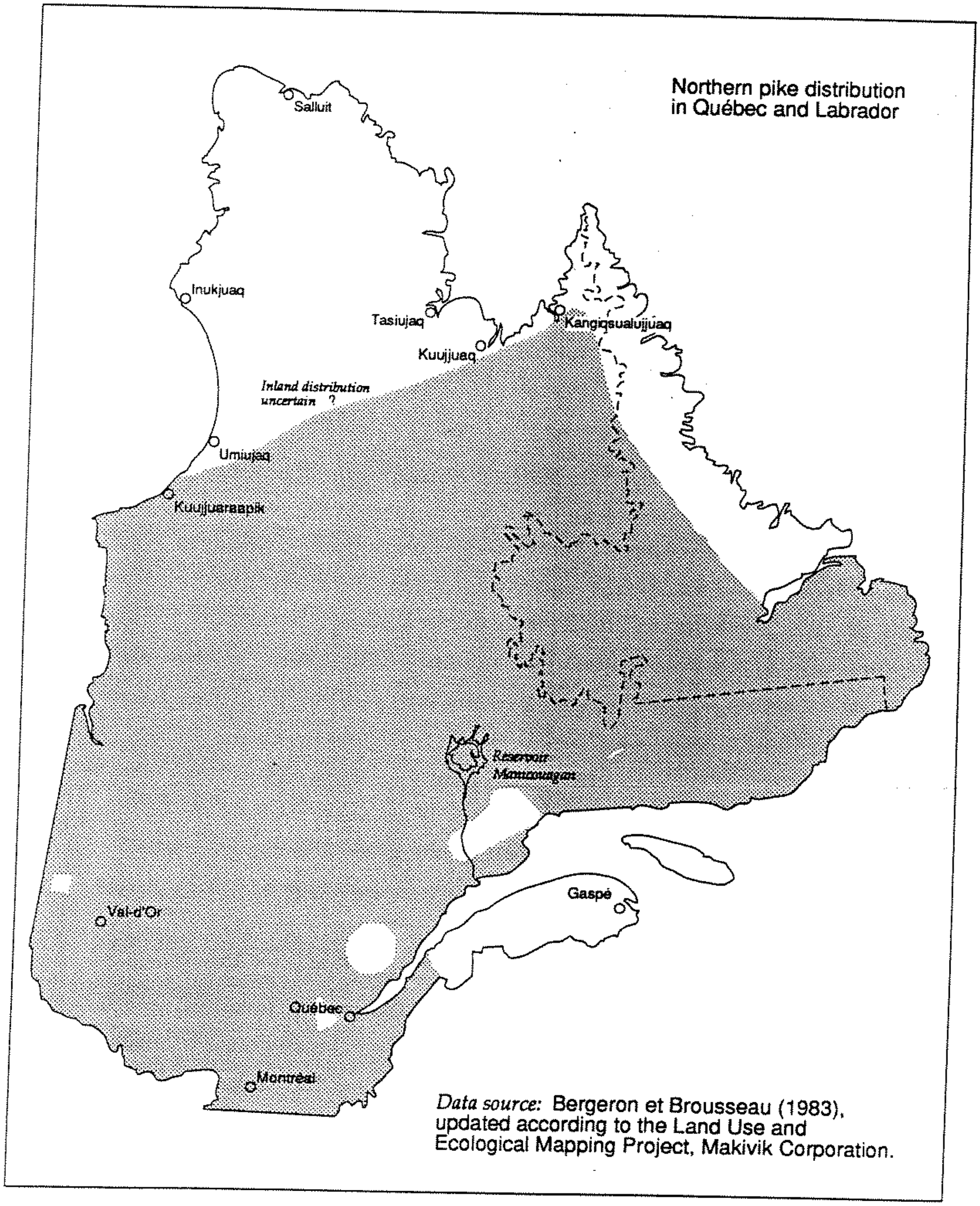


Figure 12. Northern pike distribution in Québec and Labrador.

Table 2. Average catch per unit of effort (in individuals/net-day and kg/net-day), average weights and dominant species (in numbers) collected under different studies conducted in Northern Québec: whitefish (WF) and lake trout (LT).

Region, Lake	Dominant Species	c.p.u.e. (ind/net-day)		c.p.u.e. (kg/net-day)		Average weight (kg)		Reference
		WF	LT	WF	LT	WF	LT	
La Grande:								
Detcheverry	WA	0.2	-	0.2	-	0.8	-	Boucher et Roy (1985)
Caniapiscau:								
Nouveau	WF	5.3	1.0	5.3	3.6	1.0	3.6	"
Hazen (1982)	WF	5.6	5.0	5.7	9.8	1.0	2.0	"
Hazen (1987)	WF	7.9	3.6	7.4	6.2	0.9	1.7	Therrien, et Belzile (1988)
Serigny	LT	7.6	17.7	0.5	38.1	0.1	2.2	SAGE (1981)
Châteauguay	SK	0	11.9	0	27.1	-	2.3	"
Wapanikskan	SK	0	11.1	0	38.5	-	3.5	"
Le Moyne	SK	7.1	8.2	3.4	12.7	0.5	1.5	"
Marcel	LT	6.2	10.7	5.5	22.4	0.9	2.1	"
Nachicapau	SK	5.3	8.2	3.4	14.8	0.6	1.8	"
Chakonipau	SK	6.2	9.4	7.0	16.5	1.1	1.8	"
Otelnuk	SK	10.5	19.6	12.9	33.1	1.2	1.7	"
Wakuach	SK	3.9	13.2	1.3	21.2	0.3	1.6	"
Le Fer	SK	22.0	9.0	11.1	8.8	0.5	1.0	"
Kuujjuaraapik:								
Domanchin	CS	-	-	-	-	0.4	1.0	Delisle et al. (1984)
Omble chevalier	RW	-	-	-	-	1.5	1.2	"
Benoît	BT	-	-	-	-	0.4	1.1	"

WA - walleye: *stizostedion vitreum*
LT - lake trout: *salvelinus namaycush*
SK - longnose sucker: *catostomus catostomous*
CS - cisco: *coregonus artedii*
RW - round whitefish: *prosopium* cylindraceum
BT - brook trout: *salvelinus fontinalis*

Arctic char data were not available for individual lakes, and northern pike will not be given further considerations in this report since its distribution is marginal in Nunavik and market prices are not promising.

These studies documented a wide range in c.p.u.e. for whitefish and lake trout: between 1 and 20 fish per net-day. The catches suggest respective average round weights of 0.8 kg (WF) and 1.9 kg (LT). We can expect these weights to be underestimates of what commercial catches would be because fishing effort was exerted with mesh sizes between 2.5 and 10.2 centimeters (1 and 4 inches) compared to standard 12.6 cm (5") and 13.9 cm (5.5") for commercial gear. A whitefish sample (n=22) from the David Annanack fishery in Kangiqsualujjuaq provided additional weight data. The catch averaged 1.34 kg (round weight), producing 1.18 kg (range: 0.7 - 1.7 kg) dressed, head-on fish and 350 g (average) skin-on fillet (700 g per pair). Land-locked arctic char (AC) were captured in some of the studied lakes; round weight of the catches averaged 0.6 kg (n=7).

On the bases of the above data and discussions with local Kuujjuaq fishermen, we have selected the following c.p.u.e. range and weight values for the purpose of elaborating fishing scenarios in this report.

Species	c.p.u.e.	Round weights (kg)	Cleaned weight (kg)
WF	5, 10, 15, 20	-	1.0
LT	1, 5, 10, 15, 20	3.5	3.0
AC	1, 2	1.0	-

Yield and harvest strategies

Freshwater fisheries are usually exploited on a sustained annual catch basis. Annual yields are available for different exploited lakes across Canada. Curtis et al. (1988) quote respective yields ranges of 0.22 - 1.5 kg/hectare (whitefish) and 0.34 - 0.43 kg/hectare (lake trout) for Saskatchewan lakes. For whitefish yield per surface unit increases as lake area decreases, for lake trout on the other hand, it is the opposite. Yields are calculated in different ways on the basis of annual catches, fishing effort, limnological data and lake bathymetry. Healey (1985), in comparing lakes subjected to different levels of fishing intensity, noted that whitefish yield was extremely variable (0.11-19 kg/ha.), independently of the exploitation levels. Among 17 lakes for which he documented yield, only four were under the generally accepted guideline value of 0.5 kg/ha. (approx. 1 lb/acre). Cloutier (1988) reports 0.19 kg/ha (average) for Abitibi - Témiscamingue lakes as the only yield value available for Québec.

Lakes surveyed in the Caniapiscau drainage bassin suggest a slightly higher annual potential yield for lake trout: 0.56 - 1.17 kg/ha.. (SAGE 1981). Verdon (1979) calculated a yield of 0.25 kg/hect/yr in Cladonia lake (La Grande drainage bassin). In their studies, lake trout yields were calculated as 0. 154 of the daily c.p.u.e. (1 experimental net/24 hours). M.L.C.P. considers that 0.5 kg per hectare is a conservative annually sustainable yield for lake trout (Scéance d'information, Comité de suivi du sommet québecois sur la faune, March 1 1989). The abundance and size diversity in lakes of Nunavik creates a wide range in the potential harvest level of each water system. Surface area calculations are available from Ministère de l'Environnement (1986) for many Québec lakes. Using conservative values of 0.2 kg/ha and 0.4 kg/ha for whitefish and lake trout, we obtain annual permissible harvest between 200 kg and 23 500 kg per lake (table 3). An average size lake would yield in order of 1000 kg of combined whitefish and lake trout catches. This means that for example a fishing enterprise receiving a 15 000 kg quota would require to spread its fishing effort over 15 lakes.

Table 3. Potential annual yields for whitefish and lake trout in unexploited lakes near Kuujjuaq.

		Annual yield (kg)	
Lake	Area (ha)	Whitefish	lake trout
Le Moyne	23 310	4 662	9 324
Herodier	4 196	839	1 678
Jogues	3 522	704	1 408
Laland	2 020	404	808
Le Mercier	1 054	211	422
Gerido	4 817	963	1 927
Rasle	1 137	227	455
Thévenet	3 911	782	1 564

Pulse fishing (or harvest/follow) is an alternative to annual sustained catch approach. The pulse fishery's objective is to deplete a fish population by exceeding the sustainable harvest levels. This harvest strategy can be used under different circumstances. In Scandinavian countries, intensive fishing is conducted in some lakes using gill seine nets, or traps in order to thin-out overcrowded salmonid populations (Curtis 1982), and increase fish size. The pulse fishery can also be considered when production costs can be substantially decreased by increasing quotas above the annual sustainable catch level. As we will see in the next section, fish populations, can show a wide range of different responses to exploitation. It would be unwise to select a harvest strategy for given lakes before basic population dynamic data (growth rates and mortality rates) be provided.

