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Technical Report No. 17
**The Public Regulation of
Commercial Fisheries in Canada**

Case Study No. 2

The Pacific Halibut Fishery

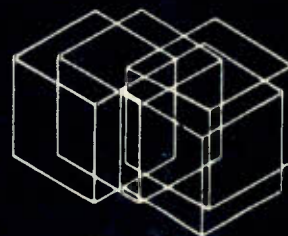
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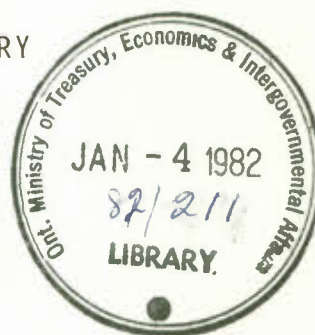
THE PUBLIC REGULATION OF
COMMERCIAL FISHERIES IN CANADA

Case Study No. 2

THE PACIFIC HALIBUT FISHERY

by

James A. Crutchfield
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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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RÉSUMÉ

LA RÉGLEMENTATION DE LA PÊCHE AU FLÉTAN DU PACIFIQUE

Les raisons suivantes ont motivé le choix de la pêche au flétan du Pacifique comme sujet d'une étude de cas :

1. la gestion de ce secteur est fondée sur une base statistique qui est peut-être plus complète que celle de toute autre grande pêche commerciale en Amérique du Nord;
2. il s'agit d'une pêche relativement simple, où l'on n'utilise habituellement qu'un seul genre d'engins; les produits sont écoulés sur des marchés directs qui n'ont évolué que lentement au fil des années;
3. une étude sérieuse a déjà été réalisée sur tout l'ensemble de la réglementation, laquelle prend la forme de quotas annuels couvrant toute la pêche, et sur les résultats de ce mode de réglementation;
4. la ressource est nécessairement partagée entre les États-Unis et le Canada; la Commission internationale du flétan du Pacifique a été établie par des conventions conclues entre ces deux pays en 1923. Ces ententes, de même que les conventions et protocoles subséquents, constituent un exemple

rare de collaboration et de conflit au sujet des ressources halieutiques entre deux grandes puissances caractérisées par des institutions politiques et des dispositions réglementaires très différentes.

Du point de vue biologique, cette ressource particulière exige que l'industrie exploite simultanément des poissons de plusieurs groupes d'âge. C'est pourquoi, les caractéristiques de la pêche au flétan s'accordent bien au modèle traditionnel de la biomasse halieutique. A cause de la longue période de croissance requise pour que le flétan atteigne sa taille adulte et sa maturité sexuelle, les stocks sont particulièrement vulnérables à la pêche excessive, et les coûts économiques pour reconstituer les stocks épuisés sont très élevés.

Divers genres de bateaux sont utilisés pour cette pêche. Comme dans le cas des autres pêches du Pacifique septentrional, les bateaux servent aussi à pêcher d'autres espèces, selon la saison et les conditions du marché. Cependant, la méthode de capture (la palangre) est uniforme dans toute l'industrie du flétan, sauf pour les importantes prises fortuites qui sont surtout le fait de chalutiers étrangers.

L'auteur fait un historique de la réglementation (à l'échelle internationale) et en évalue les résultats. Il constate que la principale méthode qui consiste à établir des quotas saisonniers

couvrant l'ensemble de la pêche et une durée réglable de la saison de pêche, n'est pas efficace économiquement et est incapable par elle-même d'éviter un épuisement tragique des stocks.

Il examine d'autres méthodes possibles de réglementation. Les impôts sur les débarquements ne sont pas jugées acceptables sur le plan politique pour réduire l'effort de pêche dans une industrie disposant d'effectifs matériels déjà trop importants, étant donné qu'à la longue, ces impôts acculeraient les entreprises à la faillite. Il étudie aussi les quotas individuels qui confèrent aux particuliers et aux entreprises un droit de propriété sur une part de la "prise totale admissible". Il considère qu'un tel système de droits quantitatifs pourrait s'avérer très efficace. Sa seule faiblesse est qu'il est nouveau et n'a pas encore été mis à l'essai.

La limitation du nombre de permis accompagnée d'un programme de rachat et d'une taxe sur les permis constitue un système beaucoup plus familier, déjà appliqué d'ailleurs dans la pêche au saumon au Canada. Il est possible cependant qu'un tel programme de limitation des permis ne puisse apporter absolument aucun changement aux lieux de pêche, étant donné l'opposition politique à des contrôles secondaires qui soient suffisamment rigides pour empêcher que les petits bateaux ne soient améliorés en conséquence.

Summary

The Pacific Halibut fishery was selected for case study because:

1. management is based on perhaps the most complete statistical base of any major commercial fishery in North America;
2. it is a relatively simple fishery, having only one type of gear in common use. The products are marketed through straightforward channels which have changed only slowly over time;
3. comprehensive regulation by means of annual quota for the entire fishery, and the results of this mode of regulation have been well studied;
4. the resource is inevitably shared between the United States and Canada. The International Pacific Halibut Commission was established by Conventions of these countries in 1923. These, and subsequent conventions and protocols, document an outstanding example of international cooperation and conflict between two powerful fishing nations distinguished by markedly different political institutions and procedures.

The biology of the fishery dictates an industry which exploits simultaneously a large number of year-classes. For this reason, the Halibut fishery is ideally characterised by the traditional biomass-fishery model. Slow growth rates and a long period to sexual maturity make halibut stocks highly vulnerable to excessive fishing mortality, and the economic costs of rebuilding depleted stocks are very high.

The fishery is exploited by a variety of vessel types. As in the case of other North Pacific fisheries, the vessels are shared with other fisheries as season and market conditions dictate. However, the method of catching (long-line skate) is uniform across the Halibut industry, with however, important by-catches being taken by (especially foreign) trawlers.

The history of (international) regulation is reviewed and the results are assessed. The chief method, overall seasonal quota with an adjustable season length, is found to be economically inefficient and not adequate to insure against tragic stock depletion.

Alternative regulatory methods are examined. Landing taxes are rejected as politically unacceptable for reducing the effort in an overcapitalized industry since their effect entails taxing enterprises into bankruptcy over extended periods of time. Individual quotas, which entitle persons or corporations to proprietary rights in a portion of the Total Allowable Catch, are considered. Such a quantitative rights system is found to be very attractive in efficiency terms. Indeed, the only fault against it is the fact that it is new and untested.

A more familiar scheme (from the Canadian Salmon fishery) is vessel license limitation accompanied by a buy-back programme supported by taxes on the licenses. But the possibility that a

license limitation programme would leave fishing grounds unchanged is quite real, given the political opposition to secondary controls tough enough to prevent up-grading of smaller vessels.

1. Introduction

The Pacific halibut fishery was chosen as one of the case studies in fishery regulation for several reasons. Management is based on perhaps the most complete statistical base (at least with respect to the resource itself) of any major commercial fishery in North America. Second, it is a relatively simple fishery in structure. Only one type of gear has been permitted during the entire regulatory period; when targeted on halibut, the gear takes relatively small quantities of other fish; and the products are marketed through straightforward channels, in fresh and frozen form, which have changed only slowly over time. Third, the fishery is, inevitably, transnational in scope. The major exploited populations migrate across present and prospective Pacific Coast boundaries between the United States and Canada. Initially this led to a generally amicable joint regulatory programme. The prospects for viable management alternatives have been clouded, however, by recent developments leading to abandonment of joint management by the United States and Canada and a return to competitive national fishing within the respective economic control zones of the two countries.

Although the quantities of halibut landed are not large (less than 21 million pounds annually in recent years, and about 70 million pounds at the peak in the late 1950s and early 1960s), it has always been a valuable fishery. Extraordinary increases in real prices of halibut since 1972 have made it economically attractive in spite of the

precipitous decline in landings that began in 1961. Consequently, it is unlikely that halibut will be treated by either Canada or the U.S. simply as one of a variety of demersals capable of being taken by non-selective large scale trawling operations. The extent to which physical and temporal separation of mass-production trawling for low valued bottom fish and halibut can be achieved is a matter of real significance if optimal utilisation is to be made of the remaining halibut stock and if any hope of rebuilding to previous levels of yield is to be achieved.

Because of its compact and relatively simple structure, the halibut fishery lends itself to consideration of a variety of regulatory alternatives. Traditional management methods, focussing on quotas, area and time closures, and gear restrictions have produced demonstrably poor economic results even during the period in which at least a major part of the rebuilding from the low levels of the '30s to the peaks of the late 1950s was achieved. As both Canada and the United States embark on another rebuilding programme, in the hope of repairing damage done to the stocks by developments in the 1960s, it seems most timely to consider regulatory regimes that offer more lasting economic as well as biological benefits.

The discussion that follows outlines the structure, regulatory history, and potential for improved performance under management of the fishery for Pacific halibut. Since much of the background material for this study has been thoroughly documented elsewhere, the descriptive review is short. References to authoritative sources are given.

I have chosen to treat the halibut fishery as a whole, despite the concern of this study with the impact of regulation on the Canadian economy.

The biological characteristics of the halibut resource make it a trans-national stock, regardless of management regimes. Throughout much of the history of the fishery, management has been conducted jointly by Canada and the United States. In addition, reciprocal fishing rights were allowed fishermen of each nation, together with joint rights to land halibut in one another's ports. The fishery was further linked by marketing arrangements under which the bulk of the catch, whether taken by Canadian or American vessels, moved to American markets, either directly through landings in American ports; through landings by American vessels in Canadian ports and shipment in bond; or by export of fish landed by Canadian vessels.

It is hoped and expected that the actions taken by both Canada and the United States to divide the halibut fishery into separate national management units will be short-lived, and that the basic common sense of managing the fishery as a unit will lead to the re-establishment of a single management regime. It seems most useful, therefore, to treat management options as if common sense is, indeed, to prevail. Since that may not be the case, however, attention is given to the options available to Canada alone under the assumption that the present division of the fishery will persist.

2. The Resource

Detailed descriptions of the biology of the Pacific halibut are available in publications of the International Pacific Halibut Commission, which also document the extensive literature in fishery science dealing with this species. This brief summary is therefore focused on those elements

of the resource that are of specific concern in determining the level and method of exploitation and the parameters to be considered in weighing alternative regulatory measures.

Pacific halibut are the largest of all flat fishes and are among the larger species of fish in the sea. An average specimen weighs about three pounds (round weight) at four years, 40 pounds at ten years, and more than 100 pounds at 20 years. Males mature sexually at about seven to eight years, while the average age of maturity for females is 12 years. It will be noted that these characteristics make the Pacific halibut peculiarly vulnerable to over-fishing. Both long line and net gear will inevitably take some proportion of immature fish, and the slow rate of growth guarantees that severe over-fishing can be corrected, if at all, only after a prolonged period of reduced catches.

Halibut are found on the Continental Shelf of the North American coast from Santa Barbara, California, to Nome, Alaska, with the major concentrations along the coasts of British Columbia and Alaska. Extensive tagging studies indicate that there is some intermingling of halibut from all regions of the North Pacific coast. Although most adults tagged and recovered in the summer are caught in the same area where tagged, trans-boundary movements in the winter are much larger. In addition, there is a pronounced westward and northward drift of eggs and larvae in the Gulf of Alaska and the Bering Sea and a generally easterly and southerly movement of mature fish. Virtually all halibut move from deep water along the edge of the Continental Shelf to shallower banks and coastal waters during the summer and return to deep water in the winter. This is, essentially, a movement from spawning grounds to feeding grounds and may involve distances of hundreds of miles.

