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The Public Regulation of Commercial Fisheries in Canada

Case Study No. 5

The Bay of Fundy Herring Fishery

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THE PUBLIC REGULATION OF COMMERCIAL FISHERIES IN CANADA

Case Study No. 5

THE BAY OF FUNDY HERRING FISHE

by

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The findings of this Technical Report are the personal responsibility of the author, and, as such, have not been endorsed by members of the Economic Council of Canada.

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R É S U M É

L'auteur du présent document analyse d'abord la structure de la pêche au hareng de la baie de Fundy. Il étudie ensuite les effets de la réglementation déjà mise en vigueur sur la performance de la pêche. Il constate que la réglementation a agi sur la performance tant de façon directe, par ses effets habituels, que de façon indirecte par sa portée sur la structure des industries primaires et secondaires. L'auteur passe ensuite à l'examen d'un mécanisme de réglementation différent qui serait fondé sur la reconnaissance des droits de propriété de diverses coopératives de pêcheurs pouvant être mises sur pied à partir de la structure actuelle de la pêche. Si de telles coopératives existaient et fonctionnaient de la façon décrite, il serait possible d'atteindre les objectifs que visait dans le passé la réglementation de la pêche; en même temps, certains règlements naguère nécessaires pourraient être annulés.

SUMMARY

This paper begins with a review of the structure of the Bay of Fundy herring fishery. It then attempts to ascertain the effects of past regulation on the performance of the fishery. Regulation is found to have affected performance both directly in familiar ways, and indirectly through its effect on the structure of the primary and secondary industries. The paper goes on to examine an alternative regulatory mechanism which recognizes and relies upon the property rights of various fishing cooperatives which could be developed from the present structure of the fishery. If these cooperatives existed and functioned in the manner described in the paper, the apparent objectives of past regulation of the fishery could be met and at the same time some of the regulations which were necessary in the past could be rescinded.

1. Biological Structure of the Resource

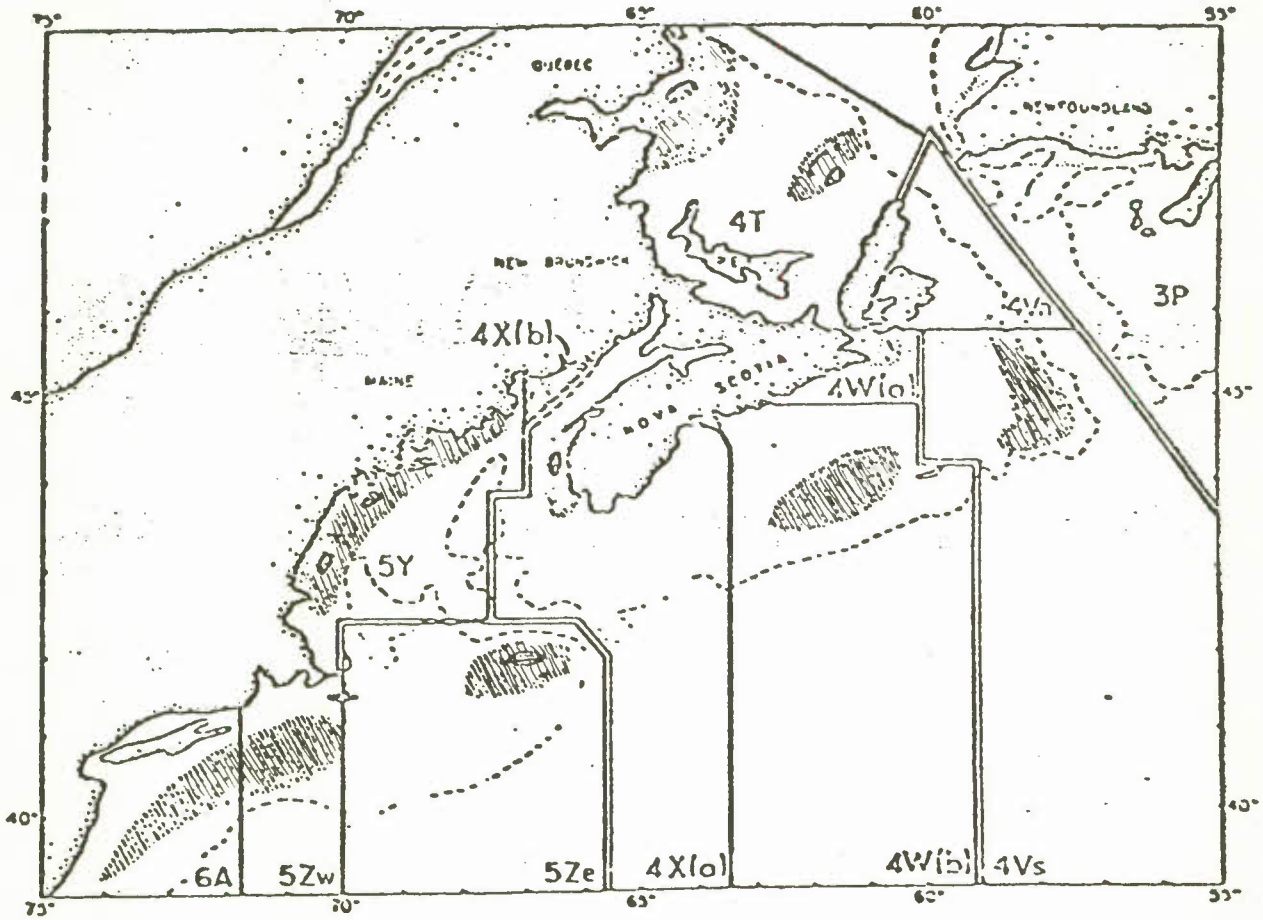
Herring is a pelagic fish which schools during feeding and spawning. There are two stocks which are exploited in the Bay of Fundy herring fishery. The southwest Nova Scotia stock winters in the 4W(b) area in Figure 1 and then travels along the Atlantic coast of Nova Scotia to its spawning grounds in the Trinity-Lurcher area off southwestern Nova Scotia, where it forms part of the Bay of Fundy fishery, and then migrates back to area 4W(b) for the winter. The Gulf of Maine stock spawns in the areas indicated in Figure 1 off the coast of Maine and the juvenile herring inhabit the coastal areas of the Gulf of Maine, including the southern New Brunswick coast, until they are old enough to join the adult migrations.

The herring larvae hatch about 12 days after they are deposited and are distributed by water currents. The juvenile herring of the Nova Scotia and Gulf of Maine stocks spend the first few years of their life in the Bay of Fundy area where they support a juvenile herring fishery. At one time it was thought that the two juvenile stocks did not intermix but it is now believed [1] that juveniles from the Gulf of Maine and southwest Nova Scotia stocks and possibly from the Georges Bank stock, intermix off the coast of Maine and southern New Brunswick. The fish become part of the adult herring stock in their fourth or fifth year of life when they are 8-10 inches in length. They then commence the annual migration described above, and in their natural state can reach an age of 20 years.

The principal fishing areas and seasons are described in Figure 2. The fishery labelled 1 in Figure 2 is the New Brunswick weir fishery which exploits juvenile herring in their second year of life from the Gulf of Maine and southwestern Nova Scotia stocks. It is estimated [2] that 30% of the catch of this fishery represents juveniles from the latter stock. The New Brunswick weir fishery

