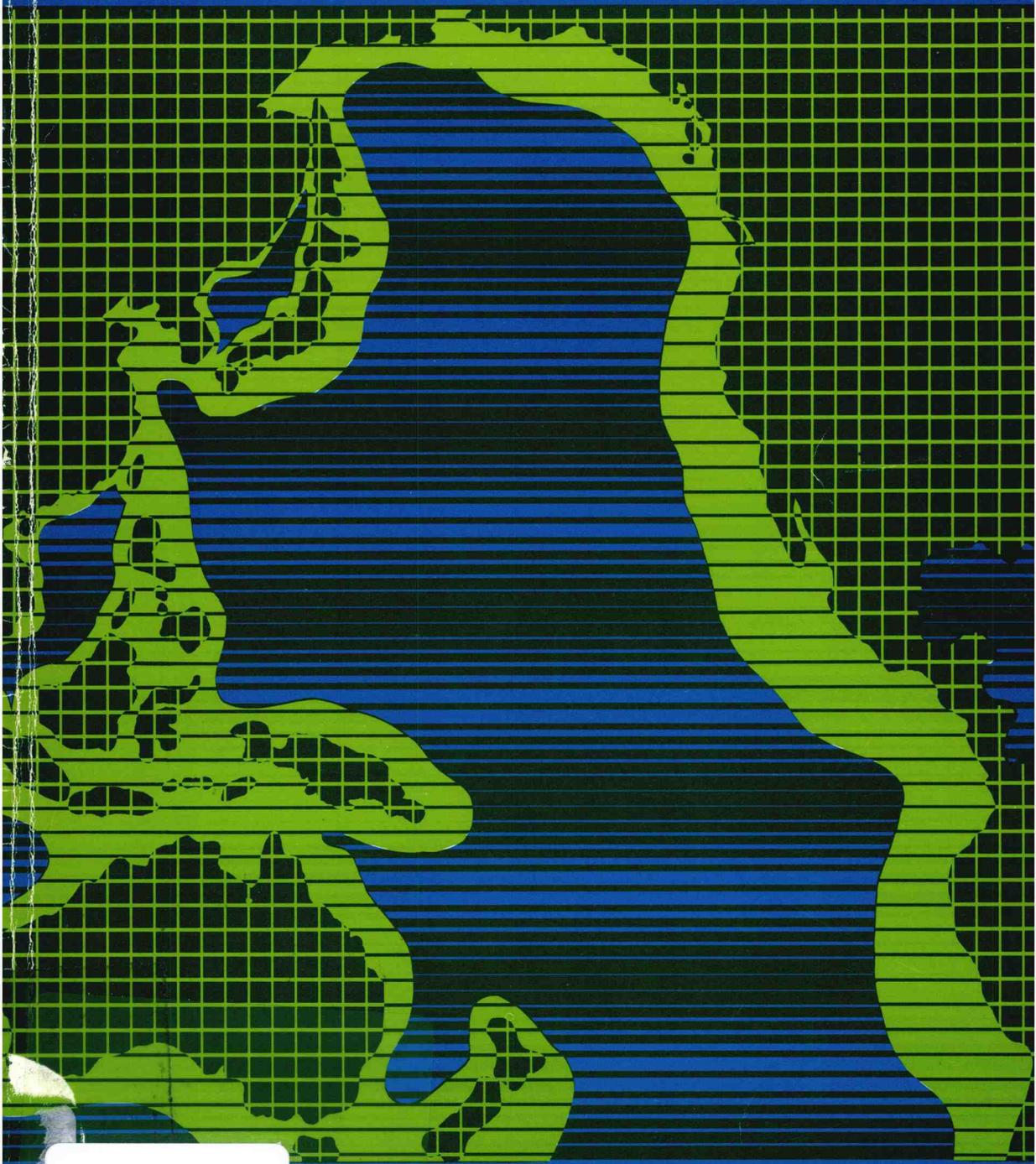


Renewable Resources in the Pacific

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Conference, held in Vancouver, Canada, 7-11 September 1981



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Proceedings of the 12th Pacific Trade and
Development Conference, held in Vancouver, Canada,
7-11 September 1981

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Canadian Regulation of Pacific Fisheries

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The rich fish stocks on Canada's west coast have been commercially exploited for a century and regulated by the Canadian government for many decades. The salmon, halibut, and roe herring fisheries are the most important, and the efforts to manage the stocks since the introduction of extended fisheries jurisdiction (EFJ) provide insights into the special requirements in managing migratory species (salmon) and fisheries, such as roe herring, that are dependent on export markets. The impact of EFJ is particularly clear for the halibut fishery. The history of regulation can be divided into two phases. Early efforts were based almost entirely on biologic considerations. Starting in the 1960s, limited entry programs were used in an attempt to reduce economic inefficiencies and to protect the stocks, but these failed because the economic incentives to remaining participants were unchanged. Landings taxes and transferable quotas have been proposed as means of rationalizing these fisheries, but any scheme that fails to address the crucial links — biologic, economic, and international — cannot succeed.

Le Canada exploite sur une base commerciale ses abondants stocks de poissons de la côte ouest depuis un siècle et le gouvernement exerce ses droits sur cette zone depuis plusieurs décennies. Les pêches les plus importantes comprennent le saumon, le flétan et le hareng. Les efforts de gestion des stocks halieutiques depuis l'extension de la juridiction sur les pêches ont mis en relief la nécessité de fixer des mesures spéciales pour la gestion rationnelle des espèces migratoires. L'impact de ces mesures est particulièrement évident dans le cas du flétan. L'histoire juridique de la gestion des pêches maritimes comprend deux étapes. Les premiers efforts réalisés s'appuyaient sur des considérations biologiques. Mais dès le début des années 60, des réglementations furent imposées pour lutter contre la surexploitation et protéger les populations mais ces moyens se sont avérés insuffisants, les rendements répartis entre les pêcheurs n'ayant pas été rajustés. D'autres formules telles que taxe par capture et quota de prise ont été proposées mais toute technique de lutte est vouée à un échec si elle ne comprend pas des paramètres fondamentaux à la fois biologiques, économiques et internationaux.

