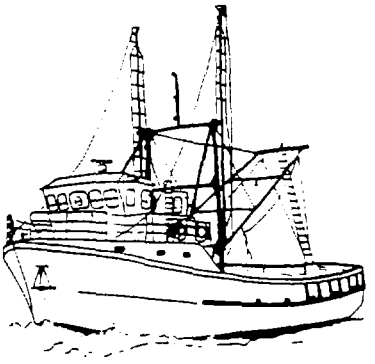

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Fisheries Series

Managing Fishery Resources

Proceedings of a Symposium Co-Sponsored by the World Bank and Peruvian Ministry of Fisheries held in Lima, Peru, June 1992

Eduardo A. Loayza, editor

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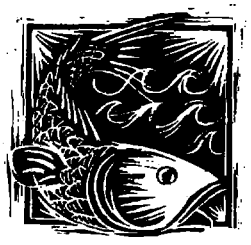

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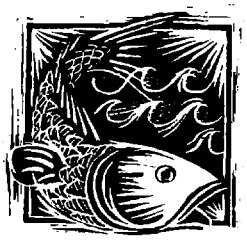


Foreword

The world's production of marine fish has increased fourfold since World War II, reaching 86.4 million metric tons in 1989. Fishing effort—expressed in terms of both number of vessels and catch capacity—has grown even faster, and yield per unit of effort has therefore dropped significantly. Despite the sustained growth in the volume of production, its value has diminished. High-value species have been systematically overexploited, and as these stocks have declined, fishers have progressively turned to low-value fish resources. Low-value species, such as small pelagics, used primarily in producing fishmeal and fish oil, today represent 30 percent of total world catch.

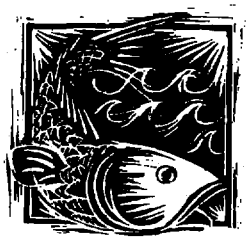
The United Nations Conference on the Law of the Sea (UNCLOS) took an important step toward reducing overfishing in 1982. It gave the seal of approval to the 200-mile exclusive economic zone, which most countries had already embraced. By giving coastal states responsibility for managing the resources within their zones, UNCLOS reduced the amount of resources considered global common property. But the establishment of exclusive economic zones has not prevented overcapitalization and excessive fishing at the national level. The reason is that most fisheries—both within and outside the zones—continue to be managed under open-access regimes, with the result that new fishers will continue to enter these fisheries until all rents have been dissipated. At this point overfishing will likely have occurred, and in extreme cases the survival of the resource will be seriously threatened.

The Food and Agriculture Organization recently reported that most commercial fish resources are being overexploited. If this trend continues unchecked, another natural resource disaster is imminent. Finding a solution to the problem is urgent. Fishery economists generally agree that the most promising solution is to adopt fishery management regimes that create "property rights" in fisheries, rather than continuing to treat fisheries as common property, a situation that gives no one an incentive to conserve the resources.

In the 1960s Sol Sinclair, a Canadian fishery economist, proposed limiting entry or restricting access to fisheries as a substitute for a property rights system. The wealth of experience with this approach in a number of countries has contributed to a better understanding of the options available for controlling open access and overfishing.

The Symposium on Fishery Resources Management held in Peru under the auspices of the World Bank and the Peruvian Ministry of Fisheries provided an opportunity to present and discuss the experiences of a number of countries in fishery management. The proceedings of the symposium are expected to be helpful to Peru as well as to other nations in developing and implementing management regimes compatible with the urgent need to conserve the world's fish resources.

Michel Petit
Director
Agriculture and Natural Resources Department



Preface

The abundance of the ocean's living resources led many to believe that they were practically inexhaustible. But events have shown how fragile fish resources can be when aggressively harvested under conditions of free and open access. North Sea herring, Californian and South African sardines, Peruvian anchoveta, and, more recently, eastern Canadian cod have been depleted as a result of overfishing, with serious socioeconomic consequences. Overfishing results from overinvestment—when harvesting effort is allowed to exceed the level at which the resource can sustain itself.

An analysis conducted more than a decade ago by the Food and Agriculture Organization (FAO) indicated that the largest annual harvest that the world's marine fish resources could sustain would be about 100 million tons. Actual trends in the world catch, under conditions of predominantly open access, largely bear this out. The world catch increased rapidly from 20 million tons in the mid-1940s to 60 million tons by the early 1970s, growing at a rate of about 6.5 percent a year. During a period in the 1970s the catch seemed to have reached a plateau, growing at a rate of less than 1.5 percent. But in the 1980s growth in world fishery production resumed, and in 1989 production reached a record 86.4 million tons. In 1990 and 1991 production dropped, to 82.8 million and 81.8 million tons, but this may be attributable to natural fluctuations in the stock of small pelagics, which now constitute about 30 percent of the world marine catch.

The statistics thus show a sustained increase in the total catch, but a breakdown of the figures reveals a rather alarming scenario. The number of underexploited major fish stocks has decreased from nearly thirty to only seven over the past decade, and one in every three major stocks is overfished. If these developments continue unchecked, we may be witnessing a global fishery crisis in the making.

Fishing represents the best example of exploitation of common property resources. Free and open access to fisheries leads to sustained entry of new vessels (overcapitalization). New entries into a fishery will continue until total costs equal total revenues, at which point all economic rents have been dissipated. World fishing effort—as measured by number of vessels and by catch capacity—has grown even faster than marine production, which has increased fourfold over the past four decades. As a result, we have too many vessels chasing too few fish. A recent FAO study shows that the total operating costs of the world fishing fleet exceed its total gross revenues by some US$22 billion. This situation can be sustained only by heavily subsidizing a large share of the fleet.

As long as the size of the world's fleet remains unchecked and a policy of open access continues to be pursued both within and outside the exclusive economic zones, overfishing will continue to pose a serious threat to the conservation of the world's marine resources. The reluctance of many countries to reduce their fleets stems in part from problems associated with the heavy financial obligations of the fleets and from the specter of unemployment that decommissioning fishing vessels would raise. But delaying reductions in fleet size for short-term political benefits will only worsen the fishery crisis, and may have irreversible consequences.

Identifying appropriate policy options for managing fishery resources has therefore become urgent. The most sensible way of going about this is to focus on the causes rather than the effects of overinvestment and to learn from the experience of countries with different fishery management policies.

The Symposium on Fishery Resources Management, the proceedings of which are presented in this paper, was organized for these purposes. In particular, it was organized in response to Peru's need to find management solutions for its fishery sector, which the country is beginning to restructure under an ambitious new program. But with mismanagement of fishery resources pervasive worldwide, the discussion of management options and the recommendations made at the symposium should be useful for all countries seeking policies to ensure the sustainability of their marine fisheries.

The symposium covered theory and practice in fishery management as well as experiences with different fishery management policies in Canada, Chile, Iceland, New Zealand, Norway, Peru, and the United States. It also analyzed management options for transboundary stocks and world trends in fishery management, and discussed aerial surveillance techniques for monitoring fishing operations.

The papers presented at the symposium discussed the economic theory of common property and open access, and analyzed policy options that are possible substitutes for private-property-based systems of managing fishery resources, including limited entry, restricted access, and individual transferable quotas (ITQs). A system based on ITQs appears to be the most effective option for controlling the overinvestment that leads to overfishing. And because ITQs may be sold, they provide a means for fairly compensating those needing to leave an overcapitalized fishery. In the absence of ITQs or another satisfactory form of property or use rights, a fisher exiting a fishery would likely have to undergo bankruptcy.

Limits on total catches were considered effective in controlling overfishing but ineffective in preventing overinvestment. The reason is that an overcapitalized industry under financial stress may exert pressure on authorities to permit fishing even when biological evidence indicates that fishing should cease. Transboundary resources shared by two or more countries raise even more complex management issues. Unless the countries sharing the resource reach agreements on an appropriate comanagement strategy, the prospects for sustainable exploitation are nil. Without such an agreement, countries would operate the fishery under open-access conditions without even limits on total catch.

Symposium participants emphasized the importance of an appropriate legal framework in support of fishery management and cited examples of how legal instruments may obstruct rather than assist in the implementation of management systems. When drafting fishery legislation, priority should be given to management practices that prevent overinvestment and the resulting overfishing and resource depletion. Essential to the success of fishery regulation is a monitoring system to ensure compliance with restrictions.

The proceedings of the symposium are intended to be widely disseminated to benefit those countries seeking to implement sound management regimes. The World Bank stands ready to assist interested developing countries in the search for appropriate management strategies, in an effort to forestall overfishing and the degradation of the world's marine environment.

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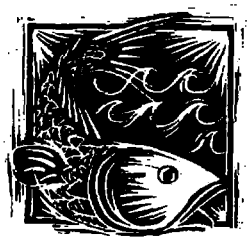


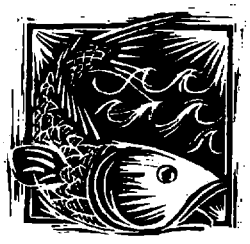
Abstract

The Symposium on Fishery Resources Management held in Lima, Peru, in June 1992 addressed several aspects of fishery management—theory and practice, the experience of different countries, and current world trends in fishery management. It also discussed strategies for managing transboundary stocks and aerial surveillance techniques for monitoring fishing operations.

Leaders in the field of fishery management from Canada, Chile, Iceland, New Zealand, Norway, Peru, and the United States presented papers on lessons learned in applying different fishery management policies. Participants concurred that individual transferable quotas appear to be the best management strategy in the current situation of overinvestment and overfishing.

The symposium was organized by the World Bank and the Peruvian Ministry of Fisheries as a first step toward Peru's implementation of a fishery management regime. But the recommendations presented at the symposium are valid for all countries with fishery management responsibilities. It is hoped that the recommendations will contribute toward the establishment of fishery management systems that guarantee both biological sustainability and economic efficiency in the world's fisheries.

The paper is divided into chapters covering the fishery management experience of different countries, as well as conceptual chapters and a review of world trends.



Summary

In the manufacturing sector open access and competition normally lead to higher productivity and lower prices, but in the fishery sector they lead to reduced output and loss of economic benefits. The better solution is to manage fishery resources. There are two main types of fishery management regimes, biological and economic. Biological management strategies—for example, setting a total allowable catch—are well suited for conserving fish stocks, but they are useless from an economic point of view—that is, in controlling investment levels. Economic management strategies can rely on direct or indirect measures. Direct restrictions—for example, limits on fishing effort, investment, or inputs—may fail to realize the potential benefits of a fishery, because they do not change its basic common property nature. The best approach appears to be an indirect measure—the allocation of catch quotas to individual fishers, which in effect gives them temporary property rights in a fishery. Other indirect measures include taxes and access licenses.

Any policy adopted should be an integral part of a fishery management regime. Such a regime should comprise a fishery management system that sets the rules for fishing, a monitoring, control, and surveillance system to monitor fishing activities and enforce fishing rules, and a fishery judicial system to ensure adherence to the management regime (chapter 2).

Most fish stocks in the Northeast Atlantic are controlled through limits on total allowable catch (TAC). In recent years it has been recognized that setting a TAC is not just a question of biology. Instead, the optimum amount of fish that should be caught in a particular year depends on the size of the stock, its growth parameters, the price of fish, the cost of fishing, and the discount rate. A basic criticism that can be levied against the TAC system is that it does not take into account economic considerations.

One of the main problems with implementation of the TAC regime is enforcement. It is notoriously weak in the European Community (EC), and fishery biologists who assess annual stock levels in EC fisheries have for years made allowances for overfishing and misreporting. Official EC documents acknowledge that the discrepancy can be as high as 60 percent.

In Norway most fish stocks have long been fully utilized and are probably overexploited. The most important weakness in Norway's fishery management system is that it neglects market forces in its decisionmaking process. Decisions on the use of fishery resources are made through political processes that give greater weight to issues of distribution and fairness than to generating wealth (chapter 3).

Canada introduced a license system for its salmon fishery in 1968 to contain growth in the fleet's harvesting capacity and protect the dwindling stocks. As salmon fishers became accustomed to trading licenses, they came to regard the licenses as personal property, and the courts tended to accept them as legal rights. The license program achieved some biological success, but it failed to reduce fishing capacity. The program was an economic disaster and an administrative nightmare.

In 1981 Canada introduced a license system in its black cod fishery, freezing the number of vessels in the fishery at forty-eight. But despite the freeze

on vessels and a TAC maintained at 3,500 to 4,500 metric tons, increasing fishing effort has made it necessary to drastically curtail the fishing season, from 245 days in 1981 to forty-five days in 1985 to fourteen days in 1989. In 1990 the season was eight days. The consequences: overcapitalization, erosion of product quality, and unsafe fishing conditions. The fishery is now experimenting with individual quotas, with very encouraging results. Individual quotas are now in use in nearly twenty fisheries in Canada, and there is a growing consensus that the full potential of management through quotas can be realized as the recognition of quotas as property rights becomes more established (chapter 4).

Fisheries in Iceland were operated for the most part as common property resources until the recognition of the 200-mile exclusive economic zone (EEZ) in 1976 and the introduction of the vessel quota system in 1984. The fisheries were then put under gradually increasing management, and by 1990 a uniform individual transferable quota (ITQ) system had been extended to nearly all fisheries. But as the ITQ system has evolved, important steps have usually been taken only in response to crises in the fisheries signaled by a sudden reduction in stock levels. This pattern reflects the reluctance of the fishing industry to accept changes in the traditional organization of the fisheries.

The uniform management system introduced in 1990 made all of Iceland's fisheries subject to vessel catch quotas. These quotas, which represent shares in the total allowable catch (TAC), are permanent, perfectly divisible, and fairly freely transferable. Under the vessel quota system, total fishing effort in the demersal fishery has been reduced to a level about 37 percent lower than what could be expected without the system. The total value of the demersal catch at the midpoint of the price range was some US$46 million in 1984 and US$166 million in 1990. The demersal fishery thus generates considerable economic rents (chapter 5).

In the United States the most serious problem in fishery management is that the system has failed to resolve the inherent conflict between the public interest and the interests of fishers exploiting a common property resource. The key regulatory instrument, the Fisheries Conservation and Management Act (Magnuson Act) of 1976, drafted parallel to the adoption of the extended jurisdiction, was guided more by the objective of excluding foreign fleets than by the goal of managing resources effectively.

A critical element missing from implementation of the U.S. fishery policy is a serious commitment to the objective of economic efficiency. Moreover, because of the industry's opposition, the United States has not adopted a policy of limited entry. As a result, the fishing season in the halibut fishery, for example, has been reduced to five or fewer days (chapter 6).

The responsibility for regulating marine fisheries in the United States is vested in the Secretary of Commerce and exercised through the National Marine Fisheries Service, which is a part of the National Oceanic and Atmospheric Administration. The power to manage fisheries is also shared with regional bodies that, by virtue of their membership and their process for selecting new members, are unique entities in American administrative law.

Based on the regulatory experience in the United States, it is suggested that the architects of Peru's management regime focus not only on economic or biological objectives, but on the allocation of power—specifically, regulatory power. Consideration should also be given to the desirability of foreign participation in the fishery sector, either directly or through passive investment. And because the El Niño phenomenon may be a disincentive to private investment, consideration should perhaps be given to some form of insurance or other means to spread the risk over time (chapter 7).

For the New Zealand fishery industry, there were three significant events in 1983: the adoption of the new Fisheries Act, the introduction of an economics-based management system, and the onset of major biological and economic problems in the inshore fishery. The deep-water trawl policy under the new act recognized that resource management should be based on control of output rather than on control of inputs, which is less efficient. Quotas in the deep-water trawl fishery were allocated according to investment in onshore processing facilities, investment in fishing vessels, and quantities of product processed.

Under the amended Fisheries Act of 1986, an ITQ system was introduced in the inshore fishery and applied more comprehensively to the deep-water fishery. The quota management system was changed in 1989 to a proportional system in which allocations

are based on shares of the total allowable catch. The essential change effected by the new fishery management policies introduced since 1983 is the creation of property rights (chapter 8).

The goal of Chile's fishery management is to make harvesting activities economically efficient by regulating access to a fishery once it becomes fully exploited. Chile's fishery sector has expanded to the limits of the available resource base. Its production increased from 3 million tons in 1980, valued at US$400 million, to 6 million tons in 1991, worth US$1.19 billion. With a fully allocated resource base, and disproportionate fishing effort and processing capacity, the country's fishery industry is at risk of destabilization.

Chile's National Congress recently approved comprehensive legislation regulating the fishery and aquaculture sector. The legislation is aimed at supporting stable, long-term growth of the sector and ensuring that it provides maximum net social benefits. The country's private sector participates in the study of management procedures, helping to assure that new regulations are accepted. The private sector also helps finance fisheries research, an essential input to management (chapter 9).

There are special problems involved in the management of transboundary stocks, such as the Peruvian-Chilean pelagic fishery. Chile and Peru are both implementing policies to manage their aquatic resources, but neither country's policies explicitly recognize that the fish stocks are shared. Rather, the two countries manage their fishery resources separately, resulting in a quasi-open-access situation in which potentially substantial benefits and rents are forgone. Application of game theory in the dynamic analysis of a fishery shared by two or more co-owners has shown that, whenever the economic returns of one of the co-owners depend on the fishing activity of the other, noncooperation will have less advantageous results than cooperation.

Analyzing and evaluating the different policy options for managing a transboundary stock requires a model representing the various activities and decisionmaking stages in the fishery linked with the basic characteristics of the resource under alternative options. Once a set of feasible management options has been identified, each option can be fed into a mathematical programming model to determine its economic value under the pertinent restrictions and functional relationships. This process can be continued until an optimum set of management options is identified (chapter 10).

Peru's fishery sector contributes modestly to the country's gross domestic product but it shows strong growth in value added. Between 1980 and 1989 annual growth in the sector's average value added was far higher than that of any other productive sector of the economy. And the contribution of fisheries to the country's foreign exchange earnings amounted to US$419.6 million in 1990, about 14 percent of total foreign exchange receipts. Small pelagics—anchoveta, sardine, mackerels—account for a substantial share of Peru's fishery resources. Over the past ten years the total allowable catch for these species has ranged from 2 million to 7 million tons a year.

Peru's fleet capacity far exceeds the potential catch of the known fish stocks, and the processing capacity for fishmeal and fish oil is three times the total allowable catch in the peak years. To forestall the inevitable consequences of overinvestment, which has been shown by the FAO to be the leading cause of the collapse of fisheries, adopting policies that limit or restrict access is crucial (chapter 11).

On a global level the increasing scarcity of fishery resources was the main driving force behind the establishment of the 200-mile exclusive economic zone. Many countries took measures to adjust the catch in their fisheries to levels that maximize sustainable yield, either by directly limiting the catch or by limiting fishing activity. Fishery regulations based on purely biological rationales often become unnecessarily costly, however. One way to limit the cost of fishing is license limitation. But license limitation programs are difficult to implement and there was increasing disappointment in the system. In its place the individual transferable quota system is being implemented by countries around the globe.

The advantages of ITQs are obvious. The sum of ITQs for a stock constitutes the amount that can be taken from the stock, the total allowable catch. Setting a TAC for each fish stock and dividing it among the vessels participating in a fishery can protect the stock from depletion by preventing a self-defeating race for the largest possible share of the catch. And making the vessel quotas transferable minimizes the cost of taking a given catch. But an ITQ system is useless if a country is unable to

adequately enforce and monitor its implementation or to make reasonably accurate predictions of the future size of the fish stock.

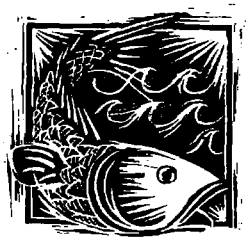
In some countries the necessary conditions for a well-functioning ITQ system are simply not in place; in others the expected side effects have led fishery authorities to modify the ITQ system or to not implement it. And in some countries ideological or political factors stand in the way.

To secure public acceptance of management systems that restrict access to a fishery, fairness in allocating the restricted rights both among individuals and across generations must be ensured. Individual transferable quotas, if their implementation is at all possible, can meet this criterion (chapter 12).

For a fishery management regime to be effective, it must have a monitoring, control, and surveillance system. Some monitoring can be done on shore, but some needs to be done at sea during the fishing activity. The sea component of the monitoring has normally been split into ship-based and the more cost-effective aircraft-based monitoring.

Nova Scotia's maritime surveillance is carried out by the Atlantic Airways surveillance system. This system consists of five major components: an aircraft, a search radar, a navigation system, a reconnaissance camera, and a data management system. The system uses a computer-controlled navigation system that is interfaced with the radar, the data management system, and the cockpit navigation system. The reconnaissance camera is interfaced with the navigation and data management systems and provides the visual record of fishing activity required for successful prosecutions.

The heart of the surveillance equipment package is the Airborne Data Acquisition and Management system, which provides the flight crew with a real-time Mercator projection map, displaying all contacts in relation to land masses, depth contours, fishing zones, and closed fishing areas. The surveillance system has been very successful; because of the accuracy and precision of the information it provides, no case prosecuting violators has yet been lost in the courts (chapter 13).



Statement by Peru's Minister of Fisheries

Jaime Sobero Taira

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Mr. Eduardo Loayza, World Bank Fisheries Advisor; international fishery experts from Canada, Chile, Iceland, New Zealand, Norway, and the United States; participants; and representatives of national fishery agencies and of the FAO:

I would first like to convey the Peruvian Government's gratitude to the World Bank for sponsoring this international symposium on fishery management. Our special thanks go to Mr. Eduardo Loayza Salazar, the organizer of the symposium, for arranging, in record time, for such qualified experts to come here to speak on fishery issues and experience at different latitudes. On behalf of the Peruvian Government, I offer you a most warm and enthusiastic welcome.

I am confident that the highly qualified speakers, complemented by the audience of distinguished representatives from all areas of the Peruvian fishery sector, will guarantee that the meeting will be a success and will benefit all in attendance.

Two recent key international events—the Conference on Responsible Fishing in Cancun, attended by representatives from sixty-nine countries, and the Earth Summit in Rio de Janeiro—focused special attention on the need to improve fishery management practices so as to guard against overfishing and biodiversity impairment. They established that it was essential to continue to support and develop fishing under a comprehensive and balanced management system, emphasizing responsible fishing.

Fishery management must be geared to ensuring the sustainability of fishery resources. This means adhering to practices that protect the environment and conserve biodiversity, and using catch and culture methods that do not harm ecosystems or the biological and economic health of the resources. And it means incorporating value added through processing methods that meet health regulations and through marketing practices that give consumers access to good-quality products at a fair price.

These general guidelines for responsible fishery management, which Peru adheres to completely, have led to a need to form a select, multidisciplinary group of representatives from public and private organizations concerned with Peru's fisheries to draft a new general law on fisheries. This law should be designed to improve the fishery management system by reconciling the goal of ensuring the sustainability and renewability of fishery resources with the goal of achieving optimal utilization of the resources.

It is out of both a sense of responsibility and self-interest that Peru has been adhering fully to the concept of sustainable development, taken to mean economic growth based on appropriate use of natural resources and the equitable distribution of wealth, and the safeguarding of the development prospects and quality of life of future generations.

In Peru, dire poverty, population problems, and drug trafficking are singled out as the main reasons for environmental deterioration, with underdevelopment in general both the cause and the effect of the ecological damage that has occurred in our country. It is a vicious circle that must be broken by establishing a new style of development. The bases for this are already contained in our constitution, in three key goals:

- Rational use of natural resources and environmental protection

- Economic growth
- Equity, achieved through the redistribution of wealth, to enable the vast majority of the population to meet their basic needs.

To accomplish these goals, coherent policies will have to be translated into programs, projects, and actions for the medium and long term. These should be aimed at economic and social development tailored to the potential and characteristics of the country and its people, and designed to bring about the substantial changes in our education, culture, and values necessary to bring them into line with these development policies.

Peru will need international support to help it implement this strategy. Because of its socioeconomic circumstances, many important issues have had to be shelved so that more urgent matters could be given immediate attention.

With regard to fisheries, we believe that it is essential that international assistance include the financial support we need to make far-reaching improvements in our systems of scientific research and resource management. It should also include investments, channeled through international and regional organizations under partnership arrangements or other forms of cooperation, to promote and expand fishing activities, from the catch and culture stages to the processes that incorporate value added into products for both domestic consumption and the foreign market.

To achieve the objectives of responsible fishing, international aid therefore needs to concentrate on developing facilities for the transfer of technology and know-how, and mechanisms to support joint scientific and technical research projects and the continuous exchange of information.

It would be helpful here to provide a general idea of Peru's current policy concerning the structure and operation of the fishery sector.

Peru's present economic policy is based on the principle of a market economy. Thus, it seeks to downsize and rationalize the entire public apparatus and, within it, all those corporations established at a time in which the state was conceived as both the developer and the executing agency of all productive activities. Under today's new concept and style of development, priority is given to applying the principle of free enterprise and encouraging private investment in all sectors of the economy and in any entrepreneurial and contractual form permitted under the constitution and the law.

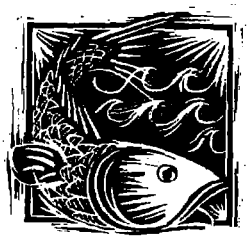
Legislation enacted along these lines includes both a framework law to boost private investment in general and a law to promote private investment in public corporations. It also includes a law to promote investments specifically in the fishery sector—a law that introduces new legal and financial guarantees for the pursuit of fishing activities in Peru.

The restrictions of earlier fishery regulations, which were based on outdated ideological, political, and financial concepts, are being eliminated in the government's across-the-board reform of the legal and institutional structures of the fishing sector. This reform is intended to achieve consistency with the constitutional principles of free enterprise, the conservation of fishery resources, and optimal fishery management. The reform includes measures to ensure sustainable catch, encourage private investment, promote foreign investment, simplify administrative procedures, and promote fish consumption under a national program designed to benefit the neediest segments of the population.

The market is not seen as a universal panacea. It can hardly be expected to be the solution to all human problems—or even to all economic problems. But it is certainly regarded as an adequate management system that can play a key role in helping to solve the problem of resource allocation—one of the most complex problems of modern society.

Even when governed by the market, however, a fishery economy cannot do without state assistance, given the nature and use of fishery resources. Peru's constitution establishes that renewable and nonrenewable natural resources are national property, and that the state is responsible for evaluating and protecting them and for promoting their rational utilization in order to stimulate economic development. The intention is not that the government should impose rigid and authoritarian regulations, but that it should strive for a flexible and participatory way of achieving economic order through a series of actions implemented in a prudent, systematic, and coherent manner.

Finally, as I open this symposium, I want to thank each of you for taking time out of your busy schedules to be here this morning and on the coming days, to enrich a discussion that we hope will be both enlightening and fruitful.



Theoretical and Practical Fishery Management

Ragnar Arnason

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The fishery problem

Many marine resources are extremely rich. Prudently utilized, they are capable of yielding very significant economic benefits. In some cases, the potential value of a country's marine resources is so great relative to the rest of the economy that they can provide the means for shifting the national economy onto a new and more favorable economic growth path. This has been true for Iceland in the past and it may very well also be true for Peru.

Yet there are formidable economic obstacles to realizing the potential benefits offered by ocean resources. For fisheries, there is an incompatibility between the traditional open-access, competitive structure and a sensible utilization of the fish stocks. Although open access and competition normally result in increased production and lower prices in manufacturing, they lead to reduced output and loss of economic benefits in ocean fisheries.

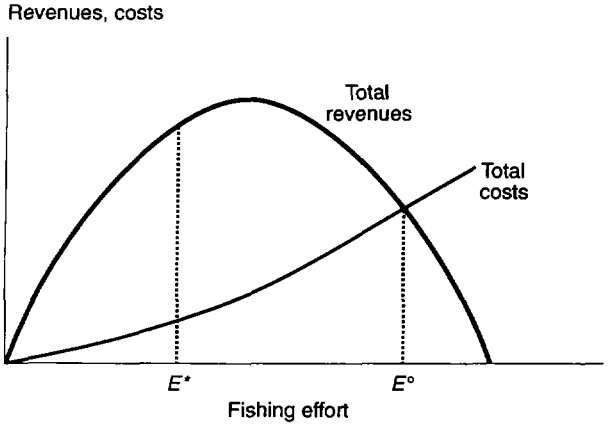
The characteristic of fisheries that gives rise to these perverse results is that fish stocks are a natural resource. This resource is not unbounded. The annual catch is limited by the reproductive capacity of the fish stocks. This natural limitation cannot be expanded by fishers. On the contrary, attempts by individual fishers to increase their catch will generally reduce the fish stock, in particular the spawning stock, to the point at which the sustainable yield of the fishery is greatly reduced. In fact, several previously large and valuable fish stocks have been depleted and the fishery destroyed by excessive fishing pressure resulting from fishers competing for catch.

The histories of most current ocean fisheries have been distressingly similar. A typical history runs as follows. Initially, when a fishery is first being developed, the resource stock is high. Therefore, catches are good and the fishers earn a high return on their investment and effort. This encourages the more enterprising fishers to expand their fishing operations. It also attracts new fishers to the fishery. Thus, fishing capacity expands and fishing effort increases. This reduces the fish stocks, and the catch per unit of effort declines. Economic returns from the fishery are correspondingly reduced. This does not put an end to the expansion in fishing capacity, however. Capacity continues to expand as long as the fishers can reasonably hope to extract a positive return from the fishery. Long before achieving a positive return ceases to be possible, however, the fish stock has normally been reduced far below the level corresponding to maximum sustainable yield, and total annual catches have actually been reduced despite the greatly increased fishing effort.

An open-access, competitive fishery will reach an equilibrium only when the expansion in fishing effort has reduced the stock to the point at which total fishing costs equal the value of the harvest. As long as harvesting revenues exceed costs there will be an incentive to invest in new capacity. At the equilibrium point, however, net returns from the fishery are zero and there is no incentive to invest in expanded capacity. Figure 2.1 illustrates these basic ideas.

In figure 2.1 aggregate fishing effort, denoted by E, is measured along the horizontal axis. Costs and revenues are measured along the vertical axis. The curve labeled total revenues represents total sustainable revenues at different levels of effort. At low lev-

Figure 2.1 The sustainable fishery model



els of fishing effort—as in the early development stages of a fishery—this curve indicates increasing revenues as higher levels of effort yield greater catches. This increase in revenues tapers off, however, and eventually they begin to fall as increased effort reduces the fish stock below the maximum sustainable yield. The curve labeled total costs represents the total costs of effort. This curve naturally rises as effort increases.

The equilibrium point for the fishery is at effort level E°. At this point the fishery has reached maturity: total costs equal total revenues, profits are zero, and there will be no further expansion or contraction in fishing effort. But at this point there are also no net economic returns from the fishery. The figure makes it clear that significant net returns could be attained by reducing effort. In fact, net returns are maximized at fishing effort E^*, where the difference between total revenues and total costs is greatest. A reduction in fishing effort to E^* will not be supported by an open-access, competitive fishery, however. The reason is that the profits realized at this level of effort would encourage an expansion in fishing capacity until the point E° was reached again.

This simple analysis closely fits the pattern observed in open-access ocean fisheries. All over the world these fisheries are characterized by excessive fishing capital and fishing effort, depressed fish stocks, and few or no net economic returns.

This failure of open-access, competitive fisheries was recognized only relatively recently. In the mid-1950s two Canadian economists, H. S. Gordon (1954) and A. D. Scott (1955), published pioneering articles about the fishery problem. These articles, which marked the beginning of the field of fishery economics, advanced essentially the analysis outlined above.

Scott threw a slightly different light on the problem, however. He noted that a single, informed owner of a fishery would not fall into the trap of excessive exploitation of the resource. Thus, from this point of view, the fishery problem is caused by the lack of private ownership of ocean resources or, in other words, by the common property nature of ocean resources.

It is this common property nature of ocean resources that compels fishers to overexploit fish stocks, even against their own better judgment. When many fishers have access to the same fish stock, each has every reason to grasp as large a share of the potential yield as possible lest the other fishers reap all the benefits the resource can offer. Prudent harvesting by one fisher in order to maintain the stocks will, for the most part, only benefit other, more aggressive fishers without preventing the ultimate decline of the stocks. Thus, each individual fisher, acting in isolation, is powerless to alter the course of the fishery. His best course of action is to try to grasp his share as quickly as possible while the resource is large enough to yield some profits.

This is what has been called the tragedy of common property resources (see Hardin 1968). The potential benefits of a resource, no matter how great, tend to become dissipated under the onslaught of a multitude of users.

The common property problem is by no means confined to fishery resources. It is also encountered in the use of common land, wildlife, and water and air resources. In all these cases the commonly owned resources tend to become overutilized, sometimes with disastrous consequences.

Thus, the empirical evidence and the economic analysis go hand in hand. Both clearly demonstrate the need for special management of fisheries if their potential benefits are to be realized. For coastal states with rich fishery resources in their waters, the potential economic benefits of well-informed fishery management are very great indeed.

Fishery management methods

A great number of different fishery management measures have been suggested. Most can be conve-

niently grouped into two broad classes: biological fishery and economic fishery management. Economic fishery management measures may be further divided into direct restrictions and indirect economic management.

Biological fishery management

The most common fishery management method is to impose an upper limit on total allowable catch (TAC). This is a typical biological management measure designed to protect the fish stock. If adhered to, total allowable catch restrictions are well suited for conserving the fish stocks. But this kind of fishery management does not alter the economic dynamics of the fisheries. Thus, if the total allowable catch approach manages to enhance the fish stocks, competition among fishers for shares in the total allowable catch will result in correspondingly increased fishing effort and overcapitalization in the fishing fleet. More vessels will be brought into the fishery and fishing effort expanded until all potential rents again disappear.

The same results can be expected from all other management measures designed to improve the state of the fish stocks, including fishing stoppages during spawning seasons, closures of nursery grounds, measures for protection of juvenile fish, and restrictions on fishing gear. To the extent that such measures succeed in enhancing the fish stocks, increased fishing effort and renewed investment in fishing equipment by fishers competing for a larger share in the fishery will dissipate the potential economic benefit.

The apparent conclusion is thus that biological fishery management measures, although well suited for preserving fish stocks, are useless from an economic point of view. In fact, the outcome is typically even worse.

Setting and enforcing biological fishery restrictions is invariably costly, with actual expenditures depending on the sophistication of the measures undertaken, the extent of the underlying research, and the vigor of enforcement. Usually these costs are quite substantial. And because biological fishery management generates no economic benefits to speak of, these costs represent a net loss.

Thus, we must conclude that fishery management based exclusively on biological conservation measures will generally generate a negative economic return. Such measures are therefore to be recommended only if the alternative is the biological destruction of the fish stocks.

Economic fishery management: Direct restrictions

The most frequently employed direct fishery management methods are restrictions on fishing effort, restrictions on the use of various fishing inputs, and limits on investment in fishing capital. These methods are designed to limit fishing effort and capital to optimal levels and thus to realize the potential economic benefits of the fishery. But because they do not change the basic common property nature of the fisheries, they encounter serious problems in achieving that objective.

Restrictions on fishing effort have been tried in many fisheries. The restrictions take various forms, including limitations on days at sea, fishing time, engine size, and the holding capacity of vessels. But irrespective of the precise nature of the constraints on fishing effort, their outcome is generally the same. Fishing effort is a composite of many variables. To maximize their returns from a fishery, competing fishers always expand fishing effort variables that are not subject to restrictions. If the number of fishing days is limited, fishers generally invest in larger and more powerful vessels. If there is a restriction on the holding capacity of vessels, fishers will add vessels and use faster ones. If there are simultaneous restrictions on the number of vessels, fishing days, and engine capacity, fishers will invest in fish-finding equipment, fishing gear, and similar variables. Competing fishers will always find ways to invest in effort variables that are not controlled. And this investment will not come to a halt until all potential economic rents from the fishery have been dissipated.

Restrictions on the use of certain fishing inputs and on investment in fishing capital lead to similar results. Imposing such restrictions will simply lead to substitution away from the restricted inputs to unrestricted ones. As long as there are any economic rents in a fishery, there will be an incentive to find ways to bypass the restrictions. Experience shows that it would be unwise to underestimate the ingenuity of fishers in finding such ways.

The conclusion therefore must be that direct fishery management methods are unlikely to gener-

ate significant economic benefits. This holds especially for single measures. A combination of direct management measures—such as access restrictions supplemented by restrictions on investment and effort—may be capable of sustaining some economic rents. But because maintaining and enforcing such measures is usually quite costly, the net benefits generated may easily turn out to be negative.