Figure 1

Distribution of Herring Stocks and Spawning Areas

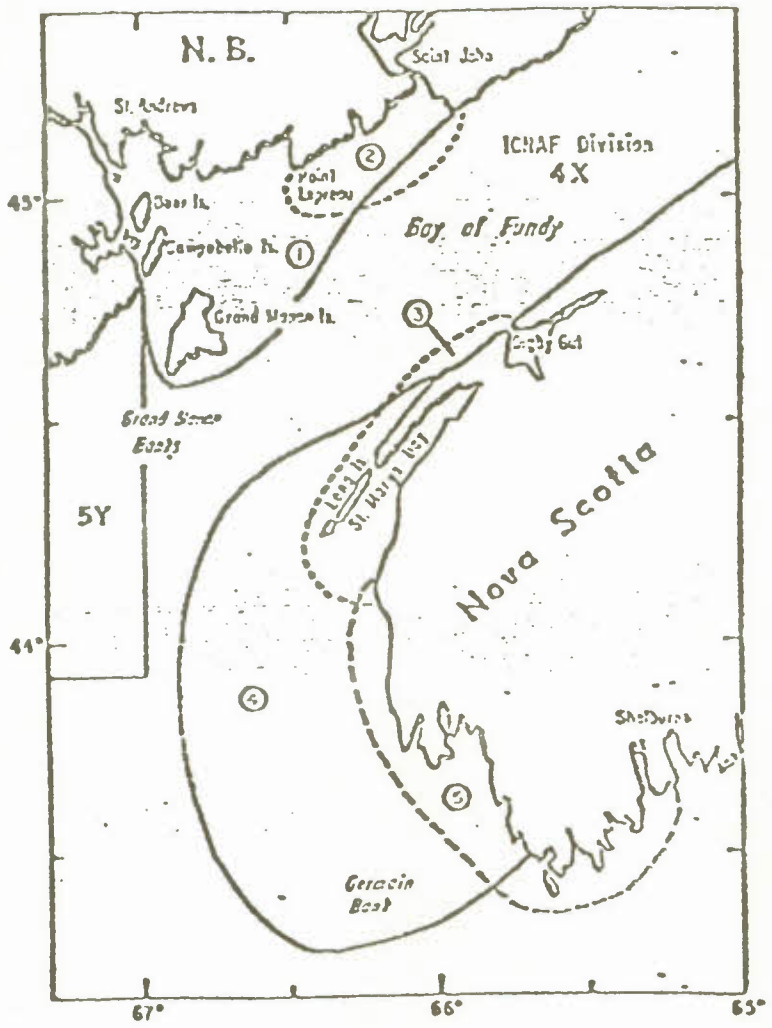


Note: Double lines indicate stock management areas; solid black areas indicate the general spawning grounds.

Source: 1978 4WX Herring Assessment, M. Sinclair, K. Matuzals, and W. Stobo CAFSAC, Res. Doc. 79/19, page 21.

Figure 2

Canadian Herring Fisheries in the Bay of Fundy



Fishery	Area	Year	Season	Stock
1	N.B.	Weir	Summer	Gulf of Maine Juveniles (70%) Southwest N.S. Juveniles (30%)
2	N.B.	Purse-Seine	Fall-Winter	Gulf of Maine Brits (70%) Southwest U.S. Brits (30%)
3	N.S.	Weir	Spring-Summer	Southwest N.S.
4	N.S.	Purse-Seine	Summer-Fall	Southwest N.S.
5	N.S.	Gillnet	Summer-Fall	Southwest N.S.

Source: Herring Assessment in Division 4WX, W. Stobo, D. Gray and K. Netuzals, CAFSAC Res. Doc. 78/25, page 14.

is a summer fishery which supplies the sardine canning plants in New Brunswick and Maine. Fishery 2 is also a juvenile fishery but exploits herring in their first year of life (termed "brits") and is conducted by New Brunswick purse seiners. This fishery, which supplied fish meal plants in New Brunswick, has been severely limited in recent years. Fishery 3 is the Nova Scotia weir fishery in the Digby-St. Mary's Bay area which exploits juvenile herring from the southwest Nova Scotia stock to supply sardine canneries in Nova Scotia. The remaining two fisheries in the Bay of Fundy area exploit the adult herring of the southwest Nova Scotia stock during their migratory cycle. Fishery 4 is the Nova Scotia purse seine fishery which supplies Nova Scotia fishmeal and food herring plants in the summer and fall, while Fishery 5 is the Nova Scotia gillnet fishery which is an inshore fishery and supplies the same plants. Both fisheries exploit the schooling propensity of the herring stocks during feeding and spawning. The gillnet fishery in particular exploits the spawning beds which are inshore areas off the southwest coast of Nova Scotia (area 5, Figure 2). The southwest Nova Scotia stock is also fished from the Chedabucto Bay area (4W(a) in Figure 1) in the months of December, January and February while overwintering.

The herring stocks are subject to severe fluctuations for a variety of reasons. Recruitment to the stock exhibits wide fluctuations from year to year because of environmental factors which affect larval survival and which cannot be managed. These factors include water temperature and the movement of ocean currents, which affect the availability of food to the larvae and juvenile herring, and the presence and density of predators such as mackerel and adult herring. The size of the recruitment to the adult stock cannot be established until after the first year of life of the recruits by which time they have reached a length of around 4½ inches and their survival rate is fairly predictable. Iles (1971) suggests that the order

of magnitude of the fluctuations in the Bay of Fundy herring year class sizes is in the order of fivefold.

The adult herring stocks are also subject to considerable fluctuations although of a less systematic nature than the juveniles. The schools of herring are susceptible to disease which can destroy a significant proportion of the adult stocks. For example, in 1953-57, an epizootic (an epidemic fungus disease) severely reduced herring stocks in the Gulf of St. Lawrence area (see Winter JFRB). Following this epidemic the juvenile herring of the 1958 and 1959 year classes apparently experienced less predation by adult herring and the recruitment from these year classes to the adult stock was exceptionally large. Thus the result of the epizootic was to deplete severely one set of year classes and to augment another. Thus it is quite common for the Atlantic herring fisheries to be heavily dependent in any given year on herring from a small range of year classes. This is, of course, unavoidable in the case of gear types such as weirs which are intended to catch herring at a particular stage in their life cycle, but is a phenomenon which also occurs in the case of gear which exploits the full range of adult year classes. Fisheries 1, 2 and 3 which exploit juvenile herring, are heavily dependent on those year classes as one would expect. However, Fisheries 4 and 5 which exploit herring of almost all year classes were dependent on two year classes, 1970 and 1973, for over 50% of their catch.

Another important characteristic of the herring stocks is their pelagic nature. In the course of their migrations the herring stocks pass through a variety of fisheries and it is important that the management of these fisheries be co-ordinated. The southwest Nova Scotia stock is fished mainly within management areas 4X(a) and 4W(b) in Figure 1 and hence the potential for co-ordinated management exists. The Gulf of Maine stock, on the other hand, is exploited as a juvenile fishery in both

Canadian (4X(b)) and U.S. (5Y) waters and as an adult fishery in U.S. waters only. Optimal management of this stock obviously requires a degree of co-operation between Canadian and U.S. authorities.

The migratory nature of the stock renders contact between the gear and the stocks less predictable than in the case of a demersal fishery. This cause of variability in catch is particularly significant for the weir fishery which uses gear which is fixed in location, but it also affects the mobile gear. A contemporary example of the variability of the herring stocks available to the fishery is the failure of the adult stocks to appear in the Bay of Fundy by late July 1979. In past years roughly 70% of landings had occurred by this stage in the season. The disappearance of the stocks of larger fish has coincided with the appearance of a large stock of juvenile herring and these two events may be related.

2. Commercial Structure

(a) Primary Sector

The primary or harvesting sector of the fishery consisted, in 1978, of 51 seine vessels, around 250 herring weirs, and a substantial number of gillnetters. The seine fleet is divided fairly evenly between Nova Scotia and New Brunswick ports, although a small number of seiners from Newfoundland also participated in the fishery. [3] The weirs are located predominantly on the New Brunswick side of the Bay [4] and the gillnet fleet is based mainly in southwestern Nova Scotia. The weir fishery harvests juvenile herring for processing as sardines, while the seine and gillnet fleets, with the exception of the "brit" fishery described in area 2, Figure 2, harvest adult herring. Shares of the total Bay of Fundy herring catch by weight in 1978 were 54% for the seine fleet, 41% for the wiers and 5% for the gillnet fleet. In the late 1960's when the seine fleet was expanding in response to plentiful stocks and rising fishmeal prices, the shares were 71%, 26% and 3% respectively.

The seine fleet consists of 28 "inside" and 23 "outside" vessels. Outside vessels are the larger and more seaworthy vessels which participate in a number of fisheries including the Bay of Fundy, whereas inside vessels are restricted by their size to the area of the Bay. Outside vessels tend to have large catches from the Bay of Fundy herring stock than inside vessels. [5] The large gillnet fleet consists of inshore vessels which are usually less than 40 feet in length and which also participate in the lobster and groundfish fisheries. The herring season off the southwest coast of Nova Scotia is in the summer and fall while the lobster season is from late fall to early summer. The weir fishery is also a seasonal fishery occurring in spring and summer but the herring weirs have no alternative employment at other times of the year.