Response of fish stocks to exploitation and biological monitoring

The response of fish populations to fishing pressure is dependent on many factors namely their respective growth and mortality rates (before exploitation), the selectivity of the gear, the fishing levels and the physico-chemical characteristics of the water bodies. Regier and Loftus (1972) describe in detail the fishing-up sequence observed in the Canadian Great Lakes where different lake habitats have successively been depleted as gear improved and became selective for smaller fish. These gear adjustments allowed sustained catch levels until the stocks eventually collapsed. Great lakes fisheries are certainly more complex than the smaller and less accessible northern lakes. The message however remains that, throughtout gear development and the search for the maximum yield, certain indicators of the "stock health" must be closely monitored.

Expected stock response to exploitation stress comprises: increased growth rate, reduced age at sexual maturation, increased number of eggs per unit of body weight and reduced mortality among small members of the population. Healey (1975) described the potential of different whitefish populations (from central Canada) to respond positively to exploitation. He suggests that populations with slow growth rates and high mortalities would have better latitude for compensatory mechanisms and thus better affinity for intensive fishing. Populations with fast growth rates are likely to have less potential for compensation under increased mortality due to fishing. The following table summarizes how the basic population parameters he describes, can be used to evaluate the fishing potential of a given fish population.

Parameter	Possibility of increasing fishing	
	Good	Bad
Growth	slow	fast
Mortality	low	high
Age structure	old	young
maturation	old	young

Dumont et Fortin (1978) report extremely low whitefish growth rates for lakes in the James Bay area, compared to other Canadian lakes at similar latitudes. It indicates that whitefish populations from that region show affinities for intensive fishing.

Ideally the monitoring of a freshwater commercial fishery should, in addition to the catch data, keep an eye on the above biological parameters. It is however unreaslistic to plan for expensive and complete biological programs, likely to exceed the value of the fishery itself. If the commercial exploitation of northern freshwater resources is going to proceed, it would be wise to select some lakes (as representative of the exploited area) for which the length-age structures and maturity would be documented. These lakes, periodically monitored (every 3 - 5 years) would then act as barometers for the others, for which only fish lengths could be collected.

Parasites

The number of different species of parasites found in Canadian freshwater fish is astonishing: lake whitefish (61), lake trout (56), arctic char (37) and northern pike (56) (Margolis and Arthur 1979). However n terms of commercial fish value or concerns for human health, two species are woth mentions. In whitefish, western Canadian freshwater fisheries report *Triaenophorus crassus* as the parasite of importance. This cestode, although not infectious to man, renders the fish flesh unattractive and improper for human consumption, when surpassing a certain parasite density. Whitefish and especially cisco act as intermediate hosts for this parasite whose adult form is found in northern pike. This means that we are likely to find *triaenophorus* free whitefish in lakes beyond the pike distribution. Commercial grade is set at 40 - 80 parasites per 100 pounds where as exports commands for less then 40 parasites per 100 pounds. This is the only parasite cited by authors discussing commercial freshwater fisheries in Northern Québec (Cloutier 1988, Curtis and Penn 1988). Little information exists on its presence in Northern Québec. A sampling program conducted by the Institute of Parasitology (McGill University) including over 2000 autopsies from 9 fish species (incl. whitefish, lake trout and arctic char) did not report any *Triaenophorus* infection (Berubé and Curtis, 1986). This is prelimnary evidence that this parasite might not be a threat to Northern Québec fisheries although it certainly would need to be verified in the commercial lakes.

The other species worth mentioning are *Diphyllobothrium (ditremum* and *dendriticum)* usually found together in Northern Québec fish. These were present in lake whitefish, lake trout and arctic char with a wide prevalence range (Berubé and Curtis 1986). These species are infectious to man but rarely found in the fish flesh. They usually encyst on the stomach or in the liver the fish and are killed both by freezing or cooking. The hazard of *Diphyllobothrium* in a commercial fishery are therefore of little importance.

Contaminants

During the past years, there has been increasing awareness, discussion and concern about contaminants in Northern Québec's environment. This has been triggered by three main events:

i) The mercury level increase in the fish from reservoirs created by the James Bay hydro-development project.
ii) High cesium and cadmium levels recorded in caribou liver.

iii) Alarming PCB levels observed in Inuit mother's milk from the Hudson Bay coast.

Among the heavy metals known to affect fish , we will retain only mercury since it is, at present, the most threatening to fish quality. Northern Québec is known for naturally high mercury levels. A survey conducted between 1979 and 1982 revealed levels above the normal range in 51% of the people tested (compared to 19.5% across Canada) (Dept. of National Health and Welfare, 1982). The Health Protection Branch guideline for commercial fish is under 0.5 ppm. However for people consuming large quantities of fish, the Medical Service Branch considers that this guideline value should be lowered. Studies conducted in the James Bay area, on watersheds unaffected by the hydroelectric project, documented mercury levels of 0.06 - 0.15 ppm for whitefish and 0.69 ppm for lake trout (Messier et al. 1985). A diet based on a equal portions of these two species would suggest a safe consumption level of approximately one kilogram of fish per week.

As a consequence of the river diversions and reservoirs creation from the James Bay project, mercury levels in fish have increased by 1.5 to 6.1 fold depending on the species and the locations. On the Kuujjuaq River (Ungava Bay), which is contaminated by high mercury waters from the Canapiscau Reservoir only by occasional spillage, lake whitefish mercury levels were between 0.10 and 0.19 ppm (Tom Boivin pers. comm), levels slightly higher than the natural range observed in James Bay. Sampling to be conducted on the George River by Makivik Corporation should soon provide, true natural mercury levels in lake whitefish, lake trout and northern pike. For now, we can consider the mercury contamination of commercializable freshwater fish as a serious matter which should be precisely assessment in the eventual experimental areas. A certain portion of the lake trout catch will definately not be marketable because of their high mercury level. McMurtry et al. (1989) predicted that 11% of the lake trout from Ontario lakes would exceed 0.5 ppm.

The other contaminant group of particular interest are PCB's. Inuit women from Northern Québec have recently been shown to have the worldwide highest levels ever documented in mother's milk (Beaulieu 1989), more than twice the safe standards established by Health and Welfare Canada. Marine mammals are suspected to be the primary source of PCB's in Inuit diet. However freshwater fish are particularly known to accumulate PCB's. A major evaluation of their presence in Northern Québec's environment is presently discussed by the different health organizations involved. An experimental fishery should certainly include mearurements of PCB and DDT levels in the fish flesh.

POTENTIAL FISHING AREAS

The selection of fishing sites can be done in three steps, from general to specific.

1. Selection of fishing areas

   criteria A. Presence of target species

   criteria B. Proximity to distribution centres (Kuujjuaq or Kuujjuaraapik), to reduce the price of transportation from the community to the markets.

2. Selection of fishing lakes and rivers

   criteria A. High yields for target species and low catches for less preferred species.

   criteria B. Accessibility by snowmobile or possibility to land Single Otter float plane.

   criteria C. No conflict with subsistence requirements sport fishing.

   criteria D. Closeness to community to reduce transportation costs from fishing sites to the community.

3. Selection of fishing site on the lake/river

   criteria A. High catch per unit of effort.

   criteria B. Suitability for fishing gear: water depth, ice thickness, bottom substrate and currents.

This section adresses the two first levels of selections. The choice of fishing sites in reference to optimal catches is to be determined during the experimental phase of the fishery.

The first level of region selection is done on the basis of species distribution, illustrated in figures 9, 10, 11 and 12 (lake whitefish, lake trout, arctic char and northern pike). Two scenarios are possible:

Scenario 1. Southern Communities

Communities: Kangiqsualujjuaq, Kuujjuaq, Inukjuaq, Akulivik, Umiujaq, Kuujjuaraapik

Target species: *(Primary):* Lake whitefish and lake trout
(Secondary): Arctic char (land-locked) and northern pike

Scenario 2. Northern Communities

Communities: Tasiujaq, Aupaluk, Kangiqsuk, Quaqtaq, Kangiqsujuaq, Salluit, Ivujivik, Povirnituk.

Target species: *(Primary):* Lake trout
(Secondary): Arctic char (land-locked)

Problematic:

- Lake trout situation is uncertain in terms of marketability in the south (commercial status and mercury).
- Arctic char (land-locked) can be sold only to beneficiaries.
- Costs of transportation to southern markets is high for these communities

Scenario 2 is less likely to be feasable for the above mentioned reason. In these communities fishermen interested in increasing their fishing effort in inland lake, might consider more appropriate to operate under the Hunter Support Program as a traditional activity, than as commercial fishermen. We will not give further consideration to this scenario. When the lake trout status is clarified with the Québec Government then we can re-evaluate the option of operating a commercial fishery targetting lake trout.

Since northern markets are likely to be a small portion of the total catch, then the transportation costs of fish to Montréal becomes a major limiting factor which will determine commmunities candidate as operation base. Unnegociated cargo rates suggests that Kuujjuaraapik (45¢ per pound) is the cheapest as a departure point, then Kuujjuaq (57¢ per pound) followed by Umiujaq - Inukjuaq (80¢ per pound) and finally Kangiqsualujjuaq - Tasiujaq (89¢ per pound). The two latter communities are on the edge of whitefish distribution. Except for the George River itself, it would probably be cheaper to exploit other whitefish stocks in the surrounding areas of these two communities, using Kuujjuaq as a base.

For scenario 1, we now can identify potential fishing regions on the basis of the following criteria:

1. Lakes and river within the distribution of lake whitefish.
2. Areas beyond the inland fishing zones (figure 1) used by Inuit in order to avoid conflicts with present and future subsistence requirements.
3. Areas within 100 air miles (160 km) of the candidate communities.

The regions are mapped in figure 13 they show a large band of land in peuphry of Kuujjuaq, Kuujjuaraapik, Umiujaq and Inukjuaq. Potential areas around Akulivik are still to be determined. One local resident is presently developing an application for a combined Arctic char - whitefish commercial fishery. We must stress that these are general regions which would need to be revised by each community in light of these respective knowledge of the area. Additionally, the territory used by the Crees of Kuujjuaraapik must be taken into consideration in the choice of lakes around this community. Finally lakes on river sections exploited by outfitters must also be closely examined to avoid conflict with the sport fishing industry.

