Arctic Development

A Study To Determine The Feasibility Of Commercially Fishing The Roos Bay Area Of Lyon Inlet

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1.0 I:?TRO!IUCTION

The purpose of this study is to determine the feasibility of commercially fishing anadromous arctic char (Salvelinus alpinus), in the Ross Bay area of Lyon Inlet. The project was initiated in response to the Repulse Bay Hunters and Trappers Association request to fish the area for the commercial market. At this time no commercial quotas have been set for the river systems flowing into Ross Bay.

While the study was in progress, tourism operators from Repulse Bay were fully supported by the membership of the Keewatin Chamber of Commerce, in their expressed desire to investigate the tourism potential of Ross Bay and Lyon Inlet. Initial discussions held with the tourism operators, indicated that they were interested in determining the viability of conducting sport fishing, sport hunting and natural history tours in the area. The operators recognized that a commercial fishery was being considered, however, they felt that the ventures could operate concurrently if properly implemented.

As no commercial arctic char quota has been established for the proposed fishery, a test fishery will have to be carried out to determine a proper level of commercial harvest. The lead time that will be required to carry out the test fishery prior to the implementation of a commercial fishery, should be utilized to conduct a detailed evaluation of the opportunities and constraints associated with the two ventures.

The original Terms of Reference guiding the feasibility study have been revised to allow the preliminary consideration of the potential implications associated with the concurrent operation of the ventures. The following introductory sub-section outlines the fishery project appraisal process which has been used to determine the feasibility of commercially fishing the Ross Bay area.

1.1 Fishery Project Appraisal Process

The particular aspects of any fishery project which require special consideration arise mainly from the fact that the activity is based on a biological resource whose abundance and productivity is affected by fishing effort. Further, the resource is the common property of a number of users, and as such, special management considerations arise.

Once harvested the product spoils very quickly, necessitating rapid and effective marketing or sophisticated and often expensive methods of preservation. Some problems are created by the fact that many fisheries are seasonal in nature, resulting in the underutilization of the expensive infrastructure required to maintain product quality.

The environmental operating conditions dictated by the location of the fishery may play a major role in determing the timing and manner in which the fishery is conducted. Often these environmental factors are closely related to the behaviour of the fish resource. Consideration must be given to the seasonal nature of these factors.

Market conditions may also play a role in determining how the fishery is carried out. Not only will prices paid for the product affect the potential revenues to the fishery, but as well, the market may determine the form in which the product is delivered.

The basics of -
- the biological resource
- its perishability
- the environment and location, and
- the delivery product form

have been considered throughout our pre-feasibility analysis of the Ross Bay fishery. The following section details the special aspects of the Ross Bay fishery.

2.0 SPECIAL CHARACTERISTICS OF THE ROSS BAY FISHERY

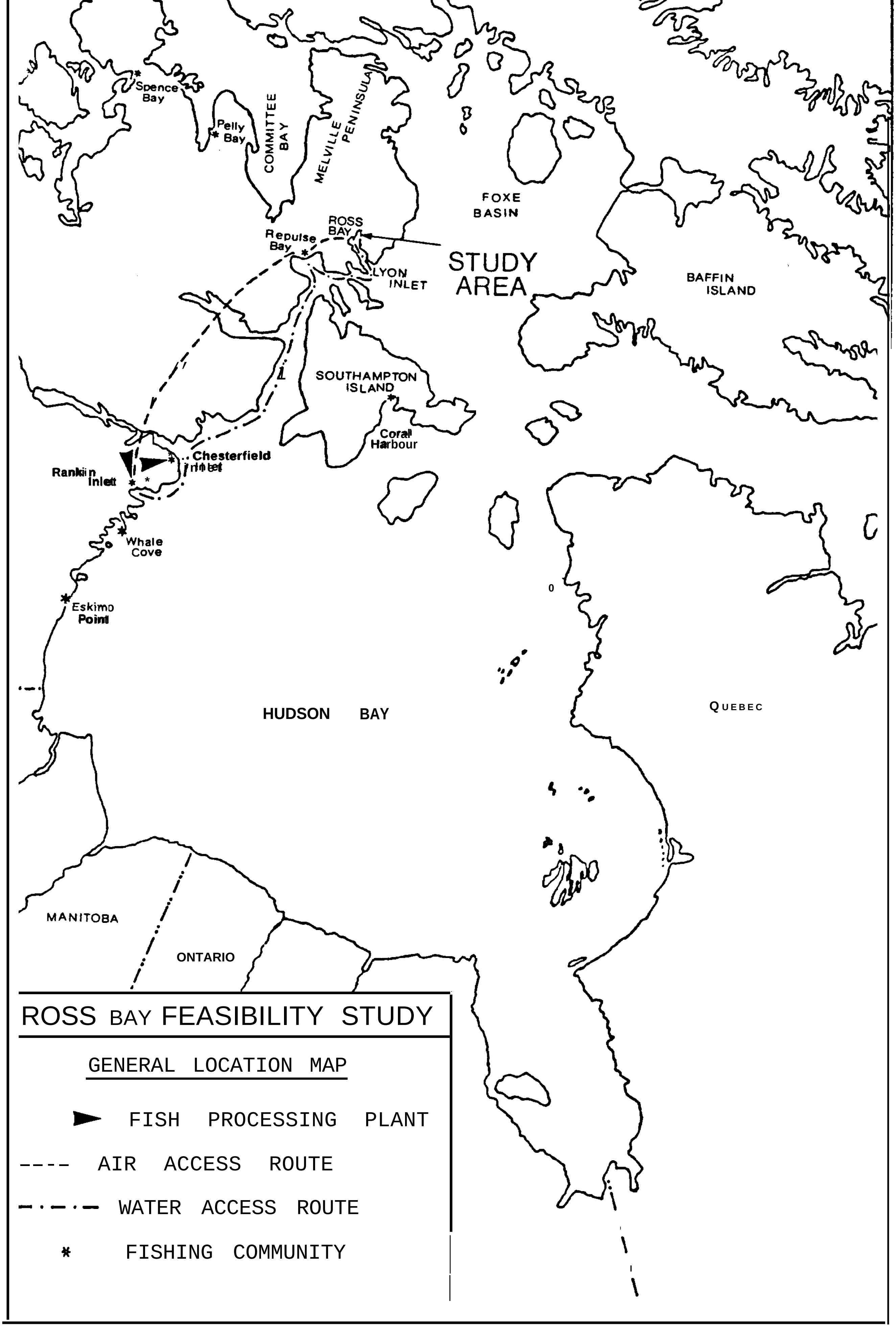
Many of the characteristics of the Ross Bay fishery are shared with the regional commercial fishery. These have been addressed by the Regional Fisheries Strategy. It is our intention in this section of the report to discuss issues with an immediate or direct bearing on the overall feasibility of the Ross Bay fishery. These issues are priorized and discussed in the following sub-sections.

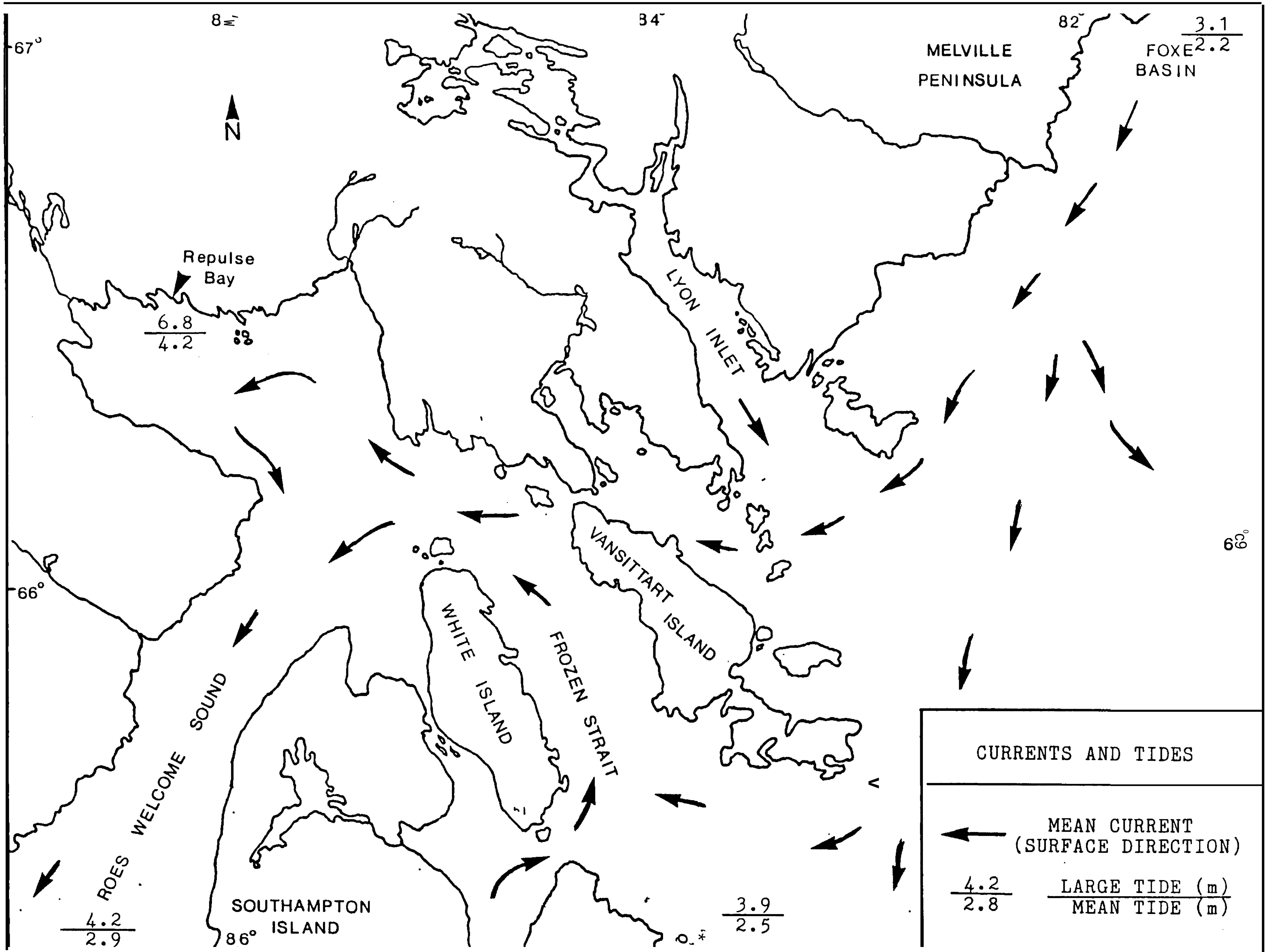
2.1 Vessel Access

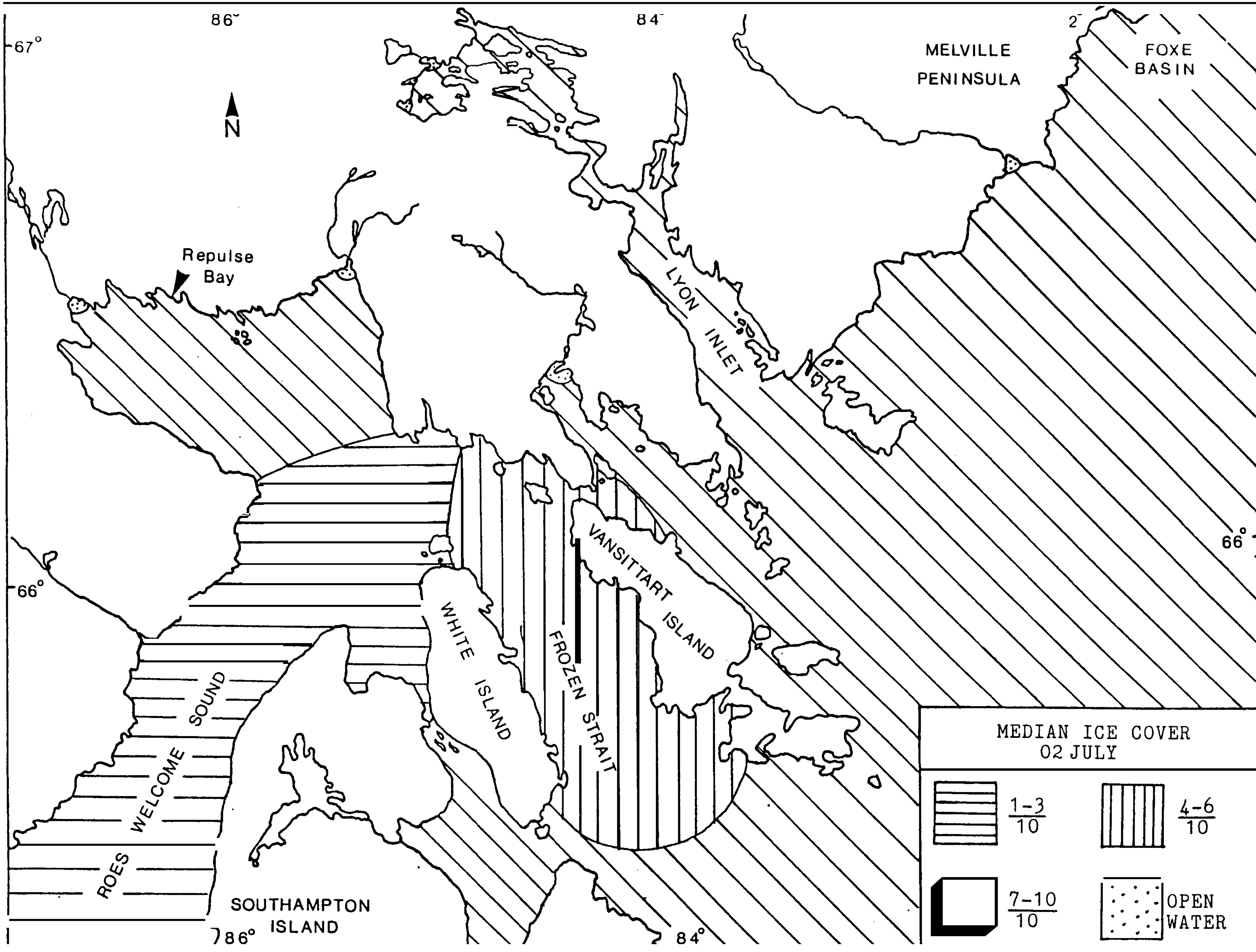
Ross Bay is situated at the upper end of Lyon Inlet approximately 65 kilometres north-east of Repulse Bay. Figure 1 provides a map of the regional setting. Summer vessel access to Ross Bay from Repulse Bay is across Repulse Bay to Cape Clarke, between Vansittart Island and the mainland to Cape Martineau and around the Sturges Bourne Islands, then up Lyon Inlet to Ross Bay, a distance of almost 200 kilometres. Travel time to the fishery by canoe is estimated at 14 hours. *under ideal conditions*