In its unregulated form the harvesting sector of the fishery has been characterized by ease of entry and exit and competition among harvesting units. Prior to the imposition of entry restrictions there was substantial entry to the seine fleet in the late 1960's in response to strong demand and abundant stocks. Following this expansionary period there was a sharp drop in the number of seine vessels in response to reduced stocks. Ease of entry is also illustrated by the substantial additions to the gillnet fleet in the late 1970's in response to high herring prices. Government regulation has both encouraged and discouraged entry and discouraged exit. Entry has been encouraged by various subsidy and loan programs which have reduced the cost of vessels to fishermen, but has been limited by entry restrictions which were imposed on the seine fleet in the later 1960's and on the weirs and gillnetters in the late 1970's. Exit from the seine fleet was discouraged in the mid-1970's by a deficiency payments program which was introduced by the federal fisheries service to compensate the seine fishermen for the poor 1975 herring season.

The secondary or processing sector of the fishery has traditionally had considerable equity participation in the primary sector. In the early 1970's about two-thirds of the Nova Scotia seine fleet (or about one-third of the total Bay of Fundy fleet) was owned by herring processors. On the New Brunswick side of the Bay ownership of individual weirs has traditionally been diversified to spread the risk associated with variability of catch from season to season and the processing companies held shares in weirs along with other owners and owner-operators. In addition, the processing companies own the majority of the carrier vessels which transport the weir catch to the canneries. Government policy has been to reduce the influence exerted by the processing sector on the seine fleet through a capital grants program which was introduced in 1976 to assist operators

to purchase their vessels; ten operators of seine vessels took advantage of this scheme in 1976.

The structure of the primary sector in the early 1970's was competitive and unorganized with the exception of the buyer-seller ties noted above. By means of its Bay of Fundy project, however, the federal government has at least partially succeeded in organizing the seine fishermen into a fishermen's co-operative. By the late 1970's, few of the seine vessels were owned by the processing sector and the government sponsored Atlantic Herring Fishermen's Marketing Co-op was engaging in collective bargaining with the representatives of the processing industry over the price of herring and was playing a role in allocating the total allowable seine catch amongst its members and distributing the catch amongst processing plants. In 1979 the Co-op split into two parts along provincial lines apparently over the issue of the dockside facilities and services to be provided to members. The federal government also took steps to organize the weir fishermen by offering initial support for a weir fishermen's catch insurance program. Following the introduction of a licensing and restricted entry program for herring gillnetters, there has been some interest among gillnetters in forming an association.

The variability in the size of the herring stock from year to year is partly responsible for variations in harvesting sector earnings from season to season and for the considerable amount of entry to and exit from the fishery prior to regulation. Within a season, the pelagic nature of the resource makes the location of the herring stocks at any time unpredictable and this contributes to variability of earnings within and across gear types. The herring weirs being of fixed location are particularly susceptible to substantial variations in earnings as a result of this unpredictability. Amongst the seiners also there has traditionally been substantial variations in earnings but this is due less to the variability in stocks than to the

superior catching power of some of the vessels (termed "highliners"); these are generally, although not always, the larger or "outside" vessels.

(b) Secondary Sector

The secondary or processing sector of the industry consists of plants which process herring in three principal ways: herring may be pickled or canned as sardines; they may be reduced to fishmeal or oil; or they may be processed as fresh or frozen food. In addition to the Canadian and U.S. processors, there has usually been some processing capacity in the form of foreign factory ships. In 1974 there were approximately 40 plants processing herring in the Bay of Fundy area. [6]

Ownership of the processing plants has been quite highly concentrated: on the New Brunswick side of the Bay, one company, Connors Brothers, controls most of the canning capacity; on the Nova Scotia side, there are a few large companies such as H. B. Nickerson's and National Sea (which have recently merged), Sea Life, S. F. D'Eon, Connors Bros., B. C. Packers, Kennebec and Comeau operating reduction and food herring plants, and some smaller companies producing food herring. While there are a substantial number of raw herring buyers (102 in 1978) [7] a high percentage of landings go to the large companies: for example, although there were 30 buyers in New Brunswick, 75% of landings in 1978 went to the Connors Brothers plants in Black's Harbour and Beaver Harbour; in Nova Scotia also, the majority of landings went to large companies in Pubnico, Yarmouth and Saulnierville.

There has been a considerable amount of investment in this sector of the industry, in reduction plants in the 1960's and in frozen herring plants in the 1970's. This investment in plants is in response to a number of factors, the main one of which appears to be the prices of herring products. Investment in capacity has also been encouraged at various times by plentiful herring stocks and substantial landings. The 1964-1968 expansion of the reduction component of

the processing sector is matched by substantial increases in Bay of Fundy herring catches whereas the recent period of expansion of the fresh frozen sector is characterized by relatively even landings. It might be concluded that the former period of expansion was mainly influenced by stocks while the latter was mainly influenced by price.

A further influence on the investment in processing capacity has been the availability of subsidies for plant construction. During the 1960's a number of new processing plants were subsidized under the Area Development Incentives Act: "This Act which was administered then by the Department of Industry and is now under the jurisdiction of the Department of Regional Economic Expansion, made provision for meeting 33½% of the first $250,000 of the cost of building and machinery of a new plant, 25% on the next $750,000 and 20% on further cost to a maximum of $5 million. Provision was also made for the expansion of existing plants based on the same rates except that they are applied to the costs of expansion in excess of $10,000 or 10% of the existing facility, whichever is greater." [8] The expansion of the fresh frozen sector of the industry in the mid-1970's was also subsidized by grants and low cost loans provided by both federal and provincial governments. In addition, the federal government through its Bay of Fundy project is attempting to convert the fishing to a wholly food based industry. One regulation which has been implemented to support this policy is banning of reduction of herring without permission of the fisheries department.[9]

A new firm considering entry to the processing sector has additional factors to consider besides the product prices, fish stocks, and government subsidies which must be taken account of by an existing firm considering investing in extra capacity. Two factors which have made entry difficult in the past are the full or part ownership of fishing vessels by large processing firms and the apparent existence of

excess processing capacity. Since the herring catch fluctuates from day to day and week to week, a new entrant without any vessel ties could expect to be able to purchase only herring that was in excess of the requirements of the large processors. Since the herring fishery is seasonal, it is difficult to conclude from casual observation whether processing capacity is at an optimal level or not. Nevertheless, the various studies which have been made of capacity conclude that there has tended to be an excessive amount.[10] Consequently, if a new entrant were forced to rely on herring surplus to the requirements of those processors who controlled a considerable portion of the fleet, he would suffer from a shortage of raw material. In view of the substantial initial capital investment required for additional capacity, particularly in the canning and reduction sectors of the industry, it is easy to understand why the government subsidy program in the 1960's and early 1970's may have encouraged additional investment by existing firms but may not have led to new entrants.

This situation was altered to some extent by the vessel buy-back program, the formation of the seiners' Co-op and the attempt to convert the industry to a fresh frozen product. A new entrant would be assured of a share of the catch through the Co-op's catch allocation scheme; there seems to have been a shortage of fresh frozen processing capacity in the mid-1970's; initial capital requirements for investment in the fresh and frozen sector of the industry are lower than in the canning and reduction sectors; and the government subsidy program was still in effect. These conditions, coupled with the high price of food herring, would tend to favour entry of new firms to the industry although to date most of the subsidies have gone to existing firms for updating existing or constructing new plants.

It has already been stressed that a considerable portion of the seine fleet was wholly or partially owned by the processing sector and could not be regarded as independent agents. For the remainder of the fleet the alternatives to selling to the concentrated domestic industry were sales to the U.S. or to foreign factory ships. A short-term oversupply of raw herring in 1972 had resulted in a diversion of herring to reduction plants in the United States. In 1973, the federal government imposed export controls on raw herring for reduction purposes following pressure by the processing companies. Exports would be prohibited "as long as prices paid to Canadian fishermen are competitive with those paid by United States processors ..." (memorandum to the Minister from the Senior Assistant Deputy Minister, July 6, 1973). Following the increases in herring prices in the 1970's, competition for raw herring for food purposes from Polish factory ships was credited with increasing prices received by the fishermen. The federal government, however, has regulated sales to foreign factory ships and has permitted them only when domestic food processing capacity has been insufficient. There can be little doubt that long-term government policy is to exclude foreign buyers from the raw herring market once domestic fresh frozen capacity has adjusted. Despite the policy of excluding foreign buyers, the seiners' bargaining position with respect to the processing sector has improved. The seine fleet is now almost wholly independent and the seiners' Co-op bargains collectively with the processors to set a price for raw herring. The price of herring to the fishermen increased dramatically after the formation of the Co-op, but it must be borne in mind that export prices of processed herring rose substantially at this time.