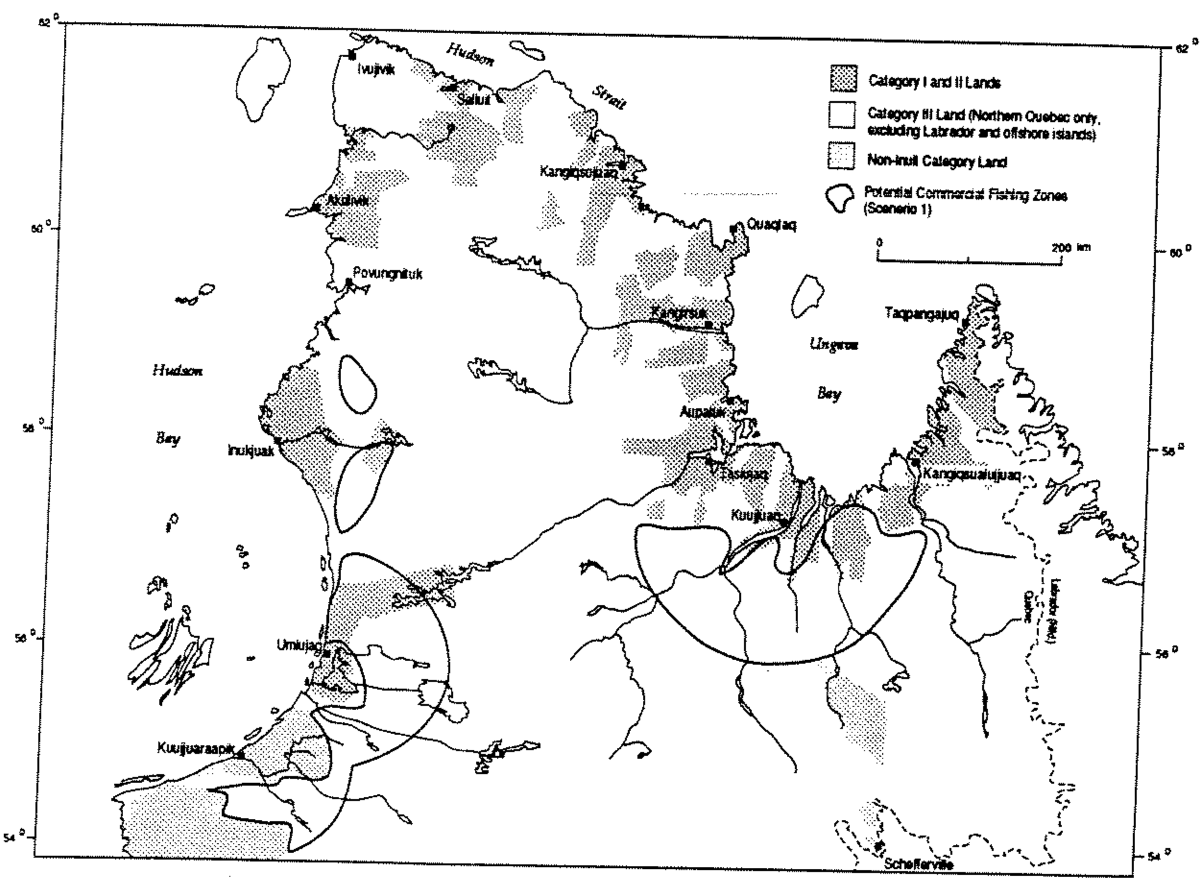


Figure 13. Potential commercial fishing zones in Nunavik's interior (scenario 1).

FISHING GEAR

Except for locations like Baie Missisquoi (Lac Champlain) and the Great Lakes where seine and trawls are respectively used, there are two main gear types widely in use to commercially capture freshwater fish: the gill net and the trap.

In selecting an appropriate gill net several parameters need to be examined in function of the catch specifications:

Gill net properties	Net specifications	Effect on the catch
Mesh size	1.5 - 6.5 inches (3.8 - 16.3 cm) by 1 inch increments	Species ratio
Twine material	Nylon twisted, knitted knottless or monofilament	Catch size
Net density	50 to 70 %	Catch numbers

Gill nets 30 meters long by 2.5 m or 3.5 m deep are appropriate for lake fisheries. Longer nets can be used in open water but would be difficult to set under the ice as in some lakes, the ice thickness will reach 2 meters by mid-winter. To set the net, one hole is drilled through the ice and a rope line passed under, using an ice jigger. A second hole is drilled at the other extremity of the line and the net set under the ice. Wood pole and extra ropes of appropriate lengths are used to set the net at the desired depth. A longer net would have more chances of freezing to the thickening ice, causing the net to be unretreivable in some cases.

The main parameter affecting the efficiency and the selectivity of a net is its mesh size. Nets of 4.5 inch mesh seem to capture the most number of fish although 6.5 inch mesh has been used to select for larger fish (whitefish and lake trout) to meet market requirements (Johnson 1975). Because the 4.5 inch mesh access the younger and smaller but more numerous age classes, it has 3 to 5 times more biomass available to itself than the 5.5 inch mesh (Healey 1975) . Also , the impact being greater on the population, there are more chances for compensatory growth to occur.

Traditionally, nets were made out of cotton. The introduction of synthetic fibers have greatly increased the durability of nets. Today, knitted knotless twine nets are available for a slighter cheaper price than the regular twisted nylon twine. Monofilaments nets, although they are very stiff and might not spread as well in very cold waters, are known for their durability.

One of the problems which commercial freshwater fisheries might be faced with in Northern Québec is a lake trout surplus because of the potential market limitations explained before. The live release of gill netted lake trout is possible during the fall for the most recently caught fish. It is, on the other hand, out of question during the winter months because fish start to freeze as soon as they are taken out of the water. Some adjustments in the gill net specifications can be made in order to reduce lake tout catches and favor whitefish. First, lake trout, unlike whitefish often get caught only by their teeth in which case the term "gill net" is unappropriate. For this season, the choice of a less fibrous material, like monofilament, is likely to reduce the incidence of lake trout in the catches. Choosing a slightly higher net density could also favor whitefish catches versus lake trout by giving a more vertical shape to the mesh. Gill nets are usually assembled at 50% density for optimal efficiency.

Gill net is the fishing gear producing the lowest quality fish product; pressures from the mesh causes marks and bruises softening the flesh. If nets are not checked regularly, fish will drown, rendering proper fish bleeding impossible. Trammel nets are an alternative to gill nets in terms of increasing the portion of fish which can be released alive. But this gear might not meet the efficiency required for a commercial fishery.

The true alternative to gill netting during the ice-free season is the fish trap (figure 14). This model, available from Les Industries Fipec Inc. (Gaspé), would cost approximately $4000 (landed in Kuujjuaq) and weigh in the order of 150 - 200 kg. The trap is designed, with 2.5 inch mesh and 4 meters deep net wings, to sit in depths inferior to 12 meters. They have been used with limited success in Kippawa Lake (Abitibi, Qc.) most likely because of the low whitefish densities. The location of the trap is certainly key to its success; it is essential to have a good knowledge of fish movements throughout the season before such an operation can be installed. A similarly designed trap was operated with tremendous efficiency to capture arctic char at sea in the Killineq area (Gillis et al. 1987). Other trap designs are used in Scandinavian countries, especially to thin out overcrowded salmonid populations. Yield ranging between 70 kg and 430 kg (or 5300 whitefish) per day have been reached (Curtis 1982).

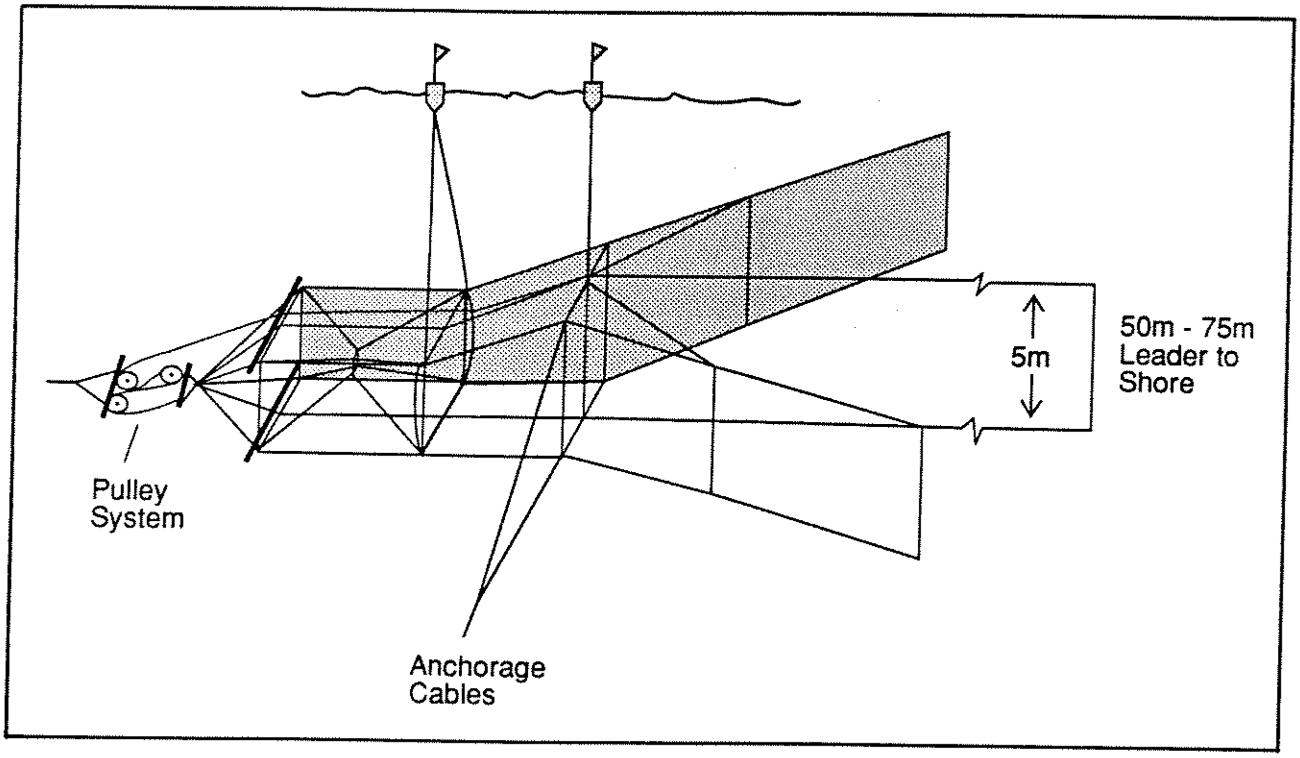


Figure 14. Fish trap designed for lakes (design: Les Industries Fipec Inc., Gaspé)

FISHING OPERATIONS

The previous market outlook and government regulations suggest that fishing operations should be designed to target the following catch structure:

Species	Product form
Lake whitefish	Fresh, dressed, head-on Frozen, dressed, head-on Fresh roe
Lake trout	Fresh, dressed head-on Frozen, whole
Arctic char (land-locked)	Fresh, Frozen whole dressed, head-on

*Northern markets

Because of the relative low value of these freshwater fish products, the commercial operations must be of optimal efficiency. This section reviews alternative fishing strategies for which the costs will be presented in the last section . The difficulties of a northern inland fishery are the means by which two main parameters can be maximized:

1) <u>Catch per unit of effort</u>: each day of fishing is costly. Proper fishing gear, season and sites must be selected for maximum catch of the target species and minimum impact on protected resources (land-locked char).

