Common Property Resource Management: Implications For Fisheries In The Northwest Territories
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Introduction

Fisheries present unusual and difficult management problems compared to other natural resources. Media headlines lament the depletion of fish stocks, closed fish plants, low earnings for fishermen, massive government subsidies and other manifestations of a resource in trouble. Many of these problems flow from the common property aspects of the fishery. While common property is only part of the problem, the economic theory of common property resources offers a simple model for analysis, possible stabilization plans, and evaluation of fisheries.

This paper describes the basic conceptual framework of common property analysis which has dominated the field of fisheries economics for the past 40 years. The problems for fishery management and government investment which arise under this framework will be discussed and approaches used in other fisheries will be described. The primary purpose of the first section of this paper is to educate the reader in the basic principles of common property resource economics. In the final section we illustrate possible applications of common property analysis for fisheries in the Northwest Territories.

Fisheries as Common Property Resources

To understand the implications of the common property nature of fisheries resources it is useful to step back and examine the biological and economic nature of a commercial fishery, The following models are useful tools to understand the behaviour of fish and fishermen in various stages of a commercial fishery.

Figure 1 Schaefer Biological Yield Curve

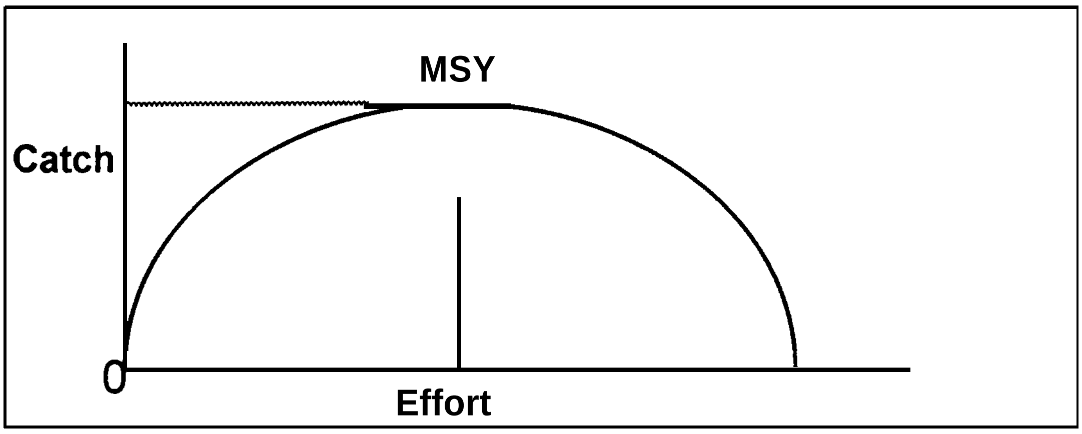
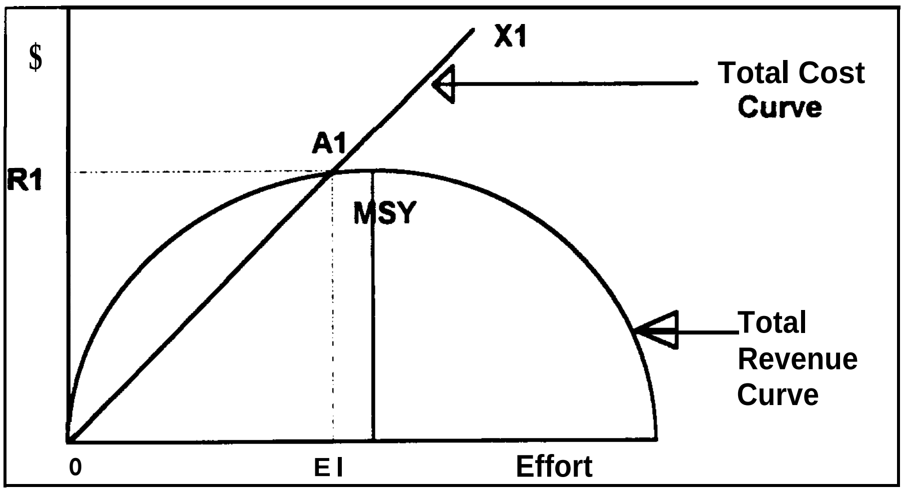


Figure 1 illustrates a simplified biological yield curve for an exploited fishery (developed by Schaefer, 1954). As fishing effort increases, total catch increases, rapidly at first but then at a decreasing rate as the fishery nears maximum sustainable yield (MSY). If fishing effort continues to increase beyond this point total catch will start to fall. Total catch and catch per unit effort will continue to decline with increasing effort until fishing stops or the stock collapses. While there are practical difficulties in determining MSY, the concept is useful in understanding the pattern of fisheries development.

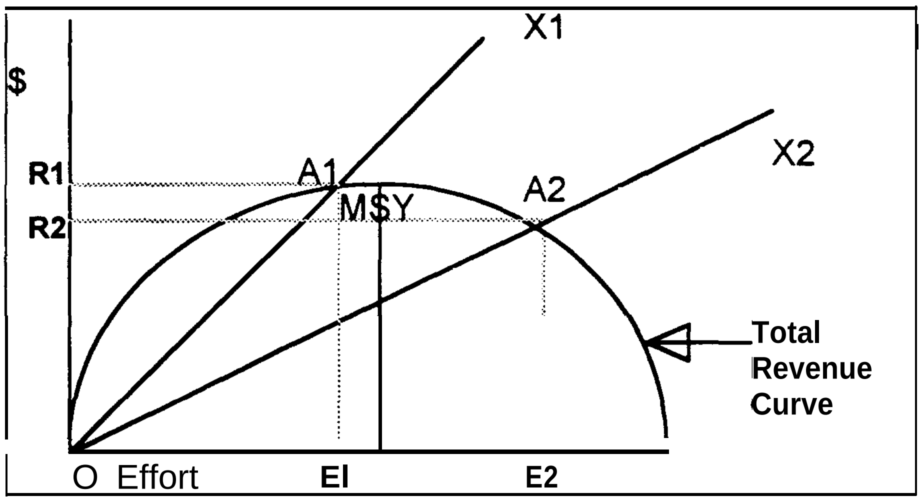
Figure 2 Scott-Gordon Model Fisheries



In Figure 2, the model has been modified to illustrate the economics of commercial fishing. This model is commonly referred to as the Scott-Gordon model after the economists that developed and refined its use. Catch is expressed as revenue ($) and the yield curve becomes a total revenue curve. The line O -Xl describes the total cost curve; this curve is linear because we assume that each additional unit of effort represents an identical cost. Therefore total costs increase directly with fishing effort. At point Al, the total cost curve intersects the total revenue curve indicating that at the level of effort E 1, total costs of fishing equal the total revenues (Rl). Any further effort would result in costs exceeding revenues.

Unless otherwise regulated, a fishery tends to develop until it reaches the point where costs meet or exceed revenues. If this point is below MSY (as seen at point A 1), the resource is not threatened. If however, it falls beyond the maximum sustainable yield shown as A2 in Figure 3, the fish stock is being over fished and more time, effort and capital is being invested to catch fewer and fewer fish.

Figure 3 Result of Lowering Total Cost Curve

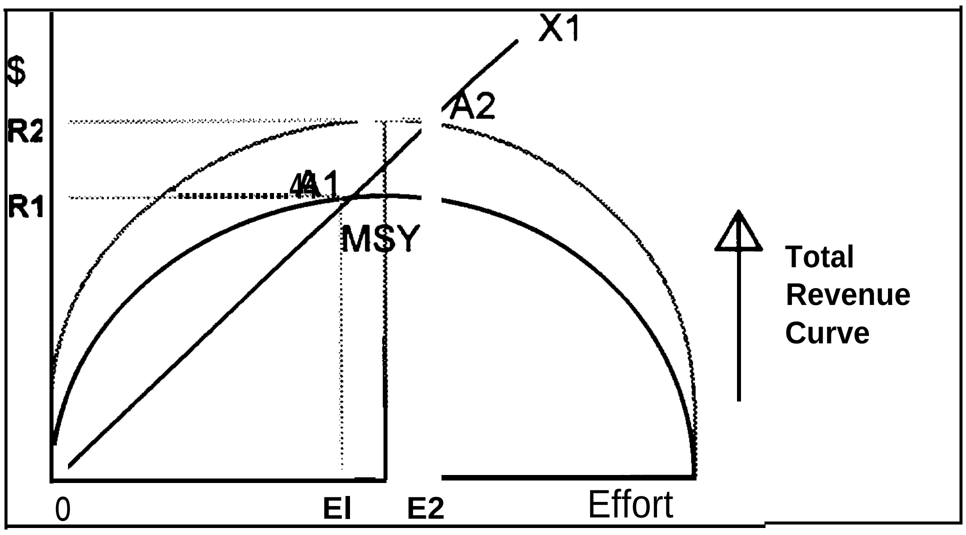


The cost and revenue curves in each fishery are determined by a number of factors including type of equipment used, operating costs, and market price. The point where costs equal revenues can move from Al to A2 as a result of improvements in efficiency which reduce the costs of fishing, moving the cost curve to O -X2.

Alternatively, a change in market conditions resulting in an increase in price would result in an upward shift in the total revenue curve relative to the total cost curve.

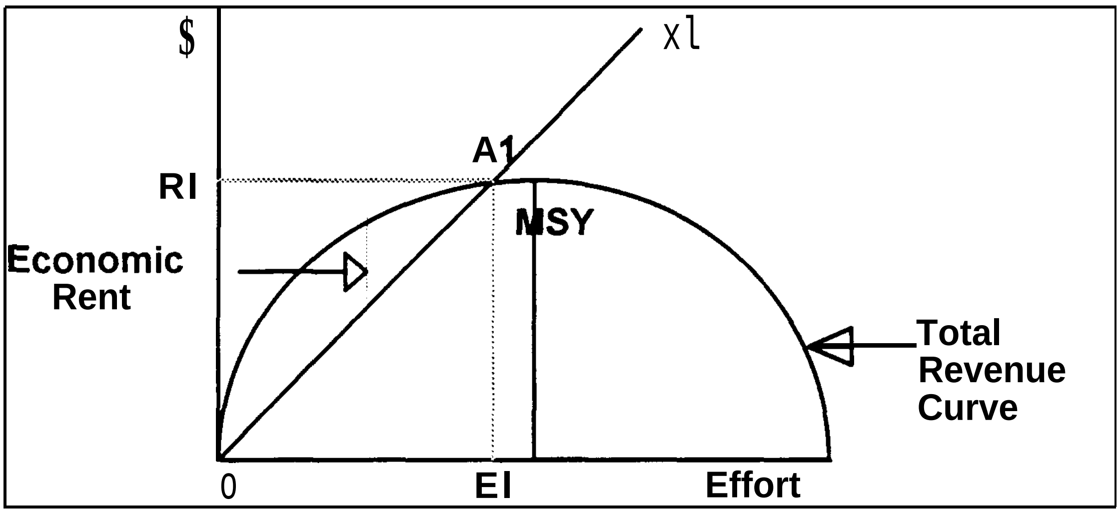
This could also push the equilibrium point (break-even point) beyond the level of maximum sustainable yield as illustrated at A2 Figure 4.

Figure 4 Result of Increasing Revenues



The difference between the total revenue curve and the total cost curve represents profits generated by the fishery. This profit is referred to as economic rent.

Figure 5 Economic Rent



If the level of fishing effort remains below E 1, revenues will exceed costs and an economic rent will be generated as shown in Figure 5, As effort increases, the economic rent disappears and at point Al it has completely dissipated.

Economic rent was first defined by David Ricardo in the early 19th century. Ricardo defined three ways of creating wealth: capital, labour, and land. The profit earned from use of capital was called interest, the profit earned from the use of labour was called wages, and the profit earned by the use of land and resources was called rent.

In fisheries economics, economic rent is the profit that can be generated by the stock because of its intrinsic productivity. The value arises from the market value of the resource itself Ideally, the role of the regulator is to manage the fishery so that capital investment and total costs are at a level which maximizes economic rent at a level below maximum sustainable yield. This ensures that the most fish are captured with the least effort.

The concept of economic rent has two important implications: rent generated from a renewable resource can continue to be extracted as long the stock generates a marketable surplus; and extraction of rent requires that ownership of the resource is clearly defined.

In North America, rent from natural resources is generally considered to belong to the citizens of the nation, as represented by government, because natural resources are held to be the common heritage of all citizens. Collection of rents by the government is justified by the need to off-set the costs of public administration, habitat maintenance and resource management which fall to the public sector.

For non-renewable resources such as minerals, several methods of capturing rent exist: resource rental taxes, profit, sales and capital gains taxes, and royalty payments. In the forestry industry, users are charged stumpage fees and royalties based on the value of trees logged.

In fisheries, governments generally fail to capture resource rent or prevent its dissipation. This failure is often the result of a deliberate strategy to maximize employment at the expense of economic efficiency. ED&T wrestles with this issue in its role as fishery developer because the balance between employment and economic efficiency has not been clearly articulated in the department's goals for fishery development.

The Common Property Effect

With this general understanding of the biology and economics of an exploited fishery we can examine the effect of common property ownership on fisheries using the Scott-Gordon fisheries economic model.

A common property resource is a resource where ownership is not vested in a single person or company. There are two basic types of resource "ownership" that are commonly referred to as common property ownership: open access and ownership held in common. While both terms tend to be used interchangeably, they actually have quite different ramifications.

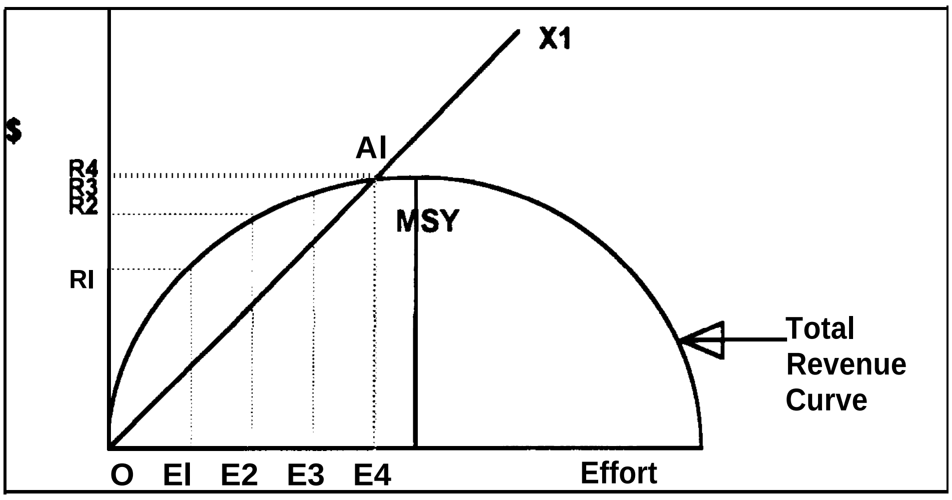
- Open access fisheries are those that belong to no one and have unregulated access; everyone is free to fish. Typically, modem commercial fisheries are open access fisheries. All NWT commercial fisheries are open access fisheries.

- Ownership held in common implies that ownership is vested in common among many. Many traditional and/or subsistence fisheries are "owned' as common property and have rules and regulations which control participation and catch.

Only unregulated open access fisheries suffer the problems associated with the "common property" effect.

The following figure illustrates a simplified version of what happens in an open access fishery.

Figure 6 Common Propetty Effect



When the first fisherman enters a fishery (El), catch rates are high and revenues (Rl) exceed costs generating a profit. This encourages more fishermen to enter the fishery. When the second fisherman enters the fishery (E2) total revenues increase to R2, however the additional or "marginal" revenue created by the second fisherman (the difference between RI and R2) is smaller than the revenue created by the first fisherman because of the nature of the biological yield curve. The marginal revenue created by each subsequent fisherman gradually decreases as the harvest approaches MSY.

At some point, the marginal increase in revenue will be equal to the additional cost of creating that revenue. This point represents the most efficient level of fishing, and the level that produces the greatest amount of economic rent. Beyond this point, total revenues continue to increase however the cost of producing additional revenues is higher than the marginal value of those revenues and profit decreases until, at effort E4 profit is completely dissipated

If the fishery was fished by only one operator, the owner's revenue would increase by the marginal revenue created by each additional unit of effort put into the fishery. Therefore, fishing would likely stop at the point of maximum profit. Beyond this point the owner would be subject to declining returns on his effort and the additional costs of fishing would exceed the additional revenues earned.

However, fisheries are not owned by single owners, but rather are unowned resources fished by a large number of people. In addition, the amount of fish available is limited and fish are not an immobile resource; fishermen cannot put a fence around their share of the catch and keep it to themselves. Therefore, when a second fisherman enters the fishery, he competes with the first fisherman for a share of the catch. Rather than the first fisherman receiving R1 and the second fisherman receiving only the smaller marginal revenue he has contributed (R2-R1), each fishermen receives half of the total revenue (R2/2) thus reducing the revenue received by the first fisherman.

As more fishermen enter the fishery each fisherman contributes a smaller and smaller marginal revenue but all fishermen receive an average revenue from the total catch. This results in declining revenues for all fishermen as more and more fishermen enter the fishery. To counter this, fishermen invest more money into bigger and better equipment to outcompete other fishermen and the cycle continues with more and more money spent on chasing fewer and fewer fish. This is commonly referred to by economists as the "tragedy of the commons".

Because each additional fisherman receives a greater revenue than the marginal revenue he contributes, fishing will continue as long as average revenues exceed the marginal costs of fishing. Therefore fishing effort will continue to increase to Al, far beyond the point where marginal costs equal marginal returns, and all profit available from the fishery will be dissipated.

The Problems and Possible Solutions

There are a number of problems that typically accompany common property or open access fisheries. These problems can be classified as biological or economic problems.

On the biological side, open access fisheries often lead to over-exploitation of the fish resource, reduction in bio-diversity (the inter-relationship among fish populations and other species), and depletion or destruction of stocks.

An open access fishery provides an economic incentive to overfish because each fisherman is trying to catch as many fish as possible to cover costs. There is no economic reason to stop fishing at MSY and over fishing is likely. Therefore most fisheries are regulated by a quota system that dictates the total commercial catch that can be taken. Unfortunately, there is a lack of basic information about the biological factors that control fish populations fished by a variety of gear, and fish recruitment and growth is often not clearly understood. The supply of fish available at any time is uncertain and it is very difficult to accurately determine, year after year, the potential catch from a stock of fish. While biologists have developed a formidable number of techniques for analyzing fish stocks, population estimation is still an art rather than a science and quotas are frequently set too high for resource sustainability.

The economic problems experienced by fishermen in open access fisheries include low earnings, dependence upon subsidies and overall lack of employment. For the industry as a whole, problems include excess capitalization in plants and equipment, low profit margins, a supply-driven market, and a high-risk, uncertain future. The costs to society are subsidies to support the industry and inhibited ability to plan for the sector.

A General Framework for Problem Solving: Micro Model

There are a number of ways that the problems accompanying open access fisheries can be prevented or mitigated. The Scott-Gordon model of fisheries shows that an economic profit is available from fisheries when there is a difference between total costs and total revenues any point to the left of equilibrium. As discussed earlier, this profit represents rent from the resource which should accrue to the owner of the resource, the Canadian public. However, rent is never extracted from Canadian fisheries, to a large degree because our fisheries are often in trouble.

The long run objective of fisheries management may be to move the fishery to some profitable equilibrium, however, in the short-run, managers are often required to somehow stabilize the fishery until the economic and biological problems can be solved.

To examine how fisheries can be stabilized it is useful to look at the components of the Scott-Gordon model in more detail. For this purpose the micro-economic factors present in the operation of a business can be used. The micro-model of fisheries uses three simple formulae: a revenue formula, a cost formula, and a profit formula.

Total Revenue = Price X Quantity $R = P \times Q$ **(eq. 1)**
Total Costs = Total Fixed Costs + Total Variable Costs $C = FC + VC$ **(eq. 2)**
Profits = Total Revenues - Total Costs $P = R - C$ **(eq. 3)**

This model captures specific problems in a fishery and can help define possible solutions at both the micro (individual business) and macro (overall industry) level.

Each of the elements that makeup the micro-model are briefly described below:

Total Revenue

Total revenues are determined by the price of fish times the quantity of fish sold. Increased total revenue in the fisheries can be achieved by increasing catches (Q) or by obtaining higher prices (P). Higher catches (Q) are achieved by improving fishing technology or finding new grounds or stocks. In fisheries controlled by quotas, the total catch cannot be increased. However, if a system of transferable quotas is put into place, the catch of each vessel can effectively be increased.

Higher prices (P) can be achieved by better marketing practices. At the vessel level this may require increased quality. At the plant level, increased prices may require value--added production. Image development may also increase market price. For example, the price for wild B.C. salmon increased once wild salmon was differentiated from farmed salmon in the marketplace.

Economies of scale can also influence market price. This was part of the rationale behind the creation of the Freshwater Fish Marketing Corporation, which represents a share of the commercial freshwater fishery which is sufficiently large to influence price.

Total Costs

Fixed and variable costs vary in importance in different fisheries.

Fixed Costs

At the harvester level, fixed costs consist of vessel and gear costs. At the plant level fixed costs consist of infrastructure, equipment and fixed operating costs.

In licensed fisheries with total quota restrictions, owners tend to “capital stuff’ their vessels to outcompete other fishermen. They buy the latest technology and equipment to make their operation more effective and thereby increase fishing effort by improving fishing techniques. Availability of financing and tax structure strongly influence the amount of capital investment made by fishermen. In a licensed fishery fixed costs tend to rise because the security of access to the resource tends to make financing easier. Government contribution programs can also contribute significantly to over capitalization in the fishery.

Variable Costs

Variable costs are those operating costs that increase as the level of fishing effort increases. Variable costs can be negligible, as in the B.C. herring-roe fishery where fishing takes place for only one day, or a major cost, as in the Bay of Fundy herring weir fishery where, once the weir is constructed, all fishing costs are variable costs. In general variable costs are fuel, provisions and wages.

The Micro Model and the Problem of Stability

The micro model is most useful in pinpointing where government should direct efforts to stabilize fisheries that are in trouble. The model is useful in analyzing the cause of instability and for defining possible policies to overcome instability. The model may appear simplistic and therefore unnecessary, but its simplicity allows policy makers to focus quickly on the problem and provides a common framework for decision making when decisions are made through collaborative effort.

Solutions in the Context of Open Access

A range of options have been proposed and attempted for managing fisheries within the context of the open access model. The options selected depend on the goals of the regulator, the political climate and the practicality of the option for a given fishery.

The options fall into two broad categories: definition of property rights, and limitation of effort. The first category applies to outputs, and the second category applies to inputs.

In the category of property rights, the major options are as follows:

- sole ownership of the resource
- individual transferable quotas
- ownership in joint tenure (common property)

In the category of effort limitation, the following are major options:

- limitations on vessel configuration
- limitations on gear
- limitations on entry (limiting the number of fishermen)

- restricting time or season
- restricting areas

A third category of options available is taxation. Taxation or royalty payments can theoretically be used to capture resource rent from the fishery and control capital investment.

Each of these options is briefly discussed in the following section.

Property Rights

1. Sole Ownership

Sole ownership of a fishery resource means vesting all rights of ownership in a single agency, company or individual. This option is appealing from the view of economic efficiency and extraction of resource rent as it is assumed that the owner would not over-capitalize. However, this option has not been seriously entertained in North America because of ideology. The development of natural resources in North America since the arrival of Europeans has very explicitly followed a path of open access in contrast to the system of private rights found in Europe and England.

A limited example of sole ownership is found in the Freshwater Fish Marketing Corporation. The FFMC has monopoly purchasing rights for fish over a large area, giving the corporation effective ownership of the fish at the commercial level. One result of this monopoly ownership has been the drastic reduction of plant capacity throughout its area of jurisdiction; the FFMC closed down many small plants and invested in a larger, more efficient plant to handle all product. This move is consistent with the prediction that the sole owner of a fishery would reduce its costs in order to improve efficiency and maximize economic rent. The economic rent captured by FFMC is redistributed to the fishermen in the form of final payments.

2. Individual Transferable Quotas (ITQ's)

Individual transferable quotas have been implemented in many fisheries in Canada and throughout the world including Atlantic Canada, Iceland, Australia's bluefish tuna fishery, and most of the coastal and offshore fisheries of New Zealand. ITQ's are also used in Lake Erie and Lake Winnipeg, two major inland Canadian fisheries.

ITQ's have received some attention in fisheries because of their use in stabilizing fishing effort and allowing quota holders to sell their quota and take out some equity when they leave. The advantage of ITQ's from society's point of view is a reduction in costs through a reduction in the number of vessels and people required to catch a given allocation of fish. Secondly, the holders of larger quotas may make larger profits and have stable earnings. While these advantages have been promoted by resource managers, fishermen have accepted ITQ's with a certain amount of reluctance.

The basic ITQ concept is the same in all applications: individual fishermen receive a set amount of the total overall quota. Usually fishermen are free to fish with gear and vessels of their choice, however certain restrictions may apply for the protection of the fish stock and habitat. Because fishermen do not have to compete for quota, there will no pressure to over-capitalize.

Fishermen are free to buy and sell quota, easing entry and exit from the fishery. More efficient operators can buy up more quota and adapt the size of their capital investment to their fishing requirements.