The wild stocks of fish on the northwest coast of North America were extraordinarily bountiful and productive in their natural state. The Pacific salmon especially has long been a highly prized fish and, along with the halibut and herring, provided the economic basis for a wealthy and stable coastal Indian culture. With the influx of settlers to British Columbia in the late 19th century, exploitation of these resources, especially those in the Gulf of Georgia, rapidly increased. The primary demand has been, and continues to be, from export markets. The United States, which provided the earliest export market, continues to be important, but Japan and the EEC nations (especially Great Britain) are importers of sub-

stantial amounts of fisheries products from the west coast.

Salmon occupies a preeminent position in the B.C. industry, accounting for up to 60% of total landed value (DFO 1980). The salmon fishery has always received a large share of public attention, particularly regulatory attention, as a result.

Regulation of west-coast fisheries in Canada is carried out exclusively by the federal government, as part of its constitutional jurisdiction over coastal fish and fisheries. Apart from limited jurisdiction over sport fish and shellfish, the provincial government has control of fish only after they have been landed on the dock. This arrangement has allowed the federal government to link

management of the stocks both to international trade in products and to international efforts at cooperation in fisheries stock management. In Canada's case, the latter has principally been with the United States but also included agreements with Japan.

Objectives

Unrestricted, open-access exploitation of fish stocks usually leads to several undesirable consequences (Gordon 1954; Scott 1955). One is that, if the market conditions are favourable and the available technology effective, the fish stock could shrink sufficiently to endanger its long-term survival. A second deleterious result is that the level of fishing effort (in the form of capital and labour inputs) typically exceeds that required to take the catch in an efficient, least-cost manner.

Those who have introduced administrative regulation of the fisheries off the west coast of Canada have not in general viewed the avoidance of the second consequence as a primary objective. The overriding goal, historically, has been protection of the fish stocks. For this reason, biologic management has until recently been the major organizing principle of the Department of Fisheries and Oceans. (This agency has undergone several name changes over the decades but will be referred to here as the DFO.) In particular, the biologic concept of maximum sustainable yield (MSY) was the typical expression of the goal of fisheries' policy over many decades, beginning early in the century. This goal is also enshrined in several international treaties relating to fisheries management to which Canada is a signatory (Logan 1974). The major regulatory tools applied were total-catch quotas, closed seasons, gear restrictions, and area regulations and closures. Effective biologic management does require protection of spawning areas and other such measures, but because salmon, for example, spawn only once, size restrictions have not always been used. Related to the biologic emphasis was the need to protect the distribution of the shrinking catch among traditional gear types and fishing groups.

The principal difficulty with the traditional approach to management was that it did not deal with the economic implications of the controls it instituted. Effort expanded in competition for the available catch (Sinclair 1978), returns to individuals were threatened, and the number of redundant inputs was enormous. As a result, open seasons were shortened over time. A demand thus existed by the 1960s for a revised

management scheme, but the programs that followed paid little explicit attention to the inefficiencies or costs of excessive effort, the one exception being the salmon management program.

Resources

Salmon

There are five major species of salmon on the west coast — sockeye, coho, pink, chinook (spring), and chum — all of which are commercially exploited. Salmon are "anadromous" fish; mature classes return from the ocean to spawn in the coastal rivers and streams in which they were spawned. The stocks available for exploitation are highly variable because time to maturity differs across the five species and because the run up a particular river is a mixture of runs from different species and genetically distinct subspecies, each making for its particular spawning ground. Specific substocks are highly vulnerable to overexploitation, owing to their habit of traveling in large schools once they move close to shore. They are easily taken by nets if they migrate when the fishing is "open."

The wide-ranging movement of the salmon during their early life, together with their high market value, makes them a subject for international debate. The two largest runs of British Columbia salmon are those returning to the Fraser and Skeena rivers. Together, these account for 50% of salmon caught in B.C. (Macdonald 1980), and both pass through U.S. territorial waters. Another significant run, bound for the Columbia River on the U.S. coast, passes through Canadian waters off the western coast of Vancouver Island. Commonly, one nation's fishing operations intercept the stocks returning to another nation's rivers.

Exploitation of the salmon resource was prompted by a strong export demand. The traditional export form was canned salmon, with the United Kingdom being the largest consumer of west-coast products. More recently, the canned salmon industry has become increasingly dependent on the domestic market, which is protected by a 7.5% tariff (Macdonald 1980). During 1966-74, roughly 47% of canned salmon was exported. Exports of frozen whole salmon have been increasing, largely in response to increasing Japanese demand since the mid-1970s. Over the same period, 75% of frozen salmon was exported (DFO 1979), with some recent years showing exports as high as 90% (Macdonald 1980). This strong international market has had predictable effects on the levels of effort devoted to salmon fishing.

Exploitation of the Fraser River sockeye stocks was well developed by the end of the 19th century, and fear for the stocks was expressed from the 1880s onward (Fraser 1977). A series of slides in the Fraser Canyon limited access to the spawning grounds, but Canada was reluctant either to invest in improvement to this access or to curb its own fleet, believing that the benefits of such actions would accrue largely to the American fleet that was fishing the same stocks as they moved through the Juan de Fuca Strait and the lower Gulf of Georgia.