2) <u>Fish quality:</u> delays in transportation due to bad weather are unpredictable. Methods of packaging must insure quality fresh products in spite of the casualties.

We will be examining two scenarios:

I) <u>Fall fishery</u>: (just before freeze-up), short and intensive, operated by plane and aiming at marketing top value products: fresh fish and roe.

II) <u>Winter fishery</u>: (November - March) operated by snowmobile, producing frozen fish.

Fall Fishery

The objective of the fall fishery is to be able to sell fish fresh, a preferred form on the wholesale market. This fishery would target only whitefish and would yield the following products:

- whitefish fresh, dressed, head-on
- whitefish roe, fresh
- lake trout fresh, dressed, head-on

Land-locked arctic char, northern pike and suckers would be likely by catches of this fishery . Whether or not they would be marketed, need be assessed at the time of the fishery, in light of the catch numbers and current prices. Processing, packaging and shipping costs might exceed revenues for the two latter species.

The timing of this fishery must take into consideration factors which will maximize revenues, such as:

- period of good fish movement
- period when roe (ovaries) is well developed

Important Notes

1. In Nunavik, lakes are usually ice free between late June and early October. This period is reduced by about three weeks in northern most areas.

2. The fall and early winter (September to December) is known by Inuit fishermen as a period of good fish movement, most likely a result of feeding and spawning behaviour.

3. In the Kuujjuaq area, the peak of whitefish spawning is most likely in early November.

Specifications of a Fall Fishery

On the basis of information provided in the previous sections, we have selected the following specifications for an experimental fall fishery. These are subject to re-evaluation in light of information such as daily landings and species ratios during the experimental phase of the fishery. The followings constitute an optimal scenario for the purpose of evaluating operation costs.

1. Fishing period: End of August - early October
   20 fishing days plus 5 days to move camp from lake to lake.

During September the temperature averages 5.3°C in the Kuujjuaq area (Ministère de l'environnement, 1984). This month offers a good combination of cool weather for better fish conservation, high fish catches and optimal roe development.

2. Fishing:
   Gill nets (5.5" mesh)
   Trap (to be tested)

3. Fishing effort:
   1 net per 400 hectare, maximum 10 nets (adapted from Levesque 1988)

4. Number of fishermen:
   1 head fishermen
   2 fishermen

5. Number of fishing lakes: 5 to 10

6. Distance of fishing site from community: 100 km (average)

7. Quota: Total quota determined by the c.p.u.e. levels
   Individual lake quota determined by sutainable yields

8. Product form:
   Dressed, head-on, gills-in, fresh

9. Packaging done at fishing site

10. Transportation:

Single Otter on floats between community and fishing sites (capacity 900 kg = 850 kg of fish + 50 kg of packing materials).

- Aluminium and inflatable boats at the fishing lakes.
- Trucking service between the airport (lake) and cargo services.

Capital investments

Items	Costs (1988 dollars)	Annual cost	maintenance Life Span (Yrs)
Fishing gear			
Gill nets (10 @ $175)	1 750	200	3
Trap	4 000	200	10
Floating packing plant	1 500	200	5
Rope	200	20	-
Fish boxes	200	20	
Knives	100	20	
Transportation equipment			
Boat (inflatable)	6 000	100	5
Boat (aluminimum) - 12'	1 500	50	10
Outboard motor (10 hp)	2 000	200	5
Outboard motor (20 hp)	2 900	300	5
Gas containers and tanks	300	30	10
Camping gear			
Radio (antenna & case)	2 000	100	
Tents (2 @ $500)	1 000	100	5
Stoves and lamps	500	50	5
Kitchen supplies	200	20	
Tools	200	50	
Miscelaneous	200	50	

To summarize, a fall fishery would require a captital investment of $24 550 with an annual equipment maintenance cost of $1 690. New capital investments of $1 930 and $12 125 would be necessary after three and five years respectively (assuming 5% annual inflation cost). The present inflation rate is 4.1% (Statistics Canada, pers. comm.).

Fall fishery - operation costs

Salaries		
Head fishermen: 25 days @ $50 (plus 20% of net profits)	1 250	
Fishermen: 25 days @ $40 (plus 10% of net profits)	2 000	
		3 250
Consumables		
Food: 75 man-days @ $12	900	
Gas: 282 *l* @ $0.74	210	
Oil: 6 *l* @ $5	30	
Parts	25	
Miscelaneous	25	
		1 190
Transportation		
Charter (single Otter): 10 trips @ $800	8 000	
Charter extras to move camps	1 000	
Truck: 32 trips @ $10	480	
		9 480

Total $13 920 or $1.71 per kg of fish product

This operation cost is based on a 10 : 10, whitefish : lake trout c.p.u.e. (in individual number of fish). Using experimental gill nets in lakes from the Caniapiscau drainage bassin, SAGE (1981) reported a catch ratio range between 2.4 to 1 and 0.3 to 1. Because of the present concerns of M.L.C.P. about lake trout, efforts should be made to maximize the lake whitefish to lake trout catch ratios. Although it is possible to adjust this ratio in the selection of the fishing site and the net mesh size, a catch highly in favor of whitefish ratio seems to be somewhat unrealistic. Table 3 shows how production costs would vary under different c.p.u.e. for lake trout and lake whitefish for a set fishing period of 20 days. As c.p.u.e. increases fishing costs decrease from $2.44 to $1.30 per kilogram of fish product, landed in Kuujjuaq.

For the sake of further discussing the feasability of a fall fishery we will take a 1:1 catch ratio (c.p.u.e. = 10) corresponding to a $1.71/kg fishing cost. If lake trout marketing is actually restricted to the north, that a gill net fishery would most certainly generate a lake trout surplus.

Table 4. Production costs for a fall fishery operation according to different whitefish and lake trout c.p.u.e.'s.

C.P.U.E.		TOTAL LANDINGS (kg) 20 fishing days (10 nets)				Number of Charters required	Total Production Costs ($)	Production costs ($/kg)
WF	LT	WF [1]	LT [2]	WF roe	Total			
5	5	1 000	3 000	70	4 070	5	9 920	2.44
5	10	1 000	6 000	70	7 070	9	13 120	1.85
5	20	1 000	12 000	70	13 070	16	18 720	1.43
10	**10**	**2 000**	**6 000**	**140**	**8 140**	**10**	**13 920**	**1.71**
10	20	2 000	12 000	140	14 140	17	19 520	1.38
20	1	4 000	600	280	4 880	6	11 160	2.20
20	10	4 000	6 000	280	10 280	12	17 840	1.51
20	20	4 000	12 000	280	16 280	19	25 400	1.30

1. using average weight of 1 kg (dressed head-on, gills in)
2. using average weight of 3 kg. (dressed, head-on, gills in)
3. 7% of total fish production (Iredale and York, 1983)

An interesting alternative to the gill net fishery is the use of a trap net (figure14) It is difficult to evaluate the feasability of a trap fishery at this stage because its expected c.p.u.e. is unknown. The efficiency of such traps widely varies depending on the fish abundance, the site and the timing of the fishery (Fritz Axelsen, pers. comm.). Assuming that the operation of a trap would not require manpower and logistics addional to the gill net operated fishery, we can calculate fishing costs for different c.p.u.e.'s averaged over a 20 fishing day period.

c.p.u.e.	Fishing cost ($/kg)
815	$1.30
410	$1.71
240	$2.20

This suggest that the trap would need to be very efficient in order to qualify as an alternative to gill nets. This needs to be tested on an experimental basis. A realistic commercial scenario would likely involve both a trap and gill nets. The gill nets would be used to monitor the avaiblility of fish towards the spawning season until the catch levels justify the installation of the trap (Fritz Axelsen, pers. comm.).

Winter Fishery

As stated earlier, fresh products are preferred by fish buyers on the freshwater fish markets. However, the operations of a fall fishery are rather expensive and do not leave much leeway for unproductive periods. It requires a high fishing success so that charters can return to base, fully loaded with catches three days old at the most. The winter fishery is likely to be a safer scenario since northern people are already familiar with the process of ice fishing and bringing catches back to town by snowmobile. The experimental arctic char fishery operated by Annanack and Sons in the Kangiqsualujjuaq area examples the problem of transforming a subsistence fishery into a viable commercial enterprise. With hard work and a good level of organization, these problems can be solved over a few seasons of operations (Tom Boivin, pers. comm.)

Between December and March, temperature averages are below 15° C and fish freeze solid within one hour after having been taken out of the net. For that reason, whitefish which do not refreeze well, must be gutted and cleaned on site immediately. Lake trout and land-locked char on the other hand are preferred whole by Inuit when they are eaten frozen. Likewise to the fall scenario, a winter fishery would target whitefish and lake trout ,yielding the following products:

- Whitefish, frozen, dressed, head-on
- Lake trout, frozen, whole
- Land-locked char, frozen, whole

Important notes

1. In the southern part of Nunavik, lakes are usually frozen from mid-October to mid-June, and accessible by snowmobile between early November and mid-May. This period extends by two to three weeks , in the northern most regions.

2. In January and February, temperature averages are below 20°C and reduced fish movement result in lower catches. It might not be commercially viable to operate a fishery during that period.

3. In winter, a netted fish is a dead fish, the live release of by-catch species is not possible. It is important to select fishing sites where lake trout catches will not exceed the market demand.

Specification of a winter fishery

The use of snowmobiles to transport fish from fishing sites to the community is much cheaper than the use of aircrafts.It would cost $0.88 per kg to airlift to Kuujjuaq, fish caught 100 km away. To transport the same load by snowmobile would cost in the order of $0.15 per kg (salaries, rentals, gas, parts).

In the following scenario, the head fishermen which is the promotor has purchased a snowmobile under his capital investments. Other fishermen need to supply their own snowmobile for which they assume the maintenance. The rental fee is included in their salary ($50 per day plus 10% of net profits). Gas and oil is supplied by the promotor. Fishermen supply their own food except for basics (tea, sugar, salt) which are provided by the promotor.

1. Fishing period:

November:	15 days
December:	15 days
January:	15 days
February:	15 days
March:	15 days

Total 75 days (15 x 5 day trips)

2. Fishing gear:

Gill net (4.5 " or 5 .5 " mesh)

3. Fishing effort:

   8 nets per lake (assuming each 5 day period really represents 4 days of fishing then total fishing effort = 480 net-days.