The first apparent effect of ITQ is a reduction in the number of jobs available to fishermen because of a reduction in vessels. Hence, resistance to ITQ's come from the fishermen who crew the vessels. Second, resistance to ITQ's results because no one is aware of all the implications. Fishermen sense that there will be winners and losers when an ITQ system is instituted and they are not sure which side they will end up on. Good cost and earnings data helps demonstrate benefits to fishermen.

Individual quota allocation has strong support among fishery regulators however the system has problems. For example, in a mixed-species fishery, a single quota for all species encourages wastage of less valuable species. In a fishery with many marketing channels, monitoring quotas becomes difficult and expensive.

The following section describes the experience of some Canadian fisheries with individual transferable quotas.

Lake Winnipeg

Lake Winnipeg is the second largest freshwater fishery in Canada after the Great Lakes. Current annual production averages 5,200 tonnes with lake whitefish and pickerel being the major commercial species taken on the lake. A system of ITQ's was introduced to Lake Winnipeg in the early 1970's and is still in place. Quota allocations vary according to the area of the lake for which they are assigned and, because of differences in fish populations between the southern and the northern basins of the lake, quotas cannot be transferred between these areas. There are also restrictions based on residency; a period of residency is prescribed in certain communities before a quota can be purchased from that community. According to fisheries regulators, the system works well and has resulted in significant increases in earnings for fishermen since its inception.

Quota assignment in the Lake Winnipeg fishery was calculated based on the market value of the primary target species and historical catches of individual fishermen. Quotas on the north basin of the lake, where whitefish predominate, are larger than quotas in the south basin where pickerel, a more valuable species, predominate.

It is significant that ITQ's have been rejected by other fisheries in northern Manitoba which are carried out by Native fishermen. Concern over purchase of quota by outsiders and a philosophical difference between ITQ systems and the idea of communal access to resources maintained in traditional Native communities lessens the appeal of ITQ's for northern Manitoba Native fishermen.

Lake Erie

The Lake Erie fishery instituted ITQ's in 1985. Vessel-owners are assigned quotas for various species from the total allowable catch and these quotas are freely transferable in part or in whole either through outright sale or lease arrangement. For example, the holder of a 50,000 lb. quota may decide to sell 30,000 lbs of the quota and to fish the remainder. All quota transfers, sales and leases must be approved by the Ontario

Department of Fisheries Department of Fisheries to prevent ITQ's from becoming concentrated in a few hands.

According to a DFO official, the system works very well. Values of up to $6.00 per pound have been recorded for a sale of a quota and the cost of leasing a quota vanes, with values of up to $1,00 per pound being recorded. The transferability of quotas has slowly evolved from the initial institution of vessel quotas in 1985 to full transferability at present.

The ITQ system is monitored by the Lake Erie Fisheries Association which is a loose co-operative consisting of eleven fish processors and the ITQ holders. The association's role is to promote the fishing industry, monitor the transfer of quotas, and ensure that quotas are not exceeded. The association has the right to inspect plants and records and can therefore prevent a fisherman who exceeds his quota from selling fish to a processor. Thus, the quota limits are maintained.

Part of the reason for the acceptance of ITQs in Lake Erie came from the US Lake Erie experience where ITQs were in effect. The final impetus to establish ITQs in Canada came from the desire of H.J. Heinz to acquire vessel licenses and quotas for its Canadian subsidiary Olmstead Fisheries. Olmstead wished to ensure a stable supply of fish and become the lowest cost producer in the region. This alarmed the Canadian government and fishermen, and all licenses and transfers became subject to a review and approval by the government.

According to DFO officials, the push to establish ITQ's came from the government.and acceptance by the fishermen came about because they knew that ITQs worked in the States, and they wanted to rationalize fishing operations to earn a profit. The Lake Erie Fisheries Association was formed because of the need for independent monitoring of harvests and quota transfers.

B.C. Halibut Fishery

The B.C. halibut fishery is a well-established fishery in which the economics and biology are understood. The fishery is carried out by longlines and stocks are protected by an overall quota. The main problem with this fishery was that the quota was captured in a short period of time and the catch was frozen because the market could not absorb the total catch. This resulted in a low fish price and a scramble by each fisherman to catch as much as possible before the quota was taken.

To resolve these problems individual quotas were instituted, some of which were transferable. Quotas were assigned based on the long history of recorded catches by each vessel. With the allocation of individual quotas, there is no longer a scramble to catch fish before the quota is taken, and the halibut catch is now spread out over a longer period of time. Halibut is now delivered fresh to the market and therefore commands a higher price. In addition, fishermen are pooling their fishing and marketing efforts. The fishery appears to be self-regulated by the fishermen who monitor vessel quotas.

The development of this management regime was possible because of the fishery's long history and the extensive knowledge of the biology of the halibut. The economics, and costs and earnings of the fishery are also known. These factors allowed appropriate and economically sustainable quotas to be set.

Atlantic Groundfish Enterprise Allocations

In the Atlantic groundfish fishery, individual quota allocations are made from the total allowable catch to individual enterprises (fish processors or large vessels. This method of quota allocation has the advantage of allowing individual fish plants to fish according to their needs while still limiting effort such that the plant receives the maximum harvest for the least cost. The Gulf of St. Lawrence redfish fishery is a good example of this type of quota allocation.

Similar to enterprise allocations are vessel allocations assigned to herring vessels in the Bay of Fundy. With a vessel allocation, each vessel can adjust its effort to the specific demands of the plant for which it fishes.

3. Common Property Ownership

Common property ownership was common in subsistence fisheries prior to commercialization, and rules for resource allocation have been documented for many common property artisanal and traditional fisheries. These rules allowed the resource to be fished in a sustainable manner and often included rules regarding who could fish, when they could fish, where they could fish and what kind of gear could be used.

Westernization has generally replaced these older patterns of resource management with new rules of open access. Berkes[1] identifies a number of changes which have occurred in the Canadian north when traditional fisheries are commercialized:

- loss of community control over the resource
- conflict between artisanal and commercial fisheries
- commercialization of subsistence fisheries
- rapid population growth and technology change
- concentration of previously scattered and migratory population in permanent settlements

Many of these changes have resulted in the breakdown of traditional common propetty resource management. In the history of Canadian resource development, particularly the commercialization of fisheries historically exploited as subsistence fisheries, a pattern of development which is common to many fisheries emerges. The cycle begins with steady-state, low-level exploitation of the resource, often used communally under some kind of common-property management regime. Pressure builds to exploit the resource for profit beyond the subsistence needs of the community. This pressure may come from outside (government development programs), from the demands of increased population, or the availability of more effective exploitation technologies.

At this stage, if open access conditions exist, the original group of users is typically displaced or marginalized by more effective harvesters who move into the area. The resource development phase begins; the fishery is no longer a steady-state system, but is expanding. Growth is sustained by mining a series of resources and from more valuable to less valuable species. Area after area, and stock after stock is depleted in an orderly fashion in the course of resource development. When all the resources are depleted, the developers move out.

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[1] Fikret Berkes, 1985. Fishermen and the 'Tragedy of the Commons', Environmental Conservation 12 (3): 199-206.

To avoid this, the Canadian government has, in the last decade, moved toward a system of cooperative management of fish stocks in which allocation decisions within communities in claim areas are usually left to the community. Such rights approach common property ownership.

This direction has been formalized in the various land claims agreements in the Northwest Territories. Under these land claims, rights of access to resources in various locations have been reserved for claimants. Wildlife Management Boards comprised of claimant and government representatives make allocation decisions for all natural resources included in the claim.

The rules or parameters used in these allocation decisions have not been examined. However, as land claims are settled and implemented, these boards and communities will increasingly be called upon to make decisions regarding allocations between subsistence, commercial and recreational needs.

Limits on Effort

All methods of limiting fishing effort require some form of external regulation through licensing. A reduction in fishing effort causes problems by lowering fishermen's incomes therefore various "buy-back" methods have been attempted to give fishermen money and at the same time reduce effort. However, the very act of putting licensing regimes in place can cause a perverse effect as the existence of licenses may provide an incentive to become licensed to ensure future participation. This sometimes results in an increase in the number of fishermen in a distressed fishery.

Effort limitation imposed by government generally results in fishermen attempting to beat the system. Restrictions on vessel length cause fishermen to build wider boats; restrictions on amount of time spent fishing cause fishermen to purchase faster vessels which are less fuel efficient, etc. In addition, a high degree of regulatory effort is required to enforce effort limitation in the fishery. For all these reasons, effort limitation schemes in Canada and internationally have not been very successful.

Because effort limitations through gear, vessel and time/space restrictions are variations on the same theme, they are not discussed individually here. Rather, examples of application in various fisheries are presented in the following section.

B.C. Herring Roe Fishery

This fishery is interesting because the method of effort limitation allowed substantial rem to be captured by the vessel owners.

The main focus of this fishery is herring roe which is sold into a single market - Japan - for New Year's gift giving.. Roe is the symbol of fertility (and hence the New Year) and eagerly bought. The Japanese market for BC roe is estimated at 35,000 tonnes with a landed value of about $100 million. The B.C. seine fleet of 252 vessels takes approximately 40 per cent of this; the remainder is taken by 1,327 gillnetters.

The management objective of the fishery is to maximize revenues and adjust fishing effort accordingly. Fishing effort has been limited by limiting the number of vessels, establishing a quota, limiting the time fishing takes place, and restricting harvesting areas. Quotas are based on market considerations and are allocated based on gear type (seine or gillnet) and area. The fishery is prosecuted in spawning populations therefore fisheries are opened for a matter of minutes; rarely a fishery is opened for a day or two. The high risk associated with this fishery has impelled vessels to "pool" resources such that one boat will fish and others will share in the catch.

A single seine license is now valued at $600,000. Annual rental of a seine license is set at $60,000. A gillnet license sells for $60,000 with an annual lease valued at $10,000. Profits generated by the fishery have gone to the fishermen.

B.C. Salmon Effort Limitation Plans

The B.C. salmon fishery is one the most regulated fisheries in the world. Because of the five different species and the various runs of salmon, management is crucial. A fishing plan is established each year based upon expected catches, and allocations are made by area and gear type. The coast is divided up into 29 areas with many sub-divisions, allowing fishing effort to be controlled to some degree. All vessels are licensed and fishing effort is controlled by area and time openings

Several attempts at vessel "buy-back" have been undertaken to control total effort but they have only reduced total effort by a small degree. There have also been attempts to control fishing effort through limiting the number and length of vessels operating. The number of vessels by gear-type is frozen (549 seines, 3,688 gillnets plus some Native licenses), however the efficiency of vessels increases as vessels are replaced therefore total effort is not affected significantly. Similarly, vessel length is restricted and a seine license costs approximately $250,000 based on vessel length. However, fishermen have circumvented this restriction as well by increasing the efficiency of the equipment on their boats. Therefore, the major control of fishing effort has been through reducing fishing time. Two and three day openings in an area have been reduced in many cases to 12 hour openings.

A new feature in this fishery has been the allocation of Fraser River salmon to native Indian bands in the Fraser Canyon. Each band has a quota and a management plan signed in agreement with DFO. Licensing and catch allocations are the responsibility of each band. The bands have formed an umbrella organization which hires its own Fishery Officers. The key feature here is the allocation of fish and management responsibility to Native Indian bands. These agreements serve as models for local Native management of other stocks harvested commercially.

Taxation

Taxation schemes have been considered for many fisheries to control the level of fishing capacity/fishing effort. A quota tax has been implemented in New Zealand where a system of individual transferable quotas is in place. The tax is calculated annually and is payable in quarterly installments. Taxes are based on the market value of quotas and expected net returns to fishermen. Implementing the quota tax is complicated by the need to determine a competitive rate of interest and market price of quota.

Taxation as a means to control capital investment and recover economic rent in the fishery has not received much support as a practical solution in most fisheries. The idea of cost-recovery for management costs and fish enhancement was explored in the B.C. Salmon

Enhancement Program where these costs were to be recovered through fees to industry and a landings tax. However, these means have yet to be implemented.

Taxation schemes suffer from the difficulties of determining an appropriate tax level given fluctuating catch and changes in fishing costs and fish prices. In addition, taxation offers no real benefits to fishermen since fishermen are unable to enjoy any of the resource rent generated by the fishery and thus are no better off than they would be under open access fishery regime.

Conclusions

Most fisheries in North America are managed as open access resources and as a result commercial fishing typically leads to over capitalization and low returns to fishermen. Attempts to control fishing effort through effort limitation are usually undermined by the ability of fishermen to develop better techniques and find different technologies to circumvent the rules. The disposition of quasi-property rights to participants may be a better alternative to restrictions on technology, however property rights in the form of ITQ's are effective only in relatively simple fisheries where there is adequate information on economics and biology. A common property approach may be more appropriate for traditional Native fisheries where resource allocation decisions can be made by the community. Sole ownership of the resource is an option that has not been pursued in North American fisheries, however this option does however offer advantages in terms of economic goals.

The regulatory instruments selected to manage a fishery should reflect the overall goals of the fishery. For governments, this requires a decision regarding the balance between economic efficiency, employment benefits, and the desire to collect economic rents from the resource.

Common Property Analysis of NWT Fisheries

In this section we apply the common property concepts and micro-model analysis to the major commercial fisheries in the NWT. The reader should note that we have simplified and adapted the conventional Scott-Gordon model to illustrate the situation in NWT fisheries. Conventionally, the Scott-Gordon model is applied only to the harvesting sector of a fishery. However, in most NWT fisheries the processing sector tends to be operated and underwritten by the government as a means of providing jobs in the harvesting sector therefore we have included the total costs required to achieve market revenues in our analysis. While we recognize that this is an unconventional and simplistic use of the model, we feel it illustrates the common property nature, and the costs and revenues that apply to NWT fisheries more clearly. In developing the following examples we relied on data readily available to us, provided primarily by ED&T.

Great Slave Lake Fishery

Great Slave Lake, the oldest commercial fishery in the NWT, has followed the classic exploitation cycle described in the first section of this paper. The fishery initially offered an economic opportunity which attracted harvesters from outside the Territories. Early exploitation concentrated on lake trout which originally accounted for 64°A of the total catch. Lake trout populations were quickly decimated and effort moved to whitefish. The proportion of the catch currently made up by lake trout has dropped to less than 10%.

Quotas were initially very high and, at one point in its early history, Great Slave Lake was the single largest producer of whitefish in North America. As catch rates declined and price dropped, the outside developers dropped out, leaving the fishery to be carried out by the more tenacious members of the original crews. These men remained in the NWT and took up permanent residence in Hay River, relying on native communities in northern Manitoba and Saskatchewan as a labour pool for crews.

In 1979 a limited entry regime was established for the fishery. Fishing effort was partitioned into four vessel classes and a limited number of certificates were issued based on what was believed to be the number of vessels which could be economically viable in the fishery. Certificates are not transferable and each certificate holder must apply annually for renewal. No quota is assigned to the certificates therefore fishermen must still compete for a share of the overall lake and area quotas.

Table 1 shows the cost of fishing and revenues earned by each vessel class on Great Slave Lake during 1991 [2]

Table 1 Cost and Earnings Data, Great Slave Lake Fishery 1991

(ED&T data based on Costs and Earnings Survey, 1991)

		Winter	Winter	Summer	Summer	
Certificate Type		A	B	A	B	Total
Number		18	20	16	29	83
Total Fixed Costs		$347,328	$116,020	$234,464	$179,916	$877,728
Total Variable Costs		$607,698	$100,380	$605,632	$211,729	$1,525,439
Total Costs		$955,026	$216,400	$840,100	$391,645	$2,403,145
Fish Revenues		$633,690	$70,120	$731,520	$195,054	$1,630,384
Capital Assistance		$45,360	$20,280	$65,264	$104,255	$235,159
Subsidies		$80,118	$8,860	$429,440	$114,492	$632,910
Total Revenue		$759,168	$99,260	$1,226,224	$413,801	$2,498,453

Costs do not include wages drawn by the owner or a return on investment to fishermen.

These figures represent costs and revenues at the harvester level only. The processing sector has not been included in this analysis because it is completely owned and operated by FFMC and as such does not represent income or investment in the NWT. In addition, it is assumed that because FFMC's monopoly represents a form of "sole ownership" over the processing sector, the corporation will behave in an economically efficient manner and will not over capitalize its operations. This assumption is borne out by the fact that FFMC has shut down smaller, inefficient fish plant operations and centralized its processing facilities to increase economic efficiency.

Using the costs and revenue data from this table we can construct a hypothetical Scott-Gordon curve for the Great Slave Lake fishery harvesting sector as shown below.

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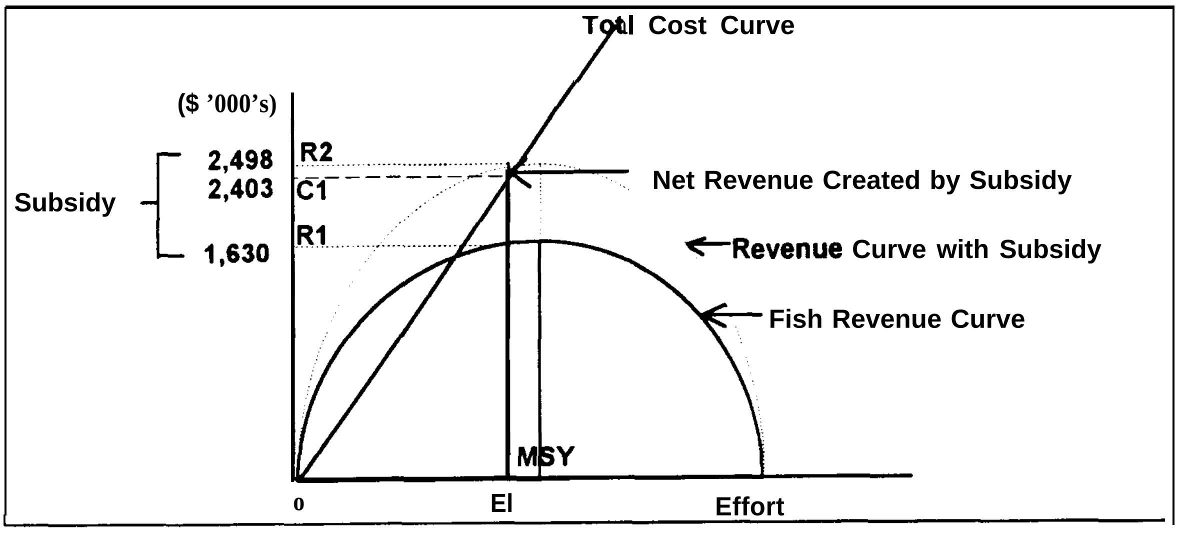
[2] Note: these figures represent values for 1991 only therefore government assistance shown, particularly capital assistance, is not necessarily representative of other years.

Figure 7 Scott-Gordon Model of the Great Slave Lake Fishery



Scott-Gordon Model Analysis

In the model above, E 1 represents the total level of effort currently employed in the Great Slave Lake Fishery. This line has been drawn to the left of MSY because Great Slave Lake has a long history of stable catches indicating that the current level of exploitation is sustainable. R 1 represents revenues earned from fish sales, C 1 fixed and variable fishing costs and R2 represents total revenues received by fishermen after factoring in government contributions and subsidies. Subsidies provided by the government have the effect of raising the revenue curve as shown by the dotted line. For the sake of simplicity we have combined government subsidies and capital assistance and applied them both to the revenue curve.

As the model shows, the level of revenue generated by fish sales is too low to cover fishermen's costs therefore, without government subsidy, fishermen would be operating at a loss. The difference between R2 and R1 represents the amount of government support received by fishermen, a total of $868,000. This level of support results in a net revenue of $95,000 being generated which is shown as the difference between R2 and C 1. This revenue is distributed among the fishermen. It is clear from the model that the net revenue created in this fishery is a function of government subsidy and capital assistance, not a true economic rent generated by harvesting. If the subsidy is removed, the revenue curve falls far below the cost of fishing and fishermen could not continue to fish without losing money, This fishery is well over capitalized in the harvesting sector and generates no economic rent.

According to the model, this situation can be improved in two ways, by increasing the revenue curve or decreasing the total cost curve. We can use the micro-model to examine these two possibilities more closely.

Micro Model Analysis

In the micro model, total revenue is determined by fish price and quantity. The total Great Slave Lake quota is assumed to be fixed with little potential for increase. In the current marketing environment, where FFMC purchases the entire catch and market projections for whitefish are very poor, the chance for substantial price gains is very limited. Given this situation, the only way to increase total revenues is for government subsidies to continue to target price. There is also an attempt underway in Hay River to develop a local market for Great Slave Lake fish and to develop value added products for this market. If successful, this may increase the price for a portion of the Great Slave Lake catch resulting in a higher revenue curve. It is unlikely, however, that increased revenues from the Hay River project would be adequate to cover all the costs incurred by the fishery.

Therefore, we must turn to the second alternative - reducing costs. The Great Slave Lake fishery is a classic case of too many fishermen chasing too few fish. Even though the fishery is limited entry, the number of productive units of fishing effort[3] is too large. Very few certificates fish to the limit of their capacity, yet the annual quota in most years is harvested or nearly harvested. The fishery could potentially yield some economic rent if effort were reduced.

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[3] a unit of fishing effort is defined according to the ED&T Great Slave Lake cost/earnings as a fishing operation with an annual production of at least 1,000 pounds. Operations that regularly pooled equipment or resources were considered to form one unit of fishing effort.

The current approach of the GNWT is to subsidize the cost of the fishery by underwriting the cost of fish freight. The fishery is currently over-subsidized, generating a false rent which is absorbed as profit. Removing this portion of the subsidy would push the revenue curve down to equilibrium at the expense of employment. The amount of effort reduction pursued therefore depends on the desired balance between economic efficiency and employment.

According to the ED&T costs and earnings survey, the A Class sector of the fishery appears to have some opportunity to earn a profit. The highest cost sector of the fishery in relation to revenue earned is the B Class fishery, in terms of both fixed and operating costs[4] Therefore, one possible approach to decreasing total costs would be to reduce the B Class sector.

If we convert the total B class production into A class certificates (by dividing total B Class production by average A class production for each season) there would be two additional A Class winter certificates and four additional A Class summer certificates based on current average production. Total costs and production on Great Slave Lake would then be as follows:

Table 2 Results of Converting Existing B Class Capacity to A Class Capacity

Season	Winter	Summer	Total
Certificate	A	A	A
Total Number	20	20	40
Total Fixed Costs	$385,920	$293,080	$679,000
Total Variable Costs	$675,220	$757,040	$1,432,260
Total Cost	$1,061,140	$1,050,120	$2,111,260
Fish Revenues	$704,100	$914! 400	$1,618,500
Capital Assistance	$50,400	$81,580	$131,980
Subsidies	$89,020	$536,800	$625,820
Total Revenues	$843,520	$1,532,780	$2,376,300

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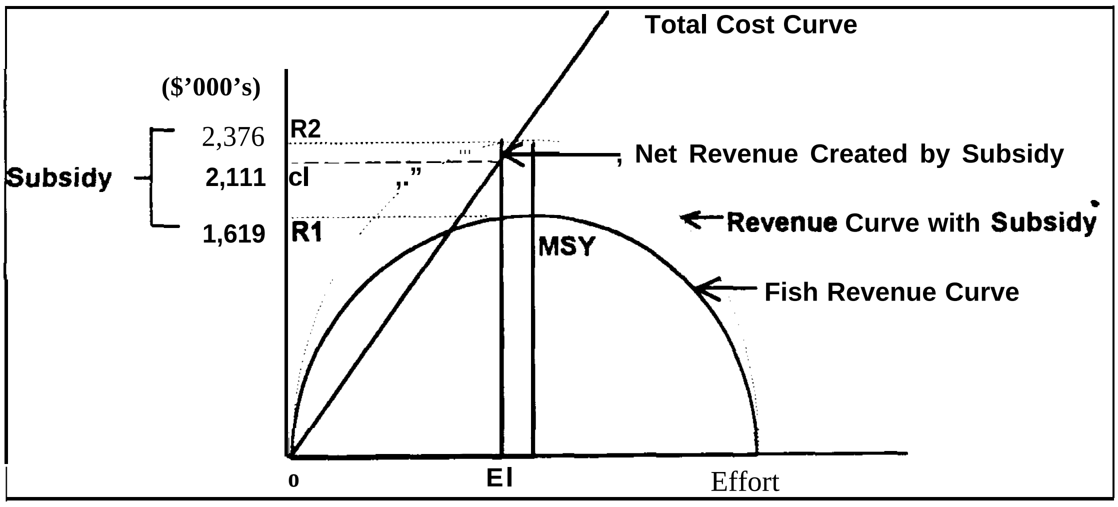
[4] Based on ED&T's Costs and Earnings Study for Great Slave Lake the costs to revenue ratios for each of the certificate classes is as follows: Winter A class - 1.5, Winter B class -3.0, Summer A class - 1.1, Summer B class -2. In other words, for every dollar earned Winter A class vessels costs total $1.50. Winter B class costs total $3.00. etc.

The conversion of B class to A class vessels would eliminate 62 fishing positions from the B class fishery representing $96,000 in wages. This would be balanced out by the creation of 24 new positions in the A class fishery representing $98,000 in wages. It is significant that conversion from the less efficient technology to the more efficient fleet would result in no net loss of employment income even though the number of participants would be reduced.