Eventually, mutual concern for the stocks led to an agreement between the U.S. and Canada, a model for international cooperation in fisheries management. The Sockeye Salmon Fisheries Convention was signed by Canada and the U.S. in 1930, although it was not ratified until 1937. It created the International Pacific Salmon Fisheries Commission (IPSF), which was empowered to improve the Fraser River sockeye migratory route and to regulate the Fraser sockeye catch. In 1946, it began to regulate exploitation, and the Fraser pink salmon stocks were added to its purview in 1956 (Gardner 1980). The Commission set total allowable catches, mesh sizes, net lengths, area closures by gear type, and weekly limits on fishing days. The outstanding aspect of this convention, however, is the distributive and protective stipulation that the sockeye catch be split on a 50:50 basis between Canadian and U.S. fishing operations and that costs of Fraser River fish ladders, spawning-ground improvements, etc., be shared equally by the two countries. These features remain in force today. The Commission invested heavily in clearing the river, and the stocks have continued to be commercially exploited.

A second international agreement of great importance to salmon was the tripartite International Convention for the High Seas Fisheries of the North Pacific Ocean (Norpac Treaty), which was signed by Japan, Canada, and the U.S. in 1952. Japan agreed to abstain from fishing salmon (and halibut) east of 175° W (a line more or less through the middle of the Bering Sea). Previously Japan had been free to take salmon stocks while they were still in their immature, high-seas stage. An important caveat to this principle was that the domestic nations fully utilize their stocks. It later became a principle of the draft law of the sea treaty that anadromous stocks should not be intercepted by foreign fleets, but this earlier treaty was clearly an important preliminary step (Logan 1974).

Despite these unique attempts at maintaining stocks by international cooperation, domestic-

stock management became increasingly difficult. The number of days of salmon fishing allowed each week declined steadily, and open seasons became progressively shorter as the amount of effort grew larger and larger. After several years of discussion and study (Sinclair 1960), a Licence Limitation Program was implemented in 1969 in the B.C. salmon fishery. Because this program was an important breakthrough in fisheries management, it is worth stating its objectives in full. These were:

- To reduce the salmon-fishing fleet so that the remaining vessels would be more efficiently utilized.
- To reduce capitalization of the salmon-fishing fleet.
- To increase the net earnings of the personnel involved in salmon fishing.
- To provide the opportunity for government to obtain an economic rent from the salmon fishery.
- To provide the basis for improved conservation techniques (Sinclair 1978).

The underlying rationale was that a reduced fleet could take the catch at lower costs and have less need of new capital investment in gear and equipment, so that rents would emerge that could be shared by the fishing fleet and the government. At the same time, pressures on the stocks could be more easily controlled. These objectives would not be seriously questioned by most fisheries economists, but the program for achieving them was doomed to partial success.

The central features of the program were to be attained in four stages, only three of which were actually implemented. (Detailed analysis of the regulations can be found in Fraser 1977; Pearse and Wilen 1979; Sinclair 1979; and Macdonald 1980.) Under the first phase, the total number of vessels was to have been limited to its 1968 level. After an appeals process allowed the entry of several marginal participants, no new vessel licences were issued. All vessels that had engaged in salmon fishing in the previous 2 years were licenced to continue participation: "A" licences for vessels with catches above a certain limit in those years and "B" licences for all others. This distinction was aimed at restricting fishing to full-time participants: only "A" licences were transferable to replacement vessels. No gear stipulations were made, however, and only nominal fees were charged.

The second phase attempted a substantial decrease in fleet size by limiting the life of "B" licences to the period ending in 1981 (subsequently extended for 5 years) and, more importantly, by introducing a buy-back program.

Under the latter initiative, the government offered to buy any "A" vessels tendered to it and arranged for an attractive price as an incentive, i.e., the price was to be that determined by two independent evaluations, plus a 15% premium (Campbell 1974). These purchases were to be funded by licence-fee revenues, and the fees were increased.¹ The buy-back program started in 1971 but was eliminated in 1973, as a result of rising vessel costs and expected resistance to the higher licence fees that continuation would have required. Another stipulation was that "A" vessels could only be replaced by a vessel of equal or less tonnage. This was aimed at curbing the early practice of retiring small vessels and replacing them with much larger ones of greatly enhanced fishing power.

The third phase was in fact industry-wide and was concerned solely with vessel standards that affected the quality of fish landed. It started in 1973.

The fourth phase, which has yet to be implemented, is to relax the restrictions on time and area available for fishing. This phase was planned on the expectation that fishing power would decline as a result of the three earlier phases, but the necessary decline has yet to be observed.

The vessels that remained in the fishery after 1969 continued to invest in new equipment and even more sophisticated vessels to the extent that revenues exceeded costs, because the fish stock remained a common-property resource among those vested with licences. No legal or property limit was imposed on a vessel's potential catch, and, in fact, a desire to prosper in the race for fish during regulatory openings justified increased speed, storage, communications, and capacity. A slight decrease in the numbers of vessels (roughly 10%) was brought about, but real-capital growth has been noted in several studies. Pearse and Wilen (1979) estimated, for example, that real capital employed in the fishery (corrected for the value of the licence) grew at an average annual rate of 5.7% between 1957 and 1968, and continued to grow at 3.7% between 1969 and 1977, despite roughly constant real-fleet revenue over the full period.² Thus, although the difference in rates is statistically significant, implying that the program did have a limiting effect on capitalization, this success was only partial.

¹This schedule remained in place until the 1981 season, at which time fees in each category were doubled.

²Pearse and Wilen do point out that there may have been some quasi-rents incorporated in their figures, but these would not likely have persisted over the fall period.

The growth in capital occurred in a variety of ways. Before the replacement rule on vessel weight, 76 vessels were replaced by vessels with a combined tonnage three times that of the previously licenced vessels (Macdonald 1980). A second method used after 1971 ("pyramiding") replaced several small vessels by a single large vessel of the same net tonnage but with a higher catch capacity than the smaller ones combined. The increment was especially large when a seine vessel (which uses a purse-seine net) replaced gillnet or troll vessels. Finally, any vessel could add another gear type to that already used. As Macdonald (1980) points out, however, the fact that many seiners became "combination" vessels over the 1970s also had much to do with the fact that those vessels began to participate in other fisheries as well.