Economic fishery management: Indirect measures

The most prominent indirect economic fishery management methods are corrective taxes and such rights-based instruments as access licenses and individual transferable quotas. Both taxes and individual transferable quotas are theoretically capable of achieving economic efficiency in fisheries. But taxes involve substantial sociopolitical problems as well as some practical ones as a fishery management tool. In any case, taxes have not been used as the main fishery management tool in any significant ocean fishery. Individual transferable quotas, however, have been used in several fisheries. They have been fairly successful and are rapidly spreading to other fisheries.

Corrective taxes. The purpose of using taxes as a fishery management tool is to alter the economic conditions of the fishing firms so as to induce them to behave in a socially optimal fashion. The many different types of corrective taxes that could be used for this purpose can be broadly classified as taxes on fishery inputs or taxes on catch.

Taxes on fishery inputs do not appear very promising. Such taxes will generally lead to a substitution away from taxed inputs to inputs that are not taxed. But, to the extent that technical input substitution possibilities are not perfect, this method will generally generate some economic rents in the form of collected taxes.

Taxing catch is a much more effective way to realize the potential economic benefits of a fishery. After all, apart from cheating, there is no way for fishers to avoid this kind of a tax. The immediate effect of a tax on catch is to make a fishery less profitable. Thus, by squeezing out the least efficient fishers, a tax on catch forces a reduction in aggregate fishing effort. Depending on the tax rate, the effort level in a fishery can in principle be brought down to the economically most rewarding level.

Rights-based approaches. Rights-based approaches to fishery management attempt to eliminate the common property problem by establishing private property rights over the fish stocks. Because the source of the economic problems in fisheries is the absence of property rights, this approach should in principle secure the full economic benefits of a fishery.

Broadly speaking, two quite different rights-based approaches have been used in fisheries: access licenses and individual catch quotas.

Access licenses give the holders the right to participate in a fishery. They thus constitute a property right and, to the extent that they are transferable, will command a market price. Access licenses do not, however, eliminate the common property problem in a fishery. The fishery is still the common property of all holders of access licenses, and they will act accordingly. To improve or even maintain their share in the fishery, fishers will be forced to invest in fishing capital and increase their fishing effort. This process continues until all attainable rents have been dissipated and the fishery finds an equilibrium.

A system of access licenses may alleviate the common property problem somewhat, however. This may occur, for example, if the number of license holders is small and, more important, there are restrictions on capacity expansion.

Access licenses have been used in many important fisheries in recent years. In British Columbia's valuable salmon fishery, for example, access licenses have been in effect for a number of years and have achieved some economic success.

Individual catch quotas are a much more promising approach to the fishery problem. The allocation of catch quotas to individual fishers in effect gives them property rights in a fishery. And because the fishers' catch is secured by their quota holdings, the common property nature of the fishery is eliminated. Thus, a vessel quota system, by freeing fishers from competing with the other fishers for catch from a limited resource, allows them to concentrate on minimizing the cost of harvesting their catch quota and maximizing its value by improving its quality.

Transferable and perfectly divisible catch quotas are usually referred to as individual transferable quotas or ITQs. If the ITQs are also permanent, they constitute a complete property right, just like a right

to a building or to a piece of land. In that case, standard economic theory should apply and, barring market imperfections, the fishery should automatically reach full efficiency.

This important point should be explained in a little more detail. First, if catch quotas are transferable, a market for the quotas will emerge. With the help of this market the quotas will tend to go to the most efficient fishing firms. The more efficient the quota market, the more pronounced this tendency will be. In this manner, an ITQ fishery management system will tend to guarantee that the TAC is always caught by the most efficient fishing firms.

Second, if the catch quotas are also permanent, the fishing firms will find it to their advantage to adjust the capacity of the fishing fleet to the socially optimal level. After all, the transferability of the quotas will ensure that only the most efficient firms do the harvesting. These firms will not hold excessive fishing capital; if they did they would not be fully efficient and would lose out in the market for quotas. For the other firms—those holding no catch quotas—there is of course no point in maintaining unutilized fishing capital. Therefore, aggregate fishing capital will tend toward the socially optimal level.

The most promising fishery management systems

Of all the fishery management systems considered, only the individual transferable quota system and the tax on catch seem capable of delivering the full potential economic benefits of fisheries. A consensus has emerged among fishery economists that the ITQ system, because it essentially eliminates the basic common property problem of fisheries, offers the most promising general approach to managing ocean fisheries. That does not mean that ITQs are necessarily the best management system for all fisheries, however. For example, for this method to work requires that the individual quota constraints be enforceable. If that is not possible in a fishery, another management method may be preferable.

Minimum information fishery management

The ITQ fishery management system, besides being generally best suited for realizing the potential economic benefits of fisheries, minimizes the need for centralized management. Under the ITQ system, the role of the fishery manager is reduced to determining the annual total allowable catch (TAC). If the quotas are transferable, the fishery manager does not have to concern himself with the allocation of the quotas,[1] but can depend on market forces to move quotas from the less efficient fishing vessels to the more efficient ones.

Calculating the optimal total allowable catch is no easy task, however. The optimal TAC depends on the detailed economics of the fishing fleet and the state of the fish stock at each point in time. Therefore, to determine the optimal total allowable catch, the fishing authority needs perfect knowledge of every variable in the fishery. This includes complete knowledge of the harvesting and cost functions of each vessel, the development of the fish stocks, their migratory pattern both generally and regionally, and the market conditions for landed catch. Clearly, these informational requirements greatly exceed the capacity of any fishery manager.

These informational difficulties do not mean that an ITQ system will yield no benefits. On the contrary, only an exceptionally inept fishery manager would set a TAC that would not generate a significant fraction of the attainable benefits of a fishery. After all, any TAC will be taken in the most efficient way. But it appears that the informational problems in an ITQ fishery management system would prevent it from generating a fishery's full potential rents. The ITQ system, in other words, appears to be a second-best management system.

Fortunately, however, the information needed to determine the optimal total catch for a fishery already exists in that fishery. The fishers have the most complete information available about their harvesting economics and catch prices and they command detailed knowledge about the state of the fish stocks. In addition, conducting successful market transactions in quotas requires sound knowledge of the overall state and development of the fish stocks. Thus, the quota market, provided it works reasonably well, will induce traders to gather the optimal amount of information about the fishery.

The workings of the quota market suggest the solution to the information problem. Given an efficient quota market, all information about the future course of the fishery, the state of the fish stocks, the

market price for landed fish, harvesting costs, and so on, will be embodied in the market value of the quotas, which will be roughly equal to their expected return in use. The total value of outstanding quotas is thus a good measure of the total expected rents in a fishery.

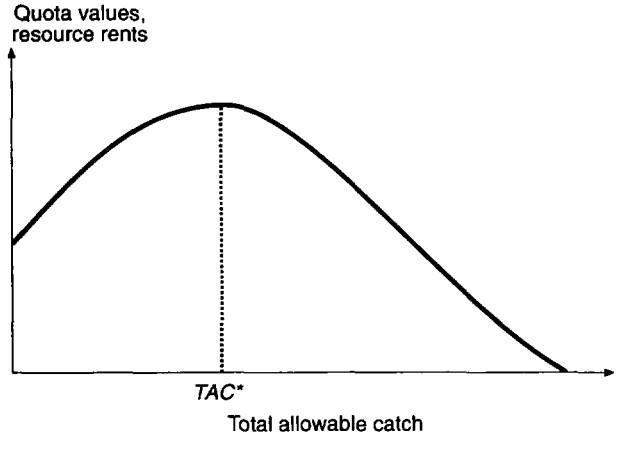
It follows that to determine the optimal total quota, the fishing authority has only to adjust the total allowable catch until the value of the outstanding quotas is maximized. This effectively exploits all the available information on the fishery.[2]

Figure 2.2 draws quota values or, alternatively, resource rents as a function of the TAC. It illustrates the proposition that the ITQ system will generally yield substantial economic rents for a wide range of TACs. More important, the figure shows that the manager of a fishery can locate its optimal TAC by simply adjusting the TAC until the market value of outstanding quotas is maximized.

This is clearly an exceptionally simple fishery management system. Under this system the fishery manager does not have to collect any information about the fishery. All the manager must do is keep a sharp eye on quota prices and adjust total allowable catch to maximize the value of outstanding quotas. For this reason, the system has been referred to as the minimum information management system (see Arnason 1990).

Putting this system into practice requires an appropriately designed ITQ system, however. First, the catch quotas must be shares in the total allowable catch. Second, the quotas must be perfectly divisible and easily transferable. Third, the market for quotas must function smoothly. The fishery manager should therefore encourage the development of the quota market and be ready to participate in it if necessary.

Figure 2.2 Resource rents and total allowable catch



The fishery manager would locate the maximum quota value by adjusting the total allowable catch and observing the resulting movement in quota prices. If total quota values go up when the total allowable catch is increased, the total quota has moved in the right direction—and vice versa. These manipulations of the total allowable catch may sound fairly complicated but they are in fact quite straightforward. Any respectable stockbroker should be able to perform these duties with little trouble.

Minimum information fishery management is a relatively recent idea that has not yet been put into practice in any ITQ fishery. Although it should be beneficial in all fisheries, it appears particularly attractive for fisheries in which there is little centralized knowledge and data processing capabilities are low.

It should be kept in mind that minimum information fishery management relies heavily on individual fishing firms behaving in an economically rational way. If the fishing firms are not rational, the minimum information management method is not likely to yield good results—but neither is any other decentralized fishery management system. Thus, even when the fishing firms are less than rational, the best management strategy may still be the minimum information management scheme.

The fishery management regime

The installation of a sound fishery management system, such as the ITQ system, is not by itself sufficient to successfully manage fisheries. To achieve that objective, a fishery management system must be supported by an effective monitoring and enforcement function backed by an efficient judicial process. Without these supporting functions, an otherwise excellent fishery management system will accomplish little.

Let us refer to the overall institutional framework within which the fisheries operate as the fishery management regime. In most industrial fishing nations, the regime is quite complicated, involving several institutes and activities. Logically, it must contain three main components—a fishery management system, a monitoring, control, and surveillance component, and a fishery judicial system (figure 2.3).

The *fishery management system* specifies the regulatory framework for fishing. It encompasses both basic fishery management rules—such as requirements concerning fishing licenses and catch quotas—and less crucial ones—such as gear and area restrictions. In most countries fishery regulations are based on legislation that aims to promote the generation of social benefits from the fisheries.

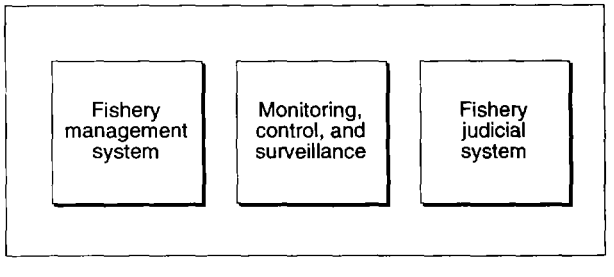
The primary task of the *monitoring, control, and surveillance* function is to enforce the management system that has been adopted. Its secondary—but nevertheless very important—task is to generate data that can be used to improve both the fishery management and judicial systems and the monitoring, control, and surveillance activity itself.

The *fishery judicial system* is usually a part of the general judicial system. It issues sanctions to those alleged to have violated fishery regulations and thus complements the monitoring, control, and surveillance activity.

The three components of the fishery management regime are strongly interdependent. For example, the fishing rules specified by the fishery management system define the scope of the monitoring, control, and surveillance activity and the focus of the fishery judicial system. The monitoring, control, and surveillance activity places demands on the fishery judicial system, and both activities in turn suggest modifications of the fishery management system.

Each of the three components of the fishery management regime is crucial to its success. To attain full economic benefits from the fishery, all three components must be appropriately designed, well coordinated, and fully functional. This point cannot be overemphasized. Any one or two of the components of the regime, however well designed and managed, will generate limited social benefits unless integrated with and supported by the other two components.

Figure 2.3 The components of the fishery management regime



These observations suggest that the design and implementation of effective fishery management requires full attention to all three components of the fishery management regime. They also suggest the importance of a single entity overseeing the regime as a whole and coordinating its components. Without a strong guiding hand of this nature, the social benefits generated by a fishery management regime are likely to be significantly reduced. In industrial fishing nations this guiding hand is usually provided by a special ministry or department of fisheries.

Establishing a successful fishery management regime

Establishing a successful fishery management regime is basically an exercise in social engineering. It involves not just technical, biological, and economic aspects, but a range of social and political considerations. For optimal results, it is very important to pay attention to as many of the sociopolitical aspects of the situation as possible. These include public attitudes, regional conditions, power relations, interest groups, and traditional social values and methods of production. Some of these aspects may justify important modifications of the components of the management regime. Others, if not attended to in time, may develop into serious obstacles to the implementation and the eventual success of the regime.

There are, of course, a great many ways to develop and implement an effective fishery management regime. Nevertheless, a few general guidelines apply:

1. Study the fisheries and the social situation carefully.
2. Avoid the wholesale import of a ready-made fishery management regime from other fisheries.
3. Design the fishery management regime with local conditions in mind. This applies to all its components—the fishery management system, monitoring, control, and surveillance, and, not least, the fishery judicial system.
4. In designing and implementing the regime and its components, work as closely as possible with the social groups most affected. Most important among these are the participants in the fishing industry and their organizations.

5. Study the most likely incidence of the fishery management regime and make provisions for flexibility in the system and for compensation to those unfavorably and unjustly affected. Compensation should always be possible because, if the system is socially beneficial, the fishery will yield monetary rents that exceed the necessary compensations.

These guidelines are intended to increase the probability that the reorganization of a fishery management regime will succeed. The first three are crucial for the effectiveness of the system, and the last two for generating the necessary social acceptance and support for the system. Without a relatively high degree of social acceptance and support, any fishery management regime will be either largely ineffective or prohibitively expensive to maintain.

Notes

1. Although the allocation of quotas may constitute a political problem.

2. This general theory is expounded in Arnason (1990).

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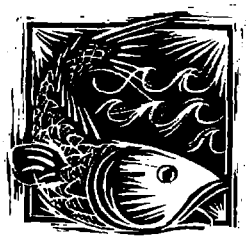


Fishery Management in Norway

Rögnvaldur Hannesson

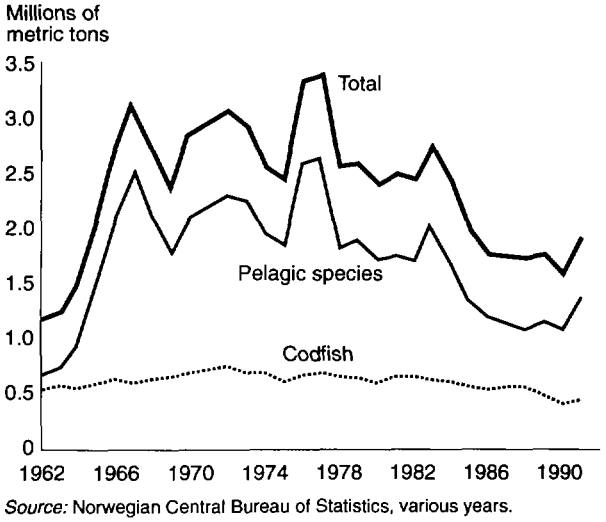
3

Introduction

Norway catches 2 million to 3 million metric tons of fish a year (figure 3.1). This ranks Norway about tenth among the world's major fishing nations, approximately on par with Thailand, the Philippines, North Korea, Denmark, and Iceland.

Most fish stocks in Norwegian waters are long since fully utilized and probably overexploited. The volume of catches increased rapidly in the early 1960s. This was due in large part to a technical innovation, the power block, which substantially increased the fishing efficiency of vessels catching herring and other pelagic species used mainly for reduction to oil and meal. That increase in efficiency probably precipitated the collapse of the herring stocks in the Northeast Atlantic and the North Sea.

Figure 3.1 Norwegian catch, 1962-91



Source: Norwegian Central Bureau of Statistics, various years.

The herring catches were replaced by capelin, another volatile pelagic species used almost exclusively for reduction to oil and meal (figure 3.2). Since 1967 the volume of Norway's catch has varied a great deal, mainly because of variations in the catches of herring, capelin, and other pelagic species. Since 1982 the total catch has declined substantially, primarily as a result of declining catches of capelin.

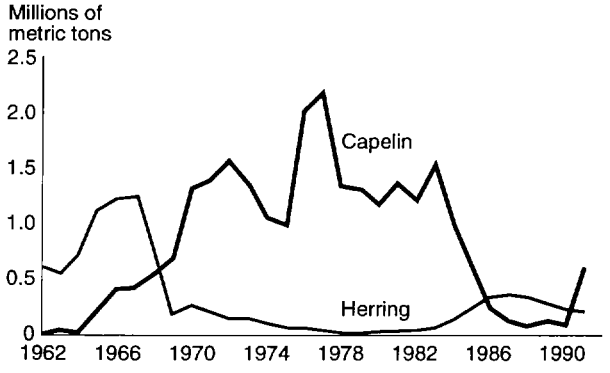
Structure of the industry

The Norwegian fishing industry is characterized by small, usually family-owned firms; large, vertically integrated firms are the exception. There are about 20,000 fishers who derive their income mainly from fishing, and some 7,000 part-time fishers. There are some 20,000 registered fishing boats, but the bulk of the catch is landed by about 100 large purse seiners (with over 8,000 hectoliters of cargo capacity) and about 80 trawlers of over 300 gross registered tons (GRT). But more than half the catch of cod and other groundfish species is taken by medium-size (50- to 90-foot) day trip boats. The large share of catch taken by these vessels is at least in part the result of a deliberate policy aimed at promoting owner-operated vessels. The medium-size coastal boats are favored over the large trawlers when fishing quotas are small, and they are not subject to license limitations as the trawlers are.

Institutional framework

Norway has a long history as a fishing nation, and the areas of sea adjacent to the country were among

Figure 3.2 Norwegian catch of herring and capelin, 1962-91



Source: Norwegian Central Bureau of Statistics, various years.

the first to suffer from overexploitation. Fishery management therefore has a long tradition in Norway. In the 1970s the international framework of fishery management was radically changed as a result of the 200-mile exclusive economic zone. Most of the fish stocks of concern to Norway are shared with neighboring countries. Because fish migrate between the economic zones of Norway and its neighbors, but seldom into the open sea outside the 200-mile zone, Norway and its neighbors have been able to manage the stocks through bilateral agreements.

The Ministry of Fisheries is the highest-level institution involved in fishery management. It is there that the important policy decisions are made, aside from those made at governmental or parliamentary meetings. The Directorate of Fisheries deals with the technical side of management, monitors catches, and implements policy; it is also charged with proposing regulations to be decided by the Ministry. Both the Ministry and the Directorate make extensive use of consultative committees composed of public officials, technical experts, and industry representatives.

The objectives of fishery policy

The main objectives of Norway's fishery policy, as stated in various official documents, are as follows:

- To preserve fish stocks
- To maintain a regional balance in the fleet
- To provide employment opportunities
- To ensure economic sustainability.

These objectives are somewhat at odds with the objective recommended by economists—to maximize rent. Economic sustainability is a far less ambitious objective and would seem little different from the long-term equilibrium that would obtain in an open-access fishery in the absence of any management. With open access to fish resources, the fishing fleet may be expected to just break even in the long term, obtaining revenues that suffice to cover costs, including capital costs. The goal of economic sustainability must, however, be viewed against the background of government subsidies provided in the past, which have occasionally been as much as 80 percent of the value added in the harvesting sector. Regional balance concerns maintaining the communities scattered along the coast, particularly in the northern part of the country, where there are few alternative employment opportunities. Preservation of fish stocks is a goal that would normally be implicit in a rent-maximizing objective.

Maximization of the economic rent in the fishery implies that the productive resources available (labor, capital) yield the same at the margin in the fishery as they do in other industries. Putting the emphasis on other goals—such as providing more employment opportunities than are strictly needed, or supporting disadvantaged fishing villages—implies forgoing economic benefits in the pursuit of such goals. How well-founded or explicit this choice is is a matter of debate.

Outline of the discussion

This chapter on fishery management in Norway first discusses the process of setting the total allowable catch (TAC) for the fish stocks. This is a natural place to begin, as the catch limits agreed on with Norway's neighbors form the basis for fishery regulations in the short term. The chapter then discusses the methods by which the fishing fleet is regulated so as to ensure that the catch limits are observed. It next considers the long-term control of fishing capacity necessitated by the limited productivity of the resources. Finally, it discusses strong and weak points of Norway's fishery policy.

Management of the fish stocks

Most fish stocks in Norwegian waters are not confined to the Norwegian economic zone over their entire life cycle. The fish migrate into Norwegian

waters from the economic zones of neighboring countries, and vice versa. These migrations are partly seasonal and partly related to the stages of the fish's life cycle. The Arctic cod, for example, spawns off the Norwegian coast, and the larvae drift north into the Russian economic zone. Older fish from this stock return to the Norwegian coast in search of food and to spawn. North Sea herring migrates into the Norwegian zone, particularly if the stock is large. The Atlanto-Scandian herring used to migrate into the Norwegian Sea and to the coast of Iceland, but has been confined to the Norwegian zone since the stock collapsed in the late 1960s.

Setting the total allowable catch

The transboundary migrations of the fish stocks mean that effective fishery management requires cooperation with the neighboring states. The present form of cooperation came into being after the establishment of the 200-mile exclusive economic zone, which left a very limited area of the Northeast Atlantic outside the exclusive economic zones of the coastal countries (chart 3.1). Most fish stocks in the Northeast Atlantic are now controlled by setting an upper limit on how much can be caught—the total allowable catch (TAC). The management of stocks encountered outside the economic zones (blue whiting, oceanic-type redfish) is overseen by the Northeast Atlantic Fisheries Commission (NEAFC), a body composed of representatives of the countries with fishing interests in the international waters of the Northeast Atlantic. There are no agreed on TACs for these stocks.

The TACs are set based on advice from international teams of fishery biologists. The TAC process starts with meetings of working groups at which fishery biologists from the countries concerned pool their data and models and make forecasts of the stocks for the near future. These meetings usually take place under the auspices of the International Council for the Exploration of the Sea, an international organization founded early this century to promote fisheries and oceanographic research. Its member states are the European coastal countries and the United States and Canada. The organization has established an advisory body, the Advisory Committee on Fisheries Management.

Earlier the fishery biologists usually recommended a single figure for the total allowable catch of each stock in the coming year. These recommendations were usually based on the criterion that fishing mortality should be at the level that allows maximum sustainable yield, or related criteria. In later years it has been explicitly recognized that setting the TAC is not just a question of biology, and various options are given, along with their consequences for the future status of the stocks. Recommendations of a single figure are now issued only for stocks judged to be particularly threatened.

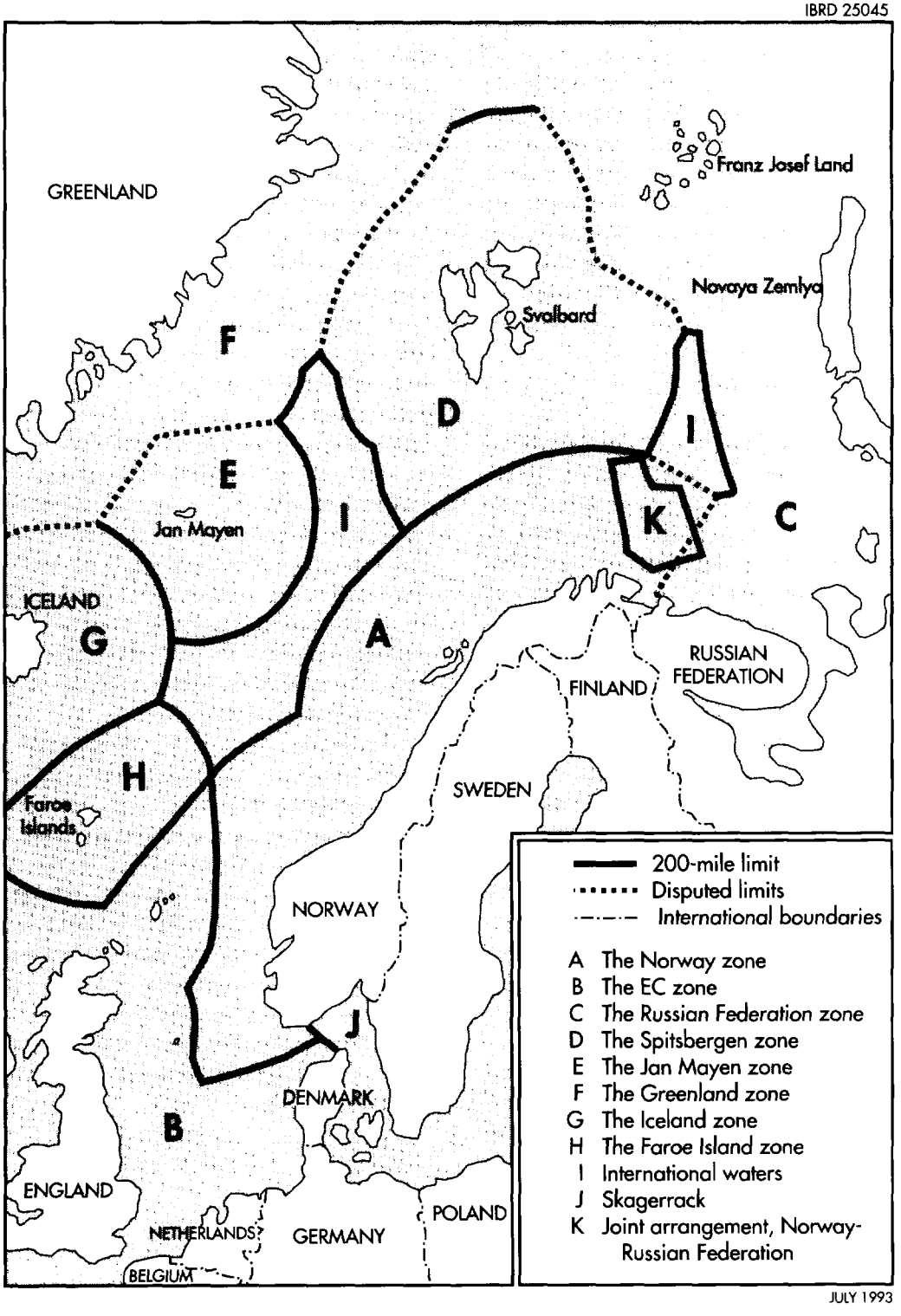
Once the biologists' advice is received, the process of actually setting the TAC starts. This is done through bilateral negotiations between neighboring countries. Norway conducts bilateral negotiations with Russia (previously with the Soviet Union) about the stocks in the northern Norwegian Sea and the Barents Sea, with the European Community about the stocks in the North Sea, and with Iceland, Greenland, the Faroe Islands, and Sweden about stocks migrating between the Norwegian zone and the zones of these countries. Before these negotiations consultations are held with representatives of the industry, both the Fishermen's Association and the processing industry.

Because most of the Northeast Atlantic stocks appear to be overexploited, the fishery biologists have usually recommended considerable and sometimes drastic cuts in catches. Such drastic cuts are unpopular among fishers even if they promise better catches in the future. Pressure from the industry has therefore usually resulted in TACs set at levels considerably higher than those recommended by the biologists. Such pressure is not unique to the Norwegian industry; it has probably been even stronger in the countries of the European Community. This has probably delayed or prevented the recovery of some stocks.

Dividing the total allowable catch

Once the TAC has been set, it remains to divide it among the nations controlling each stock. Soon after the 200-mile zone was established clear rules emerged for the division of the TAC. In some cases these rules are just established practice (Norway and Russia), but in other cases the rules have been agreed on in writing (Norway and the EC) or codified in

Chart 3.1 Exclusive economic zones in the Northeast Atlantic



international agreements (Norway, Iceland, and Greenland). In the north the most important stocks jointly managed by Norway and Russia are the Barents Sea capelin and the Arcto-Norwegian cod. The cod is split equally between the two countries, with some allowance (10 percent in 1992) for catches to be taken by third countries, and the capelin is split forty-sixty in Norway's favor. These shares are based on historical catches prior to 1977, when this system was first put into practice.

For the North Sea groundfish stocks, which are shared between Norway and the European Community, fixed shares were worked out based on a study of fish migrations which attempted to establish the "zonal attachment" of a stock—that is, how much of the various life stages of a fish (egg and larval, juvenile, and adult) was spent inside each zone. The shares agreed on were based mainly on the zonal attachment of the fishable part of the stock. In addition, there are annual exchanges of quotas and agreements on fishing in each other's economic zone.

The North Sea herring is an interesting case. This stock fluctuates widely and, when large, tends to spill over into the Norwegian zone more than usual. When the zonal attachment was being studied, there was a moratorium on North Sea herring. When the fishery was reopened, the European Community insisted on a 4 percent Norwegian share, based on actual catches while the stock was in decline. The division of the TAC was not agreed on, and the Norwegians intensified their fishery to demonstrate how much they would be able to take. A sliding scale for this stock has now been agreed on which gives Norway a larger share when the stock is plentiful.

The Icelandic capelin stock migrates into Greenland's zone and Norway's zone off the island of Jan Mayen for a part of its life cycle. A fishing treaty among these countries specifies each country's share of this stock and how much each country can take in another country's zone.

Evaluation of the TAC management

How successful has the TAC management been? In one case the TAC management may have averted the collapse of an important stock, the Barents Sea capelin. This stock was severely depleted in the 1980s, and the fishery was closed altogether from 1986 to 1990. In 1991, when the stock appeared to have recovered sufficiently, it was reopened.

This example of successful management notwithstanding, the system does have shortcomings. A basic criticism that can be levied against the system's advisory process is that it does not take into account economic considerations. As is well known, the optimum amount of fish to be caught in any particular year depends on the size of the stock, its growth parameters, the price of fish, the cost of fishing, and the discount rate. Biological advice takes only the first two into account. It can with some justice be maintained that economic factors are country-specific and cannot, therefore, be taken into account by an international body of advisors; such bodies can only consider objective facts that are common to all parties involved and independent of the economic and social situation in any particular country. The force of this argument is weakened, however, by the fact that countries are becoming more and more integrated through international markets. Nevertheless, each country needs to take into account how economic circumstances affect the TAC that would be in its best interest. In Norway this advisory mechanism is not well developed.

The main problem with the TAC regime is insufficient enforcement. In Norway it appears that a system of reporting and cross-checking is in place. Here the fishermen's marketing boards for raw fish play an important role. These marketing boards are granted an exclusive right to all first-hand sales of raw fish, a right that is likely to come under review in the near future. The Norwegian authorities were for many years less than enthusiastic about observing the TAC for Arctic cod agreed on with the Soviet Union. No real attempt was made to restrict fishing in the coastal fisheries for Arctic cod even when the Norwegian quota had been exceeded, as the Norwegian-Soviet treaty allowed continued fishing by coastal vessels in such cases. This loophole was closed in 1988.

The enforcement of quotas is notoriously weak in the European Community, and fishery biologists have for years made allowances for overfishing and misreporting in their annual assessments of stock. Official documents of the European Community acknowledge that the discrepancy can be as high as

60 percent. There is widespread popular belief, but little hard evidence, that the enforcement of fishing quotas for the Russian fleet leaves much to be desired.

If the total allowable catches and the national shares can be and in fact are enforced, the system provides a good basis for successful economic management. In this respect, however, Norway's record is not particularly impressive.

Management of the fishing fleet

The need to control the fishing fleet arises for two reasons. First, there is a need to control the activities of a given fishing fleet in the short term so as to ensure that stocks are not fished beyond what is deemed appropriate. Under the TAC regime this means that the total catch of Norway's fleet should not exceed the TAC (or, more correctly, Norway's share of the TAC) for each stock. When the fishing capacity of the fleet is greater than the TAC, the activity of the fleet will have to be constrained to prevent its catches from exceeding the TAC. This will almost inevitably be necessary from time to time even if the fishing capacity is optimal for the long term, because of fluctuations in fish stocks.

Over the long term the capacity of the fleet needs to be tailored to what the resources can support. The appropriate capacity depends on the price of fish, the cost of fishing, the variability of the fish stocks, and the objectives of fishery management. Market forces will not automatically lead to optimum fleet capacity if the goal is to maximize the resource rent in the fishery. Unregulated entry to the fishing industry is likely to lead to the use of vessels and manpower at levels that ensure that the fleet just breaks even and no rent is obtained. If employment opportunities in the fishing industry are the top priority, there is perhaps something to be said in support of this situation. It may be argued, however, that rent maximization, appropriately formulated, fully accounts for employment opportunities. If employment opportunities are of concern, it presumably means that the opportunity cost of labor is zero—that it generates no value outside the fishing industry. Employment in the fishing industry should then be increased to the point at which it generates no additional income at the margin, but not beyond, as it makes little sense to increase employment at the expense of the value produced.

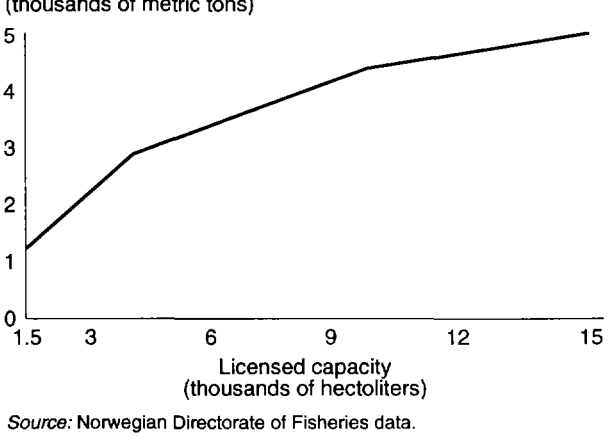
How the catch is controlled

In Norway the methods of keeping the catch within the limits set by the TAC are vessel quotas and various restraints on fishing activity. The TAC for any given species is divided between the ocean-going fleet and the coastal fleet. The ocean-going fleet is controlled by vessel quotas. If effectively enforced, this is a straightforward way of ensuring that the TAC (or, rather, the vessel group's share of it) will not be exceeded.

The way in which the TAC is divided among vessels in the pelagic fishery and the cod fishery differs. For the purse seine fleet fishing for such pelagic species as herring, capelin, and mackerel, the TAC for each species is divided on the basis of the licensed cargo capacity of the vessels (a concept I will return to later). The licensed capacity of each vessel defines the base quota of the vessel. The base quota is related to the licensed capacity in a regressive manner, as shown in figure 3.3. The actual allocation of the catch for a vessel is determined by multiplying the fleet's TAC by the vessel's base quota and dividing by the sum of base quotas. This system obviously favors small vessels. It is designed to equalize incomes among vessels, and takes into account that large vessels are more economical than small ones.

A share of the TAC for pelagic species is set aside for coastal vessels (trawlers and purse seiners of less

Figure 3.3 Base quotas and licensed capacity of Norwegian purse seiners



Source: Norwegian Directorate of Fisheries data.

than 90 feet or 1,500 hectoliters cargo capacity). Some species are in fact entirely reserved for these vessels. These vessels fish from a common quota, but for species used for human consumption a trip limit is usually applied to ensure that the catch is of a sufficiently high quality.

In the cod fisheries different methods are applied for the trawler fleet and the coastal boats. Since 1976 the trawlers have been subject to an annual quota limit. This began as a very rigid system that paid little attention to economic efficiency and did not permit transfers of quotas between vessels owned by the same company, let alone between companies. Later the rules were relaxed somewhat.

For many years there were no restrictions on the fishing activity of the coastal vessels fishing for cod. This occasionally led to the fleet's exceeding the Norwegian share of the TAC for Arctic cod. In the late 1980s these vessels were subjected to periodic inspections to keep the cod catch within the TAC. As the TAC for the cod was reduced, this became insufficient. In 1990 vessel quotas for cod were implemented for the coastal fleet for the first time. This was not an easy system to administer, as there are about 7,000 vessels fishing for cod.

The vessels exceeding a certain minimum catch in one of the preceding three years (about half the vessels) were incorporated into the vessel quota system while the others fished from a common quota. The vessel quotas were based on the length of the vessel, so that all vessels within a certain length class were allocated the same quota. This is a noteworthy departure from the usual practice in imposing quotas; generally the catch history of each boat in recent years has determined the quota allocation for each boat. The Norwegian quota allocations were designed in that way for reasons of fairness; it was felt that using the physical characteristics of the boat as a criterion would ensure that everyone was treated equally. But this system clearly discriminates against those who for whatever reason manage to do better than others with any given outfit, particularly since the transfer of quotas between vessels was explicitly forbidden. The rationale for quota transfers is that some can make a greater profit than others in taking a given amount of fish, a gain in economic efficiency that would be divided between the buyer and the seller of a quota through bilateral negotiation. The quota rules in the cod fishery may thus be said to have paid no attention to economic efficiency; all the emphasis was put on fairness, or, rather, on one definition of fairness. It has now been proposed to replace this system with common quotas for a group of vessels, dividing the year into several periods to avoid some of the consequences of competitive fishing from a common quota. How this system will fare remains to be seen.