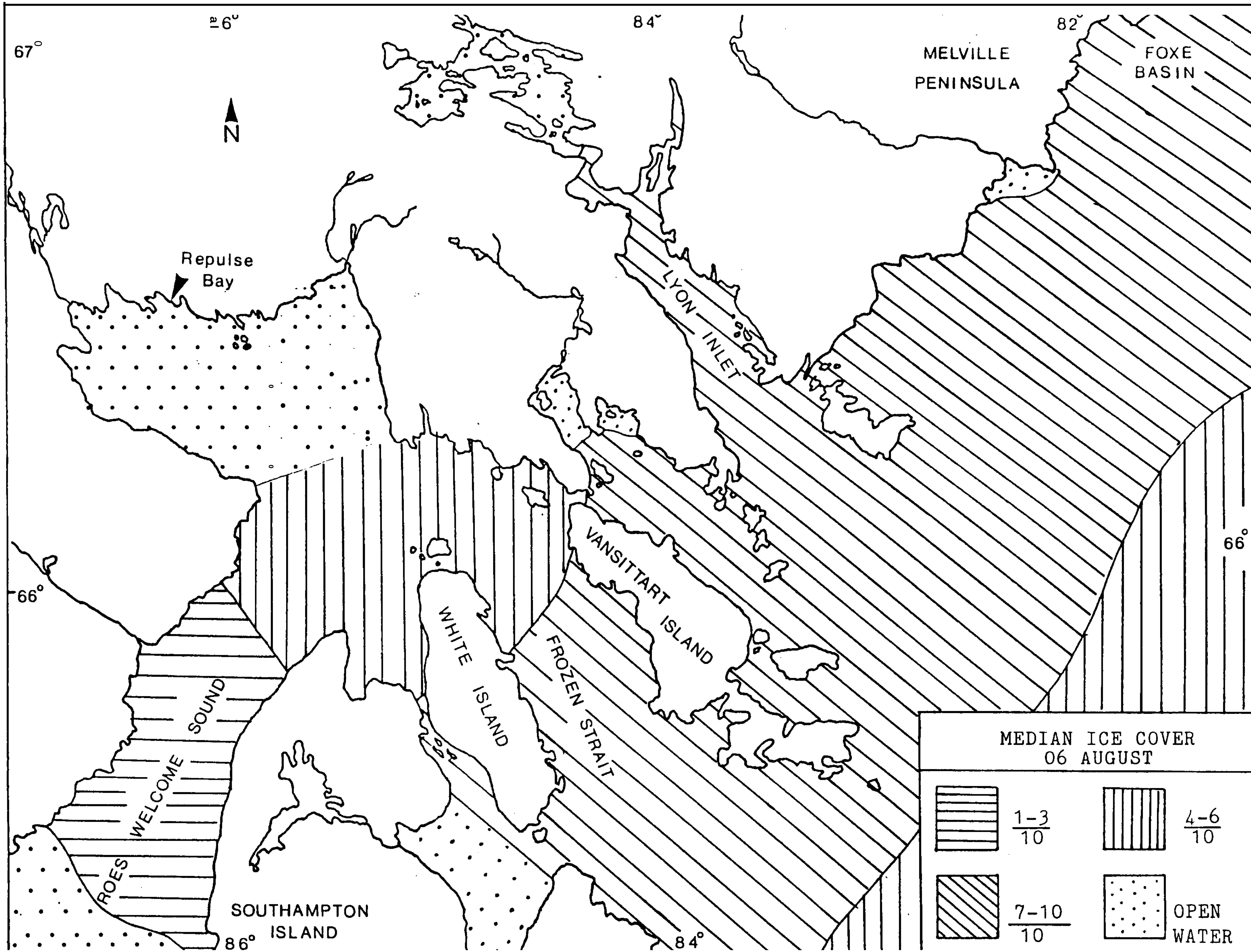
The limiting factor with summer water access is likely to be ice conditions near the entrance to Lyon Inlet. The ice regime in Foxe Basin to the north can be characterized by its extreme roughness, muddy appearance, extensive areas of land-fast ice and winter pack ice that is almost constantly in motion. The roughness of the ice is due to motion and stress produced by currents, tides, winds and thermal expansion. Its muddy appearance is due to winds and tides, which keep sediments suspended in the water column. Figure 2 shows surface currents and tidal ranges fro the area.

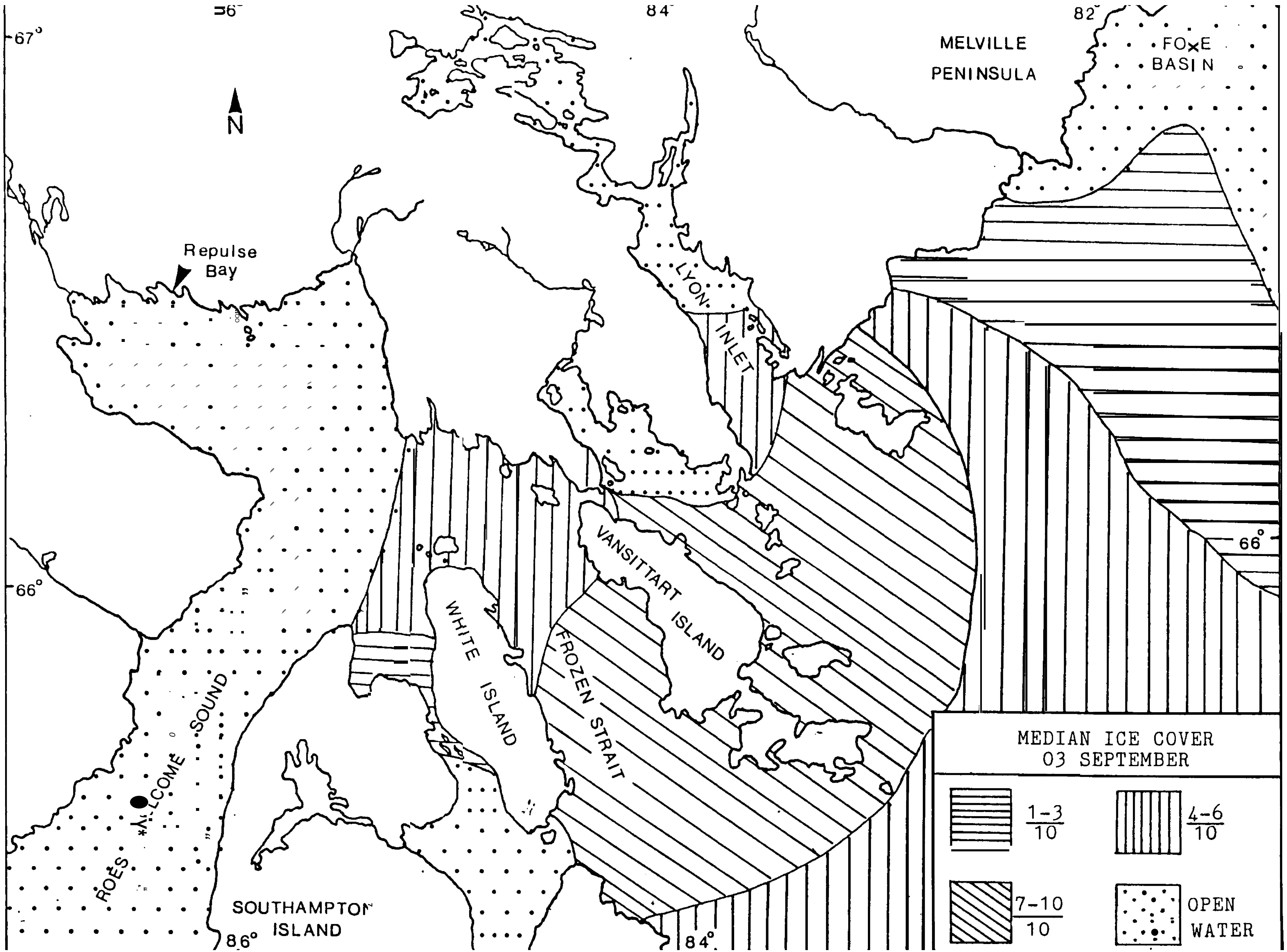
New ice forms in Foxe Basin and northern Hudson Bay normally during the second week of October. The ice spreads southward more rapidly along the coast, than seaward, to cover Foxe Basin and Frozen Strait by early November. The ice gradually thickens to become predominantly first-year ice by the end of December.


Spence Bay
Pelly Bay
COMMITTEE BAY
MELVILLE PENINSULA
FOXE BASIN
ROSS BAY
Repulse Bay
STUDY AREA
LYON INLET
BAFFIN ISLAND
SOUTHAMPTON ISLAND
Coral Harbour
Chesterfield Inlet
Rankin Inlet
Whale Cove
Eskimo Point
HUDSON BAY
QUEBEC
MANITOBA
ONTARIO
ROSS BAY FEASIBILITY STUDY
GENERAL LOCATION MAP
FISH PROCESSING PLANT
AIR ACCESS ROUTE
WATER ACCESS ROUTE
FISHING COMMUNITY


CURRENTS AND TIDES
MEAN CURRENT (SURFACE DIRECTION)
4.2/2.8 LARGE TIDE (m)/MEAN TIDE (m)
MELVILLE PENINSULA
FOXE BASIN
3.1/2.2
LYON INLET
VANSITTART ISLAND
FROZEN STRAIT
WHITE ISLAND
SOUTHAMPTON ISLAND
ROES WELCOME SOUND
Repulse Bay
6.8/4.2
4.2/2.9
3.9/2.5
N
67°
66°
86°
84°
82°


MEDIAN ICE COVER
02 JULY
1-3/10
4-6/10
7-10/10
OPEN WATER
MELVILLE PENINSULA
FOXE BASIN
LYON INLET
VANSITTART ISLAND
FROZEN STRAIT
WHITE ISLAND
ROES WELCOME SOUND
SOUTHAMPTON ISLAND
Repulse Bay
N
86°
84°
67°
66°


67°
86°
84°
82°
N
Repulse Bay
MELVILLE PENINSULA
FOXE BASIN
LYON INLET
VANSITTART ISLAND
WHITE ISLAND
FROZEN STRAIT
ROES WELCOME SOUND
SOUTHAMPTON ISLAND
66°
66°
86°
84°
MEDIAN ICE COVER
06 AUGUST
1-3/10
4-6/10
7-10/10
OPEN WATER



MEDIAN ICE COVER
03 SEPTEMBER
1–3/10
4–6/10
7–10/10
OPEN WATER
MELVILLE PENINSULA
FOXE BASIN
Repulse Bay
N
LYON INLET
VANSITTART ISLAND
WHITE ISLAND
FROZEN STRAIT
SOUND
ROES
SOUTHAMPTON ISLAND
67°
66°
86°
84°
82°

The typical ice regime in early March portrays fast ice along most shorelines and is particularly extensive among and between Southampton Island, Vansittart Island and the mainland of Melville Peninsula.

Melting commences in late May or early June resulting in puddling on the ice surface and the beginning of the ice weakening. As the temperatures rise, persistent leads become more extensive and the ice tends to be composed of ice floes of various sizes. Figure 3 represents median ice cover in early July. By early August, extensive pack ice (7/10 to 10/10 ice cover) normally still exists between Vansittart Island and the entrance to Lyon Inlet. Figure 4 shows median ice conditions in early August.

As late as early September extensive pack ice may still persist in the area due to movement by surface currents from Foxe Basin. The ice tends to pile up in the area between White Island and Vansittart Island and between Vansittart Island and the entrance to Lyon Inlet. Figure 5 shows median ice cover in early September.

Ice conditions may vary significantly from year to year. Based on ten years of ice data (from 1963 to 1973) boat access to the proposed fishery may be almost impossible in any given year.

2.2 Summer Access by Air

A long esker at the south end of Taser's Lake may meet tundra wheel aircraft landing requirements. Figure 6 provides a detailed map of the Ross Bay area. Local air charter companies do not have first hand information on the suitability of this esker for use as an airstrip. Local knowledge indicates that the esker is smooth and extensive, however, a reconnaissance survey by a qualified person may not be feasible until late May after some of the existing snow cover has melted. Should the reconnaissance survey reveal that upgrading of the esker is required, a cat will have to be walked overland about 65 kilometres from Repulse Bay. At the present time only one such piece of heavy equipment is operational in the community and is required for ongoing snow removal. A privately owned Cat located in Repulse Bay, is in need of extensive repairs and would only be made available on a guarantee of sufficient work. Should air access be preferred and runway construction be required, it is doubtful this work can be completed prior to spring break-up.