Several subsequent salmon regulations were aimed at controlling or limiting this increase in fishing capacity. In 1977, seine vessels were allowed to replace seine vessels only. In 1978, vessels replacing a group of vessels were restricted to be less than 50 feet (15.3 m) long. In 1979, the tonne-for-tonne replacement rule was bolstered by a metre-for-metre rule. Finally, in 1980, the practice of pyramiding was prohibited outright. The DFO, as regulatory authority, had been forced to adjust the salmon-vessel limitation program to close loopholes in the regulations and will likely have to continue to do so. Indeed, it is now a standard conclusion in the literature that, to the extent that inputs are substitutable one for the other, effort cannot be restricted by simple input regulation (Pearse 1978).

In terms of its biologic objectives, the program has not been a major success, as is implied by the ongoing efforts to limit capacity. Fishery conservation managers, faced with the fleet's rising mobility and power, have been forced to introduce stricter area and time closures, with the openings reduced to portions of days in many areas. Troll vessels have not been subjected to such restrictions in their catching. This permissiveness exists at least in part for reasons related to international negotiation. A possible consequence was the reduced numbers of chinook, a traditional target of troll fishing, in 1980. This lack of control seems also to have led to the imposition of catch-retention limits on trolling for sockeye, pink, and chum — traditional net fish. (Technological innovation has blurred the old rule of thumb that net-fishing operations caught sockeye and pinks while trollers caught coho and spring.)

The major response to the threats to the salmon stocks has not been any further economic

rationalization of the fleet but rather an attempt to increase the stocks directly through the Salmon Enhancement Program. This initiative, which has counterparts in the U.S. and elsewhere, has as its long-run goal the restoration of salmon stocks to their "historic" levels by direct investment in spawning grounds and channels, hatcheries, rearing ponds, etc. The first phase (1977-84) envisions total expenditures of CA\$150 million, of which \$50 million had been spent by 1980 (Fraser and Friedlander 1980). The wisdom of such investments may well be apparent, viewed in isolation, but, because of the excess capacity that remains in the fishing fleet, reliance on this approach to guarantee the health of the stocks is questionable.

The most important developments currently facing the salmon fishery, aside from the possibility of a complete revamping of management and rights to access (a major inquiry is currently under way), are linked to the 200-mile economic zones declared by Canada and the U.S. in 1977. Interceptions are being carried out largely within formerly high-seas regions now subject to the jurisdiction of one country or the other. Other species are also involved (especially halibut), but the result in the case of salmon has been open conflict between Canada and the U.S. The IPSFC has been one focus of this debate, with Canada demanding a larger share of the Fraser sockeye and pink catch and also greater financial contributions by the U.S. for spawning-ground improvements. Joint management has been based on 1-year interim agreements, and a convention seems to be taking shape that would at least put a ceiling on levels of interception. This issue is important not merely on distributional grounds, however. The strategic demands of international negotiations, based as they often are in fisheries matters on past levels of participation, are having significant effects on Canada's domestic management. The relatively lax regulation of Canadian trolling (in comparison with the tight time and area restrictions placed on net vessels) is a consequence of these demands. The trollers have traditionally intercepted chinook and coho stocks returning to the Columbia River, and such interception is a crucial bargaining point in the ongoing discussions about interception of the large Fraser and Skeena stocks. Domestic difficulties have arisen, however, because new lures have allowed trollers to take sockeye, pink, and chum salmon so that the tight regulations on net fishing are not sufficient to protect the stocks. As a result, friction between fishing operations using different gear has worsened in recent years.

Halibut

The Pacific halibut is a demersal (bottom-feeding) fish and is the largest of all flat fishes: the average halibut at 20 years weighs more than 45 kg. It is a slow-maturing species, males reaching sexual maturity at 7-8 years and females at 12 years (Crutchfield 1980). Halibut are thus particularly vulnerable, the stocks being slow to recover from overexploitation. Crutchfield points out, however, that these characteristics imply that halibut is well suited as the basis for a stable, well-managed fishery. The west-coast stocks are truly transnational in nature, in contrast with the salmon; they are known to spawn at several places along the B.C. and Alaska coasts, and the various stocks mingle with one another constantly. They typically move into the open ocean in winter and return in heavier concentrations to coastal waters in the summer. There is also a tendency for larvae and immature fish to migrate to the north and west and for the mature fish to move east and south.

Halibut are taken by "longline" fixed gear (due to regulations). Although they could also be taken by bottom trawler along with most other groundfish, they are said to be far too valuable to be subjected to such an indiscriminate and often damaging fishing method. "Longlines" are lengths of line that lie on the ocean floor; attached at regular intervals along them are shorter lines with hooks. Buoys are attached to both ends of the lines, and they are typically retrieved by power drums.

The major market for Canadian halibut is the U.S. In the first 8 months of 1980, 98% of Canada's exports of fresh halibut went to the U.S., along with some two-thirds of frozen halibut exports. Another 20% in the latter category went to Japan (Statistics Canada 1980). Between 1972 and 1979, the real price of landed halibut tripled (Crutchfield 1980), but the rate of increase trailed off in 1978 and 1979. During 1980, the nominal price fell to about one-third its 1979 level.

Halibut fishing has a long history in Canada, paralleling that of salmon in that early fears were expressed for the long-term survival of the stocks. The current lack of effort aimed at exploitation of the south coast stocks may indicate that these fears were warranted. Vessels from both Canada and the U.S. were involved in the fishery, so management could be achieved only by cooperation. In 1923, Canada and the U.S. signed the Convention for the Preservation of Halibut Stocks, the "world's first international attempt at high seas conservation" (Logan 1974:43). The treaty was revised several times after 1930, with the most recent version having been in force from

1953. The International Pacific Halibut Commission (IPHC) was created in 1924 under the convention and given powers, to be exercised through the laws of the two countries, to regulate the total catch, gear type, and season and area openings. The Commission, whose objective has always been clearly understood to be the attainment of maximum sustainable yield, is a reasonably autonomous international fisheries authority, confining national government services to implementation and enforcement.