(c) Final Markets

The rise in fishmeal prices in the mid-1960's resulted in an expansion in the reduction component of the herring processing sector; the percentage of Bay of Fundy herring landings used for meal and oil production rose from 10% in 1964 to 70% in 1969. With the rise in the prices of food herring and, in particular, of fresh and frozen herring in the mid-1970's caused in part by the collapse of the North Sea herring fishery, the proportion of landings used for reduction fell to 14% in 1976 while the proportion used for fresh and frozen products rose from 15% in 1969 to 56% in 1976. [11]

One implication of the switch from a reduction to a food fishery is that the quality of the landed product and the speed with which it is processed become important. The Bay of Fundy project has attempted to improve quality in two ways: funds have been allocated to subsidize refrigeration units on seine vessels and ice plants on shore; and the fishermen's Co-op has adopted a radio dispatch system for allocating catch to plants which have spare capacity for immediate processing. Despite these efforts of government and industry, fresh and frozen Bay of Fundy herring products are not highly regarded at the present time in the discriminating European market.

Data on the disposition of products from the Bay of Fundy herring fishery are not available but on a product by product basis, this is likely to be similar to the disposition of Atlantic herring generally. A considerable portion of the catch is sold in foreign food and reduction products markets. It is to be expected that the industry would wield little or no power in these markets although it has been suggested that one large processor has attempted to influence price in the European market.

One final comment is that, following the recent experience of the Pacific herring roe fishery, researchers are currently investigating the potential for a herring roe fishery in the Bay of Fundy area and one company has started production. This development raises management problems which will not be discussed in the present case study but which are treated in our study of the Pacific herring fishery.

3. Analysis of Past Regulation

(a) Objectives of Regulation

Regulation of the Bay of Fundy herring fishery has been aimed at three principal and related objectives: conservation of the herring stocks; increasing the level of incomes in the harvesting sector; and promoting employment.

The main regulatory instrument which is used to conserve herring stocks is the setting of a Total Allowable Catch (TAC) limit for the fishery. Herring stocks are extremely vulnerable to overfishing for two reasons: herring is a schooling species and hence is less protected by thinning as fishing progresses than other species; and environmental factors often cause large fluctuations in population which can be exacerbated by overfishing. The contribution of overfishing and changes in environmental factors can be disastrous as evidenced by the experience of the Peruvian anchovy fishery [12] or of our own Pacific herring fishery. [13] Because the spatial distribution of the stock involves exposure of concentrations of herring at a particular stage in their life cycle to fishing effort in particular areas at particular times area closures are used to supplement the TAC regulation. For example, particular spawning grounds can be protected by area closures and at present all spawning grounds are protected by a routine weekend closure which allows the schools of spawning herring time to reform after the week's fishing.

The policy goal with respect to fishermen's incomes is complex: the objective is to increase the level of incomes in the harvesting sector, reduce the dispersion of incomes across fishermen and reduce the variability of earnings over time. The goal of increasing the level of fishermen's incomes is pursued in two ways. First, a major goal of the Bay of Fundy project was to raise the value of the herring catch by encouraging the processing of herring

for food: a regulation requiring the use of herring for food purposes was invoked, processors were offered subsidies for investment in food processing capacity, and fishermen were offered subsidies for refrigeration units and ice plants to improve the quality of raw herring landings. Secondly, an attempt was made to increase the share of the end value of the herring catch accruing to the harvesting sector by improving the bargaining position of fishermen vis à vis processors, the seine fishermen were encouraged to form a cooperative which engaged in collective bargaining with the processors over herring prices and the weir fishermen and gillnetters were similarly encouraged to form associations; weir fishermen were offered a subsidy for the construction of holding pounds which would increase catching power and the weir operator's ability to hold out for higher prices; and an attempt was made to reduce the degree of oligopsony possessed by the processing sector by financing operators who wished to buy their vessels from the processing owners and subsidizing new entrants to the secondary sector.

In the event that earnings from herring fishing began to rise the previous experience of the fishery suggested that entry of additional harvesting units would occur. To forestall the impact of entry on the earnings of units already in the fishery restrictions were imposed in the late 1960's on the participation of additional seine vessels, and in the late 1970's on the participation of additional weirs and gillnetters. Thus apart from the replacement of seine vessels on a one-for-one basis (although not necessarily on an equivalent catching power basis) and some minor relaxations of the restricted entry regulation, the harvesting sector is frozen at its late 1960's seine fleet and its late 1970's gillnet fleet and weir installations.

The goal of reducing the dispersion of earnings in the harvesting sector seems to stem from two observations: first, during the 1960's, the seine fleet increased its share of the total herring catch from less than 40% to more than 70%; secondly, some of the seine vessels, described as "high liners" had very high earnings. The policy adopted was to limit the share of the TAC harvested by the seine fleet (this had dropped to around 55% by 1978), and to limit the share of the seine fleet's allocation harvested by the "high liners" by imposing a co-op operated individual quota system for seine vessels which was weighted towards equality of catch.[14] In this way the regulations protected the catch of the less capital intensive harvesting units - the gillnets, weirs and inside seines.

Reduction in the variability of fishermen's incomes over time has been promoted by various means: support programs were instituted to compensate seine fishermen for the poor 1975 season; the seine vessel quota system was expected to reduce variability of earnings from season to season; and the weir fishermen were offered initial federal funding for an insurance program to even out fluctuations in receipts from season to season due to the variability of the movements of the juvenile herring stocks.

Regulation has attempted to generate employment in sectors supplying the fishing industry and in the harvesting and processing sectors of the industry. Subsidies on boat building, boat purchasing and plant construction have reduced the costs of these items to the industry and may have generated additional demand and employment in the construction industries.

The rise in the price of raw herring in the mid-1970's has obviously created a potential for increased labour incomes in the harvesting sector. In an unregulated fishery a sudden rise in the price of raw fish would stimulate entry of both capital and labour in proportions dictated by technical rather than economic

efficiency. An example of this phenomenon in the Bay of Fundy fishery is the conversion of mid-water trawlers to herring seiners. Regulation has attempted to prevent the over-capitalization of the harvesting sector by strictly limiting the seine catch and encouraging the weir and gillnet fisheries which probably tend to have a higher labour cost per ton of fish landed.

In addition to raising income in the harvesting sector, the conversion of the adult herring fishery from a reduction to a food industry was intended to promote employment in the processing sector. This would tend to occur if labour costs became a higher proportion of the final selling price of processed herring net of the price of the raw product. The conversion to a food fishery was encouraged by subsidies on the construction of new food plants and on the conversion of existing facilities from meal to food herring processing.

To ensure that a high proportion of the catch would be of a quality which could be processed as food various regulatory measures were adopted to match the catch to the processing capacity. The imposition of a weekend closure on the seine and gillnet fleets and weekly catch quotas on the seine fleet were intended to lengthen the fishing season and even out the flow of raw herring to be processed. The introduction of the Co-op-managed system for dispatching the seine fleet's catch to the available processing capacity was also designed to prevent excess supplies of raw herring having to be reduced to meal and oil. The holding pound subsidy program for herring weirs was also designed to even out the flow of fresh herring available for food processing.

In the early 1970's, foreign factory ships had been willing to pay higher prices for raw herring for food purposes than the prices paid by the domestic processing industry which was primarily a reduction industry. Sales to Polish

factory ships played a part in raising raw herring prices and encouraging food processing. Once the industry became converted to a food fishery sales to foreign ships were severely restricted in the interests of domestic employment.