The main spawning areas have been documented from the early years of the fishery, when fishing was permitted throughout the year, and from IPHC¹ winter research cruises. A number of major spawning sites are found off the coasts of Alaska and British Columbia and some lesser concentrations in the Bering Sea. It is generally believed, however, that spawning is widespread and occurs in many areas, though not in as dense concentration as those identified specifically as spawning areas. This is supported by the very wide distribution of mature halibut during the winter months as indicated in the catches by commercial fishing and research cruises. At present, it is not possible to define with any accuracy the relative importance of spawning to maintenance of the stocks in Canadian waters vis-a-vis spawning off the coast of the United States--in total or in each other's present fishing zones.

The significance of existing knowledge about the area distribution of the resource is obvious. The halibut fisheries of British Columbia and the United States operate on mingled substocks, and it is difficult to conceive of management in any rational sense except through unified action by both countries: whether through a single management agency as in the past, or through carefully tailored national programmes that mesh closely. The combination of extensive migrations and wide distribution of the halibut populations also makes them vulnerable to incidental mortality from fisheries directed at other target species.

The biology of the Pacific halibut dictates a fishery which exploits simultaneously a large number of year classes. Consequently, short term

fluctuations in catch per unit effort (CPUE) and total landings are much less pronounced than in fisheries such as salmon and herring, where very wide excursions in catches are the rule rather than the exception. Potentially (though not in fact), a relatively stable fishery could be built around the resource.

It should be emphasized that the regulatory areas which have existed, with modifications from time to time, almost since the inception of the IPHC management program in 1930, do not imply separate stocks. The areas chosen for separate quota determination have been determined by Commission efforts to distribute catch and effort "in an optimal fashion."

3. The Fishery

(a) Geographic Range and Vessel Types

Halibut are taken commercially from the Bering Sea to the coast of Washington, with major fisheries off the coasts of British Columbia and Southeast and Central Alaska. The fishery began in the late 1880s, when three New England sailing vessels began dory fishing operations off the Washington coast. The catch was marketed primarily in Boston after shipment over the newly-completed trans-continental railroad terminating in Tacoma. Then began a long process of expansion northward and westward as the pull of expanding markets and pressure on nearby grounds forced the fleet into new fishing areas.

The small sailing vessels that pioneered the fishery were supplanted, by the 1890s, by large steam powered vessels that carried 10 to 12 dories. High operating costs later resulted in the substitution of smaller gasoline powered "schooners," carrying five to seven dories. By the 1920s technology in the halibut fleet had shifted again--this time toward diesel-powered

owner-operated schooners, designed to haul long line gear directly from the deck using mechanical power. The cost savings and speed of this operation quickly drove the dories out of the fishery.

Canadian participation in the halibut fishery came much later. As late as 1913 there is an expression of alarm that U.S. boats are exploiting the resource in B.C. banks, and an appeal for local participation. Completion of the rail link to Prince Rupert resulted in a doubling of halibut landings between 1913 and 1915 and the beginning of serious Canadian activity.

The expansion of the fishery as far west as Unimak Pass followed the familiar pattern of heavy pressure on nearby stocks, followed by movement to new grounds that could be reached by the larger and more seaworthy vessels. After 1930 most of the vessels added to the fleet were combination boats that could be used for trawling, purse seining, and long lining for other species. In addition, increasing numbers of salmon trollers and gillnetters began to participate off-season in the halibut fishery during the 1930s and '40s. This mix of older halibut schooners (completely renovated) and smaller, more versatile combination boats remained relatively stable from the post-war period through the late 1960s.

In recent years there has been a very rapid increase in the number of small boats fishing a day or two in nearby grounds. A number of larger salmon seiners have also entered the fishery. The principal stimulus for this growth came from the rapid increase in both nominal and real prices of halibut after 1972, with an additional push from the limited entry programmes in both Canadian and Alaskan salmon fisheries. Many experienced fishermen were ineligible for salmon licences; and, faced with very high

prices for existing salmon licences, many of these fishermen moved into halibut operations. As of 1976 the small boat fleet far outnumbered the licenced fleet² (3,597 boats to 743 vessels), but landed only about 20% of the total catch. This is a marked increase from the 5% to 10% of the total catch accounted for by "day boats" in the period prior to 1970.

The changes in the number of vessels in the fishery are those to be expected in an open access fishery subject to the major swings in availability of fish that have characterised the industry.

Recovery of the halibut stocks following the low point of the 1930s was marked by a more rapid increase in the number of vessels and fishermen participating in the halibut fishery, since total effort could only be controlled by a drastic shortening of the open season. The number of participants then began to drop off as halibut stocks began their long decline after 1960. Although there are only a few marginally hopeful signs of future recovery in the fishery as yet, the number of participants again turned upward in 1973-74 in response to the rapid escalation of halibut prices.

(b) Labour Force

The labour force in the halibut fishery is unusually homogeneous. A majority of halibut fishermen and vessel owners are of Norwegian ancestry. While many are the descendents of early immigrants, there has been a steady inflow of young Norwegians to the fishery as a result of chronic under-employment and economic distress in the fishing communities of northern Norway. In addition, many Nova Scotians and Newfoundlanders have also participated in the West Coast fishery, particularly in Canada.

Crews vary in size depending on the size and type of boat, with a substantial number of one and two-man operations in the day boats and seven to eight men on the larger halibut schooners. Crews on the larger vessels operate under closed shop contracts between vessel owner associations and fishermen's unions on the Pacific coast. Fishermen's compensation is based on a conventional type of share agreement, but union-vessel owner negotiations covered only provisions of the sharing arrangement. Because of anti-trust problems, the American unions and vessel owners were not permitted to negotiate with waterfront buyers for prices of halibut ex-vessel.

(c) Gear Technology

From its inception, the halibut fishery has been based on long lines--first operated from dories and later from vessels equipped to set and retrieve the gear from the deck. Whether this is the most efficient way of harvesting halibut has never been seriously questioned. In the interest of preserving an adequate data base and control over fishing mortality, the Commission has insisted that the fishery be conducted entirely by long lines, even to the extent of requiring that all trawl-caught fish be returned to the sea, regardless of mortality.

This does not mean, however, that the technology of the fishery has been entirely static. The basic long line technique, consisting of a ground line to which short branch lines with hooks are attached at intervals, has remained essentially unchanged. However, there have been significant improvements in the efficiency with which the gear can be utilised. For example, snap-on gear was introduced into the fishery about 20 years ago; branch lines (gangions) are attached to the ground line with metal snaps

rather than being tied to the ground line with twine. This permits ready modification of hook spacing and much easier storage of the gear on the drum on which the ground line is retrieved. Snap-on gear is particularly advantageous for the small boat fisherman, and has attracted many gillnetters into the fishery since the gillnet drum can easily handle halibut gear.

In addition, fishermen discovered over the years that the use of wider hook spacing, though it reduced the catch per hook, did not reduce it proportionately. This reflected the greater efficiency of each hook as competition with its neighbors is reduced. Since the larger long liners could set far more hooks than the dory fishermen, the net effect was to increase the overall efficiency of effort.

(d) Distribution of Landings

The geographical distribution of landings has also changed over the years. Initially, Seattle, Prince Rupert, and Ketchikan were major receiving ports. As the fishery extended northward and westward and as the seasons shortened under the impetus of quota regulation with expanding numbers of vessels, greater and greater incentive was placed on running to the nearest port. As a result, Kodiak, Seward, and Petersburg, Alaska, have become much more important in recent years, while Seattle and Ketchikan have declined in importance. The growth in the number and quality of receiving facilities in the northern ports now offers a substantial advantage to vessels in terms of balancing fish prices against running time and fuel costs.

4. Relation to Other Fisheries

(a) Biological

Although the halibut fishery has always been managed as a single species operation, it is linked to other operations in both biological and technological senses. It seems certain that the growing intensity of fishing for species that occupy the same space as halibut and, in varying degrees, utilise the same elements of the food web, would have an effect on the size, age distribution, and area distribution of halibut stocks. Unfortunately, present knowledge does not permit definition of these relations in a degree that permits of any useful generalisations.

(b) Technological: Multipurpose Vessels

Technological linkages between halibut and other species are more clear cut. For reasons outlined in the discussion that follows, the halibut fishery, though capable of being prosecuted on a year-round basis, has actually been concentrated in a relatively short period of each year for decades. As a result, a substantial number of halibut vessels are utilised in other fisheries, and are designed to carry different types of gear for these fisheries. Thus, the larger purse seiner hulls are used in herring and salmon fishing; some of the older schooners fish long lines or pots for black cod and other demersals; and either type can be modified to operate as a trawler. Many of the smaller boats fish for salmon, albacore, or crab after closure of the halibut season.

This is, of course, nothing new in the North Pacific. Despite the general tendency for both management specialists and economists to discuss commercial fishing in terms of single species operations, an overwhelming proportion of fisheries off the coasts of Canada and the northwestern United States are carried on by vessels that shift seasonally to other operations.

Under different institutional arrangements it is quite possible to conceive of the halibut fishery as being most efficiently prosecuted by a fleet of rather highly specialised vessels capable of fishing throughout the year, even during rough winter conditions. The proliferation of multi-purpose vessels, including a rapid influx of salmon gillnetters, seinters, and trollers in recent years, is more a result of the types of regulation imposed on halibut and salmon fishing than of any inherent economic or technical considerations in halibut fishing.

(c) Technological: Multispecies Catches by Non-Selective Gear

More significant is the inevitability of by-catches of halibut by domestic and foreign trawlers targeting on bulk catches of lower valued species--pollock, hake, lemon sole, rockfish, sablefish, etc. Until recently, this was not a matter of serious concern. Markets for the domestic bottom fish industry in the U.S. and British Columbia were too limited to attract trawlers to areas where very large incidental catches of halibut would be expected. By the 1960s, however, the situation had changed dramatically. Studies by IPHC staff (Hogue, 1976) indicated that the domestic trawl fishery, operating primarily in British Columbian waters, was taking a significant quantity of halibut, and that mortality on fish returned to the sea was perhaps in the neighborhood of 50%. On reasonable assumptions as to the distribution of the incidental catch by age and size, subsequent growth and mortality, and hooking mortality, it was estimated that the U.S. and Canadian trawl catch was costing the set line fishery approximately two million pounds of catch per year. (Even when account is taken of the fish that could be marketed if the incidental trawl catch could be retained, there would be a net loss, though much smaller in magnitude.)

The situation with respect to the foreign fleets was far more serious. During the 1960s the distant water operations of the Soviet Union, Japan--operating beyond territorial waters and virtually uncontrolled--began to make serious incursions into halibut stocks. Although the fleets were primarily interested in lower valued species (principally pollock, hake, lemon sole, Pacific Ocean perch, and other rockfish) the sheer magnitude of the operation produced by-catches of alarming magnitude.

In addition, a large proportion of the halibut taken by the trawlers were undersized fish, particularly when trawling operations were conducted in areas where juvenile halibut tended to concentrate. Although there has been some controversy over the relative importance of other factors leading to the dramatic decline in halibut stocks and catches beginning in the early '70s³, there is universal agreement that increasingly heavy catches by foreign trawlers were the largest single element.

The implications for management of these interdependencies are discussed in a subsequent section. At this point, we simply note that it is increasingly unrealistic to evaluate alternative regulatory measures involving different species and different methods of fishing solely on the basis of their impact on a single high-valued species like halibut. The approach was not unrealistic when relative prices of other demersals were so low that they were of little concern in the domestic markets of Canada and the United States and prior to the time when massive foreign fishing was undertaken. At today's prices, with today's technology, and with the increasingly broad international market for low-valued fillets

and blocks, the trade-offs involved in protecting halibut from all overlapping fisheries must be considered much more carefully--particularly as foreign trawlers give way to U.S. and Canadian vessels within the 200 mile zones.

5. Marketing

(a) Marketing Channels

Halibut marketing and distribution has changed, but only rather slowly, over the life of the fishery. In the early years, most of the fish were iced and shipped fresh to markets by rail. As southern banks were depleted, halibut fishing moved north and more and more fish were landed at Alaskan ports. Since most Alaskan ports are not served by direct rail to Canada or the lower 48 states, increasing proportions of halibut were frozen.