2.3 Overland Winter Access

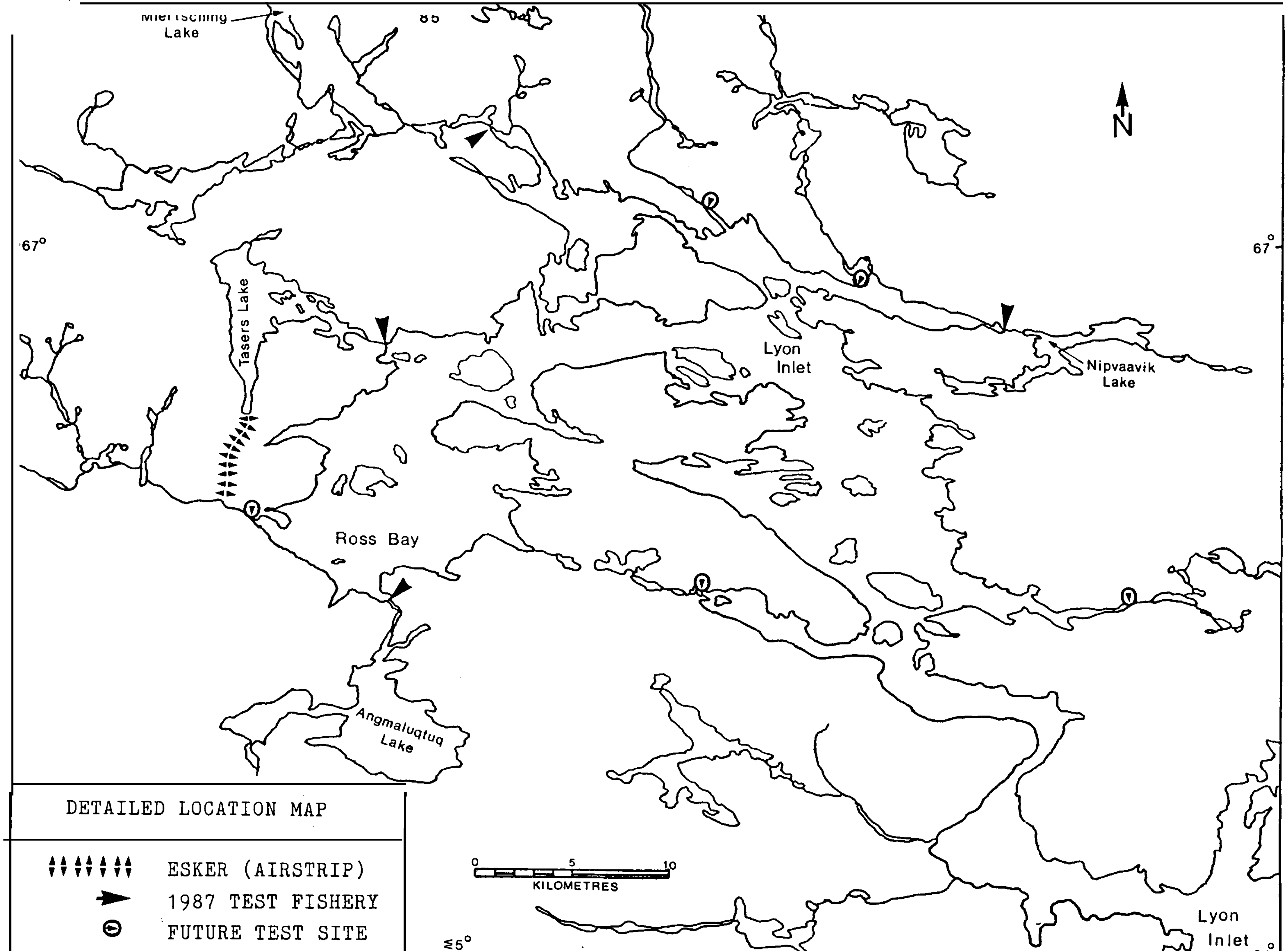
Overland winter access via snowmobile or bombardier may represent the most reliable access route to the proposed fishery. Time of travel from Repulse Bay would be in the range of 4 to 5 hours and access to the fishery would be open to more fishermen. Further, less sophisticated equipment would be required to maintain product quality acceptable to regulatory agencies.

2.4 Lack of an Existing Commercial Char Quota

At this time the only commercial char quotas open in the Repulse Bay area during the summer season are:

- Haviland Bay (66°31′ N 85°25′ W)
  2300 kg round weight
- Gore Bay (66°22′ N 84°25′ W)
  3600 kg round weight

As no commercial arctic char quotas presently exist for Ross Bay, an extensive test fishery will be required to determine the viability of the systems flowing into Ross Bay and the upper reaches of Lyon Inlet. Through discussions with the President of the Repulse Bay Hunters and Trappers Associationjnine river systems,which apparently support char stocks have been identified. These systems have been priorized for testing by the HTA and are mapped on Figure 6. Given the potential limited access to the Ross Bay fishery, testing these systems may result in a “lost opportunity” to evaluate some of the more accessible coastal river systems.



Miertsching Lake
N
67°
Tasers Lake
Lyon Inlet
Nipvaavik Lake
Ross Bay
Angmaluqtuq Lake
DETAILED LOCATION MAP
ESKER (AIRSTRIP)
1987 TEST FISHERY
FUTURE TEST SITE
0
5
10
KILOMETRES
Lyon Inlet

A number of coastal river systems potentially supporting arctic char stocks are listed on Schedule V. Those located within 150 km of Repulse Bay are mapped on Figure 7. As is the case for the Ross Bay fishery, these systems would have to be evaluated through the test fishing process, prior to being opened under a Variation Notice. Thus, if the Repulse Bay commercial fishery is to be expanded in any way an extensive test fishery will have to be implemented.

2.5 Tourism Potential of the Area

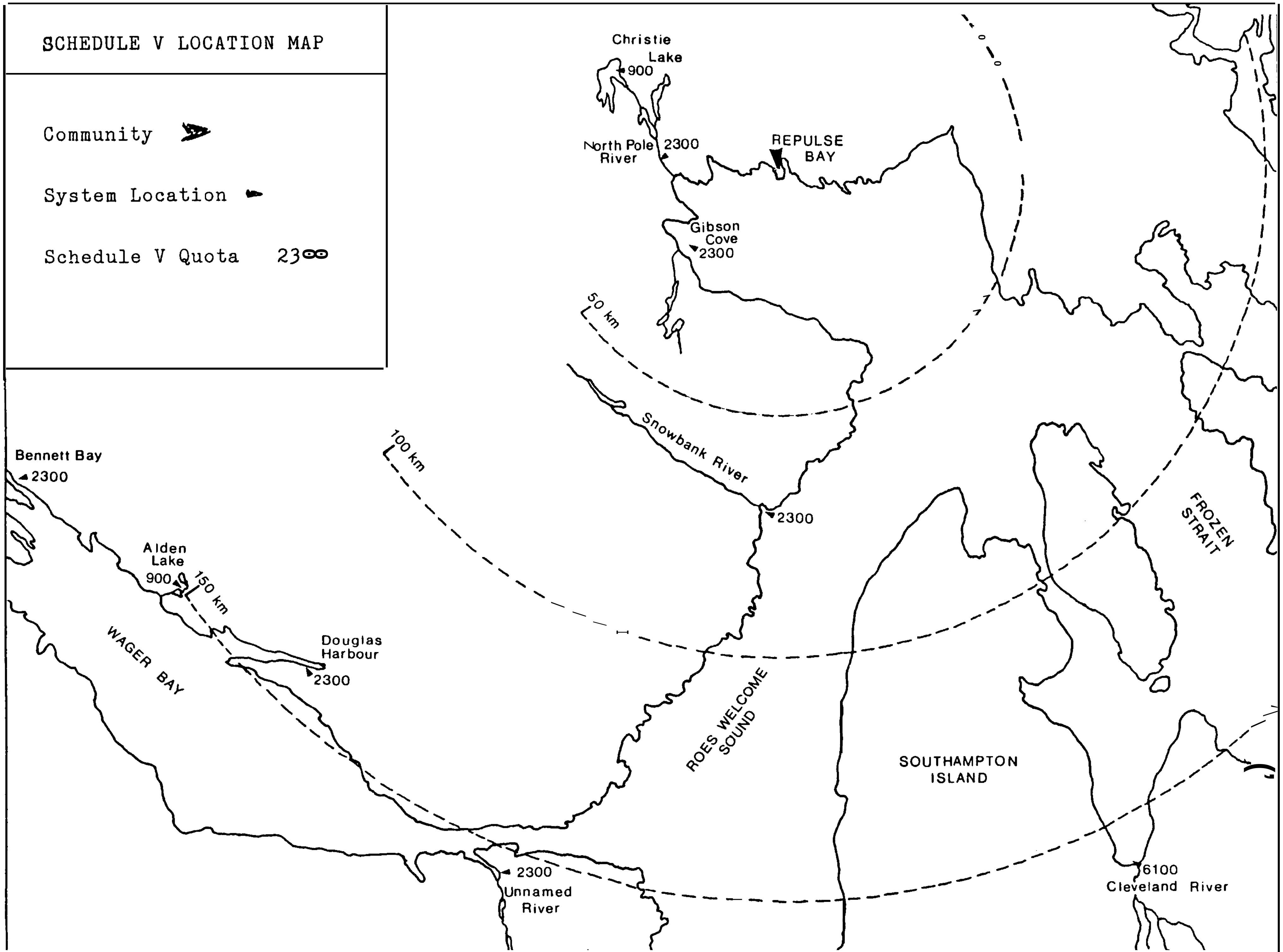
At this stage it may be impossible to determine if a sport fishery, can be carried out in conjunction with a commercial fishery. The concerns are:

- can the arctic char stocks support commercial, domestic and sport fishing pressure?

- will sport fishermen be willing to spend limited funds to fish in an area which is fished commercially?

The first concern will have to be assessed based on the results of the test fishery, a survey of the present level of domestic harvest from the area and a forecast of the potential consumption resulting from the sport fishery.

The second concern is often perceived as a problem by sport fishermen. Potential guests may decide to travel elsewhere if they are made aware of the commercial fishery. If fishermen do travel to the area and have less success than originally envisioned, they will tend to blame the commercial fishery for this lack of success. In a business where “word of mouth” is often the best form of advertizing such comments, whether based in fact or not, could have a detrimental affect on the future of the sport fishing operation. However, should the operations prove compatible, certain infrastructure could be shared reducing costs for both ventures.



SCHEDULE V LOCATION MAP
Community
System Location
Schedule V Quota 2300
Christie Lake
900
North Pole River
2300
REPULSE BAY
Gibson Cove
2300
50 km
Snowbank River
2300
100 km
Bennett Bay
2300
Alden Lake
900
150 km
Douglas Harbour
2300
WAGER BAY
ROES WELCOME SOUND
SOUTHAMPTON ISLAND
FROZEN STRAIT
2300
Unnamed River
6100
Cleveland River

3.0 AREA IDENTIFICATION PROCESS

A wide range of background material has been reviewed to provide information on the regional setting of the proposed fishery. The following sub-sections highlight specific issues and their bearing on the technical considerations for the fishery.

3.1 Regional Profile of the Fishery

The arctic char is essentially the only fish species presently exploited by the commercial fishery in the Keewatin. The high cost of production and transportation have precluded efforts to harvest species such as lake trout (Salvelinus namaycush) or whitefish (Coregonus clupeaformis). The perception of arctic char as a gourmet item has maintained prices at a level well above Pacific salmon species and other close competitors of arctic char.

Traditionally the commercial fishery has concentrated on anadromous arctic char at sea during the summer open water season. The fishery mainly utilizes gillnets set from canoes or skiffs (vessels under 8metres in length) operating in near-shore waters. The catch is delivered fresh (head on, gills and viscera removed) to the fish plant in either Chesterfield Inlet or Rankin Inlet.

During the summer of 1987, two freezer/packer vessels will be operating in the region. The Arctic Tern will likely concentrate on the Ferguson River (64°04′ N, 93°22′ W) south of Whale Cove. The second vessel, a new freezer/packer scheduled for delivery this spring, will be conducting a test fishery and fishing an existing quota in the Duke of York Bay area (65°10′ N, 84°48′ W) on the northwest end of “ Southampton Island.

It is the objective of the Government of the Northwest Territories (GNWT) to divest its interest in the Rankin Inlet Issatik Food Plant in Rankin Inlet. Private management and ownership options are presently being reviewed. The Chesterfield Inlet Fish Plant operates on an independant basis at this time.

Dressed (head on, gills and viscera removed) arctic char are sold in fresh and frozen form to the Freshwater Fish Marketing Corporation (FFMC) in Winnipeg. As well, char are sold locally in dressed, steaked, filleted and smoked form. Recently, dried char have been successfully sold in Rankin Inlet.

3.2 Regional Setting for the Ross Bay Fishery

Ross Bay is situated 65 air kilometres north-east of Repulse Bay. Travel time to Ross Bay by skiff or canoe is variable, averaging about 14 hours depending on conditions. Overland access by snowmobile, a distance of about 80 kilometres, represents a travel time of about 4 hours. Travel time to Ross Bay from Repulse Bay by air is about 20 minutes. Travel time from Ross Bay to Rankin Inlet via Peterhead is estimated at 2-3 days depending on conditions.

Repulse Bay is situated some 500 air kilometres northeast of Rankin Inlet. Repulse Bay is serviced twice weekly by scheduled aircraft. Freight rates to Rankin Inlet via scheduled airline are $ 1.25 per kg. Air charters are available from Rankin Inlet. Wheeled Twin Otter, Beaver, and Beechcraft are available. Charter rates are as follows:

-Calm Air Twin Otter
$5.37 per mile (includes fuel)
Rankin to Ross Bay (return) $ 3,545.00

-Keewatin Air Beaver
$3.30 per mile (includes fuel)
Rankin to Ross Bay (return $ 2,180.00

-Keewatin Air Beechcraft (modified)
$4.18 per mile (includes fuel)
Rankin to Ross Bay (return) $ 2,760.00

The availability of the Keewatin Air Beaver is in question at this time. Discussions with the Base Manager indicate the Beaver would only be stationed in Rankin Inlet if sufficient work was scheduled. As well initial plans to back-haul fish from Repulse Bay on Keewatin Air schedule flights to Pelly Bay and Spence Bay, have been scrapped as the schedule has been discontinued. Contract rates can be negotiated with the air charter companies, however, as these rates will be dependant on the availability of aircraft, harvest level from Ross Bay and the possibility of other work in the area, we have utilized established charter rates in any cost calculations.

3.3 Climate

Weather conditions have a direct bearing on many aspects of the fishery. Transportation is mainly affected by winds, fog, blowing snow and extreme cold. Weather conditions may have a direct bearing on fish behaviour and subsequently catch rates. Equipment designed for southern conditions may not function to specifications at more northerly latitudes.