Halibut landings declined during the 1920s but recovered (as did catch per unit effort — a standard proxy for stock size) and increased steadily to a peak in 1962. (Although the Commission claimed success for its regulations, subsequent study has attributed this fluctuation in part to environmental factors as well.) In the years since 1962, however, stocks and landings have fallen dramatically — average landings during the 1970s by both countries were less than half those of the peak 1958–63 era (Crutchfield 1979a). The reasons for the decline are straightforward and demonstrate that the Commission has encountered the same problems employing regulatory methods as the salmon managers have. The three main reasons are the increased efficiency of the fleet, halibut fishing by boats from other fisheries (especially salmon and smaller “dayboats”), and incidental catches or by-catches by large foreign and domestic trawlers, working at some distance from shore.

The increase in the numbers of combination vessels can be explained partly by the rapidly rising halibut prices and partly by the steadily shrinking open seasons in all major west-coast fisheries. This trend toward combination vessels is certainly a result of traditional management methods, but it makes direct linking of fleets with stocks in rational management much more difficult because the fleets exploiting distinct species can no longer be treated as separate entities.

The problem of incidental catches of halibut is a quite different one, due to fishing technology, but it also imposes links between fisheries. The lower valued groundfish species such as hake, sablefish, pollack, lemon sole, etc. are taken by means of ground trawls, which literally scoop up everything on the ocean floor. Some halibut catch is inevitable with this method. Regulations on gear forced domestic trawlers to throw back halibut, with resultant mortality as high as 50% (Crutchfield 1979a). But the heavy exploitation, in the 1960s, of west-coast groundfish stocks by unregulated distant-water fleets of the Soviet Union and Japan has been regarded as the most

important element in the recent declines of stock (Crutchfield 1980).

With the advent of EFJ, exploitation by distant-water fleets has diminished, but other problems have arisen. Before 1976, the halibut resource on the west coast was managed as one entity, with vessels from the U.S. and Canada free to compete for all available stocks. The thrust of EFJ, which was toward the exploitation of domestic stocks by domestic fleets, made a change inevitable. In 1979, a protocol was signed between Canada and the U.S., under which fishing operations from one country were excluded from the waters of the other. This arrangement affects the Canadian fleet more than the American as the latter took only 2.5% of its catch in Canadian waters over the period 1969–79, whereas the former took some two-thirds of its catch over the same period from Alaskan waters. A special arrangement was eventually made for the IPHC's Area 2, which encompasses Alaskan and Canadian waters. The IPHC quota for that area is to be split, 60% going to the Canadian fleet and 40% to the American. The system worked poorly in 1979, the U.S. fleet taking more than 50% of the quota early in the season, but the difference is to be made up over several years.

The IPHC had no authority to initiate economic rationalization of the halibut fleet, and by 1979 the Canadian halibut fleet was far too large for the reduced stocks in Canadian waters. The DFO response was to initiate a limited-entry program for halibut in 1979, with licences to be issued only to vessels reporting landings above a given minimum in 1977 or 1978. The minimum was set so low, however, and the appeals criteria were so generous that the result was a reduction of only about 20% of fleet capacity. Eighty percent of the vessels are thus left to compete for perhaps 50% of the catch previously available to the full fleet. The stage is clearly set, therefore, for combination vessels within the halibut fishery to increase appreciably their levels of effort in fisheries other than halibut. Part of this redistribution of effort has been officially encouraged: holders of halibut licences were offered, in exchange for the halibut licences, gear-conversion grants and licences for sablefish, which have become available as a result of reduced foreign groundfishing effort. The advent of EFJ has thus affected many fisheries through this halibut connection and has served to highlight not only the international links in west-coast fisheries but also the links among domestic fisheries. The serious problems currently facing managers of the halibut stocks clearly need to be solved by cooperative means, and a thorough

understanding of the multiplied impacts of unilateral exclusionary actions is an important prerequisite.

Roe Herring

In 1971, a market for a new product, herring roe, began to open up, and a new phase of the herring industry was entered. The Pacific herring are shore spawners, and they move into coastal spawning grounds in dense schools in the early spring. Sixteen major spawning grounds have been identified, and the herring generally return to their own spawning grounds each spring (Wilén 1980).

The herring must be taken just before spawning occurs, the roe at this time being in the most desirable condition and at maximum weight. Once unloaded, the herring are brined or frozen, and the eggs are manually removed. The amount of roe recovered can vary from 10% to 16% of the total round weight of the female (Fraser 1980). The female carcasses and the males are subsequently used for fish meal, because they do not meet standards for human consumption.

The principal market for herring roe is Japan, where *Kazunoko* is a traditional seafood, now consumed mainly as part of the New Year's activities. Roughly 99% of Canadian roe exports go to Japan (Statistics Canada), and well over 90% of the value of the domestic herring catch is accounted for by herring-roe exports. Domestic Japanese supplies declined steadily over several decades (Fraser 1977), but tight import quotas were maintained on the product. In 1971, however, these restrictions were relaxed, and total imports to Japan of 8000-14000 t followed in each year between 1972 and 1977.