Today over 90% of "processed" halibut is in the form of frozen, beheaded, and eviscerated fish. This is an intermediate step in the production of finished items: steaks, fillets, smoked halibut, cheeks, and fletches (boneless, skinless fillets). Occasionally product forms such as bait, fillets, liver, viscera, and canned halibut are also marketed.

Increasing fishing effort has also forced the industry to freeze more halibut. Short, intense seasons, resulting from increased effort on a constant or declining supply, meant that a year's supply of halibut must be processed within a very short time. Freezing units and storage must be large enough to hold excess supplies until halibut can be sent south and east to other processors and markets.

High halibut prices have also affected the marketing of halibut. At today's prices it has become profitable to cut fresh halibut into fletches,

pack it in insulated, refrigerated containers and ship it to markets by air during the short fishing season. In the past five years high prices have sharply reduced the flow of fresh or bulk frozen halibut through retail outlets. Most halibut is now sold to the hotel and restaurant trade and in frozen packaged form in retail stores.

(b) Ex-Vessel Pricing

The principal shift in marketing mechanisms involves methods of ex-vessel pricing. For many years halibut were sold in the principal receiving ports--Seattle, Prince Rupert, and Ketchikan in early days--on conventional auction markets. Prices at other ports were determined in some cases by more limited auctions or by reference to the prices established at one of the major auctions. In recent years increased mobility of the fleet, the tendency of the regulatory techniques to concentrate landings in northern ports, and improved communication facilities have led to much more use of direct sales. Vessels at sea with a full load can quickly determine by radio prices at alternative markets and consummate a sale prior to the time delivery is actually made. In general, this procedure has simply improved the fluidity with which halibut moves to the most favourable of the several primary markets available; it also tends to minimize the overloading of any given local market which occurred frequently in the past.

6. Development of the Regulatory Framework: 1923-1980

The various Halibut Conventions under which the International Pacific Halibut Commission (IPHC) has operated were initiated in 1923 and subsequently revised in 1930, 1937, and 1953.

The first Convention of 1923 went into effect after exchange of ratifications in October, 1924, following years of mounting concern over depletion of the stocks and detailed negotiations. Its most important provision was the creation of the International Fisheries Commission (later the IPHC) and the initiation of bilateral responsibility for recommending regulations for the preservation and development of the fishery on the basis of Commission research. Regulation was limited to a three-month closed season during the winter and for disposition of halibut caught incidentally during the closed season.

The 1930 Convention, faced with the obvious failure of the short closed season to accomplish anything useful, empowered the Commission to establish regulatory areas, to limit the halibut catch from each area, to regulate the type of gear used, and to designate nursery grounds on which halibut fishing would be prohibited. These basic tools have been modified but retained ever since. Enforcement responsibilities fell on the shoulders of the two governments. The Convention also provided an industry forum to inform the Commission of different views on proposed regulations; a Conference Board of fishermen and vessel owners was established in 1931.

The Convention of 1937 did not alter the basic regulatory framework laid down in 1930, but tightened control over vessels catching halibut incidentally during the closed seasons. This had assumed greater importance as the influx of new vessels resulted in shorter and shorter seasons.

Major changes were initiated in the Convention of 1953. Concern over the concentration of effort in very short seasons in the major regulatory areas led to provision of authority for multiple seasons to distribute effort over longer periods of time. The name of the Commission was changed

to its present title, and its membership expanded from four to six persons, three from each country. Significantly, the 1953 Convention provided, for the first time, an explicit objective of MSY.

The Convention of 1953 thus ushered in an era of regulation which has continued, with only modest modifications, until 1978. The basic tool of regulation has been the establishment of quotas by geographic area. These are backed up by size limits; closures in areas regarded as nursery grounds to prevent unduly large catches of immature fish; prohibitions on types of gear regarded as unduly destructive such as trawling; and, in earlier years, prohibition against the use of dories. Some flexibility has been achieved by changing the number and size of sub-areas and by staggering opening and closing dates.

Although not part of the Halibut Convention, long-standing unilateral actions by Canada and the United States permitting reciprocal port privileges, formalised in a separate Convention in 1950, had a significant influence on the conduct of the fishery. This allowed maximum flexibility in deployment of vessels and landing of catches, and enabled both Canadian and U.S. vessels to service the major U.S. market (which takes most of the Pacific halibut) from Canadian ports without penalty.

(a) IPHC Objectives

The objectives of regulation by IPHC have always been expressed, implicitly or explicitly, in terms of MSY (or equivalent wording); yet there is clear evidence, in statements by the Commission and its staff, that it has been cognizant of the economic impact of various regulatory actions

on the fleet as a whole and on particular segments of the fleet. Indeed, one of the Commission's staff members pointed out as early as 1948 that it would be highly desirable to control the number of vessels participating in the fishery if the objectives of the Commission were to be achieved, since every indication pointed toward a progressive shortening of the season with a variety of unfortunate biological and economic side effects. Nevertheless, the Commission has adhered tightly to its mandate to manage for "conservation" only.

It is not easy to determine the extent to which economic considerations were actually governing, despite the official words. For example, there was apparently a good deal of sympathy on the part of the Commission with the desire of most of the fleet to incorporate lay up provisions in Commission regulations. This could have been justified, as was later the case when the Commission undertook to subdivide regions and split seasons, by the fact that the longer season would permit more balanced harvesting of the various sub-races that make up the overall halibut populations. But the favourable economic effect on both fishermen and most processors was clearly a prime concern as well.

In view of this obvious recognition of the implicit economic as well as the overt biological objectives of management, the outright prohibition of management "for economic purposes" in the legislation that established the program is difficult to understand. The most logical interpretation is the desire to avoid any possibility that the Commission or its staff could be influenced by industry pressure to control landings with the explicit purpose of raising prices. In short, neither the United States nor Canada wanted a kind of piscatorial Texas Railway Commission. Whatever its initial

purpose, the wording of the Conventions of 1933 and 1953 made it abundantly clear that the Commission could not undertake to develop, advocate, or institute a program of limited entry (or, more broadly, to seek more economically rational harvesting methods under regulation) without specific authorisation in additional legislation. This was never provided by either of the two governments.

(b) Structure of the Commission

Commission structure since 1953 can be described briefly as follows. Three members are appointed by the Governor General of Canada and three by the President of the United States. There is no fixed term for Commission membership; the average tenure of Commissioners since 1924 has been nine years and twelve of the members have served ten years or more. As a result, there has been a remarkable degree of continuity and solidarity in Commission actions over a long period of time. Commissioners are not compensated for their services.

Though not required by the Convention, membership of the Commission from each country has tended, in recent years, toward a standard format: one member from the Federal fisheries agency, one fisherman, and one member drawn from the processor-marketing sector. In addition, one U.S. Commissioner conventionally comes from Alaska and one Canadian Commissioner from the Prince Rupert area. The Chairmanship of the Commission rotates annually between countries, and in recent years meetings have alternated annually between Canada and the United States.

The Commission has its own staff. The Director is appointed by the Commission, and the size of the supporting professional and clerical staff has been adjusted to meet the research demands placed upon it. There are

no provisions for specific division of these positions among those of Canadian or American citizenship. The staff has been housed for a long period of time on the campus of the University of Washington in Seattle. A review of Commission and staff research and activities goes beyond the scope of this study. Suffice it to say that the fisheries community generally regards the scientific work of the Commission as highly professional; its statistical records of the fishery are among the most complete to be found anywhere in the world; and it has operated without any indication of bias or partizanship toward one country or the other. As a matter of judgment, the opinion might be ventured that much of the strength of the Commission in dealing with fishermen and processors (and the general willingness to comply with its recommendations) reflects confidence in the professional ability and integrity of its staff work and the openness with which the results of that work are discussed with the several sectors of the industry concerned.

(c) Industry Inputs to the Commission

Industry views are presented to the Commission formally by a Conference Board made up of Canadian and American halibut fishermen and vessel owners. Members are broadly representative of union and vessel owner organisations at all of the major ports where halibut is landed. In addition, the Commission established in 1974 an advisory group consisting of representatives of fishermen, vessel owners, and processors. It is made up of 14 members, seven of whom are selected by the Conference Board and seven by the Halibut Association of North America.

The fact that the industry has generally supported the management programme of the IPHC should not be interpreted as quiet acquiescence to

all its decisions. Indeed, every year has seen vocal--and sometimes extremely lively--debates about the wisdom of particular Commission policies. For example, the Commission's concern (shared by many but not all members of the industry) with the economic effect of the continued shortening of the season under quota regulation gave rise to a series of bitter disputes over the wisdom of split seasons, staggered opening dates, incorporation of lay up provisions in the Commission's own regulations, and other alternatives. Similarly, any softening of the position that trawl-caught halibut could not be retained under any circumstances, despite the possible wastefulness of the policy, inevitably met with a storm of protest from the set line fishermen. The decision by INPFC to lift the abstention closure imposed on Japanese halibut fishing in the eastern Bering Sea also aroused a great deal of wrath (much of it, improperly, falling on the heads of the IPHC).

A review of the thick file of such comments, covering each year of the IPHC's operation, might leave the casual observer with the impression that the industry and the Commission were hopelessly at odds.* A more logical interpretation is that the Commission was wise to establish a forum in which steam could be blown off publicly--with some measure of benefit deriving from public exposure of the industry's feelings--prior to the time regulatory changes were actually initiated. Looking back on the record of halibut management and industry reaction, it appears that much of the clamour was for public consumption rather than a reflection of any deep seated dissatisfaction with Commission policy, long term or short term.

* Available for examination upon request to author

(d) Expenditures by IPHC

The operating budget for regulatory functions of the Commission has been remarkably small over the years, increasing only very slowly and at a rate approximating the rate of inflation in both countries (Figure 3). The recent spectacular increases in the research budget reflect the serious concern of the Commission and the industry over the dramatic decline in halibut abundance as a result of domestic and foreign trawling activities, changes in oceanic environment, and other factors.

(e) Enforcement

Implementation of Commission regulations is carried out by the governments of the two countries, since the Commission itself has no enforcement power. In Canada the Department of Fisheries and Oceans handles enforcement matters. The Coast Guard, and Customs Officers, together with the fishery agencies of the states of Washington and Alaska, share this responsibility in U.S. waters.

(f) IPHC and the International North Pacific Fisheries Commission

The unitary control of the IPHC over halibut fishing in the North-east Pacific has been challenged from time to time, but only once seriously. Immediately after World War II there were rumblings of participation in the fishery by one or more European nations, but these were effectively stopped by diplomatic action by the United States and Canada.

A very different kind of threat to the Commission's authority developed in 1962. The Convention that established the International North Pacific Fisheries Commission in 1953 included an "abstention provision" which restricted Japanese fishing for certain species east of 175° W. Longitude. This restriction was to be based on scientific findings

that the stocks subject to the abstention principle were already fully utilised by the United States and Canada. In 1962, INPFC concluded that this condition was no longer met with respect to halibut in the Bering Sea, and that Japanese fishermen should therefore be empowered to fish for halibut in that area, subject to conservation measures to be recommended annually by both IPHC and INPFC.

Apart from its highly unpopular reception among American and Canadian halibut fishermen, this division of authority caused considerable difficulty in implementation of a halibut management programme based on area quotas. From 1962 through 1977, when the extension of fisheries jurisdiction to 200 miles by Canada and the United States amputated the whole problem, management in the contested Bering Sea area was characterised by annual juggling of redefined sub-areas, with somewhat dubious success in protecting the stocks involved.

(g) Regulatory Roles of Industry Groups: Lay-Up Schemes

Industry groups have always exerted a significant influence on regulatory policy. In both Canada and the United States vessel owners are organised into associations that are nearly completely inclusive of the larger vessels and also include some of the smaller boats. Share fishermen are represented in each country by a strong union.