Total revenues from fishing would decline by about $122,000 however the overall costs of fishing would decrease by almost $300,000. These results assume that B Class capacity is completely convertible to A Class capacity and that all converted capacity would operate at average A Class levels.

We can use a Scott-Gordon model representation of these results to examine the impact of this conversion:

Figure 8 Scott-Gordon Analysis of Great Slave Lake Fishery after Converting B Class to A Class



As shown in the figure above, converting B class fishermen to A class fishermen would result in revenues from fish sales of $1,618,500 (Rl) and total fishing costs of $2,111,260 (C2). If the current average level of subsidy paid to Class A operations is maintained, total revenues received by fishermen would be $2,376,300 (R2) including a total subsidy of $757,640, a reduction of$110,269 from subsidy requirements with the Class B fishery in operation.

Under this new scenario, the fishery still does not generate any economic rent and still requires a subsidy because costs (C 1) exceed revenues (RI). However, the model also reveals that while a minimum subsidy of approximately $500,000 is required to ensure that fishermen cover costs, the current average level of subsidy, shown at R3, would generate a net revenue of $265,040 which would be distributed among the fishermen as profit. This profit represents the fisherman's return on investment and is approximately three times the level of net revenue presently created by government subsidy in Great Slave Lake. The government could chose to decrease the level of subsidy and still provide enough income to allow fishermen to cover their costs.

Removal of the B Class fishery without Conversion to A Class Capacity

The previous analysis assumes that each unit of the present A Class fleet is fishing to capacity. If the B Class fishery competes with the A Class fishery for fish, simple removal of the B Class effort might result in increased efficiency of the A Class fleet. The extent and nature of this competition is not known and therefore results based on this scenario cannot be predicted. However, an increase in efficiency of the A Class fishery would result in a move down the cost curve, reducing subsidy requirements.

options

It is assumed that the GNWT will continue to subsidize the Great Slave Lake fishery if necessary. Given the assumption that some level of subsidy support will required, the following options can be considered:

- reduce or eliminate all subsidies to the B Class Fishery
- reduce or eliminate B Class certificates and convert to A Class certificates
- institute individual transferable quotas on the lake

Reduce or Eliminate all Subsidies to the B Class Fishery

Reduction or elimination of subsidies to the B Class fishery would result in eventual removal of B Class effort from the fleet, since it assumed that effort is dependent on subsidies for continued operation. We would not reasonably expect the displaced labour to be absorbed as crew into the A Class fishery. If there exists a competitive effect between A and B Class catches, this would become apparent by an increase in the catch per A Class vessel after the B Class fleet had fallen out the fishery.

Reduce or Eliminate B Class Certificates and Convert to A Class Certificates

The ramifications of this options were demonstrated earlier. Under this option, limitations on vessel size would still limit effort. Total effort (cost) would be reduced with a minimal decline in overall harvest, however fishermen would still scramble to capture a share of the overall quota

Individual Transferable Quotas

The institution of ITQ's would allow A and B class designations to be eliminated. ITQ's would eliminate competition for fish and fishermen would be expected to capitalize to an efficient level, especially if encouraged through government contribution and financing programs which favored the purchase of efficient vessels and gear. Transferable quotas would also allow fishermen to capture a greater return on investment for equipment and vessels when they leave the fishery.

ITQ's could be assigned on the basis of historical fishing efforts for current fishermen. Quota allocations would be complicated by the partitioned nature of the lake quota and individual quotas would have to be divided among the five quota areas of the lake open to commercial fishing, probably weighted according to past patterns of harvest and/or accessibility.

If the goal of economic efficiency is desired, then individual quotas should be assigned which would allow profitable operation under prevailing economic conditions. A hypothetical level for total ITQs could be established based on the best performing A Class vessel categories. According to cost/earnings data provided by ED&T, Class A vessels can harvest up to 54,000 kilograms (dressed weight) in summer, and 33,000 kilograms in winter. This would allow total annual individual quotas of 87,000 kilograms per vessel which would allow a total of 16 operations harvesting at this level on Great Slave Lake,

This result is similar to the analysis in which we examined the effect of converting B Class to A Class effort. In that analysis we looked at licensing 20 units of effort each in winter and summer, for a combined total of 40 units annually. At this level of effort, a combined winter and summer annual individual quota of 71,480 kilograms would be appropriate. Given the accuracy of the data provided, and the fact that this analysis is based on data collected for only one year, the discrepancy between ITQ's calculated using the two methods described is not great.

To date, fishermen have rejected any proposals for ITQ's on the lake.

Impact on the B Class Fishery

The impact on B Class fishermen if B class certificates are converted to A Class depends on two factors: the ability of B Class fishermen to convert to wage labour in the A Class fishery, and the strength of the linkages between the B Class fishery and the subsistence economy.

In terms of fishing skills, a transition from B Class to A Class should not be a problem. However, B class fishermen are masters of their own vessels, and some may hesitate to take up crew positions on the larger vessels. Since many B Class fishermen fish only part-time, they may be unable or unwilling to take up full time crew positions.

There may also be a strong linkage between some parts of the B Class fishery and the subsistence economy. Certainly some B Class fishermen participate in the fishery as an adjunct to other employment while others benefit substantially from their participation since it provides food (fish) and an opportunity to live on the land. However, the exact proportion of each type of fisher has not been determined.

For part-time B Class fishermen, removal from the fishery would not present substantial financial hardship. For subsistence participants, displacement from the fishery could mean significant losses in terms of access to food and a reduction in well-being. However, because we do not know the extent of the commercial/subsistence linkage in this fishery, the magnitude of such losses cannot be estimated.

With this in mind, if the B Class fishery is reduced, a small aggregate quota should be set aside to accommodate small scale fishermen with strong subsistence interests in the fishery.

The Role of Economic Development and Tourism

ED&T has no authority to allocate fisheries resources in the NWT. This mandate is vested in the federal Minister of Fisheries and Oceans. However, ED&T does have direct involvement in investment in northern fisheries. The department funds plants, boats, and gear, and provides substantial operating subsidies. From this perspective, ED&T can have a profound impact on fishing effort. Therefore, the department should have definite goals for management of the fishing effort of the major NWT fisheries. Public requests for contributions or loans for infrastructure, vessels etc., can then be measured against these goals.

For Great Slave Lake, ED&T plays a vital role through provision of a substantial subsidy, a subsidy that exceeds the wage bill of the fishery. It is incumbent upon the department to manage its subsidy program according to sound economic principles. If Fisheries and Oceans cannot be persuaded to change its license allocation system, then ED&T could adjust its subsidy program to encourage economic efficiency.

Mackenzie Delta Fishery

While technically the Mackenzie Delta commercial fishery is an open access fishery, in reality access is controlled by a local community organization serving subsistence harvesters. Fishermen's right of access to the resource is based on camp occupation at traditional sites in the Delta, and right of access to these camps is based on historical family use. Participation in the commercial fishery is determined by the community organization and a steering committee which decides which areas will be serviced by the collector boat. While fishermen in other areas are not restricted from participation, without the services of the collector vessel they are essentially eliminated from the fishery.

The commercial fishery provides a substantial linkage between the subsistence economy and the cash economy for those fishermen participating. While the fishermen's costs of fishing, estimated at about $4,300, earn a very good return, estimated at $29,000 for 1992, the total costs of the fishery are very high (see Table 3).

Table 3 Costs and Earnings of the Delta Fishery, 1992

Fishermen's Revenues	$29,000
Fishermen's Costs	$ 4,300
Plant Revenues	$39,120
Plant Variable Costs	$71,000
Plant Fixed Costs	$71,000[5]
Total Plant Costs	$142,000

If we insert these figures into the Scott-Gordon model we can develop the following macro model representation of the fishery:

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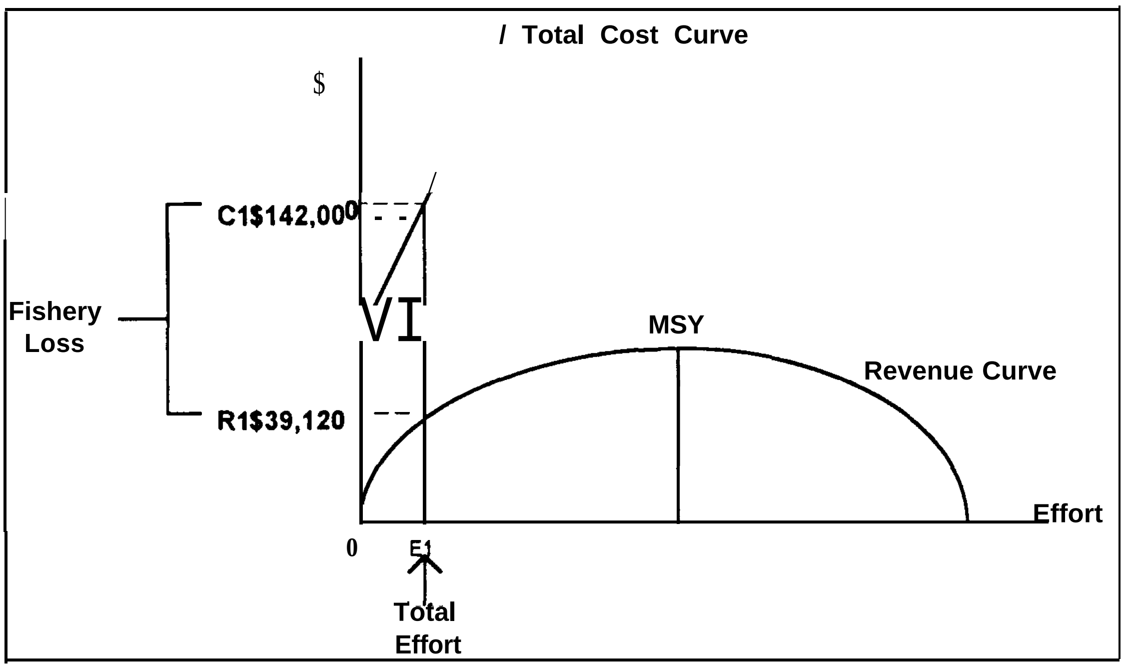
[5] Fixed costs are based on annual vessel lease, average cost of plant repairs over the life the project. average annual cost of vessel repairs, and cost of plant equipment amortized over 10 years as well as actual fixed costs of plant operation (utilities etc.) reported for 1992.

Figure 9 Scott-Gordon Model of the Mackenzie Delta Fishery



In Figure 9, E 1 represents harvesting effort, C 1 represents total fishery costs and R1 represents total revenues earned from fish sales. The distance between R1 and C 1 the fishery represents the loss incurred by the fishery, As shown by Table 3, fishermen's revenues exceed their costs, however plant costs are extremely high, with fixed costs alone far exceeding total revenues earned from fish sales. The total cost curve does not intersect the origin to illustrate the high fixed costs in this fishery. Obviously, the fishery is well-over capitalized in the plant sector. However, plant costs are relatively fixed given the requirements for the plant to meet federal inspection standards and the need to produce, weigh, process and package the catch. Little can be done to decrease total plant costs.

To bring the fishery to a position where revenues cover costs, total revenues must be increased. The micro-model revenue equation is:

Total Revenue (R) = Quantity (Q) X Price(P)

In the Mackenzie Delta fishery, quantity is extremely low because the quota assignment is small - far too small to support a commercial fishery given the minimum plant costs. The experimental quota under which the fishery operates must be increased by at least four times to bring the total cost and total revenue curves into equilibrium. However, indications from DFO suggest that a commercial allocation will not exceed the current experimental quota.

If quantity cannot be increased, then price must be increased. The fishery is pursuing this option through value added processing (fillets) and marketing the product within the local market area. Previously, the fish was sold to FFMC which is a price setter and paid low prices for whitefish.

The future of this fishery depends on getting a better price for the fish. If this cannot be accomplished, the fishery will require a high level of subsidy. In this case, it might make better financial sense to provide the fishermen with an income supplement equivalent to their earnings from the fishery and avoid the costs of the plant operation. This would be consistent with the HTC goal of providing the fishermen with a source of cash for living on the land.

Cambridge Bay Fishery

The Cambridge Bay Char Fishery is generally viewed as the most successful fishery in the NWT. Cambridge Bay has harvested approximately 40,000 kgs of char consistently since 1975. Environmental constraints in 1991 and a market failure in 1992 reduced the harvested volumes in those years.

The fishery's success is at least partially due to the fact that it is regulated as a resource with ownership held in common, rather than as an open access resource. The fishery is managed by the community as represented by the local Co-operative. The community has allocated harvesting rights to the Co-op, which in turn manages both the harvesting and processing aspects. Because the Co-op has *de facto* sole ownership of particular quotas, it is in the Co-ops best interest to minimize effort in order to maximize profit. And this is exactly what the Co-op does. The Co-op harvests char with efficient gear (primarily weirs), hires local fishermen to harvest the fish, and transports the catch to the plant by aircraft.

Until 1991, the fishery generated economic rent in the form of profit accrued to the Co-op. The rent was then distributed to the general Co-op membership in the form of dividends. Assuming that the membership represents most of the community, this dividend distribution represents one of the few fisheries in Canada where economic rents are returned to the resource owners.

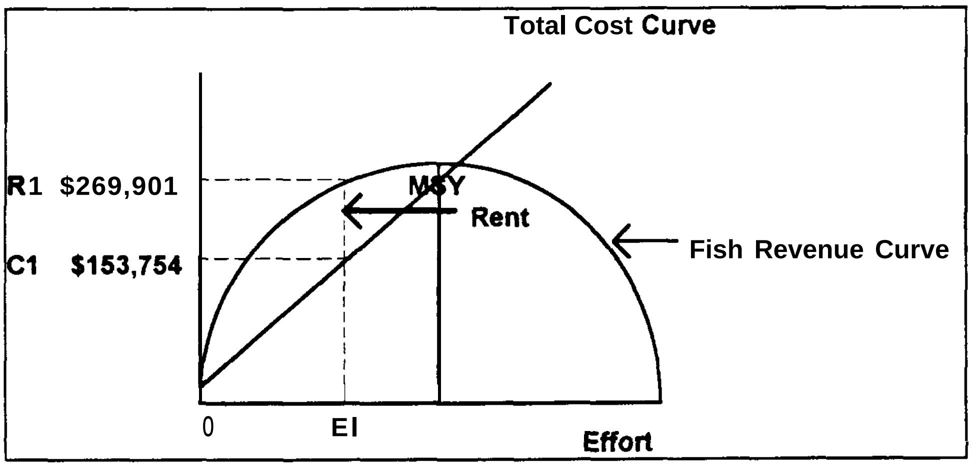
Table 4 presents a breakdown of the costs and earnings of the Cambridge Bay fishery for 1987:

Table 4 Costs and Earnings for the Cambridge Bay Coop Fishery 1987.

Total Revenue:	$269,901
Payment to Fishermen	$ 57,673
Freight	$ 39,046
Other Variable Costs	$ 36,853
Fixed Costs	$ 20,182
Total Costs	$153,754
Net Margin (Rent)	$116,156

Figure 10 presents a Scott-Gordon macro model representation of the fishery in 1987:

Figure 10 Scott-Gordon Model of the Cambridge Bay Char Fishery 1987



The economic rent generated by this fishery is clearly shown as the distance between R1 (total revenues) and Cl (total costs). In 1987 the economic rent generated was over $100,000.

Pangnirtung Turbot Fishery

The Pangnirtung turbot is a new fishery, still in the early stages of resource exploitation. As such, this fishery illustrates one of the classic principles of open access theory - effort increases until total revenues equal total costs.

Table 5 shows costs and revenues in the fishery since the 1988/89 season. These costs do not include capital and development costs, nor do they include depreciation costs for the plant. Figure 11 illustrates these trends graphically.

Table 5 Costs and Earnings for the Pangnirtung Turbot Fishery

	88/89	89/90	90/91	91/92	92/93
Plant **Revenue**	**415,269**	901,414	1,007,364	n/a	1,042,662
Plant Costs	**389,082**	1,067,076	n/a	n/a	1,283,366
Fishing Revenue	**184,459**	**346,635**	**187,593**	**544,822**	**540,684**
Fishing Costs	**130,965**	**246,110**	133,191	386,823	383,885

Figure 11 Costs and Earnings of the Pangnirtung Turbot Fishery

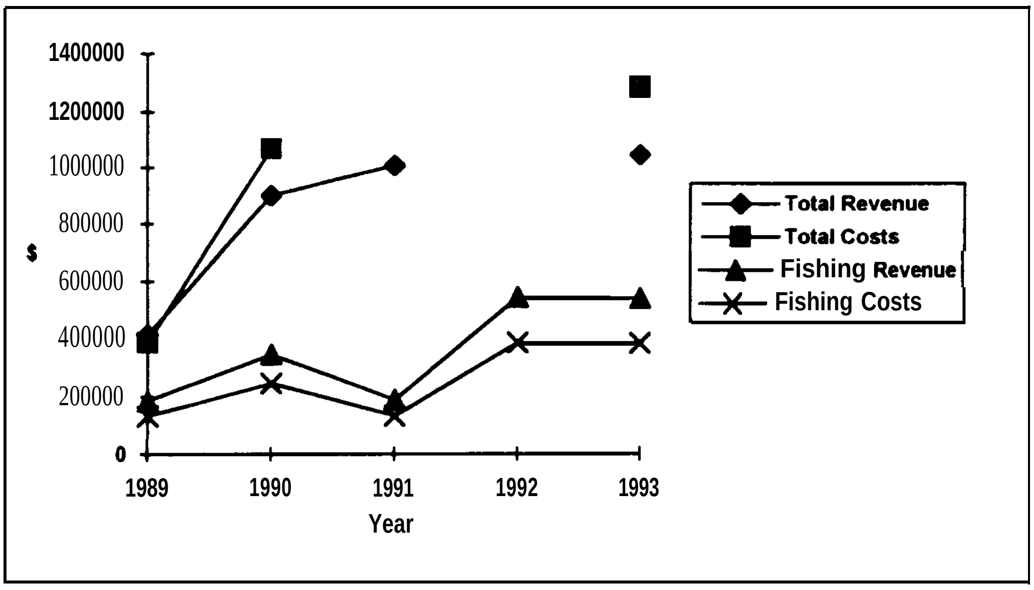


Table 6 shows the growth in participation and fishing effort since the inception of winter fishing for turbot in 1986:

Table 6 Participation in the Pangnirtung Turbot Fishery

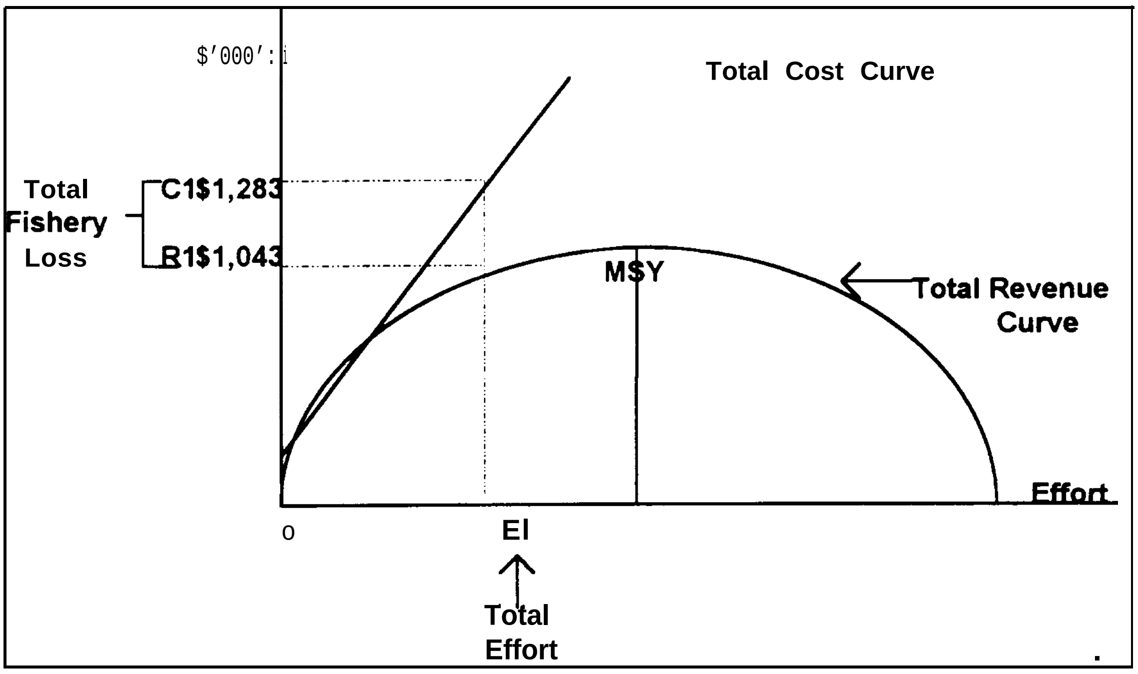
Year	1986	1987	1988	1989	1990	1991	1992	1993
No. of fishermen	8	6	14	43	77	61	93	115

Fisheries and Oceans defers to the Pangnirtung Hunters and Trappers Association for allocation of the turbot quota for Cumberland Sound. The HTA has placed no restrictions on access and anyone who wishes to participate in the fishery may do so. The fishery is therefore an open access fishery. Since the resource has not been harvested by Inuit in the past, no rules limiting effort along lines of traditional rights of access exist.

Scott-Gordon-Model Analysis

Figure 12 illustrates the Scott-Gordon model of the fishery as of the 1993 season.

Figure 12 Scott-Gordon Model of the Pangnirtung Turbot Fishery



The model indicates that the fishery is operating at loss. The difference between total cost and total revenue represents the amount of subsidy that must be provided; in 1993, this subsidized cost was approximately $300,000 including both direct freight subsidies and operating losses absorbed by the DevCorp.

Figure 12 B Scott-Gordon Model of the Pangnirtung Turbot Fishery - Harvesting Sector Only

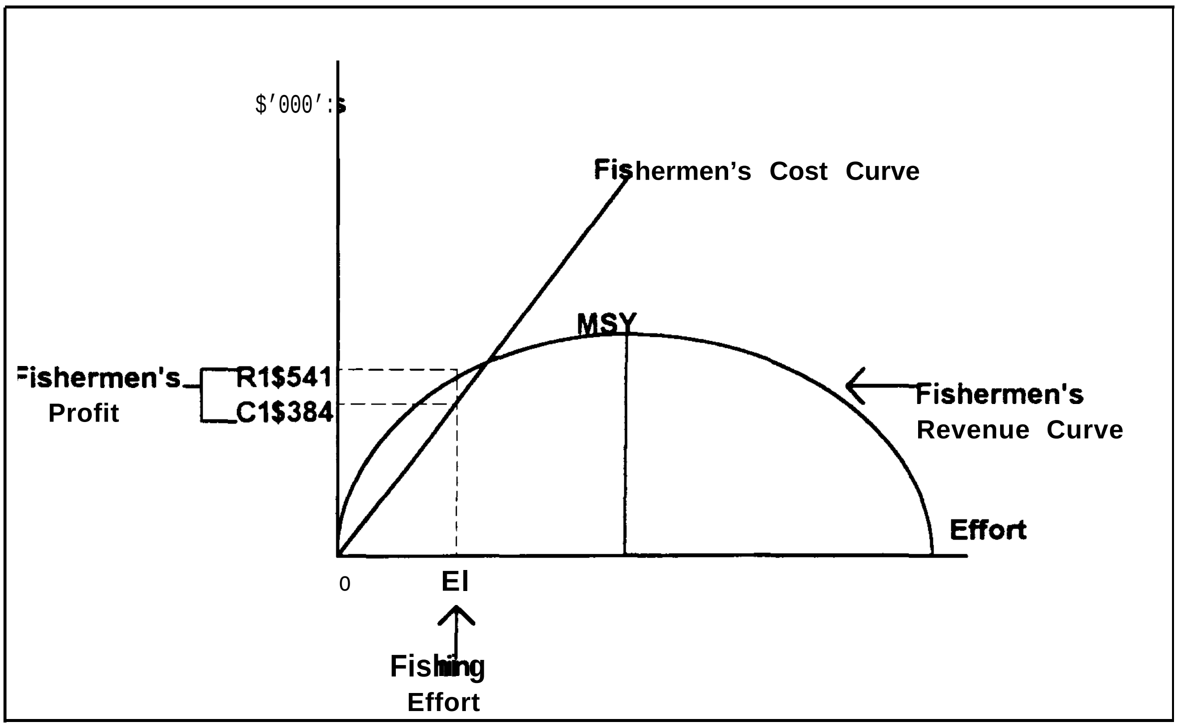


Figure 12 B illustrates the costs and earnings for the harvesting sector only. Revenue from fishing exceeds the costs of fishing by $157,000. However fishing costs do not include owners wages or return on investment. Therefore, only a small portion of this difference actually represents economic rent; most of this excess is normal wages and profit to fishermen. The harvesting sector generates very little economic rent. .

According to Fisheries and Oceans, the position of this fishery in relation to MSY is questionable given the current state of understanding of the turbot stock. The current level of effort may even be beyond MSY. If the fishery were to increase production in order to generate sufficient revenue to equal costs

Micro Model Analysis

The Scott-Gordon model shows that total costs exceed the total revenues in the fishery however the price paid to fishermen is just adequate to provide a return on effort. Therefore, in the micro analysis, adjustments must be made at the plant level.