(b) Effects of Regulation

The principal regulatory device for conserving stocks against overfishing is the total allowable catch quota. Two pieces of evidence suggest that regulation has not accomplished this objective in the recent past. In the first place, the 1978 and 1979 catch quotas were not filled:[15] obviously a constraint which does not bind is ineffective. Secondly, fishery biologists have concluded from their population estimates that the stock level is extremely low.[16] This latter piece of evidence must be interpreted with caution since herring stocks are subject to fluctuations and variability in season's catch may exist in an optimally managed fishery.

The difficulty in specifying an appropriate overall catch quota stems from the problem of estimating stock size from catch and effort data. In common with other managed fisheries the ratio of catch per unit effort (CPUE) in two successive years is used as an estimate of the ratio of herring stocks in these years. These stock ratios together with assumptions and information about recruitment and catch composition are used to build a running inventory of stocks of various year classes. The assumption underlying the use of CPUE ratios as a proxy for stock ratios is that the Shaffer production function [17] is an appropriate representation of the relationship between harvest, effort and stock. In fact this form of production function, which models a thinning effect on stocks as sustained effort increases, is not well adapted to a fish stock which schools. The effect of schooling may be to maintain the CPUE ratio in the face of declining stocks. This results in mistakenly high stock and low mortality estimates. The low mortality estimates impart a downward bias to the relationship between effort and fishing mortality and when these low

fishing mortality estimates are used in cohort analysis, they produce upward biases in stock estimates. These stock estimates are then used to estimate allowable catches which may be higher than optimal.

A second problem with the use of catch per unit effort data is the difficulty of measuring effort. The usual measurement of effort is in boat/day units. This is a consistent measure from year to year as long as the "boat" and the amount of fishing time per day remain unchanged. A side effect of regulation, however, has been to alter both these units. The development of economic rent in the fishery as a result of high herring prices coupled with the restricted entry provisions have created an incentive to upgrade the vessels of the seine fleet; upgrading consists of such measures as the installation of electronic fish-finding gear which improve the effective amount of effort which can be applied in a day's fishing. The individual seine vessel weekly quotas and the Co-op dispatching system, on the other hand, have tended to reduce the amount of effective effort which a boat can apply to the fishery in a day's fishing. If the net result of these two side-effects of regulation is to increase the amount of effective effort corresponding to a unit of measured effort over time then stock estimates will be biased upwards with the results described above. It should be stressed that fishery biologists are aware of the difficulties of measuring fish stocks on the basis of catch and effort data and have attempted to correct for increasing technical efficiency of seine vessels by incorporating alternative technical change assumptions in their models. [18]

The principal components of the regulatory program aimed at increasing incomes in the harvesting sector were measures aimed at raising the end value of the catch, raising the bargaining power of the harvesting sector vis à vis the processing sector, and restricting entry of additional vessels to the fishery. The end value of the catch was to be raised by converting the processing industry from a reduction to a food industry to take advantage of the high prices for exported food herring products following the collapse of the North Sea herring fishery. This conversion

was to be facilitated by a government regulation requiring the use of herring for food purposes and by subsidies for food herring plants. Without information about processing costs and processors' price anticipations, it is difficult to judge whether government intervention of this nature was necessary to convert the industry to a food fishery.

One argument which might support the invoking of the food regulation under the Fishery Act is that the processing sector functioned as an oligopsony and that this form of industrial structure is less conducive to product innovation than a competitive structure. [19] This view would be consistent with government measures taken to improve the bargaining sector of the harvesting sector by reducing the oligopsony power of the processing sector such as, for example, the subsidy on vessel ownership by fishermen. The subsidy offered for construction of food processing facilities could then be justified [20] as an attempt to encourage entry to and competition in the processing sector. Since most of the subsidy payments appear to have gone to existing firms, it seems that this latter measure was not very effective in its aim. It might be concluded, therefore, that the structure of the processing sector would have retarded conversion to a food fishery and that policy measures aimed at altering industry structure were expected to be too slow in producing results to offset this delay. An alternative approach, of course, would have been to allow significant entry of foreign factory ships to the processing sector; this would have provided a stimulus through higher raw herring prices to convert to the higher end value product, if that was appropriate in the long-run, but it would also have reduced employment in the processing sector at least temporarily.

While government policy does not appear to have been very effective in reducing concentration in the processing sector, it does appear to have raised the

bargaining power of the harvesting sector. There can be little doubt that, despite the favourable external market circumstances, and given the government's policy of excluding foreign raw herring buyers, the price of raw herring would have been considerably lower but for the collective bargaining conducted by the co-op on the fishermen's behalf, and that the co-op would not have been formed or have held together without considerable government assistance and pressure. If the pre-regulation harvesting/processing industry could be described as competitive/oligopsonistic then the post-regulation structure is probably best described as oligopolistic/oligopsonistic. Traditional economic analysis of the fishery [21] draws no significant distinction between these two forms of industrial structure in terms of economic efficiency although there may be differences in the distribution of income. Modern industrial organization theory,[22] however, suggests that oligopolies may dissipate at least a proportion of potential rents in investments in excess capacity which form an entry barrier which conserves oligopoly power. This argument may be extended to the creation of entry barriers in an oligopsonistic fish processing industry [23] and this paper has already alluded to evidence of excess processing capacity in the Bay of Fundy herring fishery. If this view of the industry is adopted, then the diversion of rents to the harvesting sector is efficient provided that they are not dissipated there. The unregulated fish harvesting industry is, of course, a classic example of a rent dissipating form of industrial structure but if the appropriate policy measures are adopted in that sector, the change in industry structure induced by regulation may be efficient.

The rise in the export price of raw herring created an economic rent in the industry and the increase in the bargaining power of the harvesting sector

resulted in some of the additional rent accruing to that sector. The past history of the fishery strongly suggests that the appearance of rent in the harvesting sector would be followed by the entry of additional harvesting gear raising harvesting costs until marginal harvesting units are once again earning zero profit. To prevent this dissipation of economic rent and to conserve the the value of the herring stock the government introduced a restricted entry program which applied first to seiners and was subsequently extended to weirs and gillnetters. Such a program is an important first step towards limited overfishing but its immediate effect is simply to limit competition for the allowable catch amongst the licenced gear units. The incentive remains for a wasteful expenditure of effort in the form of more technically (although not economically) efficient types of gear and more intensive fishing in the early part of the season. To counteract this tendency among the seine fleet, the regulators of the Bay of Fundy fishery have introduced what amounts to property rights on an individual vessel basis to the allowable catch. If such rights are sufficiently finely defined and can be enforced they can eliminate wasteful competition amongst harvesting vessels. Evidence of the success of this system would be the emergence of long-run profits in the seine fleet and a more even distribution of the seine herring catch over the season. The former kind of information is hard to obtain but some slight evidence of a more even distribution of the seine catch does exist.

The regulators have attempted to generate additional employment in both tne harvesting and processing sectors of the industry. The deline in the seine catch as a proportion of total allowable catch means that a higher proportion of catch is taken by the more labour intensive part of the harvesting sector - the weirs and gillnets. In the processing sector, a supply of raw herring to the domestic industry is assured by regulations preventing sales to foreign factory ships. The regulation requiring that domestic landings be processed as food

herring has probably generated additional employment in the processing sector although technical innovation in the form of automatic filleting equipment has reduced the employment generating potential of food processing relative to reduction. On balance, regulation is likely to have generated additional employment and, given the tendency for market wage rates in the region to overstate opportunity costs, this trend is in the direction of improved economic efficiency.

4. Proposals

The goal of government regulation as set out in the Regulation Reference can be summarized as achieving maximum economic efficiency subject to appropriate income distributional considerations. The basic aim of fishery regulation is to correct an allocative inefficiency which is likely to arise in the harvesting sector in the absence of regulation: in an open access fishery, an excessive amount of effort is likely to be used to harvest the catch. This results in the diversion of effort from other sectors of the economy (and, consequently, forgone output in those sectors) and low fish stocks (and, possibly,an excessive risk of failure of these stocks). The aim of regulation is to reduce fishing effort and conserve stocks. In pursuing this aim, the regulator must weigh the benefits of regulation in the form of increased output in other sectors of the economy and assured continuance of the fishery with the administrative costs of regulation.

The paradigm of a privately owned and managed fishery is often used as a model of optimal fishery management. In such a model, the objective function is the net present value of the fishery - the present value of revenues less costs. The solution to the problem of maximizing the net present value provides the two basic pieces of information which a planner would require: the appropriate annual catch and the appropriate amount and composition of effort which should be used to take that catch. These answers, of course, come from a world of costless regulation and they may be modified in the next process which is that of choosing amongst types and levels of regulatory instruments.