In addition to collective bargaining over shares and working conditions, vessel owners' associations and the fishermen's unions have exerted a substantial influence on management through implementation of lay-over plans. Halibut stocks, as measured by CPUE, increased steadily during the 1930s and 1940s. As would be expected, increased catches attracted new entrants into the fishery and quotas were reached more rapidly. A

voluntary lay-up programme was instituted in the early 1930s in order to prolong the fishing season and distribute landings over a longer time period. The programme required a ten-day lay-up between trips for every boat and limited the catch of each boat according to crew size.

The voluntary lay-up was discontinued in 1942, apparently because of inability to obtain adherence by the small boat fleet, and the effect was a shortened season for all areas. The season length continued to decline through World War II until 1955, ultimately falling to a low of 59 days in Area 3 and 29 days in Area 2.

The Commission was limited by treaty in the actions it could take to deal with the undesirable effects of shortened seasons. One provision of the 1937 Halibut Convention gave the Commission power to limit departure of vessels when the quota was about to be reached. In the late 1940s the Commission proposed to split the fishing season, but this was more for biological reasons than an effort to relieve the pressure on processors. Some sections of the industry and fishery were violently opposed to split seasons as "economically disastrous" and preferred a lay-up system.

After several years of seasons of less than 60 days duration, fishermen and processors agreed to reinstitute a voluntary lay-up system in 1956. The programme was supported by 18 unions and vessel owners' associations, whose representatives met annually to establish lay-up rules. The lay-up system was designed "...to extend the fishing season, establish rest periods for the fishermen, attain a more orderly delivery of the catch, and aid in the conservation of the resource."⁴ Larger vessels were required to take an eight-day lay-up between trips, while smaller vessels had an option

of laying up for one-half day for each day of fishing.

This second lay-up programme continued until 1977, when the fishermen announced the end of the programme due to lack of support. The system had been in jeopardy for several years because new and part time halibut fishermen were ignoring the programme. Full time fishermen were forced to abandon the programme to maintain their share in the fishery.

During the time that lay-up provisions were being followed by fishermen's unions, repeated efforts were made to incorporate the concept in Commission regulations. The request was rejected each time, however, on the ground that no authority for such action was provided in the enabling legislation of either country. Nevertheless, the subsequent Commission practice of subdividing areas and staggering opening dates, authorised by revised Treaty provisions in 1953, had something of the same effect and was doubtless influenced by pressure from vessel owners to lengthen the season as well as by the obvious biological advantages of doing so.

(h) Extended Jurisdiction to 200 Miles: Nationalization of the Halibut Fishery

Passage of extended jurisdiction legislation in Canada and the United States in 1976 apparently spelled the end of the era of Commission regulation of the halibut fishery. The United States and Canada have found it very difficult, in the face of conflicting industry pressures, to maintain the pattern of reciprocal fishing that had developed over many years (not only in the halibut fishery but in salmon, shrimp, and bottom trawling as well). As a result, the United States announced its intention to phase Canadian halibut fishermen out of American waters in two stages ending in 1980. Canada, in turn, prohibited American fishermen from fishing for halibut and severely restricted U.S. catches of a number of other species

in any Canadian waters.

The outcome of these actions with respect to halibut are unclear at the present time. For the moment, the basic pattern of Commission regulation is being carried on under a temporary Protocol. The Protocol contained three main provisions. First, all U.S. fishermen were excluded from Canadian waters effective April 1, 1979. Second, Canadian fishermen are to be phased out of U.S. waters over a two-year period, 1979-1981. Third, a special quota was established for Area 2. Provision was also made to continue reciprocal landings in all Canadian and U.S. ports.

Although the 1979 Protocol has not yet been ratified by the Canadian government, the halibut fishery operated under its provisions in 1979 and will do so again in 1980. U.S. fishermen were excluded from all Canadian waters. Canadian fishermen were allowed to catch two million pounds in U.S. waters in 1979 and will be allowed one million pounds in 1980. No Canadian fishing will be allowed in U.S. waters after the 1981 season.

The exclusion of U.S. fishermen from Canadian waters will have little impact on Canadian fishermen since U.S. fishermen have taken less than 7% of the halibut catch from Canadian waters since 1969. The U.S. catch in Canadian waters amounted to 2.5% of the total U.S. catch since 1969. Exclusion of Canadians from U.S. waters will result in a much heavier impact on the Canadian halibut fleet, since two-thirds of the total Canadian catch since 1969 has come from Alaskan waters.

Pending a more detailed set of future arrangements, the 1979 Protocol established a special quota for Area 2 in 1979. The total quota was set at 9 million pounds with 60% (5.4 million pounds) to be taken from Canadian waters by Canadian fishermen and 40% (3.6 million pounds) to be taken from Alaskan waters by U.S. or Canadian fishermen. A problem arose in summer,

1979, because U.S. fishermen overfished and caught nearly 50% of the quota which left only 4.5 million pounds for Canadian fishermen. The IPHC added 600,000 pounds to this which brought the Canadian quota to 5.1 million pounds--300,000 pounds less than promised. The 1980 Area 2 quotas (agreed to in January, 1980) are 6.1 million pounds from Canadian waters and 3.2 million pounds from U.S. waters.

For subsequent years a new and promising approach has been worked out by U.S. and Canadian negotiators. The IPHC will continue as before, except that the Area 2 catch will be divided between the two countries with no reciprocal fishing privileges in the respective national waters. The Commission will allocate a percentage of the total Area 2 quota to each country on the basis of "the condition of the resource in that country's waters." (In general this will yield an approximate 60-40 split in Area 2, with the larger share to be taken by Canadian fishermen.)

Significantly, the objective of IPHC management was changed from MSY to Optimum Yield in the Protocol. This change was obviously necessary to make quota determinations by IPHC consistent with requirements of the U.S. Fishery Conservation and Management Act of 1976. Whether it has any operational significance remains to be seen.

As an aside it might be noted that the realignment of U.S. and Canadian halibut fishing under the new arrangement is a classic example of how distributional considerations (and resulting fisherman pressure) can overwhelm other management considerations. Alaska fishermen gained a substantially larger share of the valuable halibut catch, and were unconcerned when Canada retaliated by excluding American trawlers (an entirely different group) from B.C. bottomfish and shrimp grounds. B.C. trawlers were obviously pleased,

and were not particularly worried by the subsequent threat by their ousted American colleagues to institute an offshore herring fishery that would impact yet another group of Canadians.

The burden of readjustment fell largely on the "regular" (i.e., IPHC-licensed) Canadian halibut boats, since the smaller day boats have traditionally fished inshore Canadian waters for the most part. The Canadian fleet was placed under limited entry in 1979, and efforts are under way to ease the excess capacity problem by buying out some vessels and diverting others to black cod, Area 2 halibut, and other fisheries. Total cost of the accommodation measures is estimated at about \$5 million.

7. Interest Groups and Distributional Disputants

Because it is essentially a single species fishery (if interrelations with trawling are set aside for the moment), with well defined and straightforward marketing channels and methods of processing, the number of disputants is small compared, for example, to the Pacific salmon fishery. Except for the "external" trawler-long liner relation, there is no group conflict comparable to that between the salmon trollers and other salmon users, for example, in which actions required to maximise both gross and net economic benefits from the salmon resource would clearly involve a large and uncompensated sacrifice by the trollers. Nor is there the kind of conflict that arises between commercial and recreational users, in which the optimal population size to yield maximum recreational benefits is, inevitably, greater than that which would yield the largest gross or net economic benefit in commercial channels. Nevertheless, there are significant conflicts within the industry based on usage and on distribution of proceeds.

(a) Vessel Owners and Share Fishermen

As might be expected, there is some divergence of interest between vessel owners and share fishermen. On occasions this has reached the proportions of a strike, but even in Canada, where labour relations in the fisheries have been notably more turbulent than in the United States, the halibut fleet has had fewer interruptions than the salmon operation. This probably reflects the unusual homogeneity of the vessel owner-fishermen group, a large proportion of whom are of Scandanavian origin, mixed with a generous sprinkling of Nova Scotians and Newfoundlanders. Vessel owners and share fishermen have not negotiated with buyers over

ex-vessel prices for halibut, and the range for disagreement within the sharing agreement itself is relatively limited.

(b) Alaska vs. Lower 48

Within the industry itself, two types of divergent interests can be observed. First, in the American operation there has been a continuing residue of ill feeling between Alaska-based fishermen and processor-marketers and those operating out of Seattle and other Lower 48 ports. In part this is simply a matter of the long standing resentment of Alaskans toward real or fancied "colonialist" attitudes by non-Alaska firms which have dominated Alaska fisheries for decades. There is a strong feeling in Alaska that more of the employment and income generated by fish processing and marketing should remain in the state. This attitude has contributed significantly to the breakdown of joint management of a jointly fished halibut resource. Alaskans have long resented the large Canadian share of Area 3 catches, and have argued (with some justification) that they bore the burden of cooperation with Canada while Seattle fishermen enjoyed most of the benefits.

(c) Trawlers vs. Long-Liners

The field of dispute is broadened considerably if potential participants are also included. Domestic trawlers have long argued that they should be allowed to retain incidental catches of halibut rather than return them to the sea, with associated high mortalities, and it has been argued that in some areas trawling should be a legitimate method of targeted fishing for halibut. Conflict may well assume really serious proportions in the near future, since both Canada and the U.S. have made it

clear that they expect domestic trawling to supplant most foreign operations within their respective exclusive zones. If halibut are regarded simply as one of a wide variety of fish capable of being taken by trawl gear, it seems almost inevitable that the aggregate physical yield of halibut, and probably the economic yield attributable to halibut alone, would be substantially reduced. Whether or not this would contribute to a larger aggregate economic return from harvesting of all species capable of being taken in trawling gear is an open question that must be dealt with by both governments. An indication of the magnitudes involved is developed in a subsequent section of this report.

(d) Licensed Halibut Vessels vs. "Day Boats"

The conflicts between the larger vessels and the day boats, on the other hand, do not really affect the overall exploitation of the halibut resource. They have assumed some significance, particularly with respect to the lay-over, which broke down on two occasions largely because of inability to convince owners of the smaller boats that they had any interest in the lay-over. From their standpoint, the shorter the halibut season the better, since they would shift to other operations later in the season in any event.

As long as the day boat catch remained below 5% of the total, the differences in viewpoint were of no great concern. With the exaggerated increase in the relative prices of halibut in recent years, however, the influx of small, part time participants has become so great that the lay over has had to be abandoned entirely. It has even resulted in a surprising shift of opinion in the regular U.S. halibut fleet from forthright opposition to any system of limited entry to open and increasingly strong support for some kind of effort control.

(e) Jurisdictional Problems

Finally, it should be noted that the division of responsibility for fishery management in the United States under the Fishery Conservation and Management Act of 1976 creates a set of political rivalries that carry over into the management of important species such as halibut. Indeed, the focal point of the dispute between the United States and Canada really centers on the creation of a strong Alaskan influence in the North Pacific Fishery Management Council, and the consequent success of efforts by Alaska fishermen to secure a firm hold on a much larger share of the total halibut catch. Paradoxically, although the Councils were created as a means of regionalising fishery management policy and minimising the inter-state conflicts that had impeded U.S. fishery management in so many areas, in Alaska the effect has been to enhance considerably the authority of the one state that must work with the Council--and, consequently, to dilute the influence of the Federal government. It is quite possible that what is best for Alaska with respect to halibut might not be best for Canada or the United States as a whole--hence the seriousness of the jurisdictional changes that have taken place.

8. The Impact of Regulation - Biological

The Halibut Commission, particularly in its middle years, was not shy about proclaiming its success in managing the resource. And indeed, the facts did seem to speak for themselves. Catches had declined from a peak of nearly 70 million pounds in the 1920s to a low of just over 30 million pounds by the early 1930s. After initiation of the Commission's

quota programme and its associated backup regulations, total landings, catch per unit effort, and average size of fish taken increased almost without interruption until another peak of 75 million pounds was reached in 1962.