In the revenue equation, both price and quantity affect the total revenue received. The Pangnirtung fishery currently operates in a window of higher price to maximize returns. Operation outside that small window in an effort to increase quantity will reduce price. Therefore, the only way to increase quantity effectively would be to increase effort or increase efficiency during the window of higher price. However, quantity is limited by the ability of the resource to sustain higher levels of harvest. This ability is currently unknown.

In terms of price, the DevCorp is attempting to increase price through two strategies: penetrating more lucrative markets, and developing value-added products. With respect to penetrating more lucrative markets, the Pangnirtung fishery must compete with lower cost fisheries except between January and April, therefore competition for lucrative markets will be high. With respect to value-added products, increased processing has attendant costs which can negate the price advantages gained. Therefore this option must be approached carefully.

Reducing total costs can be approached by reducing fixed or variable costs. In the Pangnirtung fishery, fixed costs represent 17% of total costs and fish freight and fish purchases represent 24% and 31?40 of total costs. One of the DevCorp's major strategies for cost reduction has been to lobby the fish freight subsidy program managers (EDT) to subsidize more of the fish freight costs. From the point of view of the DevCorp, increased freight subsidies can be counted as revenue, improving the financial performance of the DevCorp. However, such a strategy does not improve the economic performance of the fishery and actually further entrenches the fishery in its state of dependence on government.

Discussion

Involvement of both ED&T and the DevCorp in the Pangnirtung fishery was guided by the goal of increasing the number of jobs in the community. Neither ED&T nor the DevCorp has officially expressed any interest in moving toward economic efficiency in this fishery therefore we can assume that the goal of the GNWT is to maximize employment at the expense of economic efficiency. Economic rent would therefore be distributed back to the community through employment opportunities in the processing sector.

Given the goal of maximizing employment, it would be expected that the DevCorp, now the major investor in the fishery, would push the fishery toward the point where total costs equal total revenues. In private sector fisheries, this is a dangerous position because the fishery is then highly susceptible to increases in costs or decreases in price. However, the DevCorp is less sensitive to such fluctuations because its operations are subsidized. Indeed, the DevCorp's fish plant operation showed a substantial loss in 1993 **yet** the DevCorp is making a substantial investment in a new plant in the community. The DevCorp is also pressing ED&T to increase the amount of freight subsidy provided to the fishery.

The DevCorp is currently operating beyond the equilibrium point where total costs equal total revenues, whereas the fishermen are operating at a point where total revenues from fishing just exceed total fishing costs. Because the costs of fishing are not directly subsidized, fishermen must operate at this level in order to keep fishing. Of course, it could also be argued that the plant is actually subsidizing fishing operations by not passing plant losses onto fishermen.

The increase in fishing effort in both the processing and harvesting sectors suggests that the fishery is being driven by the forces typical of an open access fishery and the possibility of collapse increases as effort and investment rises. This possibility is particularly acute given the warnings from Fisheries and Oceans that the biology of the stock is not understood. Some thought should therefore be given to limiting effort to present levels until the turbot biology is better understood. If fishing effort continues to increase, at some point the marginal revenues of each fishing unit will begin to decrease.

We can also expect to see a greater investment in fishing gear as competition for fish increases. ED&T has already funded a number of fishing outfits and it is expected that applications for equipment will increase as new entrants are attracted to the fishery. By finding new entrants and providing increased freight subsidy support, ED&T could contribute to a situation similar to Great Slave Lake, where subsidy support will become mandatory and the economic benefits are widely disbursed over so many fishermen that very few actually benefit.

To avoid this situation, the department should decide on a point beyond which investment through contributions will not be extended. If the department believes that its role is to maximize employment in the fishery, then the GNWT must be prepared to provide on-going subsidies to the fishery.

ED&T does not have the mandate to regulate entry in the fishery therefore recommendations on effort limitation cannot be made directly to the department; however, ED&T can choose to lobby for such measures as in the case of recommendations for Great Slave Lake.

In the Pangnirtung turbot fishery there does not appear to much variation in gear efficiency. Rather, fishermen’s efficiency appears to be dependent on skill and experience. Therefore, any effort limitation schemes should focus on limiting the number of participants or establishing an individual transferable quota system rather regulating gear types.

ITQ's may not be acceptable to the community and it may be too early to determine appropriate ITQ quota levels. If current fishing technology cannot be substantially improved, a license limitation scheme may be more appropriate. In this case, the number of licenses should be limited to the number of financially viable fishing enterprises which the total quota could support. To determine this number, a comprehensive cost and earnings study is required.

Keewatin Char Fishery

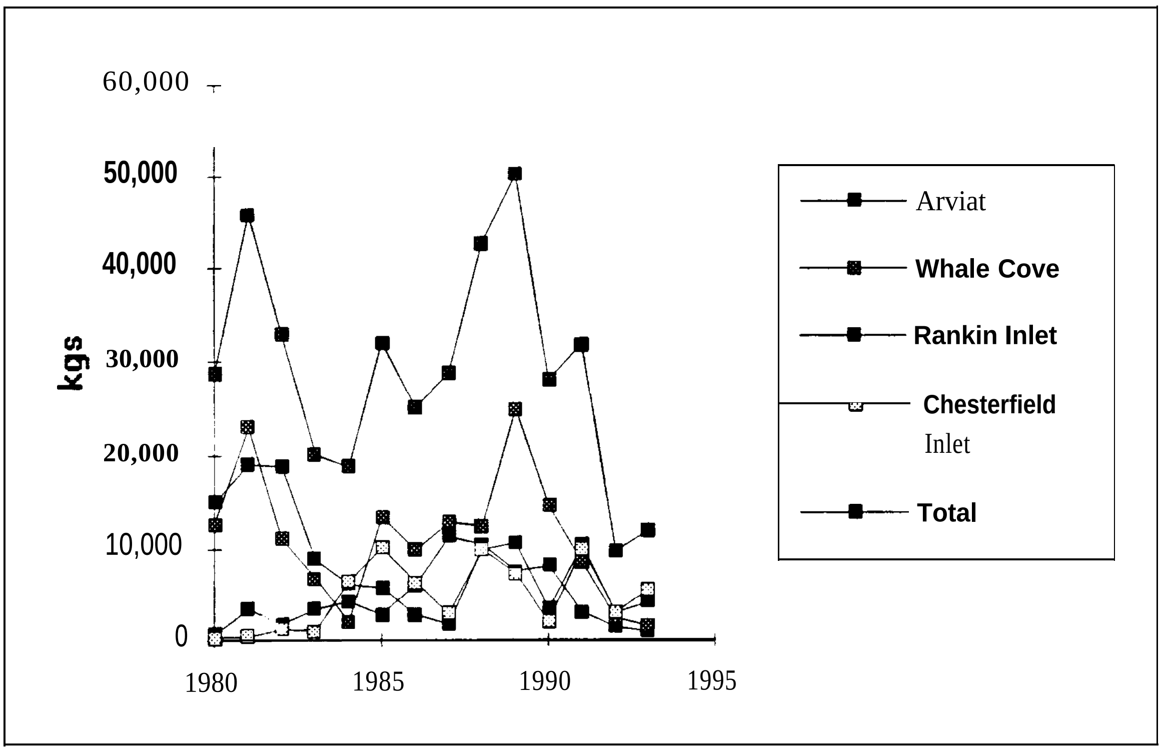
The Keewatin char fishery has been the subject of government development efforts for almost thirty years. Through its history the fishery has received government support provided in the form of contracted plant management, and capital and operating subsidies for both plant and fishermen. Staff from ED&T have played an integral role in organizing and running fisheries operations throughout the region.

Unlike Pangnirtung, where the turbot fishery has attracted an increasing number of participants because of the potential for economic profit, or the Cambridge Bay char fishery, where the fishery is managed by a stable, community-based organization, the Keewatin char fishery suffers from poor profit capability and a lack of stable central organization. As a result, char harvests have fluctuated widely over the years, as shown in Table 7 and Figure 13.

Table 7 Keewatin Char Harvests

		Harvest (kgs round weight)			
Year	Arviat	Whale Cove	Rankin Inlet	Chesterfield Inlet	Total
1980	612	12,677	15,012	331	28,632
1981	3.432	22.932	19,049	454	45,867
1982	1:804	11:026	18,777	1,209	32,816
1983	3,412	6,790	8,798	1,045	20,045
1984	4,263	2,051	6,097	6,332	18,743
1985	2,776	13,453	5,703	10,083	32,015
1986	6,029	9,821	2,829	6.274	24,953
1987	11,247	12,843	1,786	2900	28,776
1988	10.459	12,440	9,854	9,865	42,618
1989	7,523	24,841	10,581	7,267	50,212
1990	8,045	14,594	3,351	1,928	27,918
1991,	3,045	8,465	10,328,	9,953	31,791
1992	1,409	2,391	2,922	2,972	9.694
1993	937	1.570	4,073	5,378	11,958
Average	6,087	10,871	5,715	5,817	28,490
Maximum	11,247	24,841	19,049	10,083	50,212
Minumum	612	1,570	1,786,	331	9,694

Figure 13 Keewatin Char Harvests



It now appears that the fisheries in the southern Keewatin communities (Rankin Inlet, Whale Cove and Arviat), normally the largest contributors to the harvest, are in serious trouble. Results from the 1993 season strongly suggest that fish stocks in the area 'are badly depleted. If these indications are confirmed, then the Keewatin char fishery has been operating beyond MSY for several years. Given the widespread failure of the fishery in 1993, we must assume that this is the case.

Access into the fishery is completely open; anyone can buy a license for any commercial quota. Subsistence harvesting from all stocks is also unrestricted by either quota or licensing. Because the magnitude of the subsistence harvest is unknown, total fishing pressure on the stocks cannot be determined.

In the absence of complete information on fishing pressure, the GNWT has still made major investments in the Keewatin fishery. In 1985, a fish plant was constructed in

Chesterfield Inlet for a cost of about $350,000; in 1991, a fish plant costing almost $190,000 was established in Arviat; and in 1993, a new fish plant in Rankin Inlet began construction with a budget approaching $1 million. These figures do not include numerous government contracts for plant managers, fishery coordinators, and marketing studies. nor the many contributions for motors, boats and gear.

Scott-Gordon Model Analysis

The Scott-Gordon model has been constructed for two hypothetical fishing seasons: a season of high catches based on the 1988 season, and a season representing the stock crash, 1993. For the high production year, costs and earnings for fishermen are based on data gathered in 1988 for Whale Cove and Arviat and do not include fishermen's wages or return on investment. This data has also been used for Chesterfield Inlet and Rankin Inlet, for which no cost and earnings information is available. Plant costs are based on actual and projected costs of operations for all plants as they existed in 1988, **with the exception of Arviat, where costs are based on the operation of the new fish plant. Depreciation charges are included in fixed costs.**

For the low production year, revenues are based on the wholesale selling prices charged by the DevCorp for products produced by the Rankin Inlet plant. The cost of operations of the Rankin Inlet plant have been increased 3 fold over the 1988 figures to reflect a longer operating period.

Data for the two seasons is summarized in the following table.

Table 8 Costs and Revenues for the Keewatin Fishery in a High Production Year (1968) and a Low Production Year(1333J

	Capital costs	Operating costs	Total Costs	Catch (lbs)	Price	Revenue	Subsidy	Total Revenue
High Catch Year								
Harvesters Costs								
Chesterfield inlet	$10,164	$3,920	$14,084	20,107	$1.00	$20,107		$20,107
Rankin Inlet	$11,165	$8,775	$19,940	18,893	$1.40	$26,450		$26,450
Whale Cove	$21,125	$15,210	$36,335	22,209	$1.30	$28,872		$28,872
Arviat	$19,602	$7,560	$27,162	20,522	$1.40	$28,731		$28,731
Total	$62,056	$35,465	$97,521	81,731		$104,160		$104,160
Plant Costs								
Chesterfield Inlet	$20,000	$24,500	$44,500	20,107	$2.30	$46,246	$7,037	$53,284
Rankin Inlet	$25,000	$37,000	$62,000	18,893	$2.17	$40,998	$7,274	$48,272
Whale Cove	$5,000	$10,500	$15,500	22,209	$1.69	$37,533	$11,216	$48,749
Arviat	$9,500	$38,000	$47,500	20,522	$1.74	$35,708	$8,824	$44,533
Total	$59,500	$110,000	$169,500	81,737		$160,485	$34,351	$194,837
Base Price/lb	$4.00							
Stock Crash Year								
Harvesters Costs								
Chesterfield inlet	$7,623	$2,940	$10,563	10,057	$1.50	$15,085		$15,085
Rankin Inlet	$20,096	$15,795	$35,891	7,617	$1.50	$11,425		$11,425
Whale Cove	$8,938	$6,435	$15,373	2,936	$1.50	$4,404		$4,404
Arviat	$17,424	$6,720	$24,144	1,752	$1.50	$2,628		$2,628
Total	$54,081	$31,890	$85,971	22,361		$33,542		$33,542
Plant Costs								
Chesterfield Inlet	$20,000	$24,500	$44,500	10,057	$4.40	$44,210	$1,559	$45,769
Rankin Inlet	$25,000	$111,000	$136,000	7,617	$4.71	$35,843	$0	$35,843
Whale Cove	$5,000	$10,500	$15,500	2,936	$4.34	$12,730	$161	$12,892
Arviat	$9,500	$38,000	$47,500	1,752	$4.22	$7,387	$166	$7,544
Total	$59,500	$184,000	$243,500	22,361		$100,171	$1,887	$102,057
Base Price/lb	$6.21							

Figures 14 through 17 illustrate these two years in the fishery using the Scott-Gordon model.

Figure 14 Scott-Gordon Model of the Keewatin Fishery -1988 Harvesting Sector

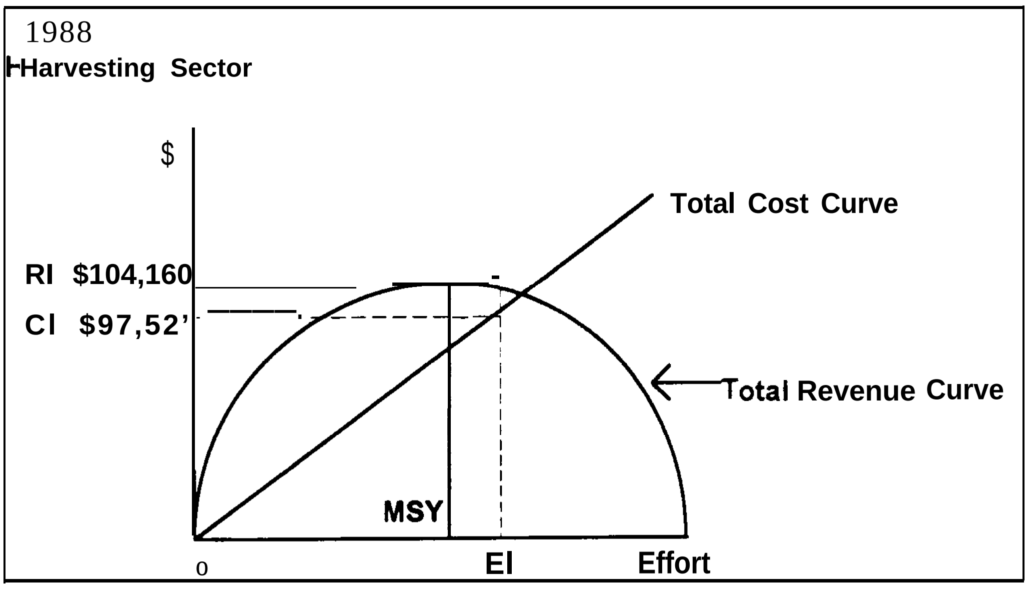
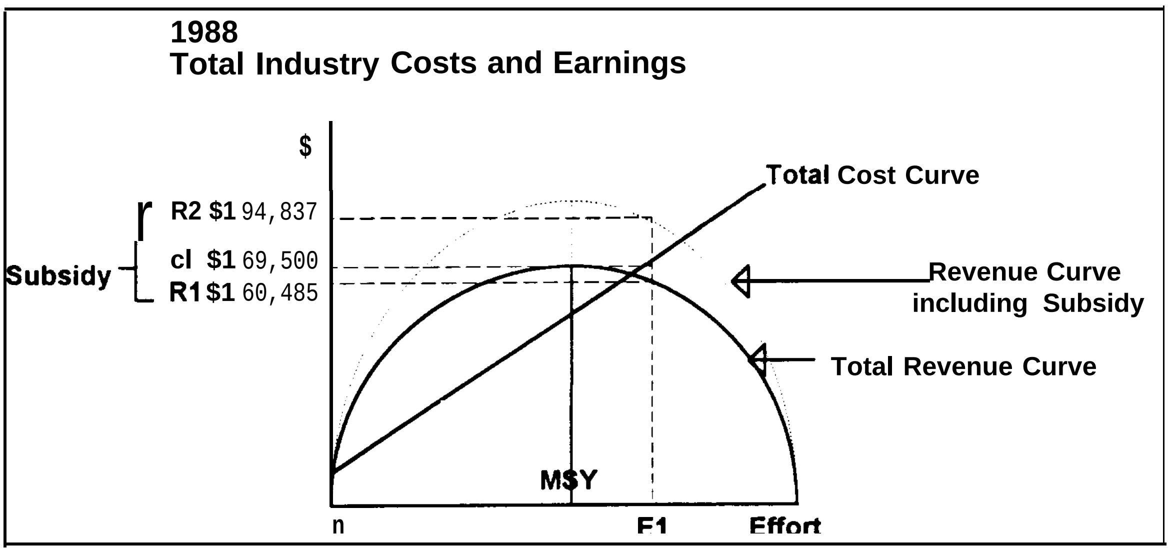


Figure 14 shows that during the high catch year of 1988 total revenues earned by fishermen exceeded estimated costs producing a small economic rent. However, as wages and return on investment were not included in estimating fishermen’s costs, this economic rent is actually distributed among fishermen as a return to their labour. In 1988 this return was small but positive. The reader will note that we have drawn E 1 to the right of MSY. to illustrate the effect over fishing the resource. Once effort exceeds the point of MSY, increased effort results in smaller and smaller revenues.

Figure 15 illustrates total industry costs and earnings for the same high catch year.

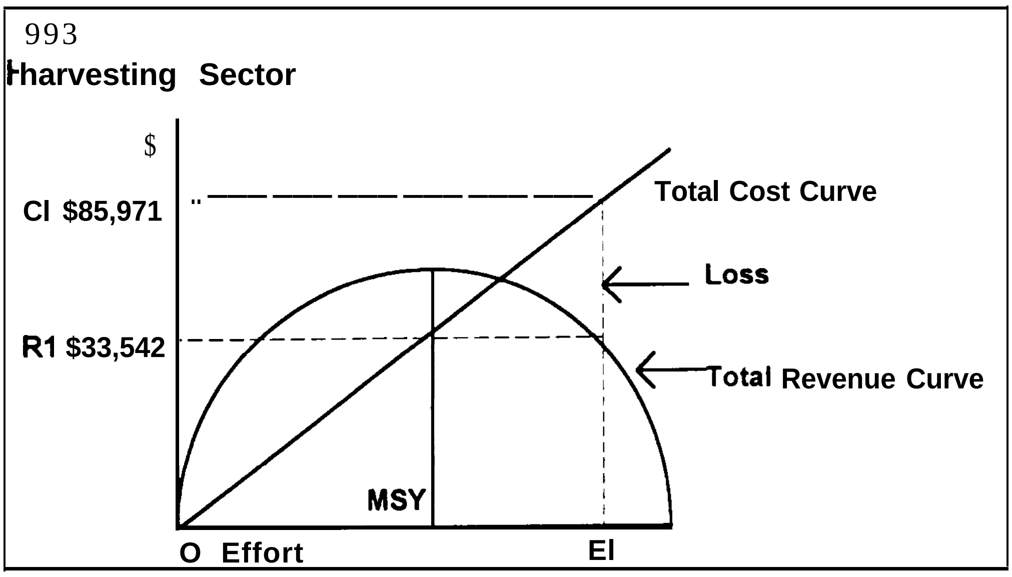
Figure 15 Scott-Gordon Model of the Keewatin Fishery -1988 Processing Sector



In the high catch season, revenues received by the processing sector were lower than total costs resulting in a small loss. However, the subsidies provided by the GNWT push the revenue curve up above the cost curve creating a false economic rent of approximately $25,000.

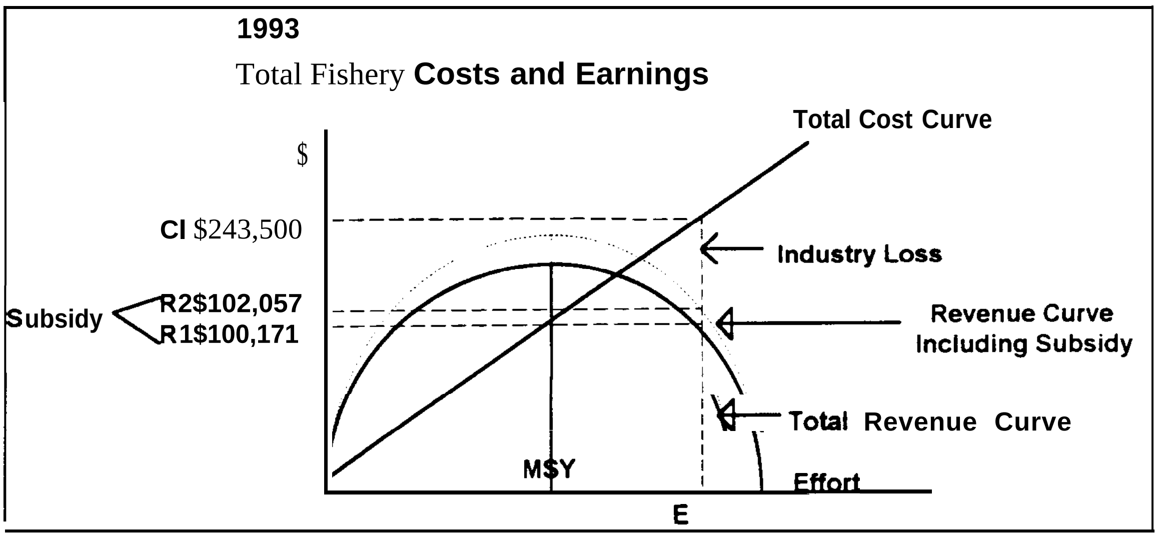
In contrast, Figures 16 and 17 illustrate the Keewatin Fishery during the low harvest year of 1993.

Figure 16 Scott-Gordon Model of the Keewatin Fishery -1993 Harvesting Sector



As Figure 16 clearly shows, during 1993 fishermen's costs far exceeded the revenues and no profits were generated by the fishery. Figure 17 indicates that, as a whole, the fishery suffered from the same situation. Total Costs exceeded both the revenues generated by fish sales and the total revenues received after factoring in GNWT subsidies. In fact, the revenues from GNWT subsidies contributed only a very small amount to total revenues in 1993 because the subsidies came from the freight subsidy program only and this program is based on volume. The low volume of char harvested in 1993 meant that very little subsidy could be claimed.

Figure 17 Scott-Gordon Model of the Keewatin Fishery - 1993 Total Fishery



Micro Analysis

Closer scrutiny of the revenue and cost curves for the Keewatin fishery reveals failures in the cost equation in the high catch year and in the revenue equation in the low catch year.

In the high catch year of 1988, costs in the processing sector exceeded fish revenues in Arviat and Rankin Inlet. The Whale Cove operation produced the most char yet had the lowest costs by far. The low cost of operations in Whale Cove is attributable to its function as a packing station rather than a freezing station.

In the low catch year, a failure in quantity resulted in revenues that were much lower than costs. In addition, the cost of plant operations in Rankin Inlet has increased considerably because of value-added production which resulted in both a longer operating period and higher costs. The increased revenue from NWT sales of whole and value-added char cannot compensate for the low catches and higher costs of production.

If the low catch rates are attributable to a stock crash, the failure in quantity is far more serious than the failure in the cost variables.

Discussion

Even at peak production, the Keewatin fishery produces less char than the Cambridge Bay fishery at considerably more cost. No rent is generated by the fishery and profits accrue from subsidy revenues.

The Keewatin fishery has been actively promoted by the GNWT as an income opportunity and to that end ED&T and now the DevCorp have made considerable investment in infrastructure and labour. The crash of the Diana River char stock in 1984 caused the GNWT to promote the development of char fisheries in Whale Cove and Arviat to supply the Rankin Inlet plant. Rather than treat the Diana River char crash as a warning, fisheries managers and developers proceeded with investment strategies even to the extent of attempting to entice private investment in infrastructure. For example, new fish plants were constructed in Chesterfield Inlet and Arviat and the DevCorp is now investing in a new plant in Rankin Inlet.

The harvesting sector is well over-capitalized for the amount of fish harvested. The amount of effort could be significantly reduced without reducing the volume of harvest. However, such a reduction in effort would require a limitation scheme such as ITQ's or limited entry. Such measures do not seem to be consistent with community aspirations, especially given the strong linkage between the subsistence economy and the commercial fishery.

If the fish stocks in the southern Keewatin have indeed collapsed, then an important aspect of the macro model has not been fully measured: total effort. The Keewatin fishery includes both subsistence and commercial harvesting - both fisheries take place at the same time and place, harvest the same fish, and are often carried out by the same fishermen. However, no accurate measure of the subsistence effort exists. In a fishery such as Cambridge Bay where commercial fishery is concentrated in areas which are not harvested for subsistence needs, community input and control can prevent the potentially disastrous effects of combined commercial and subsistence exploitation of the same stock. In the Keewatin, such a separation has not been pursued.