The impact of this new market on the B.C. herring fishery was explosive. In 1972, 196 seine vessels and 58 gillnet vessels took a total of 31 500 t of round roe herring (fish plus roe), with a landed value of CA\$2.1 million. In 1973, 161 seiners and 223 gillnetters took 50 400 t with a landed value of CA\$9.1 million (Wilén 1980). Although the season extends for 6 weeks at most, 1973 average vessel returns were \$56 400 for seine vessels and \$5700 for gillnet vessels (Sinclair 1979). The prospects for additional income for salmon seiners, and for anyone willing to invest \$5000 to bring a new gillnet vessel into the industry (Fraser 1980), were obvious, and thousands of vessels were expected to enter the fishery during the 1974 season. Excess capacity and effort had yet to develop but were clearly imminent. The time was right for a well-conceived management scheme that would prevent the problems experienced with other fish stocks.

Effective January 1974, a limited-entry licensing program was instituted for the roe-herring fishery. The stated objectives of the program were to control the fleet at a level that would not endanger the stocks, to guarantee returns above fishing costs, and to provide a source of revenue for the Crown (Fraser 1980). Because the fishery was new and because some new entry was still officially encouraged for employment reasons (Wilén 1980), the only criterion for gaining a licence was payment of a fee (\$2000 for seine vessels and \$200 for gillnet vessels). These fees were higher than those levied on salmon vessels but were low when measured against the potential returns. The licences were granted to individuals rather than to vessels and were made non-transferable (the inevitable result of this provision was that licences were leased for long periods). Entry continued to be open until January 1975, and the number of participants increased significantly; 250 seiners were licenced in 1974. A much larger jump in the number of gillnetters occurred, with 1579 licences issued. A significant number of these licences were left inactive, however, and some ultimately lapsed, so that there was clearly some speculative entry.

A series of shocks over subsequent years made the roe-herring industry into the second most important fishery on the west coast. The landed value of roe herring increased by an astounding 1000% during 1975-79, despite a 30% decline in the harvest (Fraser 1980). Two external developments initiated this trend. In 1974, the Chinese had supplied nearly 50% of Japan's import needs; Canada had 35% of the market. In 1975, the Chinese supply inexplicably dropped to 15% of its former level and, in 1977, dropped further to 5%. Canada was left in the position of dominant supplier, and its market share rose steadily from 54% in 1975 to 80% in 1979 (Fraser 1980; DFO 1979). Second, the yen appreciated by 40% against the Canadian dollar during 1977 and 1978. The harvest declined steadily from a peak of 78 300 t in 1976 to 37 000 t in 1979 (Fraser 1980) and contributed to the upward pull on price.

The result in terms of capital and effort devoted to the fishery was easy to predict. The two main focuses for new inputs have been increased gillnet capacity and enhanced vessel mobility among the various spawning grounds. These had dramatic effects on the primary method of biologic management: area openings for specified periods. Although an overall annual catch quota is set each year, the actual level of effort permitted is determined as a result of online management systems (Wilén 1980). In

brief, the system works as follows: local fisheries officers carry out random checks of the stock approaching the spawning grounds to determine both the size of the stocks (and thus the allowable catch) and the optimum time at which to open the fishery. When that moment is reached, the fishery is opened for the time that these officers estimate will be required for the number of vessels on hand to take the prescribed catch. The increasing capacity is causing severe problems for this system, however, in that if all vessels at an opening were allowed to participate, the entire stock might be taken almost instantaneously. Thus, 15-minute openings for the seine fleet have become rather common (Fraser 1980), this being the time required for one "set" of a purse-seine net. Openings are occasionally canceled altogether.

The present outlook for the roe-herring fishery is somewhat mixed. In 1980, the trend of declining catches accelerated, the total harvest amounting to some 18 000 t — one-half of the 1979 level and only one-quarter of the 1976 and 1977 catches. The significance of the 1980 catch is unclear.³ A large portion of the fleet was on strike at the time, and this fact may account for the small harvest. Nonunionized vessels did continue to fish, however, and as many as one-third of the usual number of seiners and one-sixth of the usual number of gillnetters were involved. This reduced fleet may have been sufficient to take the larger 1979 catch, but the 1981 catch recovered somewhat to about 28 800 t. The overall trend is clear, nonetheless, and there is some cause for alarm with respect to the health of the stocks.

A decline in landed price of about 50% in 1980 brought into question capital investments made on the expectation of prices' continuing at the 1979 level of nearly \$3000/t. Nevertheless, the 1980 price remains nearly twice the \$700/t paid in 1978 and four times that paid in 1977. Licence fees have remained at their 1974 levels (\$2000 and \$200), and gross returns in 1978 (before the quadrupling of price in 1979) were \$36 000 for gillnetters and \$74 000 for seiners. Thus, participants in the roe-herring fishery are continuing to earn significant rents, quite possibly at a level significantly above that justified by any government desire to "improve" their incomes.

³Some participants argue that recent stock declines are a reflection not of overfishing but of the methods of exploitation. In particular, they argue that the herring are being driven to less-productive spawning grounds and that the conditions are leading to reduced survival rates. This issue has yet to be adequately analyzed by biologists.

A rational approach to management of the fishery demands a reduction in effort on a scale that can only be achieved by a removal of some of the participants in it. In the 1981 season, vessels were required to nominate one of three areas to which their effort would be exclusively restricted; the areas are the Gulf of Georgia, the west coast of Vancouver Island, and the mainland coast north of Vancouver Island. This is useful only as a transitional measure, however, as is a proposed "vessel-pooling" scheme under which all vessels must pair off and only one vessel from any pair can attend a particular "major" opening, although both share in the catch.

In conclusion, the short history of the roe-herring fishery has demonstrated that inadequate control of the level of effort exerted in a fishery can lead to serious management and distributional problems when the industry is subjected to drastic shocks. The rapid escalation of effort and investment has been based on an assumption that the price rise recently observed will not be cyclical or temporary. The dominant position of the Canadian supplies in the Japanese market may well be eroded by external forces, unrelated to domestic stock difficulties. Alaska is expected to compete more heavily in this market and the previously dominant supplier, China, may reenter at any time. Although most of the seine fleet participates in the salmon and other fisheries, the gillnetters use equipment specially designed for roe herring (Fraser 1980) so that redundant capacity would represent a significant social waste. The fact that these problems have arisen from developments in an external market does not mean that they are unique to export-led resource development, of course. Instead, they simply draw attention to the fact that international markets can be volatile, especially from the point of view of a single player, and that inadequate or ad hoc stock, catch, and income management systems are particularly vulnerable to the shocks that external markets can produce.