Rathem than a lengthy discussion of the basic climatic controls of the Arctic region, it must be realized that the weather in any given year poses a significant level of risk to the success of the fishery. The specific climate conditions affecting the summer fishery are fog, wind, freezing degree days and thawing degree days. During the winter, blowing snow, fog and extreme cold most impact the operation of the fishery.

Detailed weather data are not gathered for Repulse Bay. Climatic data for Coral Harbour and Chesterfield Inlet are summarized in Table 1 and Table 2 respectively.

TABLE 1

CLIMATIC DATA FOR CORAL HARBOUR

$64^{\circ}12'$ N $83^{\circ}22'$ W

Month	Mean Daily Temp	Rain Mean Amount	Days	Snow Mean Amount	Days	Mean Wind Speed	Most Prevalent Direction	Days With Fog *	Days Blowing Snow **	Freezing Degree Days	Thawing Degree Days
	°C	cm	#	cm	#	knots		#	#		
Jan.	-29.7	0	0	8.5	7	10.9	NW	1	10	1736	0
Feb.	-29.4	0	0	9.2	7	10.9	N	1	12	1517	0
Mar.	-25.2	0	0	10.8	7	9.6	N	1	6	1259	0
Apr	-16.3	0	0	14.4	8	10.4	N	1	7	771	1
May	- 6.3	0.3	2	19.1	8	11.1	NW	4	5	317	11
Jun.	2.1	1.8	6	8.1	3	10.6	N	5	1	25	157
Jul.	8.7	3.3	10	1.0	***	9.8	N	4	0	0	479
Aug.	7.4	4.1	10	0	0	10.7	N	4	0	0	431
Sep.	0.9	2.8	6	9.1	5	11.4	N	5	1	39	114
Oct.	- 7.8	0.5	2	27.2	12	11.9	NW	5	4	484	3
Nov.	-17.5	0	0	17.1	11	12.5	N	2	7	980	0
Dec.	-25.5	0	0	12.2	9	11.1	N	1	11	1417	0
YEAR	-11.6	12.8	36	136.7	77	10.9		34	64	8545	1196

Period of Record 1951 - 1983

* Visibility less than 5/8 of a mile

** Visibility less than 6 miles

*** Partial day

TABLE 2

CLIMATIC DATA FOR CHESTERFIELD INLET

$63^{o}20'$ N $90^{o}43$ W

Month	Mean Daily Temp	Rain Mean Amount	Days	Snow Mean Amount	Days	Mean Wind Speed	Most Prevalent Direction	Days With Fog *	Days Blowing Snow **	Freezing Degree Days	Thawing Degree Days
	°C	cm	#	cm	#	knots		#	#		
Jan.	-31.5	0	0	7.4	7	12.4	N	1	15	No Data	No Data
Feb.	-31.6	0	0	4.8	5	13.3	N	1	12		
Mar.	-26.5	0	0	7.4	7	12.5	N	2	10		
Apr.	-16.5	0	0	10.7	9	11.6	N	2	7		
May	-6.0	0.3	2	7.1	7	11.1	N	3	7		
June	2.9	2.2	6	2.0	2	10.0	N	5	1		
July	8.9	4.2	11	0	0	9.3	N	6	0		
Aug.	8.4	4.4	9	0	0	11.0	N	4	0		
Sep.	2.5	3.9	8	3.3	2	12.6	N	4	1		
Oct.	-5.7	1.1	3	13.7	9	15.1	N	3	6		
Nov.	-17.4	0	0	13.0	9	13.2	NW	3	10		
Dec.	-26.4	0	0	11.9	8	12.9	N	1	14		
YEAR	-11.6	16.1	39	81.3	65	12.0		35	83		

Period of Record 1951 - 1983

* Less than 5/8 miles visibility

** Less Than 6 Miles Visibility

The Coral Harbour and Chesterfield Inlet climatic data are fairly similar and should be representative of conditons at Repulse Bay. Both stations have a mean annual temperature of -11.6°C. More rain falls at Chesterfield Inlet than Coral Harbour. Each of the stations report the heaviest rains in July and August. Coral Harbour receives more snow than Chesterfield Inlet, with both of the stations reporting the heaviest snowfall between October and January. Both stations report about 35 days of reduced visibility due to fog annually. The months of June through October are the most affected by fog, with a mean of 5 days per month during this period. Reduced visibility due to blowing snow is most prevalent during November through February. Not reported on the Tables, but having a direct bearing on transportation and fishing effort, are gale force winds (greater than 34 knots). Coral Harbour data indicate these storms can be expected every month of the year, however, November through January are the most likely months of occurance. Coral Harbour experiences an average of 17 days per year with gale force winds. Finally, Freezing Degree Days (one degree–day results for each degree that the mean daily temperature is below the base of O“C) give an indication of the severity of the climate as well as the duration of the cold weather. Coral Harbour experiences 8,545 freezing degree-days in a year compared to 500 freezing degree-days in Toronto and 1,500 in Montreal. Though the arctic receives more solar radiation in the summer months than southern Canada, the high reflectivity of the surface allows only a small percentage of the heat energy to remain and heat the earth and atmosphere.

Essentially, the hisorical climate data point out the need for a cautious approach when” estimating travel cycles for the fishery. As well, it is apparent that some infrastructure or inital processing such as drying will be required to maintain product quality during periods of inclement weather when travel is not a possibility. Weather conditions, particularly ambient temperatures, must be considered along with catch rates when sizing freezers or icing facilities.

3.4 Geology and Terrain

The predominant features of the Repulse Bay and Lyon Inlet area are hills and valleys carved out of bedrock. The bedrock fluting is extensively fractured resulting in very complex drainage basins.

Little soil exists in the area except for valley and beach deposits. The valley deposits are generally poorly drained silty sand and gravel. Course aggregate can generally be found along raised beaches and esker tops. Due to the lack of soil, lichens, mosses and small flowering plans are predominant.

The Ross Bay area offers some of the most spectacular scenery in the Keewatin. Cliffs rise from the waters edge to an elevation of 400 metres in some locations. The Ross Bay area has many islands offering fairly sheltered waters. The suitability of landing vessels and the catch on shore will have to be given consideration during the test fishing process.

3.5 Wildlife Considerations

The Melville caribou herd's calving grounds are well to the north of the Ross Bay area and should not be impacted by commercial fishing activities including the possible air traffic in the area.

Polar bear conflicts are a distinct possibility even though Ross Bay is siutated well inland. A daily program of garbage burning and burial will have to be implemented in order to reduce the potential for bear/man conflicts. The Department of Renewable Resources has a Wildlife Officer stationed in Repulse Bay and have indicated that if a test fishery is to be conducted the Wildlife Officer should be contacted and made aware of all camp locations and garbage disposal procedures. Bear deterrant weapons may be issued to each camp.

3.6 Sectoral Review

Development of the Repulse Bay commercial fishery has been limited by the lack of commercial quotas, distance from existing processing plants, high freight costs and a limited local market. Consequently, the number of fishermen entering the fishery is small and there is a Present lack of processing infrastructure, suitable vessels and fishing equipment.

A review of the fishery sector was carried out in the spring of 1984. Seven of the twelve licenced fishermen were interviewed. With the exception of one fisherman who harvested 1350 kg of char in the Pelly Bay area, mean harvest was about 300 kg. Local sales to the Nauyaat Cooperative provided the bulk of revenues. Of the respondants completing the appropriate sections of the questionnaire, mean revenues were $ 900. Mean expenses, as recalled by the fishermen, were $ 820. Expenses were limited to fuel, food and equipment and did not include wages, benefits, insurance or repairs.

The majority of respondants report the need to replace existing canoes and fishing equipment. Mean capital cost to replace existing equipment was estimated at $ 7030.

All interviewed fishermen report the need for infrastructure to allow cold storage of the catch. Until quotas can be increased through the test fishing process, potential revenues may not support such infrastructure.

Data on domestic harvest levels from the area are limited. The Keewatin Wildlife Federation Harvest Study provides an estimate of 3082 kg of arctic char for 1982/83. It is noted that a portion of this estimate may include actual commercial harvest.

The technical feasibility review in a later section of this report further addresses infrastructure requirements and considerations.

3.7 Tourism Potential

The Keewatin Destination Zone Tourism Development and Marketing Strategy prepared for the Keewatin Chamber of Commerce by the consulting firm Marshall Macklin Monaghan Limited outlined an implementation strategy for tourism development in the Keewatin Region. Community based information were gathered for the Repulse Bay area and implementation plans for boat tours, sports hunting, historical tours and scenic tours in the area have been prepared. The study recognized the Repulse Bay area as one of the most scenic in the Keewatin.

The perspective of this feasibility study is not to duplicate previous efforts, rather, it is our intention to point out the potential of the area in perspective with the operation of a commercial fishery in Ross Bay. In most instances it would appear that the tourism potential of the area would not conflict with the operation of a commercial fishery. In fact, it would appear that with planning, the operations could share some infrastructure such as an airstrip, thereby enhancing the viability of both operations. Without specific knowledge of discrete arctic char stocks in the area, one would have to be concerned if large capital investments were considered for the purpose of developing a sport fishery, prior to completion of a test fishery.

Along with a test fishery to determine commercial viability, a sport test fishery should investigate timing and duration of the downstream run in the spring, matchability, access for fishermen, losses due to angling damange, best fishing locations, matchability during the time at sea, matchability during the upstream run in the fall and potential for angling other species.

At the time of the test fishery, efforts should be undertaken to determine potential locations for a camp or lodge, access to and from this area, and should document other attractions in the area.

Along with site-specific attractions and opportunities, an evaluation of community based opportunities should be undertaken in order to provide suitable day trips in the event of delays due to weather. This evaluation should build on existing infrastructure and could include:

- local scenic tours
- archeological sites
- historic sites
- arts and crafts
- wildlife viewing
- the whaling and fur trade eras
- day fishing trips

Information gathered through this process should be utilized to develop promotional materials. A detailed proposal should be developed in conjunction with the proposed test fishery.

4.0 TECHNICAL FEASIBILITY CONSIDERATIONS

A wide range of technical options for the catching, preservation, initial processing and transportation of the catch have been reviewed and considered. These technical options are applicable to either a Ross Bay fishery or a fishery carried out at some of the coastal river systems supporting arctic char stocks.

The initial problem is to design a technically feasible test fishery to determine if potential yields can support the required infrastructure. The test fishery can be designed based on the type of product delivered from the fishery. The options are:

- dried fish or “pipsik”
- fresh iced fish
- frozen product

4.1 Test Fishery Requirements

The test fishery process is carried out to provide an evaluation of each fishing site. This site evaluation is based on the following criteria:

- accessibility
- suitability for fishing (tides, currents, water depth)
- suitability for landing catch
- suitability as a camp location
- other problems affecting the fishery

The biological investigation component of the test fishery provides information on:

- the strength and timing of the run
- age composition of the population
- length and weight composition
- sex, maturity and productivity
- growth and relative condition
- recruitment, mortality and yield
- catch/effort data

As soon as fishing locations have been finalized the logistics of the test fishery can be further considered. Based on the selection of fishing locations and delivered product form certain management requirements associated with the operation of infrastructure will have to be addressed.

It is anticipated that provisional quotas assigned to each fishing location will be in the order of 1000 kilograms. In order to gather the required biological data from each fishery, fishing effort is usually controlled in order to allow fishing to be carried out over the duration of the run prior to filling the provisional quota. Utilizing a gillnet test fishery, a minimum of two seasons fishing should provide sufficient data for the estimation of potential yield. Utilization of a weir fishery allows for a enumeration of the stock in one season. The field season for either method would be about six weeks in duration.

4.2 Pre-Project Cost to Provide Air Access

Prior to outlining the technical feasibility options for the commercial fishery we outline the pre-project costs for accessing the fishery by air.

The suitability of the esker south of Tasers Lake as an airstrip will have to be evaluated by qualified personnel. This should be carried out by the firm providing air services for the fishery.

Should runway construction be required a Cat will have to be walked overland from Repulse Bay. Pre-project costs to provide air access are estimated as follows:

Air charter to investigate esker	$ 3,500.
Cat rental 60 hours at $.85.00/hour	5,100.
Cat operator at $ 16.00/hour	960.
Operators assistant at $ 12.00/hour	720.
Fuel (300) gallons)	1,000.
Meals for operators	300.
Land Use Permit	600.
	$ 12,180.

It must be noted that annual maintenance of an airstrip may be required.

4.3 Catch Phase

The commercial arctic char fishery utilizes 139 mm (5½ in.) mesh gillnets. Nets are generally 50 to 100 m in length and 24 to 40 meshes deep. Mono mesh netting is most comonly used. Mesh sizes are regulated in order to make the fishing gear size selective.

The commercial fishery concentrates on char at sea early in the summer fishing season (mid July) and moves to the river mouths later in the open water season when char commence their upstream (approximately mid August). The winter fishery is most successful immediately after freeze-up (end of October).

The weight of char generally increases during the summer feeding season and often decreases over the winter. Length increases occur in both summer and winter, the latter being made at the expense of nutritional reserves. Fat content increases throughout the summer. Spawning char often demonstrate morphological changes such as kype development and coloration. At the time of spawning some scale absorption may occur. These changes may decrease marketability. More importantly, fishing on spawning grounds raises the issue of future productivity.

Harvesting arctic char just prior to their upstream run in the fall provides a product in prime condition. The fish are heavier at this time and fewer individual fish are required to fill a quota. As well, fishermen do not have to search for fish; they can wait for their arrival at river mouths, thus reducing effort and costs.

As the test fishery attempts to gather biological data from discrete stocks the test fishery concentrates efforts in the river systems as char are making their upstream run to overwintering and spawning grounds. In order to fish shallow rivers, short (50 m) and shallow (24 mesh) nets are suggested. The test fishery will provide information on catch rates and size classes of char required for the design of infrastructure such as freezing rates and capacities.