4. Number of fishermen:

   1 head fishermen

   2 fishermen

5. Number of fishing sites:

   10 lakes

6. Distance of fishing sites from community:

   150 km (average by land)

7. Quotas:

Lake whitefish:	2400 kg
Lake trout:	8400 kg
Arctic char (land-locked)	480 kg

8. Product form:

   Dressed or whole, head-on, gills in, frozen

9. Fish cleaning:

   Done on the ice (inside a collapsable floorless shelter for the coldest months)
   Fish glazed with water three times and hung on suspended line

10. Packing:

    At fishing site: once frozen and glazed, fish are placed in nylon bags for transportation by wooden box sleds to the community.
    In the community, fish are sorted by size (according to the buyers specifications, and packed in waxed, corrugated cardboard boxes (23 kg capacity) for shipping to markets.

11. Transportation:

    Snowmobile and wooden box sleds

12. Housing at fishing sites:

    Canvas tents heated with wood stoves

Capital investments

Items	Costs (1989 $)	Annual maintenance costs	Life span (yrs)
Fishing gear			
Gill nets (10 @ $175 each)	1750	200	3
Collapsable shack on skies	1500	200	3
Ice drill	500	50	3
Rope	200	20	-
Ice jigger (2 @ $100)	200	-	3
Ice chisel (3 @ $50)	150		3
Knives	100	20	-
Ice skimmer (3 @ $5)	15		1
Transportation equipment			
Snowmobile (Alpine)	9000		3
Sled	300	20	3
Gas containers	100	20	
Camping gear			
Radio (antenna and case)	2000	100	10
Tents (2 @ $500)	1000	100	3
Stove and lamps	500	50	3
Kitchen supplies	200	2	-
Tools	200	50	
Miscelaneous	200	50	

A winter fishery would require a capital investment of $17 915 and an annual equipment maintenance cost of $915. New capital investments of $16 430 would be necessary after three years (assuming 5% annual inflation rate). Combined, fall and winter fisheries required capital would be $36 215 and the annual maintenance $2 505.

Winter fishery - operation costs

Salaries		
Head fishermen : 75 days @$65 (plus 20% of net profits)	4875	
Fishermen: 75 days @ $55 (plus 10% of net profits)	4125	
		8990
Consumables		
Food: 225 man-days @ $2/day	450	

Gas: 3240 *l* @ $0.74	2400	
Oil: 65 *l* @ $5	325	
Naptha: 30 gallons @ $10	300	
Miscelaneous	<u>200</u>	
		3675
Transportation (in Community)		
Snowmobile: 45 trips @ $5		<u>225</u>

Total $12890
or $1.14 per kg of fish product

Similar to the fall fishery scenario, this cost analysis is based on a 5 to 5, whitefish: lake trout c.p.u.e. (in individual number of fish). Table 4 examines how different c.p.u.e. respectively for whitefish (WF), lake trout (LT) and arctic char (AC) would affect productions costs per kilo of fish product. However, unlike the fall fishery, the transportation of fish in the winter fishery is assumed by the fishermen themselves. The reference scenario assumes that a fish load is taken back to the community after every five day period (15 loads for the entire season). Additional loads required for the alternative scenarios shown in table 4, would need to be done by supplementary personal hired for the job. One load is defined as the charge pulled by three snowmobiles (800 kg total) at a price of $285 per load (or $0.35 per kg).

Table 5. Production costs for a winter fishery operation according to different whitefish (WF), lake trout (LT) and arctic char (AC) c.p.u.e.'s.

c.p.u.e.			Total landings (kg) 60 fishing days (8 nets)				Number of trips required	Total Production costs ($)	Production Costs ($/kg)
WF	LT	AC	WF [1]	LT [2]	AC [3]	Total			
5	**5**	**1**	**2 400**	**8 400**	**480**	**11 280**	**15**	**12 890**	**1.14**
5	10	1	2 400	16 800	480	19 680	24	15 455	0.80
10	5	1	4 800	8 400	480	13 680	17	13 460	0.98
10	10	1	4 800	16 800	480	22 080	28	16 595	0.75
15	5	2	7 200	8 400	960	16 560	21	14 600	0.88
15	10	2	7 200	16 800	960	24 960	31	17 450	0.70
15	15	2	7 200	25 200	960	33 360	42	20 585	0.62
20	1	1	9 600	1 680	480	11 760	15	12 890	1.10
20	10	2	9 600	16 800	960	27 360	34	18 305	0.67
20	20	2	9 600	33 600	960	44 160	55	24 290	0.55

1. Average cleaned weight = 1 kg
2. Average weight = 3.5 kg (mixed dressed and round fish)
3. Average round weight = 1 kg

As c.p.u.e. increases, the production costs (per kilogram of fish product) decrease. Because of its larger weight, production costs are widely influenced by the lake trout yields. Although high catches are not unrealistic for this species, marketing large quantities will be a definite problem if M.L.C.P.'s anticipated restrictions are implemented. We will retain a value of $1.14 per kilogram for the cost of fish products landed in the community. This corresponds to a 5: 5:1, WF: LT: AC catch ratio as selected for the reference scenario.

FISHING TRANSFORMATION, PACKING AND SHIPPING

As stated in the introduction, this report deals with the production of non-processed fish products: whole or dressed fish, fresh or frozen and roe (fresh). Because of the relatively low value of freshwater fish (in relation to anadromous one), the transformation of primary fish products into more valuable ones would certainly render the fishery more secure. We can consider four main levels of tranformation: filleting, smoking, pickling and salting (roe). Product forms for which specific packaging would need to be used namely vacuum packing and canning.

These aspects are covered under other projects funded by E.R.D.A.: the Fish Product Quality Project (K.R.G.) and the arctic Fisheries Marketing strategy: development and testing (Makivik).

Fish packing

For the fall fishery, we are offered two options for fish packing. They can be placed in reusable 70 *l* reusable containers (approx. $20 ea.) of 100 pound capacity, at the fishing site, ready for airlift. Fish then need to be repacked in other containers, conform to airline regulations (corrugated or styrofoam), before delivery to local cargo services. This implies the use of a building in the community, where fish can be washed and repacked. More practical is the second option where fish are placed in boxes fit to aircargo standards directly at the fishing site. Properly scheduled charters would allow the catch to be taken immediately to cargo refrigerators from the charter aircraft. This way the cost of building and maintaining some sort of repacking plant can be avoided.

In the winter fishery, the fish need to be gutted immediately after being taken out of the net. At - 25°C, fish will be frozen solid within one hour. The fish are then glazed and suspended on lines. One of the main problem for fish appearance it that the tail and the fins get broken in the transportation by sled from the fishing site to the community. Although this does not affect the quality of the flesh, it makes the fish much less attractive if they are to be retailed as a dressed product. One way to solve this problem would be to use foam mats between each layer of fish and fit the packing box with a tight cover to keep the densely packed fish from moving. Obviously , the packing container would be used exclusively for fish.

To ship fish from the community to the southern markets, there are two groups of containers involved: waxed corrugated boxes for frozen or fresh fish and styrofoam boxed for fresh products. There are a number of companies manufacturing corrugated boxes, usually to customers specifications. For medium sized frozen salmonids, a 50 pound (23 kg) capacity box (approximate dimensions: 70 cm x 40 cm x 20 cm), waxed on the inside or saturated with wax on both sides, with an optional internal tray to eliminate fluid leaks. The marketing name can be printed on the box for better recognition. These boxes are available for $1.84 or $2.65 (F.O.B. Montréal, orders of 1000 from Maritime Paper Products, Nova Scotia) plus $1.00 for the polyethlyne bag in which the fish will be placed (plus transport costs to north: 2967 kg or 17.5 m^3 per 1000 boxes). This represents about 36¢ per kg (or 16¢ per pound) in packaging for freshwater fish. The most expensive but stronger model (350 pound burst strength instead of 200 pound) would be advisable since boxes presently in use have been reported to burst in some cases.The value of the fish does not command for fish to be individually bagged (for a cost of $0.50 to $1.00 per fish). These boxes can be made with ventilation holes on the side (like the ones used by Arctic Adventures) for better preservation of fresh fish. Solid fiber-board polyetheline-impregnated boxes, an alternative used by the Norwegians to airfreight their salmon, is a high quality watertight packing with superior burst strength (Brailsford 1986). Unfortunately we have no price quotes for these boxes.

For fresh fish products, the key element in packing is to provide cool storage environment inside the box. The use of ice in the packing (using a 5:1 fish to ice ratio) is certainly the best way to preserve the product freshness throughout the transportation from fishing site to markets especially in the period between the time of the catch and arrival to cargo services. An ice machine with a one ton per day production capacity (weighing 150 kg) would cost around $13 000 once equiped with a generator. This is a major investiment for a small scale fishing operation. Since a fall fishery would not substantially overlap with the salmon fishery, it certainly would be worthwhile for commercial fishermen to look into co-ownership of such equipment.

With or without ice, styrofoam boxes are providing the best packing environment to preserve freshness. They come in a variety of sizes. The 50 pound (23 kg) capacity box, holding 38 *l* would be quite appropriate for dressed fish. This container priced at $3.40 - $3.85 in Montréal (Polymos, Ile Perrôt), when used with 20% ice will maintain a 2° C internal temperature over 48 hours, at an ambiant room temperature of 20° C. Grooves in the bottom of the box will keep bottom fish from soaking in their own "juice". Bottom trays are optional at 23¢ a piece to better eliminate this problem. The recycling of the styrofoam containers is quite common in Japan, but the re-use of the container as is, would not be advisable for hygiene reason because of the porousness of the material (R. Hews, pers. comm.). Boxes manufactured by Polymos are said to be solid and do not require an outside cardboard sleeve. The brand name can be molded on the box, but colorful identification of the product would require a sticker.

The disadvantage of styrofoam boxes is the fact that they are not collapsible, rendering outrageously expensive the cost of their transportation to the north by air, because cargo charges apply to volume. It is much cheaper to ship merchandize to northern communities by sealift. Because its costs are standardized throughout Canada, post remain the cheapest way of shipping packages to the north. Packaging costs are summarized in Table 6.

Table 6. Cost of packing materials and their transportation to the north (Kuujjuaq)

Packing type	Price in Montreal	Transportation costs			Total costs (Minimum)	Cost per kg of fish
		Air cargo	Sealift	Post		
Styrofoam (23kg capacity)	$3.85	$28.00	$7.80	$2.80*	$6.65	0.29
Corrugated (23 kg capacity)	$2.65	$6.52	$5.60	-	$8.25	0.36

*includes 25¢ for labelling individual boxes.