There is not enough information available about the growth of the herring stock, the effectiveness of the various gear types and their opportunity costs to construct a model of present value maximization which will yield appropriate catch and effort levels. The best that can be done at present is to provide qualitative

solutions to the planner's problem. Although the traditional deterministic model of maximization of present value of sustainable rent may not at first sight seem suitable for analysing a pelagic fishery in which the fish stock is subject to significant variation due to unforeseeable external influences, its use can be justified. In the first place, Smith (1979) has shown that the introduction to the model of a random disturbance to the stock growth process does not affect the qualitative nature of the maximizing solution. Secondly, the characteristics of the herring fishery make it unlikely that it would pay to operate it as a pulse fishery (see Hannesson (1975)): the value of the food catch is not a simple function of weight since the processing sector requires juvenile herring which can be processed as sardines and adult herring which are small enough to be filleted mechanically; and there are few alternative opportunities for much of the harvesting gear during the herring season.

The traditional deterministic model could be used in a three step process for determining total allowable catch (TAC) in a season. First, the TAC in an average year could be determined and this would form a benchmark around which year to year fluctuations would take place. Secondly, on the basis of the last few seasons' experience, a current inventory of the fish stock would be estimated as is done at present, and on this basis, an adjustment to the normal TAC would be made in advance of the season, Thirdly, this pre-season TAC could be adjusted within the season if sampling of actual fish stocks indicates that the population is different from its estimated level. The purpose of the normal TAC estimate is to determine the amount of harvesting gear which should be available for the fishery while the pre- and in-season TAC's permit fine tuning. [24]

The normal TAC and the amount of gear which is necessary for efficient exploitation of the fishery should be determined simultaneously and on the basis of harvesting costs as well as fish population data. Since updated harvesting

cost data are difficult to obtain it may be necessary to make an initial estimate of the normal TAC on the basis of fish population data alone and this is, in fact, how the fishery is currently managed. The TAC is set on the basis of the $F_{0.1}$ criterion which is a rule of thumb designed to prevent stocks being significantly reduced through over-fishing. The basis of the rule is that the marginal physical product of effort (MPPE) declines as total effort devoted to the fishery increases. In an open access fishery the MPPE will tend to decline to a very low level at which the total cost of effort expended is equal to the <u>average</u> value product of effort times the number of units of effort. To prevent this decline, the $F_{0.1}$ criterion places a lower limit on the MPPE: effort is to be limited to the level at which MPPE has fallen to 1/10 of the value it would have in a relatively unexploited fishery. In the absence of effort cost information, this would be a useful starting point for regulation provided that the difficulties alluded to earlier of obtaining accurate fishing mortality and effort data could be overcome.

Once normal TAC has been established, a mechanism is needed for determining the gear that is to be permitted to fish the stock; the restricted entry provisions of the Bay of Fundy herring fishery currently perform this function. If rent maximization is the policy goal then gear with the lowest unit opportunity cost per unit of effort should be favoured. Because of the lack of cost information, the likelihood that cost conditions will change,[25] and the need to take regulatory costs into account, it is desirable to have some market type of mechanism to select the "normal" gear portfolio, and eventually to adjust that portfolio along with the similarly adjusted normal TAC level. The market type of mechanism should also be capable of pre- and in-season adjustments.

The principal reason for studying the Bay of Fundy herring fishery as an example of fishery regulation is the existence of the government sponsored Atlantic

Herring Fishermen's Marketing Co-operative or the "seiners' Co-op" as it is known. This organization has attempted to fulfil a number of functions usually performed by a producers' co-op. For example, the co-op levies membership dues as a percentage of the value of each member's catch and uses the revenues to provide production facilities such as ice plants which are used by members in common. It also bargains collectively over the herring price with the fish buyers and allocates the night's catch amongst the processing plants. The feature which is of most interest in the present study, however, is the co-op's system for allocating the seiners' share of the TAC amongst its members. When the co-op was formed, all 51 seine boats became co-op members and the TAC which was allocated to the seine fleet by the regulators was divided up amongst the co-op members on the basis of a rule which gave one-third weight to equality of catch, one-third to vessel size and one-third to each vessel's historical performance [26]. What is interesting about this system is not the way in which the quota was allocated, but the possibilities the system offers for self-regulation and policing of the fishery and, in consequence, for efficient regulation at low cost to the government. Before examining these possibilities, some qualifications need to be made.

It is probably fair to say that the co-op was formed under and was held together by government pressure. There were two principal divisions within the co-op: the "highliners" or vessels with a large historical catch, found that the catch allocation system penalized them and favoured the vessels with lower catching power; and New Brunswick and Nova Scotia vessels differed over the provision of shore facilities. [27] Given the amount of effort expended under the Bay of Fundy project, it would be premature to describe the co-op as self-regulatory. Furthermore, there is no evidence available on the effectiveness of the co-op members in policing themselves. If the seine fleet's TAC is effectively

policed by fishery officers, then any vessel which exceeds its quota does so at the expense of a fellow co-op member, but co-op members have a common, although short-term interest in evading the TAC regulation. In addition, even if the seine fleet's TAC and the individual vessel quotas are observed, this regulatory system has not removed all of the incentive for wasteful competition amongst seine vessels. Because the uncertainty about the size of the herring stocks remains well into the season, each vessel has an incentive to take its share of the TAC early in the season. This problem is addressed by establishing weekly quotas which limit the rate at which each individual vessel can approach its season's limit. This illustrates the point that property rights to the allowable catch may have to be very finely defined for economic efficiency. The more finely defined such rights are, the costlier they will be to enforce.

In addition to uncertainty about the size of the herring stocks and the size of the feasible catch, the seine operators also face uncertainty about their own ability to fish; fishing time is often lost through breakdown or damage to gear or vessel. If a vessel is unlikely to fill its quota, then clearly it is in the short-term interests of the co-op to have this shortfall filled by another vessel which has met its quota. At present, the co-op management arranges such transfer of quota but it would be possible to have them occur through a market mechanism. A damaged boat could offer the remaining portion of its quota for sale to another co-op member. This would have the advantage of cutting management costs and at the same time contributing to the policy objective of reducing disparities in fishermens' earnings. The system could be extended even further. The co-op could auction off rights to the pre-season TAC to any seine vessels which cared to purchase them. The purchasers could subsequently trade or exercise the fishing rights they had purchased.

Within season management could be effected by selling additional rights or by buying up surplus rights in the event that the pre-season TAC estimate turned out to be too high. If fishing rights under such a system could be enforced, then they would come to have a market value which would approximate the profit which each season's fishery yields and this profit could be divided amongst the owners of the co-op who might consist of fishermen, the general public or government.

Researchers in our study team found that the participants in the fishery with whom the proposal to sell rights to the catch was discussed, tended to be dubious about various aspects of such a scheme's operation.[28] Assuming for the moment that such a scheme could be operated and enforced at reasonable cost, the main objection seems to be that the selling of rights would result in undue concentration of ownership of fishing rights among the larger vessels of the seine fleet. If there are no capital market imperfections, this situation would only develop if it were efficient for the larger or "outside" vessels to harvest the Bay of Fundy herring catch, and it was argued earlier in this study that this is unlikely to be the case. Indeed this objection to a property rights system can be turned around: it is the absence of a property rights or similar system for collecting the potential rent of the fishery that makes it profitable for outside vessels to misallocate[29] their fishing effort by fishing in the Bay of Fundy. While the problem of capital market imperfections deserves to be taken seriously, it seems to present no overwhelming difficulties. The type of capital which is required is essentially of a "working capital" nature and co-operatives (and even banks) have traditionally been willing to provide this type of loan. It is obviously important that rights to the catch be denominated in small enough units to suit the convenience of those vessels with the lowest catch.

The property rights system which is being discussed here has obvious advantages from the regulator's point of view, the most significant of which is that it obviates the need for the fishing cost data which would be necessary to plan the allocation of the catch among vessels, and it provides through the rights market information on the amount of rent being generated annually by the fishery. It is now appropriate to ask whether this system could be extended to the other gear types and whether it could be used to determine the appropriate division of the TAC amongst the three gear types.