(a) Controversy Over Effects of Regulation on Catch

The claims of the Commission were not to go unchallenged, however. The details of the scientific controversies over interpretation of catch and effort data and their implications for success of the halibut management programme are beyond the scope of this paper. They are treated objectively and in great detail in Skud (1976). The essential argument can be summarised briefly as follows.

Although a number of biologists (e.g., Graham, 1935; Holt, 1951; Beverton and Holt, 1957; Ricker, 1958; and Fukuda, 1962) raised questions about the analytical techniques used by IPHC, none questioned the fact that overfishing had, in fact, accounted for the precipitous decline in halibut catches and abundance prior to 1930. Burkenroad, however, in a series of publications from 1948-1953, seriously questioned the basic conclusions of the earlier studies on which the halibut programme rested. He argued that the stock decline prior to 1930 could not have been the result of fishing alone, and--a more cutting criticism--that the subsequent recovery was too rapid and too substantial to be accounted for by management measures of the Commission. The debate raged for a number of years, and concluded, somewhat uneasily, with agreement that overfishing had been a major factor, but that environmental changes unrelated to fishing may also have been a significant cause of fluctuations of stock abundance in Pacific halibut.

(b) Technological Change and the Data Base

Skud's analysis rests on a much more sophisticated interpretation of available data, particularly with respect to the importance of fishing techniques in developing a standard unit of fishing effort--the essential step in establishing comparable CPUE data and estimates of stock abundance. It became evident during the '60s that estimates of stock abundance had been too high (Skud, 1972).

In the 1940s and 1950s, halibut catch per unit effort was based on a standard unit of effort, the 120 hook skate. This basic skate was a length of line that had hooks periodically attached at 13-foot intervals, to a total of 120 hooks. Catch was assumed to be proportional to the number of hooks, and was in no way dependent on the hook spacing. Therefore, any changes in hook spacing would only affect the unit effort measured, and was adjusted accordingly (e.g., if a 120-hook skate with 13-foot interval spacing was 1.00 units of effort, then an 80-hook skate with 18-foot spacing was adjusted to .67 units of effort).

Unfortunately, the assumption that catch is independent of hook spacing was false. Harvest methods evolved into wider hook spacing, going from the original 9 feet in the 1920s, to 26 feet today. The catch per skate is inversely related to hook spacing, but not in linear fashion. The catch per hook increased as the spacing increased. Incorporation of new data on productivity at greater spacing indicated that gear efficiency had been under-estimated and the catch per skate over-estimated, indicating a halibut stock size greater than actually existed.

Skud also returned to earlier data to assess the effects of differences in fishing techniques as the fishery shifted from dory gear to long

line gear during the 1915-1930 period. There were significant differences in both hook spacing and "soak-time" between dory gear and long line gear, and these differences also produced biased estimates of stock abundance. Recalculation of the 1915-1930 data was undertaken to account for these changes. An additional adjustment was required to account for seasonal variations in catchability; catches in later years were significantly altered by regulatory measures limiting the fleet to very short fishing seasons.

The analysis suggests that the original calculations by W. F. Thompson and his colleagues under-estimated the effectiveness of total fishing effort and therefore over-estimated catch per standard unit effort during the early years of the halibut fishery. Thus, the decline in abundance prior to 1930 was not as sharp as Thompson had concluded. Skud also notes that the recovery of the halibut stocks after the introduction of regulations by the Commission in the early '30s was influenced by economic factors--the severe depression of halibut prices during the mid to late 1930s--as well as by control measures instituted. Indeed, the initial introduction of quotas was at levels roughly those that the fleet had been willing to catch at the very low prices of the early 1930s.

In short, both sides to the debate were right in some degree. There can be little doubt that heavy fishing, increasing in efficiency, during the development period of the halibut fishery resulted in declining abundance and catch per unit effort. On the other hand, the revised data also leave considerable room for the argument that variations in oceanic parameters also had a significant effect. It is simply impossible, with available data, to quantify the impact of such environmental changes (and, incidentally, of stock interrelations that may have influenced the

abundance of halibut as a result of other fishing activities even before the incursions of foreign trawlers in the 1960s).

The significance for regulatory policy of both the scientific disputes and the summary and partial resolution by Skud is apparent. Models based on the assumption that long run equilibrium values change only modestly from year to year (and the presumed ability to distinguish readily between movements along yield functions and shifts in the functions arising from biological factors) are simply unrealistic. Any management programme, regardless of its objectives, must accommodate the hard fact that estimates of abundance and potential yield should be drawn as bands rather than single valued functions. Major fluctuations in availability of fish result from changes and environmental conditions that are not only beyond man's control, but beyond his ability to monitor with present techniques. In the case of halibut, management decisions must be further tempered by the very slow recovery time of long-lived demersals, and the resulting loss in present value if errors in judgment occur.

(c) Biological Effects of Unbalanced Harvesting

In one important respect, the Commission itself was cognizant of the failure of its programme to produce as large catches as the resource could yield. The quota technique, unaccompanied by any power to control fishing effort or numbers of vessels directly, resulted in a progressive and drastic shortening of the fishing season--first in the period following the Second World War, and again during the past two years. In each case, relative returns from halibut fishing increased to the point where substantial new entry was attracted, most of it consisting of existing vessels switching from other fisheries. Since the total quota was fixed, this inevitably

required shortening of the fishing season. But the very short season caused a further set of reactions by the fleet itself. First, it tended to concentrate its efforts on grounds near delivery ports so that the number of trips each individual could expect to make would be maximised. In addition, the short season guaranteed that intense fishing effort would be centered on whatever stocks were available on these accessible grounds during the period after the opening date. But enough is known of the migration habits of halibut to suggest that this could and did lead to heavy harvesting of some subgroups of the total population, leaving others lightly harvested or untouched. For obvious reasons, this reduced aggregate output for any given level of input; and, given the very slow recovery rates of halibut populations, would have made subsequent shifts in harvesting patterns to produce maximum yield even more expensive economically.

9. The Effects of Regulation: Economic

The effects of the overall multiple area quota system on economic efficiency were more complex, less thoroughly documented, and clearly less promising in terms of social well-being. In this section the economic evaluation is divided into two segments: first, a retrospective look at what occurred as the halibut stocks were rebuilding to levels that permitted maximum physical yields; and second, a prospective look at the additional issues to be faced when rebuilding the sadly depleted stock requires choice among alternative recovery periods and their corresponding implications for net present value.

(a) Economic performance: 1933-1957

The economic response to the increase in abundance and average size of halibut as a result of the management programme (and whatever other forces may have been operating) from the 1930's to the 1960's followed a predictable course. With increasing abundance, the catch per unit effort increased rapidly. On the Area 2 grounds, which had been hardest hit during the period of overexploitation, the catch per skate increased from 35 lbs. in 1931 to more than 100 lbs. in each of the years 1952 through 1958. The improvement in CPUE in Area 3 was smaller, but still significant. This meant, of course, lower average unit fishing costs, an increasingly attractive return from halibut fishing as compared to other fishing alternatives, and a rapid increase in total effort. In 1933, when the programme was first initiated, 384 regular vessels and boats manned by 1,903 fishermen, participated in the fishery. By 1951, 820 regular boats and 4,077 fishermen participated. In addition, there was a very large though undocumented increase in the number of day boats landing occasional fares of halibut. The actual fishing power of the fleet increased during the period as a result of steady improvements in vessels,

propulsion, line materials and deck equipment, and wider hook spacing.

As a result, the inputs required to take increased quotas declined steadily from 1932 through the early '50s. A rough index of capital and labour inputs, calculated by Crutchfield and Zellner by multiplying the number of regular boats and men by the number of permitted fishing days, declined sharply throughout the period. Man-days fell from about 55,000 to less than 30,000 from 1933 to 1951, while boat-days fell from 12,000 to slightly more than 5,000 days.

Since the Commission had no authority to limit the number of units participating in the fishery, its only alternative was to shorten the fishing season. In 1933 the quota was taken in Area 2 in 206 days and in Area 3 in 268 days. By 1950 this had dropped to 32 and 66 days respectively, despite the fact that total landings had increased substantially.

The economic consequences of these developments to the late 1950's, as physical yields approached MSY, are summarised below. They are based largely on the results of a detailed study of the halibut fishery by Crutchfield and Zellner (1962).

(b) Overcapacity: 1955-1957

The most serious economic cost of the fleet's reaction to an improving fish population subject only to total quota control is the inevitable tendency toward excessive numbers of participating units. The number of regular vessels fishing for halibut in 1951, 820, was more than double the number participating in 1932, but the increase in catch was only 27%; and the amount of fishing effort required to take that larger quota had declined rapidly.

The number of boats and fishermen in the halibut fishery began to decline after 1951, largely because of unfavourable economic conditions in halibut

markets (reflecting rapid growth in domestic production and imports of frozen bottomfish fillets) and increases in most items entering into fishing costs. Despite this reduction, the fleet was still 40% larger in 1958 than at the start of the management programme.

A detailed analysis of the earnings of halibut fishermen and boat-owners, covering about a third of the Seattle-based halibut fleet, provides empirical verification of the economic consequences of these developments. The survey covered the years 1955-1957, during which the unfavourable effects of weak halibut prices and rising costs had been felt for several years. As might be expected, incomes of halibut fishermen from all sources were slightly below the levels enjoyed by others of the same general age groups in Northwest states and British Columbia. Had the survey been taken in the late '40s and early '50s, it probably would have shown total income from all sources at approximately opportunity levels. It is also disturbing to note that more than 50% of all fishermen drew unemployment compensation during the survey years, and for fishermen in higher age groups the combined proportion of the income received from unemployment compensation and social security payments was a major part of total income--this at a time when total landings were approaching their peak values.

With due regard for the caution necessary in interpreting these data, the conclusion seems warranted that incomes of halibut fishermen from all sources, including transfer payments, were at or slightly below opportunity levels during the period in question, and that these relatively unattractive earnings had resulted in a persistent increase in the proportion of older men in the fleet. This might also have been accelerated by the very poor boat earnings noted below, since the attractiveness of halibut fishing for the share fisherman is definitely influenced by his prospects for becoming

a skipper-owner as he gains the necessary experience.

The survey of boat earnings was much more discouraging, as would be expected. Boat incomes, expressed as a percentage of replacement costs, averaged only 3.9% before depreciation. Returns in the most profitable group--vessels 30 to 39 net tonnage--were only 4.8% before depreciation. Squeezed between constant or declining product prices and rising costs after 1951, the halibut fleet had been deteriorating by the time this survey was undertaken, as evidenced by the average age of the vessels surveyed (29.5 years) and the extremely low return on investment indicated for vessels of all size groups.

Again, as theory suggests, the "squeezing out" process in the face of low earnings was very slow. The typical fishing vessel, with reasonable maintenance, has a very long life indeed, and only sustained earnings below out-of-pocket costs will suffice to drive out large numbers of boats (particularly if the same open access-excess capacity syndrome exists in other fisheries in the region).

Analysis of the catch per unit effort data and season length indicates that about one-third of the halibut vessels of identical average configuration of the fleet in 1955-57 could have taken the entire catch, with a season extending over six to nine months. If that had been the case, the Crutchfield-Zellner analysis of vessel and fisherman earnings indicates that returns to vessel owners after depreciation on replacement cost would have sufficed to yield a net return equal to 8% to 10% of replacement cost. Incomes of individual fishermen from all sources would have been nearly double those actually earned in the period 1955-1957. The increase in total rent from the fishery would, of course, have been substantially higher if the reduction in effort had been tailored to permit only the most efficient vessels to remain in operation. Had the fishery been conducted by a smaller

number of vessels fishing on a six to nine month basis, even the adverse economic developments of the 1951-1957 period would have left the fleet in a reasonably satisfactory economic position.