Roe production

Whitefish roe is the most valuable product (on a per weight basis) coming from a freshwater fishery. Fishermen involved in roe utilization can expect an approximate 30% increase in their catch value (Iredale and York 1983). Prepared "Canadian Lake Whitefish Golden Caviar" is successfully marketed by the Freshwater Fish Marketing Corpration in North America. The consumer is offered two packages: a 250g vaccuum sealed three piece (for the institutional market) and a 30g screw cap sealed glass jar (for the retail consumer at $5 a piece).

The ideal time to collect whitefish roe is during the period just preceeding spawning. This optimal period varies between mid-September and late November depending on climatic regions, latitude and lake bathymetry. In Nunavik, such a by-product from a fall fishery would be available before freeze-up in September, as most areas might not be accesible by snowmoble before spawning, which usually peaks in early November. Iredale and York (1985) report roe production, to achieve, on average 7% of the total fish production. A gonado-samatic index of 14% is known as the optimal collection stage in western Canada. They have prepared a detailed description of processing methods:

1. Selection of harvest time
2. Careful removal of roe stored at fishing site in sanitary containers, covering ovaries with a plastic film to avoid air-borne contamination.
3. Caviar production (in salted form) within 24 hours of harvesting, in a processing plant:

   A. Water flushing of roe sacs.
   B. Separation of individual eggs through 7mm screens.
   C. Washing of eggs to remove most foreign elements.
   D. Secondary screening through 2.4 mm mesh.
   E. Dewatering (draining of water).
   F. Salting.
   G. Bulk packing into air-tight containers (will keep for 2 1/2 months at 4° C) before immediate distribution, shipment to repacking plants for freezing or secondary processing (can/jar).

The costs involved in the maintenance and construction of processing plants being beyond the scope of this report. We will consider fresh roe valued at $12 per kilo which would be its selling price to an eventual community processing plant.

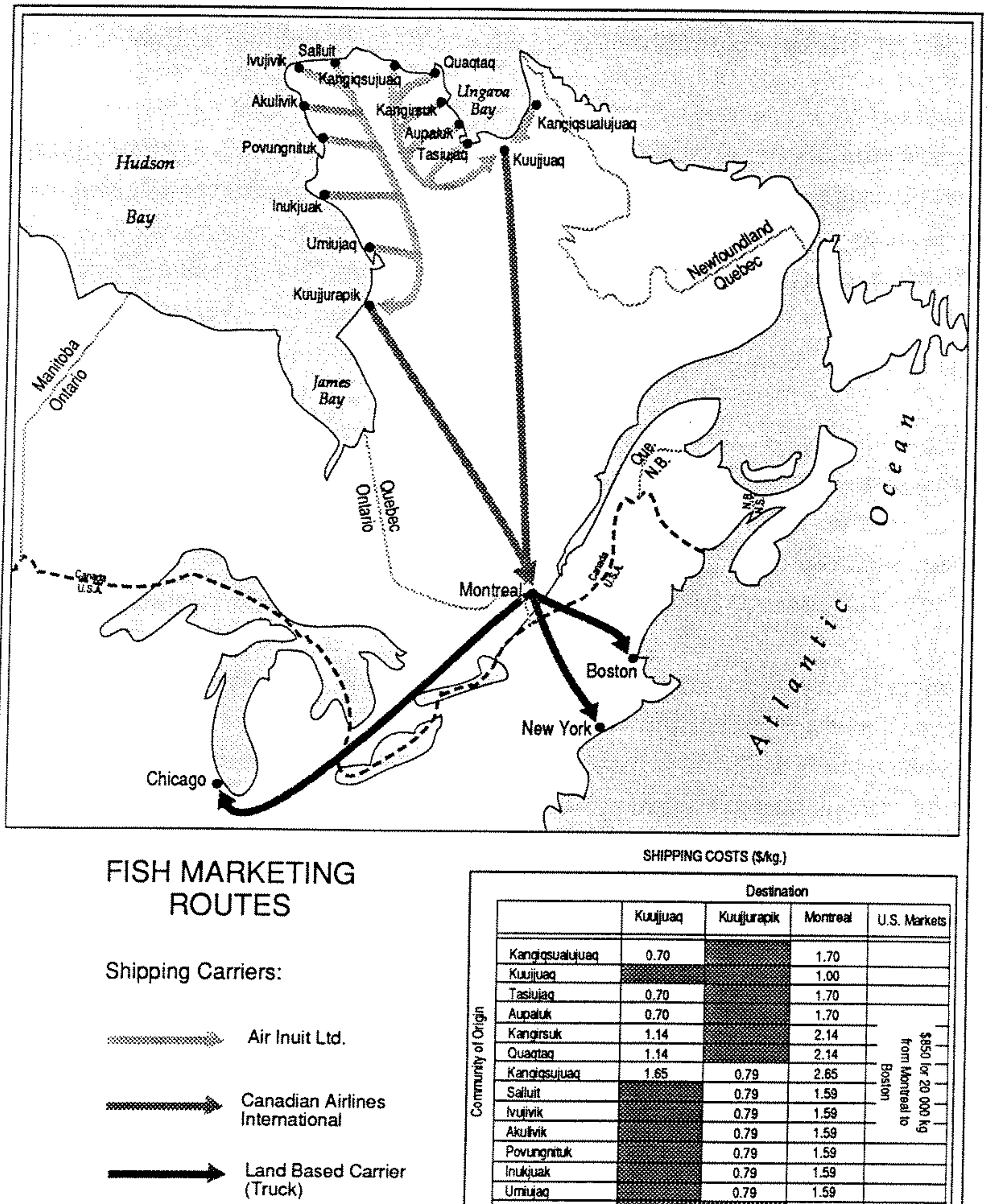
Transportation to southern market

Transportation is the main fear of northern commercial fishery promotors. Often these costs are born by the fish buyer so the fishermen do not have to worry about them. None of Northern Québec Inuit communities have southern access by road. Two communities have daily (except Sundays) jet flights to Montréal, nine have airstrip which can accomodate a Boeing 748, all have scheduled flights two to five times a week, by Air Inuit Twin Otters. Each community is additionally supplied by two to three ships during August and September. Although the sealift option might be interesting to ship materials like fishing gear and packing boxes to communities, it is not practical to meet the regular demand of fish, which somehow would need to remain frozen during the transportation period. The cost of transportation by Air Inuit 748 is also prohibitive. For example the operating cost of a Boeing 748 charter to Montréal would be $1.05 per pound. ($2.31 per kg) or at best, if the charges could shared on some occasions with a north bound flight, transport prices would still be in the order of $1.15 per kg. This leaves the regular flight by Canadian Airlines International Boeing 737, the only option for transporting fish to the south. Their standard costs are also very high (Kuujjuaq - Montréal: $2.21 per kg) since they are the only airline servicing this route. However it is possible to negociate a special rate with the airline if we guarantee them a certain volume. Regular south bound weekly loads throughout the year are interesting for them since their aircrafts are not returning south fully loaded. Following a phone conversation with a C.A.I cargo representative there are indications that, for example a 300 kg weekly shipment would benefit from the special northbound food rate (Kuujjuaq - Montréal: $1.26 per kg). Serious negociations with a firm guarantee would provide an additional rebate in order of 20% (Kuujjuaq - Montréal: $1.00 per kg). We will use this expected negociated rate in the cost analyses of the freshwater fishery.

We can look at three levels of transportations corresponding to three market levels for which costs are summarized and illustrated in figure 15:

1. Northern (Kuujjuaq, Kuujjuaraapik): Air Inuit (Twin Otter)
2. Montréal, Québec: Canadian Airlines (Boeing 737)
3. New-York, Boston (refrigerated trucking services)

It appears difficult to sell fish directly to U.S. markets because of the ground transportation system. One truck load (20000 kg) from Montréal to Boston costs $850. The price is set for the trip regardless of the quantity. The volume of fish involved in a freshwater fishery would simply not meet the quantities required for a full truck load. For this reason, it is more practical to access the U.S. markets through Canadian brokers.



SHIPPING COSTS ($/kg.)

Community of Origin	Destination: Kuujjuaq	Kuujjurapik	Montreal	U.S. Markets
Kangiqsualujjuaq	0.70		1.70	
Kuujjuaq			1.00	
Tasiujaq	0.70		1.70	
Aupaluk	0.70		1.70	
Kangirsuk	1.14		2.14	$850 for 20 000 kg from Montreal to Boston
Quaqtaq	1.14		2.14	
Kangiqsujuaq	1.65	0.79	2.65	
Salluit		0.79	1.59	
Ivujivik		0.79	1.59	
Akulivik		0.79	1.59	
Povungnituk		0.79	1.59	
Inukjuak		0.79	1.59	
Umiujaq		0.79	1.59	
Kuujjurapik			0.80	

Figure 15. Fish marketing routes and associated transportation costs.

Fish inspection and exports

At present, there are no inspection standards for freshwater fish sold in Québec (Marcel Matthieu, M.A.P.A.Q., pers. comm.). Inspection of the fishery facilities would be done only if a complaint would be formulated on the quality of the product. However, because of the growing interest for aquaculture in Québec, we expect that regulations will be created in future years (Camille Choquette, pers. comm.). At present, the sole standards of hygiene for freshwater fish are those of the fishermen and in the end, those of the ultimate judge: the consumer. If the fish buyer gets a poor quality shipment, most likely the fisherman will be turned down on his next harvest.

It is in the fishermen best interest to set high standards for his products, building a good reputation for himself and seeking better prices for his fish. When it comes to export, each country has its own standards, the better the fish is, the more doors it will see opened. All fish products leaving Québec must be inspected by fisheries an Oceans.

There are no duties on freshwater fish or their roe (expect for sturgeon) exported to the U.S There is however a 15% duty for caviar entering the U.S., which should be eliminated before January 1, 1993 according to the Canada - U.S. Free Trade Agreement (External Affairs Canada, 1988). In terms of U.S. standards, commercial trout must be over 21 inches (53 cm). There are no restrictions for whitefish and arctic char (Paul Vesel, Québec delegation in New-York, pers. comm.).

COST ANALYSES AND DISCUSSION

As shown in the previous section, the production costs decrease as the efficiency of the fishing gear improves. The reason for this is that the fishing period is set at 20 days for the fall and 60 days for the winter. As c.p.u.e. and consequently the quota increase, only total transportation costs go up while all other costs are constant. In result, the cost of the fish products landed in the community is reduced.

Important notes

1. Frozen products are more difficult to sell than fresh ones. The prices will definitely be lower but difficult to predict. The figures quoted below are conservative.

2. Mercury levels in lake trout will definitely be above the commercial standard for an unknown portion of the catch. Arbitrarily we assume that 70% of the lake trout will be marketable. The fate of the rejected fish is to be determined.

3. The transport and packing costs for whitefish roe (fall scenario) are included under whitefish (assuming roe will accounts for 7% of the catch). We will use the 30% plus value guideline (or $12 per kg) suggested by Iredale.