4.4 Provision of Ice

The Ross Bay fishery will require icing facilities if fresh fish are to be delivered to the fish processing plant. Adequate supplies of ice are required during the catch phase for on-site initial processing and during the transportation phase. At present, no icing facilities are available in Repulse Bay. Due to the high cost of operating and maintaining mechanical ice making facilities an ice harvest is proposed. Two options have been reviewed:

- a traditional block ice harvest
- a mechanical ice aggregate harvest

When an ice harvest is planned, the amount of ice required is estimated at 2.5 times the fish quota. This allows for ice loss, fish packing and re-packing. For example, if the Ross Bay quota was 4,500 kg (round weight) than 11,250 kg of ice would be required.

The traditional block ice harvest is usually carried out as soon as the ice is of sufficient thickness to support men and equipment. Hand saws, ice chisels, chainswas and hand-pushed motorized circular saws are used to cut the ice blocks. When saw cuts do not reach the water, a chisel is used to crack the ice blocks loose. They are then sledded to the ice house and winched into the storage area. Once the ice house is filled, the ice is covered with a sheet of plastic and some form of insulation. The ice house is then closed until summer. When ice is required, blocks are cut or broken loose and shaved by hand or machine for use.

In practice, there are a number of problems with the traditional ice harvest:

- Cutting and storing lake ice is hazardous and labour intensive. The ice cutters are exposed to personal hazards when using power saws and related equipment, handling heavy blocks of ice, or when working on a slippery surface in freezing temperatures near open water.

- Many ice houses are not properly constructed nor is ice properly stored and insulated. Improper ventilation in the roof peak results in a build-up of heat causing an

TRADITIONAL BLOCK ICE HARVEST

Ice House Capacity Calculation

- o Assume a quota of 25,000 kg round weight
- o Ice reuired for initial icing and repacking for transportation @ 2.5 times quota
  62,500 kg of ice
- o Assume in-house loss at 50 %
  62,500 kg x 1.50
  93,750 kg of ice required
- o 93,750 kg of ice has a volume of approximately 3,315 ft^3
- 0 Inside measure of ice house 24′ x 17.5′ x 8'
- o Construction cost at $ 100/ft2
  462.5 ft^2 (outside mmnt) x $ 100
  $ 46,250 plus freight on materials

Cost of construction and freight estimated at $ 60,000.

ICE HOUSE
ALLOWABLE ANNUAL DEPRECIATION*

COST	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
60,000	12,000	9,600	7,680	6,144	4,915

* Straight line declining balance at 20%

May be eligible for three year write-off at 25% - 50% - 25 %

TRADITIONAL BLOCK ICE HARVEST
PRODUCTION COSTS

Annual Production Costs

Wages @ 6 men x $ 100 x 15 days	$ 9,000
Food @ 6 men x $ 25 x 15 days	2,250
Fuel	1,500
Lubricants	500
Miscellaneous (parts,insulation,etc)	1,500
ANNUAL PRODUCTION COST	$14,750

	Year 1	Year 2	Year 3	Year 4	Year 5
Equipment*	60,000	0	0	0	0
Production**	14,750	15,487	16,262	17,075	17,929
Total	74,750	15,487	16,262	17,075	17,929
Per kg cost 93,750 kg	0.7973	“0.1652	0.1735	0.1821	0,1912

* Assumes ice house built at no interest” through grants.
Does not include roller ramps, ice chisels, chainsawa, etc.

** Assumes annual cost increases of 5 %.

increase in ice loss. The ice is exposed to summer temperatures every time ice is removed from the building. Insufficient quantities of insulation will result in increased ice loss. When stored, ice blocks should be cut so that all touching surfaces are flush. Air spaces are minimized between the blocks to reduce the rate of melting. This can be a time consuming task requiring one or more people working in the ice house to fit the blocks properly.

- Contamination of the ice increases with the amount of handling required. Chain saws must be lubricated with a vegetable oil as petroleum based lubricants are unacceptable. Insulation may also contaminate ice.

- Ice house construction is very costly at an estimated $85 - $100 per square foot. The cost of an ice house with sufficient ice capacity for 25,000 kg of fish quota is estimated at $ 75,000.

4.5 Ice Aggregate Harvest

An experimental aggregate ice harvest system has been developed by our associates I.D. Engineering Canada Inc. A brief excerpt from their work titled "Interim Report on The Development, Construction and Testing Of A Prototype Ice Storage Facility At Kisseynew Lake, Manitoba follows. The entire report is appendid at the end of this report:

In **1981**, I.D. Engineering Canada Inc. developed a method of producing "ice aggregate" from in situ natural lake ice which was then used to construct ice roads. In 1985, I.D. Systems Ltd. received a grant from the Manitoba Department of Industry, Trade and Technology to carry out research for the production and storage of ice aggregate for use in the inland commercial fishery. This project, which was carried out at Winnipeg Lake and Mosse Lake, Manitoba, refined the production, handling and storage of ice aggregate and led to the request for funding by DRIE to test a new method of storing ice aggregate.

At Moose Lake, the existing ice house was modified to accommodate four grain bins (4.3 m diameter, 4.6 m height) since the ice house walls would not be capable of sustaining the pressure exerted by the ice aggregate when filled. These innovations led to the idea that a free-standing, insulated grain bin may be the solution for ice storage at fisheries where ice houses do not exist.

The basis of methodology used in the production, handling and storage of ice aggregate consists of:

- rotavating surface lake ice with a modified farm rotavator mounted on a farm tractor with a three-point hitch and power take-off.
- bucketing the ice aggregate into a hopper mounted on a standard grain auger, and
- augering the ice into an insulated storage building or container for use in the summer fishery.

All of the equipment used with the exception of the ice screener, is existing farm equipment which has been modified for the production and handling of ice aggregate. The specifications of most of this equipment are appended at the end of this report.

I?otavator

A 178 cm Howard rotavator was used to produce ice aggreage. The rotavator blades were removed and replaced with industrial pick tines.

The 42 pick tines were mounted in the same location as the original rotavating blades with three tines on either side of each hub.

Grain Auger

A Westfield LD80-46 grain auger was purchased from Westfield Industries Ltd. in Rosenort, Manitoba. The auger was 20.3 cm (8 in.) in diameter, 14 m (46 ft) in length and equipped with wheels. The intake housing was removed from the auger and replaced with a prototype hopper used in other studies. The auger was driven by a gasoline-run 16 HP Briggs and Stratton engine, complete with electric start.

The prototype hopper was designed by I.D. Systems Ltd. and manufactured by Westfield Industries Ltd. to fit the 20.3 cm diameter grain auger. An iron bar safety mesh was incorporated in the hopper since the safety screen over the intake flighting had been removed.

Screener

In previous projects, I.D. Systems Ltd. had a grain auger modified to remove fine ice crystals from the aggregate. As a prototype, a 10 cm by 100 cm strip of 0.6 cm square mesh #12 steel wire screen was welded onto a slot cut on the underside of the auger. In operation, fines were driven out through the screen resulting in fewer fines in the stored aggregate.

The screener is basically a hopper with a large fan and screen which the aggregate drops between before entering the storage bin (Figures 5 & 6). A three-speed, 110 volt box fan was used for expediency in this test as 110 volt electric power was available at Kisseynew Lake fish-packing station. Fine snow and ice are blown out of the aggregate before entering the storage bin.

Tractor

A number of farm tractors have been used to drive the rotavator and for piling and bucketing the ice aggregate. These range from the 2000 Ford series (30 to 35 HP) to the 5000 Ford series (over 50 HP). In all tests, the tractors performed well. The only criteria are that the tractors require a three-point hitch, a power take-off, and should be a ❑inimum of 30 HP.

In this study, a new 4610 Ford, with four–wheel drive was rented from a farm implement dealer in Swan River. Suitable rental tractors were not available in The Pas area. In addition, Mr. Matkowski had an older tractor with a half-yard bucket available at the site (but without a three-point hitch) and it was used to bucket the aggregate into the hopper. A front end loader was rented to do bin site clearing, gravel spreading, and to clear the lake of snow.

Grain Bin Construction

A Model 196 “Yellow Top” grain bin was purchased from Westeel Rosco in Winnipeg and shipped to The Pas. A four-wheel utility trailer was used to transport the steel (1318 kg) from The Pas to Kisseynew Lake. Three grain bin erection jacks were rented from a farm equipment dealer in Newton, Manitoba (Newton Enterprises) and shipped to the site in a half-ton truck.

Mr. Matkowski chose the location fro the grain bin. It was within 6 m (20 ft) of his packing shed and roughly within 4.5 m (15 ft) of the lake share. The area was cleared of snow and a gravel base put down. The gravel was spread to give a level pad with a minimum of 20 cm (8 in) depth and a diameter of approximately 6.7 m (22 ft.)

A local contractor from The Pas (J & K Construction) was hired to erect the grain bin. The bin should have been erected on a concrete pad but due to winter construction and the station's isolation, a support pad of 7.6 cm by 30 cm (3 in by 12 in) timbers were used to set the bin on. The bin was erected in one day and clue to cold weather, was shrouded with insulated tarps before insulating. The grain bin jacks were left attached *to* the bin so that the bin could be raised to place scaffolding in the bin and to remove it once the bin was insulated.

Grain Bin Insulating

The ideal method of insulating a grain bin is to spray insulation on the exterior of the grain bin. In cold weather, this is not possible unless a hording is erected around the bin and heat is supplied to keep the bin warm. In addition, the insulation would have to be sprayed with an expensive ultra violet inhibitor or covered to prevent insulation breakdown by sunlight. In this project, it was easier and cheaper to shroud the bin and apply heat within the bin in order to insulate the inside of the bin.

Dauphin Spray On Application from Dauphin, Manitoba was contracted to spray on 10 cm (4 in) of polyurethane foam (0.9 kg/m^3 density) on the inside of the grain bin. The contractor supplied his own heater to heat the bin to a temperature at which the foam would adhere to the metal. This type of foam has been used in food storage bins throughout Manitoba since it is non-toxic and relatively inert. On the top of the bin, the foam coating was increased to approximately 12 cm (5 in) because of potential heating from the sun.

The insulation was first applied to a thickness of approximately 3 cm and checked to see if it had properly adhered. In some places it did not, due to moisture, and was torn off and reapplied. Daily temperatures were near zero. Once the base layer had been successfully applied, the remainder of the insulation was quickly applied. During this operation, ambient temperatures dropped to -25°C but the inside temperature of the bin was held above freezi.ng without difficulty. The total application was applied in one day.

Upon completion of the insulating, the bin was jacked up, scaffolding removed and the bin replaced on the timber sills, ready for ice aggregate loading.

Ice Aggregate Production

An area in front of the grain bin was cleared of snow and the auger and hopper were positioned in front of the grain bin. The area cleared for aggregate production was roughly 18 m (60 ft) from the auger because of emergent weeds and was approximately 0.4 hectares (1 acre).

The first pass across the ice with the rotavator engaged was done with a tractor speed just under 3 km/h (2 mph). The rotavator gear setting for all ice production was 235 rpm. The rotavator depth guide setting was 12 cm (5 in) although it is unlikely the machine will cut to that depth. A second cut was made at right angles to the first cut but with tractor speeds of 5 to 6 km/h (3 to 4mph). Once the surface had been cut, the aggregate was piled in a windrow. Temperatures ranged from -15°C to -28”C.

In this study, the screener prototype was placed in the top opening of the grain bin and an extension tube was attached to the discharge end of the auger and placed in the screener inlet.

Once the equipment was in place and ice aggregate production started, the aggregate was bucketed into the hopper with the auger and screening fan running. In this study, two employees of Mr. Matkowski’s were trained to put up ice. After each double cut, the aggregate was windrowed for hopper loading while succeeding cuts were made with the rotavator.

ICE AGGREGATE HARVEST
CAPITAL COSTS

EQUIPMENT

Ford 2810 Tractor with 1.8 m^3 bucket	**$ 17,500**
Freight to Rankin Inlet	**2,000**
Modified Howard HR20 Rotovator	**4,200**
Freight	**700**
Custom Built Hopper 1.8 m^3	**1,200**
Freight	**170**
Modified Westfield LD8-46 Auger	**3,300**
Freight	**650**
Westeel Rosco 196 Grain. Bin	**6,600**
Freight	**1,990**
Landed Equipment Costs	**$ 38,310**

SET UP OF BIN

Pad and Erection	$ 2,000
Insulation Application	7,500
Built Aggregate System*	$ **47,810**

* Capacity 100 tons (90,900 kg)
sufficient ice for a 40,000 kg round weight quota

PRODUCTION OF 100 TONS ICE AGGREGATE

Manpower 3 crew, 3 days @ $100.	$ 900
Fuel and lubricants	200
Miscellaneous	400
Total Production Costs*	$ 1,500

*' Does not include initialtraining

ICE AGGREGATE HARVEST

ALLOWABLE ANNUAL DEPRECIATION *

Equipment	Rate	Cost	Year 1	Year 2	Year 3	Year 4	Year 5
Tractor	30%	17,500	5,250	3,675	2,573	1,801	1,261
Auger	[illegible]0%	3,300	330	297	267	241	217
Rotovator	[illegible]0%	4,200	420	378	340	306	276
Grain Bin	[illegible]0%	6,600	1,320	1,056	845	676	541
Hopper	[illegible]0%	1,200	120	108	97	87	78

* Straight Line Declining Balance

ICE AGGREGATE PRODUCTION *

	Year 1	Year 2	Year 3	Year 4	Year 5
Equipment (Built) **	47,810	300	350	400	450
Production (100 Tons) ***	1,500	1,575	1,654	1,736	1,823
Total	49,310	1,875	2,004	2,136	2,273
Per kg Costs	0.5425	0.0206	0.0221	0.0237	0.0250

** Assumes equipment provided at no interest cost and nominal annual increase in maintenance

*** Assumes annual labour and fuel increase of 5 %

Thas was continued and in 15 hours, the bin was full (approximately 90,100 kg - 100 tons). With more experienced people, the bin could be loaded in about 10 hours. It should also be noted that in this operation, the auger speed was reduced and as a result, large pieces of ice were crushed by the auger flighting. This eliminated ice jamming in the hopper which was experienced in other trials and made for a very efficient operation. At lower speeds, the auger operating time per tank of fuel increased. There was no perceivable effect on the auger engine at slow speeds such as lugging or engine loading.