(c) Other efficiency effects of short seasons

But these are, of course, the results predicted in Scott Gordon's first airing of the issue, and verified empirically by virtually every subsequent study. There is, in addition, evidence of substantial secondary economic costs resulting from shortening of the season under a fixed quota system without control over entry. The Crutchfield-Zellner study identified the following.

1. Inefficient, geographic distribution of fleet effort and location of processing and primary receiving facilities, leading to a considerable increase in total transfer costs. The rush to get in as many trips as possible led to the establishment of additional receiving and freezing operations in areas where they could be used only for a few months each year.

2. Increased freezing and storage costs. While it might be argued that the increase in the proportion of catch frozen was dictated in part by changes in consumer demand, much of the costs of frozen storage, reglazing, and loss of quality in extended storage were real costs imposed by the short season: a direct result of the regulatory technique.

3. Level and uniformity of fish quality. In addition to quality deterioration in storage, the effect of short season quotas on the individual fishing enterprise is to stimulate efforts to achieve maximum catches for each trip to the grounds, since curtailment of a single trip short of a full load would rarely suffice to permit an extra trip at the end of the season. This resulted in undesirable ageing of fish first taken on any given trip, and--on many occasions--actual deck loading of fish with

resultant poor quality at delivery. Since halibut's position as a luxury fish product rested in part on the very high quality which the product can maintain with proper handling and frozen storage, the effect of variable quality was perhaps more significant in market acceptance than the actual deterioration of individual portions of the catch.

There was no way, given the data available, to evaluate these additional costs fully. Crutchfield and Zellner estimated, however, that they added at least 5% to total landed cost for the years of the study. At 1980 prices, these costs would be much higher, given the very sharp increase in real prices of halibut and increased labour and material costs in fish processing and storage.

It is impossible to reach any meaningful conclusion as to the effects on economic efficiency of restrictions on gear types other than long lines handled from the deck of the halibut vessel. Trawling as a means of taking halibut would, of necessity, be combined with a multi-species fishery, and there is no logical way in which costs could be allocated among the different species taken. In addition, the demonstrated tendency for multi-species trawling to take a larger proportion of undersized halibut would make smaller numbers of larger fish available to the set line fishery. These numbers can only be estimated very roughly on the basis of existing data.

(d) Effect of limitation to long line gear

The studies referred to earlier, relating to the impact of both foreign and domestic trawling on the halibut catch, suggest that it would be unlikely that any net economic benefit could accrue from harvesting halibut in part through legalised trawling. On the other hand, the corrolary conclusion--that the halibut fishery should be reserved entirely for the set line operator (with the possible exception of some retention of halibut

taken as by-catch) -- would follow only if it could be demonstrated that preservation of the halibut fishery would not require excessive sacrifice, in net value terms, of very large trawl catches of lower valued species. Experience in recent years under bilateral agreements (and, more recently, under Extended Fisheries Jurisdiction legislation) seems to indicate that by-catches of halibut can be reduced very significantly by appropriate seasonal and area closures with minimal effects on either domestic or foreign trawling operations. On balance, then, it seems unlikely that the gear restriction imposed throughout the period of IPHC management had any very significant effect on economic efficiency of halibut harvesting or, in a broader sense, of bottomfishing in the region as a whole. Should there be major increases in the scale of U.S. and Canadian trawling in areas where halibut would be taken incidentally, the issue would assume much larger proportions. It could be much more difficult to win acceptance of sacrifices by trawlers for the benefit of setliners when domestic rather than foreign operators are involved, but some measures to discourage halibut by-catches (eg. stiff taxes on incidental halibut catch) would be essential.

In terms of social efficiency, then, the overall economic results of the IPHC programme to 1960 were disheartening. The same catch could have been taken in the peak years just prior to 1960 at far lower costs than were actually incurred. An exercise involving proposed reductions in fleet size by varying amounts, translated into impacts on operating results of fishermen remaining in the operation, revealed that dramatic increases in net income and shares could be realised. This is, of course, another way of saying that substantial rents would have been available if the reduction in effort had been achieved in a manner that would permit a smaller number of operating units to be employed over six to nine months of the year. And the distortions in location of fishing activity and in

marketing and processing sectors resulting from fishermen's reaction to the overall quota device reduced net economic benefits still further. This is not to say that the management effort was wasted; without it there might have been no resource at all. But it is a hollow victory to preserve an industry that could contribute so little to the overall welfare of the Canadian and American economies under the regulatory regime that was followed.

(e) Economic performance: 1975-1979

The behaviour of the fishery in recent years is, from the standpoint of economic efficiency, even more frustrating. The decline in catch and abundance that began in the early 1960's carried the industry from landings in excess of 70 million pounds to the 1980 quota of 20.3 million pounds. As expected, the number of units participating in the halibut set line operation declined moderately until 1973.

The astonishing acceleration in real prices that began in 1972 then produced a new gold rush, despite general knowledge of the Commission's pessimism about prospects for early recovery of the stocks and upward revision of quotas. Indeed, many in the industry shared the view of some of the Commission staff that even deeper cuts in quotas would be required (together with vigorous efforts to reduce trawl mortality) if any recovery at all was to be expected. In 1975, 150 vessels over 5 tons fished for halibut in Area 2 and 154 vessels in Area 3. By 1978 the number had jumped to 217 in Area 2 and 313 in Area 3.

The number of permitted fishing days dropped accordingly--from a total of 128 in each area in 1975 to 23 in Area 2 and 32 in Area 3 in 1978. The Commission reinstituted split seasons to lengthen the overall fishing period in 1980, but this does not alter the drastic reduction in actual fishing days.

In brief we now face the same problem of unnecessary new entry at a time when total fishing mortality has reduced the halibut stocks to near-crisis levels. Apart from the obvious economic costs of this development, future management must deal with the complex issue of target recovery rates. Under the best of circumstances, the biology of the Pacific halibut dictates a long recovery period even if sharp curtailment of present quotas are accepted as necessary. Within limits the IPHC could (assuming necessary political and industry support) achieve more rapid recovery at a cost of heavier current sacrifice, or ease the present burden of very low quotas at a cost of lower and slower increases in the future (if any).

Assuming that the optional time paths of catches can be quantified, the resulting impact on net present values can be estimated if vessel operating costs and returns are assumed to remain constant over time.
[To be elaborated when modeller reports.]

The implications of the analysis for a management policy geared to improving net economic benefits can be summarised as follows:

1. Because of the slow growth rates of halibut, economic gains from curtailed quotas, expressed in present value terms, are relatively small.
2. On the assumption that present prices remain constant or increase in real terms, rationalisation of the fishery will bring large increases in present value (virtually as great as those available at the MSY catch levels of the early '60s). Since technical coefficients have changed only in the direction of greater potential vessel efficiency, the proportion of net rent in total payments to fishermen has soared. If we still believe in consumer sovereignty, there is as much to be gained from more rational harvesting of a sadly depleted halibut stock as could have been realised when biological results of management were most impressive.

3. The division of Area 2 quotas into fixed sub-quotas for U.S. and Canadian fleets and the exclusion of Canadian vessels from Area 3 after 1981 would make it possible for either country to rationalise its share of the halibut fishery by unilateral action. Under the previous programme neither fleet could agree to reduce effort since this would simply donate any initial "investment" to the other. Canada has already adopted a limited entry approach, and the North Pacific Fishery Management Council (with grudging support from the industry and the Commission) is considering the same step.

10. Alternative Management Regimes: General

In discussing alternative management regimes, the following framework for analysis is employed. The overriding consideration is to improve economic efficiency in a rather broad sense -- that is, to increase the present value of net economic yields from fishing and to minimize costs imposed on marketing and processing functionaries. This would be subject to three sets of constraints. First, a workable arrangement for division of the catch between American and Canadian fishermen must be maintained in order to permit equally workable dovetailing of management programmes instituted by the two countries. These need not be identical, but must be non-aggressive and compatible. Second, efficiency considerations may require modification to accommodate distributional objectives where native fishermen and the well-being of isolated communities dependent on small boat participation in the halibut operation are important. Third, a management programme for halibut, looking forward, must deal with a resource that has been badly mauled during the past decade. Whether this is due largely or entirely to the combined impact of foreign and domestic trawling or to unaccounted parametric changes in the complex ocean environment is not known at this time. There is, however, strong evidence to suggest that the trawl fishery incursion has been a major factor -- and that recovery is therefore possible.

The discussion of alternatives in the pages that follow is limited specifically to their applicability to the halibut fishery. Different fisheries in different locations might call for significantly different treatment; that is the task of others in the working group. For the same reason, attention is focused on the impact of different methods of regulation on the decision-making processes of individual fishing ventures; the effects on the overall fishery and various measures of public well-being are derived from those reactions. Much of the earlier literature has focused on what might be termed long term static evaluations of fleet impacts. But, as pointed out by Dr. Scott many years ago, and as evidenced by operating experience under both halibut and salmon management programmes in Canada, rational decisions by individual fishermen, adjusting to a given set of regulations, has surprising and sometimes distressing effects on economic efficiency for the operation as a whole.

We start with licence limitation; not because it is necessarily the preferred option, but because it is the only one for which we have a North American track record, and because it has already been imposed by the Canadian government and almost certainly will be the choice of U.S. policy-makers.

(a) Licence Limitation

As indicated in previous discussion (see Crutchfield, 1979, for example), a licence limitation scheme would be assumed to start with a moratorium on further entry to the fishery. This would not be overwhelmingly difficult under normal circumstances, but does take on some interesting ramifications in view of the fact that implementation of a moratorium would require action by the Canadian government (already taken) and, on the American side,

by the states of Washington and Alaska and the North Pacific and Pacific Regional Fishery Management Councils. The matter is complicated further by the fact that the initiative in proposing limited entry schemes in Alaska has come from the Council, whereas the Pacific Council has favoured an approach under which the individual states are encouraged to establish their own limited entry programmes subject only to guidelines laid down by the Council. Since the Protocol provides specific catches for the two countries in Area 2, it was possible for Canada to proceed independently. This would have been impossible under the previous regime, where no division of area quotas by country was authorised.

Eligibility and definition of licence unit.

The first major policy issue to be faced is the determination of eligibility. If the programme contemplates a subsequent reduction in the number of initial licences, whether by buy-back or some other scheme, the easiest course of action would be to licence initially anyone with a reasonably credible claim to recent activity in the fishery. This should present no difficulty, since sensible rules can be laid down about eligibility on the basis of vessels contracted for or under construction at the time of the cutoff date, and truly unusual hardship cases can be dealt with through a prescribed hearing procedure. If, on the other hand, capacity is to be reduced immediately, alternative criteria for eligibility--singly, or in combination--could be used to reduce the number of fishermen initially qualifying. In the halibut case, there is much to be said for a qualification standard that eliminates many of the more recent entrants, since they came into the fishery at a time when their presence was notably unnecessary, and--in an overwhelming proportion of cases--participation in the halibut fishery by these vessels represents only a portion of the

planned annual utilisation of the boat and gear. Cut-off dates of participation and minimum landings could be established to eliminate much of the recent addition to capacity, if desired. On the other hand, it would be easier to win acceptance of the programme if all presently engaged in the fishery were made eligible.

The question of the unit to be licenced--fishermen, vessels, or the unit of fishing gear--will not be dealt with in great detail. For reasons outlined in a previous paper (Crutchfield, 1979) it seems that the vessel is the most useful unit to work with in a licence limitation programme, particularly if it is to be accompanied by a staged reduction in fishing capacity and is backed up by measures to control fishing power of the vessel (e.g., number of skates of long-line gear).

None of these problems of initial implementation seem overly serious in the case of the halibut fishery. Experience in Alaska, British Columbia, and Washington in salmon licence limitation should point the way to procedures that would be acceptable to both industry and governmental units concerned in the basically simpler halibut operation.