4. Fish prices (per kg) used (whitefish includes roe) respectively in light of fall 1988 fresh fish and mid-winter 1989 frozen fish prices:

	Whitefish	Lake trout	Arctic char
Fresh	4.30	7.15	-
Frozen	4.40	3.85	4.40

The table below summarizes costs and revenues involved in the fall and winter scenarios previously identified. Shipping costs are projected negociated cargo rates from Kuujjuaq to Montréal. Operations based in Kuujjuaraapik would see these costs reduced by about 20¢ per kg.

Costs and revenues summary (per kg of fish product

	Fall Fishery		Winter Fishery		
	WF	LT	WF	LT	AC
c.p.u.e.	**10**	**10**	**5**	**5**	**1**
Costs (per kg)					
Fishing	1.71	1.71	1.14	1.14	1.14
Packing	0.35	0.29	0.36	0.36	0.36
Shipping: fish	1.07	.00	1.00	1.00	**
Shipping: box	*0.04	0.04	0.12	0.12	0.12
Total cost	$3.42	$3.00	$2.62	$2.62	$2.62
Fish price (per kg)	4.30	7.15	4.40	3.85	4.40
Net Revenue (per kg)	**0.88**	**4.15**	**1.78**	**1.23**	**2.78**
Quota 2140	6000	2400	8400	480	
Marketable volumes	2140	4200	2400	6720	480
Total revenues	$1 885	$17 430	$4 720	$8265	$1 335

*assuming no ice is used.
** northern market; no transportation costs

The above costs summary suggests that the fall scenario would be a much more profitable than the winter one. Although operations costs are reduced by using snowmobiles, the value of frozen fish simply does not compete with fresh ones.

For this reason, we can rule out the winter scenario unless it is associated with a fall fishery. We are left with two alternatives:

1. fall fishery requiring a capital investment of $24 550
2. fall and winter fishery requiring a capital investment of $36 215.

We will assume that the eventual promotor would have at hand 10% of the required investment and as a subsistance fishermen already own equipment equivalent to 30% of the total capital value. The promotor would then need a loan for 60% of the required investment. We will assume a three year loan at 13 3/4% (interest rate used by the Investment Fund of the Kativik Regional Development Council). According the above calculated revenues, we can calculate the net profits of the entreprise and bonuses which each fishermen would receive.

	Fall fishery (25 working days)	Fall - Winter fishery (100 working days)
Loan (3 years)	15 000	22 000
Annual revenues	19 315	33 185
Loan payments	5 880	8 580
Equipment maintenance	1 590	2 505
NET REVENUES	11 845	22 102
Bonus to fishermen (2 @ 10%)	2 370	4 420
Bonus to head fisherman (20%)	2 370	4 420
NET PROFITS	$8 290	$13 262

In summary, using the above example, a promotor running a freshwater commercial fishey could expects profits in the order of $8 000 for the month of September and an additional $5 000 spread over November to march if he chose to extend his fishery into the winter. If this promotor would choose to be directly involved in the fishing activity as the head fishermen, then his profits would be supplemented by the corresponding daily income:

	Fall (daily income)		Winter (daily income)	
	Salary	Bonus	Salary	Bonus
Fisherman	$40	$24	$55	$14
Head fisherman	$50	$96	$65	$28

The bonus to the head fisherman seems high and disproportionate compared to other fishermen. However this person would be responsible for coordinating field operations and would be likely to put in extra days of work.

Moreover the profit margin also seems to be high. However we must not forget that fish prices fluctuate throughout the season. Lake trout will be in tight competition with other salmonids on the market, especially since farmed trout is available fresh most of the year. For these reasons, the profit margins must be secure enough to absord a drop in the fish price.

The number of lakes available for commercial development (within previously identified zones will likely not be a factor limiting the quota levels discussed in this report. A fishery harvesting in the order of 16000 kg of fish would spread its effort over approximately 15 lakes, in the fall and the winter. Quotas on individual lakes will be assigned according to sustainable yields previously discussed, where as the total quota is detrmined by the of lakes involved in the fishery. Since the fishing period is set and limited by climatic conditions then the total revenues from the fishery are determined by two factors:

1. catch per unit of effort
2. current fish prices

Because there are so many combination possibilities between species specific c.p.u.e.'s and prices, it would be a long task to evaluate the different break-up points below which the fishery becomes in deficit. However, we can identify guideline values, keeping in mind that one can be exceeded as long as it is compensated by an other. Using a profit margin (before bonuses paid) of $1.00 per kilo, which would result in an overall net profit of $9500 to the promotor, we can set the following guide values below which the fishery would not operate .

	c.p.u.e. (fish/net -day)		Price ($/kg)	
	WF	LT	WF	LT
Fall	10	3	4.30	4.75
Winter	5	5	3.65	3.50

CONCLUSION

The prospects of developing a profitable commercial fishery based on whitefish and lake trout in Nunavik lakes are promising. In light of the most current prices, there are indications that a small scale enterprise could operate successfully in the Kuujjuaq region. However nearly 80% of the revenues would come from lake trout and it is unfeasible for a commercial fishery operate without marketing this species to the south.

Under reserve of identifying areas where such activities would not conflict with cree subsistence requirements, Kuujjuaraapik would be the cheapest , as operating base. On the Hudson Bay coast, Umiujaq, Inukjuaq and Akulivik also show potential for a commercial harvest, but transportation cost to southern markets are higher than for the two southernmost communities. Although all other Nunavik communities are also likely to be able to develop commercial activities based on lake trout only. These avenues were not explored as the experimental phases would be logically first initiated in the less costly southern regions.

Many key pieces of information are still required before producing a definite opinion on inland commercial fishery. Most of these points can be adressed through an experimental fishery, namely:

1. Catch per unit of effort for target species in lakes from identified potential areas.

2. Marketability of lake trout and non-processed whitefish roe.

3. Proportion of fish (especially lake trout) which will meet the commercial standards for mercury levels.

4. Proportions and market potential of by-catch species such as land-locked arctic char, northern pike and suckers.

As an additional long-term of objective, sustainable harvest levels per species and the possibilities for pulse fisheries will need to be assessed.

It is recommended that an experimental fall and winter fishery be conducted over a period of two years to adress the above short term questions. A proposal to initiate such an operation in unused lakes of the Kuujjuaq region is presented in appendix 1.

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APPENDIX 1:

PROPOSAL

Inland Fisheries Development in Nunavik: an experimental fishery

PROJECT PROPOSAL

Inland Fisheries Development in Nunavik: an experimental fishery

Submitted to:

Economic Regional Development Agreement Committee

Submitted by:

Kuujjuaq Research Centre
Makivik Corporation

Kuujjuaq
January, 1989

Background Information

Inland fish resources are generally used by Nunavik (Northern Québec) Inuit within a 150 kilometers band from the coast (Land-use and Ecological Mapping Project, Makivik Corporation, unpublished data). This leaves a large portion of the Labrador peninsula interior which is non-populated and practically non-utilized.

Anadromous and marine fish species in Nunavik have been commercially exploited under different scenarios and enterprises. Among these ventures some were failures, others successes, depending on the value of the resource, the quality of the delivered product and the manner in which these fisheries were managed. On the other hand, commercial fishing for strictly freshwater species have a virgin history above the 55th parallel (at least in Inuit territory). Several local promotors have shown interest in establishing such fisheries, but none have gone further than the proposal stage.

In order to evaluate the economic possibilities of freshwater fish resources, a preliminary assessment is nearly competed under E.R.D.A. There are indications from this report that a small scale whitefish fishery could be operated with some profits (Dumas, in prep.) The success of such an operation would however be conditional on many points:

- Availability of subsidies for capital investments and the packing operations.
- Negotiation of a lower cargo rate for fish transportation from to southern markets
- Sustained catch per unit of effort throughout the fishing season (October to April).
- Development of alternative fishing gear for the fall period.
- Marketing possibilities and legal adjustments for by-catch products; namely lake trout, suckers, pike and land-locked char.
- Northern markets for a portion of the catch.
- Annual sustainable yields comparable to those experienced in other areas of Canada.

In Nunavik , we have generally accepted the principle that subsistence requirements have priority over commercial activities. To avoid any conflict , the development of an eventual commercial inland fishery should be operated beyond the land-use boundary.

This means that potential lakes for such a fishery are most likely unknown biologically and therefore, the above assumption need to be examined.

To complete the feasability of inland fisheries development, we need to get out in the field to collect complementary information and validate our assumptions.

This document proposes appropriate methodology to complete the feasability study through an experimental fishery. This phase would be for a period of one year divided in two segments:

1) Fall fishery (1989)

2) Winter fishery (1989 -1990)

This experimental phase will provide a definite evaluation of the commercial fishing possibilities in Nunavik's interior.

Study objectives

The experimental fishery will adress objectives centered on the commercial potential of the lake whitefish *Coregonus clupeaformis*. Some objectives also include Lake trout *Salvelinus namaycush* and Arctic char (land-locked form) *Salvelinus alpinus.*

1. Evaluate optimal scenarios and costs of fall and winter inland fisheries.
2. Identify potential fishing sites for a gill net operated commercial fishery.
3. Select the optimal mesh size net for such fisheries.
4. Document the proportion of target and by-catch species in commercial catches from potential fishing sites.
5. Collect Lake whitefish length and weight frequencies from said sites and provide basic population dynamics parameters (growth rate, age structure, mortality rates) from one of the targeted populations.
6. Explore southern and northern fish markets for freshwater fish products.

Methodology: field work

Fishing sites

Because transportation by air is expensive, but the only way to get fish to southern markets, the experimental fishery should be close to a main centre: Kuujjuaq or Kuujjuaraapik. Since our research facilities are based in Kuujjuaq and since promotors from this community have already shown an interest in inland fisheries, we have selected Kuujjuaq as the base for the proposed experimental fishery.

In determining experimental lake areas, we need to consider selection criterias such as:

- lakes unfished at present or in near future
- lakes large enough to land a float plane
- lakes within the or close to the tree line to facilitate heating in the winter
- area offering a diversity of lake sizes within a close range of each other.
- area within 150 km of Kuujjuaq, easily accessible by snowmobile

On basis of the above, we have selected the Le Moyne/Herodier Lakes zone as an example of an experimental area (figure 1.) These lakes were taken as examples because area measurements were available, rendering fish production estimates possible (table1).

Table 1. Example of lakes within an experimental area with reference to their area and estimated annual fish production.

Lake	Area (hect)	Fish production (kg/yr)*
Le Moyne	23,310	9,324
Herodier	4,916	1,678
Jogues	3,522	1,408
Lalande	2,020	808
Le Mercier	1,054	422

*using 0.4 kg/hectare following recommendation of 0.3 - 0.5 kg/hectare (Fritz Axelson, pers. comm.)