MANAGEMENT: IMPLICATIONS FOR FISHERIES

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Common Property Resource Management: Implications for Fisheries in the Northwest Territories

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December 1993

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Introduction

Fisheries present unusual and difficult management problems compared to other natural resources. Media headlines lament the depletion of fish stocks, closed fish plants, low earnings for fishermen, massive government subsidies and other manifestations of a resource in trouble. Many of these problems flow from the common property aspects of the fishery. While common property is only part of the problem, the economic theory of common property resources offers a simple model for analysis, possible stabilization plans, and evaluation of fisheries.

This paper describes the basic conceptual framework of common property analysis which has dominated the field of fisheries economics for the past 40 years. The problems for fishery management and government investment which arise under this framework will be discussed and approaches used in other fisheries will be described. The primary purpose of the first section of this paper is to educate the reader in the basic principles of common property resource economics. In the final section we illustrate possible applications of common property analysis for fisheries in the Northwest Territories.

Fisheries as Common Property Resources

To understand the implications of the common property nature of fisheries resources it is useful to step back and examine the biological and economic nature of a commercial fishery, The following models are useful tools to understand the behaviour of fish and fishermen in various stages of a commercial fishery.

Figure 1 Schaefer Biological Yield Curve

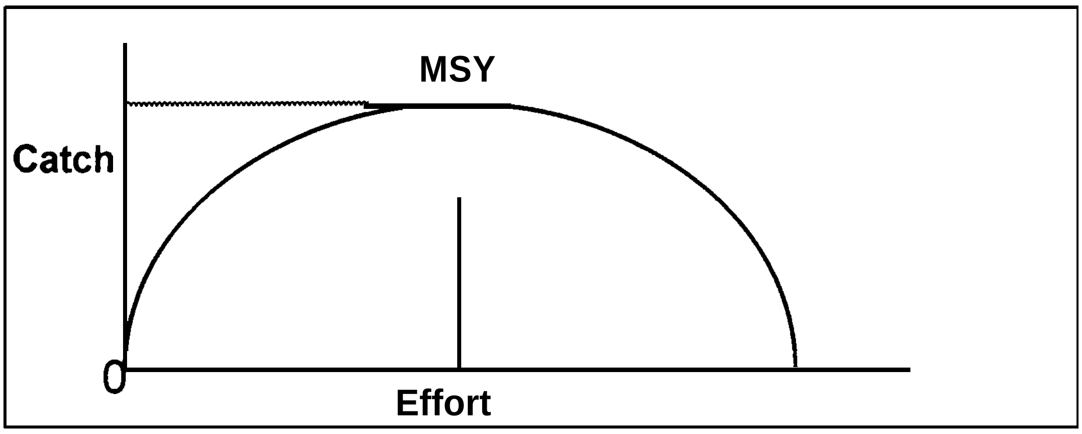
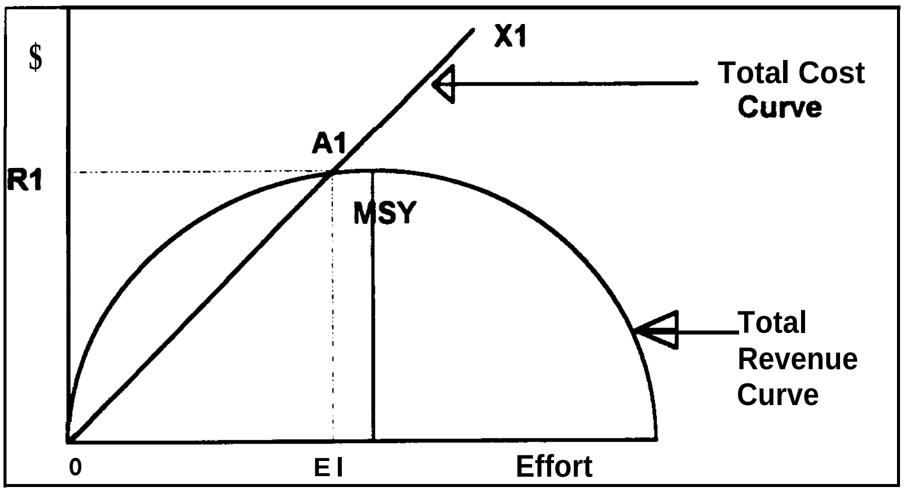


Figure 1 illustrates a simplified biological yield curve for an exploited fishery (developed by Schaefer, 1954). As fishing effort increases, total catch increases, rapidly at first but then at a decreasing rate as the fishery nears maximum sustainable yield (MSY). If fishing effort continues to increase beyond this point total catch will start to fall. Total catch and catch per unit effort will continue to decline with increasing effort until fishing stops or the stock collapses. While there are practical difficulties in determining MSY, the concept is useful in understanding the pattern of fisheries development.

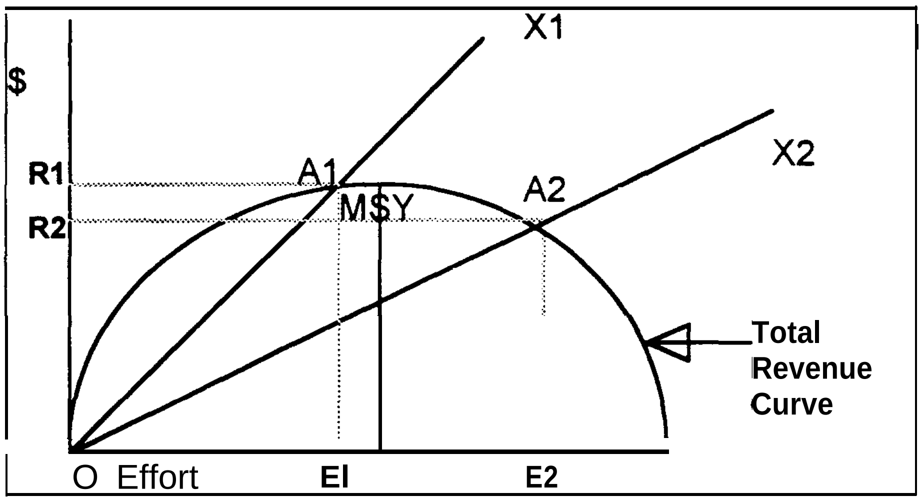
Figure 2 Scott-Gordon Model Fisheries



In Figure 2, the model has been modified to illustrate the economics of commercial fishing. This model is commonly referred to as the Scott-Gordon model after the economists that developed and refined its use. Catch is expressed as revenue ($) and the yield curve becomes a total revenue curve. The line O -Xl describes the total cost curve; this curve is linear because we assume that each additional unit of effort represents an identical cost. Therefore total costs increase directly with fishing effort. At point Al, the total cost curve intersects the total revenue curve indicating that at the level of effort E 1, total costs of fishing equal the total revenues (Rl). Any further effort would result in costs exceeding revenues.

Unless otherwise regulated, a fishery tends to develop until it reaches the point where costs meet or exceed revenues. If this point is below MSY (as seen at point A 1), the resource is not threatened. If however, it falls beyond the maximum sustainable yield shown as A2 in Figure 3, the fish stock is being over fished and more time, effort and capital is being invested to catch fewer and fewer fish.

Figure 3 Result of Lowering Total Cost Curve

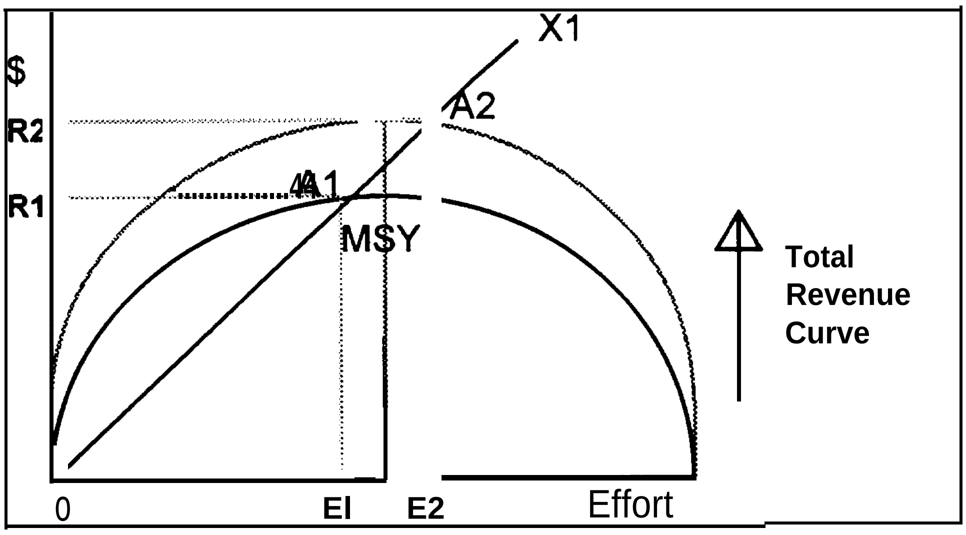


The cost and revenue curves in each fishery are determined by a number of factors including type of equipment used, operating costs, and market price. The point where costs equal revenues can move from Al to A2 as a result of improvements in efficiency which reduce the costs of fishing, moving the cost curve to O -X2.

Alternatively, a change in market conditions resulting in an increase in price would result in an upward shift in the total revenue curve relative to the total cost curve.

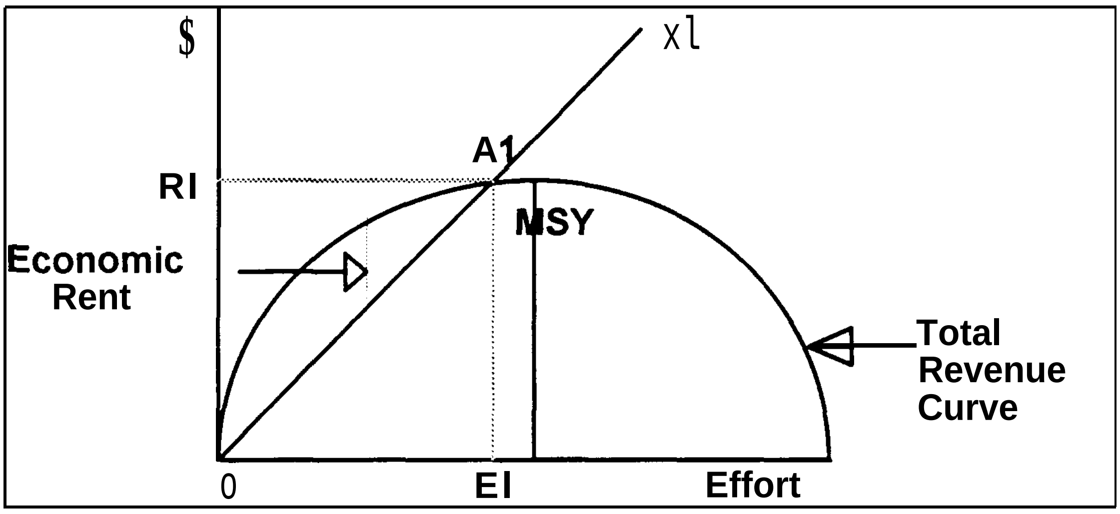
This could also push the equilibrium point (break-even point) beyond the level of maximum sustainable yield as illustrated at A2 Figure 4.

Figure 4 Result of Increasing Revenues



The difference between the total revenue curve and the total cost curve represents profits generated by the fishery. This profit is referred to as economic rent.

Figure 5 Economic Rent



If the level of fishing effort remains below E 1, revenues will exceed costs and an economic rent will be generated as shown in Figure 5, As effort increases, the economic rent disappears and at point Al it has completely dissipated.

Economic rent was first defined by David Ricardo in the early 19th century. Ricardo defined three ways of creating wealth: capital, labour, and land. The profit earned from use of capital was called interest, the profit earned from the use of labour was called wages, and the profit earned by the use of land and resources was called rent.

In fisheries economics, economic rent is the profit that can be generated by the stock because of its intrinsic productivity. The value arises from the market value of the resource itself Ideally, the role of the regulator is to manage the fishery so that capital investment and total costs are at a level which maximizes economic rent at a level below maximum sustainable yield. This ensures that the most fish are captured with the least effort.

The concept of economic rent has two important implications: rent generated from a renewable resource can continue to be extracted as long the stock generates a marketable surplus; and extraction of rent requires that ownership of the resource is clearly defined.

In North America, rent from natural resources is generally considered to belong to the citizens of the nation, as represented by government, because natural resources are held to be the common heritage of all citizens. Collection of rents by the government is justified by the need to off-set the costs of public administration, habitat maintenance and resource management which fall to the public sector.

For non-renewable resources such as minerals, several methods of capturing rent exist: resource rental taxes, profit, sales and capital gains taxes, and royalty payments. In the forestry industry, users are charged stumpage fees and royalties based on the value of trees logged.

In fisheries, governments generally fail to capture resource rent or prevent its dissipation. This failure is often the result of a deliberate strategy to maximize employment at the expense of economic efficiency. ED&T wrestles with this issue in its role as fishery developer because the balance between employment and economic efficiency has not been clearly articulated in the department's goals for fishery development.

The Common Property Effect

With this general understanding of the biology and economics of an exploited fishery we can examine the effect of common property ownership on fisheries using the Scott-Gordon fisheries economic model.

A common property resource is a resource where ownership is not vested in a single person or company. There are two basic types of resource "ownership" that are commonly referred to as common property ownership: open access and ownership held in common. While both terms tend to be used interchangeably, they actually have quite different ramifications.

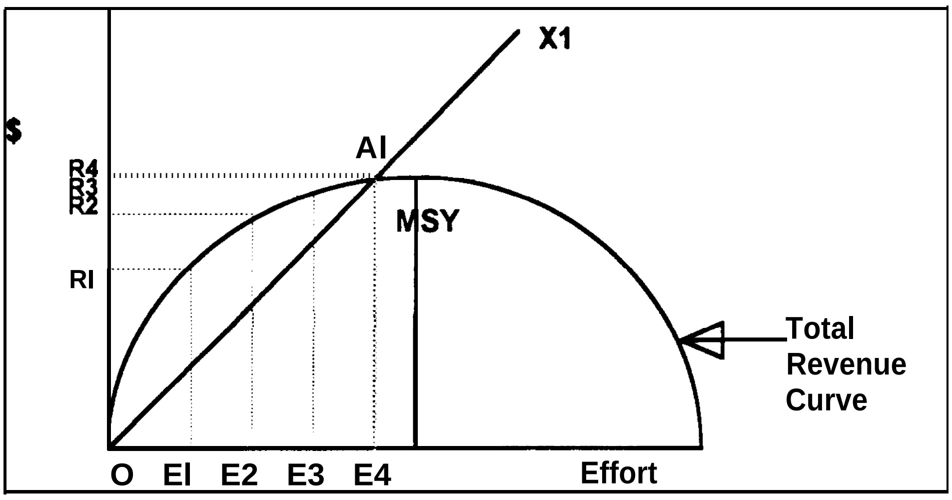
- Open access fisheries are those that belong to no one and have unregulated access; everyone is free to fish. Typically, modem commercial fisheries are open access fisheries. All NWT commercial fisheries are open access fisheries.

- Ownership held in common implies that ownership is vested in common among many. Many traditional and/or subsistence fisheries are "owned' as common property and have rules and regulations which control participation and catch.

Only unregulated open access fisheries suffer the problems associated with the "common property" effect.

The following figure illustrates a simplified version of what happens in an open access fishery.

Figure 6 Common Propetty Effect



When the first fisherman enters a fishery (El), catch rates are high and revenues (Rl) exceed costs generating a profit. This encourages more fishermen to enter the fishery. When the second fisherman enters the fishery (E2) total revenues increase to R2, however the additional or “marginal” revenue created by the second fisherman (the difference between RI and R2) is smaller than the revenue created by the first fisherman because of the nature of the biological yield curve. The marginal revenue created by each subsequent fisherman gradually decreases as the harvest approaches MSY.

At some point, the marginal increase in revenue will be equal to the additional cost of creating that revenue. This point represents the most efficient level of fishing, and the level that produces the greatest amount of economic rent. Beyond this point, total revenues continue to increase however the cost of producing additional revenues is higher than the marginal value of those revenues and profit decreases until, at effort E4 profit is completely dissipated

If the fishery was fished by only one operator, the owner’s revenue would increase by the marginal revenue created by each additional unit of effort put into the fishery. Therefore, fishing would likely stop at the point of maximum profit. Beyond this point the owner would be subject to declining returns on his effort and the additional costs of fishing would exceed the additional revenues earned.

However, fisheries are not owned by single owners, but rather are unowned resources fished by a large number of people. In addition, the amount of fish available is limited and fish are not an immobile resource; fishermen cannot put a fence around their share of the catch and keep it to themselves. Therefore, when a second fisherman enters the fishery, he competes with the first fisherman for a share of the catch. Rather than the first fisherman receiving R1 and the second fisherman receiving only the smaller marginal revenue he has contributed (R2-R1), each fishermen receives half of the total revenue (R2/2) thus reducing the revenue received by the first fisherman.

As more fishermen enter the fishery each fisherman contributes a smaller and smaller marginal revenue but all fishermen receive an average revenue from the total catch. This results in declining revenues for all fishermen as more and more fishermen enter the fishery. To counter this, fishermen invest more money into bigger and better equipment to outcompete other fishermen and the cycle continues with more and more money spent on chasing fewer and fewer fish. This is commonly referred to by economists as the “tragedy of the commons”.

Because each additional fisherman receives a greater revenue than the marginal revenue he contributes, fishing will continue as long as average revenues exceed the marginal costs of fishing. Therefore fishing effort will continue to increase to Al, far beyond the point where marginal costs equal marginal returns, and all profit available from the fishery will be dissipated.

The Problems and Possible Solutions

There are a number of problems that typically accompany common property or open access fisheries. These problems can be classified as biological or economic problems.

On the biological side, open access fisheries often lead to over-exploitation of the fish resource, reduction in bio-diversity (the inter-relationship among fish populations and other species), and depletion or destruction of stocks.

An open access fishery provides an economic incentive to overfish because each fisherman is trying to catch as many fish as possible to cover costs. There is no economic reason to stop fishing at MSY and over fishing is likely. Therefore most fisheries are regulated by a quota system that dictates the total commercial catch that can be taken. Unfortunately, there is a lack of basic information about the biological factors that control fish populations fished by a variety of gear, and fish recruitment and growth is often not clearly understood. The supply of fish available at any time is uncertain and it is very difficult to accurately determine, year after year, the potential catch from a stock of fish. While biologists have developed a formidable number of techniques for analyzing fish stocks, population estimation is still an art rather than a science and quotas are frequently set too high for resource sustainability.

The economic problems experienced by fishermen in open access fisheries include low earnings, dependence upon subsidies and overall lack of employment. For the industry as a whole, problems include excess capitalization in plants and equipment, low profit margins, a supply-driven market, and a high-risk, uncertain future. The costs to society are subsidies to support the industry and inhibited ability to plan for the sector.

A General Framework for Problem Solving: Micro Model

There are a number of ways that the problems accompanying open access fisheries can be prevented or mitigated. The Scott-Gordon model of fisheries shows that an economic profit is available from fisheries when there is a difference between total costs and total revenues any point to the left of equilibrium. As discussed earlier, this profit represents rent from the resource which should accrue to the owner of the resource, the Canadian public. However, rent is never extracted from Canadian fisheries, to a large degree because our fisheries are often in trouble.

The long run objective of fisheries management may be to move the fishery to some profitable equilibrium, however, in the short-run, managers are often required to somehow stabilize the fishery until the economic and biological problems can be solved.

To examine how fisheries can be stabilized it is useful to look at the components of the Scott-Gordon model in more detail. For this purpose the micro-economic factors present in the operation of a business can be used. The micro-model of fisheries uses three simple formulae: a revenue formula, a cost formula, and a profit formula.

Total Revenue = Price X Quantity **R = P X Q** **(eq. 1)**
Total Costs = Total Fixed Costs + Total Variable Costs C = FC + VC **(eq. 2)**
Profits = Total Revenues - Total Costs **P = R - C** **(eq. 3)**

This model captures specific problems in a fishery and can help define possible solutions at both the micro (individual business) and macro (overall industry) level.

Each of the elements that makeup the micro-model are briefly described below:

Total Revenue

Total revenues are determined by the price of fish times the quantity of fish sold. Increased total revenue in the fisheries can be achieved by increasing catches (Q) or by obtaining higher prices (P). Higher catches (Q) are achieved by improving fishing technology or finding new grounds or stocks. In fisheries controlled by quotas, the total catch cannot be increased. However, if a system of transferable quotas is put into place, the catch of each vessel can effectively be increased.

Higher prices (P) can be achieved by better marketing practices. At the vessel level this may require increased quality. At the plant level, increased prices may require value--added production. Image development may also increase market price. For example, the price for wild B.C. salmon increased once wild salmon was differentiated from farmed salmon in the marketplace.

Economies of scale can also influence market price. This was part of the rationale behind the creation of the Freshwater Fish Marketing Corporation, which represents a share of the commercial freshwater fishery which is sufficiently large to influence price.

Total Costs

Fixed and variable costs vary in importance in different fisheries.

Fixed Costs

At the harvester level, fixed costs consist of vessel and gear costs. At the plant level fixed costs consist of infrastructure, equipment and fixed operating costs.

In licensed fisheries with total quota restrictions, owners tend to “capital stuff’ their vessels to outcompete other fishermen. They buy the latest technology and equipment to make their operation more effective and thereby increase fishing effort by improving fishing techniques. Availability of financing and tax structure strongly influence the amount of capital investment made by fishermen. In a licensed fishery fixed costs tend to rise because the security of access to the resource tends to make financing easier. Government contribution programs can also contribute significantly to over capitalization in the fishery.

Variable Costs

Variable costs are those operating costs that increase as the level of fishing effort increases. Variable costs can be negligible, as in the B.C. herring-roe fishery where fishing takes place for only one day, or a major cost, as in the Bay of Fundy herring weir fishery where, once the weir is constructed, all fishing costs are variable costs. In general variable costs are fuel, provisions and wages.

The Micro Model and the Problem of Stability

The micro model is most useful in pinpointing where government should direct efforts to stabilize fisheries that are in trouble. The model is useful in analyzing the cause of instability and for defining possible policies to overcome instability. The model may appear simplistic and therefore unnecessary, but its simplicity allows policy makers to focus quickly on the problem and provides a common framework for decision making when decisions are made through collaborative effort.

Solutions in the Context of Open Access

A range of options have been proposed and attempted for managing fisheries within the context of the open access model. The options selected depend on the goals of the regulator, the political climate and the practicality of the option for a given fishery.

The options fall into two broad categories: definition of property rights, and limitation of effort. The first category applies to outputs, and the second category applies to inputs.

In the category of property rights, the major options are as follows:

- sole ownership of the resource
- individual transferable quotas
- ownership in joint tenure (common property)

In the category of effort limitation, the following are major options:

- limitations on vessel configuration
- limitations on gear
- limitations on entry (limiting the number of fishermen)

- restricting time or season
- restricting areas

A third category of options available is taxation. Taxation or royalty payments can theoretically be used to capture resource rent from the fishery and control capital investment.

Each of these options is briefly discussed in the following section.

Property Rights

1. Sole Ownership

Sole ownership of a fishery resource means vesting all rights of ownership in a single agency, company or individual. This option is appealing from the view of economic efficiency and extraction of resource rent as it is assumed that the owner would not over-capitalize. However, this option has not been seriously entertained in North America because of ideology. The development of natural resources in North America since the arrival of Europeans has very explicitly followed a path of open access in contrast to the system of private rights found in Europe and England.

A limited example of sole ownership is found in the Freshwater Fish Marketing Corporation. The FFMC has monopoly purchasing rights for fish over a large area, giving the corporation effective ownership of the fish at the commercial level. One result of this monopoly ownership has been the drastic reduction of plant capacity throughout its area of jurisdiction; the FFMC closed down many small plants and invested in a larger, more efficient plant to handle all product. This move is consistent with the prediction that the sole owner of a fishery would reduce its costs in order to improve efficiency and maximize economic rent. The economic rent captured by FFMC is redistributed to the fishermen in the form of final payments.

2. Individual Transferable Quotas (ITQ's)

Individual transferable quotas have been implemented in many fisheries in Canada and throughout the world including Atlantic Canada, Iceland, Australia's bluefish tuna fishery, and most of the coastal and offshore fisheries of New Zealand. ITQ's are also used in Lake Erie and Lake Winnipeg, two major inland Canadian fisheries.

ITQ's have received some attention in fisheries because of their use in stabilizing fishing effort and allowing quota holders to sell their quota and take out some equity when they leave. The advantage of ITQ's from society's point of view is a reduction in costs through a reduction in the number of vessels and people required to catch a given allocation of fish. Secondly, the holders of larger quotas may make larger profits and have stable earnings. While these advantages have been promoted by resource managers, fishermen have accepted ITQ's with a certain amount of reluctance.

The basic ITQ concept is the same in all applications: individual fishermen receive a set amount of the total overall quota. Usually fishermen are free to fish with gear and vessels of their choice, however certain restrictions may apply for the protection of the fish stock and habitat. Because fishermen do not have to compete for quota, there will no pressure to over-capitalize.