Quota allocations and some other management measures (such as mesh size regulations, the opening and closing of areas) are proposed by the Directorate of Fisheries, but the final decision on these measures rests with the Ministry of Fisheries. Before formulating such proposals, the Director of Fisheries must consult an advisory board on fishery regulations. This advisory board is composed of representatives of the authorities (the Ministry of Fisheries and the Directorate of Fisheries), fishery biologists, labor unions in the fishing industry, and the Fishermen's Association. The Fishermen's Association is heavily represented on the board of advisors, an arrangement that has both positive and negative aspects. On the positive side, involving representatives of fishers in the management process enhances the legitimacy of any management measure and can be expected to improve compliance. The process is open and transparent, with the minutes of the advisory board accessible to the public. On the negative side, this arrangement turns fishery management into a political process. Issues are decided based on the number of hands raised and on political clout, rather than on the economic merits of each measure.

Selective gear

A recent development in catch regulation that is particularly worth mentioning is the application of devices that sort out by-catch before it is trapped by the fishing gear. These devices have been used successfully in the shrimp fishery, where juvenile cod and other groundfish often got caught by the trawl, and experiments are under way in other fisheries plagued by by-catch problems. Driving the introduction of these devices is a regulation stipulating that no fish may be thrown overboard once caught. This contrasts with by-catch regulations in the European

Community, which require fishers to release by-catch into the sea.

Control of fishing capacity

The main method for regulating the size of the fleet is a system of licenses. Under the fishery law a permission is required to own and to operate a fishing vessel, but such permissions are given as a matter of course, and there is a general exemption for vessels of less that 50 feet. The biting constraint is a specific license required in certain fisheries, such as purse seining and trawling. Most large vessels are covered by this system of licenses, the exception being long-line ocean-going vessels.

This system of special licenses is really a collection of different licensing schemes that have emerged at various times in response to different needs. Large trawlers were allowed into the fisheries with some reluctance, and then only because the processing industry was becoming more capital-intensive and dependent on a regular supply of raw material. The trawling licenses stipulate a size limit for each licensed boat, but the system is sufficiently flexible to allow a substantial upgrading of vessels. The large trawlers are owned by companies, usually fish-processing companies, with the exception of factory trawlers that process the catch on board. These vessels are an exception to the rule stipulating that the fishing vessels should be owner-operated.

The fishing capacity of the trawling industry was expanded considerably in the 1980s. In addition, a number of new trawling licenses for small vessels were issued—even though it was generally agreed that the catch capacity of the trawler fleet was more than enough—so as to maintain a better regional balance in the fleet. These licenses cannot be sold unless they are sold with the boat, and even then only with the permission of the Ministry of Fisheries.

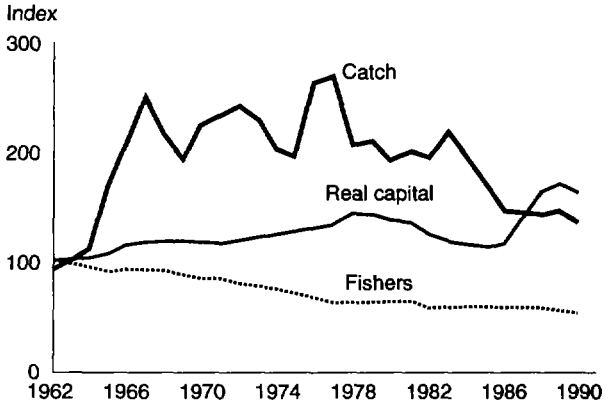
Licenses for the purse seine fleet were introduced after the collapse of the herring stocks in the late 1960s. It was by then clear that the fishing capacity of the fleet was much greater than that needed to take the available catch of herring and other pelagic species for the foreseeable future. To begin with, all vessels in the purse seine fleet longer than 90 feet were licensed. The licenses were defined in terms of hectoliters of cargo capacity, as it was believed, and with reason, that the fishing power of the vessels was directly related to their cargo capacity. No one is allowed to own more than two purse seiners.

The purse seine licensing system evolved in an interesting way. Originally, the licenses were to be transferable to next of kin, at the discretion of the authorities. Fishers were aware that efficiency gains could be achieved through the transfer of licenses from old vessels to new vessels. Pooling the licenses of two old vessels could accommodate a new and more efficient vessel, even if the transfer of hectoliters of cargo capacity was not allowed on a one-for-one basis (there was a reduction in the amount of hectoliters exceeding a certain number). The efficiency gains are due to the economies of scale in purse seining: a vessel with twice the cargo capacity of another vessel has approximately twice the catch capacity, but a crew that is not much larger. Pressure mounted to allow the transfer of licenses, and an informal market in licenses developed, with the licenses of vessels to be withdrawn from the fleet being sold separately and sometimes in shares to different buyers. This apparently unforeseen development was initially frowned upon by the authorities, but in the end the market was tolerated.

In addition, the government initiated a buyback program to reduce the catch capacity to a level that the resources could bear. The licenses bought in this program were permanently withdrawn, together with the vessels. The economic benefit of this, for the fleet as a whole, was a reduction in the operating costs by the amount otherwise incurred by the decommissioned vessels, and it can be argued that the buyback program did yield a net economic benefit. The buyback program also benefited the vessels that remained active by increasing the share of each in the TAC. It could be argued that the industry itself could have financed the buyback program from the increased revenue for the remaining vessels, but the government-financed program came into being before any such solution was seriously considered.

The licensed capacity of the purse seine fleet declined from 1.3 million hectoliters in 1973 to 0.8 million in 1990, but the fleet's catch capacity is nevertheless still far greater than needed to take the available catch. Efforts to reduce capacity in the cod fishing fleet were even less successful. Figure 3.4 shows trends in catch, real capital in the catching

Figure 3.4 Catch, real capital, and fishers in Norwegian fisheries, 1962-90



Source: Norwegian Central Bureau of Statistics, various years.

industry, and number of fishers since the early 1960s. There was an investment boom in the catching industry in the late 1980s as a result of the relaxation of a previous ban on increasing the fleet capacity, the deregulation of the credit markets, and an anticipation of greatly improved yields of the cod stock, an expectation that only partly materialized. This investment boom occurred even though the fishing capacity for cod was probably already much too great. The result has been that the largest and most modern Norwegian trawlers have been forced out of Norwegian waters because the quotas, reserved primarily for the coastal vessels, are too small to accommodate them.

Conclusion

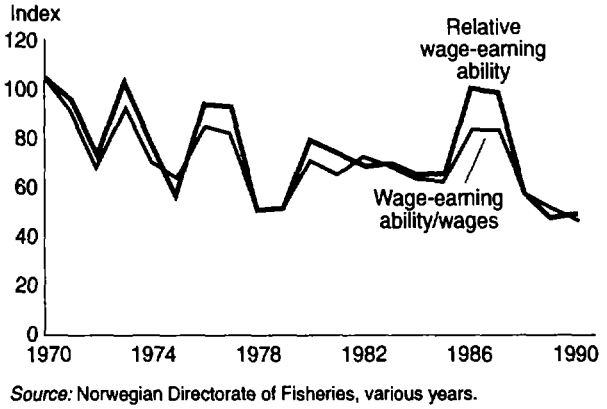
The strong points in the Norwegian fishery management system relate to the management of fish stocks. There is well-established expertise among fishery biologists who give advice on setting TACs. And there is an elaborate system in place to monitor catches, so the implementation of TACs for the fleet that lands in Norway (and that is still a dominant part of the fleet) should not be much of a problem. High grading, the disposal of less valuable fish at sea to make room for more valuable fish, is more of a problem. Although the practice is explicitly forbidden, it is known to occur: at what scale it occurs is not known, however.

The weakest points of the system are on the economic side. Even if the fisheries have potential rents, they hardly break even and in fact yield less than a normal profit when government subsidies are deducted. Figure 3.5 shows the fleet's profitability, defined as wage-earning ability. This is calculated by deducting all costs, including capital costs (depreciation and an alternative rate of return), from the revenue, thus arriving at a sum that can be distributed among all crew members. The curve showing relative wage-earning ability has been derived by dividing the wage-earning ability in the fishery sector by the annual wage cost per man year in the construction industry, which in terms of hardship and skills should be comparable with the fishing industry. The curve for all vessels (boats of 13 meters or more used year-round) shows that the wage-earning ability in the fishing industry has usually been less than the annual wage cost in the construction industry, indicating negligible rents in the fishing industry.

The other curve in the figure shows wage-earning ability divided by actual remuneration. This curve usually lies below the first one, indicating that actual wages usually exceed the wage cost in the construction industry. Furthermore, the ratio has in most years been less than 1, indicating that the invested capital does not yield a normal rate of return. That the two curves follow a very different pattern indicates that actual wages in the fishing industry fluctuate much less than the wage-earning ability.

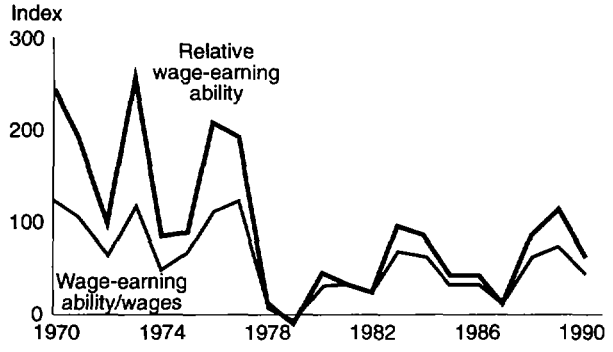
Figures 3.6, 3.7, and 3.8 show the same curves for the largest vessels in the Norwegian fleet. The volatility for these vessels is greater, as they form smaller and more homogeneous groups subject to substantial fluctuations in fish stocks that are inde-

Figure 3.5 Wage-earning ability of Norwegian fishing fleet, 1970-90
(all vessels over 13 meters)



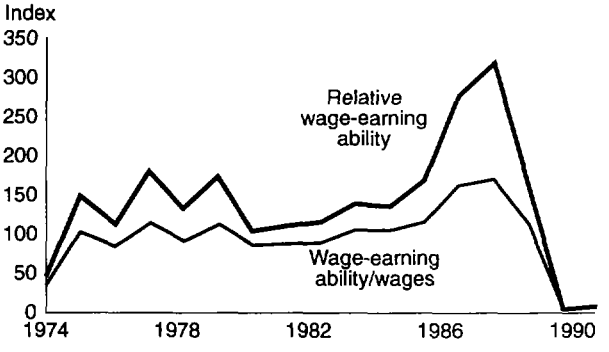
Source: Norwegian Directorate of Fisheries, various years.

Figure 3.6 Wage-earning ability of Norwegian large purse seiners, 1970-90



Source: Norwegian Directorate of Fisheries, various years.

Figure 3.7 Wage-earning ability of Norwegian factory trawlers, 1974-90



Source: Norwegian Directorate of Fisheries, various years.

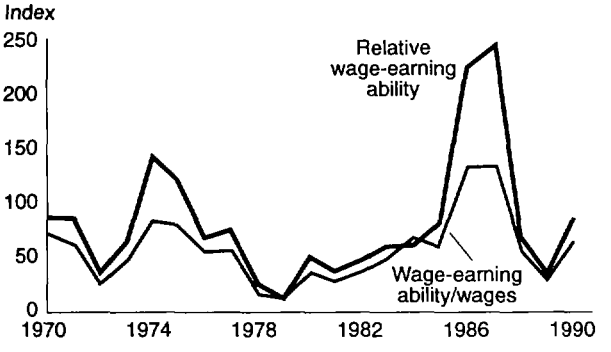
pendent of one another, but the overall picture is not more advantageous than for the fleet as a whole—rather, it is less advantageous.

Government subsidies offer another angle on the limited, or most likely negative, profitability of the fishing industry (figure 3.9). The subsidization began as an ad hoc emergency measure in the mid-1950s as profitability in the fishing industry began to lag behind that in other industries. In 1964 a formal agreement was concluded between the government and the Fishermen's Association granting the association the right to demand negotiations with the government for financial support whenever the wage-earning ability of the fishing industry fell short of wages in comparable industries. At the time the subsidies were not intended to become permanent; in fact, they were intended to increase the efficiency of the industry so that it would be self-supporting in five years. This agreement nevertheless developed into a fairly open-ended commitment to support the industry no matter what, and the subsidies reached their all-time high in 1981. This has undoubtedly increased the overcapacity in the industry. Now, nearly thirty years later, achieving economic sustainability is again on the agenda.

Why is the profitability of the Norwegian fisheries so low? Is this the logical consequence of not making profitability a priority, or an unintended consequence of the fishery management system's design? Preserving viable fishing villages scattered along the entire coast is a stated priority of government policy, along with the industry breaking even and becoming independent of government subsidies. Maintaining a smaller and more profitable fleet would most likely mean that some of the smallest fishing villages would no longer be viable, and possibly also that a greater share of the catch would be taken by vessels from the southern part of the country. Having a larger number of vessels and fishers than strictly needed is likely to counteract the tendency toward greater spatial concentration, but at the cost of the value that could have been produced by allocating manpower and capital to other uses. General support of the small fishing villages through the promotion of economic activity and through tax relief, for example, is likely to be a better and less costly way to preserve them. In fact, there are now plans to stop using the fishing industry for this purpose and to rely on more general measures. Apart from that, one might ask what sense there is in preserving communities that apparently have difficulty in attracting sustainable economic activity.

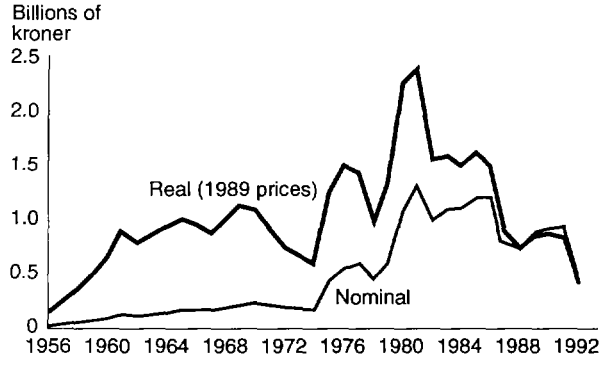
It is also possible that preserving the fishing communities is just a useful argument for the interest groups in the fishing industry and the politicians most closely associated with them. As already men-

Figure 3.8 Wage-earning ability of Norwegian fresh fish trawlers, 1970-90



Source: Norwegian Directorate of Fisheries, various years.

Figure 3.9 Government subsidies to the Norwegian fishing industry, 1956-92



Source: Norwegian budget statistics.

tioned, the influence of the Norwegian Fishermen's Association on policymaking is considerable. As in all organizations based on democratic principles, its positions are based on sheer numbers. The association tends to speak for the more numerous small-scale fishers, who feel most threatened by structural change. This tips the scale heavily in favor of forestalling structural changes that promote economic efficiency. Arguably the most fundamental weakness of the Norwegian fishery management system is that it shuns markets but lets decisions that affect the use of resources be made through political processes that put more emphasis on issues of distribution and fairness than on generating wealth. As a result, transfers of fishing quotas or fishing licenses through voluntary exchanges that divide the gains between the parties concerned are either explicitly forbidden or reluctantly allowed. With all due respect for the political process, some issues are better left to an apolitical market mechanism that allocates resources on the basis of profitability and mutually beneficial exchange. Despite all the limitations inherent in markets and the corrections that in many cases are necessary, the market system is unparalleled as a wealth-generating mechanism.

A fable: The arbiter of fairness

To what good purpose, then, is the fishery management undertaken in Norway? In terms of economic efficiency, the ambition is not much higher than to have the industry break even. This it would probably do anyway if it were left to its own devices and no management were attempted. There remain, then, distributional goals, concerning who should fish, when, and where. Whatever the legitimacy of such goals, they are expensive, both in direct costs and in the value forgone because of inefficient fishing. The management of Norway's fisheries is estimated to cost about 500 million kroner annually. This amounts to about 10 percent of the gross value of the catching industry, and 15 to 20 percent of its value added (there are now plans to have the industry contribute to these costs). The value of forgone production due to overcapacity in fishing could be as high as 3 to 4 billion kroner, which amounts to 60 to 80 percent of the gross value of the catching sector.

It is tempting to conclude with the fable of the mice and the monkey. Two mice found a piece of cheese, but could not agree how to divide it. They asked the monkey for help. The monkey took the cheese, broke it in two, and looked at the pieces. He observed that they were unequal, and since this was not fair, he took a bite from the bigger piece. The bite was, unfortunately, slightly too big, so the small piece was now the big piece. The monkey took a bite from the other piece, and the same thing happened again. This went on until only two small pieces were left. At this point the monkey put both pieces in his mouth, saying "What is left now is only my rightful fee." Sad to say, many policies pursued for the sake of fairness lead to results that are little better.

Note

I am indebted to Sigmund Engesaeter of the Directorate of Fisheries for comments and factual information. The views expressed in this paper are my own and not those of any Norwegian public institution.

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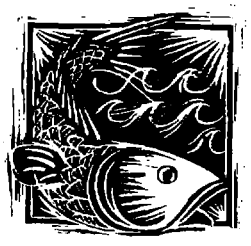

Fishery Management in Canada

Philip A. Neher

4

European interest in aboriginal Canada was driven by the abundance of the land's biological resources. The distant-water fishing fleets of England and France were early to exploit the rich stock of Atlantic cod found on the Grand Banks off Newfoundland and in adjacent waters. The associated shore-based support for the fisheries motivated rival colonial settlement in Canada. Today, however, the modern Canadian state has emerged as the dominant sovereign power with its own management responsibilities under international law. Canadian jurisdiction over fisheries now encompasses most of the contiguous shallow waters of the oceans and the many commercial fish stocks that they contain. I will concentrate on the management of salmon in the Pacific Ocean and of cod and lobster in the Atlantic Ocean because of their economic importance and the notable failure of their management to achieve sustainable economic and social objectives. I also will comment on some promising new experiments in rights-based fishing, particularly in Pacific waters, to suggest principles that might apply to other fisheries under other jurisdictions.

I begin with a brief review of Canada's legal and administrative framework for achieving objectives of fishery management.

Law and administration

The Canadian Constitution (the British North American Act, 1864, as amended) assigns regulatory powers over all fisheries to the federal government and gives powers over property rights and natural resources to the provinces. For fish, this division stems from the English legal tradition of extending common access to wild animals (and the rule of capture) while assigning private property rights to the land and waters that contain them. In practice, this confusing legal structure has been distilled to a shared federal-provincial responsibility for freshwater fish with the provinces taking the lead and the federal government dominating the administration of tidal waters and their marine resources.[1]

The fuzzy boundary dividing fishery authority could rob Canada of coherent fishery policy. For example, provinces could subsidize new fish processing capacity while the federal government restrains the raw fish input, and the federal authority to protect the spawning habitat of salmon could be subverted by provincial logging practices.

The federal authority is the most relevant for this chapter. It is implemented under an act of parliament, the Fisheries Act, which has three conspicuous features. First, the minister of fisheries is mandated to protect the stocks (the target level of abundance is not specified). Second, the minister's personal discretion in discharging this mandate and in regulating other matters pertaining to fishing is virtually unconstrained in the Act except by higher law. And third, fishery regulations have the status of criminal law.[2] Although today these features of the Fisheries Act seem to be anachronistic artifacts of the last century, they have shaped the modern development of Canadian fishery management.

This development is conveniently, but roughly, divisible into three stages since World War II. The first stage corresponds with the early post-war years, which were characterized by abundant fish stocks

relative to catching capacity. Administration, which was minimal, employed "game warden" techniques to restrain destructive fishing practices, to moderate gear conflicts and competition for preferred fishing grounds, and to enforce compliance with international agreements (mainly the International Halibut Agreement and the prohibition on the pelagic catch of the Pacific fur seal).

But the war spawned new technologies that could be applied to finding and catching fish: radar and loran for navigation, sonar for underwater location and net minding, synthetic fibers for lines and nets, intercooled turbo-supercharging for engines, and hydraulics for winches and lifts. These developments, against a background of steady advance in naval architecture and propulsion, were driving fish mortality beyond the capacity of fish stocks to replenish. Although some new stocks were discovered, most stocks were depleted and some were endangered. In administrative jargon, stocks were *fully utilized* or *overutilized.* For Canada, problems with home-based overfishing were exacerbated by competitive foreign distant-water fleets operating in Canadian "domestic" waters with nonselective gear (mainly bottom trawls) and indiscriminate catching.

Licenses

Salmon: Vessel licenses

Pacific salmon were a special case for Canadian fishery administration. These fish spawn in fresh running water flowing into the western Arctic Ocean and into the Pacific Ocean as far south as central California. But most species mature as commercial fish along migratory routes in the relatively shallow waters extending across the North Pacific toward Asia before returning to home waters in North America to spawn and die.

Although these salmon were vulnerable to interception outside the then national waters of the United States and Canada, they were protected from this by international agreement that, in effect, recognized a proprietory interest of the home country in the migratory stocks. The proprietory interest was a motivating precondition for the United States (mainly Alaska) and Canada to manage their domestic salmon industries in their own interests. Time and area restrictions were imposed, and, in an important step for Canada, a system of vessel licensing was introduced in 1968. This marked the beginning of the second stage of fishery management—restrictive licensing.[3]

The vessel licenses were not just administrative conveniences. They were restrictive; demand for them exceeded the supply at the nominal administrative price. The license system was intended to contain the growing fishing power of the fishing fleet as a complement to the other restrictions aimed at protecting dwindling stocks.

Restrictive vessel licensing on this scale was a novel Canadian innovation in commercial fishery management. But did it succeed in reducing fishing power? In retrospect, most observers agree that the ingenuity and determination of Canadian salmon fisheries to legally subvert the intent of the license system was vastly underestimated, even as the system was refined to restrict vessel characteristics, such as length and displacement. Fishers saw commercial advantage in "stuffing" their boats with even more sophisticated and effective electronics and more powerful and lighter engines. Just as important, a new class of naval architecture sprang up to increase vessel mobility (speed) and seaworthiness, and to accommodate new catching gear and handling equipment. These measures blunted the restrictive impact of licenses and were very expensive for fishers. Nonetheless, licenses took on market value, indicating that these measures taken by fishers to substitute characteristics of fishing effort for the restricted ones were only partly successful.

Put another way, although individual vessels became more efficient killing machines, restrictive licensing reduced the fishing power of all vessels combined to less than it would have been without the license restriction.

But the cost of achieving this reduction in fishing power was enormous for fishers and for society as a whole. The allowable catches of the salmon could have been taken at far less cost. The license program may have achieved some biological success, but it was an economic disaster.[4]

It was also an administrative nightmare. The massive power developed to make restricted catches during short seasons (measured in hours and minutes) for geographically concentrated stocks resulted in such confusion and conflict on the fishing grounds that achieving adequate "escapement" of

breeding stock for reproductive purposes was a regulatory challenge of unprecedented proportions. It remains so today.

Lobster: Gear restrictions

Restrictive licensing spread in Canada from the important salmon fishery to other fisheries on both the west and the east coasts. The lobster fishery on the Atlantic coast was also subjected to restrictive licensing. But there, the effective restriction was on the number of traps that each licensed enterprise could deploy.

Lobster fishers responded to the restriction on traps by visiting their traps more frequently, hauling them faster, and setting them farther out to sea, where lobster densities were higher. And so with lobster, as with salmon, the response of fishers legally subverted the intent of the restriction at great expense. And again with lobster, the licenses took on market value.

From licenses toward quotas

Canadian fishers, particularly those in the salmon and lobster fisheries, became accustomed to the trading of licenses and came to regard them as personal property, although they were officially permissions. This is perhaps the most significant outcome of the Canadian restrictive licensing program. Restrictive licenses convey the right of fishing to some people while denying it to others, thus breaching the principle in English common law of equal access for all. A transferable license, however, conveys the right of fishing to a person who is prepared to pay the market price. In this sense there is equal access for all who pay the (market) price. It is remarkable that Canadian fishers have accepted this principle as an integral part of their business environment. It represents a degree of economic sophistication that helps smooth the current transition to the third stage of Canadian fishery management—rights-based fishing.

Current Canadian legislation does not allow for legal rights of fishing. Legally, restrictive licenses are mere permissions for fishers to operate vessels, gear, or enterprises (Crowley and Palsson 1992). It is inevitable, however, that fishers will have disputes with the authorities and with each other in connection with licenses, and that some of these disputes will be taken to courts of law for settlement. And if the courts interpret permissions as rights, fishers are confirmed in their belief that permissions that they have paid for, or can sell, are indeed rights. Canadian courts have tended toward accepting the interpretation of fishing licenses as legal rights, but the common law seems unclear on this.

This legal ambiguity in Canada does not deter the implementation of regulations that are consistent with rights-based fishing. Individual fishing quotas are now used in nearly twenty Canadian fisheries and there is a growing consensus that the full potential of management through quotas can be realized as they become more secure as property rights.[5]

Area licenses are another instrument of rights-based fishing, but these have not been as popular as quotas and I will not discuss their potential here.

The economics of quotas, as compared with licenses, are clear. Licenses are a control on the input of economic resources into the fishing effort with the intent, presumably, of (indirectly) controlling the output of caught fish. Quotas are a direct control on output and promise more precision in controlling catches. But fishing over quota, poaching, high grading, by-catches, and competition with open-access catching sectors exploiting the same stock of fish pose potential problems for quota management.[6] These can be more or less important, compared with the problems under other modes of management, depending on conditions in particular fisheries. Some fisheries are better suited for quota management than others; there has been mixed success with quotas in the twenty fisheries in Canada that now use them.

Quota management was at first an industrial success in the important North Atlantic cod fishery, but the recent discovery of exceptionally thin breeding-year classes suggests a management failure of unprecedented proportions that might be linked to quotas. Other fisheries have enjoyed remarkable successes. I will comment on these in turn.

Cod: Enterprise quotas

The Canadian North Atlantic cod stocks were historically regarded as so abundant and resilient as to be nondepletable and thus capable of supporting

both popular inshore, small boat fishing and offshore factory trawling on a sustainable basis. The 200-mile exclusive economic zone (EEZ) declared by Canada in 1977 was seen as an opportunity not so much for better stock management as for the displacement of foreign distant-water vessels by a new and powerful class of Canadian trawlers.

The codfish move seasonally on the Grand Banks off Newfoundland between inshore and offshore areas within the EEZ, and so it was thought prudent to place the offshore commercial fishery companies under enterprise quotas to protect the inshore social fishery. This measure was particularly important for the province of Newfoundland, which had developed on the resource base afforded by the cod stocks and still, in modern times, derived about 30 percent of its income from fishing. Inshore fishing had come to be an occupation of last resort in an area that offered limited alternative employment opportunities to a population not prone to migration.

The politics of this resource dependence and the associated social assistance programs are particularly complicated in Canada's federal system and are difficult to describe and understand. But it is safe to say that fishery policy evolved to maximize fishery employment in economically depressed areas of Atlantic Canada subject only to the constraints of sustaining the fish stocks at some density, however thin, and offering minimally feasible commercial satisfaction to the large, vertically integrated, offshore fishing enterprises (Gardner 1989; and Fraser and Jones 1989).

Quotas were, from all accounts, an economic success for these enterprises. Quotas offered release from artificially restricted short fishing seasons that had been introduced in recent years to conserve stocks. The flow of raw fish inputs into processing plants could be smoothed out, and landings could be planned by time, place, and fish characteristics. Corporate cultures shifted from rewarding crisis control of gluts and shortages of fish to quality control and to the development of products and markets.

These developments had merit because they added value to landed fish and enhanced profits, but they also may have induced wasteful fishing practices—high grading and discarding of fish and lack of respect for the boundaries of management areas. Vessel skippers were "hired guns," rewarded for timely delivery of the specified caught fish, but not for respect for the wild fish. An observer program is said to have had some success in limiting abuses.

Whether or not offshore fishing practices had anything to do with the current crisis in the Canadian Atlantic fisheries, it is hard to believe that offshore information on the condition of fish stocks could not have been included in a timely way in the management of stocks. This could have signaled the depletion problem before it got out of control.[7]

If this view is accepted, what blocked the information transfer? After all, the large, integrated companies had a great deal to lose from collapsing stocks and shrinking quotas.

Part of the answer may be found in the fact that the quotas were exclusive to the offshore area and not to the species that was shared with the inshore, open-access social fishery. And although the allocation of stock between the inshore and offshore fisheries had remained unchanged for years, the political imperative for sustaining the social fishery was well-known, and it was reasonable to believe that the offshore quota would have borne the brunt of adjustment if the shortage of breeding stock had been known or suspected before it was in fact discovered. In short, the lack of exclusive rights to harvest the stock may have eroded the respect for it and induced the offshore companies to behave as if they were competitive with the social fishery.

Exclusivity was not the only missing quality of the offshore quota. The allocation of the quota was administered by the year and could have been canceled at the discretion of the minister at any time. Thus, security and durability were lacking. Buying and selling of quotas were prohibited (but some trading was allowed) and so it could not be said that the companies had made a financial investment in the quotas (the initial allocation was free, based on historical landings). Lacking all these qualities, the quotas were not bankable (that is, they could not be used as security for loans). In short, the quotas were not really a credible instrument of management because the companies had little reason to take them seriously.

It will take some time for information to emerge for any confident understanding of why the Canadian Atlantic cod fishery is now in such difficulty. But it is not too early to speculate in a constructive way on how a defective quota management system can imperil a fish stock. Quotas should be designed to

mimic (or, better, to be) real property rights of high quality in order to provoke a proprietory interest in the well-being of the underlying asset (the fish stock) and to capture the benefits of efficient harvesting and product and market development. These are preconditions for commercial profitability and for the generation of economic rents from the natural resource.

Sablefish (black cod): Individual quotas

The black cod fishery is a small (comprising forty-eight vessels), but profitable, fishery on Canada's west coast. The stock, which is not migratory, is found in local concentrations on the narrow continental shelf between northern California and the Gulf of Alaska, with the Canadian zone lying between the U.S. zones. The stock is thought to be subject to a modest ten-year cycle of abundance. The fish is long-lived. Harvesting is done from multiple cohorts using traps and longline. The captured fish are now processed mostly at sea—J-cut, frozen, and then boxed. Almost all the product is exported to Japan, where it enjoys a reputation for high quality.

The fishery is now in the last year of a three-year trial period (1990-92) using individual quotas.[8] These quotas were allocated according to a formula devised in consultations between the forty-eight original licensed owner-operators and the Canadian fishing authority (Department of Fisheries and Oceans, or DFO).

Although the number of vessels was frozen at the original forty-eight when licenses were introduced in 1981, the catching effort had so increased that a stable total allowable catch of 3,500 to 4,500 metric tons was enforced by restricting the fishing season from 245 days in 1981 to 45 days in 1985 and to 14 days in 1989. A fishing season of eight days was planned for 1990. The consequence of very short seasons for fishers are well understood and do not require elaboration here. Paramount among these for the black cod fishers were:

- *Erosion of product quality.* Short-season fishing put a premium on fishing faster, not smarter. The quality advantage of Canadian fishers over their American counterparts was being eroded in Japanese markets.
- *Unsafe fishing.* Short-season fishing encouraged captains to overload vessels with crew and gear, to operate in bad weather, and to force themselves and their crews to fish around the clock, leading to fatigue and bad judgment.

The DFO was experiencing serious fiscal constraints. This had two consequences relating to the short season. First, although the DFO recognized that the negative economic and safety effects of short seasons could be lessened by trip or day catch limits and restrictions on gear or crew, these alternatives were judged to be unacceptably inefficient for the industry and too costly to enforce. And second, more intense surveillance of the illegal fishing encouraged by short seasons could not be financed. (The abalone fishery, administered by individual quotas at the time, had already collapsed because of poaching.) Individual quotas seemed to promise amelioration of these problems, and economic and administrative advantages.

Has the trial period suggested that the promises of individual quotas for black cod fishing can be realized? Early indications are encouraging:

- Year-round fishing has relaxed the pace of fishing, leading to improvement in product quality, less waste and high grading (cargo space is not so much at a premium), and better working conditions. There has been significant retirement of vessels (about half of the original vessels in the fishery are now inactive). These are all to the commercial advantage of the enterprises, and the income of crew is now higher and more regular.
- The fishers have contracted out for enforcement services. The annual cost is Can$250,000 for the verification program. There is said to be effective self-enforcement of environmentally sound and legal fishing practices. The DFO has marginally reduced its enforcement activity while compliance has improved. Abuses of the individual quota system have been reported, but are considered to be isolated and not systematic. One problem fisher will probably lose his license and pay a stiff fine.

DFO administrators and the black cod fishers favor the more permanent institution of individual quotas beginning in 1993, based on favorable experience during the trial period. But that the government will approve this is by no means a sure thing, mainly because it is opposed by the Fishermen and Allied Workers. This powerful and articulate body opposes any form of rights-based fishing, including quotas. I believe that the union will not prevail, but

it may succeed in diluting the quality of the more permanent quotas by restricting their term (durability) and limiting transfers (marketability).

Conclusions

Canada is moving cautiously in the direction of a more rights-based management of its fisheries on a case-by-case basis. For example, the important Canadian Pacific halibut fishery conducted a trial period with individual quotas one year after the black cod fishery did. (The United States, by contrast, will probably institute individual quotas in its Alaskan black cod and halibut industries at the same time, and with no trial period.) A trend toward rights-based fishing in Canada seems well established. And professional management generally favors it.

The complicated and important Pacific salmon fishery on the west coast is probably not suitable for quota management, however, and area management would be problematic. In addition, the social fishing of Atlantic cod will not be regulated in any significant way as long as it is viewed by politicians as a vehicle for social assistance. But the question of regulating the cod fishery may be academic in view of the fishery's collapse.

For the rest of the world Canada is an example of a medium-size, industrially advanced country that has undertaken cautious but significant experiments with rights-based institutions for the economic management of its ocean fisheries. In these experiments mistakes have been made and Canada has learned some lessons. Can other countries benefit from the Canadian experience?

The question does not invite easy answers. But it is safe to say that *institutional transplants* are out of the question. There has been little success with *technological transplants* even though these are far easier to achieve and more predictable in their results. But the fundamental principles of science and engineering transcend cultural, religious, developmental, and other profound differences between countries and peoples. And so there is no harm, and possibly some benefit, in making these fundamental technological principles available as options to those who choose to take them up.

And for institutional transplants, even though they are out of the question, the fundamental principles of institutional design can be illuminated by examples drawn from the experience of nations worldwide.

For fishery economics, experience in Canada, Iceland, New Zealand, and even the United States suggests that it is possible to devise institutions so that people can do well by doing good, so that self-interest can be harmonized with the public interest.[9] Ethnographers, anthropologists, and historians report similar results from other times and in other places where spontaneous institutions have given people incentives to use natural resources responsibly.

What do these institutions have in common that transcends the diverse circumstances in which they are found? What fundamental principles are revealed? The most notable are these:

- The economic performance of the fishery is not subverted by the pursuit of other objectives. Fisheries that fail economically cannot be expected to contribute to other components of social welfare.
- Individual fishers have, and perceive, collective and individual opportunities to enjoy the rewards of responsible economic fishing. Institutions of open-access fishing and command-and-control management are positively inimical to this purpose. Other institutions are more promising: secure and durable individual quotas, possibly leading to such management institutions as professional fishery associations or cooperatives; secure and durable comanagement arrangements involving government and industry groups sharing chiefly economic objectives and with cooperating directorates so that each partner in collective decisionmaking is working with the same data base; and secure and durable area entitlements for individuals and groups in fisheries that do not share serious stock straddling problems with other jurisdictions.

These institutions have in common a structure permitting local and personal knowledge of fish and fishing to be fed into more or less formal administrative processes. These will encompass making decisions on, for example, management plans, in which fishers' knowledge can complement the directorate's expertise. A plan could include, if needed, modes and intensity of enforcement by third parties to augment natural self-enforcement. Administration, including enforcement, can be very expensive. But economic fishing generates operational profits (rents), part of which can be used for administration, thus financing fishing on a user-pay basis.

The role of self-enforcement should not be underestimated as a benefit of the promising institutions described above. Even the South Pacific islands, which negotiate quotas and fees with distant-water fishing nations through FORUM, can benefit from it. FORUM is to its "guest" fishers as a landlord is to tenants. But to the extent that FORUM is seen to be serious in its intent to set and enforce its total annual catch by "fee fishers," each fee fisher will see self-interest in the prosecution of others who abuse their fishing privileges or who poach. This self-enforcement eases the administrative burden on the "sealord."