Other Fisheries

Salmon, halibut, and herring roe account for nearly two-thirds of the landed value of the total catch in west-coast waters, but there are a number of smaller, thriving fisheries on the coast as well (DFO 1980b). A new approach has been taken with respect to the regulation of these fisheries over the past 5 years. During this period, six new limited-entry programs were initiated, and a seventh was begun earlier, in 1975. The common characteristic of these is that the licencing programs seem to have been set up in a manner that aimed at encouraging development

into major income sources, while maintaining at least some control over the pace of that development. Employment goals, and particularly distributional objectives, concerned with spreading the potential benefits from these resources among participants with limited employment opportunities, have been emphasized much more heavily in these programs than in others.

The fact that these programs followed almost immediately the introduction of EFJ in 1976 does not seem to have been a coincidence. One motivation was to exploit protected stocks in an orderly fashion. Another arose from the displacement of Canadian vessels from American waters, which was another result of EFJ. The principal example is the dislocated halibut fleet, and special provision was made for these vessels to enter the growing sablefish fishery, as well as others for which they had already been licenced or for which no licence was required. Significant increases in the value of abalone, geoduck, and sablefish, among others, attracted new effort in these fisheries, and management was necessary for this reason as well.

In terms of landed value, the herring spawn-on-kelp industry is the most important example. This is a traditional native Indian food fishery that was viewed as having commercial potential in the early 1970s, in light of the growing Japanese roe market. A limited-entry program was announced for 1975, with the start of commercial exploitation. The concurrence of licencing with the beginning of commercial exploitation is absolutely unique among the west-coast fisheries.

The principal aim of the spawn-on-kelp licence distribution system was to provide employment and higher incomes for native Indians and those living in remote coastal areas. Twenty-eight participants were involved in 1981. Each licence has an individual quota attached to it as a special condition, but the aim of these quotas is to prevent the market from being flooded, rather than to achieve optimum economic performance (the quotas are not transferable). In fact, the quotas are rarely reached, and available stocks have provided the true constraint. Production is complex: live herring are caught by seine nets and transported to enclosed ponds where they spawn and they are then released; high quality kelp is transplanted in the pond beforehand, and the kelp is subsequently harvested and the roe recovered from the surface of the kelp. The market is the same as that for roe herring, so that returns are quite high, in excess of \$100 000 per licence in recent years. The goal of boosting incomes is thus clearly being met. The administrative costs are also quite high, however, because supervision of

quality is maintained throughout the process, and observance of catch quotas must be ensured, nominally at least. In other words, this may be a rather inefficient way of subsidizing isolated communities.

The groundfish fishery in aggregate is the most valuable of the smaller fisheries, but each of the several species involved (various types of cods, soles, etc.) is individually unimportant, and a general groundfish trawl licence is issued. This fishery has a long history of exploitation, but the Canadian fleet has traditionally been only one part of a larger fleet fishing the groundfish stocks on the west coast. The Canadian catch has been gradually increasing since 1977, the year in which limited-entry licencing was imposed. The licences were distributed on the basis of prior catches, but special provision was made for dislocated halibut vessels to join the fishery without prior effort. In 1977, 112 of the 131 vessels reporting trawl landings were multiple-gear vessels, and income from their groundfish participation provided just less than one-half their total fishing income on average (Sinclair 1979). This fact highlights an important characteristic of several of the smaller fisheries: participants often are involved in the fishery mainly to supplement their income, especially in bad years for salmon and herring.

Sablefish is subject to a licence separate from that put on exploitation of the rest of the groundfish. The sablefish catch hovered between 500 and 700 t during the 1970s but jumped to 1400 t in 1979. The sablefish have increased in value relative to some other fish, and this improvement presumably accounts for the recent harvest increase. Large specimens are exported to Japan, whereas the smaller fish are marketed domestically.

Entry was restricted in 1980, and, although a historical-catch criterion was used as the basis for licence distribution, a series of special conditions attached to the program provides a revealing example of the conflicting objectives involved in managing particular fisheries. The historical-catch criterion was applied to longline and trap vessels, but entry into the fishery was allowed for vessels with these types of gear if they invested in refrigeration equipment. This provision reflects a tolerance of further growth in capacity in the interest of an upgraded product. Halibut vessels were also granted licences but only if they already held "A" salmon licences, or the new halibut licences. This condition is a further reflection of attempts to accommodate displaced vessels. Other halibut vessels were also allowed to retain longline sablefish catches if they were engaged in the halibut fishery at the time of the catch. This

provision is clearly difficult to police. Finally, groundfish trawl vessels that had established a historical stake in the sablefish catch were allowed to retain any sablefish caught on trawl, but only so long as the overall quota had not been reached. This condition was clearly aimed at establishing some sort of equity between the traditional gear types and those encouraged to develop the fishery in a new direction. The result, in terms of potential capacity that could be brought to bear on the stocks, not only is inefficient but also portends the kind of biologic management problems experienced in the more developed fisheries.

The other fisheries subject to limited-entry licencing — abalone, geoducks, and shrimp — have each exhibited a pattern of a large jump in effort and harvest in 1 year, in response to a rapid price increase, followed by the imposition of licencing for the next season. Abalone and geoducks are exploited by divers and so are rather separate from the other fisheries. The shrimp trawl fishery is basically an extension of the other trawl fisheries.