Fishermen are free to buy and sell quota, easing entry and exit from the fishery. More efficient operators can buy up more quota and adapt the size of their capital investment to their fishing requirements.

The first apparent effect of ITQ is a reduction in the number of jobs available to fishermen because of a reduction in vessels. Hence, resistance to ITQ's come from the fishermen who crew the vessels. Second, resistance to ITQ's results because no one is aware of all the implications. Fishermen sense that there will be winners and losers when an ITQ system is instituted and they are not sure which side they will end up on. Good cost and earnings data helps demonstrate benefits to fishermen.

Individual quota allocation has strong support among fishery regulators however the system has problems. For example, in a mixed-species fishery, a single quota for all species encourages wastage of less valuable species. In a fishery with many marketing channels, monitoring quotas becomes difficult and expensive.

The following section describes the experience of some Canadian fisheries with individual transferable quotas.

Lake Winnipeg

Lake Winnipeg is the second largest freshwater fishery in Canada after the Great Lakes. Current annual production averages 5,200 tonnes with lake whitefish and pickerel being the major commercial species taken on the lake. A system of ITQ's was introduced to Lake Winnipeg in the early 1970's and is still in place. Quota allocations vary according to the area of the lake for which they are assigned and, because of differences in fish populations between the southern and the northern basins of the lake, quotas cannot be transferred between these areas. There are also restrictions based on residency; a period of residency is prescribed in certain communities before a quota can be purchased from that community. According to fisheries regulators, the system works well and has resulted in significant increases in earnings for fishermen since its inception.

Quota assignment in the Lake Winnipeg fishery was calculated based on the market value of the primary target species and historical catches of individual fishermen. Quotas on the north basin of the lake, where whitefish predominate, are larger than quotas in the south basin where pickerel, a more valuable species, predominate.

It is significant that ITQ's have been rejected by other fisheries in northern Manitoba which are carried out by Native fishermen. Concern over purchase of quota by outsiders and a philosophical difference between ITQ systems and the idea of communal access to resources maintained in traditional Native communities lessens the appeal of ITQ's for northern Manitoba Native fishermen.

Lake Erie

The Lake Erie fishery instituted ITQ's in 1985. Vessel-owners are assigned quotas for various species from the total allowable catch and these quotas are freely transferable in part or in whole either through outright sale or lease arrangement. For example, the holder of a 50,000 lb. quota may decide to sell 30,000 lbs of the quota and to fish the remainder. All quota transfers, sales and leases must be approved by the Ontario

Department of Fisheries Department of Fisheries to prevent ITQ's from becoming concentrated in a few hands.

According to a DFO official, the system works very well. Values of up to $6.00 per pound have been recorded for a sale of a quota and the cost of leasing a quota vanes, with values of up to $1,00 per pound being recorded. The transferability of quotas has slowly evolved from the initial institution of vessel quotas in 1985 to full transferability at present.

The ITQ system is monitored by the Lake Erie Fisheries Association which is a loose co-operative consisting of eleven fish processors and the ITQ holders. The association's role is to promote the fishing industry, monitor the transfer of quotas, and ensure that quotas are not exceeded. The association has the right to inspect plants and records and can therefore prevent a fisherman who exceeds his quota from selling fish to a processor. Thus, the quota limits are maintained.

Part of the reason for the acceptance of ITQs in Lake Erie came from the US Lake Erie experience where ITQs were in effect. The final impetus to establish ITQs in Canada came from the desire of H.J. Heinz to acquire vessel licenses and quotas for its Canadian subsidiary Olmstead Fisheries. Olmstead wished to ensure a stable supply of fish and become the lowest cost producer in the region. This alarmed the Canadian government and fishermen, and all licenses and transfers became subject to a review and approval by the government.

According to DFO officials, the push to establish ITQ's came from the government.and acceptance by the fishermen came about because they knew that ITQs worked in the States, and they wanted to rationalize fishing operations to earn a profit. The Lake Erie Fisheries Association was formed because of the need for independent monitoring of harvests and quota transfers.

B.C. Halibut Fishery

The B.C. halibut fishery is a well-established fishery in which the economics and biology are understood. The fishery is carried out by longlines and stocks are protected by an overall quota. The main problem with this fishery was that the quota was captured in a short period of time and the catch was frozen because the market could not absorb the total catch. This resulted in a low fish price and a scramble by each fisherman to catch as much as possible before the quota was taken.

To resolve these problems individual quotas were instituted, some of which were transferable. Quotas were assigned based on the long history of recorded catches by each vessel. With the allocation of individual quotas, there is no longer a scramble to catch fish before the quota is taken, and the halibut catch is now spread out over a longer period of time. Halibut is now delivered fresh to the market and therefore commands a higher price. In addition, fishermen are pooling their fishing and marketing efforts. The fishery appears to be self-regulated by the fishermen who monitor vessel quotas.

The development of this management regime was possible because of the fishery's long history and the extensive knowledge of the biology of the halibut. The economics, and costs and earnings of the fishery are also known. These factors allowed appropriate and economically sustainable quotas to be set.

Atlantic Groundfish Enterprise Allocations

In the Atlantic groundfish fishery, individual quota allocations are made from the total allowable catch to individual enterprises (fish processors or large vessels. This method of quota allocation has the advantage of allowing individual fish plants to fish according to their needs while still limiting effort such that the plant receives the maximum harvest for the least cost. The Gulf of St. Lawrence redfish fishery is a good example of this type of quota allocation.

Similar to enterprise allocations are vessel allocations assigned to herring vessels in the Bay of Fundy. With a vessel allocation, each vessel can adjust its effort to the specific demands of the plant for which it fishes.

3. Common Property Ownership

Common property ownership was common in subsistence fisheries prior to commercialization, and rules for resource allocation have been documented for many common property artisanal and traditional fisheries. These rules allowed the resource to be fished in a sustainable manner and often included rules regarding who could fish, when they could fish, where they could fish and what kind of gear could be used.

Westernization has generally replaced these older patterns of resource management with new rules of open access. Berkes[1] identifies a number of changes which have occurred in the Canadian north when traditional fisheries are commercialized:

- loss of community control over the resource
- conflict between artisanal and commercial fisheries
- commercialization of subsistence fisheries
- rapid population growth and technology change
- concentration of previously scattered and migratory population in permanent settlements

Many of these changes have resulted in the breakdown of traditional common propetty resource management. In the history of Canadian resource development, particularly the commercialization of fisheries historically exploited as subsistence fisheries, a pattern of development which is common to many fisheries emerges. The cycle begins with steady-state, low-level exploitation of the resource, often used communally under some kind of common-property management regime. Pressure builds to exploit the resource for profit beyond the subsistence needs of the community. This pressure may come from outside (government development programs), from the demands of increased population, or the availability of more effective exploitation technologies.

At this stage, if open access conditions exist, the original group of users is typically displaced or marginalized by more effective harvesters who move into the area. The resource development phase begins; the fishery is no longer a steady-state system, but is expanding. Growth is sustained by mining a series of resources and from more valuable to less valuable species. Area after area, and stock after stock is depleted in an orderly fashion in the course of resource development. When all the resources are depleted, the developers move out.

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[1] Fikret Berkes, 1985. Fishermen and the 'Tragedy of the Commons', Environmental Conservation 12 (3): 199-206.

To avoid this, the Canadian government has, in the last decade, moved toward a system of cooperative management of fish stocks in which allocation decisions within communities in claim areas are usually left to the community. Such rights approach common property ownership.

This direction has been formalized in the various land claims agreements in the Northwest Territories. Under these land claims, rights of access to resources in various locations have been reserved for claimants. Wildlife Management Boards comprised of claimant and government representatives make allocation decisions for all natural resources included in the claim.

The rules or parameters used in these allocation decisions have not been examined. However, as land claims are settled and implemented, these boards and communities will increasingly be called upon to make decisions regarding allocations between subsistence, commercial and recreational needs.

Limits on Effort

All methods of limiting fishing effort require some form of external regulation through licensing. A reduction in fishing effort causes problems by lowering fishermen's incomes therefore various "buy-back" methods have been attempted to give fishermen money and at the same time reduce effort. However, the very act of putting licensing regimes in place can cause a perverse effect as the existence of licenses may provide an incentive to become licensed to ensure future participation. This sometimes results in an increase in the number of fishermen in a distressed fishery.

Effort limitation imposed by government generally results in fishermen attempting to beat the system. Restrictions on vessel length cause fishermen to build wider boats; restrictions on amount of time spent fishing cause fishermen to purchase faster vessels which are less fuel efficient, etc. In addition, a high degree of regulatory effort is required to enforce effort limitation in the fishery. For all these reasons, effort limitation schemes in Canada and internationally have not been very successful.

Because effort limitations through gear, vessel and time/space restrictions are variations on the same theme, they are not discussed individually here. Rather, examples of application in various fisheries are presented in the following section.

B.C. Herring Roe Fishery

This fishery is interesting because the method of effort limitation allowed substantial rem to be captured by the vessel owners.

The main focus of this fishery is herring roe which is sold into a single market - Japan - for New Year's gift giving.. Roe is the symbol of fertility (and hence the New Year) and eagerly bought. The Japanese market for BC roe is estimated at 35,000 tonnes with a landed value of about $100 million. The B.C. seine fleet of 252 vessels takes approximately 40 per cent of this; the remainder is taken by 1,327 gillnetters.

The management objective of the fishery is to maximize revenues and adjust fishing effort accordingly. Fishing effort has been limited by limiting the number of vessels, establishing a quota, limiting the time fishing takes place, and restricting harvesting areas. Quotas are based on market considerations and are allocated based on gear type (seine or gillnet) and area. The fishery is prosecuted in spawning populations therefore fisheries are opened for a matter of minutes; rarely a fishery is opened for a day or two. The high risk associated with this fishery has impelled vessels to "pool" resources such that one boat will fish and others will share in the catch.

A single seine license is now valued at $600,000. Annual rental of a seine license is set at $60,000. A gillnet license sells for $60,000 with an annual lease valued at $10,000. Profits generated by the fishery have gone to the fishermen.

B.C. Salmon Effort Limitation Plans

The B.C. salmon fishery is one the most regulated fisheries in the world. Because of the five different species and the various runs of salmon, management is crucial. A fishing plan is established each year based upon expected catches, and allocations are made by area and gear type. The coast is divided up into 29 areas with many sub-divisions, allowing fishing effort to be controlled to some degree. All vessels are licensed and fishing effort is controlled by area and time openings

Several attempts at vessel "buy-back" have been undertaken to control total effort but they have only reduced total effort by a small degree. There have also been attempts to control fishing effort through limiting the number and length of vessels operating. The number of vessels by gear-type is frozen (549 seines, 3,688 gillnets plus some Native licenses), however the efficiency of vessels increases as vessels are replaced therefore total effort is not affected significantly. Similarly, vessel length is restricted and a seine license costs approximately $250,000 based on vessel length. However, fishermen have circumvented this restriction as well by increasing the efficiency of the equipment on their boats. Therefore, the major control of fishing effort has been through reducing fishing time. Two and three day openings in an area have been reduced in many cases to 12 hour openings.

A new feature in this fishery has been the allocation of Fraser River salmon to native Indian bands in the Fraser Canyon. Each band has a quota and a management plan signed in agreement with DFO. Licensing and catch allocations are the responsibility of each band. The bands have formed an umbrella organization which hires its own Fishery Officers. The key feature here is the allocation of fish and management responsibility to Native Indian bands. These agreements serve as models for local Native management of other stocks harvested commercially.

Taxation

Taxation schemes have been considered for many fisheries to control the level of fishing capacity/fishing effort. A quota tax has been implemented in New Zealand where a system of individual transferable quotas is in place. The tax is calculated annually and is payable in quarterly installments. Taxes are based on the market value of quotas and expected net returns to fishermen. Implementing the quota tax is complicated by the need to determine a competitive rate of interest and market price of quota.

Taxation as a means to control capital investment and recover economic rent in the fishery has not received much support as a practical solution in most fisheries. The idea of cost-recovery for management costs and fish enhancement was explored in the B.C. Salmon

Enhancement Program where these costs were to be recovered through fees to industry and a landings tax. However, these means have yet to be implemented.

Taxation schemes suffer from the difficulties of determining an appropriate tax level given fluctuating catch and changes in fishing costs and fish prices. In addition, taxation offers no real benefits to fishermen since fishermen are unable to enjoy any of the resource rent generated by the fishery and thus are no better off than they would be under open access fishery regime.

Conclusions

Most fisheries in North America are managed as open access resources and as a result commercial fishing typically leads to over capitalization and low returns to fishermen. Attempts to control fishing effort through effort limitation are usually undermined by the ability of fishermen to develop better techniques and find different technologies to circumvent the rules. The disposition of quasi-property rights to participants may be a better alternative to restrictions on technology, however property rights in the form of ITQ's are effective only in relatively simple fisheries where there is adequate information on economics and biology. A common property approach may be more appropriate for traditional Native fisheries where resource allocation decisions can be made by the community. Sole ownership of the resource is an option that has not been pursued in North American fisheries, however this option does however offer advantages in terms of economic goals.

The regulatory instruments selected to manage a fishery should reflect the overall goals of the fishery. For governments, this requires a decision regarding the balance between economic efficiency, employment benefits, and the desire to collect economic rents from the resource.

Common Property Analysis of NWT Fisheries

In this section we apply the common property concepts and micro-model analysis to the major commercial fisheries in the NWT. The reader should note that we have simplified and adapted the conventional Scott-Gordon model to illustrate the situation in NWT fisheries. Conventionally, the Scott-Gordon model is applied only to the harvesting sector of a fishery. However, in most NWT fisheries the processing sector tends to be operated and underwritten by the government as a means of providing jobs in the harvesting sector therefore we have included the total costs required to achieve market revenues in our analysis. While we recognize that this is an unconventional and simplistic use of the model, we feel it illustrates the common property nature, and the costs and revenues that apply to NWT fisheries more clearly. In developing the following examples we relied on data readily available to us, provided primarily by ED&T.

Great Slave Lake Fishery

Great Slave Lake, the oldest commercial fishery in the NWT, has followed the classic exploitation cycle described in the first section of this paper. The fishery initially offered an economic opportunity which attracted harvesters from outside the Territories. Early exploitation concentrated on lake trout which originally accounted for 64°A of the total catch. Lake trout populations were quickly decimated and effort moved to whitefish. The proportion of the catch currently made up by lake trout has dropped to less than 10%.

Quotas were initially very high and, at one point in its early history, Great Slave Lake was the single largest producer of whitefish in North America. As catch rates declined and price dropped, the outside developers dropped out, leaving the fishery to be carried out by the more tenacious members of the original crews. These men remained in the NWT and took up permanent residence in Hay River, relying on native communities in northern Manitoba and Saskatchewan as a labour pool for crews.

In 1979 a limited entry regime was established for the fishery. Fishing effort was partitioned into four vessel classes and a limited number of certificates were issued based on what was believed to be the number of vessels which could be economically viable in the fishery. Certificates are not transferable and each certificate holder must apply annually for renewal. No quota is assigned to the certificates therefore fishermen must still compete for a share of the overall lake and area quotas.

Table 1 shows the cost of fishing and revenues earned by each vessel class on Great Slave Lake during 1991 [2]

Table 1 Cost and Earnings Data, Great Slave Lake Fishery 1991

(ED&T data based on Costs and Earnings Survey, 1991)

		Winter	Winter	Summer	Summer	
Certificate Type		A	B	A	B	**Total**
Number		18	20	16	29	83
Total Fixed Costs		$347,328	$116,020	$234,464	$179,916	$877,728
Total Variable Costs		$607,698	$100,380	$605,632	$211,729	$1,525,439
Total Costs		$955,026	$216,400	$840,100	$391,645	$2,403,145
Fish Revenues		$633,690	$70,120	$731,520	$195,054	$1,630,384
Capital Assistance		$45,360	$20,280	$65,264	$104,255	$235,159
Subsidies		$80,118	$8,860	$429,440	$114,492	$632,910
Total Revenue		$759,168	$99,260	$1,226,224	$413,801	$2,498,453

Costs do not include wages drawn by the owner or a return on investment to fishermen.

These figures represent costs and revenues at the harvester level only. The processing sector has not been included in this analysis because it is completely owned and operated by FFMC and as such does not represent income or investment in the NWT. In addition, it is assumed that because FFMC's monopoly represents a form of "sole ownership" over the processing sector, the corporation will behave in an economically efficient manner and will not over capitalize its operations. This assumption is borne out by the fact that FFMC has shut down smaller, inefficient fish plant operations and centralized its processing facilities to increase economic efficiency.

Using the costs and revenue data from this table we can construct a hypothetical Scott-Gordon curve for the Great Slave Lake fishery harvesting sector as shown below.

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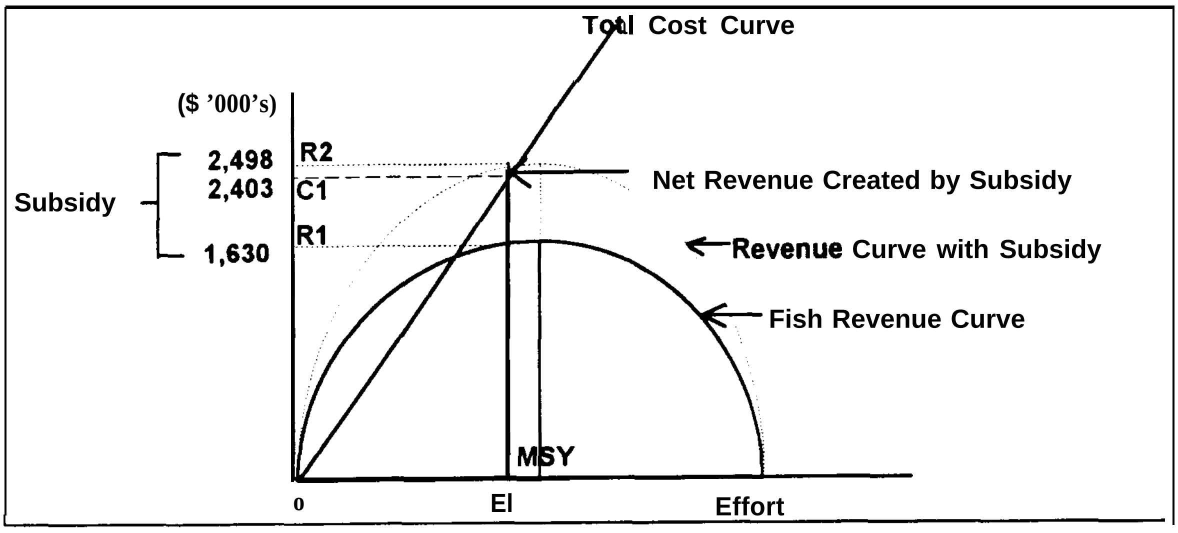
[2] Note: these figures represent values for 1991 only therefore government assistance shown, particularly capital assistance, is not necessarily representative of other years.

Figure 7 Scott-Gordon Model of the Great Slave Lake Fishery



Scott-Gordon Model Analysis

In the model above, E 1 represents the total level of effort currently employed in the Great Slave Lake Fishery. This line has been drawn to the left of MSY because Great Slave Lake has a long history of stable catches indicating that the current level of exploitation is sustainable. R 1 represents revenues earned from fish sales, C 1 fixed and variable fishing costs and R2 represents total revenues received by fishermen after factoring in government contributions and subsidies. Subsidies provided by the government have the effect of raising the revenue curve as shown by the dotted line. For the sake of simplicity we have combined government subsidies and capital assistance and applied them both to the revenue curve.

As the model shows, the level of revenue generated by fish sales is too low to cover fishermen's costs therefore, without government subsidy, fishermen would be operating at a loss. The difference between R2 and R1 represents the amount of government support received by fishermen, a total of $868,000. This level of support results in a net revenue of $95,000 being generated which is shown as the difference between R2 and C 1. This revenue is distributed among the fishermen. It is clear from the model that the net revenue created in this fishery is a function of government subsidy and capital assistance, not a true economic rent generated by harvesting. If the subsidy is removed, the revenue curve falls far below the cost of fishing and fishermen could not continue to fish without losing money, This fishery is well over capitalized in the harvesting sector and generates no economic rent.

According to the model, this situation can be improved in two ways, by increasing the revenue curve or decreasing the total cost curve. We can use the micro-model to examine these two possibilities more closely.

Micro Model Analysis

In the micro model, total revenue is determined by fish price and quantity. The total Great Slave Lake quota is assumed to be fixed with little potential for increase. In the current marketing environment, where FFMC purchases the entire catch and market projections for whitefish are very poor, the chance for substantial price gains is very limited. Given this situation, the only way to increase total revenues is for government subsidies to continue to target price. There is also an attempt underway in Hay River to develop a local market for Great Slave Lake fish and to develop value added products for this market. If successful, this may increase the price for a portion of the Great Slave Lake catch resulting in a higher revenue curve. It is unlikely, however, that increased revenues from the Hay River project would be adequate to cover all the costs incurred by the fishery.

Therefore, we must turn to the second alternative - reducing costs. The Great Slave Lake fishery is a classic case of too many fishermen chasing too few fish. Even though the fishery is limited entry, the number of productive units of fishing effort[3] is too large. Very few certificates fish to the limit of their capacity, yet the annual quota in most years is harvested or nearly harvested. The fishery could potentially yield some economic rent if effort were reduced.

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[3] a unit of fishing effort is defined according to the ED&T Great Slave Lake cost/earnings as a fishing operation with an annual production of at least 1,000 pounds. Operations that regularly pooled equipment or resources were considered to form one unit of fishing effort.

The current approach of the GNWT is to subsidize the cost of the fishery by underwriting the cost of fish freight. The fishery is currently over-subsidized, generating a false rent which is absorbed as profit. Removing this portion of the subsidy would push the revenue curve down to equilibrium at the expense of employment. The amount of effort reduction pursued therefore depends on the desired balance between economic efficiency and employment.

According to the ED&T costs and earnings survey, the A Class sector of the fishery appears to have some opportunity to earn a profit. The highest cost sector of the fishery in relation to revenue earned is the B Class fishery, in terms of both fixed and operating costs[4] Therefore, one possible approach to decreasing total costs would be to reduce the B Class sector.

If we convert the total B class production into A class certificates (by dividing total B Class production by average A class production for each season) there would be two additional A Class winter certificates and four additional A Class summer certificates based on current average production. Total costs and production on Great Slave Lake would then be as follows:

Table 2 Results of Converting Existing B Class Capacity to A Class Capacity

Season	Winter	Summer	Total
Certificate	A	A	A
Total Number	20	20	40
Total Fixed Costs	$385,920	$293,080	$679,000
Total Variable Costs	$675,220	$757,040	$1,432,260
Total Cost	$1,061,140	$1,050,120	$2,111,260
Fish Revenues	$704,100	$914! 400	$1,618,500
Capital Assistance	$50,400	$81,580	$131,980
Subsidies	$89,020	$536,800	$625,820
Total Revenues	$843,520	$1,532,780	$2,376,300

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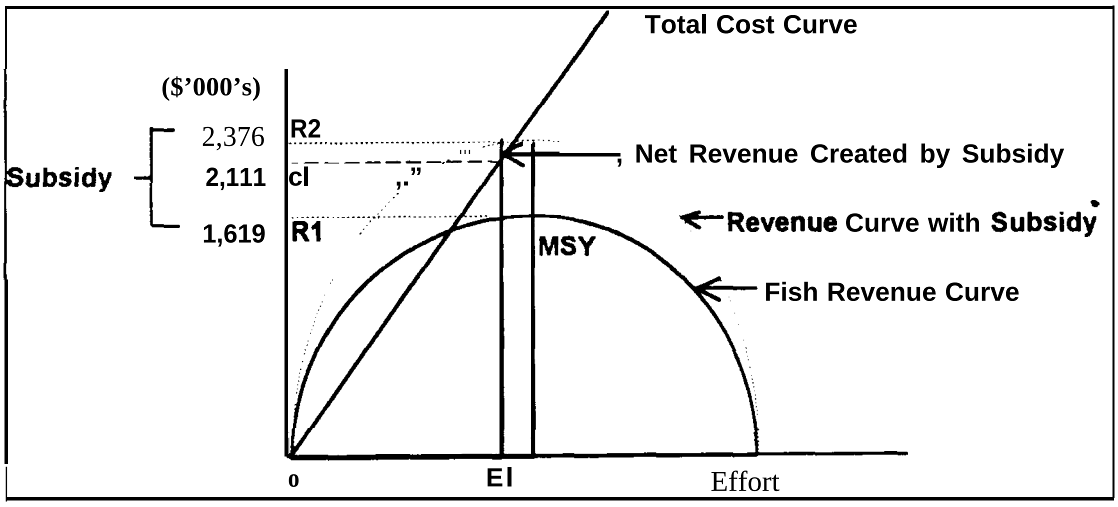
[4] Based on ED&T's Costs and Earnings Study for Great Slave Lake the costs to revenue ratios for each of the certificate classes is as follows: Winter A class - 1.5, Winter B class -3.0, Summer A class - 1.1, Summer B class -2. In other words, for every dollar earned Winter A class vessels costs total $1.50. Winter B class costs total $3.00. etc.