For Canada, given its stage of political, social, and economic development, the principle of economic fishery management is to devise institutions that provoke a proprietary interest among fishers in the fish. More generally, a *sense of occupancy* is a necessary condition for the management of sustainable ocean fisheries.

Notes

The views expressed in this paper are not necessarily shared by other people or by any institutions.

1. Scott (1982) describes and analyzes the constitutional foundation of federal and provincial powers to regulate Canadian fisheries. Scott describes how "creative federalism" facilitates redistribution of "concurrent" powers in fisheries jurisdictions.

2. See Crowley and Palsson (1992) for a discussion of the Fisheries Act.

3. Wilen (1989) provides a penetrating and vivid analysis of fishing regimes using restrictive licensing.

4. See Pearse and Wilen (1979) for a good critique of restrictive licensing of salmon vessels. The problems have intensified since their article was published.

5. See Crowley and Palsson (1992) for an assessment of Canadian fisheries with individual quota management.

6. In Neher and others (1989), D. D. Huppert discusses difficulties with New Zealand's quota management system in his comments on Clark, Major, and Mollett (1989).

7. Incentives for information transfer are important in all fishery management regimes. The information failure reported here is based on anecdotal reports.

8. Individual quotas are attracting intense interest from fishermen and governments in many jurisdictions. They are now the principal instrument in rights-based fishing. See Scott (1989) for a description of their evolution and Arnason (1989) for a theoretical rationale. Looking forward, Scott (1989) sees individual quotas as the nuclei of larger sole-ownership corporations or collectives having characteristics described by his earlier work, Scott (1955). This article can be usefully read along with Gordon (1954).

9. The New Zealand fishery management regime is described by Clark, Major, and Mollett (1989). The New Zealand system is much studied, in part because of its swift transition from traditional management to rights-based individual quota management.

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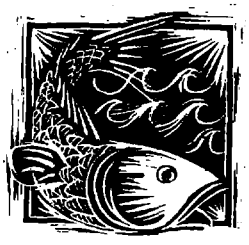


Fishery Management in Iceland

Ragnar Arnason

5

Iceland is a small country, with only a quarter of a million inhabitants. Situated in the North Atlantic just south of the Arctic Circle, the country is rather inhospitable and has few natural resources of economic significance. The most important natural resources are the fish stocks off the coast; fisheries are the country's most important industry. On this resource base, the Icelandic population has managed to generate per capita income and living standards that have consistently ranked among the highest in the world. This remarkable achievement must be attributed in large part to the relative success of the Icelandic fisheries.

The Icelandic fisheries: A descriptive background

The most important Icelandic fishery by far is the demersal or groundfish fishery (table 5.1). In recent years this fishery has usually generated between 75 and 80 percent of the total value of Iceland's catch. The most important demersal species are cod, haddock, redfish, and saithe. Pelagic fisheries—capelin and herring—are also important, usually yielding 10 to 15 percent of the total catch value. In addition to the demersal and pelagic fisheries, there are significant shrimp, lobster, and scallop fisheries.

Table 5.1 lists only the Icelandic catch. Some of the fish stocks, most notably the capelin stock, are shared with other nations. A recent agreement allocates 22 percent of the annual total allowable catch (TAC) of capelin to Greenland and Norway. Under bilateral agreements, foreign catches add about 2 percent to the demersal catches in table 5.1.

The fishing fleet consists of several types of vessels (table 5.2). It is convenient to break them down into four main classes.

1. *Deep-sea trawlers* are relatively large fishing vessels, usually between 200 and 1,200 gross registered tons (GRT) and 130 to 250 feet in length. They are engaged almost exclusively in the demersal fisheries and use bottom, and occasionally mid-water, trawls. Because of their size, deep-sea trawlers have a wide range and can exploit nearly any fishing ground off Iceland. Each trip usually lasts about five to fifteen days. A number of the deep-sea trawlers have recently been turned into freezer trawlers.

2. *Specialized purse seiners*, 200 GRT and up, are engaged primarily in the capelin fishery. Most also operate in other fisheries, particularly the deep-sea shrimp fishery and the herring fishery. The specialized purse seiners usually follow the capelin schools over great distances and land their catches where it is most convenient.

3. *Multipurpose vessels* cover a wide range of sizes. Although the typical multipurpose vessel is smaller than the first two types of vessels, some are quite large—more than 200 GRT. The multipurpose fleet is, for the most part, specialized with respect to neither fishing gear nor fishery. Most of the multipurpose vessels are designed as gill-netters or long-liners, but they are technically capable of using trawl and purse seines too. The range of the smaller multipurpose vessels is limited, and they are normally confined to one- to three-day fishing trips exploiting fishing grounds relatively close to their home port.

4. *The part-time fleet* includes many vessels up to 20 GRT, although most are under 10 GRT. These

Table 5.1 Amount and value of catch in Icelandic fisheries, 1981-90

Species	Average catch, 1981-90 (thousands of metric tons)	Estimated catch values[a] (millions of US$)	Estimated MSY (thousands of metric tons)	Estimated MSY values[a] (millions of US$)
Demersal				
Cod	356.0	367.8	400.0	412.7
Haddock	55.6	79.9	60.0	86.3
Saithe	68.3	41.8	85.0	52.0
Redfish	98.1	96.9	90.0	88.9
Other[b]	92.3	102.0	75.0	82.9
Subtotal	670.3	688.4	710.0	722.8
Pelagic				
Herring	67.6	10.4	110.0	16.9
Capelin[c]	662.1	42.2	750.0	47.8
Subtotal	729.7	52.6	860.0	64.7
Crustaceans				
Shrimp	24.1	42.9	30.0	53.4
Lobster	2.4	11.6	3.0	14.5
Subtotal	26.5	54.5	33.0	67.9
Shellfish				
Scallops	13.3	5.8	14.0	6.1
Total	1,439.8	801.3	1,617.0	861.5

a. At 1990 prices and 1990 U.S. dollars.
b. Mainly Greenland halibut, catfish, plaice, tusk, and ling.
c. Maximum sustainable yield estimate represents the Icelandic share.
Source: Utvegur 1991.

Table 5.2 The Icelandic fishing fleet, December 1990

Vessel class	Number	Total tonnage (thousands of GRT)	Average age (years)
Deep-sea trawlers	112	55,612	13.2
Standard	84	—	—
Freezer	28	—	—
Purse seiners	45	21,490	20.8
Multipurpose fleet	344	38,603	21.6
Over 200 GRT	48	11,676	20.4
111-200 GRT	99	15,347	20.4
51-110 GRT	115	8,982	25.1
21-50 GRT	82	2,598	21.9
Part-time fleet	495	4,451	14.3
Total	996	120,156	

— Not available.
Source: Utvegur 1991.

vessels are typically owner-operated and employed on a seasonal basis. This fleet employs hand lines, gill nets, and longlines. Depending on the fishery, crews consist of one to three persons. Some of the vessels in this fleet are essentially recreational vessels. Because the smaller part-time vessels—those under 12 GRT and, subsequently, 10 GRT—were not subject to vessel quota restrictions until 1988,[1] this size class of the part-time fleet has mushroomed in recent years.

The average age of the fishing fleet is rather high. This reflects, among other things, the effects of more restrictive fishery management measures and official efforts in recent years to halt new investment in the fishing fleet.

The origins and evolution of the fishery management system

Until the introduction of the vessel quota system in the demersal fisheries in 1984, the Icelandic fisheries were for the most part common property resources.[2] And until the extension of national jurisdiction to 200 miles in 1976, the Icelandic fisheries had been for all intents and purposes international fisheries. The extension of jurisdiction all but eliminated the presence of the large foreign fishing fleets that had featured prominently on Icelandic fishing grounds, taking almost half the total demersal catch. The initial management measures taken in the demersal fisheries following the extension of jurisdiction were inadequate, however, and did not alter the

common property nature of these fisheries as far as domestic fishers were concerned. They were still forced to compete for shares in the catch. Therefore, not surprisingly, the development of the Icelandic fisheries in the post-war era closely followed the path predicted for common property fisheries—increasingly excessive fishing capital and effort relative to the reproductive capacity of the fish stocks (see, for example, Gordon 1954).

The capital employed in the Icelandic fisheries increased by almost 1,300 percent from 1945 to 1983 (figure 5.1). Real catch values, on the other hand, increased by only 300 percent during the same period. Thus, the growth in capital exceeded the increase in catch values by a factor of more than four. This means that in 1983 the output-capital ratio in the Icelandic fisheries was less than one-third of the output-capital ratio in 1945.

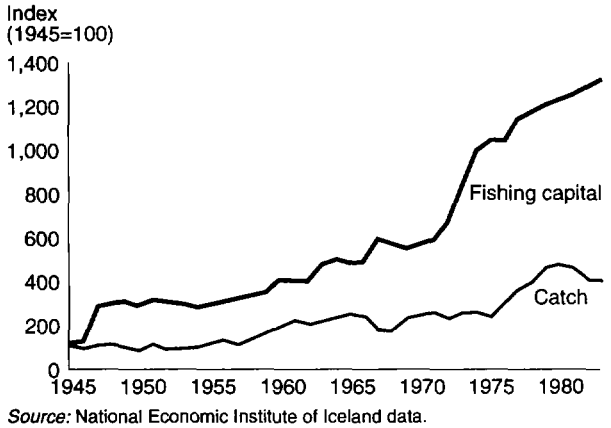
Most of the increase in the value of catch since 1945 is due to greater catch volumes. This increase has stemmed largely from new fisheries—for example, redfish in the late 1950s, herring in the 1960s, and capelin in the 1970s. At the same time, the old fisheries have been overexploited. Thus, in the early 1980s, the valuable demersal stocks were only one-half to two-thirds of their size in the 1950s. The previously huge Atlanto-Scandian herring stock[3] has been unable to sustain significant catches for more than two decades, and the once bountiful Icelandic spring-spawning herring is all but extinct.

The economic indicators for the fishing industry show a similar trend. Since the late 1960s the profitability of the fishing firms has been poor. In fact, from 1970 to 1984, when the individual transferable quota (ITQ) system was introduced in the demersal fisheries, the harvesting sector appears to have lost money in most years.

This long-term decline in the economic performance of the Icelandic fisheries did not go unnoticed by fishery authorities. In fact, over the years they had taken various measures in an attempt to reverse this trend. But before the extension of the exclusive fishing zone to 200 miles in 1976, effective management of the fisheries, especially the demersal fisheries, appeared impracticable because of the presence of large foreign fleets. Fishery management had therefore been minimal.

With the de facto recognition of the exclusive 200-mile fishing zone in 1976, the situation changed dramatically. Since that time the Icelandic fisheries have come under gradually increasing management; by 1990 a uniform ITQ system had been extended to nearly all fisheries (box 5.1).

Figure 5.1 Fishing capital and catch values in Icelandic fisheries, 1945-83
(constant prices)



Source: National Economic Institute of Iceland data.

The herring fishery

An alarming decline in the herring stocks led authorities to impose an overall quota on this fishery in 1966. But this failed to halt the decline in the stocks, and a complete moratorium on herring was introduced in 1972. In 1976, when fishing from the Icelandic herring stocks was partly resumed, it was obvious that the entire fleet could not participate.

Box 5.1 Key steps in the evolution of Iceland's ITQ management system

1976	Herring fishery—Individual vessel quotas introduced
1979	Herring fishery—Vessel quotas made transferable
1981	Capelin fishery—Individual vessel quotas introduced
1984	Demersal fisheries—Individual transferable vessel quotas introduced
1985	Demersal fisheries—Effort quota option introduced
1986	Capelin fishery—Vessel quotas made transferable
1988	Transferable vessel quotas extended to all fisheries; effort quota option retained
1990	Complete uniform system of transferable vessel quotas extended to all fisheries

Thus, an individual vessel quota system with limited eligibility was introduced. The vessel quotas were small, however, and in 1979, under a ministerial decree and with industry support, fairly unrestricted transfers of quotas between vessels were permitted. In 1988 this vessel quota system became part of Iceland's general fisheries vessel quota system.

The capelin fishery

The capelin fishery was very large in the 1970s. But by 1980 the stock was seriously threatened with exhaustion, and the fishery was subjected to limited entry and individual vessel quotas for license holders. The positive experience with the vessel quota system in the herring fishery proved a convincing argument for adopting a similar system in the much more important capelin fishery. In 1986, in conjunction with an increasing transferability of demersal vessel quotas, capelin vessel quotas became partly transferable. In 1988 the capelin vessel quota system became a part of the general fisheries vessel quota system with fairly unrestricted transfers of quotas.

The demersal fisheries

The major demersal fisheries were subjected to overall catch quotas in connection with the extension of the exclusive fishing zone in 1976. The quotas recommended by the marine biologists soon proved quite restrictive and thus difficult to uphold. Therefore, individual effort restrictions, in the form of limited allowed fishing days for each vessel, were introduced in 1978. But because new entry remained possible and the demersal fishing fleet continued to grow, the allowed fishing days had to be reduced each year. Thus, it became gradually obvious to everyone concerned that this system was economically wasteful. Consequently, in 1984, following a sharp drop in the demersal stock and catch levels, a system of individual vessel quotas was introduced. Regulations to this effect were initially issued for only one year, but the system's generally favorable results led to its extension for another year. To ensure sufficient support for the system, the extension included a very important provision: vessels were allowed to opt for effort restrictions rather than catch quotas. In 1986 this vessel quota system was enacted by special demersal fishery legislation passed by Iceland's legislature, the Althing. In 1988 the Althing enacted general vessel quota legislation applying to all Icelandic fisheries effective for 1988-90. This legislation retained the effort quota option but made it somewhat less attractive. In 1990 comprehensive ITQ legislation was passed by the Althing which abolished the effort quota option and closed certain other loopholes in the previous legislation.[4] In addition, the Althing extended the ITQ system indefinitely, although it stipulated a review in 1993.

As may be inferred from this description, the course toward a complete ITQ fishery management system in Iceland has evolved more by trial and error than by design. In most countries, and Iceland is no exception, there is strong public opposition to radical changes in the institutional framework of production and employment. Much of this opposition seems to derive from traditional values and vested interests rather than rational arguments. Thus, in Iceland, the evolutionary process that fishery management underwent, in which various methods were tried in different fisheries, was probably unavoidable from a sociopolitical point of view. The knowledge and understanding gained from these experiments were probably crucial for the eventual acceptance of the much more efficient ITQ system.

The key steps in the evolution of the ITQ system have usually been taken only in response to crises in fisheries due to a sudden reduction in stock levels. Thus, individual vessel quotas were introduced in the herring fishery in 1976 following a collapse in the herring stocks and a prolonged moratorium on herring catches. Similarly, vessel quotas were introduced in the capelin fishery and the ITQ system was introduced in the demersal fisheries in the early 1980s because of the anticipated collapse of these fisheries.

This pattern reflects the reluctance of the fishing industry to accept changes in the traditional organization of the fisheries. Only when faced with a disaster in the form of a significant fall in income due to stock reductions or a drop in the world market price for fish products have the interest groups been willing to consider changes in the institutional framework of the fisheries.

The comprehensive ITQ fishery management legislation passed in 1988 and 1990 constitutes a break with this pattern. For the first time, the fishing industry agreed to a significant improvement in

the fishery management system while not under the threat of financial disaster. This must be attributed to the potentially immense economic benefits of the vessel quota system that have now become apparent to most of the participants in the fisheries.

The current ITQ fishery management system

The current ITQ fishery management system in Iceland, which was instituted at different times and in somewhat different forms in the various fisheries, was made uniform by the fishery management legislation passed in 1990.

Features of the ITQ management system

Under the uniform system, all fisheries are subject to vessel catch quotas. These quotas represent shares in the total allowable catch (TAC). They are permanent, perfectly divisible, and fairly freely transferable. The quotas are issued for a small annual fee to cover enforcement costs.

The ITQ system was superimposed on, but did not replace, an earlier management system designed mainly for the protection of juvenile fish. This system, which imposes complicated restrictions on gear, area, and the size of fish caught, is still largely in place.

Total allowable catch. The Ministry of Fisheries determines the total allowable catch (TAC) for each of the most important species in the fisheries. This decision is made on the basis of recommendations from the Marine Research Institute. In the past the Ministry of Fisheries has followed the recommendations of the Marine Research Institute quite closely.

Several species for which fishing pressure is regarded as slight are not currently subject to a TAC and can therefore be pursued freely. Most of these fisheries are of negligible commercial value, however.

Permanent quota shares. Each eligible vessel is issued a permanent share in the TAC for every species for which there is one. These permanent quota shares may be referred to as TAC shares. Vessels eligible for quotas under previous versions of the ITQ system are eligible for TAC shares. These vessels are essentially those that had participated in the fishery before the introduction of the vessel quota system.

The initial allocation of TAC shares to individual vessels varies among fisheries. In the demersal, lobster, and deep-sea shrimp fisheries the TAC shares are normally based on the vessel's catch record during certain base years. In the demersal fisheries this is usually a vessel's average share in the total catch during the three years prior to the introduction of the vessel quota system in 1984. There are noteworthy exceptions to this rule, however. If, for example, a vessel was not operating normally during 1981-83 because of major repairs or because it entered the fleet after 1981, the calculated share is adjusted upward. And during 1985-87 it was possible to modify the TAC shares by temporarily opting for effort restrictions rather than vessel quotas and demonstrating large catches during this period. In the herring and inshore shrimp fisheries the initial TAC shares were equal. The initial TAC shares for the capelin fishery were also equal except for one-third of the shares, which were initially allocated on the basis of vessel holding capacity.

Annual vessel quotas. The size of each vessel's annual quota in a fishery is simply a multiple of the TAC for that fishery and the vessel's TAC share.

Divisibility and transferability. Both the TAC shares and the annual quotas are transferable and perfectly divisible. This means that any fraction of a given quota may be transferred to another vessel.

TAC shares are transferable with no restrictions. Transfers of annual vessel quotas, however, are subject to some restrictions. Annual vessel quotas may be freely transferred between vessels within the same geographical region but transfers between geographical regions are subject to review by each region's fishermen's unions and local authorities. The rationale for this stipulation is to stabilize local employment in the short run. In practice, however, few interregional transfers are blocked.

Apart from these restrictions, transfers of quotas are subject only to registration with the Ministry of Fisheries. The details of the exchange, including price, are not registered.

Restricted access. All commercial fishing vessels must hold valid fishing licenses.[5] Fishing licenses are issued only to vessels that were already in the fishery in 1990 and to their replacements if they are deemed comparable in terms of fishing power. The fishing licenses are not transferable.

Thus, in addition to the ITQ system, the Icelandic fisheries are subject to restricted access. One of the functions of a well-designed ITQ system is to

provide a socially appropriate incentive for investment (disinvestment) in the fishing fleet. The fishing license requirement clearly adds a further deterrent to such investment.

Exemptions from the ITQ system. There are two minor exemptions from the current ITQ system, both in the demersal fisheries. First, 50 percent of the demersal catch of vessels employing longline during November through February each winter is exempt from quota restrictions. This is intended primarily to support regional employment during this period.

Second, very small hand-line vessels—those less than 6 GRT—are exempt from quota restrictions and subject to limited fishing days. This arrangement is only temporary, however, and is due to end in 1993, when this class of vessels is also supposed to become subject to the ITQ system.

Quota fees. The annual vessel quotas were initially issued by the Ministry of Fisheries free of charge. But the fishery management legislation of 1990 stipulates that the Ministry of Fisheries is to collect fees for catch quotas to cover the cost of monitoring and enforcing the ITQ regulations. The law imposes an upper bound on this fee amounting to 0.2 percent of the estimated catch value.

The performance of the ITQ system

The main purpose of the vessel quota system is to improve the economic efficiency of the fisheries. The Icelandic fisheries are biologically very productive and should be able to generate high economic rents. Until the adoption of the vessel quota system, however, few rents were generated in the industry. In fact, in the years before 1984 the industry's profits were negative.

Fishing capital and fishing effort. One of the reasons for the dissipation of economic rents in the Icelandic fisheries has been overinvestment in fishing capital and excessive fishing effort. Thus, one of the tests of the efficacy of the vessel quota system is how fishing capital and aggregate fishing effort have changed since the introduction of the system.

As table 5.3 shows, the previously rapid growth in the value of aggregate harvesting capital in Iceland's demersal fisheries halted abruptly in 1984 when the vessel quota system was introduced. In fact, fishing capital contracted in 1984-85. This was the first time since 1969 that the value of the fishing fleet actually decreased. In the fifteen years before 1984-85 the value of this capital had grown at an annual rate of more than 6 percent. Thus, at that point the vessel quota system seems to have generated beneficial results.[6] But in 1986 investment in fishing capital resumed at a high rate. This resumption of investment should not be interpreted as a failure of the vessel quota system, however. Since the inception of the ITQ system fishing capital has grown just over 3 percent annually, compared with 6 percent a year during the preceding fifteen years. Moreover, most of the investment since 1986 can be explained by factors other than the ITQ system.

Table 5.3 Capital and fishing effort in Icelandic demersal fisheries, 1978-90

Year	*Fishing capital*[a]	*Fishing effort*[b]
1978	0.967	0.953
1979	1.000	1.000
1980	1.020	1.058
1981	1.051	1.082
1982	1.069	1.234
1983	1.078	1.250
1984	1.072	1.061
1985	1.055	1.004
1986	1.109	1.069
1987	1.223	1.129
1988	1.370	1.201
1989	1.382	1.185
1990	1.347	1.243

a. In value terms.
b. Measured in ton-days at sea in the demersal fisheries only.
Source: Utvegur 1978-90; and National Economic Institute of Iceland data.

First, a good deal of the investment in fishing capital since 1986 has gone toward the installation of freezing equipment and the corresponding modification of several deep-sea trawlers.[7] This part of the investment is thus in fish processing capital employing new and profitable techniques. Second, part of the investment was in specialized trawlers for the emerging and very valuable deep-sea prawn fishery, which was not subject to vessel quotas until 1988. Third, by the mid-1980s a significant fraction of the deep-sea trawler fleet was due for replacement. Because 1986 and 1987 were unusually profitable years for the harvesting sector, many firms took the opportunity to replace their aging vessels. Fourth, during this period there was a very significant investment in small vessels (less than 12 and, subsequently,

10 GRT) that were not subject to the vessel quota system. Finally, the effort quota option introduced in 1985 in the demersal fisheries undermined the efficiency incentives of the ITQ system, inducing many vessel owners to upgrade or replace their vessels. The effort quota option was abolished in 1990, and there was a significant reduction in fishing capital in that year.

The course of fishing effort in the demersal fisheries tells a similar story. As shown in table 5.3, fishing effort in the demersal fisheries dropped by some 15 percent in 1984, the first year of the vessel quota system, and by an additional 6 percent in 1985. Since 1986, however, fishing effort has increased considerably. This is no doubt due primarily to the widespread selection of the ill-advised effort quota option within the ITQ system during 1986-90. Another important explanation for the increase in fishing effort in 1989 and 1990 is the decline in the demersal fish stocks with no commensurate reduction in the TACs, with the result that more fishing effort was required to fill the catch quotas.

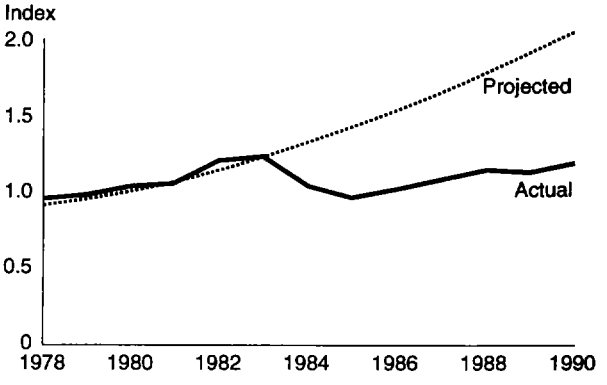
In measuring the effect of the vessel quota system, however, the main question is not whether fishing effort has been reduced from its 1983 level. The crucial question is how the actual fishing effort in 1984-90 differed from the fishing effort that would have prevailed during the period if the vessel quota system had not been introduced.

Clearly, estimating what the fishing effort would have been under the earlier management regime is not at all straightforward. In an attempt to provide a partial answer to the question, a simple trend model describing the path of fishing effort under the two management regimes was specified.[8] This model permits us to estimate what the fishing effort would have been if the vessel quota system had not been introduced in 1984 and to compare this to the actual fishing effort observed.

The results of the estimation, illustrated in figure 5.2, suggest that under the earlier fishery management system, fishing effort would have continued to increase at a high rate after 1983.[9] Actual fishing effort under the vessel quota system initially declined significantly and then grew at a much slower rate (table 5.4).

Thus, according to these estimates, the vessel quota system has reduced total fishing effort in the demersal fisheries by about 37 percent compared

Figure 5.2 Actual fishing effort and projected fishing effort assuming no ITQ system in Icelandic demersal fisheries, 1978-90



Source: Author's calculations.

with the fishing effort that could have been expected under the previous management system. The financial benefits of this kind of reduction in effort are very substantial.

Estimates of economic benefits. Let us now turn to more direct estimates of the economic benefits generated under the vessel quota system. Unfortunately, little research has been done in this area and the available information is thus rather scant.

Theoretically, a vessel quota system should yield the following economic benefits:

- *A reduction in fishing effort.* The vessel quota system eliminates competition among vessels for a limited stock of fish. Consequently, fishing firms will attempt to catch their vessel quota with minimum

Table 5.4 Actual fishing effort and projected fishing effort under old management system in Icelandic demersal fisheries, 1978-90

Year	*Actual fishing effort*	*Projected fishing effort under old management system*	*Proportional differences (percent)*
1978	0.953	0.944	-1.0
1979	1.000	1.000	-0.0
1980	1.058	1.060	0.2
1981	1.082	1.123	3.8
1982	1.234	1.190	-3.6
1983	1.250	1.261	0.9
1984	1.061	1.336	25.9
1985	1.004	1.416	41.0
1986	1.069	1.500	40.4
1987	1.129	1.590	40.8
1988	1.201	1.685	40.3
1989	1.185	1.844	55.6
1990	1.243	1.963	57.9

Source: Author's calculations.

fishing effort. But aggregate fishing effort will not necessarily be reduced if the TAC is excessive.[10]

- *Reduced cost of fishing effort.* Having secured private ownership of a certain volume of catch under the vessel quota system, each fishing firm can concentrate on taking that catch with minimal costs.
- *Improved quality of the catch.* Bound by their vessel catch quotas, the fishing firms can increase their revenues only by improving the quality of their catch.

In a 1985 study the National Economic Institute attempted to estimate the benefits of reduced fishing effort and improved quality of catch in the demersal fisheries for 1984. It concluded that the benefits of reduced fishing effort amounted to some US$14 million and the benefits of improved quality of catch to some US$6 million. The total number, US$20 million, is about 8.5 percent of the value of the demersal fisheries in that year. These results were confirmed in a less comprehensive study done in 1987.

According to official figures on operating results in the harvesting sector, its profitability has improved dramatically since 1983. In fact, the financial results of the harvesting sector from 1986 to 1990 appear to be among the best in decades. Although many factors besides the fishery management regime affect the operating results of the fishing industry, this must nevertheless be regarded as another indication that the vessel quota system has beneficial effects.

There is yet another way to approach the problem of estimating the rents generated in the fisheries as a result of the vessel quota system. Because the catch quotas are transferable, a market has developed for them. In this market quotas are exchanged for other things with value—such as money. Thus, according to standard economic theory and assuming that the market for quotas is reasonably effective, the value of the fishery should equal the total value of outstanding quotas.[11]

Table 5.5 Quota market for Icelandic demersal fisheries, 1984-90

Year	Quotas transferred: Thousands of metric tons	Quotas transferred: As a percentage of outstanding vessel quotas	Vessel quotas as a percentage of total demersal catch
1984	64.1	11.2	100.0
1985	81.0	19.2	76.8
1986	52.2	24.4	36.0
1987	40.1	21.1	28.1
1988	61.4	23.7	43.8
1989	72.2	29.8	42.5
1990[a]	78.9	22.6	68.2

a. The new, complete ITQ system took effect on September 1, 1990.
Source: Icelandic Ministry of Fisheries data.

The demersal quota market is extensive (table 5.5). In 1984, the first year of the vessel quota system, about 11 percent of outstanding quotas were exchanged. Since 1986 the share of quotas exchanged has fluctuated between 20 and 30 percent. Because of a contraction in the volume of outstanding quotas as a result of the widespread use of the effort quota option, however, the actual quantities exchanged were no greater in 1986-90 than in 1984-85.

The total value of outstanding quotas valued at the midpoint of the price range in table 5.6 was some US$46 million in 1984 and US$166 million in 1990. But these numbers almost certainly underestimate the true value of demersal catch rights because they ignore the value of the nontradable catches, which are taken mostly under effort quotas. If all the demersal catch is valued based on the vessel quota prices, we obtain the values in the last column of table 5.6. These indicate that the economic rents generated in the demersal fisheries are very considerable and constitute a significant fraction of the gross earnings of the fisheries.[12]

The estimates must be interpreted with great care, however, especially those for the later part of the period. During that time, demersal catches were good and fish prices extremely good. For this reason the quota prices for 1986-90 were probably higher than would otherwise have been the case.[13] More important, it must be realized that one of the first effects of a reasonably complete ITQ system is to make excessive fishing capital commercially redundant. This means that its market price falls drastically, the opportunity cost of its use is reduced, and the market value of catch quotas is correspondingly increased. This is a short-term effect, however, which will be reversed in the long run when the level of fishing capital reaches a new equilibrium.

How does the economic performance of the vessel quota system for the demersal fisheries compare with optimal economic utilization? This question can be addressed by comparing the quota price valuation of fishery rents with the maximum attainable rents calculated in an empirical study of the

Table 5.6 Economic rents in Icelandic demersal fisheries, quota price valuation, 1984-90

Year	Price range (U.S. dollars per metric ton)		Total quota values (millions of U.S. dollars)	
	Cod	Other	All quotas	Entire fishery
1984	55-87	24-40	36-57	36-57
1985	84-126	54-72	36-53	51-72
1986	127-176	79-109	23-32	66-91
1987	206-259	104-131	35-44	104-131
1988	208-277	154-205	49-65	108-144
1989	262-349	157-209	62-83	143-189
1990	428-514	256-308	151-182	222-267

Source: Author's calculations.

Icelandic demersal fisheries (Arnason 1984). In 1990 the economic rents, calculated on the basis of quota prices, were US$222 million to US$267 million, more than 50 percent of the maximum attainable rents of US$410 million estimated by Arnason (1984).

The reservations about the probable upward bias of the quota values as estimators of sustainable rents in 1990 should be kept in mind, but it is nevertheless clear that the demersal vessel quota system has generated significant benefits. Because fishing effort has been reduced only slightly, the benefits must be attributable primarily to reduction in the harvesting costs per unit of catch and an improvement in the quality of the catch. In fact, there is ample evidence of both.

Performance of the vessel quota system: A summary. The evidence on the performance of the vessel quota system is mixed. On the one hand, the fishing fleet has increased in value and aggregate fishing effort in the demersal fisheries has been reduced only slightly. On the other hand, various indicators, including quota values in the demersal fisheries, strongly suggest that the system is generating significant rents.

It is important to realize, in interpreting the evidence since 1986, that because of the widespread use of the effort quota option the demersal fishery management system during those years was only partially a vessel quota system. In particular, the upward trend in harvesting capital and demersal fishing effort during the later part of the period cannot be taken as evidence of a failure of the vessel quota system.

Lessons from the Icelandic ITQ system

Individual transferable quotas have been in effect in Icelandic fisheries for more than ten years. As mentioned earlier, they were introduced in the herring fisheries in 1979, in the capelin fisheries in 1981, and in the all-important demersal fisheries in 1984. Since the ITQ system was introduced, it has been under almost continual revision and many different versions of the system have been tried. The experience gained provides valuable lessons about the appropriate design of an economically efficient ITQ system. A review of that experience suggests that there are six crucial aspects in the design of a successful ITQ system.

1. *Permanency.* Permanency is critical for ensuring the economic effectiveness of an ITQ system. Only if fishers can be reasonably certain that their ownership of the catch quotas is secure and that the ITQ system is not going to be replaced in the near future will they be willing to reduce their fishing capital to socially optimal levels.

2. *Share quotas.* It is very important that the quotas be stipulated as shares in the TAC rather than as fixed quantities. One reason is that quantity quotas may easily give rise to very difficult adjustment problems when TACs have to be changed. Another is that share quotas give the holders a vested interest in the conservation of the fish stock, which quantity quotas do to a much lesser extent.

3. *Exemptions.* It is crucial that the ITQ system be as complete as possible. Exemptions, even though they may appear negligible in the beginning, have a tendency to expand—especially if the ITQ system is successful in reducing overall effort and rebuilding the fish stocks.

4. *Quota trades and quota markets.* A good deal of the economic efficiency of the ITQ system derives from the transferability of the quotas. Transferability allows the quotas to be reallocated to the most efficient fishing firms at each point in time. But this occurs only if trading is sufficiently easy. For this reason it is very important to facilitate quota trades by seeking ways to reduce transactions costs. One promising way to do this is to set up a quota exchange similar to the stock exchange. After all, share quotas have many of the characteristics of shares in a company.

5. *Distribution of rents.* Many fisheries are capable of yielding substantial economic rents or profits. A well-designed ITQ system will usually allow a large fraction of these rents to be realized. This raises the question of how these rents should be distributed. Without special provisions, these rents will generally fall to the initial recipients of catch quotas. This is potentially damaging for two reasons. First, it deprives the government of an economically nondistortive tax base.[14] Second, this distribution of the benefits may become a source of dispute, undermining public support for the ITQ system and even threatening its continued existence. Because it is very difficult to change the distribution of rents after an ITQ system has been launched, it is important to consider this issue while the ITQ system is still at the design stage.

6. *Discards.* An ITQ system normally creates incentives for discarding inferior catch at sea,[15] especially when different types of catch—for example, different sizes of fish—fetch significantly different prices. This reduces the efficiency of the ITQ system and should thus be dealt with from the outset.

Conclusions

The Icelandic ITQ fishery management system seems to have yielded significant economic benefits. There is good reason to believe that other fishing nations would benefit from adopting similar systems. And any nation opting for such a system would do well to learn from the mistakes made in developing the Icelandic fishery management system, especially in the early stages.

Notes

1. See the section below on the ITQ fishery management system.

2. The introduction of vessel quotas in the herring and capelin fisheries a few years earlier had ended the common property nature of these fisheries. But they accounted for only about one-tenth of the value of Icelandic fisheries.

3. This stock was about 10 million metric tons in the early 1960s and capable of sustaining catches of up to 2 million metric tons annually.

4. Especially with regard to the operation of very small fishing vessels (under 10 GRT).

5. This is in addition to catch quotas.

6. Note, however, that 1982-84 were years of heavy losses for the fishing industry. Therefore, the contraction in investment in 1984-85 can hardly be attributed solely to the vessel quota system.

7. In 1983 there were three freezer trawlers; in 1990 there were twenty-eight.

8. It is hypothesized that during the thirteen-year period 1978-90 fishing effort evolved according to the following relationship:

$$e(t)=e(0)\exp[(aD1+bD2)t],\ t=0,1,2,...10,$$

where $e(t)$ represents fishing effort in year t and t represents the years measured from 0 to 10. $D1$ and $D2$ are dummy variables for the two management regimes. Thus $D1 = 1$ during the years of restricted effort (1978-83) and 0 thereafter. $D2 = 0$ in the years preceding 1984 and 1 thereafter. The coefficients a and b represent different growth rates of effort under the two management regimes.

9. Here fishing effort is estimated as a multiple of fleet tonnage and days at sea.

10. Each TAC requires a certain minimum fishing effort. If the TAC is set high relative to the size of the fish stocks, aggregate effort may actually increase under an ITQ system.

11. This value will not necessarily equal bookkeeping results, however. Quotas will be bought on the market at a price up to their marginal variable profits. Fixed costs—for example, those associated with harvesting capital—are irrelevant for these transactions. Therefore, a firm may buy quotas at a high price without being able to cover fixed costs.

12. Thus, in 1989 the value of the demersal quotas was more than one-quarter of the total earnings in the demersal fisheries.