4.6 Ice Aggregate Feasibility

Once harvest levels are established for Ross Bay, an ice aggregate harvest system could be sized and put in place. In the interim, the ice aggregate harvest shows potential for other communities with large quotas. Using Rankin Inlet as an example a number of technical considerations must be reviewed.

- locating a suitable lake for an ice source giving consideration to original water quality, and factors affecting same (i.e. dust suppression, traffic, potential deleterious substance encroachment)

- training in harvest techniques

- management and ownership of equipment

- quantities of ice required to meet future needs

- approval of various regulatory agencies (eg DIAND - Water Use Authorization, DFO)

The aggregate harvest will provide a more suitable ice product with less effort and for a reduced cost. The cost of a traditional block ice harvest is estimated at $0.16 per kg (not including ice house construction). The cost of putting up 90,100 kg of ice aggregate is estimated at $0.54 per kg in the first year and includes capital cost for equipment. Harvest costs of less than $0.03 per kg are estimated thereafter.

4.6 Provision of Freezing Facilities

Initially, a small walk-in freezer could be utilized to meet the freezing requirements of the harvest from the test fishery. The level of harvest will depend on the number of river systems selected for testing. Provisional quotas of 1000 kg per river system are likely to be permitted. If four systems are tested a small (8' x 8') Bally box with a 3/4 hp coppression is suggested. A gasoline powered generator would be required to provide electricity. One of the large (1800 Va) generators would be sufficient.

The Bally style freezer can be moved from location to location as required. Bally boxes are recommended if portability is required, as the construction type will withstand the rigors of knock-down and set-up.

Once commercial quotas are established a permanent freezer with sufficent capacity to meet these needs can be considered. At this time it would appear present harvest levels will not support the operating costs of a permanent freezing and processing facility.

A small walk in freezer as suggested for the test fishery will have to be approved by DFO if it is to receive registered fish plant status.

Provisions for fish holding racks, sinks, cleaning tables, water storage, drainage, effluent disposal, chlorination, electrical systems, lighting, etc. would have to be designed based on quota allotments and estimated catch and processing rates.

4.7 Transportation Options

The range of transportation options appears to be limited based on final product form. If fresh fish are to be transported out of Ross Bay then transport would have to be arranged approximately every third day in order to maintain product quality. If chartered aircraft are used some of the factors limiting cost effectiveness include weather, catch rates and inefficient loads (high ice to fish ratio). Close on site management and communications will be required to minimize the required flights.

Frozen or dried product would allow load building in order to maximize aircraft capacities. Ice would not be required for suitably packed products. Frozen product would have to be flown out of Ross Bay as product deterioration would occur in the 14 or more hours required to travel from Ross Bay to Repulse Bay. Further loss of quality would likely occur between Repulse Bay and Rankin Inlet.

Dried char would appear to present the most economical transportation options. Once dried the product could be held to build loads for any available transportation mode. If possible, the catch could be transported to Rankin Inlet from Repulse Bay via the freezer/packer vessel operating out of Duke of York Bay at the end of its test fishing season. Further market analysis for dried char is required to determine if the local market is large enough to absorb the quantity of product generated by the test fishery.

5.0 OPERATIONAL SCENARIOS

The following sections detail operational, logistical and financial considerations for the various scenarios proposed to access and implement the Ross Bay fishery. Initial consideration is applied to the required test fishery.

5.1 Summer Test Fishery

The test fishery proposed allows for the collection of all required biological data while minimizing infrastructural requirements such as freezers and the provision of ice as a dried product would be produced on-site.

The test fishery would concentrate on the upstream run and would take place between August 1 and September 15. Four river systems would be investigated as shown in Figure 5. Eight fishermen would be hired to carry out the fishing and initial processing (drying) of the catch. A crew of 4 technicians would be required to gather biological data. The following equipment would be required at each fishing camp:

1 - Canoe (24')	$ 4,400.
1 - Outboard (50 hp)	4,000.
4 - fuel tanks (5 gal)	60.
1 - tent (10' x 12')	280.
1 - stove	70
1 - lantern	60.
1 - VHF radio (complete)	1,800.
4 - gillnets (139 mm x 50 m x 24)	880.
4 - fish tubs	60.
4 - insulated 500 lb. fish boxes	1,200.
1 - hanging dial scale	160.

4 - tarps (10’ x 12’)	*60.*
1 - cutting table	50.
2 - fish knives	25.
2 - sharpening steels	25.
1 - shovel	25.
2 - paddles	50.
2 - Danforth anchors	210.
- spare parts and tools	350.
- drying racks (home built)	250.
	$ 14.015.

The biological sampling crew would supply all of their required equipment. The following provides an operational budget for the first season of test fishing:

Equipment

4 Field Camps @ $14,015.	***$ 56,060.***

Labour

8 fishermen @ $65. per diem x 45 days	23,400.
benefits @ 10%	2,340.
4 Technicians @ $200 per diem x 45 days	36,000.
benefits @ 10%	3,600.
1 Biologist @ $300 per diem x 45 days	13.500.

Operating Expenses

Food 13 men x 15/day x 45 day	***8,775.***
Gasoline 1000 gal. x $3.50	3,500.
Oil @ 20% of fuel cost	700.
Naptha 400 L @ $1.25 per	500.
Travel for biological crew	6,000.

Freight (equipment to Repulse Bay)	2,000.
Freight (dried fish to Rankin Inlet)	3,000.
Miscellaneous (phone, etc.)	500.
	24,975.

Biological Data Analysis

Aging of samples (600 ÷ 50/day x $200/day)	2,400.
Data Analysis and reporting (25 days x $300/day)	7,500.
	9,900.
Total Budget	$169,775.

It should be noted that the budget proposed for the summer test fishery, provides the majority of required eguipment. The fishery has been so designed as the sectoral review indicates certain equipment such as boats and motors are in limited supply.

5.2 Winter Test Fishery

A number of advantages are offered by a winter test fishery. These are priorized as follows:

- easy access to the fishery
- less sophisticated eguipment are required to preserve the quality of the catch

  equipment required to access the fishery (ie. snowmachines) are owned by the majority of fishermen
- the staff required for the collection of biological data can be reduced from 4 technicians to 2 technicians

The collection of biological data from the test fishery would be similar to the summer test fishery, but would depend heavily on accurate Cath/Effort data to provide information on the relative abundance of char overwintering in the freshwater systems as opposed to the utilization of CPE data to demonstrate the timing, strength and duration of the upstream run into the freshwater system.

As proposed the fishermen would record CPE data in the field, the catch would be heavily glazed on site and biological sampling would take place in the Rankin Inlet Fishplant.

The following cost savings over the summer test fishery are assumed:

4 -	Canoes @ $ 4,400	$ 17,600.
4 -	Outboard motors @ $ 4,00	16,000.
16 -	Insulated fish boxes @ $ 300.	4,800.
	Miscellaneous equipment	2,000.
2 -	Technicians	15,000.
		$ 55,400.

An additional pre-project saving of $ 12,000 would likely be accrued as no runway construction would be required at Ross Bay.

5.3 Cash Flow From A Commercial Fishery

Risk analysis?

Given the risk associated with any northern commercial fishery it is very difficult to accurately predict profitability. It is safe to assume that like many fisheries the Ross Bay fishery will be marginal. The entrepreneurial skills of individual fishermen play an important role in determining the success of individual operations. The following cash flow chart documents known revenues and costs associated with various harvest levels:

	QUOTA			
	2300	5000	10000	25000
REVENUE				
$ 6.60 per kg	15,180	33,000	66,000	165,000
COSTS				
Payment to fishermen @ $ 2.50/kg	5,750	12,500	25,000	62,500
Freight to Rankin @ $ 1 .25/kg	2,875	6,250	12,500	31,250
In plant costs @ $ 0.50/kg	1,150.	2,500	5,000	12,500
Freight to Wpg. @ $ 1. 79/kg	4,117	8,950	17,900	44,750.
PROFIT (LOSS)	1,288	2,800	5,600	14,000

Various costs such as insurance, licences, employee benefits, repairs, annual maintenance etc. would have to be considered in detail to provide an accurate proforma financial statement for the eventual operating scenario of the commercial harvest level determined through the test fishery process.

6.o Management Considerations for a Common Property Resource

A wide range of biological and economic management considerations for a fishery. concentrating on a common property resource are discussed in the following section. The discussion concentrates on the historical inland Canadian fishery, however the discussion has applicability to the future fishery of the region.

INTRODUCTION

Since the early 1900's almost all of Canada's commercial fisheries have been characterized by economic hardship and declining fish stocks. The present depressed state of the industry is mainly the result of inadequate resource management. Cauvin (personal communication, 1984) appropriately describes this situation as the "tragedy of fisheries".

Since the field of fisheries management is so diverse, this paper will be restricted to a discussion of the "tragedy" of central Canada's inland commercial fishery. A brief profile of this fishery, along with an assessment of its performance, provides the necessary background information to fully appreciate the extent of this problem. This will be followed by a discussion of current management schemes and shows how they have contributed to the poor performance of the industry. The final section introduces a variety of management alternatives and assesses their potential to rectify the problems currently faced by the fishing industry.

PROFILE OF CENTRAL CANADA'S INLAND COMMERCIAL FISHERY

The geographic extent of central Canada's inland commercial fishery coincides with the territory served by the federally operated Freshwater Fish Marketing Corporation (Fig. 1). This region includes the Northwest Territories, Alberta, Saskatchewan, Manitoba and Northwestern Ontario. Fish are harvested from approximately 500 lakes, ranging in size from one square kilometer to over 28,500 Km^2 (Thompson, 1981). Annual harvests are composed of over twenty freshwater fish species, and have averaged 20,600 tonnes (45.4 million pounds) since 1972 (Fisheries and Environment Canada, 1983). Harvests and gross revenues for 1977 are summarized in Table 1.

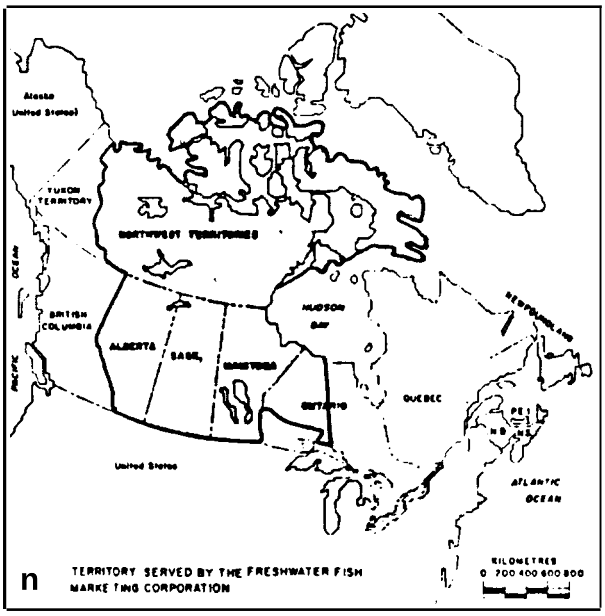


FIG. 1. Western region fisheries and area of operation of the Freshwater Fish Marketing Corporation (source: FFMC Annual Report 1975-76).

TABLE 1 Total FishHarvests and Gross Revenues, Northwest Territories, Alberta, Saskatchewan, Manitoba and Northwestern Ontario, 1977-78 Fishing Seasons

Species (grade)	Live Weight Equivalent. ('000 lb)	Delivered Weight ('000 lb)	Gross Revenues ($'000)
Whitefish	16,715	13,826	4,632
Walleye	10,079	8,332	6;702
Pike	8,143	6,198	1,034
Sauger	3,333	2;755	1,423
Trout	1,815	1,499	517
Others'	7,006	5,959	951
Total	47,091	38,569	15,259

IOthers include by volume, mullets 51%, carp 22%, tullibee 16%, arctic charr 4%, inconnu 3%, buffalofish 2%, perch 2%. Sturgeon, catfish, goldeye and fish roe account for less than 1% of harvest volume.

Source: Thompson (1981)'

Commercial fishing enterprises can operate throughout the year, harvesting occurring on both open water and through the ice. However, summer harvests usually represent more than 70 percent of the total fish harvested annually (Thompson, 1981). The harvesting sector utilizes four types of “fishing platforms”, the “whitefish” boat (a type of gill net tug), the skiff (an open boat powered by one or two outboard engines), snowmobiles and power toboggans. Fishing enterprises rarely employ both winter and summer technologies; they tend to operate during one season only (Thompson, 1981). The most common method of fish harvesting is the manual lifting and setting of gillnets from skiffs. Approximately 92% of the vessels which operated during the summer of 1977 were classed as skiffs (Thompson, 1981). Furthermore, skiffs harvested 75 percent of the fish caught during the 1977 open water period and earned 79% of the gross revenues (Table 2).

The marketing structure for central Canada’s inland fisheries resembles that of a monopsony (Cauvin, 1979). The Freshwater Fish Marketing Corporation, a federal Crown Corporation, has an exclusive mandate to purchase and sell all fish harvested in this region (Cauvin, 1979). Fishermen can, however, sell their fish directly to the final consumer. The most common means of regulating catch is an aggregate or lake quota, for example, in 1980 Cedar Lake, Manitoba had a quota of 110,000 lbs. of Whitefish (Thompson, 1981) .

PERFORMANCE OF THE COMMERCIAL FISHERY

The performance of central Canada’s fishing industry is extremely variable due to the dispersed geographic nature of inland fisheries. Despite

TABLE 2 Comparison of Skiff Harvests to Total Summer Fishery Harvests Summer 1977.

Species	Total Summer Harvest[1] ('000 lb)	Skiff %	Total Summer Gross Revenues ($'000)	Skiff %
Whitefish	13,381	75.0%	3;565	70.1%
Walleye	8,933	86.0	5,880	85.6
Pike	4,728	82.8	555	80.4
Sauger	2,357	96.9	976	96.9
Trout	1,763	83.0	500	81.0
Others	3,728	24.8	532	31.0
Total	34,890	75.4%	12,008	79.1%

[1] Live weight equivalent

this variation most economists (Cordon, 1953; Loftus, 1976; Reiger, 1976; Cauvin, 1978; Thompson, 1981) agree that the performance of the industry can be characterized as poor and deteriorating. Low financial returns to commercial fisheries production and the high incidence of public sector assistance programs are indicative of this poor performance.