The conversion of B class to A class vessels would eliminate 62 fishing positions from the B class fishery representing $96,000 in wages. This would be balanced out by the creation of 24 new positions in the A class fishery representing $98,000 in wages. It is significant that conversion from the less efficient technology to the more efficient fleet would result in no net loss of employment income even though the number of participants would be reduced.

Total revenues from fishing would decline by about $122,000 however the overall costs of fishing would decrease by almost $300,000. These results assume that B Class capacity is completely convertible to A Class capacity and that all converted capacity would operate at average A Class levels.

We can use a Scott-Gordon model representation of these results to examine the impact of this conversion:

Figure 8 Scott-Gordon Analysis of Great Slave Lake Fishery after Converting B Class to A Class



As shown in the figure above, converting B class fishermen to A class fishermen would result in revenues from fish sales of $1,618,500 (Rl) and total fishing costs of $2,111,260 (C2). If the current average level of subsidy paid to Class A operations is maintained, total revenues received by fishermen would be $2,376,300 (R2) including a total subsidy of $757,640, a reduction of$110,269 from subsidy requirements with the Class B fishery in operation.

Under this new scenario, the fishery still does not generate any economic rent and still requires a subsidy because costs (C 1) exceed revenues (RI). However, the model also reveals that while a minimum subsidy of approximately $500,000 is required to ensure that fishermen cover costs, the current average level of subsidy, shown at R3, would generate a net revenue of $265,040 which would be distributed among the fishermen as profit. This profit represents the fisherman's return on investment and is approximately three times the level of net revenue presently created by government subsidy in Great Slave Lake. The government could chose to decrease the level of subsidy and still provide enough income to allow fishermen to cover their costs.

Removal of the B Class fishery without Conversion to A Class Capacity

The previous analysis assumes that each unit of the present A Class fleet is fishing to capacity. If the B Class fishery competes with the A Class fishery for fish, simple removal of the B Class effort might result in increased efficiency of the A Class fleet. The extent and nature of this competition is not known and therefore results based on this scenario cannot be predicted. However, an increase in efficiency of the A Class fishery would result in a move down the cost curve, reducing subsidy requirements.

options

It is assumed that the GNWT will continue to subsidize the Great Slave Lake fishery if necessary. Given the assumption that some level of subsidy support will required, the following options can be considered:

- reduce or eliminate all subsidies to the B Class Fishery
- reduce or eliminate B Class certificates and convert to A Class certificates
- institute individual transferable quotas on the lake

Reduce or Eliminate all Subsidies to the B Class Fishery

Reduction or elimination of subsidies to the B Class fishery would result in eventual removal of B Class effort from the fleet, since it assumed that effort is dependent on subsidies for continued operation. We would not reasonably expect the displaced labour to be absorbed as crew into the A Class fishery. If there exists a competitive effect between A and B Class catches, this would become apparent by an increase in the catch per A Class vessel after the B Class fleet had fallen out the fishery.

Reduce or Eliminate B Class Certificates and Convert to A Class Certificates

The ramifications of this options were demonstrated earlier. Under this option, limitations on vessel size would still limit effort. Total effort (cost) would be reduced with a minimal decline in overall harvest, however fishermen would still scramble to capture a share of the overall quota

Individual Transferable Quotas

The institution of ITQ's would allow A and B class designations to be eliminated. ITQ's would eliminate competition for fish and fishermen would be expected to capitalize to an efficient level, especially if encouraged through government contribution and financing programs which favored the purchase of efficient vessels and gear. Transferable quotas would also allow fishermen to capture a greater return on investment for equipment and vessels when they leave the fishery.

ITQ's could be assigned on the basis of historical fishing efforts for current fishermen. Quota allocations would be complicated by the partitioned nature of the lake quota and individual quotas would have to be divided among the five quota areas of the lake open to commercial fishing, probably weighted according to past patterns of harvest and/or accessibility.

If the goal of economic efficiency is desired, then individual quotas should be assigned which would allow profitable operation under prevailing economic conditions. A hypothetical level for total ITQs could be established based on the best performing A Class vessel categories. According to cost/earnings data provided by ED&T, Class A vessels can harvest up to 54,000 kilograms (dressed weight) in summer, and 33,000 kilograms in winter. This would allow total annual individual quotas of 87,000 kilograms per vessel which would allow a total of 16 operations harvesting at this level on Great Slave Lake,

This result is similar to the analysis in which we examined the effect of converting B Class to A Class effort. In that analysis we looked at licensing 20 units of effort each in winter and summer, for a combined total of 40 units annually. At this level of effort, a combined winter and summer annual individual quota of 71,480 kilograms would be appropriate. Given the accuracy of the data provided, and the fact that this analysis is based on data collected for only one year, the discrepancy between ITQ's calculated using the two methods described is not great.

To date, fishermen have rejected any proposals for ITQ's on the lake.

Impact on the B Class Fishery

The impact on B Class fishermen if B class certificates are converted to A Class depends on two factors: the ability of B Class fishermen to convert to wage labour in the A Class fishery, and the strength of the linkages between the B Class fishery and the subsistence economy.

In terms of fishing skills, a transition from B Class to A Class should not be a problem. However, B class fishermen are masters of their own vessels, and some may hesitate to take up crew positions on the larger vessels. Since many B Class fishermen fish only part-time, they may be unable or unwilling to take up full time crew positions.

There may also be a strong linkage between some parts of the B Class fishery and the subsistence economy. Certainly some B Class fishermen participate in the fishery as an adjunct to other employment while others benefit substantially from their participation since it provides food (fish) and an opportunity to live on the land. However, the exact proportion of each type of fisher has not been determined.

For part-time B Class fishermen, removal from the fishery would not present substantial financial hardship. For subsistence participants, displacement from the fishery could mean significant losses in terms of access to food and a reduction in well-being. However, because we do not know the extent of the commercial/subsistence linkage in this fishery, the magnitude of such losses cannot be estimated.

With this in mind, if the B Class fishery is reduced, a small aggregate quota should be set aside to accommodate small scale fishermen with strong subsistence interests in the fishery.

The Role of Economic Development and Tourism

ED&T has no authority to allocate fisheries resources in the NWT. This mandate is vested in the federal Minister of Fisheries and Oceans. However, ED&T does have direct involvement in investment in northern fisheries. The department funds plants, boats, and gear, and provides substantial operating subsidies. From this perspective, ED&T can have a profound impact on fishing effort. Therefore, the department should have definite goals for management of the fishing effort of the major NWT fisheries. Public requests for contributions or loans for infrastructure, vessels etc., can then be measured against these goals.

For Great Slave Lake, ED&T plays a vital role through provision of a substantial subsidy, a subsidy that exceeds the wage bill of the fishery. It is incumbent upon the department to manage its subsidy program according to sound economic principles. If Fisheries and Oceans cannot be persuaded to change its license allocation system, then ED&T could adjust its subsidy program to encourage economic efficiency.

Mackenzie Delta Fishery

While technically the Mackenzie Delta commercial fishery is an open access fishery, in reality access is controlled by a local community organization serving subsistence harvesters. Fishermen's right of access to the resource is based on camp occupation at traditional sites in the Delta, and right of access to these camps is based on historical family use. Participation in the commercial fishery is determined by the community organization and a steering committee which decides which areas will be serviced by the collector boat. While fishermen in other areas are not restricted from participation, without the services of the collector vessel they are essentially eliminated from the fishery.

The commercial fishery provides a substantial linkage between the subsistence economy and the cash economy for those fishermen participating. While the fishermen's costs of fishing, estimated at about $4,300, earn a very good return, estimated at $29,000 for 1992, the total costs of the fishery are very high (see Table 3).

Table 3 Costs and Earnings of the Delta Fishery, 1992

Fishermen's Revenues	$29,000
Fishermen's Costs	$ 4,300
Plant Revenues	$39,120
Plant Variable Costs	$71,000
Plant Fixed Costs	$71,000[5]
Total Plant Costs	$142,000

If we insert these figures into the Scott-Gordon model we can develop the following macro model representation of the fishery:

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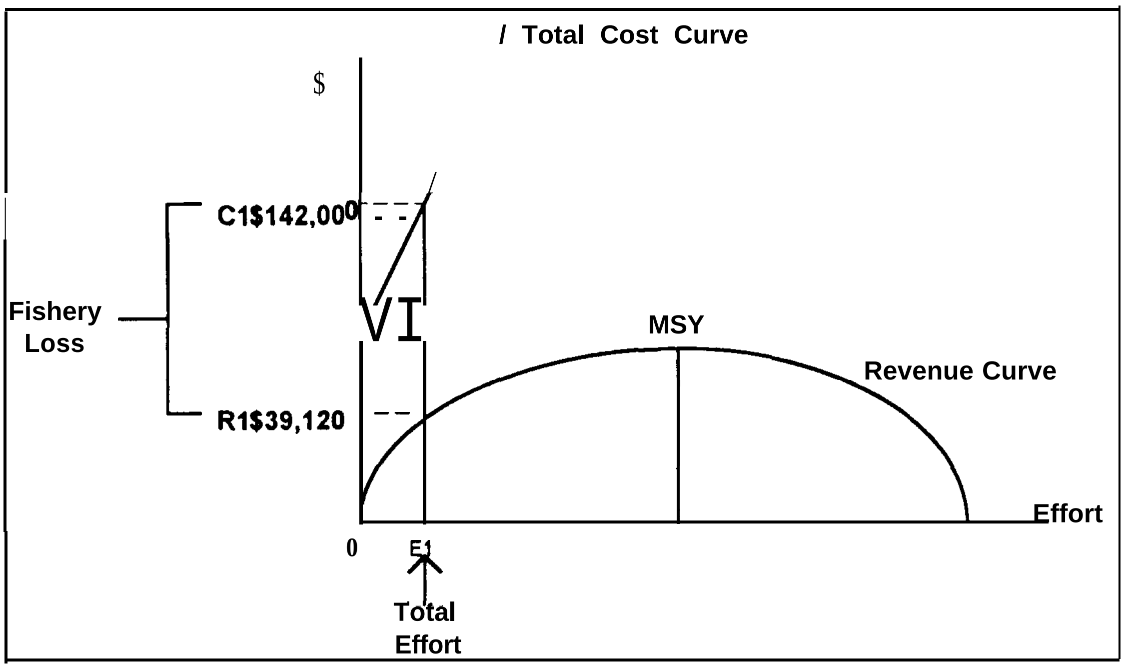
[5] Fixed costs are based on annual vessel lease, average cost of plant repairs over the life the project. average annual cost of vessel repairs, and cost of plant equipment amortized over 10 years as well as actual fixed costs of plant operation (utilities etc.) reported for 1992.

Figure 9 Scott-Gordon Model of the Mackenzie Delta Fishery



In Figure 9, E 1 represents harvesting effort, C 1 represents total fishery costs and R1 represents total revenues earned from fish sales. The distance between R1 and C 1 the fishery represents the loss incurred by the fishery, As shown by Table 3, fishermen's revenues exceed their costs, however plant costs are extremely high, with fixed costs alone far exceeding total revenues earned from fish sales. The total cost curve does not intersect the origin to illustrate the high fixed costs in this fishery. Obviously, the fishery is well-over capitalized in the plant sector. However, plant costs are relatively fixed given the requirements for the plant to meet federal inspection standards and the need to produce, weigh, process and package the catch. Little can be done to decrease total plant costs.

To bring the fishery to a position where revenues cover costs, total revenues must be increased. The micro-model revenue equation is:

Total Revenue (R) = Quantity (Q) X Price(P)

In the Mackenzie Delta fishery, quantity is extremely low because the quota assignment is small - far too small to support a commercial fishery given the minimum plant costs. The experimental quota under which the fishery operates must be increased by at least four times to bring the total cost and total revenue curves into equilibrium. However, indications from DFO suggest that a commercial allocation will not exceed the current experimental quota.

If quantity cannot be increased, then price must be increased. The fishery is pursuing this option through value added processing (fillets) and marketing the product within the local market area. Previously, the fish was sold to FFMC which is a price setter and paid low prices for whitefish.

The future of this fishery depends on getting a better price for the fish. If this cannot be accomplished, the fishery will require a high level of subsidy. In this case, it might make better financial sense to provide the fishermen with an income supplement equivalent to their earnings from the fishery and avoid the costs of the plant operation. This would be consistent with the HTC goal of providing the fishermen with a source of cash for living on the land.

Cambridge Bay Fishery

The Cambridge Bay Char Fishery is generally viewed as the most successful fishery in the NWT. Cambridge Bay has harvested approximately 40,000 kgs of char consistently since 1975. Environmental constraints in 1991 and a market failure in 1992 reduced the harvested volumes in those years.

The fishery's success is at least partially due to the fact that it is regulated as a resource with ownership held in common, rather than as an open access resource. The fishery is managed by the community as represented by the local Co-operative. The community has allocated harvesting rights to the Co-op, which in turn manages both the harvesting and processing aspects. Because the Co-op has *de facto* sole ownership of particular quotas, it is in the Co-ops best interest to minimize effort in order to maximize profit. And this is exactly what the Co-op does. The Co-op harvests char with efficient gear (primarily weirs), hires local fishermen to harvest the fish, and transports the catch to the plant by aircraft.

Until 1991, the fishery generated economic rent in the form of profit accrued to the Co-op. The rent was then distributed to the general Co-op membership in the form of dividends. Assuming that the membership represents most of the community, this dividend distribution represents one of the few fisheries in Canada where economic rents are returned to the resource owners.

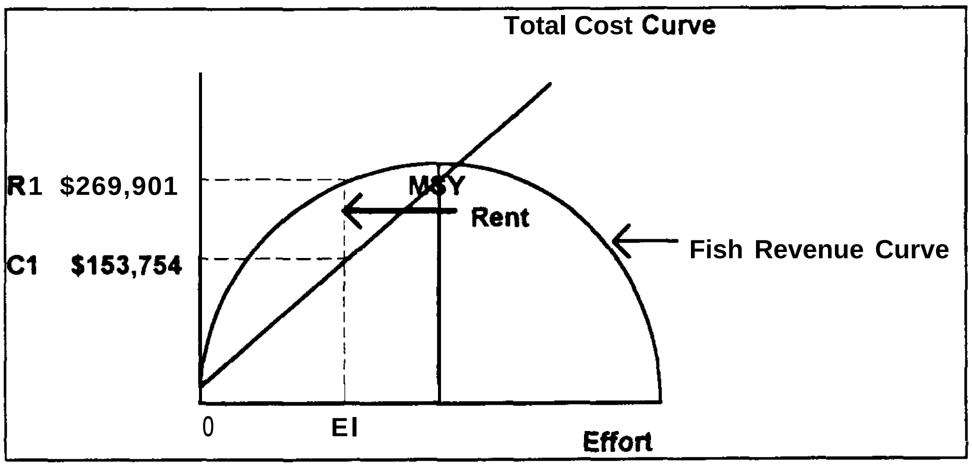
Table 4 presents a breakdown of the costs and earnings of the Cambridge Bay fishery for 1987:

Table 4 Costs and Earnings for the Cambridge Bay Coop Fishery 1987.

Total Revenue:	$269,901
Payment to Fishermen	$ 57,673
Freight	$ 39,046
Other Variable Costs	$ 36,853
Fixed Costs	$ 20,182
Total Costs	$153,754
Net Margin (Rent)	$116,156

Figure 10 presents a Scott-Gordon macro model representation of the fishery in 1987:

Figure 10 Scott-Gordon Model of the Cambridge Bay Char Fishery 1987



The economic rent generated by this fishery is clearly shown as the distance between R1 (total revenues) and Cl (total costs). In 1987 the economic rent generated was over $100,000.

Pangnirtung Turbot Fishery

The Pangnirtung turbot is a new fishery, still in the early stages of resource exploitation. As such, this fishery illustrates one of the classic principles of open access theory - effort increases until total revenues equal total costs.

Table 5 shows costs and revenues in the fishery since the 1988/89 season. These costs do not include capital and development costs, nor do they include depreciation costs for the plant. Figure 11 illustrates these trends graphically.

Table 5 Costs and Earnings for the Pangnirtung Turbot Fishery

	88/89	89/90	90/91	91/92	92/93
Plant **Revenue**	**415,269**	901,414	1,007,364	n/a	1,042,662
Plant Costs	**389,082**	1,067,076	n/a	n/a	1,283,366
Fishing Revenue	**184,459**	**346,635**	**187,593**	**544,822**	**540,684**
Fishing Costs	**130,965**	**246,110**	133,191	386,823	383,885

Figure 11 Costs and Earnings of the Pangnirtung Turbot Fishery

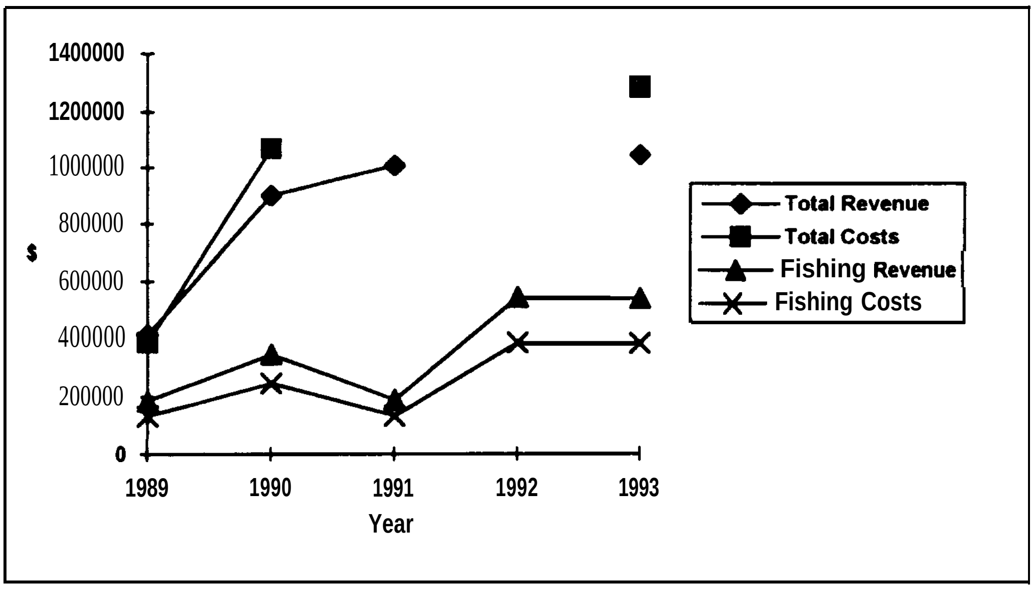


Table 6 shows the growth in participation and fishing effort since the inception of winter fishing for turbot in 1986:

Table 6 Participation in the Pangnirtung Turbot Fishery

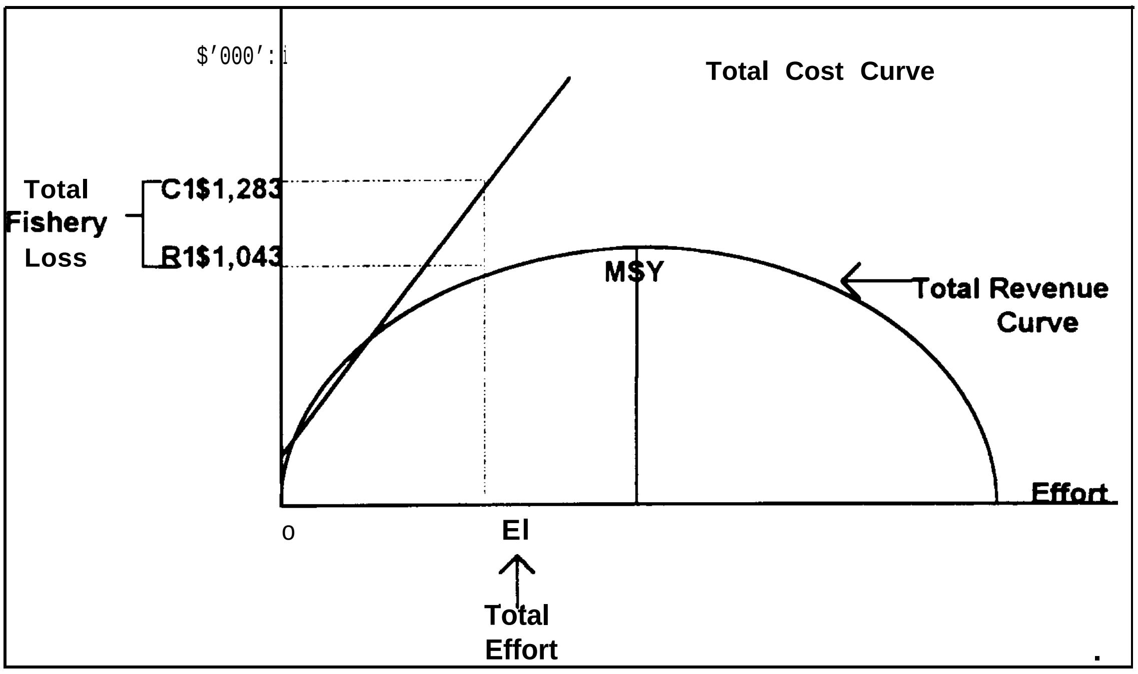
Year	1986	1987	1988	1989	1990	1991	1992	1993
No. of fishermen	8	6	14	43	77	61	93	115

Fisheries and Oceans defers to the Pangnirtung Hunters and Trappers Association for allocation of the turbot quota for Cumberland Sound. The HTA has placed no restrictions on access and anyone who wishes to participate in the fishery may do so. The fishery is therefore an open access fishery. Since the resource has not been harvested by Inuit in the past, no rules limiting effort along lines of traditional rights of access exist.

Scott-Gordon-Model Analysis

Figure 12 illustrates the Scott-Gordon model of the fishery as of the 1993 season.

Figure 12 Scott-Gordon Model of the Pangnirtung Turbot Fishery



The model indicates that the fishery is operating at loss. The difference between total cost and total revenue represents the amount of subsidy that must be provided; in 1993, this subsidized cost was approximately $300,000 including both direct freight subsidies and operating losses absorbed by the DevCorp.

Figure 12 B Scott-Gordon Model of the Pangnirtung Turbot Fishery - Harvesting Sector Only

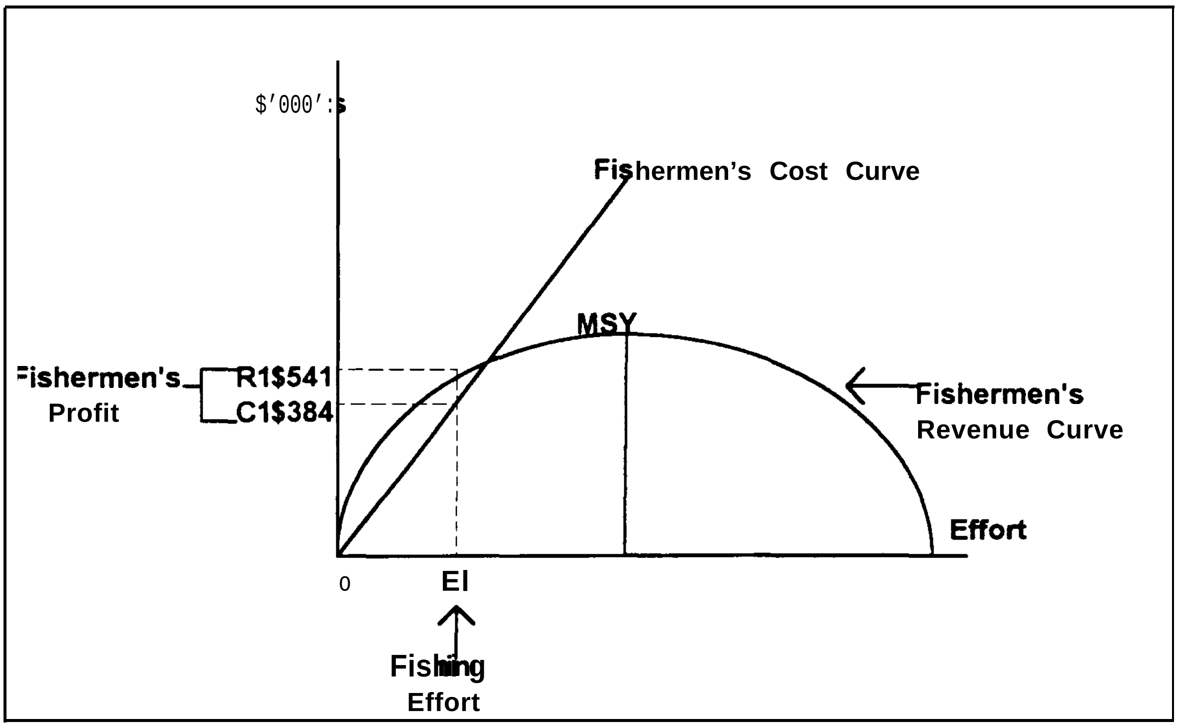


Figure 12 B illustrates the costs and earnings for the harvesting sector only. Revenue from fishing exceeds the costs of fishing by $157,000. However fishing costs do not include owners wages or return on investment. Therefore, only a small portion of this difference actually represents economic rent; most of this excess is normal wages and profit to fishermen. The harvesting sector generates very little economic rent. .