13. Quota prices were considerably lower than they would have been in fully efficient equilibrium, however.

14. The nondistortive nature of resource rent taxes is well-known and easily proven.

15. This is often referred to as high grading.

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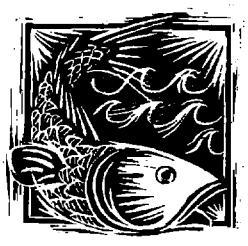

U.S. Fishery Regulation Policy: Lessons for Peru

James E. Wilen

6

Before 1976 many coastal nations were caught in a vexing trap: if they regulated their domestic fishing fleets so as to promote a high sustainable return, their successes would only draw in foreign fleets to profit from these policies and ultimately reduce the potential of the fisheries. The stocks of many fisheries were severely depleted in the period following World War II, and by the 1970s most fisheries were generating only a small fraction of their physical and financial potential.

The extension of coastal nations' jurisdictions in 1976 created important new opportunities for these nations to regulate fisheries for the benefit of their own citizens without having the rewards from their sacrifices reaped by other parties. Coastal nations responded in a variety of ways to these new opportunities and fishery management policy has evolved rapidly and in diverse directions. Lessons are now emerging from comparisons of the successes and failures of the various regulatory attempts.

In this chapter, I examine the experience of the United States in managing the fisheries off its coasts since the extension of jurisdiction in 1976. I begin by reviewing the legal and administrative structure underlying U.S. fishery regulation. I then discuss experience from policy implementation and, finally, I discuss some of the lessons provided by the U.S. experience.

U.S. fishery regulation policy

The keystone legislation of U.S. policy regulating fisheries is the Fisheries Conservation and Management Act (the Magnuson Act) enacted into law in 1976. This act was drafted largely by the fishing industry, and the Act's structure reflects circumstances of the period just before the extension of jurisdiction in 1976. The main impetus for both the extension of jurisdiction and the drafting of the Magnuson Act was the large amount of fishing by foreign fleets off New England and in the North Pacific during the 1970s. Thus, the industry was not looking for fishery management per se but for ways to keep foreign fishing fleets out of the fisheries off the U.S. coasts. This fact certainly colored both the design of the fishery management legislation in 1976 and the subsequent implementation of the law.

The Magnuson Act is an article of legislation with several layers of detail. It states six broad purposes: (1) to conserve and manage fishery resources within the exclusive economic zone (EEZ); (2) to support international agreements for conserving and managing migratory species outside the EEZ; (3) to promote fishing under sound management principles; (4) to provide for the preparation and implementation of fishery management plans that achieve and maintain optimum yield; (5) to establish Regional Fishery Management Councils to prepare fishery management plans; and (6) to encourage the development of underutilized fisheries.

There are several important points to note about the intent of the United States' fishery management system as expressed through these overarching goals. First, fisheries are to be managed to achieve *optimum* yield rather than maximum physical yield. Although this seems sensible, optimum yield was not explicitly defined in the Act. This omission by the framers of the Act was deliberate; they expected the concept

to "evolve" as experience grew. As it turned out, however, this imprecise articulation of an important goal of management has led to a lengthy and confusing process that has yet to resolve the operational definition of what management ought to be pursuing. Second, that *regional* fishery management councils are directed to implement the law by preparing, monitoring, and revising fishery management plans has meant that the management process is decentralized. This structure was intended to ensure that the process would "take into account the social and economic needs of the States" and enable participation in the planning process by "the States, the fishing industry, consumer and environmental organizations, and other interested persons." In fact, the attempt to give consideration to all of these competing interests has most often simply gridlocked the process and produced inferior compromises and hindered movement away from the status quo.

The regional fishery management council system is an important feature of U.S. policy and deserves further discussion. Eight councils have been established, embracing fisheries in New England, the Mid-Atlantic, the South Atlantic, the Caribbean, the Gulf of Mexico, the Pacific, the North Pacific, and the Western Pacific. Each council has seven to seventeen voting members, consisting of one official from each of the states encompassed by the council, together with a number of appointees whose names have been forwarded by the states' governors after consultation with representatives of user groups. The principal job of each regional council is to develop, monitor, and amend fishery management plans for the fisheries within its jurisdiction.

The Magnuson Act provides the legislative framework for developing and carrying out the process of fishery management in the United States. It sets forth broad guidelines and standards and a structure within which to develop more detailed fishery regulations that have the force of law. The procedure operates roughly as follows. First, regional councils select fisheries for which a management plan is deemed necessary. Then, fishery management plans and accompanying recommended regulations are developed by council staff, drawing on inputs from in-house staff, advisory subpanels (drawn from user groups), and scientific and statistical subcommittee members. The draft plans are presented at public hearings for broader comment and passed up the administrative chain to the National Marine Fisheries Service Regional Office. The Regional Office then forwards the plan to the Secretary of Commerce, who may ultimately approve, partially approve, or reject the plan. Plans are rejected, in principle, if they do not conform to certain legal standards or other standards set up under the Act. Upon receipt of a draft plan, the Secretary of Commerce publishes a notice in the Federal Register, solicits more public comment, and reviews the plan. If the plan is approved, its accompanying regulations are promulgated as law. Subsequent amendments must be adopted through essentially the same process, but must also satisfy extra requirements, such as environmental impact reporting and regulatory impact analysis.

A fishery management plan must contain descriptions of the fishery, assessments of present and probable future conditions, recommended measures appropriate for conservation and management, and assessments of the impacts of such measures. Plans must also adhere to the National Standards for Fishery Conservation and Management set up under the Magnuson Act. These standards require that plans (1) prevent overfishing while achieving optimum yield for the U.S. fishing industry; (2) use the best scientific information available; (3) manage each stock as a unit; (4) avoid discrimination between residents of different states; (5) promote efficiency; (6) allow for stock variability; and (7) minimize costs and avoid duplication.

This structure has provided the foundation for the management of U.S. fisheries over the past sixteen years since the extension of the jurisdiction. In the next section I examine the success of this structure and address some of the practical issues in implementation.

Experience under the Magnuson Act

There are many ways to measure the success of any fishery regulation scheme. Perhaps first and foremost (certainly for biologists and perhaps also for the public) it should be asked whether the regime is successful in averting overfishing defined from a biological perspective. Although the concept of overfishing is not without ambiguity, the basic issue is whether management mechanisms have been employed to ensure a safe and sustainable stock

level. In some sense, this *conservation objective* is the minimum standard to which a regime ought to be held. If the management system cannot keep a stock from declining (other things being equal) because of fishing activities, the fishing system is not really under control and management must be judged ineffective.

Another issue is whether the fishery is generating any financial returns to the industry or to society at large. This *economic objective* is a more contentious criterion, of course, since who gets the returns is often as important as whether they are being earned. A basic benchmark often used is the amount of profits that might be earned by a sole owner if that owner were able to control all fishing inputs. This benchmark is useful because it gives us some idea of how much surplus might be generated from a fishery under circumstances designed to maximize the return to the resource "owner," which may be society at large. It is also useful because an important characteristic of open-access fisheries is the dissipation of this surplus—far more effort is drawn in than a sole owner would choose until costs rise to the level of revenues.

There have been several recent reviews of how successful the United States has been in managing its fisheries under the Magnuson Act. A recent paper that examined the status of 233 species appearing in U.S. coastal waters documented a serious increase in biological overfishing. The number of overfished stocks rose from twenty-one in 1976 to sixty-eight in 1992, with most overfishing on the Atlantic Coast and in the Gulf of Mexico. The condition of many fisheries on the Pacific Coast improved, however; although fifteen were overfished in 1976, only nine were still overfished in 1992. A similar study that examined both average weight landed and earnings per fisher during this period found a general slide in both, except in a few Pacific fisheries. Thus, by these simple measures of success in addressing conservation and economic objectives, the U.S. experience has not been particularly good.

A broad look at the history of the implementation of the Magnuson Act suggests several conclusions:

- The failure of the original Act to define fishery management goals in unambiguous, consistent, and operational terms has been a continual source of difficulty. By specifying goals in a vague and caveat-laden manner and by decentralizing the process, the Act has essentially left the direction of management up to the industry. The industry, in turn, has not had the self-discipline to address the conservation and economic objectives set out in the Act. Instead, the process has brought to the forefront of the debate issues concerning the allocation of the dwindling catches among user groups.
- Decentralization has allowed regional plans to reflect local concerns, but this has only amplified the conflict among user groups and the problem of lack of specific goals for fishery management. And decentralization has allowed user groups better access to the process, which has been beneficial overall, but most user groups still view the management process as an adversarial one pitting managers against the industry.
- A serious shortcoming of the Act is its ban on using taxes or fees for fishing activities. This essentially limits the policy options to such traditional policies as closed seasons and gear restrictions, and works against options that might change the basic incentives that fishers face. For example, some fishers support such measures as catch penalties for by-catch rather than the present policies requiring that by-catch be discarded at sea. The inability to utilize fees disallows, for example, surrendering by-catch and paying a penalty equal to its value. It also makes it infeasible to auction off permits for new fisheries, or to raise funds for beneficial programs.
- The gathering of data in the current system is haphazard at best. There is no centrally designed program to collect consistent data on the economic or biological health of all important fisheries. It seems essential, at a minimum, to know how much is being harvested, and when, how, and by whom. Some consistent "fish ticket" or logbook information is needed in both over- and underutilized fisheries to track harvests. It is probably also important to periodically gather data measuring costs and revenues in the industry.
- Perhaps the most important conclusion is that one key policy seems to separate successfully managed fisheries in the United States from those that are in trouble. That policy is limited entry. Current U.S. policy does not encourage or even facilitate the use of limited entry to avoid overexpansion. In fact, the decentralized nature of the system almost guarantees that such policies can be

blocked by user groups that oppose them. Most fisheries currently in decline are in that state as a result of problems associated with excess capacity. One central lesson of fishery management experience around the world is that the future of valuable fisheries without limited entry is bleak; they are virtually guaranteed to decline.

Lessons from the U.S. experience

It is probably safe to say that the U.S. fishery management experience is not one that Peru or other countries should aim to emulate when designing new regulatory schemes. With a few important exceptions, most U.S. fisheries are not in better shape either biologically or economically than they were in 1976. In fact, the United States lags considerably behind the rest of the world in developing innovative and forward-looking management regimes. Better examples of such regimes can be found in Australia, Canada, Iceland, and New Zealand. Still, there are some insights from the U.S. experience that might benefit other countries.

Perhaps the most serious problem with the U.S. system of fishery management is that it has not dealt successfully with the inherent conflict between the public interest and fishers operating under common property conditions. It has been universally demonstrated that common property incentives generate decline, both of the biology and of potential economic surplus. Even where management measures protective of the biology have been vigorously pursued, these perverse incentives have encouraged excessive inputs and waste of the financial potential of the resources. More often than not, these incentives also have affected managers' ability to implement, monitor, and enforce biologically protective controls. These factors have clearly been at work in the United States, with many of its fisheries in serious biological decline and almost all generating only a fraction of their potential economic yield.

These problems are not unique to the United States, of course. Fundamental to the successes and failures of different regulatory structures around the world is the manner in which they have dealt with the common property incentives. These incentives have generated many types of problems, including overharvesting, excessive entry, distorted input combinations, low-quality raw products, and unwieldy regulatory structures. Only a few nations regulate their fisheries in a manner that comes close to achieving the high levels of sustainable financial returns that fisheries are capable of yielding. A recent report by the Food and Agriculture Organization (FAO) estimates that world fisheries as a whole are not even earning returns sufficient to cover their operating costs, let alone interest on the capital invested or returns to the biological resources. The FAO paper estimates that the world's fisheries, rather than generating surpluses, are actually generating *deficits* of about US$50 billion a year.

A critical element missing from U.S. fishery policy implementation is a serious commitment to the objective of economic efficiency. The U.S. system essentially passes both the task of determining policy objectives and the job of carrying them out to the regional councils and thus to the user groups. This leads to a political process among user groups that sets the operational procedures of fishery management from the bottom up. This is a critical point and it stands in contrast to more successful experiences in both Iceland and New Zealand. Both of these countries have unequivocally mandated from the federal level that fisheries should be managed to maximize efficiency and net financial surplus.

A second issue raised by the U.S. experience is the potential for decentralization. Ideally, regulatory systems would allow fishers to determine at local levels how fisheries ought to be managed. As the U.S. experience suggests, however, this is not workable unless the institutional structure generates incentives that bring private actions and social goals into agreement. The regional council system with its minimal federal leadership, has essentially allowed fishers to dictate their own management goals. As we know from experience, there is an inherent conflict between the generation of social surplus and private incentives under conditions of open access. The industry has found it virtually impossible to generate the self-discipline necessary to impose upon itself structures that provide the right incentives.

One solution to this dilemma seems to be to develop a strong, federally mandated set of goals, and then perhaps to decentralize the procedures for meeting these goals. This is essentially the structure set up in the successful individual transferable quota (ITQ) programs of Iceland and New Zealand. It appears to be important to separate the process of

setting the goals of fishery management from the process of designing management structures to achieve those goals. The process of setting goals is essentially a political one that addresses this question: What does a nation want from its fishery resources? A good analogy is that of making a pie. Does a country want a large pie cut into a few large pieces? Or a small pie cut into many smaller pieces? How much of the pie should the industry keep? How much should go to the "public" owners? Clearly, the different groups concerned will not easily agree on the answers to these questions and some federal directives will be necessary.

Beyond setting goals that establish guidelines for management, it is important to enforce accountability in a decentralized system. That is because any system that breaks the link between the public interest and the user groups' interests in a fishery runs the risk of producing policies distorted by mismatched incentives. One way to help avoid this is to give fishers a considerable role in designing the operational details of programs once goals have been mandated. This is important for two reasons. First, fishers have useful insights into how fisheries operate, and it is important to incorporate their experience into management plans. Second, fishers need to accept as fair and to legitimize whatever system is adopted to avoid heavy monitoring and enforcement costs. This is especially true with individual incentive systems such as ITQs; fishers need to embrace the management system in order for it to succeed.

Another lesson from the U.S. experience (as well as experience elsewhere) is that limited entry is absolutely necessary to help manage fisheries. There has been a tendency recently to view limited entry as an alternative to incentive-based systems such as ITQs but it should, in fact, be viewed as a first step that eases the way for the introduction of further options should they be desired. Overwhelming evidence shows that a failure to adopt limited entry, or a delay in its adoption, leads to high costs and limited options. A major failure of the U.S. system has been the failure to adopt limited entry because of the industry's opposition. Again, this is largely the outcome of the lack of real federal commitment to efficiency goals. A case in point is the U.S. halibut fishery, which has recently seen its season shortened to five or fewer days in order to contain a huge capacity buildup. In the early 1980s the Secretary of Commerce rejected a limited entry plan, largely because of pressure from industry groups. The justification offered was "as an Administration, we're just opposed to limiting fishing to only those who have formerly fished...we are concerned that it would interfere with basic economic liberties" (*Los Angeles Times*, June 28, 1992). This is a dramatic illustration of a political process responding to private interests under common property conditions at the expense of the public interest; the waste to society of compressing a fishery's season into five days surely must outweigh the costs of interfering with "basic economic liberties."

Finally, the U.S. experience points to the importance of trying to design regulatory regimes that generate both private and public benefits from fishers' incentives to pursue profits. Much effort in U.S. fishery policymaking has been wasted in trying to contain these very natural incentives—for example, by allowing capacity to expand and then restricting its use. Seen in this light, even limited entry must be viewed as a necessary but only partially effective measure. There is little doubt that the next decade will witness the adoption of even more rights-based systems (including ITQs), territorial use rights systems, and comanagement structures. The strength of these systems is that their more clearly defined rights encourage fishers to direct investments and skills toward producing a higher-quality product at lower cost without compromising the safety of the resource or generating the inefficiencies inherent under systems with limited rights.

Allocation of Regulatory Power: The United States' Experience

Robert J. McManus

7

My assigned task at this symposium is to assist in the creation of a new management system for Peru's marine fisheries by describing the successes and failures of fishery management in my own country. In anticipation of my presentation today, I therefore attempted to compile two lists, one headed *successes*, and one *failures*. Regrettably, I am still trying to think of entries for the first list. The second, however, could go on for several pages.

I am not simply joking. Responsibility for regulating marine fisheries in the United States is vested in the Secretary of Commerce. This responsibility is exercised through the National Marine Fisheries Service (NMFS), a component of the National Oceanic and Atmospheric Administration (NOAA), which I served as general counsel for more than four years. I was responsible for the legal review and, ultimately, the enforcement of U.S. marine fishery regulation during that period—long enough to conclude that our system simply fails to solve most of the problems with which it must deal. In some cases it has made things worse.

Why have things turned out this way, some sixteen years after the passage of our basic fishery law, the Magnuson Fisheries Conservation and Management Act? In my view, the political sentiment in favor of this landmark law was based almost entirely on the desire of U.S. coastal fishers to exclude foreign distant-water fleets. (This they did, producing the major entry on my list of successes.) As a result, the statute was not written to respond very well to the many *other* problems that U.S. fishery policy encounters.

At the time the Magnuson Act was being written, I was a member of the U.S. delegation to the Law of the Sea negotiations. As one would expect, our delegation closely followed congressional consideration of the Magnuson Act. The central concept of the Act was directly relevant to our negotiations on the subject of the exclusive economic zone and was ultimately reflected in the treaty that emerged from those negotiations. At the time, the firm official position of the United States favored the doctrine of Freedom of the Seas, with very few exceptions. For reasons related primarily to the Cold War, we resisted what we then called "creeping jurisdiction"—for example, the Declaration of Santo Domingo and its 200-mile patrimonial sea; Canada's 1970 Arctic Waters Pollution Prevention Act, pursuant to which it asserted pollution control jurisdiction in a zone extending 100 nautical miles seaward from its fragile arctic coastline; Indonesia's assertion of rights over archipelagic waters; and the desires of U.S. fishers to expel foreign fishers so as to permit capitalization of a greatly increased domestic fishing effort.

In the United States the fishers won this debate. In the process, though, they accepted the principle of fishery management—but just barely. As one might expect, U.S. fishers had a particularly deep distrust of what we sometimes call "pointy-headed bureaucrats" in Washington, D.C. Accordingly, the members of the U.S. Congress who were most closely attuned to the desires of the U.S. fishers created the system of Regional Fishery Management Councils, which has been described by my compatriot, Dr.

setting the goals of fishery management from the process of designing management structures to achieve those goals. The process of setting goals is essentially a political one that addresses this question: What does a nation want from its fishery resources? A good analogy is that of making a pie. Does a country want a large pie cut into a few large pieces? Or a small pie cut into many smaller pieces? How much of the pie should the industry keep? How much should go to the "public" owners? Clearly, the different groups concerned will not easily agree on the answers to these questions and some federal directives will be necessary.

Beyond setting goals that establish guidelines for management, it is important to enforce accountability in a decentralized system. That is because any system that breaks the link between the public interest and the user groups' interests in a fishery runs the risk of producing policies distorted by mismatched incentives. One way to help avoid this is to give fishers a considerable role in designing the operational details of programs once goals have been mandated. This is important for two reasons. First, fishers have useful insights into how fisheries operate, and it is important to incorporate their experience into management plans. Second, fishers need to accept as fair and to legitimize whatever system is adopted to avoid heavy monitoring and enforcement costs. This is especially true with individual incentive systems such as ITQs; fishers need to embrace the management system in order for it to succeed.

Another lesson from the U.S. experience (as well as experience elsewhere) is that limited entry is absolutely necessary to help manage fisheries. There has been a tendency recently to view limited entry as an alternative to incentive-based systems such as ITQs but it should, in fact, be viewed as a first step that eases the way for the introduction of further options should they be desired. Overwhelming evidence shows that a failure to adopt limited entry, or a delay in its adoption, leads to high costs and limited options. A major failure of the U.S. system has been the failure to adopt limited entry because of the industry's opposition. Again, this is largely the outcome of the lack of real federal commitment to efficiency goals. A case in point is the U.S. halibut fishery, which has recently seen its season shortened to five or fewer days in order to contain a huge capacity buildup. In the early 1980s the Secretary of Commerce rejected a limited entry plan, largely because of pressure from industry groups. The justification offered was "as an Administration, we're just opposed to limiting fishing to only those who have formerly fished...we are concerned that it would interfere with basic economic liberties" (*Los Angeles Times*, June 28, 1992). This is a dramatic illustration of a political process responding to private interests under common property conditions at the expense of the public interest; the waste to society of compressing a fishery's season into five days surely must outweigh the costs of interfering with "basic economic liberties."

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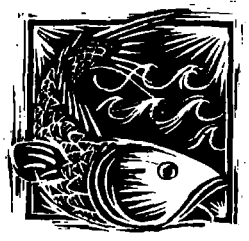

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James Wilen of the University of California at Davis. In this unique system, the councils develop fishery management plans for the marine fisheries in their regions. If the Secretary of Commerce approves a management plan, the Secretary must then adopt implementing regulations.

Thus, the power to manage fisheries is shared between a member of the President's Cabinet and regional bodies that, by virtue of their membership and their processes for selecting new members, are unique entities in American administrative law. Although they include certain full-time government officials (for example, the Regional Director of the National Marine Fisheries Service and the senior state fishery official of each of the states encompassed by the region), the essential character of the councils derives from their members who are not full-time government employees. These members, supposedly knowledgeable in fishery matters, must be chosen by the Secretary of Commerce from lists submitted by the governors of each state in the region encompassed by the council. Recent statutory changes have required some movement toward inclusion on the councils of persons not intimately connected with commercial fishing enterprises, but the dominant voice on all the councils has been that of commercial fishing interests.

Moreover, for legal reasons that it would not be useful to explain in detail to this distinguished audience, it is extremely difficult for the Secretary of Commerce to reject a fishery management plan devised by a council. To summarize, the statute requires that a fishery management plan must conform to the national standards set forth in the Act itself, as expanded upon by regulatory guidelines adopted by the Secretary of Commerce. The statutory standards are extremely general, however, and reasonable people often differ as to whether a complex FMP devised by a council in fact contravenes one or more of the standards, even as clarified by the Secretary's guidelines. Besides, as the result of amendments to the Magnuson Act in the early 1980s, secretarial approval is presumed unless express disapproval is registered within a prescribed and foreshortened time period. In other words, the consistency of a fishery management plan with the national standards is effectively presumed, and disapproval by the cognizant Cabinet official is extremely difficult to register. And, because the plans are devised primarily by the fishery sector, some would say that the fox guards the henhouse.

Against this background, here are some of the problems that fishery policy in the United States must address:

- *Scientific uncertainties relating to the assessments of stocks.* There are limited resources to engage in such assessments. In addition, the same questions about the accuracy of data submitted by industry referred to by Mr. Hannesson are applicable in the United States. Some problems, like some fishery stocks, know no national boundaries.
- *Jurisdictional overlaps between states and the federal government.* The federal government may have succeeded in Americanizing marine coastal fisheries, but the states continue to exercise plenary authority over fishing out to the limits of their own territories—in most cases, three nautical miles. The fish do not read charts, however. Although the Magnuson Act supplies a procedure through which the Secretary of Commerce can take over management of a marine fishery resource in a state's ocean waters (but not, it should be noted, in internal waters, such as bays and estuaries), the Secretary must first find that the state's policies are interfering with the implementation of a federal fishery management plan. In many cases both the federal government and the states exercise regulatory authority over a fishery stock in different parts of its range.
- *Damage to fishery stocks from other developmental activities.* For example, the development of hydroelectric power in the Pacific Northwest has had severe adverse effects on certain stocks of salmon, a highly prized fishery resource for both commercial and recreational sectors; some salmon have recently been designated endangered. In another example, the dredging and filling of wetlands in the marshy areas adjacent to the Gulf of Mexico have had adverse effects on commercial shrimp fisheries and on commercial and recreational finfish. The Magnuson Act and other statutes are of little help in resolving these conflicts.
- *Gear conflicts.* For example, shrimp trawls off the coast of Florida interfere with the stone crab fishery there. The shrimp trawls get tangled with the crab pots, a situation that has actually led to violence on occasion. In addition, the large percentage of

finfish by-catch associated with shrimp fisheries has produced conflict with recreational fishers in the same region. And in the Gulf of Alaska we have seen highly charged confrontations between the pot fishers and the "long-liners." This conflict led to an extremely complex regulatory mechanism that phased out pots east of designated longitudes over a three-year period.

- *Shared stocks, such as tuna and salmon.* Until 1990 the United States' approach to shared stocks was simply to exclude them from the legal definition of fish in the Magnuson Act. This has changed.
- *Enforceability.* Marine fisheries present an especially difficult enforcement problem. Neither the fish nor the fishers stand still, making it difficult for government inspectors to ascertain whether laws and regulations are being obeyed. Moreover, other priorities demand the law enforcement resources available for surveillance and interception at sea.
- *The costs of change.* It is necessary to distinguish between the cost of implementing a system of fishery management—*any* system—and the additional cost arising from a change in that system. Professor Arnason has referred to this in his paper on theoretical and practical issues relating to fishery management. For example, the institution of a limited entry system will give rise to costs that will not be encountered on an annual basis once the system is in place. I do not refer to cash expenditures—although there may be some of these, too—but to indirect costs, including social costs, that are always attendant upon changes that enrich some at the expense of others.

None of these serious issues is addressed well by current fishery management in the United States. Because of the autonomy and relative power of the councils, we have seen groups of fishers with conflicting interests each try to capture control of a council by politicizing the selection of its members. Until recently, moreover, management of U.S. fisheries has assumed open access to fishery stocks. Accordingly, although FMPs have established an annual total allowable catch, we have witnessed extreme resistance to the initiation of limited access strategies, such as transferable quotas. Instead, we have used, singly and in combination, all the biological and direct economic methods that Professor Arnason has told us will not work.

If this sounds too pessimistic, I hasten to observe that there is some good news in the present circumstances: as I understand the situation, Peru's industrial fisheries do not present many of the problems I have just summarized. For example, I understand that the water off the Peruvian coast is generally too deep to give rise to gear conflicts. Political subdivisions are not involved in the management and regulation of fisheries at sea. Other developmental activities do not seem to interfere with the stocks of greatest commercial importance. And the coastline of Peru is not characterized by wetlands that provide spawning grounds for commercially important marine fish, nor has it given rise to such activities as seismic exploration on the outer continental shelf.

But the news that gives the most hope, in my opinion, is Peru now has the chance to begin anew, drawing on the experience of other countries and—of particular relevance in the context of my remarks—to profit from their mistakes. Peru need not create an administrative nightmare in the form of special purpose quasi-governmental authorities, appointed politically to work part-time to regulate their own business, if necessary at the expense of their competitors.

Of course, to reject the U.S. model is not to solve all problems. But I suggest that Peru's new fishery management regime is more likely to confront those problems successfully if its architects focus not merely on economic or biological concepts but on the allocation of power—specifically, regulatory power. If, for example, such power is exercised by those with the greatest economic interest in the greatest short-term financial return, the fishery so managed will probably not achieve maximum sustainable yield on a stable basis; at best it will experience pulse fishing, and at worst it will be driven to biological extinction. If, on the other hand, power is vested solely in academics who well understand "the tragedy of the commons," but who need not meet a payroll, fishery management may become so divorced from real-world considerations that it will not attract the investment needed to maximize society's benefits from an important resource.

The architects of any new fishery management regime should be constantly aware of the need to think through and to answer definitively at least the following questions:

- By what procedure is a fishery regulation to be prepared? Who will have input? What time constraints or requirements will apply to the creation of a plan, to comments on a proposal, and to the final decision? Who will coordinate the effort?
- Who will have the enforceable legal authority to adopt a regulation applicable to a particular fishery? Is such authority to be shared in some manner guaranteed to produce gridlock? Or, conversely, is it to be exercised by individuals or entities not answerable, as a practical matter, to any legal or political authority?
- Once the regulations governing a fishery are adopted, can they be changed, and, if so, how? For example, would annual announcements of the total allowable catch require the promulgation of a new regulation, or could technical functionaries exercise this authority?
- What resources are available to develop and implement a plan for a particular fishery? Are they available in sufficient quantity to get the job done? And who will decide how the resources available are to be allocated? For example, how is research trawl time to be allocated among competing priorities? Who will decide what level of surveillance effort is necessary or appropriate to enforce a particular regulation?
- Once infractions are observed and documented, who decides what penalty is appropriate, and what processes of review or appeal are available to the prosecution or the defendant? Is the standard of review appropriate to the nature of the regulation being enforced? If it is very strict, will enforcement be practicable, considering available prosecutorial resources? If it is very permissive, will the regulated interests be effectively at the mercy of officials who may have priorities other than fishery management or enforcement (for example, raising revenues)?
- Are there to be alternative enforcement choices (for example, civil, criminal, judicial, or administrative)? If so, who decides which would apply to a particular case?
- May a regulation applicable to a particular industrial fishery consist solely of requirements to collect and report information to governmental authorities, at least for an interim period? That is, will fishery officials have the power to impose on the regulated industry the costs of collecting the information necessary to regulate that fishery intelligently? If so, why? If not, why not?

This is by no means an exhaustive menu of hard questions, but each of them reflects problems that I have witnessed in the management and enforcement of fishery laws in my own country. Other such questions will surely occur to those more familiar than I with the specifics of Peru's fisheries and with Peru's legal system.

Issues of power must not be ignored by those who design management systems. As the proceedings of this symposium should illustrate well, many hard questions surround intelligent management of fisheries, questions that would be much easier to answer satisfactorily if we could only be confident that good theoretical solutions will be reflected in practice. The reason they so often are not, I suggest, is that the architects of regulatory regimes, consciously or otherwise, often fail to pay enough attention to the allocation of regulatory power among competing private interests and government bureaucracies. But they must do so if they are to ensure that decisionmaking authority is wielded by persons or entities as free as possible from conflicts of interests, furnished with the resources reasonably necessary to get the job done, and backed up by a legal system whose procedures are well understood and of an appropriate level of complexity for the subject matter.

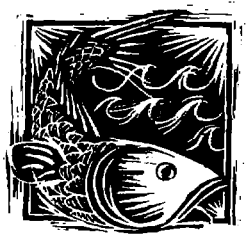
In conclusion, I also suggest that a new system for managing Peru's fisheries might consider two additional problems not significantly encountered in the United States. The first of these is the desirability of—and perhaps the need for—foreign participation in the fishery, either directly or through passive investment. To generate an appropriate level of foreign participation will require a delicate balance. On the one hand, the system will need to attract foreign capital, including technology and know-how. On the other hand, it will need to retain as many of the benefits of fishery development as possible for the Peruvian people.

Second and finally, Peru confronts the reality of El Niño, which has devastated its fishery sector on several occasions in the past two decades. I do not yet know whether or to what extent this phenomenon affects investment, or how it would affect the operation of a system of individual transferable quo-

tas suggested by some participants at this symposium. But it strikes me that the El Niño phenomenon would serve as a substantial disincentive to private investment in Peru's fishery sector. Perhaps a new fishery policy should take El Niño into account. Laws and regulations are still unable to control climate and weather, but perhaps they could provide for some form of insurance or other means of spreading the risks of this phenomenon over time.

Note

The views expressed herein are those of the author and do not necessarily represent the position of any agency of the U.S. government.



Fishery Management in New Zealand

Ian N. Clark

8

The fishing industry in New Zealand's economy

New Zealand's 200-mile exclusive economic zone is about 1.3 million square nautical miles or more than fifteen times the country's land mass. Although the zone is the fifth largest in the world, it is not, by world fishery standards, very productive. It has only a very narrow continental shelf, with 72 percent of the zone deeper than 1,000 meters.

The value of production in the fishing industry increased from US$290 million in 1984 to more than US$550 million in 1991. The volume of production increased dramatically with the establishment of the 200-mile exclusive economic zone. At present it is estimated that there is an available fishing resource of some 700,000 metric tons, of which a little less than 600,000 metric tons is subject to New Zealand's quota management system. About half the total catch is taken by foreign vessels under charter to New Zealand fishing enterprises. New Zealand's domestic market is limited, and domestic sales of fish have remained relatively static. About 80 percent of total fish production is exported. In 1970 exports amounted to US$10 million, in 1980 to US$88 million, and in 1991 to US$550 million.

Japan, the United States, and Australia are New Zealand's most important export markets. In 1991 they accounted for 67 percent by value and 84 percent by volume of all fishery exports. Japan is New Zealand's most valuable market, taking US$165 million or 30 percent of total exports in 1991. The U.S. market amounted to US$148 million or 27 percent of exports, and the Australian market to US$55 million or 10 percent of exports.

Orange roughy, with exports of US$74 million in 1991, fell to second place in the ranking of the most valuable species. Squid brought US$25 million and rock lobster US$53.5 million in export earnings. Together, these three species accounted for more than 40 percent of total exports. Hoki became the most valuable species, bringing US$83 million in export revenues. Other valuable export species were snapper (US$28 million), mussels (US$22 million), oreo dory (US$11 million), barracouta (US$11 million), and warehou (US$11 million).

Investment patterns in the industry corresponded to the expansion that followed the declaration of the exclusive economic zone, with the development of the deep-water fisheries demanding additional gear and processing facilities. Investment in the catching sector is estimated to have increased by US$34 million and investment in processing capacity by more than US$53 million between 1984 and 1990. The expansion in investment was accompanied by growth in employment, with total jobs in the fishing industry increasing by some 3,000 between 1984 and 1991.

The history of New Zealand's fishery management

Before New Zealand declared its 200-mile exclusive economic zone in 1978, its fisheries were small and confined to an inshore domestic industry operating to a depth of approximately 200 meters—effectively the near continental shelf. New Zealand's jurisdiction was extended initially to 3 miles and then to 12 miles. Beyond this zone the fisheries were exploited

by fishing vessels from Japan, Korea, and the former Soviet Union.

The management of the fisheries during this period was often confused by fundamental changes. For example, from 1938 until 1963 the inshore fishery was managed under a restrictive licensing system with extensive gear restrictions and area controls requiring boats to fish from specified ports. In 1963 the inshore fishery was completely deregulated and remained that way until 1978, when a moratorium was imposed on rock lobster permits and scallop permits, followed in 1980 by the introduction of a moratorium on fish permits.

During this period of open entry the New Zealand government's policy was to encourage investment in the fishing industry through investment in fishing vessels, capital grants, allowances, and tax breaks. The rapid expansion of the domestic industry during the period laid the foundations for its further development into the deep-water fishery after the declaration of the 200-mile zone. In 1978 and 1980 the government introduced some controls, but the economic objectives of the policy remained unclarified and it failed to discourage the natural tendency toward overcapitalization that comes with open access. Although the controls limited entry, they did not in any way limit increases in effort, which continued apace. In the rock lobster fishery, for example, a number of separately managed, limited entry fisheries were established, with nontransferable licenses rationed through a licensing authority. But the new policy to limit entry failed to reduce investment in the fishery. This fishery has now been brought into the individual transferable quota (ITQ) management system.

For finfish it was gradually realized that both economic and biological objectives were necessary for effective management but that, more important, the management program itself had to be effective to some degree in achieving these objectives.

The declaration of the 200-mile zone added impetus to further clarifying objectives in appropriate management approaches. The government was faced with the need to develop management strategies for the fish resources of a very large and unfamiliar area. At least initially the government chose to manage the exclusive economic zone and the inshore fisheries as separate entities, applying to the zone outside 12 miles a policy of limited domestic expansion, joint venture arrangements, and foreign licensed fishing. This policy was occasioned in large part by a wider trading arrangement with those who had traditionally fished beyond the 12-mile limit.

In 1983 three events occurred that were significant for New Zealand's fishing industry. First, a new piece of legislation, the Fisheries Act 1983, was passed. Second, the government introduced an economics-based management system for the deep-water fisheries based on individual company transferable quotas. Third, major economic and biological problems in the inshore fishery reached a point at which they could no longer be ignored.

The Fisheries Act 1983 consolidated earlier legislation and introduced the concept of fishery management plans. It did not, however, address the key fundamental question of how, or by what criteria, fisheries were to be managed, and still relied heavily on the preservation and conservation philosophies with all their attendant regulatory control requirements. But for the first time recognition was given in the Act to a range of objectives that went beyond conservation. Among these was the objective of attaining an optimum return from the fishery—an objective that inevitably embraced economic goals beyond the short-term financial goals of participants.

The deep-water trawl policy introduced under the Act recognized the need for management to be economics-oriented and relied heavily on managing the resources through controls on output rather than through inefficient controls on inputs. Until the commercial discovery of orange roughy in 1980 and the increases in its harvest from 1981 on, the joint venture operators had achieved only limited commercial success and several ventures had ceased operation. Those that survived until 1981 tended to be associated with larger, established fishing companies. With growing harvesting pressure in the deep-water trawl fishery and a growing desire by fishing companies to invest in larger domestic deep-water trawlers to harvest orange roughy in particular, the government introduced a system of company allocations in 1982 that formed the basis for the deep-water trawl policy.