Thompson (1981) calculated a frequency distribution of harvests and resultant gross revenues for all commercial fishing enterprises in central Canada during 1977-78 (Table 3). The mean harvest was only 2511 kg (5536 lb) delivered weight, while mean gross revenue was only $2,063. Further emphasizing the poor performance of the industry, more than 85% of all enterprises harvested less than 9072 kg (20,000 lbs) delivered weight and earned gross revenues of less than $8,900.

Economic Viability Continuum

Thompson (1981) notes that it is possible to define a rough gradation of lakes in Canada’s inland commercial fisheries based on their level of economic viability. Table 4 examines the economic viability (long run, short run, not viable) of 27 lakes in central Canada. The gradation is primarily related to the geographic location of a lake and the species composition available at the lake.

Economically accessible fisheries such as lakes; Winnipeg, Playgreen, Deschambault, Canoe, Kakisa and Moose are located at one end of the viability continuum (Table 4). The fish species composition of these lakes is comprised mainly of walleye and high grade whitefish and therefore provides relatively high gross revenues per pound of fish harvested. Furthermore, average transportation costs per pound of fish are relatively low because the lakes are located close to major fish distribution channels. Consequently these lakes are classed as economically accessible because relatively small annual harvests

TABLE 3 Distribution of Harvest for Fishing Enterprises Located in F.F.M.C. Jurisdiction, Summer 1977.

Harvest Range ('000 lb)	No. of Enterprises	Mean Deliveries	Mean Harvest (lb)	Mean Gross Revenue
o to 5	96	15	2,626	$ 980
5 to 10	114	28	7,245	2,901
10 to 15	72	36	12,355	4,382 ""
15 to 20	55	42	17,110	5,661
20 to 25	33	52	21,196	8,351
25 to 30	9	52	27,803	10,462
30 to 35	7	55	31,540	12,341
35 to 40	8	62	37;339	12,554
40 to 45	2	50	44,086	16,367
45 to 50	2	73	47,349	21,862
over 50	5	50	63,127	17,753
All Enterprises	403	33	8,805	3,261

Source: Thompson (1981)

TABLE 4 Estimated Economic Viability of Selected Skiff Fisheries.

Lake	Harvest Intervals										
	0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	Over 50
Descharme Lake	nv	nv	nv	nv	nv	nv	nv	nv	nv	nv	nv
Lac la Ronge	nv	nv	nv	nv	nv	nv	nv	nv	nv	nv	nv
Lac la Loche	nv	nv	nv	nv	nv	nv	nv	nv	nv	nv	SR
Lac la Biche	nv	nv	nv	nv	nv	nv	nv	nv	nv	SR	SR
Island Lake	nv	nv	nv	nv	nv	nv	SR	LR	LR	LR	LR
Bigstone Lake	nv	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR
Reindeer Lake	nv	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR
Wapawekka Lake	nv	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR
Rat Lake	nv	nv	nv	SR	LR	LR,	LR	LR	LR	LR	LR
Beaverhill Lake	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR
Wollaston Lake	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR
Bennet Lake	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR
Utik Lake	nv	nv	nv	SR	LR	LR,	LR	LR	LR	LR	LR
Southern Indian Lake	nv	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR
Stevenson Lake	nv	nv	SR	SR	LR	LR	LR	LR	LR	LR	LR
Great Slave Lake	nv	nv	SR	SR	LR	LR	LR	LR	LR	LR	LR
Knee Lake	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR	LR
Red Sucker Lake	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR	LR
Sharpe Lake	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR	LR
Cedar Lake	nv	nv	SR	LR	LR	LR	LR	LR	LR	LR	LR
Moose Lake	nv	SR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Kakisa Lake	nv	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Canoe Lake	nv	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Deschambault Lake	nv	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Playgreen Lake	nv	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Lake Winnipeg (non-quota)	SR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
Lake Winnipeg (quota)	SR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR

nv not economically viable
SR economically viable in the short-run
LR economically viable in the long-run

of fish (over 2270 kg or 5000 lb) are in theory required for fishing enterprises to achieve long-run viability (Table 4). Although these fisheries have great economic potential they have attracted much more labour and capital than is necessary to harvest the productive potential of the resource (Cauvin, 1979). As a result costs of production are excessive, profit margins have eroded and fish stocks are dwindling.

At the other end of the viability continuum it is possible to define economically inaccessible fisheries (Table 4). They have the poorest combination of species composition and geographic location. Many of these lakes are accessible by aircraft only. The excessively high cost of transportation is the major economic constraint in these fisheries. At Island Lake in 1977 fewer than 2 percent of the fishing enterprises harvested enough fish to be viable in even the short run (Thompson, 1981). In many remote lakes fishermen's average costs actually exceed their average revenues (Thompson, 1981). Another economic constraint of low-accessibility fisheries is their low biological productivity. Lakes tend to become increasingly inaccessible as one travels from south to north. Since northern lakes are relatively unproductive, fish are characterized by slow growth rates (Cole, 1979). For example, in Great Bear Lake an eight year old lake trout weighs only .4 kg (.9 lb) (Scott and Crossman, 1979). Consequently, many "inaccessible" lakes are unable to biologically sustain economically successful fishing enterprises regardless of transportation costs. Cauvin (1979) states that in the absence of government subsidies most "inaccessible" commercial fisheries would cease to exist.

MISMANAGEMENT OF THE COMMERCIAL FISHERY

Although pollution, habitat destruction and other environmental problems are obviously detrimental to Canada's commercial fisheries, the present depressed state of the industry is mainly the result of government mismanagement. The following categories of mismanagement will be discussed 1) narrow scope of present management 2) management of fisheries as common property resources 3) indiscriminate use of subsidy program and 4) inefficient regulation.

Narrow Scope of Fisheries Management

Commercial fisheries resource management has been so dominant by biological considerations that the economic success of the industry has totally deteriorated (Gordon, 1953; Gulland, 1978; Cauvin, 1979; Mitchell, 1979; Economic Council of Canada, 1981). The culprit of this "narrow headed" approach is a management strategy referred to as Maximum Sustainable Yield (MSY).

Almost all fisheries in central Canada are managed according to MSY (Cauvin, 1979). The MSY strategy is based on a biological model referred to as the Schaefer model (1953) (Fig 2). This model shows that fishing effort , for example the number of boats, fishermen or days fished, can result in an increased yield of fish with increased effort up to a maximum referred to as the maximum sustainable yield (Mitchell, 1979). In order to fully understand this model it is necessary to explain some basic biological aspects of fish production Mitchell (1979) provides a good review.
In the absence of fishing pressure a fish population will reach a size imposed by the environment; the amount of nutrients in a waterbody will support only a finite population of fish. Fishing reduces the size of the fish stock.

However, an increase in growth rate will occur because there are fewer fish relative to the food supply; hence the fish population will tend to return to its maximum level. As long as fish are harvested at the level of the new growth rate there will be no change in the size of the fish stock. Returning to the Schaefer model (Fig. 2), any effort beyond the MSY level will result in overexploitation of the resource, as the combined effects of man's fishing effort and natural mortality will exceed the natural growth rate of the fish population (Mitchell, 1979). The MSY strategy allows for the maximum quantity of fish to be harvested, while simultaneously conserving the resource. Based on this type of fisheries management any quotas which are set below the MSY level are considered to be wasteful as the maximum biomass potential of the resource is not being utilized (Economic Council of Canada, 1981). Many biologists also consider MSY to be the optimum economic level of exploitation (Mitchell, 1979). This rationale is probably based on the notion that the level of effort that produces the highest catch produces the largest amount of food, and is therefore in the best interests of society.

Economists strongly disagree that the management of commercial fisheries under the MSY criterion is in the best interests of society (Economic Council of Canada, 1981). Economists object to this strategy because it is based solely on physical yields. They emphasize that the costs and benefits of obtaining these yields should also be considered. The economists' viewpoint can be graphically depicted by turning the production yield function into a total revenue function, and by introducing a total cost function (Mitchell, 1979). Economic efficiency, as opposed to physical efficiency, occurs at a different level of fishing effort than MSY (Fig. 3). It occurs at the point where economic rent from the resource is maximized, more specifically where the difference between revenues from fishing and total costs of fishing

Biological Model: Schaefer

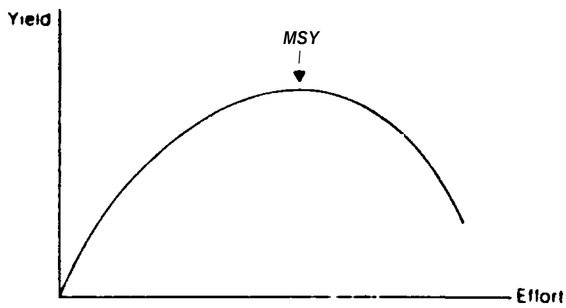


Figure 2

Economic **Model: Gordon**

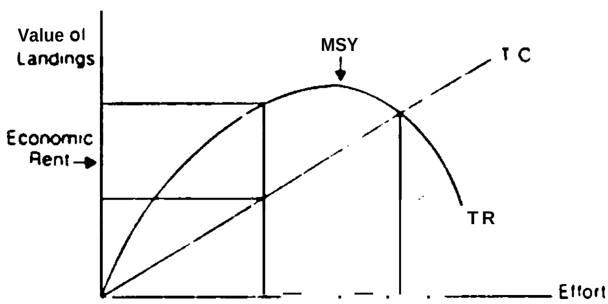


Figure 3

is maximized (Economic Council of Canada, 1981). This harvest level is referred to as the Optimum Sustainable Yield (CSY). Ironically the economic efficiency strategy dictates a more conservative management policy than MSY does (Economic Council of Canada, 1981). Although the CSY strategy would benefit the commercial fishing industry by simultaneously increasing ' economic efficiency and conserving fish stocks, the present mismanagement of fisheries as common property resources would invariably destroy any benefits gained by adopting this strategy.

Management of Fisheries as Common Property Resources

The present management of Canada's inland fisheries as common property resources has served neither the biologists' interest in protecting fish stocks nor the economists' interest in promoting the most economically efficient resource utilization (Cauvin, 1979). Maloney and Pearse (1979) define a common property resource as one which is managed under open access conditions since individual property rights to the resource are ill-defined or nonexistent. Almost all inland fisheries in Canada are governed by lake (or aggregate) quotas rather than individual quotas, and have uncontrolled access in terms of the number of fishermen who wish to fish a particular lake (Thompson, 1981). As a result of this common property feature excessively large numbers of fishermen are left to compete among themselves for a share of the allowable quota (Thompson, 1981). This competition in turn leads to economic inefficiency and in many cases overexploitation of the resource.

Management of fisheries as common property resources leads to economic inefficiency because it generally attracts much more labour and capital than is required to harvest the optimum sustainable yield (Gordon, 1953; Cauvin, 1979). Since access is not controlled, a situation is created wherein too many fishermen are chasing too few fish. Furthermore, quotas are of an aggregate variety, meaning individual fishermen are not formally limited in their catch. Consequently, there is incentive for fishermen to try and beat others to the limited allowable aggregate catch. This often involves adopting methods of fishing which are more costly as larger and faster boats are purchased in the competitive face for fish. The final result is that the net revenue that the fishing industry could have obtained from the resource is dissipated through larger numbers of fishermen and higher costs. Similarly, any potential value to society in the form of a resource rent is essentially foregone (Cauvin, 1979).

Although annual quotas are placed on lakes to conserve fish stocks, management of fisheries as common property resources tends to lead to overexploitation of the fish resource (Economic Council of Canada, 1981). This overexploitation originates as a result of the “economic trap” which fishermen often find themselves in. Fishermen find it extremely hard to exit from the industry because they have large investments in vessels and equipment that cannot be liquidated, and have few employment opportunities that are consistent with their skill and experience (Cauvin, 1979). Furthermore there is the continuous and immediate need to support their families. Consequently commercial fishermen often demand an increase in lake quota so they can meet their economic needs. Government officials often find themselves in a corner because they don’t have the funds necessary to accurately determine quota levels and thus are unsure if they have set quotas properly. Unfortunately, in many cases the commercial fishermen’s concrete evidence for a quota increase holds more power in final management decisions then the resource manager’s interest in protecting fish stocks (Robert Sopuck, personal communication, 1984).

Government Subsidy Programs

The problems associated with managing fisheries as common property resources have been further accentuated by the establishment of government subsidy programs which help maintain fishermen in overcapitalized and/or non-viable fisheries (Adams, 1978; Cauvin, 1978; Gulland, 1978; Sinclair, 1978; Cauvin, 1979; Thompson, 1981). To be successful in the long run fishing enterprises must generate enough earnings to cover all costs and provide a return to labour and capital. However, most commercial fishermen ignore investment costs in vessels and equipment (Thompson, 1981). They tend to continue fishing as long as their earnings are sufficient to cover variable costs. When capital equipment becomes exhausted and a new investment is required, the fisherman is faced with the problem of covering total costs or going out of business (Thompson, 1981). The development of government sponsored social welfare program has been extremely detrimental to the fishing industry because they inhibit natural adjustments in the industry infrastructure (Sinclair, 1978).

Government subsidy program inhibit natural adjustments in the commercial fishing industry in a variety of ways. Capital equipment (i.e. vessel) subsidies and operating (i.e. freight) subsidies, maintain fishing enterprises, and in some cases total fisheries, which would have naturally exited from the industry in the absence of financial support (Thompson, 1981). Capital and freight subsidies also tend to reduce the private cost of fishing as perceived by incoming fishermen, and therefore encourage the entry of more fishermen into the industry (Economic Council of Canada, 1981). Similarly, the existence of seasonal unemployment insurance benefits, which individuals would not collect unless they worked in the fishing industry, also tend to encourage more individuals into the industry. Cauvin (1984), (personal communication) suggests that many commercial fishermen enter the industry for social welfare benefits, rather than for the income derived directly from their fishing effort. It is very ironic that government officials are perpetuating the problem of overentry through the development Of subsidies, yet at the same time are trying to develop regulations which restrict entry.