Flexibility

An important element in administrative feasibility is the inherent flexibility of a management device (more precisely, the flexibility of that device in conjunction with other measures). On this count, licence limitation probably ranks quite low. The initial limitation would necessarily start at a level of fleet capacity far beyond the yield potential of the resource. From its inception, then, a licence limitation programme would have to be supplemented by other measures to reduce fishing mortality to levels consistent with chosen recovery rates and with other biological and economic objectives. In addition, licence limitation per se offers

no means of rapid response to changes in biological conditions affecting the availability of fish and the desired catch level for any given season in any given quota area.

Compatibility with other controls

On the other hand, licence limitation is, by its very nature, reasonably compatible with the flexible use of other, more direct measures of controlling fishing mortality--area closures, time closures, prohibition of fishing in nursery areas, and prohibition against the use of destructive types of gear--all of which are familiar to both fishermen and regulators. Since it is, in essence, the mildest possible step away from the status quo in the halibut fishery, it could be introduced and progressively tightened without impeding the necessary utilisation of back-up control measures of the type mentioned above. Since it seems highly likely that the halibut fishery will continue to operate only with long-line gear, a licence limitation programme in the halibut fishery would not have to contend with the inertia effect of entrenched positions by users of different kinds of gear. The efficiency criterion becomes much easier to evaluate in halibut as compared to a situation in which unappealing choices might have to be made between efficiency and expediency on the basis of the historical position of different types of gear in the fishery.

Adaptability to multipurpose fishing

Licence limitation as a means of rationalising the halibut fishery does not come off well in terms of its adaptability to multi-purpose fishing.

The question of whether halibut could be more efficiently harvested by a small group of specialised vessels, sufficiently limited in number to permit operations over six to nine months of the year, as compared to the present mixed fleet, admits of no simple answers.

On the basis of present evidence, it seems likely that the specialised fleet approach would yield the greatest economic return from the fishery,

assuming that the number of licences could be steadily reduced to the appropriate level if halibut fishing is treated in isolation. But it seems equally likely that this would create a degree of social dislocation and concomitant political opposition that would make it impractical. The options in halibut management are constrained by regulatory regimes in other fisheries.

If that be the case, licence limitation as a means of rationalisation becomes less attractive. Assuming that the small boat operator is most likely to seek and receive special consideration in the halibut fishery, it is essential that he be able to participate in more than one fishery, given the seasonal nature of physical access to halibut from small boats and the inherent limitation of bad weather conditions on the grounds during a considerable part of the year. Since salmon fishing is the most likely alternative, the small boat fisherman faces the necessity of purchasing increasingly expensive licences in both fisheries, in competition with specialised and probably more efficient vessels.

It is possible, of course, to get around the problem--if it is indeed a serious one--by having the government reserve some licences in both fisheries and make them available, free or at subsidised prices, to the groups it proposes to assist. On the other hand, this could become cumbersome, particularly if it interferes with the eminently desirable condition that vessel licences be freely transferable.

Distribution effects

Experience in both British Columbia and Alaska salmon fisheries

demonstrates graphically that a licence limitation scheme not accompanied by a parallel tax program that extracts an increasing amount from remaining licencees as their number is reduced, creates windfall gains, most of which accrue to the initial owners of the property rights conferred by

licence limitation. To the extent that their expectations are reasonably correct, the existing licencees would, theoretically, collect the present value of the entire future stream of benefits (including any benefits from special unemployment insurance for this fishery). In practice, the inherent riskiness of fishing and fish marketing, despite long-term upward trends in real prices, would suggest that purchasers of existing licences, in sequence, would also share some of the benefits. The important point is that unless specific fiscal action is taken to collect taxes or royalties, a substantial amount of the total economic gain will be conferred on one group of halibut fishermen. The public will gain only in the sense that a properly conceived and executed licence limitation programme will probably result, over time, in larger catches, a better time and area distribution of halibut landings, and a more efficient processing-marketing sequence.

However, this distribution effect of a limited entry programme need not be particularly worrisome. First, it does not appear to have serious efficiency-reducing side effects. Indeed, it simply repeats a process very common in Canadian and American history: the transfer of valuable resources from the public to the private sector on the ground that creating private property rights in such resources is the most efficient way to utilise them over time. Moreover, it does not seem overwhelmingly difficult to correct distribution effects that may be politically or ethically troublesome by relatively simple tax measures. Indeed, the combined efficiency and distribution effects of a landing tax or royalty, which -- as pointed out below -- should be a normal accompaniment of any limited entry programme, would appear to deal neatly with the problem of equity.

Protection of stocks. One vitally important criterion in assessing any rationalisation programme must be its effectiveness in protecting basic productivity of a resource subject to frequent and sometimes violent fluctuations in biomass

and yield potential from natural causes. As pointed out by a number of authors (e.g., Anderson, 1979) licence limitation, as a mild modification of the status quo, is not a particularly effective means of establishing desired fishing power on a year-to-year basis. This is of less concern in the case of halibut, however, since the halibut fishery is probably more stable than almost any other with which the Canadian government must deal. As pointed out in a previous section, the fishery operates on a large number of year classes, and the stock does not seem to be subject to severe fluctuations in recruitment. Thus, it is unnecessary to make drastic changes in year-to-year allowable catches except as a result of man's own activities. In addition, the necessary flexibility would have to be provided under any form of economic rationalisation by a combination of direct controls over fishing mortality--the only difference is the degree of reliance on direct measures and the frequency with which they would be employed.

Efficiency effects

The most serious reservation about licence limitation as a means of achieving an economically rational halibut fishery is the likelihood of undesirable impacts on the efficiency of both individual vessel and fleet.

To summarise the recent discussion on this subject,⁵ the principal weakness of effort reduction through licencing of vessels is the reaction of the individual vessel owner to perceived opportunities to increase net income by expanding inputs other than the controlled vessel.⁶ As long as the anticipated increase in catch exceeds the increment of cost required,

it would appear rational for each individual vessel owner to expand his catching power. Moreover, each vessel owner would perceive not only the advantage of trying to expand his share of the available catch, but also, in a negative sense, the loss that he would necessarily suffer if he does not follow the example of those who do expand catching power--in short, the loss of aggregate output may offset the gains of remaining smaller and more efficient. Thus, individual factor distortions and inefficiency are translated into significant reductions in economic efficiency for the fleet as a whole. In a sense, entry remains open if only one or more inputs are not restricted by the rationalisation programme and if some measure of factor substitution is possible.

There can be no doubt of the analytical validity of the argument. What remains at issue is the functional shape of the relations involved. If factors are substitutable with only minor cost increases, the amount of misallocation and induced inefficiency could be very serious indeed. Even in the extreme case, however, it seems analytically incorrect to argue that all of the potential economic gain from rationalisation will be dissipated just as thoroughly (or perhaps more so) than if open access persisted. On the other hand, it is plausible to argue that in many fisheries technological requirements for the harvesting operation do encourage factor substitution. Increases in catching power as a result of increased mobility (larger propulsion units); better location capability (radar, sonar, and Loran); or deck equipment designed to facilitate the speed of handling gear are examples of ways in which the catching power of a vessel of fixed length and tonnage could be increased.

But the actual degree of distortion cannot be deduced from the theoretical considerations alone. It is most likely that at least some of these improvements are truly cost reducing, and were not introduced previous to

limited entry only because of other types of regulation or because low incomes restricted access to the capital market. In other cases (e.g, the provision of back-up electronic capability), it can be argued persuasively that what is involved is less a matter of increasing catching power than of increasing the safety of vessel and crew. In this sense, much of what has gone into making fishing vessels in restricted entry programmes safer and more comfortable is properly regarded as consumer expenditure made possible by the increased incomes generated by the restricted entry programme, rather than excessive capital investment. Finally, factor substitution functions for some types of fishing become nearly right angled; a specific type of vessel and fishing operation demands a specific type of gear and a specific number of crewmen. In this case, it is difficult to conceive of increases in capital sufficient to dissipate all of the potential economic rent, since the perceived marginal revenue would decline rapidly to zero.

Effects on progressiveness

A licence limitation programme would not appear to stand out as a strong stimulator of technological research and innovation. Unless the increases in fishing power resulting from technological advance are paralleled by a reduction in the number of operating units, the regulator would have no recourse but to impose other direct controls, the effects of which would largely mitigate the cost-saving possibilities--indeed, the certainty of such outcome is a potent force in restricting the amount of investment in research and development work, both public and private. As Anderson (1979) points out, restriction on one dimension of the factor combination used might also tend to distort technological advance by focusing R and D on the specific problem of evading whatever constraint has

been imposed--number of vessels, length, tonnage, or some other characteristic. One need only look at the weird development of the so-called Alaska salmon seiner to see what kinds of distortions can result when a vessel designed for a specific fishery is restricted in only one dimension.

Summary: Licence limitation in the halibut case.

When these generalisations are applied to the specific case of the Pacific halibut fishery, the results are, not unexpectedly, mixed. Long-line gear is relatively simple, and while technological improvements have taken place, they have not been particularly spectacular in improving productivity, nor have they involved substantial amounts of capital investment. Such changes as the introduction of snap-on gangions, automatic baiting machinery, and use of gillnet drums to retrieve and store long-line gear are really adaptations of the basic equipment to suit different boat configurations rather than major technological advances. The advantages of getting to the grounds first and most often would be no greater under limited entry than under the present open access situation that has prevailed for the entire duration of the fishery. Thus, the incentive to expand horsepower would have been expended long ago. On balance, it would seem unlikely that the regular licenced halibut vessel would undergo any major change in total inputs or factor combinations under a licence limitation scheme as opposed to the present open access.

The situation could be quite different, however, with the smaller day boats, and the numerical dominance of this type of craft makes the issue more serious. Even if measures were undertaken to prevent upgrading by increasing the size of the boats carrying initial licences, there could well be room for considerable increases in range and in the amount of long-line gear carried by such boats if real prices continue to rise, if increased

effectiveness of management measures rebuilds stocks and increases yields, and if the limited entry programme is accompanied by a vessel reduction programme that results in successive lengthening of the seasons. In effect, partial conversion of part-time into full-time halibut boats could lead to a major increase in effort unless rigorously controlled. But rigorous control⁷ would, in turn, freeze these vessels into their present multipurpose fishing patterns, which may or may not be efficient in an overall sense.

The possibility that a licence limitation programme, even accompanied by a buyback or other method of reducing the number of vessels, would leave fishing power unchanged is quite real, given the political opposition to secondary controls tough enough to prevent up-grading of smaller vessels. Moreover, the measures that would seem most effective in preventing such developments might run directly counter to the distributional objective of permitting fairly widespread participation in halibut fishing by small boat operators operating out of isolated fishing communities.

How well a licence limitation programme would do in halibut depends heavily on the relative weight to be attached to initial feasibility--the fact that such a programme could be instituted with a minimum of political opposition--versus the likelihood that individual fisherman reaction to limitation would necessitate other types of controls that would reduce the potential economic gain and possibly exacerbate social problems with small boat operators. On the other hand, the relative simplicity of the fishery, the absence of gear competition, and the nature of long-lining itself suggests

that the negative effects of reaction to a licence limitation programme would be significantly smaller in halibut than has been the case in the British Columbia salmon fishery. The British Columbia fleet is small enough to permit case by case diversion of redundant halibut vessels to other fisheries with minimal social and economic impacts, and to control undesired investment in the remaining licenced vessels.

(b) Taxes

In this section we are concerned with taxes as a method of inducing individual operators to reduce fishing activity and thus to adjust capacity efficiently to the yield capabilities of the stock involved. Obviously, taxes or royalties, used as an allocative device, also have distributional consequences; and taxes may be used in conjunction with any other rationalisation scheme to achieve distributional objectives (or to mitigate undesired distribution effects).