The selection of experimental areas and the choice of lake within them will be finalized after consultation with governmental and regional organizations, local fishermen, the municipal council, the Landholding Corporations (if necessary), and final discussions within Makivik Corporation.

Fall fishery

The fall fishery will be operated on one lake in September, just before freeze-up. This is the optimal period for the collection of whitefish roe, a valuable product of this fishery. During that period, all transportation between the fishery sites and Kuujjuaq will be done by float plane (Single otter). Opportunity will be taken to collect biological data on population of Lake whitefish, Lake trout and Arctic char, during this period of good fish movement. The following protocol is inspired from Lévesque (1988) and Boivin et al (1988):

Fishing period: - five days between September 15 and 30

Fishing gear:
- 2 experimental gill nets (stretched mesh sizes: 2.5 cm, 3.8 cm. 5.1 cm. 6.4 cm, 7.6 cm, 11.4 cm, 15.2 cm.)
- 4 commercial nylon nets (4" and 5", stretched mesh sizes)

Morphological data to collect:
- fork length
- round weight
- cleaned weight
- sex

Anatomical structures to collect for age determination (100% of the catch):

	Scales	Otoliths
Lake whitefish	X	X
Lake trout		X
Arctic char		X

Only lake whitefish otoliths will be read under this project.

Fish quality: 30 fish of each lake whitefish will be filleted. Fillets will be weighed fresh and sent for:
- mercury analyses (n=20 per sp)
- test for smoking (n=10 per sp)

(Not included in budget, assuming that seperate arrangements can be taken with M.A.P.A.Q. and Hydro-Québec).

Lymnological data (at each fishing sites):

- depth
- temperature (stratified sample)
- dissolved oxygen (stratified sample)

Winter fishery

The winter fishery will be operated on 4 or 5 lakes by snowmobile, using only commercial type gill nets. This fishery is meant to simulate a commercial scenario. In order to measure C.P.U.E. throughout the winter the fishery effort, 4 to 10 days sampling periods will be spread between late November and early April. Sample sizes will follow quotas established on the basis of estimated annual production.

All the fish catches will be returned to the community after each five day period. Fish from respective l akes will be kept separate. All biological sampling will be done at the Research centre on the frozen specimen. The fish heads will be cut off from fish for which age will be determined. The fishing protocol will conform to the following:

Fishing days:	November	5 days
	December	10
	Jan/Feb	5
	March	5
	April	5

Total fishing effort = 30 days

Fishing gear:
- 6 commercial gill nets (4"and 5", stretched mesh sizes)
- 2 experimental gill nets

Morphological data:
- fork length
- round weight

Anatomical structures for age determination:

- Lake whitefish: Otoliths collected for the first 150 fish of each lake.

- Lake trout and Arctic char: otoliths collected on every fish (maximum: 150 samples per species per lake).

These otoliths will be stored, but not aged under this project.

Lymnological data at each fishing site:

- depth
- ice thickness (white ice : black ice)
- temperature

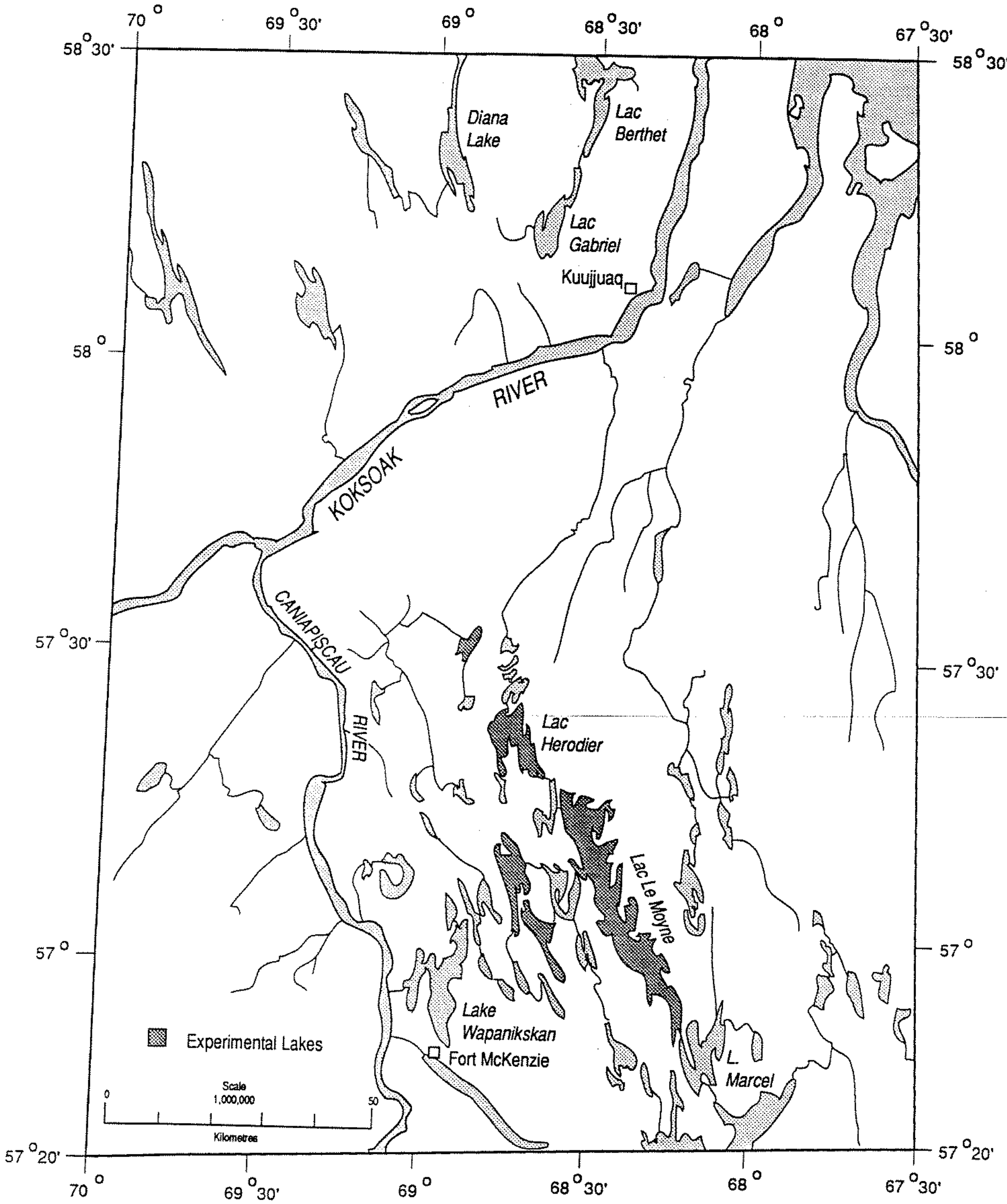

Figure 1 - Location of Potential Experimental Fishing Areas in the Kuujjuaq Region

Marketing of Fish Products

Lake whitefish and lake trout will be shipped to Montréal/Ottawa and/or Boston/New-York markets. Land-locked Arctic char (as well as some whitefish and some lake trout) will be sold strictly in the north according to restrictions set by M.L.C.P. and the James Bay and Northern Québec Agreement.

Report preparation and recommendations

The report will be divided into two sections:

1. *Fishing Operations* which will describe fishing techniques and difficulties. It will include recommendations for proposed fishery scenario (sites, periods, gear, costs, product form).

2. *Biology of the catches* which will document fish size distribution in each lake and fish product weights. This section will focus on sustainable harvest levels and the impacts of a whitefish fishery on by-catch species namely lake trout and Arctic char.

Finally, The report will outline overall recommendations on the commercial potential of inland fish resources.

Project personel

This project will be conducted by staff from the Research Centre of the Makivik Corporation in Kuujjuaq:

Project director: Réjean Dumas (biologist)

Responsible technicians: Alix Gordon
Peter May

Experimental Inland Fisheries
(revised)

BUDGET

Capital investment		
Commercial gill nets: 10 @ $200	2,000	
Experimental gill nets: 2 @ $400	800	
Portable fish cleaning hut	2,000	
Fish containers	1,000	
		5,800
Preparation		
Salaries		
Biologist: 10 days @ $142	1,420	
Technician: 10 days @ $115	1,150	
Consultants: 20 hours @ $25	500	
Subtotal		**3,070**
Fall experimental fishery		
Salaries		
Biologist: 5 days @ $142	710	
Fishermen: 3 x 5 days @ $100	1,500	
Cook: 5 days @ $80	400	
	2,610	
Travel		
Charter (Single Otter) 2 trips @ $1,200	2,400	
Cargo (Montreal - Kuujjuaq) 300 kg @ $2.20	660	
	3,060	
Equipment rental		
Tent units: 2 @ $60.00	120	
Working tent: 1 @ $30	30	
Radio 5 days: @ $8	40	
Inflatable boat: 5 days @$30	150	
Outboard motor: 5 days @ $30	150	
Chain saw	50	
Miscelaneous camp equipment and tools	150	
Limnological instruments	100	
	790	

Consumables

Food: 25 man-days @ $20	500	
Gas: 30 gallons @ 3.33	100	
Oil:	20	
Naptha: 4 gallons @ $8.50	34	
Outboard motor parts	100	
Miscelaneous	50	
	804	
Sub-total		**7,264**

Winter experimental fishery

Salaries

Biologist: 15 days @ $142	2,130	
Technician: 15 days @ $115	1,725	
Fishermen: 3 x 35 days @ $100	10,500	
Cook: 30 days @ $80	2,400	
	16,755	

Equipment rental

Tent units: 2 x 5 @ $60/week	600	
Working tent: 5 weeks @ $30	150	
Radio: 30 days @ $8	240	
Snowmobile and sleds: 120 days @ $55	6,600	
Chain saw	100	
Miscelaneous camp, equipment and tools	400	
Lymnological instruments	400	
	8,490	

Consumables

Food: 175 man days @ $15	2,625	
Gas: 600 gallons @ $3.33	2,000	
Oil: 3 cases (24)	180	
Naptha: 20 gallons @ $8.50	170	
Snowmobile parts	500	
	5,475	
Sub-total		**30,720**

Fish aging data analyses

Biologist :10 days @ $142	1,420	
Technician: 10 man days @ $115	1,150	
Computer: 50 hours @ $10	500	
Microscope: 10 days @ $10	100	
Sub-total		**3,170**

Report production

Biologist:10 days @ $142	1,420	
Technician: 5 days @ $115	575	
Word processing: 20 hours @ $25	500	
Drafting: 10 hours @ $25	250	
Sub-total		**2,745**
SUB-TOTAL	52,769	
Administration (10%)	5,277	
TOTAL		**58,046**

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