Quotas in the deep-water trawl fishery were allocated according to three criteria: investment in

onshore processing facilities, investment in fishing vessels, and quantities of product processed. Investments were valued on the basis of the insured values of facilities reported by firms. Each of the criteria was weighted equally in allocating the quotas.

The different species being allocated are caught at different depths, with only larger vessels able to catch species located in deeper waters. The allocation procedure accounted for this by dividing the vessels into two categories, those between 20 and 30 meters, which were able to fish depths of about 400 meters, and those over 30 meters, which were able to fish depths of about 800 to 900 meters. Investment in the smaller vessels was not taken into account in allocating the quotas for species found in extremely deep water, such as orange roughy.

Allocations were made only to firms that would receive an allocation of more than 2,000 metric tons. Several firms that would have received less than 2,000 metric tons organized themselves into two consortia whose members collectively would receive quotas exceeding 2,000 metric tons. Quotas were allocated among nine companies, including the two consortia.

Additional controls were added to encourage domestic ownership of the fishery. Quotas were restricted to firms with at least 75.1 percent New Zealand ownership, and those holding quotas were required to process 35 percent of the total deep-water catch onshore in New Zealand.

Provisions were made to set aside a part of the fishery's total allowable catch for harvesting in a common property fishery by small operators who had less than 2,000 tons and who had not joined one of the consortia. The catch set aside for these firms exceeded their aggregate historical catches and allowed for the future development of this segment of the industry.

Fishing was monitored in several ways. Vessels were required to maintain landing logs indicating what was caught and under which quota. They were also required to make daily location reports and weekly landing reports. Fisheries officers made random checks of landings and monitored transshipments at sea to ensure that landing and transshipment reports were accurate.

The biological and economic problems in the inshore fishery focused attention on the inability of traditional management methods to deal with them and forced fishery managers to examine alternatives for this fishery as well. These problems, and New Zealand's experience with its fishery management efforts, led to the integration of economic objectives and strategies into the overall management programs and, in 1986, to a further amendment to the Fisheries Act. The amendment gave more explicit recognition to the role of economic goals in the management of fisheries and provided for the introduction of the individual transferable quota system in the inshore fishery and its more comprehensive application to the deep-water fishery.

The inshore program was proposed by the government in 1984 and widely discussed throughout the year. This consultation proceeded in two phases: one-on-one conversations with industry leaders, and an extensive round of public hearings. The one-on-one conversations were considered a necessary preliminary to the meetings to ensure that community and industry leaders were familiar with the concept of individual transferable quotas before the public hearings were held.

The public hearings—about sixty-five in total—were conducted by three teams of Ministry staff during a three-week period at the end of 1984 and the start of 1985. These meetings were used to brief fishers on the nature of and the rationale for the ITQs, to collect comments from them about their concerns, and to find out how they felt specific program elements might work and whether they supported the management system.

Fishers were concerned about the government's ability to control the dumping of excess harvests at sea or efforts to land fish in excess of the quotas. They were concerned about the initial allocation of quotas being based on catch records, which some suggested had often been filled out inaccurately for tax reasons. Some were concerned that larger fishing companies would use the individual quotas to gain control over the fishery. These concerns about the concentration of quotas prompted a proposal for an important modification to the program—that the share of any total allowable catch that could be owned by a single entity be limited to 20 percent. Fishers also expressed philosophical concerns about the program—for example, concerns about exchanging a hunting for a business lifestyle.

The program was adopted in 1985. Several factors contributed to this. Whether or not the program was adopted, the total allowable catch needed to be reduced in a number of fisheries. If the program was not adopted, the catches would have been reduced through uncompensated reductions in total quotas. If the program was adopted, the government would reduce total quotas by buying back some of the quotas allocated to individual fishers. Payments under the buyback program were to be tax-free. Thus, many fishers were given a large and immediate financial stake in the program.

A second factor was the positive experience that larger firms involved in both the deep-water trawl fishery and the inshore fisheries had had with individual quotas in the deep-water trawl fishery. These companies supported the extension of quotas to the inshore fisheries. The success of the deep-water program carried less weight with the smaller inshore fishers.

The government had decided to initiate the new inshore quota system in October 1985, but problems in allocating quotas to individual fishers delayed the program's start to October 1986. The steps taken in introducing and implementing the ITQ-based management system can be summarized as follows:

- The twenty-four major commercial inshore species were identified.
- Total allowable catches were established based on the best available information.
- Catch histories for fishers were determined based on the average of their best two of the previous three years.
- Provisional ITQs were allocated based on the catch histories.
- An appeals process was established to handle anomalies.
- The government bought back, by tender, provisional ITQs in an attempt to match quotas to the TACs.
- Final ITQs were allocated to fishers.

The quota management system was based at its inception on allocating specific tonnages as ITQs. In other words, the TAC was divided into tonnages and these were allocated according to catch histories. Inherent in such a system is the idea that the government adjusts the TAC up or down by selling or buying quotas on the open market. This approach was perceived as having a number of drawbacks—the principal one being the cost to the government of reducing TACs.

For this reason, the quota management system was changed in 1989 to a proportional system in which allocations are based on shares of the TAC. Each fisher was allocated a percentage share of the TAC that would always remain the same while the actual tonnage held would vary depending on changes in the TAC. Under this arrangement, the cost of TAC adjustments is borne by the quota holder.

Since the introduction of the quota management system the industry appears to have redirected much of its energy from activities designed to increase harvesting power to activities that increase harvesting efficiency and the value of the final product. There is evidence that the system has allowed the operators remaining in the fishery to fish more efficiently. Uncertainty has been reduced and the ability to effectively plan the year's operations has increased as a result. Companies have been able to take advantage of the guaranteed harvests associated with their quota and to defer harvesting operations until periods when fish are concentrated and the catch per unit of effort is high. Subsequently, many fishers have been able to lower their operating costs.

The experience with orange roughy illustrates the types of efficiency benefits associated with ITQs. Orange roughy freezes well, can be stored relatively inexpensively, and during the winter, when its stocks are highly concentrated, fishing returns a high catch per unit of effort. The most efficient way to harvest orange roughy—a harvesting strategy supported by ITQs—is to fish intensively during the winter, freeze and store the harvest, and then process it as it is needed by the markets. The savings in harvest costs exceed the increase in storage costs and any decline in product value. In the absence of ITQs, competitive pressures force companies to concentrate a large part of their harvesting efforts during the winter at significantly higher harvesting costs to ensure that they maximize their share of the total allowable catch in an Olympics-style race for fish.

A more secure supply of orange roughy allows companies to process and market it more efficiently. For example, the cost of processing orange roughy has been reduced by smoothing out the flow of the

product. Firms have been able to reduce staffing requirements but provide more job stability. The ability to promise a steady flow of orange roughy throughout the year has made it easier to market the product.

Having a set quota encourages firms to squeeze the most value possible out of each kilogram. This means making the best possible use of by-products. For example, one firm tried to discover uses for orange roughy oils in the cosmetics industry.

Many fishers have improved on-board handling practices, and a number have switched gear types to produce higher-quality product. New investments have been redirected into value-adding production, such as surimi lines, live fish export, and fillet production, and into techniques to reduce wastage during processing.

The essential element of the new fishery management policies that have developed since 1983 is the creation of property rights in the form of individual transferable quotas. The quotas, their tradability, the reduced government intervention (and the shift from regulatory interference to intervention through market forces), and the matching of effort to resource allow the industry to develop while maximizing returns to the nation through resource rents and increased profitability based on international competitiveness.

The ITQ-based quota management system

New Zealand's quota management system now covers thirty-two species—most of the commercially significant finfish species in the exclusive economic zone with the exception of tunas. In addition, the rock lobster fishery was incorporated into the quota management system in 1989. The government has confirmed that the ITQ-based quota management system is the basic mechanism by which fisheries in New Zealand will be managed.

Monitoring tools

To monitor fisheries and harvesting activity, the quota management system relies on four basic reports that participants in the industry are required to complete. These are the Catch Effort and Landing Return, the Catch Landing Return, the Licensed Fish Receiver's Return, and the Quota Management Report. These documents are used to confirm information about catching activity and the use of harvesting rights. They also provide detailed data on catches and fishing effort.

The Catch Landing Return must be completed by the skipper of a fishing vessel immediately after landing a catch. The report provides an on- site record of catch landing activity and must be available on demand to any fisheries officer or examiner. A Catch Effort and Landing Return is also required for each fishing method. This report provides detailed information to assist in the scientific stock assessment program.

These two reports provide the following information on fish species landed:

- Date
- Species and area
- State—for example, green, gutted, filleted
- Number and container
- Fisher identification number (the quota registration number under which the fish is caught)
- Destination by licensed fish receiver number or vessel registration number
- Greenweight
- Purchase tax invoice from the licensed fish receiver.

The Licensed Fish Receiver's Return must be completed by all those licensed to receive fish from commercial fishers. These reports must be submitted to a registration office monthly, or at shorter intervals if specified. They show, for fish received, the quota holder's name and identification number, the species, and the greenweights. The report is designed to help monitor commercial fish-receiving operations beyond the landing point.

A fish receiver is defined as any person who receives fish from a commercial fisher for handling or processing other than through small boat-side sales. Unless there are special circumstances, a fish receiver must receive 30 metric tons or more of fish from three or more New Zealand fishing vessels each fishing year. It is against the law for an unlicensed person to receive fish from a commercial fisherman. Fish export licenses and fish packinghouse licenses can be recognized as fish receivers' licenses. A license or certificate of registration may be declined, revoked, or not renewed if the applicant or any per-

son involved in the management of the operations has been convicted of any fishery offense or has been involved in the management of a corporate body that has been convicted of a fishery offense.

The Quota Management Report is completed by quota holders. It must be submitted to a registration office monthly, or at shorter intervals if specified, and the fishers must hold the supporting documents for a least three years. The report gives the quantity of fish caught during the period covered for each species, by area, for which a quota is held, and thus provides the basic information needed for the monitoring of harvesting rights.

Requiring these different reports from the fishers, quota holders, and fish receivers gives them all responsibility for monitoring the use of the resources. Each type of document can be cross-checked against the others to ensure the accuracy of the information they contain. If the cross-checking reveals a discrepancy, an Exception Report is prepared and an appropriate investigation is carried out.

Compliance and enforcement

Before the introduction of the quota management system the enforcement approach in New Zealand's fishery management policies was of the traditional "game warden" type. The objective of this type of system is to apprehend people who are breaking the law and to provide a presence in an attempt to reduce offenses.

It was New Zealand's intention, with the introduction of the quota management system, to change the nature and focus of the enforcement activity. The game warden approach is expensive to carry out well and was seen as being inappropriate to the new management strategy. The quota management system gave the enforcement authority the opportunity to move away from an enforcement approach centered on managing people to one centered on monitoring the flow of product from fishing vessel to retail disposal and the resources generated from that product flow. Rather than monitoring the fish, the enforcement authority seeks to establish a paper trail that can be followed. The focus of enforcement activities has shifted from sea to land. In short, the movement has been from game warden to auditor.

There is still a substantial role for traditional enforcement in two areas, however—poaching or illegal fishing, and recreational or amateur fishing. Both require physical monitoring, surveillance, and enforcement rather than the new type of enforcement that relies more on auditing and targeted operations.

Other issues

New Zealand's quota management system raises several other issues that merit comment. These include consultation between the government and the industry, rents in the fishery, restructuring of the industry, registration of quota ownership, and trading of quotas.

Consultation. Involving the fishing industry in the development and implementation of New Zealand's quota management system was seen as of fundamental importance. The detailed consultation with the industry was seen as critical to gaining the industry's commitment to and support for the management system, which in turn was considered vital to the system's success. The industry's support made the transition to the new system easier.

Rent. The issue of rents has probably been the one that has caused the greatest conflict between the commercial industry and the government. The dispute has centered on three questions—whether there is management rent, what the size of any rent is, and whether it can be measured.

The New Zealand government still seems to take the view that the existence and operation of the quota management system generates significant management rents and that these rents should accrue to the government. But the industry is of the view that to remove rents from the fishery will reduce future investment, inhibit innovation and technological development, and leave the industry a controlled-profit sector of the economy.

The policy for the next four years has already been determined. What is exercising the minds of the industry and the managers at the present time is what will happen at the end of this transition period.

The industry will argue strongly that, with the move to proportional quotas and the consequent transfer to the industry of the risk of changes in total allowable catch, any rent should accrue to the industry and no resource rents should be payable to the government. In addition, a very strong case can

be made that in New Zealand any rents that may have existed have been capitalized in the value of quotas, and have in fact been captured in the sales of quotas. At least 80 percent of all quotas in New Zealand have changed hands at prices that have been determined by the market and that therefore clearly incorporate any rents that might have existed in the fisheries.

Based on New Zealand's experience, it would seem that if rents are to be appropriated from the fishery, this should be done either from the very beginning, or from some specified future date (after all, rents may not be generated until restructuring has occurred). The rents should be fixed in amount over time to ensure the certainty of information for planning and investment purposes by the industry. And the rents to be appropriated should be equal to the costs of management, with some return to the asset if appropriate.

Restructuring. There has been substantial restructuring within the fishing industry since the introduction of the quota management system, as one would expect with such a system. Although it is difficult to quantify the changes in terms of vessel numbers and capital investment, some data are available. It is known, for example, that about 80 percent of the total quota has changed hands through permanent trades. It is also known that there has been a substantial concentration of quotas, with the result that the ten major quota holders now own or control at least 80 percent of the total quota.

The Fisheries Act prevents a quota holder from owning, holding, or controlling quotas for more than 35 percent of the catch of a deep-water species or 20 percent of the catch of an inshore species. This restriction is perceived by some in the industry as an impediment to further restructuring and by others as a safeguard against too great a concentration of quotas in too few hands. A recent report concluded that over time quota ownership is likely to become as concentrated as the law allows and that the legislative restriction is merely slowing the restructuring, not halting it, and is imposing a greater cost on the restructuring than would be the case if it were allowed to take place more rapidly.

Foreign ownership of quotas is also limited, with the Act precluding foreign ownership or control of more than 24.9 percent of the total quota. Clearly, there are arguments both for and against this restriction related to restructuring, domestic industry expansion, technology transfer, and new investment.

Quota ownership registration. The New Zealand government has declined to implement a registration system for quota ownership that guaranteed clear title to quota. There were a number of reasons for this, related primarily to the perceived difficulty in operating a suitable system. Most important, however, the government did not consider such a system essential to the operation of the quota management system. But lenders are reluctant to advance funds against quotas when a guarantee of title cannot be recorded, and they insisted that they have security against some fixed asset other than the quotas.

The industry has proposed a number of options for a quota registration system that could be incorporated into legislation and that would provide greater security to banks and other financiers relying on quotas as collateral for loans. These include a stand-alone system under a personal property securities arrangement, and a system of registering charges over quotas to identify such liabilities as mortgages. Also proposed is a registration system within the current quota management system, to be operated by the administrative authority, that would add to the management system's data base information on ownership, interests in, leases of, and mortgages on quotas. This system is preferred because it is the most comprehensive, covering all interests in any quota.

Quota trading. One of the fundamental elements of an ITQ system is transferability of quotas. Without transferability any quota management scheme is largely unworkable except in the very short term, and even then it has significant drawbacks. The inability to transfer quotas precludes their efficient use by restricting fishers to existing patterns. It prevents restructuring to reduce overcapitalization and consequently prevents efficiency gains. It leads to an aging fisher population because it makes it difficult for quota holders to enter the fishery and, conversely, it limits the entry of new participants. And it restricts the development and application of new technology. The ability to transfer quotas is therefore critical to ensure that the market is allowed to operate effectively.

During the first two years of the New Zealand scheme a quota trading exchange was in operation. The exchange was intended to facilitate the trans-

fer of quotas. But with the concentration of significant tonnages of quotas in fewer and fewer hands, it proved unnecessary. And the exchange had shortcomings. For example, the quota holders thought it revealed too much information to the government, which used the information to form judgments about appropriate levels of resource rents. When the exchange was abandoned, trading was left to the informal market and to a limited number of quota brokers. This arrangement appears to be working quite well, although it is difficult to judge its success in strict efficiency terms and the transactions costs are not known. There is no need for any additional trading systems, however.

The future of fishery management administration

The administration and the industry both agree that the quota management system is the only sensible management option and that by and large it does work to meet the objectives of conservation, sustainability, and economic efficiency. Yet there is a great deal of conflict between the two. Why?

The answer lies in the complexity that has crept into the system through regulatory interference, inadequate or poorly drafted legislation, and administrative structures that have been unable to adequately cope with the operation of the system.

The key to a successful ITQ-based management system is to keep it simple and true to the underlying principles of sustainability and economic efficiency. Adjustments to a quota management system need to be made within the framework of the principles on which the system is built. In New Zealand's system, however, ad hoc interventionism has more often been the case. This inevitably results in legislation, which in turn is inadequate for the intervention because legislation, by its nature, is designed primarily to restrict, inhibit, prevent, and regulate. It layers complications upon complexity until the system begins to falter.

As more and more people struggle to make inappropriate solutions work, bureaucratization of the system results. This leads to increasing aggravation and conflict between the administration and user groups, and they lose sight of the purpose of the adjustments to the system in the bureaucratic jungle.

The administration's proposals for change

The New Zealand Minister of Fisheries has clearly signaled a desire to see changes made in the administration of fishery management. The probable aim is to minimize the cost to the government of managing fisheries and the conflict and aggravation between user groups and the government. In August 1991 an independent task force was established to review New Zealand's fishery legislation. This review is expected to result in a revised Fisheries Act.

The task force was requested to prepare a report to be issued by the Minister of Fisheries by March 1992. Its terms of reference centered on building on the philosophy of the quota management system to:

- Recognize the competing claims to fisheries of the different user groups, including Maori, recreational, and conservation interests
- Provide for the ongoing exploration, development, and enhancement of New Zealand's fisheries
- Provide a sound basis for further development
- Reduce unnecessary government intervention in fishery management.

The industry welcomed the task force review as an opportunity to improve the operation of the quota management system, end unnecessary regulatory intervention in fishery management, and increase the involvement of user groups in fishery management.

In December 1991 the task force released a paper that outlined different options and that was designed to provoke discussion on a wide range of issues. The discussion paper did provoke discussion, but it was perceived by the industry as heavy on concept and light on detail. The industry is concerned that there is insufficient time to put the necessary legislation together properly during the term of the current government. Plenty of time is needed to scrutinize and debate the issues to ensure that the review does not result in flawed legislation.

The task force signaled several important views in the discussion paper. These are summarized below:

- The task force endorsed the expansion of the quota management system as the most appropriate direction for fishery management in New Zealand. And it suggested that the quota management system

is robust enough to accommodate Maori fishing rights, sound environmental management, and recreational fishing rights.

- The government should state its objectives more clearly in the revised Fisheries Act. Probable objectives include the creation and allocation of property rights, protection of the environment, compliance with the Treaty of Waitangi, and the meeting of international obligations.
- Processes should be developed to empower those holding rights in fisheries to form collective organizations ruled by binding votes. For the commercial sector, this might mean the formation of Fisheries Quota Holder Associations. These groups would negotiate issues of common concern with recreational fishers, conservationists, and Maori.
- A duty of care not to infringe on the rights of others, nor to contravene environmental rules, should be imposed on users.

The industry's proposals for change

The Fishing Industry Board made an interim submission to the task force, which was endorsed by the Fishing Industry Association and the Fishing Industry Union. The Federation of Commercial Fishermen, although in partial agreement with the Board's submission, did not support the institutional reform it proposed. The main points of the Board's submission are as follows:

- The objective of fishery management is "to maximize the economic and social benefit of the fishery for New Zealanders."
- Future management should be based on an expansion of the philosophy and the application of the quota management system.
- There should be an integrated approach to fishery management, in which all users of the resource are managed under one regime.
- Clearly defined, transferable, and secure property rights should be allocated for commercial fishing activities. This will ensure that appropriate incentives exist for industry to invest in long-term management, fishery enhancement, and exploration programs.
- All commercial fisheries should be integrated into the quota management system.
- Existing and new aquaculture operations should be administered under the revised Fisheries Act. Regulation of the environmental effects of aquaculture should remain under the Resource Management Act.

The underlying assumption of the Board's submission is that New Zealand's fisheries should be managed under a regime that is proactive, planned, and user-directed, with the government responsible for setting minimum standards and issuing environmental rules. This regime would require institutional reform to permit groups of quota holders to get together and jointly devise fishery management programs. This would build on existing processes in which quota holders and other users have prepared management and exploration plans for the orange roughy, paua, squid, and rock lobster fisheries.

Additional amendments to the quota management system proposed by the commercial sector are as follows:

- The administrative burden associated with the system's paper flow should be reduced. Processes should be developed that are efficient and flexible, particularly for monitoring catch against quotas and for registering quota transfers. Because quota holders will probably have to pay for the administration of the quota management system, administrative systems should be provided on a contestable basis to ensure that services are efficient and cost-effective.
- A quota registration system should be established in order to allow lending institutions to take title to quotas for the purpose of collateral security. There are indications that an expansion of the current quota registration system to incorporate securities is feasible.
- An enforcement agency should perform enforcement activities independent of other fishery management services. Because enforcement of the law is a public good, the government should fund these activities.
- Penalties for all but the most serious and deliberate infringements of the law should be imposed through graduated infringement notices. But there must continue to be a heavy deterrent against the most serious offenses.

Environmental issues

Defining environmental rules is a complex process. The task force stated that environmental protection includes maintaining the integrity of the marine

ecosystem and minimizing any possibly harmful effects on the environment resulting from commercial fishing activities. The fishing industry supports sustainable management of the fisheries, and it contends that a modified maximum sustainable yield approach would be sufficiently broad to address most environmental issues, including interaction of fisheries and the diversity of marine ecosystems. It is essential that the revised Fisheries Act give clear direction on the government's environmental objectives, without, however, defining environmental rules so rigidly that they are inflexible or require the imposition of unnecessary constraints on fishery development.

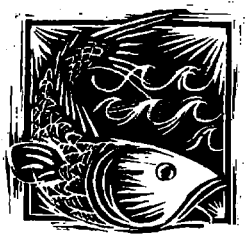
Financing issues

In assuming greater responsibility for fishery management, the industry accepts that it should pay the management costs attributable to commercial fishing on a cost-recovery basis. Under this arrangement, the concept of resource rents should be abandoned as they would no longer be appropriate. In addition, the industry must have the right to ensure efficient and effective delivery of those services for which it is expected to pay. The government must continue to fund a significant share of the costs involved in fishery management, however, because of the large public good component.

Summary

Advances have been made toward formulating new legislation governing fishery management in New Zealand, but at the time of writing many issues remained that require further deliberation and discussion before general agreement is reached on the shape of the revised Act. The industry is continuing to develop its positions, particularly regarding environmental prescriptions, funding and the institutional framework, quota management system administrative requirements, compliance and enforcement, enhancement and exploration of fisheries, and aquaculture management.

There is a window of opportunity to build on the current approach through the quota management system, which is generally accepted as the most effective fishery management regime. And it is hoped that the revised Fisheries Act will provide a suitable foundation to enable the industry to plan and invest with confidence in an increasingly important sector of New Zealand's economy.



Chile's General Law of Fisheries and Aquaculture

Patricio Pavez

9

Overview of Chile's fishery sector

Fishery production in Chile has shown a steady increase since 1980, rising from 3 million tons (with an export value of US$400 million) to 6 million tons in 1991 (with an export value of US$1,119 million). The annual rate of growth in production fluctuated between 11 and 13 percent over the period 1980-89, and the rate of growth in export value between 10 and 11 percent. The fishery sector accounts for 13 percent of Chile's export earnings, making it the country's third most important production sector after mining (46 percent) and agriculture (20 percent).

Exports from the aquaculture sector have also developed considerably. In 1991 the salmon and trout industry produced 37,400 tons (32 percent more than in 1990), with an export value of US$158 million. This production represents only 50.6 percent of the capacity of the authorized facilities. The projected harvest for 1992 has an export value of US$200 million.

The present situation

Chile's fishery sector has reached maximum expansion in terms of the available resource base. Most of the country's fisheries are fully exploited—that is, the effort deployed in a fishery results in the extraction of all of the annual surplus biological production.

The catch per unit of effort has dropped in the country's principal fisheries. The exploitation rates are not sustainable, and at their present level threaten the stocks of southern hake (*merluza austral*) in the Xth, XIth, and XIIth regions.

The present situation—with a fully allocated resource base, and disproportionate fishing effort and processing capacity with the associated higher production costs—places the country's fishing industry squarely at risk of destabilization. With the principal threat facing the sector the gradual deterioration of its resource base, its major challenge is to establish a resource administration and management system capable of undertaking conservation measures to ensure the sector's future sustainable development.

The future growth of Chile's fisheries—with the exception of a few potential locations requiring large investments—will depend on greater installed production capacity, incremental value added, and an expansion in aquaculture, with appropriate monitoring of its environmental impact.

Socioeconomic importance of the fishery sector

In 1990 the fishery sector generated earnings of about US$940 million in nominal terms, about one-ninth of the country's total foreign exchange earnings from exports. The sector directly employs about 115,000 people—65,000 artisanal fishers, 40,000 workers in the industrial subsector, and 10,000 in aquaculture and service activities. The total replacement value of investments in the fishery sector is approximately US$3.5 billion. The sector accounts for about 1 percent of extractive gross domestic product (GDP). In addition, the industrial subsector produces significant economic rents, part of which

has been collected in the form of direct and indirect taxes.

Behind these figures is the daily productive labor of some 1,000 industrial vessels and 20,000 artisanal vessels throughout the country. These vessels exploit about 100 species of fish, shellfish, and algae, landing some 5 million metric tons of catch a year. In the aquaculture sector, there are some 500 production units, most of them salmon farms in the country's southern regions.

This description of the fishery sector shows that it makes a significant contribution to the national economy. This contribution can be increased over the long term if resource exploitation in the sector is made more efficient, if aquaculture (in which Chile has important comparative advantages) is developed further, and if products with greater value added are developed. This potential warrants investment in designing a fishery administration policy, and in developing public institutions that comport with the fishery sector's contribution.

Underlying principles of fishery legislation

Chile's National Congress recently approved comprehensive legislation regulating the country's fishery and aquaculture sector—the General Law of Fisheries and Aquaculture (see appendix for a description of the law). This section discusses some of the underlying principles of a fishery management system and the governing legislation.

To develop solid fishery administration requires a clear understanding of both the goal of fishery management and the policies and strategies defined for the fishery sector. Chile's government therefore needs to take an unequivocal approach, establishing clear guidelines for fishery management and an appropriate ranking and coordination of its functions, and structuring an efficient and effective public fishery authority.

The goal of Chile's fishery administration is to develop its fishery sector, which means transforming it into a sector that will experience stable long-term growth and yield maximum net social benefits. And because the fishery sector is part of the country's productive economy, all policies and strategies devised for its development must be placed in the context of the national economic policy and a balance must be maintained with the country's other productive sectors.

The traditional concept of fishery development in the post–World War II period—a concept that still prevails in some developing countries—is based on a view of the fishery industry as simply an extractive activity. Under this concept, vessels normally have free entry to fisheries, and fishery profits are generally measured in terms of their contribution to the country's GDP and foreign exchange earnings. This concept is normally derived from development strategies based on the exploitation of both renewable and nonrenewable natural resources, strategies whose principal effects over time are overexploitation and slumps in production, with undesirable social and political costs.

Fishery management policies consistent with the concept have traditionally been oriented toward increasing extractive activity through one of two approaches:

- An increase in the number of vessels, or improvements in the gear used to fish traditionally exploited stocks, or both—a process known as *intensification of production*
- An expansion of the fishing fleet's area of operation to new fishing grounds, or exploitation of underexploited stocks, or both—a process known as *extensification of production.*

These two approaches, geared to maximize extraction through the most efficient and effective means, reflect fishery administration policies that are not designed to lead to sustainable development—that is, to the conservation of marine resources, to job security or industrial stability, or to the consolidation of artisanal fisheries. Instead, they lead to overfishing and put the fisheries at risk of exhaustion.

These approaches are facilitated by the inadequate definition of the ownership of fish stocks, which are treated as commonly owned resources, and the failure of the market to efficiently allocate production resources.

What this wrongheaded and shortsighted vision of fishery development does is encourage greater mechanization of fishing vessels and a more rapid expansion of fleets, principally through free-access options and subsidized government loans. The goal is to achieve increases in fishers' incomes over the short term.

And indeed, there is often a significant increase in earnings at first, thanks to the higher unit yields resulting from technological improvements. Over the long term, however, the higher earnings are not sustainable, as a result of several effects of this fishery management approach:

- The congestion, or overcrowding, effect, which generates a significant increase in operating costs
- The conservation effect, with stock deteriorating through overfishing
- Conflict between artisanal and industrial fishers exploiting common areas or resources.

These effects lead to widespread economic deterioration of the fishery sector, a situation in which any management guidelines enacted by the government lack both effectiveness and support. From a macroeconomic viewpoint, this type of management approach, which has been common in fishery sectors throughout the world, results in the waste of scarce commodities, such as capital and renewable natural resources, in labor market distortions, and in increased impoverishment of the country.

The conclusion to be drawn from this is that Chile must take steps to achieve sustainable development of its fisheries, with sustainable production over the long term and a pattern of balanced and equitable development for the participating economic agents. This different approach to the exploitation of renewable natural resources demands management strategy that takes explicit account of the nature of marine resources.

There can be no truly sustainable development if the fishery management strategy does not ensure the conservation of marine resources. Regulating fisheries to conserve the resources is an urgent prerequisite for achieving biological, economic, and social equilibrium between the fishing industry (fishing, processing, and marketing capacity) and the fish stocks.

A development strategy that is intended to achieve sustainability in the fishery sector must meet the following technical criteria if it is to succeed:

- It must make provision for regulating access to fisheries.
- It must prevent overfishing, which may in the long run jeopardize conservation of the fishery resources.
- It must impose regulations designed to resolve conflicts between artisanal and industrial fishers.
- It must impose regulations designed to minimize the fishing industry's polluting effects.
- It must establish flexible management that can adapt to changing social, biological, economic, and political conditions and generate political support for fishery management.
- It must define a modern administrative structure and public management system with the appropriate hierarchical levels, coordination, and financing.
- It must formulate fishery legislation that clearly defines the rules of the game and offers appropriate incentives to each participant in the fishing sector.

The most important policies for the fishery sector concern the design of a fishery administration system. To be effective, a system must meet the following conditions:

- It must be an efficient mechanism for preventing overexploitation of the marine resources.
- It must ensure efficient fishery performance.
- It must encourage private operators to carry out fishery research.
- It must involve low administrative costs.
- It must generate support among users for the fishery management guidelines.

This last aspect is a very important part of fishery administration. If management guidelines are not acceptable to the users, they will generally be disputed. And if a disputed guideline is adopted, it may be only partially complied with because of incentives encouraging private individuals to keep violating it or there may be constant pressure to revoke it, at heavy political and socioeconomic costs, because of the uncertain business environment that such circumstances will create for fishers.

For these reasons it is necessary to have the private sector participate formally in fishery management, to ensure that the management guidelines enacted by the government are fully understood and accepted.

Public decisions on fishery management affect the private production sector in the following ways:

- Public decisions affect the productive functions of each production unit operating at one of

the three levels of fishery operations—extraction, processing, and marketing.

- Management procedures have a multisectoral impact on society, with different effects on entrepreneurs, artisanal fishers, laborers, dockworkers, the financial system, and regional plans and policies which cannot be easily assessed or monitored by the authorities.

That is why fishery user groups and the general population demand that the public decisionmaking process be absolutely transparent. Another reason is that the methods for estimating fish stocks always involve a degree of uncertainty.

Chile's fishery management system

Working for the good of society as a whole, Chile's government channels its intervention in the fishery sector through the administrative system for the different fisheries and aquaculture centers. For fisheries, its objective is to maintain the fishing effort at a level that assures maximum long-term net social benefit while allowing efficient use of the fishery resources. For aquaculture, its goal is to regulate the installation and operation of production units so as to preserve the natural environment in which the fish are raised, thus ensuring that the maximum level of aquaculture production may be achieved and sustained over the long term.

Industrial fisheries

The aim of the management of industrial fisheries is to make extractive activities economically efficient by regulating access to a fishery once it becomes fully exploited. At that point, annual limits can be introduced on the entry of new vessels into the fishery. This transfers the extractive risk to the private sector, and private investment projects would therefore need to take account of the future costs arising from the introduction of any regulations in the fishery.

Before beginning operations, a fishing vessel must obtain authorization from the Fisheries Undersecretariat. To do so, the vessel owner submits an application to carry on industrial extractive activity targeting certain species and certain fishing grounds.

To conserve fish stocks in the industrial sector, management guidelines have been developed for checking quantities, times, and methods of fishing of a given stock.

Artisanal fisheries

The government's goal for artisanal fisheries, just as for industrial fisheries, is to achieve economic efficiency. Access to artisanal fisheries will be controlled through listing artisanal vessel owners and their vessels. The registration of new owners and vessels will be temporarily suspended when a resource exploited by artisanal fishers reaches maximum or full exploitation.

Under this system of regulating access to artisanal fisheries, like that for industrial fisheries, private investment projects should take into account possible costs resulting from future economic adjustments to the fisheries concerned. But the system would not prevent artisanal fishers from leaving those fishing grounds to fish elsewhere; in that case, however, they would have to compete with industrial fishing operations.

Management procedures to monitor exploitation are being designed for the conservation of fish stocks. In addition, consideration is being given to special measures, such as rotating fishing grounds, granting concessions to artisanal fishing communities, and setting and allocating capture quotas in benthic fisheries.

To promote the artisanal fishing sector, a development fund is to be set up to finance restocking, the development of port infrastructure, the marketing of fishery products, and training and technical assistance.

Aquaculture

In the aquaculture sector, the government is responsible for overseeing conservation of the natural environment in which the fish are raised and for promoting efficient use of public assets.

Although conservation of the natural environment is the responsibility of the fish farmers themselves, the Fisheries Undersecretariat regulates the use of equipment for monitoring contaminants from aquaculture units. Private individuals wishing to

operate an aquaculture unit must obtain an aquaculture concession, a new instrument that combines authorization to initiate aquaculture activities with a maritime concession.

The cultivation of exotic species in the natural environment is prohibited in Chile unless an environmental impact study proves that there is no risk to the ecosystem.

Fishery research

Chilean fishery activities, with the help of fishing research institutions and specialists, have outlined research requirements in the management plan formulated for each fishery and aquaculture unit. The research activities are essential to undergird the fishery management guidelines. To secure the necessary funding for the government's research activities, public fishery institutions will need to ensure that their regular draft budgets include funds for investment in fishery management.

The new fishery law establishes a Fishery Research Fund, to be financed by both the private and the public sector. The law also stipulates that the proceeds of advance payments for fishing licenses will be used to finance the Fishery Research Fund. The government's two research ships, the *Abate Molina* and the *Carlos Porter*, will carry out the fishery research activities required by the fishery management plans.

Monitoring and enforcement

To ensure that the private sector has adequate incentives to conserve resources and observe the fishery management guidelines, a system to monitor adherence to those guidelines and a legal system for the prosecution and punishment of offenders have been proposed.

The proposed monitoring system would ensure that both private and public operators observe the management guidelines. The government, through a specialized agency, would perform the requisite monitoring, oversight, and supervisory activities both on land and in the fishing grounds.

Under the proposed legal system, instances of lawbreaking by both industrial and artisanal operators are categorized as (1) violations (*infracciones*) under civil law, or (2) offenses (*delitos*) under criminal law. Violations of sport fishing rules are handled by the local police courts.

Penalties will be determined based on the type of offense, the damage to the conservation of the fish stock, and the scarcity cost of the stock. Those who commit repeated violations or offenses will be subject to significantly higher penalties.

Processing and marketing of fishery products

Processing and marketing are the responsibility of the private sector, and the market determines the economic efficiency of these activities. The government's intervention in these areas is restricted to preserving the marine environment into which processing plants channel their hazardous waste, the result of market inefficiency in this area.

Investors may freely enter the processing sector, although they must first obtain authorization from the Fisheries Undersecretariat. This system of access leaves investments in the processing and marketing of fishery products up to the market, and private investors must therefore expect to bear the costs of constant economic adjustments.

The one exception to free entry in processing and marketing activities is the benthic fisheries, which will be covered by the benthic extraction and processing system outlined in the new fishery law. Under this system individual processing quotas may be allocated to facilities that meet certain requirements.