Problems with static analysis of impact

It is surprising that the tax mechanism, viewed as a means of reducing redundant capacity (and of adjusting to yearly fluctuations in stock abundance) retains its vitality in the literature despite the fact that even its analytical attractiveness rests on a set of assumptions as to the nature of the fishery that run completely counter to the facts. The practical problems of implementing and carrying out such a programme in an already heavily overcapitalised fishery are overwhelmingly difficult. In brief, if all functions relating effort to yield were stable and all future prices and costs known with reasonable certainty, tax systems could be devised to convert any of the several types of external effects from open access fishing into specific costs as seen by the individual entrepreneur himself (Smith, 1969; Scott, 1955). Unfortunately, the obstacles to use of

taxes as a means of inducing disinvestment or as a short-term allocative technique are more formidable. The assymetry between entry and exit conditions, as viewed by the individual firm, is critical. While there is every reason to use a tax device as a means of making explicit to the individual fisherman the cost he imposes on others in an expanding fishery, thus preventing the development of overcapacity (or, more realistically, reducing the pace and magnitude of such development), the use of taxes to reduce an already overcapitalised fishery presents entirely different problems. It would be necessary to reduce returns to the individual fisherman sufficiently to induce him to cease fishing entirely or to shift to other fisheries. But this would require driving price below out of pocket costs for the marginal firm whose exit is required. Since the halibut fishery, like most others, uses a share system to compensate labour inputs, this would require a very severe cut indeed in receipts available to the individual vessel for each trip; a level so low that it would require that all participants be subjected to losses over a substantial part of the adjustment period required to bring productive capacity to desired levels. This is unappealing from the standpoint of both equity and political plausibility.

If the reduction of excess capacity via taxation is difficult and painful, the stimulation of new entry and subsequent expulsion of capacity in response to short-term fluctuations in the availability of fish goes far beyond the realm of practicality. Even if legislative bodies could be persuaded to grant this degree of discretion in taxing to an administrative body, the lags in both perception of need and economic effect would make it impossible to achieve the intra- and interseasonal changes required

for even a second best management system. Finally (in common with other rationalisation schemes), the use of taxes to determine the desired level of catching power assumes parallel action in other fisheries to which inputs may be diverted. Otherwise, the correction of factor allocation in the taxed fishery is offset by excessive inputs to others that remain untaxed or are taxed at a lower level.

All of these objections would apply, in practice, to the use of the tax device as the major regulatory tool in the halibut fishery. While short-term excursions in resource availability are probably considerably smaller in halibut than in most other fisheries, the dismal prospect of curing a depressed fishery by taxing all of its present participants to the point of operating losses cannot be regarded as a politically feasible alternative.

Again, it is stressed that the division of regulatory methods into mutually exclusive boxes is artificial. A licence limitation programme certainly can be bolstered in achieving a desired reduction in excess capacity by appropriate taxation; and it would be appropriate to finance the management programme from the proceeds of a tax on those who benefit from it. It is simply argued, at this point, that it is not rewarding to consider the use of taxes alone as a short-term or a long-term device to achieve the proper level, composition, and deployment of fishing effort in the halibut fishery. It could achieve long-run biological objectives only through pressures on individual decision-makers which would almost certainly violate any standards of equity that would be considered generally acceptable; and there is no conceivable way in which it could be tailored to provide even the limited year-to-year flexibility demanded by the nature of the halibut resource.

Individual Quotas for Fishermen

Though the idea is not new, there has been a substantial resurgence of interest in a radically different approach to rationalisation. Rather than restrict the inputs (as in licence limitation) or make social costs explicit in marginal cost calculations of individual fishermen (the tax approach), regulation would specify the quantity to be taken by each individual operator, leaving the level and combination of inputs and time and area distribution of effort to his discretion. The shares would presumably be freely transferable with minimal transactions costs, and could be used to adjust the individual fisherman's catch limit within season as well as between seasons. The quota could be specified as an absolute quantity or as a percentage of a total allowable catch which would vary from year to year (assuming that the TAC would be announced far enough in advance of each fishing season to permit orderly planning of the season's activities by each individual fisherman).

Implementation

The idea is very attractive in efficiency terms. Indeed, the only real argument against it is the fact that it is new and untested--hence very hard to push through the initial implementation. It proposes a completely new concept of rights to participate in the fishery, and while it has many parallels in the use of natural resources other than in the marine setting, it would require very extensive educational work to persuade both fishermen and legislators of its practicality and desirability. With respect to the fisherman, in particular, adoption of an individual quota system would require a complete revision of methods of planning the fishing venture, from inception to intra-seasonal deployment. It is not likely to be immediately apparent to him how he would fare in competition with others under such a

scheme, even in a relatively straightforward fishery like that for Pacific halibut.

Initial distribution of rights

The initial level of quota rights to halibut and the method of distributing them should present no insuperable problems. The line of least resistance would be to issue individual quotas summing to the amount currently taken and distribute them roughly on the basis of recent past participation by the individual boat owner. With the level of catch at historic lows, it seems certain that an almost immediate concentration of those quota rights would occur, since the more efficient vessels could afford to pay a price for them which would exceed their value to a host of marginal fishermen participating only on a casual basis. A more direct, but probably less acceptable approach would be to achieve the initial distribution by auction, probably on the same basis as the auction of Treasury bills.

On closer examination, however, there are distributional aspects of this technique which would make it suspect. First, it would give an enormous advantage to fishermen whose current financial situation is favourable, and this could not be accepted as a completely reliable index of efficiency. Second, fishermen based in larger communities with ready access to capital from a variety of sources would have an enormous advantage over fishermen living in smaller and more isolated communities. Third, there is a presumption that the initial distribution, particularly if it were designed to implement an immediate total quota reduction, would end up in the hands of the larger specialised vessels. This may be desirable, but it would seem wise to allow a longer test in the market for quota rights before concluding that this is the case.

Efficiency effects

The concept of output limitation on the individual fishing unit, with an overriding quota limitation on total catch, has a great deal to offer in terms of flexibility, efficiency, and progressiveness. It would be particularly easy to initiate such a programme in the halibut fishery since fishermen are already thoroughly familiar with area quotas and the monitoring framework established by IPHC is equipped to establish annual quotas far enough in advance to permit orderly adjustment by the fleet. While these characteristics would not guarantee success of an individual fisherman quota system, they would certainly make the adjustment easier. For obvious reasons, the double quota concept would make the rationalisation programme more consistent with both short-term and long-term biological objectives than any other management framework that can be envisaged. Except for some enforcement problems, discussed below, it virtually guarantees achievement of desired catch levels, season by season, and permits the fleet as a whole, via the market for transferable individual quotas, to adjust in its own fashion to year-to-year changes.

In terms of static efficiency, there seems no reason to doubt that market forces alone, given adequate access to capital by potential purchasers, will shift the fleet in the direction of optimal vessel configuration, optimal factor combinations, and improved, if not perfect, temporal distribution of effort. The latter qualification reflects the possibility that a substantial number of halibut vessels would continue to operate in multiple fisheries. If so, there might be a strong temptation to take the individual quota as rapidly as possible to permit the fullest utilisation of vessel equipment in other profitable operations. Since the halibut season opens earlier than the most likely complementary operations

(salmon and herring), this could lead to the kind of undesirable bunching of landings at the beginning of the season which has characterised the unrestricted quota system.

Whether or not the thinning effect of heavy concentration of effort in the early part of the season would induce even the more flexible operators to fish late rather than early is an empirical question that simply cannot be answered at this point. In some respects much would depend on the relative advantages of lower catch per unit effort later in the season, offset by higher prices as daily landings diminish. On balance, it would not appear that thinning problems would be of serious magnitude. The more likely source of lowered efficiency would be the bunching of landings by vessels eager to complete halibut operations and shift to other fisheries. If this should prove to be a serious issue, it might be necessary to issue quotas for different seasons. Presumably, differential prices would develop in the market for quotas that would equalise marginal anticipated returns and therefore lead to a leveling tendency in temporal distribution of fishing effort.

The impact of individual fisherman quotas in halibut on the efficiency with which multiple operations could be carried on is blurred by an institutional problem of real significance. If all complementary fisheries were also under an individual fisherman quota, conventional marginal analysis would suggest a highly desirable market test of the relative efficiency of specialised versus multiple fishery operation. The transferability of shares in the complementary operations would permit a desirable degree of flexibility to permit different fishing programmes to be implemented at minimum cost. But this assumes that all fisheries are under

precisely the same kind of quota programme. This is not the case, and seems unlikely to be the case for a long period of time in the North Pacific. The complexities of the salmon fishery are so great as to raise serious doubts about acceptance of a fisherman quota scheme in that operation, though it is obviously not impossible. Herring might be more amenable to the system, but it is an option only for a relatively few larger seiners also participating in halibut fishing. The trawl fishery is another option, but trawling is inherently non-selective and the concept of the individual fisherman quota becomes much more complex in operation. This would not rule out the possibility of establishing such a system in the trawl fishery, but it could not be expected to be developed and accepted quickly.

Enforcement

Potential difficulties with enforcement of individual quotas have been discussed in several places (see Crutchfield, 1979 and Stokes, 1979) and need only be summarised here. Where both buyer and seller have an economic incentive to underreport, and where a large number of ports of entry are available, it may be very difficult to monitor efficiently the adherence to individual quotas. This would be true, of course, of landings taxes as well. While there may be problems in other fisheries, this would seem to be of less concern in the halibut operation, for a number of reasons. First, landings are concentrated rather heavily in a limited number of ports because of the need to use freezing facilities intensively. Second, the industry has a long history of adherence to regulations that it regards as beneficial to its long term interest. This may be related in part to the cultural and social homogeneity of the participants. If an individual fisherman quota system were adopted after detailed consultation with and

acceptance by the majority of vessel owners and share fishermen, it would seem unlikely that systematic violation would be a major problem. Certainly it would be far less than would be expected in the more complicated salmon fishery, with its intense gear conflicts.

Individual quotas and limited entry as complementary steps

It is worthwhile to explore the possibility that more than one of these approaches might be undertaken, serially or in combination, to achieve the best mix of biological, economic efficiency, and distributional objectives over time. For example, the relative ease with which licence limitation in halibut could be carried through the legislative process and accepted by fishermen's groups would at least prevent further entry of totally redundant capacity--a threat which has become a serious reality in the last three years. This could be accompanied by a buyback programme to reduce excess gear and by initiation of informational and educational consultation with the industry to develop an acceptable way of converting the limited licence-overall quota system to one based on individual fisherman quotas. The programme could include, from the outset, a schedule of landings taxes starting at a relatively low level and increasing as market evidence of fleet efficiency is evidenced by rising licence prices or quota prices.

These actions would appear to provide biological protection of stock productivity, prevent further deterioration in fleet efficiency, and buy time to prepare and sell to the industry a regime that would actively promote individual vessel and fleet efficiency. They would also be capable of implementation under divided Canadian-American authority, provided that agreement can be reached on TACs in the Area 2 fishery now shared by the two countries.

Footnotes

1. The International Pacific Halibut Commission was originally called the International Fisheries Commission. For brevity, "IPHC" is used throughout this paper.
2. Only vessels over 5 GRT were required to carry IPHC licences to fish for halibut.
3. Example, deliberate increases in quotas by IPHC to demonstrate to the International North Pacific Fisheries Commission the need for "abstention" east of 175 W. Longitude; inaccurate stock assessments based on CPUE data that underestimated gear efficiency; and possible changes in the oceanic environment.
4. IPHC #16.
5. See, for example, Fraser, Wilen and Pearse, Pearse.
6. "Controlled" with respect to numbers of units, together with some measure or measures to prevent up-grading (e.g., limitations in length, tonnage, units of gear that can be fished, or size of gear).
7. For example, by limiting the number of hooks each licensee could fish.

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