At the present time, the regulators determine the overall TAC and then estimate what the weir catch will be. The weir catch is subtracted from the overall TAC to give the TAC which is then divided between the gillnet and seine fleets. Clearly it is not desirable to have the wier catch determined exogenously by the chance movements of the juvenile herring stocks. The juvenile herring exploited by the weirs have a user cost in terms of a forgone catch later of larger (though not necessarily of higher unit value) herring. The determination of the weir quota should take this user cost into account. The main difficulty with a system of auctioning rights to juvenile herring to the weir fishermen would be the uncertainty which attends the operation of a weir. This problem could be alleviated by making the rights transferable so that a weir which had filled its quota could purchase additional rights from one which was experiencing a poor season. Furthermore, the government could bear some of the risk by undertaking to buy back any unexercised rights at the end of the season. The revenues from the sale of rights would be distributed amongst the shareholders of the weir fishermen's co-op who might include the government, the public and the processing firms and the weir fishermen. If membership of the co-op were limited to weir fishermen only then would this scheme

be very similar to the weir fishermen's insurance scheme which is currently being proposed and sponsored by the federal government.

The principal difficulty in establishing a marketable quota system for the gillnet fleet is the large number of vessels involved. The advantage of a large number of bidders in fostering a competitive market for the rights would probably be outweighed by the transactions costs in administering the scheme and the costs of policing it. Gillnetters are small vessels which typically fish reasonably close to their home ports. They are used to fish lobster in season and, in fact, the current herring licensing system for gillnet vessels limits the vessel to fish for herring in a particular lobster district. This structure suggests a way of overcoming the problem of large numbers. Each lobster district could have a gillnetters co-op which auctioned off its quota of rights among its members and it could distribute its revenues amongst its shareholders.

At present, the organization of the fishery consists of the seiners' co-op [30] and an embryonic weir fishermen's insurance scheme and gillnetters' association. The organization being proposed in this paper would involve a seiners' co-op (or two separate co-ops if necessary), a weir fishermen's co-op[31] and four gillnetters' co-ops.[32] Ownership of each co-op could be as widely or narrowly dispersed as the policy-maker wished, while membership would consist of the successful bidders for rights in the season in question. How should the total quota be allocated amongst these groups? Again the market mechanism for disposing of each season's quota can help answer this questions. The current season's distribution of the TAC among these groups can be adopted and quota prices will emerge. In subsequent seasons, quotas would gradually be shifted to co-ops in which a relatively higher price of rights has emerged - "relatively" higher because the maximization of the

present value of rent probably requires a higher price per ton of juvenile than of adult herring. The value of the total quota or TAC is the annual rent of the fishery; anything the regulator does which increases current annual rent (without decreasing future rents) is an improvement in economic efficiency.

Finally we come to the question of how the total annual quota is determined. The purpose of the TAC is to protect future harvests against current overfishing. In a relatively stable demersal fishery, the appropriate TAC might remain stable from year to year and permanent rights to the quota could be sold thereby capitalizing the future rents anticipated from the fishery. This policy might be undesirable on distributional grounds and it is likely to be inappropriate in a fishery which is subject to considerable variation from year to year. If maximizing the present value of rent is the policy aim, the current year's TAC should be determined by balancing the net value of additional harvest in the present against the forgone net value of future catches. Since the relationship between stock and recruitment does not appear to be very significant in the herring fishery, the "user cost" of adult herring may be relatively low up to some limit at which survival of the stock becomes of concern. The determination of the TAC is probably best undertaken by the regulators as trustees for future generations and representatives of the fishing co-operatives.

The system described above requires little alteration of the current management structure. It offers a rational system for determining and disposing of herring quotas in the Bay of Fundy area. For these quotas to have a market value, the rights to the TAC that they represent must be protected by adequate enforcement. One possible method of enforcing the system would be to issue coupons in the amount of each successful bid, a coupon to be surrendered with each ton of herring sold to the processing sector. Each processing plant could be required to maintain a

set of "materials balance" accounts which would relate output to raw fish input matched by the appropriate number of coupons. This system would have the advantage of reducing enforcement costs by policing the processing sector with its relatively small number of producing plants. Foreign processors, however, could not be policed in this way and it may be necessary to require foreign sales transactions to pass through a government intermediary. These issues in enforcement are currently tackled by the sales slip system but in the absence of marketable property rights failure of this system has fewer (although still significant) implications for the management of the fishery.

We now turn to an examination of the structure of the processing sector. The processing sector has traditionally been oligopsonistic in structure and despite government programs aimed at encouraging competition for raw fish, it seems likely to remain that way. While there seem to be few scale economies calling for large plant size, there is the same incentive in the processing as in the harvesting sector to organize to spread risk. Thus, the typical processing firm in the area has a number of plants purchasing raw herring from various areas of the fishery. In a simple theoretical model [33] a fishery with a competitive/monopsony or a monopoly/monopsony structure will be efficiently managed without any government intervention other than providing the entry barrier necessary for costless maintenance of the non-competitive sector or sectors [34]. If the harvesting sector is organized as a series of co-ops, as described earlier, and if the processing sector remains oligopsonistic, as seems likely, then the potential for efficient management exists provided that rent dissipation can be prevented in the processing sector. If rent in the harvesting sector is to be collected by the sale of rights to the TAC, then it is worth inquiring why rights to process the catch should not be used to collect rent in the processing sector. The sum total of the sales of harvesting

and processing rights would be the annual rent from the fishery and its division in terms of harvesting and processing sector receipts would reflect the relative bargaining power of the two sectors.

When harvesting rights are sold to the industry, the relative ease of entry to the fishery will ensure some degree of competition and the value of rights determined in this market will reflect the resource rent. The processing sector, however, is not characterized by ease of entry and we would expect the oligopsonists to refrain from competing for rights and at the same time to indulge in wasteful capital investment designed to deter the entry which low processing rights prices would tend to encourage. This problem would be alleviated if foreign competition for processing rights were permitted: bids for processing rights could first be invited from domestic processors, but only bids above a reserve price would be accepted; the reserve price would be roughly the price foreign processors are willing to pay for raw fish less the price of harvesting rights and the harvesting cost.

If the regulatory scheme sketched out in this paper were adopted, some of the current regulatory structure of the industry could be abandoned with consequent savings in regulation costs. The simplest way to compare the current regulatory scheme with the proposed scheme is to examine each of the current regulations and explain why it would be retained or abandoned under the proposed system:

(i) the total allowable catch - this regulation is retained because of a decision to sell rights to the catch on a seasonal rather than a perpetual basis. In principle, the latter type of scheme would lead to efficient exploitation of the fishery, but its operation in practise is uncertain and it might have undesirable income distributional consequences;

(ii) area and seasonal closures - to some extent the spatial configuration of the herring catch can be regulated by the distribution of the TAC among the co-ops. Finer control may be desirable in certain locations to protect spawning beds or to prevent gear conflict. For example, certain spawning areas may be closed to all gear types at certain times and at all times to gear types which may damage the spawning beds or are incompatible with an alternative and more efficient method of fishing; it has been suggested that seine vessels be excluded from the spawning beds in area 5 because they damage the beds and interfere with the gill-net operations. Another example of a closure regulation which should be maintained to prevent gear conflict is the regulation of the herring and lobster seasons;

(iii) licensing and restricted entry - in any season participation in the fishery would be limited to successful bidders for rights. This would be a form of restricted entry but would not have some of the adverse efficiency[35] and income distributional implications of a restricted entry scheme;

(iv) sales slips - these are currently of great importance in collecting data for regulatory purposes and in sharing the value of the catch amongst the crew members. They would assume even greater importance under a rights system since the success of the scheme rests on the ability of the fisheries service to protect the rights which have been purchased. Under the rights system, each ton of raw herring harvested would be matched by a seller's and a buyer's right to the fish;

(v) vessel quotas for seiners - these would be retained with the difference that they would be purchased by the vessel owners at the start of the season and would be fully marketable. This quota system would be extended to the other gear types;

(vi) the Co-op and weir fishermen's association - these organizations would be strengthened and this form or organization extended to the various gillnet fleets;

(vii) pricing of raw fish by collective bargaining - it is important from an efficiency viewpoint that the price of raw fish reflects its quality and its relative scarcity at the time or place where it is landed. Collective bargaining over price tends to result in rigidity in the price structure and it may be best abandoned in favour of a market system;

(viii) the central dispatch system - this Co-op operated system for distributing the seine catch could be transformed into a market system. Each co-op could act as an intermediary between its members and the fish buyers. The technology of seine and weir fishing is such that fish can be captured and held while they are sold by means of radio telephone. If bid prices are too low to justify exercising scarce fishing rights the fish can be released unharmed. Gillnetters are unable to hold the fish in this way and it may be necessary for the gillnetters' co-ops to establish prices in advance of each night's fishing.