Benthic fisheries are a special case. Artisanal fishers generally harvest benthic fish stocks, and industrial facilities handle the processing and marketing. This situation leads to overinvestment in processing capacity, and thus to severely skewed resource allocation in that phase. As a result, in the short term a black market develops for benthic resources that is difficult to monitor and has undesirable social effects; and in the long term the bottom fisheries become exhausted through overfishing, leaving much of the processing and artisanal vessel capacity idle.

Participation of public agencies in the fishery sector

Because of its scale and socioeconomic importance in Chile, the fishery sector warrants an executive and

legal institutional structure and a public-private fishery management system that are adequate for meeting the sector's conservation and economic efficiency goals. Proposed structures include an agency with normative and decisionmaking authority to be responsible for the technical administration of the fishery sector; an agency to handle the research required for fishery management in areas not satisfactorily covered by the private sector; and a legal system for dealing with violations of the management guidelines.

Public service in the fishery sector will center on the support of artisanal fishing. Such support is necessary because of the socioeconomic conditions of the artisanal fishing communities, especially those in rural areas.

To support artisanal fishing, the government plans to assist in the construction of port infrastructure and to encourage rural development through policies that target rural artisanal fishing communities. In addition, the government provides training to artisanal fishers, primarily through programs supported by the *Fundación para la Capacitación del Pescador Artesanal.* Finally, the government has proposed tariff reductions for gear imports for the artisanal sector, and exemption from category I and value added taxes.

Participation of the private sector in fishery management

The private sector participates in fishery management at two levels. First, the private sector participates in the study of management procedures. This helps ensure that fishery users understand, contribute to, and participate in the work being done by the government—and support the management procedures adopted.

Second, the private sector participates in public decisionmaking on fishery management. The new fishery law has established three mechanisms through which the private sector can voice its concerns and take part in decisionmaking with regard to the management guidelines:

- The National Fishery Council is a consultative and decisionmaking board that handles selected areas of fishery management. It has nineteen members, of whom four represent the private business sector and four the workers.
- There are five Area Fishery Councils (*Consejos Zonales de Pesca*), consultative and decisionmaking boards that deal with selected areas of fishery management. Each has seventeen members, of whom four represent the private business sector and four the workers. The councils are based in Iquique, Coquimbo, Talcahuano, Puerto Montt, and Punta Arenas.
- The Regional Fishery Councils advise the regional *Intendencias.* Each has thirteen members, of whom four represent the private sector and four the workers.

Appendix Description of the General Law of Fisheries and Aquaculture

The General Law of Fisheries and Aquaculture (No. 18.892 of 1989) and its substantive amendments were recently approved by the National Congress and have been in effect since September 6, 1992. The law and its amendments have been revised, and their many provisions are now being coordinated and compiled in a single text, by virtue of the powers invested for that purpose in the President of the Republic.

Decree No. 430 of September 28, 1991, containing the new single text, has 172 permanent articles, divided into thirteen titles, and twenty-one temporary articles.

Title I contains general provisions, establishes the scope of the law, and identifies words and concepts frequently used in its text.

Title II, which concerns fishery administration, consists of three sections. The first contains provisions governing conservation of fishery resources; the second provides the guidelines for fishery management plans; and the third concerns imports of marine species.

Title III regulates access to industrial extractive activity. It consists of four sections. Section 1 contains rules on the general system of access; section 2 relates to the system of full exploitation; section 3 handles arrangements for fisheries in recovery or just starting to be developed; and section 4 contains rules common to all the above systems.

Title IV regulates artisanal fishing and contains three sections. Section 1 deals with the access system and the duties involved in marine resource conservation; section 2 concerns the National Registry of

Artisanal Fishermen; and section 3 covers the Artisanal Fishery Development Fund (*Fondo de Fomento para la Pesca Artesanal*).

Title V covers common rules governing industrial and artisanal fishing operations.

Title VI consists of two sections regulating aquaculture, the first dealing with aquaculture concessions and authorizations and the second with procedures.

Title VII contains regulations on research. Its three sections concern research related to fishery administration, the Fisheries Research Fund, and fishery research.

Title VIII contains rules governing sport fishing.

Title IX contains three sections, which cover violations and penalties; procedures; and liabilities of captains and owners of fishing boats.

Title X defines specific offenses and penalties, and Title XI covers due dates, permits, authorizations, and concessions.

Title XII relates to the Fishery Councils. Its three sections concern the National Fishery Council; the Area Fishery Councils; and the Regional Fishery Councils.

Title XIII contains various provisions on the topics covered by the law.

The temporary articles contain provisions governing events and circumstances unique to fishing and aquaculture, in conformity with the general principles of law, with a view to their gradually being made to conform to the provisions of the permanent articles.

Management Options for Transboundary Stocks: The Peruvian-Chilean Pelagic Fishery

Max Aguero and Alejandro Zuleta

10

Chile and Peru are the two most important fishing nations of Latin America, and they share one of the five most productive fishing areas of the world (Bohle-Carbonell 1989). The productivity of their fishing grounds is due to the system of currents along their coastline. This system, known as the Peruvian or Humboldt Current, is associated with an upwelling of deep and nutrient-rich waters that support a large biomass of aquatic resources (chart 10.1).

Together, Chile and Peru annually harvest 10 million to 12 million tons of fishery resources (fish, crustaceans, mollusks, and algae), about 80 percent of the region's total catch and 16 percent of the world's catch (FAO 1989). The two countries' fishery sectors generate about US$2 billion a year in export earnings, mainly from fish meal and oil. Their fishery sectors also are an important source of employment and food supply for the coastal population.

The continental shelf in this region is rather narrow. Although it is unfavorable for demersal species, it supports a large stock of small neritic pelagic species organized in short trophic chains.

The catch in Chile and Peru consists primarily of a few pelagic species—anchovy (*Engraulis ringens*), sardine (*Sardinops sagax*), and mackerel (*Trachurus murphy*). Most of the catch of these species is harvested by industrial and semi-industrial vessels and directed as raw material to the fish meal industry. Fish meal is exported to industrial nations, such as Japan and the United States.

The abundant fishery resources in the Chilean and Peruvian coastal waters are being increasingly recognized as a shared multi-species stock whose distribution along the southern part of Peru and the northern part of Chile follows a seasonal pattern. Both countries are implementing policies to manage their aquatic resources. But neither country gives explicit recognition in its policies to the fact that the fish stocks are shared; rather, the two countries are managing their fishery resources separately. This has resulted in a quasi-open-access situation in which potentially substantial benefits and rents are forgone.

Joint management of a shared or common stock has been demonstrated to offer potential gains if not only the biological and environmental conditions are taken into account, but the characteristics of the industry and each country's economic, social, and institutional conditions as well (Caddy 1982; and Munro 1987).

The purpose of this chapter is to provide a brief overview of the salient features of the Chilean and Peruvian fishery and a simple bioeconomic framework to analyze the benefits that could be attained if the shared stock were managed jointly or in a coordinated way (Gulland 1980; Caddy 1982; and Munro 1987). The chapter first summarizes the main biological, economic, technological, and institutional features of the fishery. It then reviews alternative management options for a shared stock. Finally, it presents a brief conceptual framework for discussing the bioeconomic aspects of a shared stock, and a bioeconomic approach for identifying and evaluating alternative management options.

Chart 10.1 Main upwelling areas of the world

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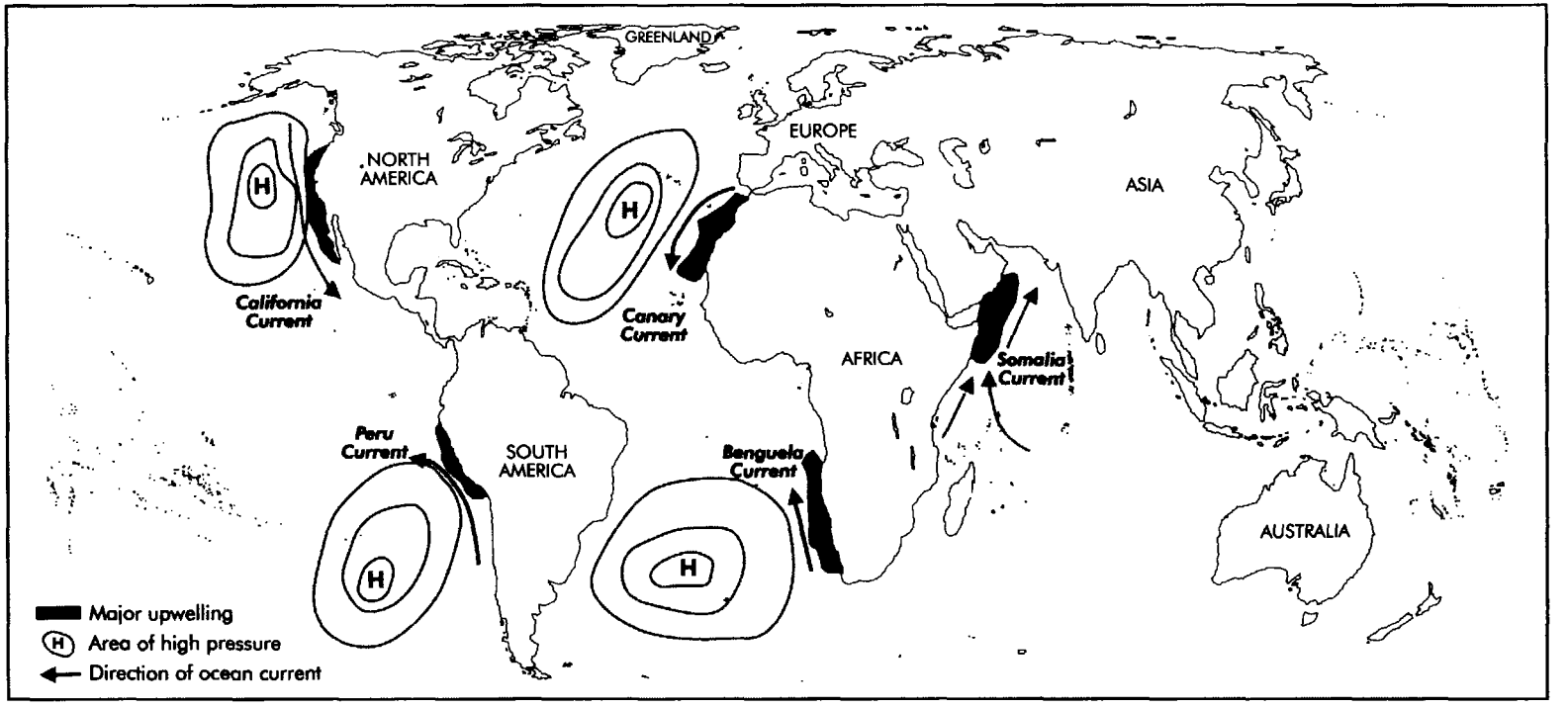


JULY 1993

The resource, the industry, and the fishery policy

The productive marine ecosystem of Chile and Peru is influenced not only by the Humboldt Current and its associated upwelling system. It is also affected by a random current system (Bohle-Carbonell 1989) with warm waters known as El Niño, which produces important changes in the habitat and behavior of the fish stocks.

Over the years the fishing industry has learned to cope with the fluctuating ecosystem and changes in the size of fish stocks by expanding its harvesting and processing capacity to take full economic advantage of periods of peak abundance. This buildup of capacity, the environmental fluctuations to which the coastal area is subject, and the behavior of the fish stock together create the conditions for a highly vulnerable resource and unstable fishery industry.

Government efforts to counterbalance the risks and undesirable consequences of the overexploitation or collapse of the fishery have led to the introduction of regulatory measures with varying degrees of success.

Variability and vulnerability of pelagic resources

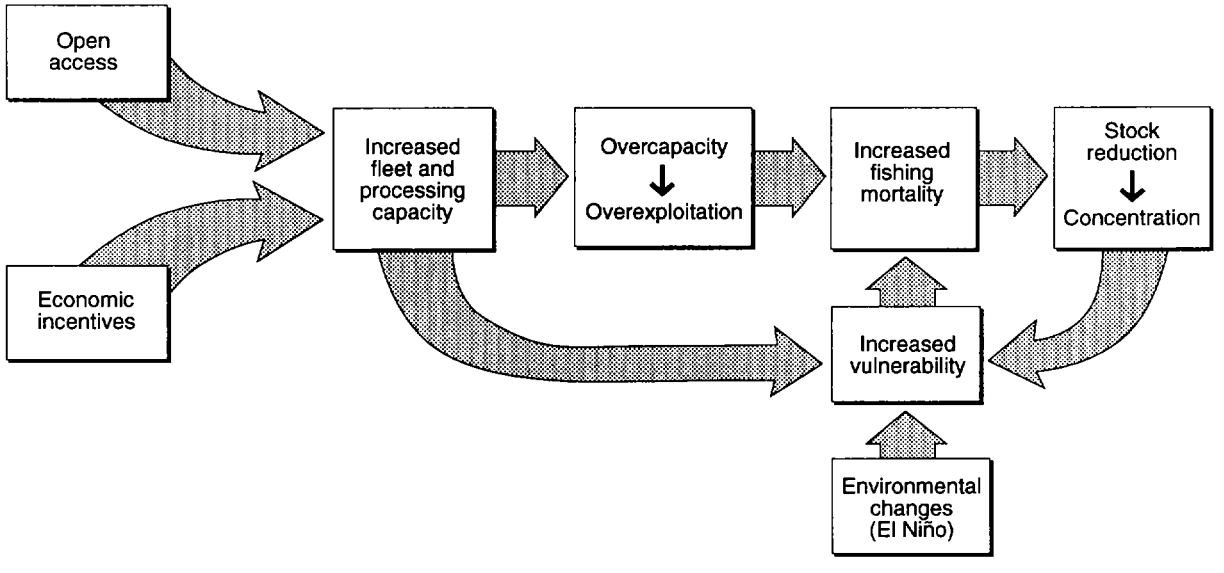
Small pelagic fish such as the sardine, anchovy, and mackerel are the most abundant species off the coast of northern Chile and southern Peru. These stocks are characterized by large seasonal concentrations for breeding or feeding purposes. The stocks also are subject to large fluctuations associated with changes in recruitment due to recurrent changes in the physical environment and to interspecies competition.

Another important characteristic of these species, especially anchoveta, is their short life span, which makes the stock highly sensitive to changes in the environment. And their tendency to aggregate in large schools, especially in coastal areas, makes them particularly vulnerable to fishing effort.

The 1982-83 El Niño, probably the most intense occurrence registered in this century, showed how vulnerable the species are. The nutrient-poor tropical water mass that El Niño caused to emerge pushed the sardine stock toward the shore, where the large harvesting capacity accumulated over the years was utilized in landing a significant part of the spawning stock. Thus, the vulnerability of these resources is due not only to biological or oceanographic conditions, but to the threat of a large fleet and the excess processing capacity that has developed since the early days of the anchoveta fishery.

These factors, which have even more serious effects on a stock when it is shrinking, are an intrinsic part of the mechanism that drives small pelagic species to collapse (figure 10.1), and they explain

Figure 10.1 Pelagic fisheries' cycle of vulnerability



the difficulty that regulatory agencies responsible for resource management face in effectively controlling the cycle of overexploitation once it has been triggered (Muck 1989).

Units of stock and shared stocks

The relevant unit for this analysis is "shared stock" and not "shared species," in the sense suggested by Simpson (1985), quoting Gulland (1980), as

> an empirical grouping of fish that is sufficiently large, that, when analyzing the data concerning it, or taking policy decisions about its exploitation and management, events on adjacent stocks can be ignored, or at least treated in a different way to events within the stock. Equally, it should be sufficiently small to be for practical purposes homogeneous, and for possible divisions within the stock, into smaller groupings, to be ignored.

In the past researchers have found, based on morphometric, meristic, anatomic, and tagging evidence, that the regions comprising south-central Peru (6° to 14° south latitude) and southern Peru–northern Chile (14° to 24° south latitude) are populated by different stocks of sardine, mackerel, and anchoveta. And in a recent study Mendo (1991) reviewed biological and fishing data on anchoveta stocks and, providing additional genetic evidence, demonstrated the existence of different units of stocks. Parrish, Serra, and Grant (1989) have also established the existence of different units of stocks in the same region, based on the distribution of eggs and larvae.

In each region anchoveta and sardine coexist, with some spatial segregation parallel to the coast. Anchoveta is found within the first 20 nautical miles from the coast, and the sardine is found up to 80 miles, and occasionally more than 200 miles, from the coast.

The mackerel, however, does not display genetic differences at regional levels that allow the identification of discrete populations (Galleguillos and Torres 1988). Parrish (1989) reviewed the world's *Trachurus* and concluded that none of the eastern Pacific forms of *Trachurus* merits the full rank of species. All are subspecies of the oceanic horse mackerel (*Trachurus picturatus*). Serra (1992), among others, describes the regional mackerel as an oceanic-neritic species with a spawning ground off south-central Chile, especially off Talcahuano.

Vinogradov, Shushkina, and Evseyenko (1990) hold that the spatial distribution of these species is directly related to the size of the zooplankton biomass. They distinguish two zones: a spawning area north of the subtropical convergence with small zooplankton that provides appropriate food for larvae and juveniles, and a feeding area for adults south of the convergence with larger plankton (45° and 50° south latitude). According to these authors, the seasonal north-south migration pattern of the species is due to the seasonal changes in the feeding areas for the young and adult fish. Similarly, the seasonal migration toward the coast during the southern hemisphere's summer and autumn and away from the coast during its winter and spring can probably be traced to breeding and trophic reasons.

Based on these research findings and the fishing areas in which the region's fleets operate, it is possible to conclude that Chile and Peru share a stock of sardine and anchovy located off southern Peru and northern Chile and a regional stock of mackerel that is also exploited by the international fleet operating beyond the exclusive economic zone.

Spatial and temporal distribution of pelagic resources

The spatial and temporal distribution and movements of a fish stock are of vital importance in determining how the stock should be shared. Factors influencing the national shares from the common resource need to be well understood to address issues related to cooperation or competition between the co-owners of the stock.

Patterns in the movements of fish stocks may range from small, local dispersions near the boundary between two exclusive economic zones to long migrations in which the entire stock moves from the zone of one country to that of the other, or even beyond the zones of both countries sharing the stock. The movements may have a well-defined seasonal pattern corresponding to the fish's life cycle stages, or they may be random movements or dispersions over time in which the fish may return to its original habitat or make a definitive change in location.

Whether or not a stock is shared by two nations on a seasonal or permanent basis, some movement across boundaries will occur even in the absence of any systematic migratory movement. When this is the case, fishing effort on one side of the boundary is not likely to have a significant effect on harvests on the other side and relations therefore tend to be symmetrical. But when all or part of a stock moves from one country's zone to the other's, fishing in one zone may have a significant effect on the availability and characteristics of the catch in the other, and thus on the benefits to be accrued by each country. Gulland (1980) suggests distinct terms for these two cases, *transboundary stocks* for the first and *migratory stocks* for the second.

The small pelagic fish off southern Peru and northern Chile can be classified as migratory stocks with seasonal movements between zones. Whether the seasonal movement corresponds to spawning and feeding habits or to other environmental factors is not yet clearly established, and differences in interpretation persist among scientists in both countries (Tsukayama, Yanez, and Serra, personal communications).

The ups and downs of the fishing industry in southern Peru and northern Chile

The small pelagic fishery of the southwestern Pacific, based on anchoveta resources, began during the mid-1950s, first in Peru and then immediately after in Chile. It apparently developed as a result of the collapse of the California sardine.

At the peak of this fishery, in the mid-1960s, the total catch for the two countries reached a record 15.5 million tons, of which the southern Peru–northern Chile stock contributed about 2.5 million tons (16 percent of the total catch). After the fishery's collapse in 1973 catches fell dramatically in the region, and the average total catch over the next twelve years was about 0.5 million tons.

Despite the collapse of the anchoveta fishery, catches began to recuperate, especially in southern Peru and northern Chile, mainly because of the increasing substitution of sardine and mackerel for anchoveta (figure 10.2). In fact, four years after the anchoveta collapse, the catch of sardine in northern Chile reached the historic average of anchoveta catches. Suddenly the sardine became the target and dominant species of the fishery, and the mackerel and anchoveta became incidental catches.

Mackerel continued increasing at a rate similar to that observed for the sardine throughout the entire southwestern Pacific and particularly off the coast of Chile. As a result, it has been a target species since the late 1970s for the coastal, deep-sea, and international fleets operating in the region.

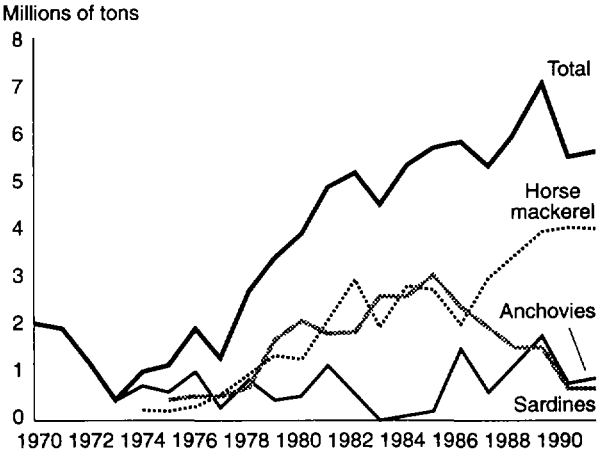
As a result of the growing sardine and mackerel catches, Chile and Peru now rank among the five largest fishery producers and the top suppliers of fish meal in the international market.

The spectacular growth of this fishery can best be appreciated by noting that in 1986 total landings of anchoveta, sardine, and mackerel off the southern Peru–northern Chile region amounted to slightly more than 4 million tons. There were 160 vessels operating in the area, mostly purse seiners, with a total annual haul capacity of 9 million tons. The number of processing plants in the industry was close to that in 1965 at the peak of the anchoveta fishery, but they had twice the processing capacity (6.8 million tons). In 1990 northern Chile alone (regions I and II) had 186 vessels in operation, landing approximately 1.7 million tons, and nearly fifty processing plants (chart 10.2).

Vertical integration, overcapacity, and vulnerability

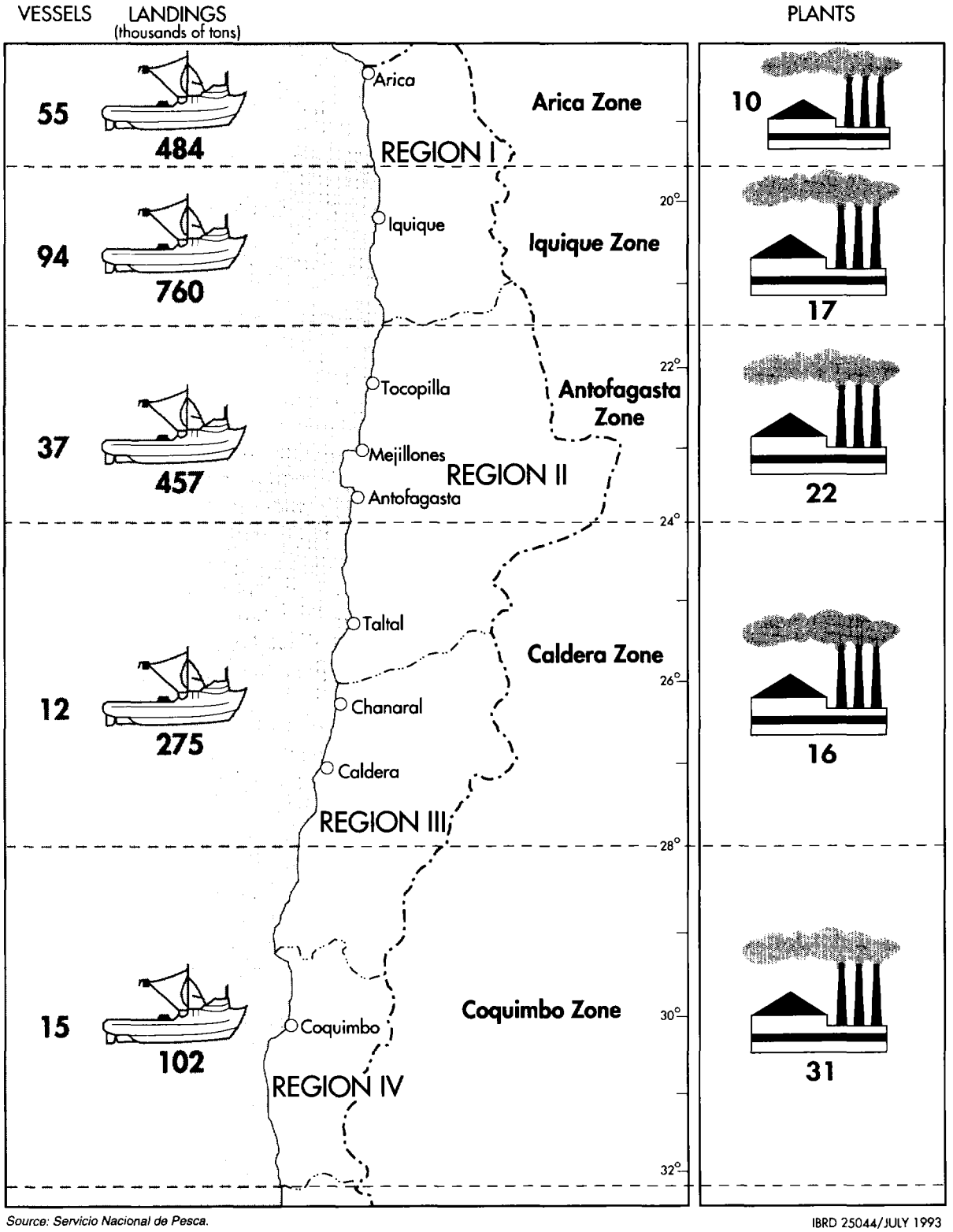
In both Chile and Peru there is strong vertical integration between processing plants and fleet. In

Figure 10.2 Landings from the transboundary stock of Chile and Peru, 1970-91



Source: Data from Servicio Nacional de Pesca, Chile, and Ministry of Fisheries of Peru.

Chart 10.2 Vessels, catch, and fish processing plants in northern Chile, 1990



Source: Servicio Nacional de Pesca.

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Chile, however, the fishery industry is also characterized by horizontal integration, with a property structure very different from that in Peru.

Where there is strong vertical integration between processing plants and fishing fleet (whether the industry is owned by private individuals or the government), harvesting capacity is determined not only by the abundance of fish stocks and the cost-price ratios of harvesting operations, but by the relative cost structure of the processing sector.

Because processing plants are usually structured to take full advantage of peaks in harvests, however, fluctuations in fish stocks have led processing plants to increase their installed capacity; this in turn has triggered increases in fleet size and fishing capacity. This two-way process has increased the vulnerability of the fish stocks in the region (see figure 10.1). A clear example of this process occurred during the past two years in Chile: as pelagic resources became increasingly abundant in the south-central region, part of the northern fleet moved into the area.

Ownership, decisionmaking, and performance

The ownership of assets in northern Chile's fishing industry is highly concentrated (about 70 percent of the industry is owned by one family), with strong family and financial ties among the enterprises conducting harvesting, processing, marketing, and associated activities (fish detection, fleet maintenance, research). The concentration of ownership and the vertical and horizontal integration of operations has facilitated the effective adoption of production, marketing, and financial strategies that are consistent with profit-maximizing objectives. As a result, Chile's fishing industry is one of the most dynamic sectors of the economy, with an average annual growth rate of about 10 percent during the past twelve to fifteen years. And Chile's major fishing enterprises have ranked among the country's most profitable businesses. But serious issues concerning the distribution of income and property are still to be resolved.

In Peru, where much of the industry ownership is owned by the government (PESCA PERU), the management decisionmaking process has faced social, institutional, political, and financial constraints to the introduction of the changes needed to achieve a more effective performance in the industry.

Although reliable information on the economic and financial performance of the industry in the two countries is not yet publicly available, the industry's efficiency and profitability are clearly much higher in Chile than in Peru. The implications of these differences need to be recognized in evaluating alternative management strategies for a shared stock and possible compensation schemes, if cooperation between the two countries—to increase the social benefits for each—is to be achieved.

From open access to optimum management

Chile and Peru have historically relied on similar institutional and legal regimes to govern access to and exploitation of their fishery resources, although under different time paths. In both countries fishing was initially conducted under open-access conditions; subsequently, government institutions took control or ownership of a large part of the industry. In Peru part of the assets—and in Chile all of the assets—were later transferred to private ownership.

Over the past decades both countries have implemented measures to preserve the stocks through indirect controls on fishing effort. The primary measures used have been seasonal closures of spawning and breeding grounds, and gear restrictions aimed at protecting coastal recruits. The measures have not been fully successful in preventing a continuing decline in catches.

The only direct regulation of catch that has been implemented was a failed attempt by Chile's Undersecretary of Fisheries in 1983 to establish a total catch quota of 1.3 million tons for sardine in northern Chile. The fleet responded by adopting a "gold rush" strategy, shortening the fishing season and, at the same time, exerting strong social and political pressure on the government to end the restrictions.

Chile instituted new regulations in 1986, however, declaring a "fleet freeze" (including haul capacity) for a period of three years.

Today Chile is implementing a sophisticated access and quota allocation system based on both biological and economic efficiency principles (*Ley de Pesca*). And Peru is seriously considering the adoption of a comprehensive body of regulatory measures with similar characteristics. The two countries have different constitutional concepts of resource own-

ership (in Peru fishery resources belong to the state; in Chile they are considered the common property of the citizens), but both have made considerable progress toward introducing management interventions aimed at resource conservation and economic efficiency.

Although in the laws and regulations of both countries mention is made of the possible need to cooperate with neighboring countries in managing fishery resources, no explicit mechanisms for cooperation are yet in place and the present management strategies do not consider collaboration or joint management of the shared stock. But government agencies in Chile and Peru have initiated some cooperative activities to coordinate the closure of breeding and recruitment areas for anchoveta and sardine. And there has been collaboration in scientific research activities between the countries' national research institutions (Instituto del Mar del Peru and Instituto de Fomento Pesquero in Chile).

Managing a shared stock: Cooperation with competing objectives

Managing a migratory and multispecies stock of small pelagic fish such as those off the coasts of Chile and Peru presents unique problems. Sedentary fishery resources can probably be effectively managed without cooperation (Munro 1987). But the application of game theory to the dynamic analysis of a fishery shared by two or more co-owners has shown that, whenever the economic returns of one of the co-owners depend on the fishing activity of the other, noncooperation will have less advantageous results than cooperation. This holds even if rational management is established in each of the jurisdictions (Munro 1987). This situation is similar to the noncooperative game known as the Prisoner's Dilemma. Even if both "players" behave rationally, the game has an outcome recognized by both as undesirable, demonstrating that cooperation is the better alternative.

Noncooperative game theory (Nash 1953), as applied to fisheries by Munro (1990), offers three alternative scenarios for the sharing of a fish stock:

- The country with the highest cost per unit of effort (C_oPUE) will tend to disappear.
- The country with the greatest fishing capacity and efficiency tends to dominate.
- If catch per unit of effort (CPUE) is inelastic with respect to abundance, noncooperation will lead to dissipation of rents.

Thus, cooperation can be shown to improve total social benefits. But differences between countries sharing a stock in costs, size, efficiency, perceptions, and discount rates can lead to competition at the expense of social benefits. Therefore, even if both countries recognize the net gains attainable through cooperation (minimizing rent dissipation), and can enter into binding agreements controlling effort and access and institutional arrangements for collaboration in research, training, management, and marketing, there will still be problems to solve. Not only does the durability of such agreements need to be secured (a problem of enforcement); compliance with the agreements also needs to be assured.

Even if both countries adhere to the agreement, however, differences in their perception of what is the best management strategy may still persist. Differences in perception may arise because of differences in discount rates, cost of fishing effort, or preferences. In turn, differences in discount rates could result from different economic conditions in the two countries, and differences in the cost of effort and in consumer preferences could stem from technological advances in one country but not the other. Therefore, focusing more on the allocation of net economic benefits (compensation principle) than on shares of catch offers a better chance of success in solving problems related to conflicting objectives between both countries (Munro 1987).

Management options for a shared stock

It is difficult to identify a single approach as the best one for managing a shared stock; the best approach is probably a mix of different regulatory options. This section summarizes interventions addressing total catch, the efficiency of effort, and the social and economic performance of the fishing industry.

Policy options affecting total catch

Total catch could be controlled through the establishment of fishing zones, through closed seasons and closed areas, and through global quotas.

Establishing an *open-access border zone* (195 miles wide and 25, 50, or 75 miles long, for example), near

the border between Chile and Peru and covering the area in which the shared stock is located, would not limit access to the fishery but would in fact probably encourage more vessels to enter it. In the absence of catch quotas or restrictions, overexploitation and overcapitalization would eventually result.

But imposing a total allowable catch quota in each country, differentiated by size, species, or season, or a combination of these, would favor conservation and improve total yields. And making the quotas transferable and perfectly divisible would improve economic efficiency by allowing the reallocation of the quotas to the most efficient units in each country.

Because of the migratory pattern of the stock shared by Chile and Peru, establishing an *open-access, unrestricted zone* near their common border for harvesting the migratory portion of the stock would lead to overexploitation with an associated loss of rents and reduction of stock. Global benefits would decrease because of the excessive effort and reduced catch (with rent dissipation). Conservation of the stock would also be threatened.

Closed seasons and areas near the border between Chile and Peru would improve yield because the border area is an important spawning and recruitment ground for the stock. But without limits on entry, total effort would probably increase, leading in turn to diminishing rents (overcapitalization). Conservation of the stock would be assured, but efficiency would suffer.

Establishing a *global quota* for both countries together would encourage them to adopt a gold rush strategy, to capture as much as possible of the quota before the fishing period expires. This would lead to distortions in fishing capacity and economic efficiency. Fishing effort would be distributed in a "guerrilla" fashion over time; conservation of the stock would be secure, however.

Policy options affecting efficiency of fishing effort

The efficiency of fishing effort can be affected through the introduction of taxes or subsidies, of licenses or permits, or of restrictions on the species and size of fish that may be caught.

The imposition of a *tax* (variable or fixed) on individual catch or effort would reduce individual gains and induce the exit of the less efficient marginal firms. It would reduce total effort to appropriate levels, and increase average efficiency. Partial rents would be captured by the government, and yield would increase with improved conservation. A *subsidy* would lead to increases in effort, and its effect would therefore depend on the prevailing conditions.

General licenses or fishing permits (which may be viewed as a kind of fixed tax), used as a mechanism to control total effort in an area, could have different effects. Even if the number of fishing units is kept under control, fishing capacity may be expanded to take fullest advantage of the license, resulting in total real effort that exceeds the desired levels. Thus, a fishery may be overexploited even when the number of fishing units in the fishery is controlled.

Restrictions on the species and size of fish that may be caught usually take the form of restrictions on gear—limits on the size of mesh and hooks and on maximum horsepower, for example. Such restrictions may have positive effects on yields, but the efficiency of individual vessels and the economic performance of the fishery as a whole are likely to suffer. Generally, these restrictions have a positive effect only on the conservation of a stock.

Policy options affecting social and economic performance

In general, joint agreements for purchasing inputs and equipment improve purchasers' bargaining power and thus reduce their costs. Joint marketing agreements between two major world producers of fish meal and oil could allow them to take advantage of opportunities that would otherwise be forgone. In addition, they could share marketing costs and information, again increasing their bargaining power and reducing their costs.

Collaborating in research on a shared stock offers potential benefits in the acquisition of data and information, and reduced costs for each country for processing, analyzing, and reporting data. And exchange of scientific knowledge and expertise between countries improves research capability in each. Joint research would enhance the collaborating countries' information and knowledge about the fishery sector, and thus help improve their decision-making and policy design in fishery management.

Coordinating control, monitoring, and surveillance activities would not only reduce each country's

costs but improve performance and effectiveness, especially when extensive coastal areas must be covered, as in Chile and Peru.

Bioeconomic aspects of a shared stock

Fishery resources have the characteristic of being renewable, meaning that under normal conditions they are capable of generating levels of biomass (yield) that can be harvested ad infinitum without affecting their regenerative capacity. This characteristic is precisely the notion of sustainability.

The renewability of a stock can be disrupted if the rate of its extraction exceeds the rate of its net growth over time. Incentives to adjust the fishing effort (rate of extraction) relative to the limits of a stock's sustainability are determined mainly by the prevailing property rights system and economic conditions in which fishing takes place.