The reasons provided by provincial and federal governments for the development of commercial fishing subsidy and assistance programs are very questionable. One reason put forward is to reduce unemployment levels through the provision of job opportunities in the fishing industry (Thompson, 1984, personal communication) . While the provision of employment may be valid for underutilized fisheries, the indiscriminate application of this philosophy has been very detrimental to the fishing industry (Cauvin. 1978). The creation of employment opportunities will perpetuate the problems of excess fishing effort and excess capital investment, thereby further dissipating economic returns and further stressing fish populations (Cauvin, 1978). Conversely a reduction of labour and capital in fishing would increase the income of those fishermen who remained. The problem of unemployment in society should be dealt with directly by economic policies that are explicitly aimed at the target problem, rather than disguising unemployment in a non productive society (Economic Council of Canada, 1981).

Another reason that has been provided for the development of government assistance programs in commercial fishing is to promote regional development through economic growth. The major shortcoming of these programs is that they fail to recognize that fish populations are limited in their capacity to generate economic growth (Adams, 1978). They face the same problems as other development programs based on a single resource. In an earlier section it was noted that a large proportion of fisheries, most notably northern fisheries, have little or no economic viability in even the short run (Table 4). Despite this non-viable character, a number of lakes in northern Canada have been "developed" through subsidy and assistance programs (Robert Sopuck, personal communication, 1984). The continuation of these fisheries even at the brink of poverty requires continuous economic support at the expense of the Canadian taxpayer. Subsidies cannot be justified on regional development grounds because most northern lakes have absolutely no potential to be self sufficient in the foreseeable future (Thompson, 1981). Furthermore, northern development projects such as subsidy schemes for fishing cooperatives usually meet with failure, because the indigenous peoples' existing way of life is neither recognized nor respected (Adams, 1978). Sinclair (1978) notes that regional development subsidies often encourage individuals to invest in unhealthy fisheries rather than other types of employment, and usually result in economic hardship and misallocation of the fish resource.

Inefficient Regulation

Traditionally the problems of common property resource exploitation and overfishing have been dealt with by regulations such as gear restrictions, closed seasons, closed areas and aggregate quotas. Although these regulations may be effective in preserving fish stocks they have not addressed the problems of economic inefficiency related to excess fishing effort and capital investment (Thompson, 1981). In fact, such regulations have probably contributed to the economic problems that the industry is currently facing.

Economists have continually pointed 'out the economic "absurdities" in current fisheries policy, since most regulations attempt to control exploitation by imposing gross inefficiencies on fishing enterprises

(Gulland, 1978). Gear restrictions prohibit high efficiency fishing and therefore increase the costs of fishing (Cauvin, 1979). Closed seasons intensify the common property “peanut scramble”, as they create a strong inducement for fishermen to expand their vessel size (storage capacity) and speed in order to take advantage of the shorter fishing season (Sinclair, 1978). Aggregate quotas prevent overutilization of the fish resource, but have failed to prevent overinvestment in the industry and the resultant decline in profits to fishermen (Adams, 1978). Based on this brief summary it is obvious that traditional fisheries regulations have not contributed to the economic health of the industry. Although the collapse of fish stocks must be avoided, regulations which achieve this single goal do not ensure successful fisheries management (Gulland, 1978).

Gordon (1954) notes that the regulations which have been developed to protect fish stocks from overexploitation are so numerous that they greatly exceed those applied to any other industry. The commercial fishing industry is characterized by a multitude of efficiency reducing regulations, due to the excessive amounts of labour and capital which are continually allowed to enter most fisheries. Overcapitalization encourages futher exploitation and usually leads to continued dissipation of the fish resource. This in turn makes it necessary to further intensify fishing regulations, which causes even greater economic inefficiencies in the industry (Sinclair, 1978). The final result of this cycle is a deteriorating commercial fishery, characterized by declining fish stocks and economic hardship.

FISHERIES MANAGEMENT ALTERNATIVE

The identification of multiple goals is the first step towards developing successful fisheries management programs (Crutchfield, 1973). The ultimate management scheme is one that will best serve the interests of 1) the resource, 2) the fishing industry, and 3) the general public (Crutchfield, 1973; Gulland, 1978; Sinclair, 1978, Cauvin, 1979). Although this ultimate state may realistically not be obtainable, management schemes aimed at controlling excess fishing effort and overcapitalization are definitely in the best interest of the three aforementioned sectors. Sinclair (1978) states that any management system that eliminates the tendency to dissipate the value of fisheries by reducing excess capacity will generate benefits. The potential benefits include: less pressure on fish stocks, a more economically efficient fishing industry, increases to fishermen's incomes, and finally the generation of an economic return for the general public.

The following section describes the advantages and disadvantages of several management alternatives aimed at controlling excess fishing effort and reducing overcapitalization. The management alternatives described include: 1) restricting the number of licenses issued 2) increasing license fees 3) a tax on landings, or royalty system 4) the "grandfather approach" and 5) a quantitative rights system.

Restricting the Number of Licenses Issued

The most obvious method of controlling fishing effort and reducing overcapitalization is to implement a fishing license ata nominal fee and restrict the number of licenses issued (Gordon, 1954; Sturman, 1976; Sinclair, 1978). Unfortunately, there are a number of problems associated with this method. The most serious problem is that it does not eliminate the incentive for individual fishermen to overinvest through the purchase of larger and faster boats (Sinclair, 1978). Even though the total number of vessels may be reduced, there will still be a competitive race among the remaining fishermen to ensure a greater share of the total allowable catch. In order to avoid this wasteful capitalization government agencies could restrict the size of vessels and types of gear used. However, in all likelihood this would hinder the economic efficiency of both the individual fishermen and the fishing industry (Cauvin, 1979).

Another problem associated with the license limitation method is whether to restrict vessel or individual fishermen licenses (Sinclair, 1978). If vessel licenses are limited, vessels will become a scare commodity and there will be incentive to increase catching power by increasing the number of deckhands. If fishermen licenses are restricted, fishermen will bcome the scarce commodity and there will be incentive for vessel owner to overcapitalize (Sinclair, 1978). In either case the economic waste generated may be the same as that which occurs in the absence of a license limitation system.

Another difficulty associated with this method is determining a way to allocate the limited number of licenses (Sinclair, 1978). Since one of the main objectives to a licensing program is to attain an economically efficient industry, it makes sense to distribute the licenses among the most efficient fishing enterprises. It also seems reasonable that license distribution should be done on a equitable basis. Unfortunately there is no acceptable method of distributing "free" licenses that meets these criteria (Sinclair, 1978).

The final problem associated with this management scheme is that the rent generated from the resource will accrue almost toally to the license holder. This will occur in any licensing system where the fee charged is less than the full amount that the market will bear (Sinclair, 1978).

Increased License Fee

Another alternative to control excess fishing effort and overcapitalization is to issue fishing licenses at a price that would just clear the market (Sinclair, 1978; Economic Council of Canada, 1981). The aim of this scheme would be to increase the private cost of fishing to a level that would dictate the optimum number of fishing units, thereby discouraging excess capacity, maximizing economic returns and conserving fish stocks. Sinclair (1978) notes that this strategy offers several other advantages: 1) it would distribute licenses to the most ~~meet~~ efficient operators 2) it solves the problem of allocating licenses and 3) it ensures that the general public gets an adequate proportion of the resource rent.

Unfortunately this management alternative has a number of disadvantages. The most critical disadvantage of this method is that its proper functioning depends almost entirely on the resource managers' ability to determine the correct license fee (Sinclair, 1978). Setting the fee too low would encourage overexploitation, while too high a fee would result in underutilization of the resource's potential. This management technique also does not specifically address the problem of competition between individual fishermen for the total allowable catch, since fishermen will still be encouraged to overcapitalize through the purchase of larger and faster boats.

Another problem with this method is that it favors full time fishermen over part-time fishermen (Sinclair, 1978). Part time fishermen would be at a disadvantage because they have a shorter period of time to recover the cost of the license. Since many individuals rely on a combination of part-time jobs (trapping, guiding, fishing) to make a living it can be argued that the "license fee increase system" would be disadvantageous to this segment of society.

<u>Tax on Landings or Royalty System</u>

Another alternative to control excess capacity in the fishing industry is to implement a tax or royalty based on the weight of fish harvested

(Gordon, 1954; Sinclair, 1978; Moloney and Pearse, 1979; Thompson, 1981). Sinclair (1978) notes that there is a natural tendency for fishermen to expand effort to the point where costs equal revenue, and suggests that a tax on landings would encourage a new equilibrium at a lower level of fishing effort.

A tax on landings system has a variety of attractive advantages. The most obvious advantage of this technique is that it will ensure an economic return to the general public in the form of a resource rent (Cauvin, 1979). Another major advantage is that it will improve the economic efficiency of the industry by reducing the number of fishing units to a level commensurate with the productive potential of the resource (Cauvin, 1979). A third advantage is that it will place less stress on the fish resource. A fourth advantage of a tax on landings system is that it enables the resource manager to charge variable rates to discourage the harvest of species which are in limited supply. A fifth advantage, unlike the licensing scheme discussed earlier, is that a tax on landings system does not put additional risks on the fishermen or discriminate against part time users (Sinclair, 1978). If a fisherman's landings are low the amount of his revenue captured by the government will also be low. Finally, since marketed fish are always counted and weighed for biological purposes, a tax on landings system would be easy to administer.

Although a tax on landings system has a variety of advantages it also has two very serious shortcomings. Firstly if this system is not used in combination with an aggregate quota it would be almost impossible to predict the proper level of taxation that would ensure that the optimum number of fish were caught. Secondly, since fishermen are not assured of a share of the total allowable catch the incentive to overcapitalize (purchase larger and faster boats) will still exist.

The Grandfather System

The "Grandfather System" is a management scheme whereby each fisherman is issued a nontransferable, lifetime license (Sinclair, 1978). As fishermen die or retire their license is withdrawn, thereby reducing the number of fishing units over time. The main advantage of this method is that it , can be used in combination with other schemes to overcome implementation problems (Sinclair, 1978).

Like other licensing systems this alternative has a number of problems. The most important shortcomings are as follows: 1) the resource rent will accrue to the established fishermen at the expense of the general public and fishermen unable to enter the fishery; 2) it doesn't allow for the adoption of new technology such as new low cost production units; 3) it doesn't solve overcapitalization due to competition for the limited allowable total catch: and 4) any improvements in the fishing industry will be extremely slow (Sinclair, 1978) and; 5) Equipment pertaining to estates of lapsed licenses will tend to have little or no market value.

Quantitative Rights System

Although the previously mentioned management alternatives would be effective at limiting access to the fishery, they fail to fully control the problem of overcapitalization. Consequently, the adoption of a quantitative rights system appears to be the best possible alternative to successfully manage a commercial fishery. In this system not only is access limited but the share of the resource available to each fishermen is also limited (Moloney and Pearse, 1979; Economic Council of Canada, 1981).

Before discussing the advantages and disadvantages of a quantitative rights scheme, a description of the system is in order. This method is best described using a hypothetical example (Moloney and Pearse, 1979). Assume lake X has a stable fish stock for which a total allowable catch is predetermined. Also assume that a large number of fishermen commercially fish the lake. A quantitative rights system involves issuing rights that authorize fishermen to capture a specified weight of fish. These rights would be denominated in small enough units so that individual fishermen would require several of them to operate efficiently. By ensuring that the sum of the individual landing rights adds up to the total allowable catch two objectives are met: 1) the individual fisherman's share of the allowable catch is protected, and 2) the total aggregate catch is controlled. Individual landing rights would be issued to the highest bidder, by way of an open auction, thus guaranteeing an economic return to the general public. The devolution of the landing rights would have to be of a sufficient length of time for fishermen to get a return on their capital investment. The rights could actually be of a perpetual nature (Moloney and Pearse, 1979) as is the case for our land resource. The final aspect of this management scheme is that the individual landing rights are transferable (Moloney and Pearse, 1979). In other words, fishermen can freely transfer their landing rights among themselves, or may sell them back to the government.

The advantages of a quantitative rights system are numerous. The most important advantage of this system is that it reduces overcapitalization, which is the basic cause of economic waste in today's fisheries. Since fishermen have rights to take specific quantities of fish there is no longer incentive to compete for the limited allowable catch (Economic Council of Canada, 1981). Instead of increasing their fishing power to secure a portion of the limited allowable catch, fishermen can now concentrate on reducing costs, thereby maximizing their net revenues. Another advantage of this scheme is that the development of a competitive market for quantitative landing rights will further encourage the development .of an economically efficient industry; if fishermen fail to adopt the most efficient methods available, they will be unable to compete for landing rights alleviated by restricting the total amount of rights which each individual can purchase. This maximum allowable quantity of rights would have to be set above the amount required to have a fishing enterprise which is viable in the long run. The final problem associated with this management scheme is that a large number of fishermen may be left without a job in the industry. Although this is definitely a problem, sooner or later it has to be realized that the ability of fisheries to provide employment is limited, as each fishery can biologically and economically support only a certain number of fish.

SUNMARY AND CONCLUSION

To summarize, the present depressed state of central Canada's inland commercial fishery is mainly the result of government mismangement. Although several categories of mismanagement were discussed, management of fisheries as common property resources appears to be most responsible for the depressed state of the industry. Uncontrolled access has led to both excess fishing effort and overcapitalization, and has resulted in the dissipation of any potential economic value from the resource as well as the depletion of fish stocks.

A variety of management alternatives such as restricting the number of licenses issued, increasing license fees and a tax on landings scheme have been suggested to alleviate the common property problem. Although these alternatives would be effective at limiting access, they fail to fully control the problem of overcapitalization. Consequently, the adoption of a quantitative rights system appears to be the best possible alternative to successfully manage a commercial fishery. In this system not only is access limited but the share of the resource available to each fishermen is also limited.

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