(ix) weekend closure - the purpose of the weekend closure was to protect spawning grounds and to lengthen the time taken to harvest the TAC. The former objective can be achieved by closures as described in (ii), while the latter can be effected through the market system described in (viii). The usual and classic [36] pattern followed by the fishery is that each gear unit attempts to harvest as much of the TAC as quickly as it can. Under the quota system there is less incentive to do this since vessel quotas are determined in advance of the season and unused quota will be reimbursed at the end of the season. Furthermore, under the system proposed for marketing raw herring, prices will reflect the relative scarcity and the quality of fish. Any imbalance in the season's landings will tend to be corrected by raw fish price movements;

(x) food regulation - the requirement that Bay of Fundy herring be used for food may or may not have been advisable during the transition phase of the fishery. It would be unnecessary in the system proposed since in reducing herring processors would be using up scarce and expensive rights and would be forced to pay lower prices for raw herring for this purpose. The lower prices would deter fishermen from using their scarce and expensive rights to land herring of poor quality or in excess of processing capacity such that it had to be reduced;

(xi) sales to foreigners - because of the amount of concentration in the processing sector, it is advisable to permit sales to U.S. plants and foreign factory ships to ensure that processing rights fetch a reasonable market value. To enforce the harvesting and processing rights system, it will probably be necessary to arrange foreign sales through some regulated agency;

(xii) subsidies to effort - the only reason for subsidizing effort from an economic efficiency viewpoint is the belief that input prices are not representative of opportunity costs. For example, it might be argued that in an area of high unemployment, the wage exceeds the opportunity cost of labour because of institutional constraints. In these circumstances, it is appropriate to subsidize labour input, not capital inputs as has been the record of regulation of the Bay of Fundy fishery. Subsidies on harvesting and processing gear should be terminated and if a case can be made that wages exceed the opportunity cost of labour, a subsidy per man hour of employment could be paid to employers. The current system of linking transfer payments to employment in the industry should be abandoned since its lumpiness is likely to be distortionary.

Footnotes

1. See T. D. Iles

2. See T. D. Iles

3. Nova Scotia ports 23 Newfoundland ports 3
   New Brunswick ports 25 Total 51

4. There are around 250 weirs, 220 of which are located off Charlotte County in New Brunswick.

5. Inside/Outside Vessels 1978

	Inside	Outside
Number	28	23
Average Length (feet)	60	87.5
Average Quota (tons)	1,279	1,374
Average Catch (tons)	954	1,206
% of Quota Caught	75%	88%

   Source: data collected by St. Andrew's Biological Station.

6. The provincial and product breakdown was:

	Canning	Reduction	Fresh and Frozen	Total
New Brunswick	8	2	9	19
Nova Scotia	1	4	16	21
Total				40

   In addition to the above plants, a number of small processors, some U.S. plants and some foreign factory vessels were supplied by Canadian harvesting gear.

7. Unpublished data from the St. Andrew's Biological Station.

8. Mitchell and McEachern, p. 16

9. Under section 29 of the Fisheries Act, whole fish cannot be used for the production of meal and oil except with the permission of the Minister. This permission was in general withheld from 1976 onwards. See Bay of Fundy Herring Fishery Review of the 1976 Season and Prospects for 1977.

10. Estimates of processing capacity provided by Mitchell and Lennon (p. 39) indicate that the total Bay of Fundy herring landings could be processed in 27 days using one 8-hour shift a day. This estimate exaggerates the amount of excess capacity since it takes no account of peak day catches and the spatial distribution of catch and plants. A possible shortage of fresh and frozen capacity in Nova Scotia in 1974 is indicated since in the peak month of July only 70% of the N.S. seine fleet catch could be handled by N.S. fresh and frozen capacity working three 8-hour shifts per day.

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11. Source: Annual Statistical Review of Canadian Fisheries, 1955-1976, Volume 9.

12. See C. P. Idyll, "The Anchovy Crisis", Scientific American, 228 (June 1973), p. 22-29.

13. See the study by Wilen.

14. In 1978, vessel quotas ranged from 1200-1500 tons whereas catches ranged from 100 to 1900 tons. Catches in excess of quota were made by special arrangement within the co-op.

15. CAFSAC 79/19 p. 8

16. CAFSAC 79/19 pp. 5-6

17. This function is: $h = AEx$, where h = harvest, E = units of effort, x = fish stock and A is a constant.

18. See CAFSAC 79/19 p. 4

19. See F. M. Scherer Industrial Market Structure and Economic Performance, pp. 423-428.

20. An alternative justification is that the market price of labour overstates its opportunity cost and that in the absence of a subsidy fewer of the more labour intensive food facilities would be in operation that optimal. If this were the problem, the subsidy should presumably have been paid on employment of the over-prices factor and not on capital as was the case.

21. See, for example, C. W. Clark and G. R. Munro "Fisheries and the Processing Sector: Some Implications for Management Policy", Resources Paper 34, 1979.

22. See A. M. Spence "Entry, Capacity, Investment and Oligopolistic Pricing", Bell Journal of Economics 8, 2 (Autumn, 1977), 534-544 and B. C. Eaton and R. G. Lipsey "Exit Barriers and Entry Barriers: The durability of capital as a barrier to entry", Department of Economics, Yale University, Discussion Paper No. 80-3.

23. This has been suggested by M. Shaffer.

24. See the paper by Wilen for a similar point.

25. See Munro and Clark "The Economics of Fishing and the Developing World", The School of Competitive Social Sciences, Penerbit Universiti Sains Malaysia, 1979, p. 22.

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26. Formally the i_{th} vessel's TAC might be expressed as

$$TAC_i = \frac{TACS}{51} \left\{\frac{1}{3} + \frac{1}{3}\frac{v_i}{v} + \frac{1}{3}\frac{c_i}{c}\right\}$$

where TACS is total allowable catch by the seine fleet, v_i is size (tonnage), of vessel i and v is average size, c_i is historical catch (last year's) and c is average historical catch.

27. In fact, the co-op broke into two groups in 1979 over this issue. The seiners based in Pubnico in Nova Scotia claimed that the co-op was not providing adequate facilities for them and they formed an independent co-op.

28. But see "Fishing for Answers" recorded by H. Rae Grinnell, February 1977, where the anonymous fishermen being interviewed express an interest in purchasing quotas.

29. For the classic exposition of this economic argument, see H. Scott Gordon (1954).

30. As of late 1979, there are two seiners' co-ops.

31. The intermixing of the Bay of Fundy and Gulf of Maine stocks suggests that separate New Brunswick and Nova Scotia weir fishermen's associations are not necessary from a stock management point of view, but given the breakup of the seiners' co-op, it might be difficult to operate weir fishermen's co-op with members from both sides of the Bay and two co-ops might be formed.

32. These co-ops correspond to lobster districts 1 (off Charlotte County, N.B.) and 2 (off Grant Manan), 3 (off Annapolis County, N.S.), 4 west of Baccaro (off Digby and Yarmouth Counties, N.S.), and 4 east of Baccaro (off Shelbourne, Queen's and Lunenberg Counties, N.S.).

33. See Crutchfield and Ponticorvo, The Pacific Salmon Fishery: A Study in Irrational Conservation and Clark and Munro, "Fisheries and the Processing Sector: Some Implications for Management Policy", Resources Paper No. 34, February 1979.

34. Meany (1979) describes an Australian prawn fishery which was managed simply by conferring duopoly status on two processing firms which subsequently merged.

35. See Fraser (1979).

36. See for example, Agnello and Donnelly "Some Aspects of Optimal Timing of Intra-seasonal Catch" in Economic Impact of Extended Fisheries Jurisdiction, L. G. Anderson (ed.) Ann Arbour Science, 1977.