In summary, the DFO has established a record of responding quickly to situations in which effort is observed to be rapidly increasing, or in which significant potential for new products is observed. (Actual exploitation of such potential obviously requires some effort on the part of the processing sector as well, in terms of identifying and entering new markets.) These initiatives are certainly laudable in terms of providing for orderly market development and exploitation of new opportunities for international trade. The pitfalls of the regulatory tools employed tend to offset the benefits, however.

Current Management Issues

One particularly thorny issue that arises in the salmon and roe-herring fisheries is that of allocation of catch by gear type. The DFO is being forced to ensure particular divisions of the harvest among the gear types, for reasons both of equity and of stock management. In the salmon fishery, the different gear types have traditionally targeted on different species. They also fish in separate areas, the trollers tending to be seaward of the net fisheries. With the recent development of troll gear that can be used to catch sockeye, pink, and chum, the share of the gillnet fleet in the catch has dropped considerably. The significant catch by people who are sport fishing further complicates the issue. The DFO must, therefore, adjust catch limits, and area and time restrictions, to satisfy both biologic and equity objec-

tives. In the roe-herring fishery, the gillnet fleet is usually allowed to begin fishing first, and the number of seine vessels on hand at a particular spot may be so large that no opening can be allowed. Gear-type allocations are highly controversial, and the various participants are jealous of their stake in the fishery. These facts greatly complicate efforts to reduce the fleet to a manageable size and to reduce the costs of taking harvests. The problem is complicated further by efforts to accommodate vessels moved out of other fisheries.

Another issue that applies to all fisheries is that of recovering at least a portion of the potential rent that these resources could return to the Crown, or the general public, as ultimate resource owner. A debate is currently under way as to the relative merits of profit taxes, catch royalties, greatly increased licence fees, and other means of garnering a portion of the rent. The impact of these levies is difficult to determine. Significant rents are being earned, however, the most obvious examples being the roe-herring and spawn-on-kelp industries in recent years. Government policy is unclear as to the extent to which rents must be left to the participants alone, and resolution of this question is a prerequisite to a satisfactory end to the debate.

A closely related question is whether the fisheries should be completely reorganized or redirected. The limited-entry licencing approach to regulation does not work, because it ignores the economic incentives to the remaining participants. Biologic difficulties have developed precisely because of this inattention to the economic aspects of the fishery. Thus, for rational stock management and economic efficiency, a complete restructuring of the fishery is warranted. So long as any rents at all are allowed to accrue to the participants, distortions from the optimal levels of effort and stock will result.

One alternative to methods that attempt to force fisheries into economic efficiency by extracting all the rents is that of using transferable catch quotas. Quotas would be equal to the optimal catch. The incentive to rush and compete for the catch would be eliminated, and the fishing operations would face incentives to minimize the costs of taking their predetermined catch. Because the quotas would be transferable, and finely divisible, they would shift to the most efficient participants, i.e., those with the lowest costs, thus maximizing the rents realized from the resource. Government policy could then determine the distribution of rents. In principle, then, the result is the same, in terms of efficiency, as that of a landings tax that extracts all the rent.

The quota system has the advantage of requiring somewhat less information for the regulators, and it also allows flexibility in the distribution of rent. Such rationalization is clearly required. Any scheme that aims at economic rationalization on this scale, however, would be difficult to implement not only because of its novelty but also because of variations in stock levels and dispersions of particular substocks.

Conclusions

The topic of west-coast fisheries management is a large and complicated one. Many details have been passed over in this discussion, a notable example being the special provisions for native Indians included in every regulatory program

described here. Fluctuations in prices, stocks, harvests, and effort have been all but ignored in an effort to convey the broad trends around which the industry inevitably cycles. The conclusion that must be drawn is that these fisheries are truly interdependent—biologically, economically, and internationally. Recognition of this fact in future efforts at fisheries regulation around the world would constitute a most valuable lesson from experience.

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Discussion

Yoshiaki Matsuda: Professor Moloney has stressed the importance of governments' recognizing the links among fisheries if they are to improve management of their fish stocks. These links include the biologic interactions among species; the interaction embodied in multiple-gear fleets that exploit quite different stocks over large and separated areas; and the interactions between domestically owned resources and foreign markets and fleets.

He finds that limited-entry licencing programs do not work because they ignore the economic incentives to the remaining participants and that the difficulties in managing the resources biologically have developed because of the inattention to the economics of the fishery. Thus, Moloney has concluded that the fisheries are truly interdependent, biologically, economically, and internationally.

In my view, the key to fisheries management is good administration based on:

- Attention to natural and artificial sources of fish;
- An understanding of the objectives, priorities, and limitations of fisheries regulation or management among administrators (Moloney has not spelled out the priorities of previous or future management practices, and yet one cannot produce satisfactory results without defining objectives, setting priorities, detailing the methods, and revising the approach systematically on the basis of feedback and results);

- Appropriate administrative costs;
- Qualified personnel; and
- Simple, practical, and flexible regulations that respond to needs rather than precede them.

Canada cannot blame Japan for the inadequate management of its resources just because Japan has provided a market for such products as roe herring and spawn-on-kelp herring. Conserving resources and capturing rents for access to them are part of the responsibility of coastal nations. The responsibilities are great, as are the benefits of ownership. The first responsibility is to decide objectives and set priorities among them. If the most important objective is employment, then efforts should not be devoted to expanding capital-intensive fishing operations but rather to encouraging small-scale, labour-intensive operations. The impact and efficiency of large-scale, capital-intensive fishing operations is greatest when fish are abundant, whereas those of small-scale, labour-intensive fishing operations are greatest when fish are scarce.

Coastal nations should not dismiss the possibility of permitting open access to their newly acquired resources. Open access is a valid tool in fisheries resources management. Fish are quite vital renewable resources with quick turnover rates. Natural selection under open access might be the best way to achieve maximum social welfare: fishing operations understand that what they are doing is at their own risk, and administrative costs are minimized. I believe that conser-