According to Fisheries and Oceans, the position of this fishery in relation to MSY is questionable given the current state of understanding of the turbot stock. The current level of effort may even be beyond MSY. If the fishery were to increase production in order to generate sufficient revenue to equal costs

Micro Model Analysis

The Scott-Gordon model shows that total costs exceed the total revenues in the fishery however the price paid to fishermen is just adequate to provide a return on effort. Therefore, in the micro analysis, adjustments must be made at the plant level.

In the revenue equation, both price and quantity affect the total revenue received. The Pangnirtung fishery currently operates in a window of higher price to maximize returns. Operation outside that small window in an effort to increase quantity will reduce price. Therefore, the only way to increase quantity effectively would be to increase effort or increase efficiency during the window of higher price. However, quantity is limited by the ability of the resource to sustain higher levels of harvest. This ability is currently unknown.

In terms of price, the DevCorp is attempting to increase price through two strategies: penetrating more lucrative markets, and developing value-added products. With respect to penetrating more lucrative markets, the Pangnirtung fishery must compete with lower cost fisheries except between January and April, therefore competition for lucrative markets will be high. With respect to value-added products, increased processing has attendant costs which can negate the price advantages gained. Therefore this option must be approached carefully.

Reducing total costs can be approached by reducing fixed or variable costs. In the Pangnirtung fishery, fixed costs represent 17% of total costs and fish freight and fish purchases represent 24% and 31?40 of total costs. One of the DevCorp's major strategies for cost reduction has been to lobby the fish freight subsidy program managers (EDT) to subsidize more of the fish freight costs. From the point of view of the DevCorp, increased freight subsidies can be counted as revenue, improving the financial performance of the DevCorp. However, such a strategy does not improve the economic performance of the fishery and actually further entrenches the fishery in its state of dependence on government.

Discussion

Involvement of both ED&T and the DevCorp in the Pangnirtung fishery was guided by the goal of increasing the number of jobs in the community. Neither ED&T nor the DevCorp has officially expressed any interest in moving toward economic efficiency in this fishery therefore we can assume that the goal of the GNWT is to maximize employment at the expense of economic efficiency. Economic rent would therefore be distributed back to the community through employment opportunities in the processing sector.

Given the goal of maximizing employment, it would be expected that the DevCorp, now the major investor in the fishery, would push the fishery toward the point where total costs equal total revenues. In private sector fisheries, this is a dangerous position because the fishery is then highly susceptible to increases in costs or decreases in price. However, the DevCorp is less sensitive to such fluctuations because its operations are subsidized. Indeed, the DevCorp's fish plant operation showed a substantial loss in 1993 **yet** the DevCorp is making a substantial investment in a new plant in the community. The DevCorp is also pressing ED&T to increase the amount of freight subsidy provided to the fishery.

The DevCorp is currently operating beyond the equilibrium point where total costs equal total revenues, whereas the fishermen are operating at a point where total revenues from fishing just exceed total fishing costs. Because the costs of fishing are not directly subsidized, fishermen must operate at this level in order to keep fishing. Of course, it could also be argued that the plant is actually subsidizing fishing operations by not passing plant losses onto fishermen.

The increase in fishing effort in both the processing and harvesting sectors suggests that the fishery is being driven by the forces typical of an open access fishery and the possibility of collapse increases as effort and investment rises. This possibility is particularly acute given the warnings from Fisheries and Oceans that the biology of the stock is not understood. Some thought should therefore be given to limiting effort to present levels until the turbot biology is better understood. If fishing effort continues to increase, at some point the marginal revenues of each fishing unit will begin to decrease.

We can also expect to see a greater investment in fishing gear as competition for fish increases. ED&T has already funded a number of fishing outfits and it is expected that applications for equipment will increase as new entrants are attracted to the fishery. By finding new entrants and providing increased freight subsidy support, ED&T could contribute to a situation similar to Great Slave Lake, where subsidy support will become mandatory and the economic benefits are widely disbursed over so many fishermen that very few actually benefit.

To avoid this situation, the department should decide on a point beyond which investment through contributions will not be extended. If the department believes that its role is to maximize employment in the fishery, then the GNWT must be prepared to provide on-going subsidies to the fishery.

ED&T does not have the mandate to regulate entry in the fishery therefore recommendations on effort limitation cannot be made directly to the department; however, ED&T can choose to lobby for such measures as in the case of recommendations for Great Slave Lake.

In the Pangnirtung turbot fishery there does not appear to much variation in gear efficiency. Rather, fishermen's efficiency appears to be dependent on skill and experience. Therefore, any effort limitation schemes should focus on limiting the number of participants or establishing an individual transferable quota system rather regulating gear types.

ITQ's may not be acceptable to the community and it may be too early to determine appropriate ITQ quota levels. If current fishing technology cannot be substantially improved, a license limitation scheme may be more appropriate. In this case, the number of licenses should be limited to the number of financially viable fishing enterprises which the total quota could support. To determine this number, a comprehensive cost and earnings study is required.

Keewatin Char Fishery

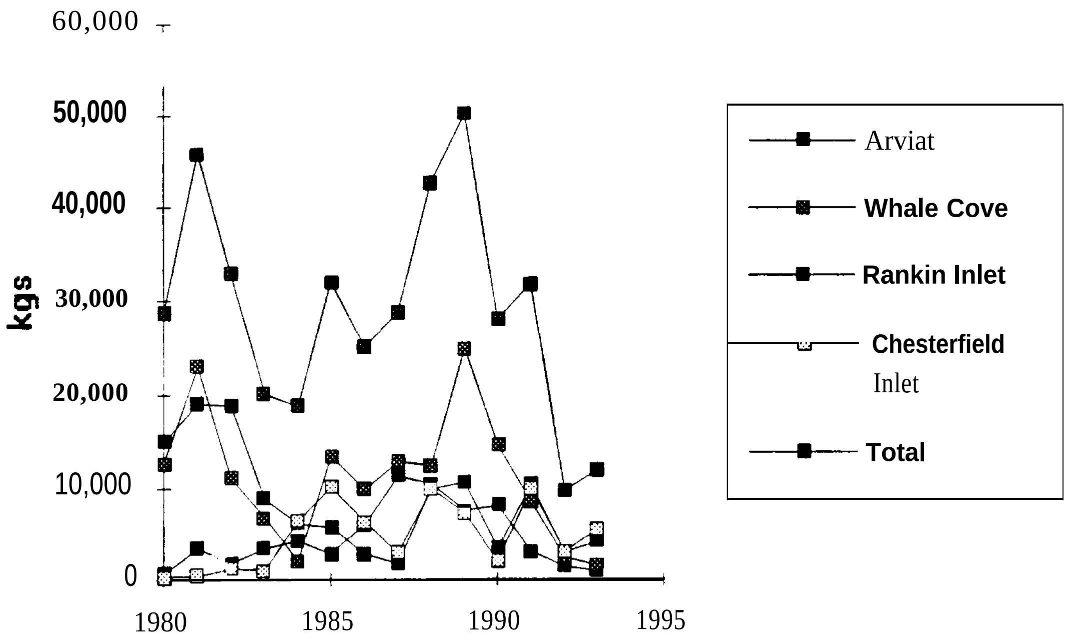
The Keewatin char fishery has been the subject of government development efforts for almost thirty years. Through its history the fishery has received government support provided in the form of contracted plant management, and capital and operating subsidies for both plant and fishermen. Staff from ED&T have played an integral role in organizing and running fisheries operations throughout the region.

Unlike Pangnirtung, where the turbot fishery has attracted an increasing number of participants because of the potential for economic profit, or the Cambridge Bay char fishery, where the fishery is managed by a stable, community-based organization, the Keewatin char fishery suffers from poor profit capability and a lack of stable central organization. As a result, char harvests have fluctuated widely over the years, as shown in Table 7 and Figure 13.

Table 7 Keewatin Char Harvests

		Harvest (kgs round weight)			
Year	Arviat	Whale Cove	Rankin Inlet	Chesterfield Inlet	Total
1980	612	12,677	15,012	331	28,632
1981	3.432	22.932	19,049	454	45,867
1982	1:804	11:026	18,777	1,209	32,816
1983	3,412	6,790	8,798	1,045	20,045
1984	4,263	2,051	6,097	6,332	18,743
1985	2,776	13,453	5,703	10,083	32,015
1986	6,029	9,821	2,829	6.274	24,953
1987	11,247	12,843	1,786	2900	28,776
1988	10.459	12,440	9,8541	9,865	42,618
1989	7,523	24,841	10,581	7,267	50,212
1990	8,045	14,594	3,351	1,928	27,918
1991,	3,045	8,465	10,328,	9,953	31,791
1992	1,409	2,391	2,922	2,972	9.694
1993	937	1.570	4,073	5,378	11,958
Average	6,087	10,871	5,715	5,817	28,490
Maximum	11,247	24,841	19,049	10,083	50,212
Minumum	612	1,570	1,786,	331	9,694

Figure 13 Keewatin Char Harvests



It now appears that the fisheries in the southern Keewatin communities (Rankin Inlet, Whale Cove and Arviat), normally the largest contributors to the harvest, are in serious trouble. Results from the 1993 season strongly suggest that fish stocks in the area 'are badly depleted. If these indications are confirmed, then the Keewatin char fishery has been operating beyond MSY for several years. Given the widespread failure of the fishery in 1993, we must assume that this is the case.

Access into the fishery is completely open; anyone can buy a license for any commercial quota. Subsistence harvesting from all stocks is also unrestricted by either quota or licensing. Because the magnitude of the subsistence harvest is unknown, total fishing pressure on the stocks cannot be determined.

In the absence of complete information on fishing pressure, the GNWT has still made major investments in the Keewatin fishery. In 1985, a fish plant was constructed in

Chesterfield Inlet for a cost of about $350,000; in 1991, a fish plant costing almost $190,000 was established in Arviat; and in 1993, a new fish plant in Rankin Inlet began construction with a budget approaching $1 million. These figures do not include numerous government contracts for plant managers, fishery coordinators, and marketing studies. nor the many contributions for motors, boats and gear.

Scott-Gordon Model Analysis

The Scott-Gordon model has been constructed for two hypothetical fishing seasons: a season of high catches based on the 1988 season, and a season representing the stock crash, 1993. For the high production year, costs and earnings for fishermen are based on data gathered in 1988 for Whale Cove and Arviat and do not include fishermen's wages or return on investment. This data has also been used for Chesterfield Inlet and Rankin Inlet, for which no cost and earnings information is available. Plant costs are based on actual and projected costs of operations for all plants as they existed in 1988, **with the exception of Arviat, where costs are based on the operation of the new fish plant. Depreciation charges are included in fixed costs.**

For the low production year, revenues are based on the wholesale selling prices charged by the DevCorp for products produced by the Rankin Inlet plant. The cost of operations of the Rankin Inlet plant have been increased 3 fold over the 1988 figures to reflect a longer operating period.

Data for the two seasons is summarized in the following table.

Table 8 Costs and Revenues for the Keewatin Fishery in a High Production Year (1968) and a Low Production Year(1333J

	Capital costs	Operating costs	Total Costs	Catch (lbs)	Price	Revenue	Subsidy	Total Revenue
High Catch Year								
Harvesters Costs								
Chesterfield inlet	$10,164	$3,920	$14,084	20,107	$1.00	$20,107		$20,107
Rankin Inlet	$11,165	$8,775	$19,940	18,893	$1.40	$26,450		$26,450
Whale Cove	$21,125	$15,210	$36,335	22,209	$1.30	$28,872		$28,872
Arviat	$19,602	$7,560	$27,162	20,522	$1.40	$28,731		$28,731
Total	$62,056	$35,465	$97,521	81,731		S104,160		$104,160
Plant Costs								
Chesterfield Inlet	$20,000	$24,500	$44,500	20,107	$2.30	$46,246	$7,037	$53,284
Rankin Inlet	$25,000	$37,000	$62,000	18,893	$2.17	$40,998	$7,274	$48,272
Whale Cove	$5,000	$10,500	$15,500	22,209	$1.69	$37,533	$11,216	$48,749
Arviat	$9,500	$38,000	$47,500	20,522	$1.74	$35,708	$8,824	$44,533
Total	$59,500	$110,000	$169,500	81,737		$160,485	$34,351	$194,837
Base Price/lb	$4.00							
Stock Crash Year								
Harvesters Costs								
Chesterfield inlet	$7,623	$2,940	$10,563	10,057	$1.50	$15,085		$15,085
Rankin Inlet	$20,096	$15,795	$35,891	7,617	$1.50	$11,425		$11,425
Whale Cove	$8,938	$6,435	$15,373	2,936	$1.50	$4,404		$4,404
Arviat	$17,424	$6,720	$24,144	1,752	$1.50	$2,628		$2,628
Total	$54,081	$31,890	.$85,971	22,361		$33,542		$33,542
Plant Costs								
Chesterfield Inlet	$20,000	$24,500	$44,500	10,057	$4.40	$44,210	$1,559	$45,769
Rankin Inlet	$25,000	$111,000	$136,000	7,617	$4.71	$35,843	$0	$35,843
Whale Cove	$5,000	$10,500	$15,500	2,936	$4.34	$12,730	$161	$12,892
Arviat	$9,500	$38,000	$47,500	1,752	$4.22	$7,387	$166	$7,544
Total	$59,500	$184,000	$243,500	22,361		$100,171	$1,887	$102,057
Base Price/lb	$6.21							

Figures 14 through 17 illustrate these two years in the fishery using the Scott-Gordon model.

Figure 14 Scott-Gordon Model of the Keewatin Fishery -1988 Harvesting Sector

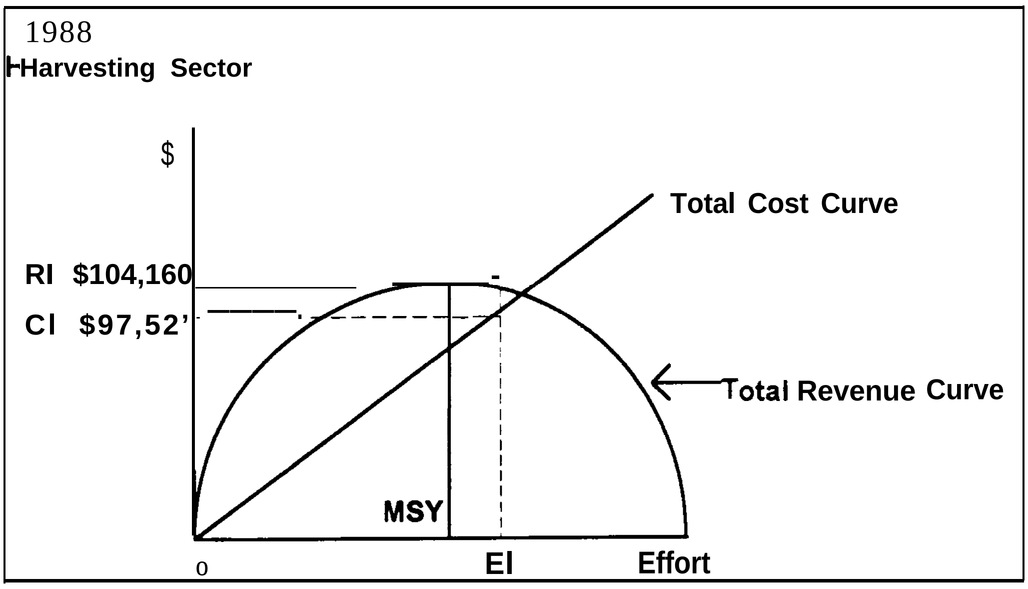
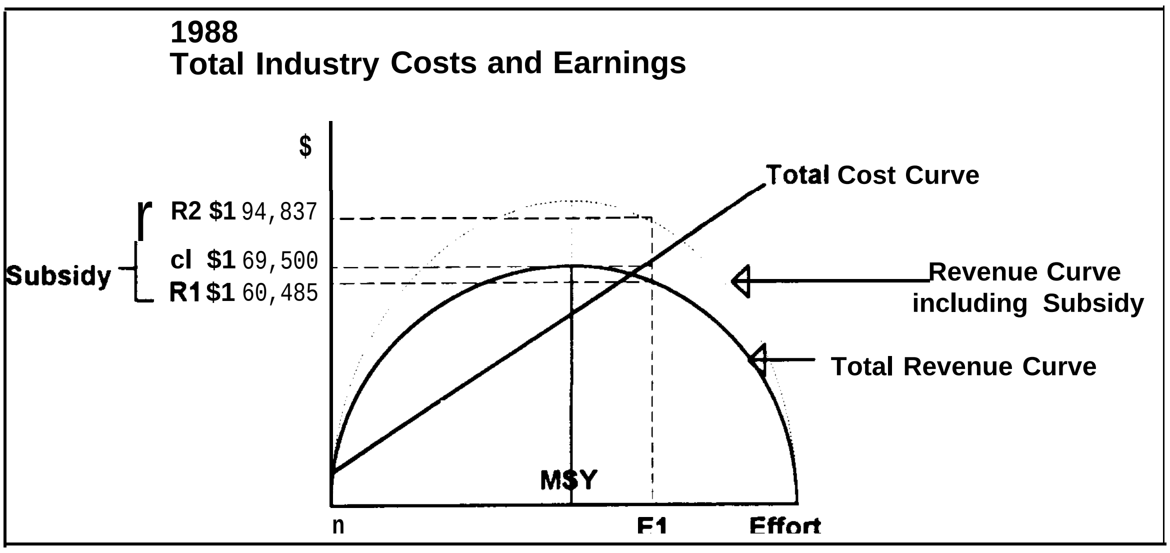


Figure 14 shows that during the high catch year of 1988 total revenues earned by fishermen exceeded estimated costs producing a small economic rent. However, as wages and return on investment were not included in estimating fishermen's costs, this economic rent is actually distributed among fishermen as a return to their labour. In 1988 this return was small but positive. The reader will note that we have drawn E 1 to the right of MSY. to illustrate the effect over fishing the resource. Once effort exceeds the point of MSY, increased effort results in smaller and smaller revenues.

Figure 15 illustrates total industry costs and earnings for the same high catch year.

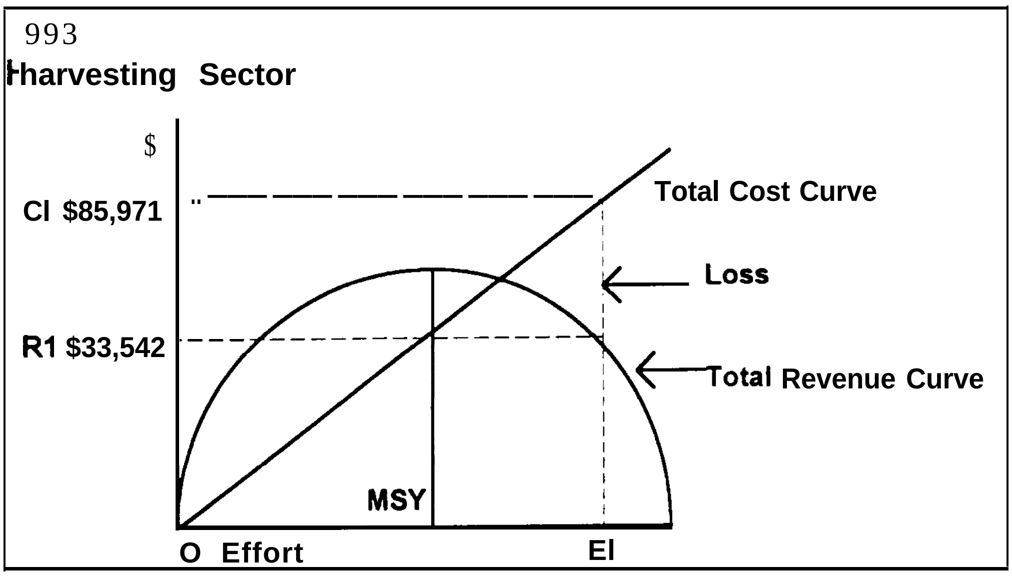
Figure 15 Scott-Gordon Model of the Keewatin Fishery -1988 Processing Sector



In the high catch season, revenues received by the processing sector were lower than total costs resulting in a small loss. However, the subsidies provided by the GNWT push the revenue curve up above the cost curve creating a false economic rent of approximately $25,000.

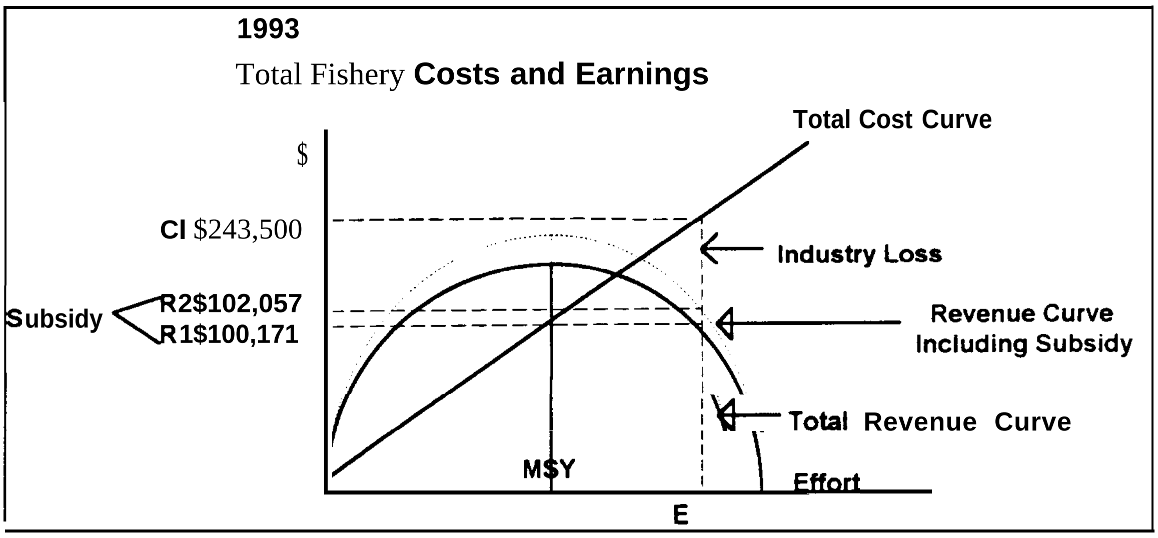
In contrast, Figures 16 and 17 illustrate the Keewatin Fishery during the low harvest year of 1993.

Figure 16 Scott-Gordon Model of the Keewatin Fishery -1993 Harvesting Sector



As Figure 16 clearly shows, during 1993 fishermen's costs far exceeded the revenues and no profits were generated by the fishery. Figure 17 indicates that, as a whole, the fishery suffered from the same situation. Total Costs exceeded both the revenues generated by fish sales and the total revenues received after factoring in GNWT subsidies. In fact, the revenues from GNWT subsidies contributed only a very small amount to total revenues in 1993 because the subsidies came from the freight subsidy program only and this program is based on volume. The low volume of char harvested in 1993 meant that very little subsidy could be claimed.

Figure 17 Scott-Gordon Model of the Keewatin Fishery - 1993 Total Fishery



Micro Analysis

Closer scrutiny of the revenue and cost curves for the Keewatin fishery reveals failures in the cost equation in the high catch year and in the revenue equation in the low catch year.

In the high catch year of 1988, costs in the processing sector exceeded fish revenues in Arviat and Rankin Inlet. The Whale Cove operation produced the most char yet had the lowest costs by far. The low cost of operations in Whale Cove is attributable to its function as a packing station rather than a freezing station.

In the low catch year, a failure in quantity resulted in revenues that were much lower than costs. In addition, the cost of plant operations in Rankin Inlet has increased considerably because of value-added production which resulted in both a longer operating period and higher costs. The increased revenue from NWT sales of whole and value-added char cannot compensate for the low catches and higher costs of production.

If the low catch rates are attributable to a stock crash, the failure in quantity is far more serious than the failure in the cost variables.

Discussion

Even at peak production, the Keewatin fishery produces less char than the Cambridge Bay fishery at considerably more cost. No rent is generated by the fishery and profits accrue from subsidy revenues.

The Keewatin fishery has been actively promoted by the GNWT as an income opportunity and to that end ED&T and now the DevCorp have made considerable investment in infrastructure and labour. The crash of the Diana River char stock in 1984 caused the GNWT to promote the development of char fisheries in Whale Cove and Arviat to supply the Rankin Inlet plant. Rather than treat the Diana River char crash as a warning, fisheries managers and developers proceeded with investment strategies even to the extent of attempting to entice private investment in infrastructure. For example, new fish plants were constructed in Chesterfield Inlet and Arviat and the DevCorp is now investing in a new plant in Rankin Inlet.

The harvesting sector is well over-capitalized for the amount of fish harvested. The amount of effort could be significantly reduced without reducing the volume of harvest. However, such a reduction in effort would require a limitation scheme such as ITQ's or limited entry. Such measures do not seem to be consistent with community aspirations, especially given the strong linkage between the subsistence economy and the commercial fishery.

If the fish stocks in the southern Keewatin have indeed collapsed, then an important aspect of the macro model has not been fully measured: total effort. The Keewatin fishery includes both subsistence and commercial harvesting - both fisheries take place at the same time and place, harvest the same fish, and are often carried out by the same fishermen. However, no accurate measure of the subsistence effort exists. In a fishery such as Cambridge Bay where commercial fishery is concentrated in areas which are not harvested for subsistence needs, community input and control can prevent the potentially disastrous effects of combined commercial and subsistence exploitation of the same stock. In the Keewatin, such a separation has not been pursued.