This problem is traditionally analyzed and illustrated by means of a simple logistic function representing the dynamics of the individual fish (or age class) over time (mean length/weight). When growth is related to environmental conditions (carrying capacity) and interactions within and between species in relation to varying levels of harvesting intensity (fishing effort), it is best described by a simplified quadratic function (Schaefer 1954) of the form:

$$Y = aE_t - bE_t^2$$

where Y represents sustained yield (in biomass), E is total effort displayed (in standard units), and a and b are parameters of the yield equation.

Based on these simplified relationships, economists have introduced market values (output prices) into the total sustainable harvest potential of a stock (total revenue) and production costs (cost per unit of effort, or C_oPUE) associated with different levels of fishing effort (total costs). The net benefits and potential rents to be accrued from the fishery are then determined for different levels of effort. Access conditions and property structure are the main factors determining the level of effort exerted.

Bioeconomic performance of a single stock

The simple steady-state bioeconomic conditions of a single stock and fleet are depicted in figure 10.3. In the figure, curve Y denotes yield (sustained) at varying levels of effort (E_t) and curve TR denotes gross revenue at each level of E and is obtained by multiplying Y times a constant price P. Curve TC represents the total cost of effort at each level of effort; its representation by a straight line implies a constant cost per unit of effort (C_oPUE) (Clark 1976).

Although a wide array of institutional arrangements may be considered in analyzing the performance of a fishery, I consider only two, opposite regimes: open access and optimal management.

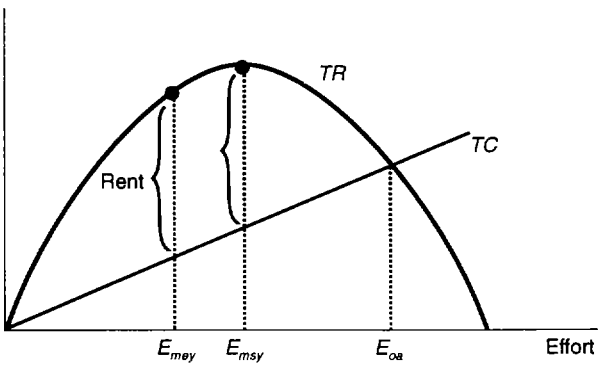
Under open access conditions, in which there are no restrictions on entry into or exit from a fishery, fishing effort will be exerted whenever $TR \leq TC$. Therefore, total effort will reach an equilibrium at E_{oa}, where rents will be completely dissipated.

Management interventions can be introduced, however, aimed at two different objectives: maximum output or maximum rents. If output is to be maximized, total effort should be E_{msy}; if economic rent is to be maximized, total effort should be E_{mey}.

The characteristics, dynamics, and consequences of a fishery consisting of a single stock being exploited under an open-access regime have been extensively analyzed in the literature. It has been well established that open access can be expected to result in overexploitation of the resources, overinvestment, and dissipation of rents. It has also been established that optimal management strategies aimed at controlling effort or access can lead to maximization of rents and conservation of the resources.

When a stock is exploited simultaneously by two or more countries operating independently, each

Figure 10.3 Basic bioeconomic model for single stock and fleet



faces similar incentives to overexploit the resource and overinvest in the industry. These are the same incentives as those generally found under open access, and they tend to arise for a shared stock even if each country imposes regulatory measures on its fishing sector. In this situation, there is no incentive for any one country to reduce fishing effort because there is no assurance that it will enjoy the benefits to be gained from doing so.

Coordinated or joint management of a shared stock, however, can lead to increased economic benefits and resource conservation, as I demonstrate below.

Bioeconomic performance of a shared stock

A shared stock is one that is located within the exclusive economic zones of two or more coastal nations or within and beyond the zones, according to the United Nations Conference on the Law of the Sea (UNCLOS). Shared stocks have different spatial and temporal migratory patterns, depending on their biological characteristics, and may therefore present spatial and temporal differences in composition, size, abundance, and location (Gulland 1980). And a stock may migrate in a regular or random pattern within the exclusive economic zones of the countries that share it, or beyond the zones during certain periods. The spatial and temporal movements of a stock determine the abundance of fish that a fleet encounters and therefore its economic performance (cost per unit of catch).

For simplicity and the purpose of this analysis, it is assumed that a shared stock is being exploited independently by two nations (*CH* and *PE*) with no regulatory intervention or coordination; it is also assumed that both countries face similar output prices (P_{ch} and P_{pe}) but possible differences in the cost of effort.

Effort is assumed to be exerted by two homogeneous fleets (E_{ch} and E_{pe}). Effort is measured using a common unit—that is, the fishing effort of one of the two fleets is used as a numeraire expressed in terms of catch rates C_{ch} and C_{pe}. Then

E_t = total effort

$$E_t = E_{ch} + E_{pe}$$

and total net benefits for both countries from the shared stock can be expressed as

TNR = total net revenue

$$TNR = TR - TC$$

$$TNR = \sum P_i Y_i - \sum C_o PUY_i Y_i$$

where $i = 1,2$
1 = Chile
2 = Peru

where $P_i = P_{ch}$ and $P_{pe\ (constant)}$

$Y_i = Y_{ch}$ and Y_{pe}

$$Y_{ch} = (aE_t - bE_t^2)\ (E_{ch} / E_{ch} + E_{pe})$$

$$Y_{pe} = (aE_t - bE_t^2)\ (E_{pe} / E_{ch} + E_{pe})$$

and TR = total revenue

$$TR = TR_{ch} + TR_{pe}$$

$$TR = (P_{ch} Y_{ch}) + (P_{pe} Y_{pe})$$

$$TR = P_{ch}\ [(aE_t - bE_t^2)\ (E_{ch} / E_{ch} + E_{pe})] + P_{pe}\ [(aE_t - bE_t^2)\ (E_{pe} / E_{ch} + E_{pe})]$$

and TC = total cost

$$TC = TC_{ch} + TC_{pe}$$

$$TC = (\alpha_1 - \beta_1 E_{ch}) + (\alpha_2 - \beta_2 E_{pe})$$

$$TC_{ch} = (\alpha_1 - \beta_1 E_{ch})$$

$$TC_{pe} = (\alpha_2 - \beta_2 E_{pe})$$

$$TNR_{ch} = P_{ch}\ (aE_t - bE_t^2)\ (E_{ch} / E_{ch} + E_{pe}) - (\alpha_1 - \beta_1 E_{ch})$$

$$TNR_{pe} = P_{pe}\ (aE_t - bE_t^2)\ (E_{pe} / E_{ch} + E_{pe}) - (\alpha_2 - \beta_2 E_{pe})$$

Calculating total net benefits for different levels of effort and different ratios of effort displayed by each country, we obtain maps of iso-benefit curves—contour lines showing the various combinations (allocations) of effort by the two countries (*CH* and *PE*) that yield a given amount of net benefits.

Figure 10.4 has been lifted from Caddy (1982) to show, as an example, a map of iso-benefits calculated for two countries sharing a stock with cost as a linear function of effort, constant price for output, and yield represented by a logistic growth function. The highest level of benefit that country *A* can obtain for successive levels of effort of country *B* is represented by line *DC*. A similar line, line *AB*, can be drawn for country *B*. Point *X* represents the best level of effort for both country *A* and country *B*. Independent increases in effort by either country away from point *X* do not increase benefits; therefore, point *X* represents the equilibrium effort ratio between both

countries and the level of effort at which total benefits for both countries together are maximized. (For a simple computational program for this exercise, see Caddy 1982.)

A bioeconomic approach to evaluating alternative management options

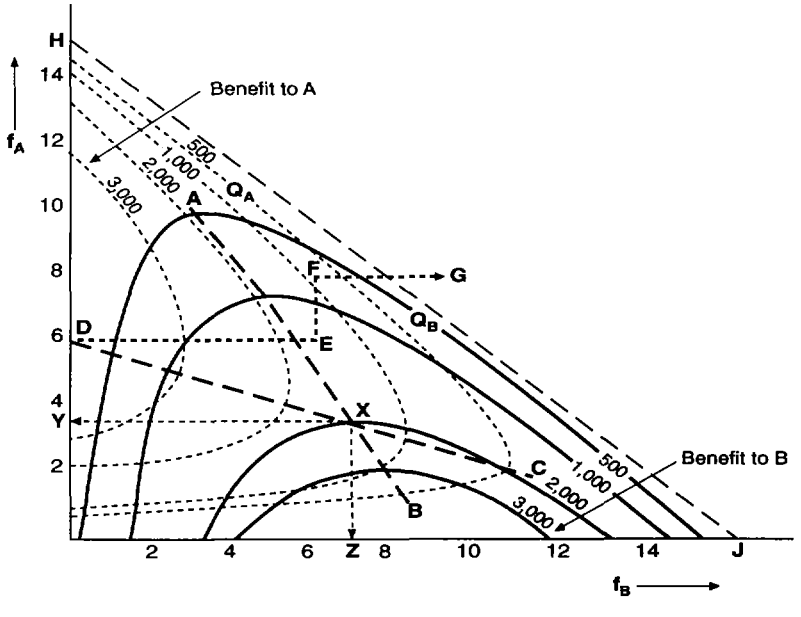
The bioeconomic nature of the problem of managing a shared stock, as discussed in the preceding sections, shows that different management interventions can be used to affect the performance of different components of the fishery. It also shows that the response to the interventions by the fishing units (fleets) in either country will depend not only on biological aspects of the resource but on the technological, socioeconomic, and institutional conditions under which fishing takes place. It is the level of benefits that each country expects to obtain from the shared resource that will finally determine whether the strategy adopted by the co-owners of a stock is one of cooperation or competition. And it is this strategy, therefore, that will determine whether the shared stock is exploited under the best possible conditions for society or whether rents are dissipated and the resource overexploited.

To analyze and evaluate the final outcome of each policy requires a model representing the various activities and decisionmaking stages in the fishery linked with the basic characteristics of the resource under alternative management options. Also required are comparable quantitative indicators for each management option.

The model proposed for this purpose is a mathematical programming model integrating harvesting, processing, and marketing activities with technological and biological input-output relationships through a net benefit objective function for fishery exploitation (for the details of this model, see Aguero 1988). This model allows the calculation of the net value of all fishing and related activities from the shared stock under given scenarios (management policies). The optimization process—the search for the best values of the control variables (regulatory interventions) within the set of feasible alternatives—is conducted using the Revised Simplex Algorithm and considering restrictions imposed by factor endowments and efficiency, cost structures, resource sustainability, market conditions, and legal and institutional regulations. A simple, dynamic, mathematical submodel, representing the recruitment, growth, and natural and fishing mortality of the fish population and the relevant environmental conditions, is designed to obtain levels of yield (sustained) in relation to effort displayed by the fleets fishing the shared stock. Alternative expected performance values for the stock—that is, yields—are then compared with sets of alternative (and multiple) management objectives. A minimum-maximum optimization criterion is used to determine the set of multiple objectives and management policies that are consistent with the estimated biological parameters and that minimize the difference between expected objectives and feasible options.

Once the set of feasible management options—those that minimize differences in management objectives—and values for the biological parameters are determined, they are fed

Figure 10.4 Iso-benefits for two countries sharing a stock of fish



Note: Benefits to two fleets sharing a common stock under conditions of fishing effort by countries *A* and *B* such that $f_A + f_B = f_t$ is the total effort exerted on the stock.
Source: Caddy 1982.

into the mathematical programming model in a recursive way to determine the economic value of each proposed management option under the restrictions and functional relationships described above. This process is continued until the optimum set of management options is determined.

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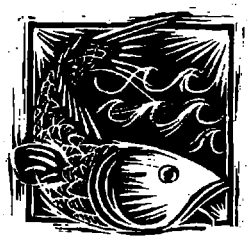

Fishery Management in Peru

Alfredo García Mesinas

11

I am delighted to be present at this distinguished gathering arranged by the World Bank and formally endorsed by a proclamation by Peru's government, and to have this opportunity to speak with Peruvian and international fishery experts of such high repute.

It is customary to begin seminars of this type with enthusiastic and confident affirmations that we do indeed have the tools, the means, and the collective will to resolve the many problems inherent in fishery management; I sincerely hope that this is the case.

Perhaps the central idea to keep in mind when discussing fishery issues is that the problems encountered in this area of production and commerce are unique; the ownership and the limited sizes of fish stocks are concerns that have no parallel in other sectors. When any other area of the economy collapses, there is a chance that it will in time rebound, but once a nation's fish stocks have been depleted, it is virtually impossible to rebuild them.

Fishery management is the process of making decisions concerning a country's fishery resources—the inputs in the process—and the objectives sought for this area of production—the desired outputs.

The chief concern of fishery management efforts in the past has been the conservation of fish stocks. It is now clear that fishery resources must also be used responsibly, to ensure that their contribution to a country and its people will be sustainable. The role of a fishery administration is to make certain that the policies and strategies pursued in developing fisheries will afford the greatest possible net benefits to society.

The cornerstone of a sound fishery management system is a long-range management philosophy. Contrary to the common wisdom, fishery management does not consist simply of restrictions or limitations on activities in the sector. If stocks are underexploited, for example, fishery authorities may need to take steps to increase fishing effort. If harvesting costs are higher than the selling price of fish, authorities may need to take measures to bring costs and prices in line with each other, or fisheries will not be developed. And if a fleet consists of vessels that are old or equipped with inefficient gear, authorities may need to undertake a modernization program. In addition, government action may be needed to upgrade ports and market facilities, or to provide support for research to improve fishing and processing technologies.

Programs to prevent the overexpansion of a fishery can operate alongside programs to upgrade the fishing fleet by bringing in modern technology and replacing old vessels. *Expansion* and *replacement* are two very separate issues, and it is essential that the distinction between them is perceived.

Fish stocks and the fishing sector are by their nature dynamic, and fishery management policies or practices that were appropriate in the past may well not be appropriate today. Thus, policies and practices must be continually reviewed and adapted to keep pace with change in fisheries.

Properly managing a country's fisheries requires meeting a series of objectives. A fishery management system needs to devise limits on the exploitation of fish stocks. And because fisheries are expected to make a solid contribution to the public welfare, it

needs to take into account social, economic, political, and environmental considerations. Fishery management is a multidisciplinary pursuit.

Having provided this general frame of reference, I now turn to five specific subjects: the features of Peru's marine habitat that explain its enormous biological productivity; the status of its most important fish stocks; the harvesting capacity of its fishing fleet; the objectives and strategies devised to develop its fisheries; and possible options for controlling entry in its fisheries.

Much of what I discuss here follows the lines of a recent mission by the Food and Agriculture Organization (FAO) to Peru, and draws on valuable data furnished by the Peruvian marine institute (Instituto del Mar del Peru).

Peru's ocean habitat

Peru owes the wealth of its marine biological resources primarily to the South Pacific ocean processes that condition the distribution, abundance, and variety of the living resources supported by its waters. General features, such as the system of surface and subsurface currents, combine with local features, such as the sea surface, seabed, and coastline, to produce a unique ecosystem.

Coastal upwelling and the phenomenon known as El Niño are two of the ocean processes that give Peru's coast its special character. The chief cause of the upwelling and a leading factor in the occurrence of El Niño is the wind system along Peru's coast. The prevailing winds are southeasterly trades, which are stronger in winter and weaker in summer. They move parallel with the coastline, which has a predominantly southeastern orientation.

Upwelling is the process in which cold marine water from 100-meter depths rises to the surface and is driven far from the coast by horizontal movements. These waters are rich in biological resources generally, and remarkably so in the area bordering the coast, where the important Peruvian anchoveta is harvested.

The upwelling off the coast of Peru, which is stronger than upwelling anywhere else in the world's oceans, is responsible for the wealth of fish resources found all along the country's coastline. Different features predominate at different points along the coast: an equatorial front at Tumbes and Paita, the effect of subtropical surface water from the west in Chimbote and Callao, continual upwelling at Pisco, and waters from the north and south meeting at Ilo. These features determine the specific nature of each of these locations—and the distribution of fish resources. The area to the north of 10° south latitude is home to a huge array of abundant resources, which fluctuate in accordance with coastal upwelling, the equatorial front, and the southern extension of the Cromwell Current.

In upwelling ecosystems—and nowhere more than in Peru—food chains are short; that is, there are very few trophic links or levels between the primary marine producers (phytoplankton) and fishable stocks. This nutrient-rich marine habitat supports large quantities of microscopic algae, which form large chains that are consumed directly by herbivorous species. Although such upwelling areas may be small compared with other marine zones, their output is remarkable (table 11.1).

The second important ocean process that characterizes Peru's coast, El Niño, occurs at irregular intervals, with different characteristics each time. Each El Niño event wreaks a number of changes, whose severity depends on the intensity of the event. El Niño is caused by massive displacements of equatorial waters following the collapse of the trade winds in the western Pacific, which encounter the coast of Peru mainly between 5° and 12° south latitude.

Peru's continental shelf is the flat reach bordering the continent, gently sloping and delimited in chart 11.1 by the 100-fathom isobath. Its width varies. It is greatest between 6° and 10° south latitude, mainly between Pimentel and Huarmey. Chimbote, where the shelf stretches 65 miles from shore, marks the widest point. The shelf narrows considerably north of Punta Aguja and south of San Juan. The width of the shelf has a direct bearing on biological

Table 11.1 Characteristics of the oceanic, continental shelf, and upwelling food chain

Area	Annual primary production (gram-calories per square meter)	Number of trophic levels	Annual fishery production potential (milligram-calories per square meter)
Oceanic	50	5	0.5
Shelf	100	3	340.0
Upwelling	500	1-2	86,000
Peru (Chimbote)	400	1-2	1.25×10^6 tons

Source: Instituto del Mar del Peru.

Chart 11.1 Salient features off the coast of Peru

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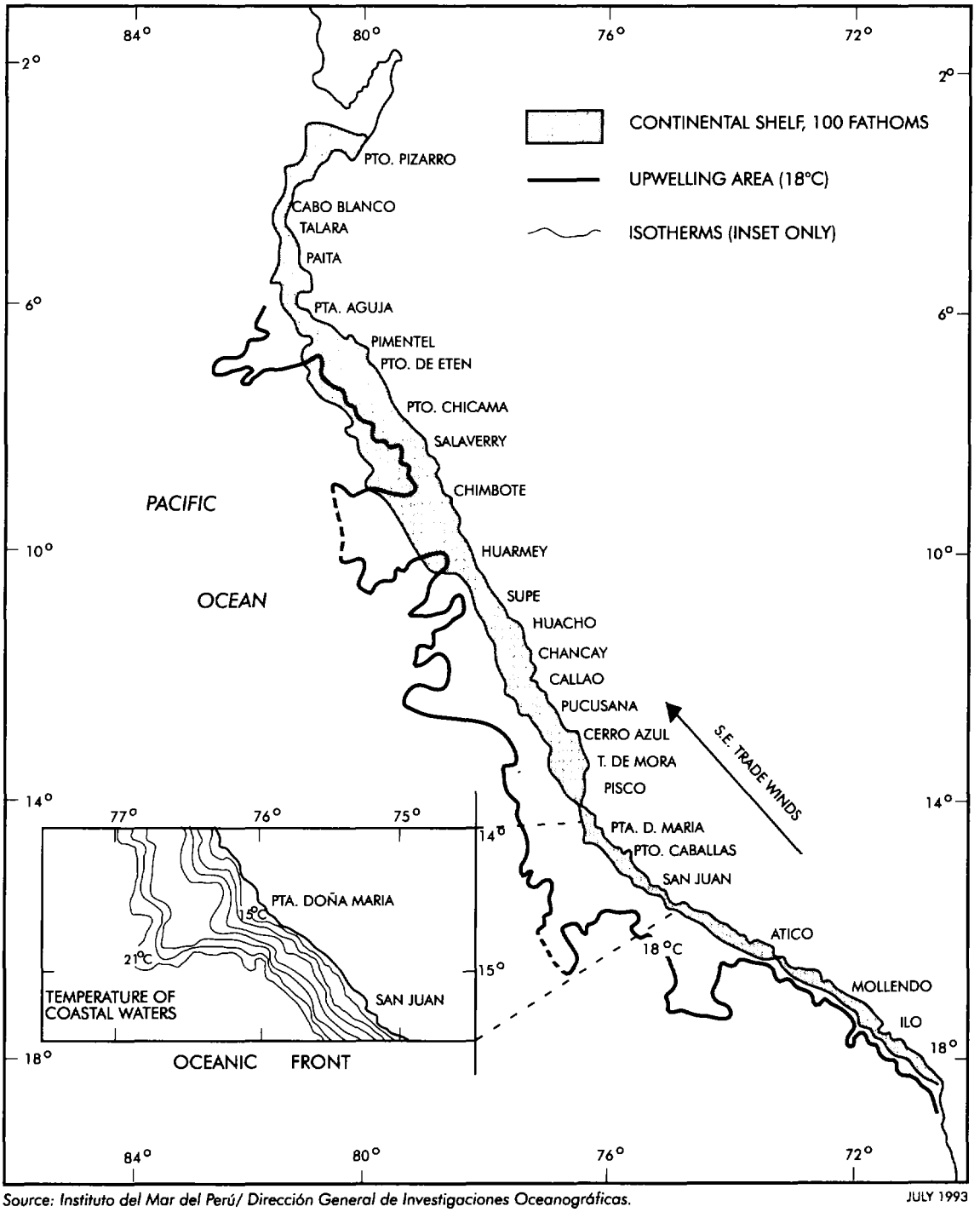


Source: Instituto del Mar del Perú/ Dirección General de Investigaciones Oceanográficas.

JULY 1993

Salient features of the ocean off Peru: continental shelf (100 fathoms); upwelling areas: Pimentel, Chimbote-Huarmey, Callao, Pisco-San Juan, Atico and the oceanic front off Pta. Doña María.

production, which depends on deposits of organic matter or the debris of dead organisms as material for the recycling of the mineral salt nutrients of phytoplankton or microscopic algae, the first link in Peru's marine food chain.

Contribution of fisheries to the national economy

Peru's fishing industry has experienced serious problems, and its development has been slow. This is due in part to natural causes, but it is in large measure because of political, social, and economic factors, both domestic and international. Nevertheless, the industry has never ceased to be an important area of production, contributing steadily to the national economy.

Fisheries benefit the economy in several ways. They produce wealth that is recorded in the gross domestic product (GDP). They generate foreign exchange to help the trade balance, create jobs, and supply food. They also can promote regional development, although lasting gains have yet to be made on this front.

Share in gross domestic product

If we look only at the share of GDP that Peru's fisheries provide, their contribution to the economy might appear meager—as would be the case in most countries. In 1989, for example, fishing accounted for a mere 1.25 percent of the country's GDP, down from 1.88 percent in 1970, when the sector posted an all-time record for landings. As one area of economic activity reflected in the GDP, then, fishing is clearly of modest weight. What does stand out about the sector, however, is its growth in value added.

Between 1980 and 1989 the fishery sector recorded a cumulative 90.5 percent increase in value added. That translates into average annual growth of 9.05 percent, a rate of growth far higher than that in other sectors of production. Over that same ten-year period, GDP growth was 2.12 percent, or an average of only 0.21 percent a year, and the agricultural sector reported a 20.2 percent cumulative increase in value added, or an average 2.02 percent a year.

In only three years during that period—1980, 1983, and 1987—did the annual growth rate of the fishing sector fall. The details of these reversals point up the uncertainty of the universe in which fishing takes place and the harsh effect that changes in the environment and in fishery resources can have on harvests.

The 1983 downturn was the most dramatic, and it can be attributed in large measure to the effects of El Niño that year, the most devastating on record in this century. The sardine and anchoveta stocks, the prime source of raw material for the fish meal industry, were particularly hard hit. The less severe declines in 1980 and 1987 can be traced to fluctuations in the abundance, distribution, and species composition of resources exploited by the country's industrial-scale fisheries.

The sector does, then, have limitations, and the resources on which it depends are indeed volatile. Yet it has grown faster than other sectors, and has been able to weather the ups and downs of the economy and shifts in economic policy with relative ease. Thus, we can conclude that in at least some areas its structure is sound, providing a fairly solid foundation upon which to press for action and support to rebuild and modernize the fishery sector.

Contribution to the foreign exchange balance

The fishing sector ranks third in foreign exchange generated, after mining and manufacturing. The US$419.6 million in foreign exchange brought in by the fishing industry in 1990 accounted for 14.26 percent of the country's total foreign exchange receipts. The sector has thus largely regained its importance as a contributor of foreign exchange to the trade account. Its significance as a source of foreign exchange had been very evident in the late 1960s and early 1970s, but had then declined, in part because of the 1972-73 collapse of Peru's fisheries.

Contribution to employment

The fishing industry is a major source of employment and income for much of Peru's population. According to 1989 estimates, some 56,000 persons were directly employed in fishing operations, 42,000 of them in harvesting activities and 14,000 in processing. But the actual number of people who derive their sustenance from the fishery sector is far higher than suggested by these numbers, which

exclude those engaged in marketing, transport, and other services associated with fishing.

Contribution to the food supply

In 1990 average per capita consumption of fish in Peru stood at 16.2 kilograms a year, exceeding the world average of about 13 kilograms a year. Fish is the largest component of Peru's meat supply, outstripping red meat, with an estimated average per capita consumption of 12.6 kilograms a year, and poultry, with consumption of 11.1 kilograms a year.

But these average per capita consumption figures conceal the fact that the fish consumption is concentrated in certain areas of the country, mainly along the coast and in urban centers. A large segment of the population living in rural and marginal urban areas do not have ready access to fish markets.

Contribution to regional development

Deep-sea fishing is the principal economic activity along most of the Peruvian coast, and thus a leading engine of regional development there, bringing progress to communities and areas that would otherwise find it difficult to subsist. Inshore fisheries, however, account for less than 0.5 percent of the country's fishery output, and just under 5 percent of the fish utilized for direct human consumption. But these fisheries offer a vital means of subsistence for communities in remote and isolated areas.

State of Peru's fishery resources

Peru has 2,330 kilometers of Pacific coastline, 87,200 square kilometers of continental shelf, and 617,500 square kilometers of enormously productive territorial waters. In an ecosystem characterized by one of the strongest upwellings in the world, climate, geology, and biology combine to produce vast—though fluctuating—volumes of marine biomass relatively close to shore.

The data available on the catch and stocks of marine species reveal sharp year-to-year fluctuations. These fluctuations can be attributed in large measure to natural causes, notably environmental conditions that influence the abundance and distribution of different fish populations. But often, particularly in the case of adverse changes, responsibility for the downturn rests with humans, because of excessive fishing pressure. Most susceptible among Peruvian fisheries are the anchoveta and sardine stocks exploited for fish meal production.

Despite considerable fluctuations in individual fish stocks, however, the total biomass of commercially valuable species and the potential catch in Peruvian waters are virtually always high, and the fluctuations in these totals are less pronounced (table 11.2). Generally, 40 to 70 percent of the total biomass is found within 30 miles of the coast, and 70 to 90 percent is less than 60 miles offshore.

Because these rich stocks are relatively close to the mainland, and navigation and fishing conditions are generally favorable, fishing can go on virtually year-round along Peru's entire coast. Even old, poorly equipped vessels (which are the norm for the

Table 11.2 State of the main fish resources of Peru

Species	*Potential catch (thousands of metric tons)*	*State of exploitation*
Pelagics	3,500 to 8,500	Variable
Anchovy	1,000 to 4,000	Fully to overexploited
Sardine	1,000 to 8,000	Fully to overexploited
Horse mackerel	700 to 2,800	Underexploited
Mackerel	100 to 400	Underexploited
Bonito	40 to 80	Lightly exploited
King mackerel, dorado	20 to 40	Underexploited
Others	10 to 50	Variable
Demersals	120 to 800	Variable
Hake	100 to 180	Lightly to fully exploited
Comber	10 to 30	Lightly to fully exploited
Croaker	10 to 30	Lightly to fully exploited
Rays, dogfish	20 to 50	Lightly to fully exploited
Others	10 to 50	Lightly to fully exploited
Coastal	80 to 160	Variable
Bream	20 to 60	Generally lightly exploited, some fully exploited locally
Mullet	60 to 80	
Scad	10 to 40	
Smelt	5 to 20	
Others	8 to 20	
Other species		
Shrimp	5 to 10	Fully to overexploited
Mussel	10 to 30	Lightly to fully exploited
Scallop	2 to 10	Overexploited
Giant squid	30 to 200	Underexploited
Others	100 to 800	Variable
Total	4,000 to 9,000	Variable

Source: Instituto del Mar del Peru.

country's industrial and artisanal fleets alike) can land fairly substantial catches. Precisely for this reason, there has been no perceived need to modernize the country's fishing fleet, and the advantages offered by the few smaller, more efficient, and more profitable vessels with modern gear that have begun to appear in recent years have not always been obvious. The higher returns and efficiency of the newer vessels come clearly into focus when the issue is to guarantee a steady supply of good-quality fish, however, particularly when fish stocks dwindle, the composition of fisheries changes, or market demand for a certain species or product increases.

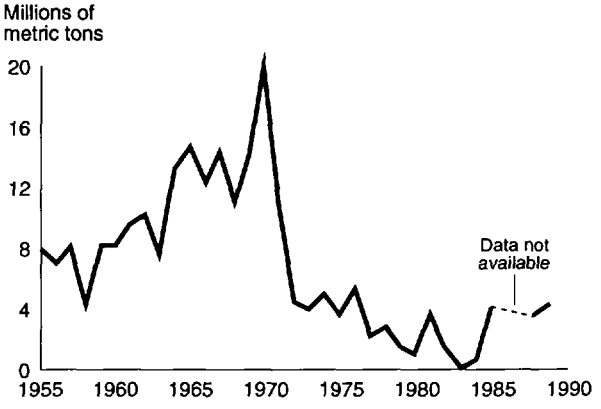
Peru's present fishing fleet has excess capacity: the nominal potential catch for some fisheries exceeds the maximum allowable catch, and for others it is too large to be handled by the infrastructure in place for the intake, storage, and distribution of the fish landed. Thus, regardless of its state of repair and operating capabilities, the country's fishing fleet must operate under restrictions to prevent overexploitation of marine resources and saturation of the first-hand market. Under these circumstances, it is only to be expected that the efficiency and yield of fishing boats will be well below optimal levels.

Small pelagic species

Small pelagic species account for a substantial share of Peru's fish resources. The mainstays are the anchoveta (*Engraulis ringens*), sardine (*Sardinops sagax*), horse mackerel (*Thachurus murphyi*), and chub mackerel (*Scomber japonicus*). (See figures 11.1-11.3.) These species together account for more than 90 percent of total landings in Peru and of the known fishable stocks in its ocean waters. Over the past ten years the total allowable catch for these species has ranged from 2 million to 7 million tons a year, and the overall harvest from 1.4 million tons in 1983 to 6.5 million tons in 1989 (figures 11.4-11.6). For some stocks, particularly anchoveta and sardines, catches have surpassed the recommended or estimated allowable levels.

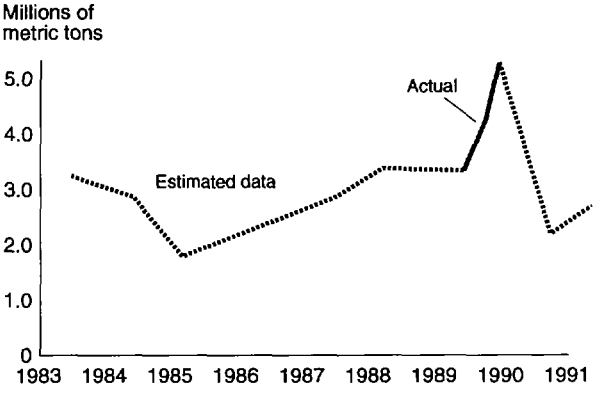
Anchoveta and sardine stocks are being fully exploited, and in some years they have been overexploited, with harvests above the recommended limit. To conserve the resource, regulations have had to be continually adopted to restrict, and in some

Figure 11.1 Biomass of anchoveta, north and central stocks, Peru, 1955-89



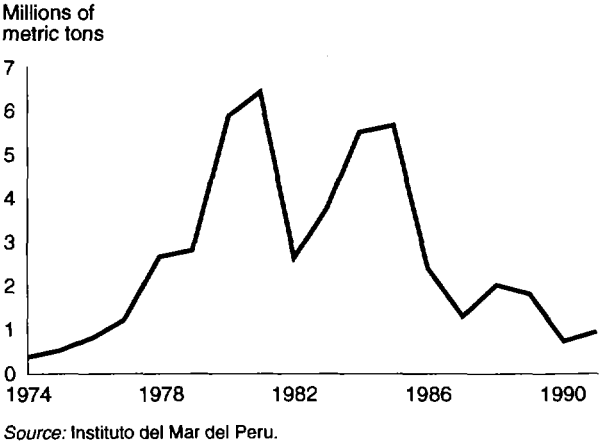
Source: Instituto del Mar del Peru.

Figure 11.2 Biomass of sardine, north and central stocks, Peru, 1983-91



Source: Instituto del Mar del Peru.

Figure 11.3 Biomass of sardine, south stock, Peru, and north stock, Chile, 1974-91



Source: Instituto del Mar del Peru.

instances ban, the harvesting of these species for relatively long periods of time. Still underexploited, however, are the stocks of horse mackerel and, to a lesser extent, chub mackerel.

Other pelagic species

Other pelagic species whose catch or commercial value makes them important Peruvian fisheries are bonito (*Sarda chiliensis*), sierra or Spanish mackerel (*Scomberomorus sierra*), dolphin (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), swordfish (*Xiphias gladius*), and several species of sharks (figure 11.7).

The paucity of data on these stocks makes it difficult to make reliable projections of potential catches and to predict whether fisheries can be expanded for these species, which are widely distributed in the southeast Pacific. Because of the fleet's constraints and because the exploitation of these species is at an early stage of development and largely inshore, part of the stocks are very likely underexploited. A better equipped, more autonomous fleet could be expected to land far higher volumes of these fish, particularly the more widely distributed species—dolphin, swordfish, sierra, yellowfin, skipjack, and some shark species.

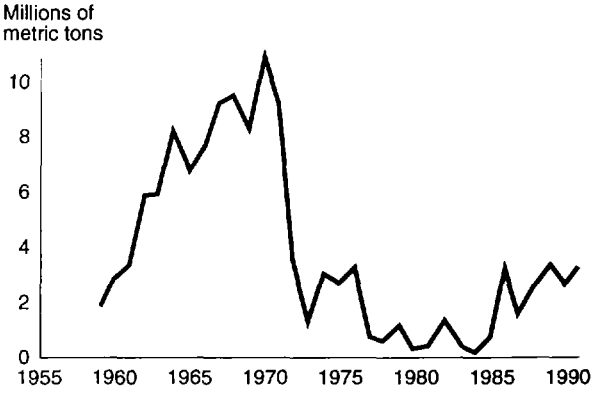
Most of these species bring good prices on domestic and export markets. These fisheries should therefore be kept very much in mind in future development programs for the country's artisanal and industrial fleets.

Demersal resources

Peru's most valuable groundfish is hake (*Merluccius gayi*), which is harvested mainly by coastal industrial trawlers and the deep-sea fleet. Next in importance are Peruvian rock bass (*Paralabrax humeralis*), drums (*Cynoscion analis*), croakers (*Paralonchurus* spp), dogfish (*Mustelus* spp), various species of rays, flounders (*Paralichthys* spp), and groupers (*Epinephelus* spp). These species are caught by both industrial trawlers and artisanal fishers.

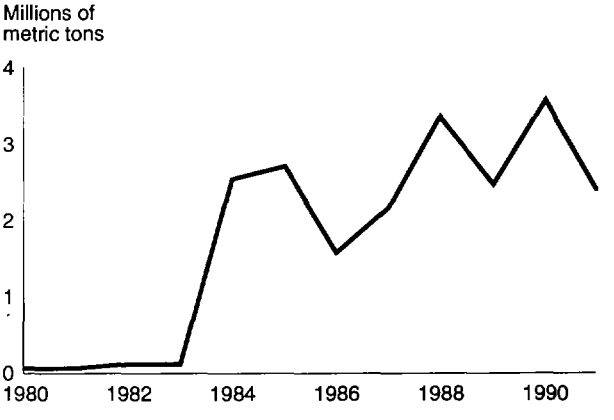
In past years the hake catch has fluctuated from a high of 300,000 metric tons in 1978 to a low of 6,000 metric tons in 1983, when El Niño made its appearance (figure 11.8). Estimates of the total hake biomass range from 150,000 to 800,000 metric tons (fig-

Figure 11.4 Anchoveta landings, north and central stocks, Peru, 1959-91



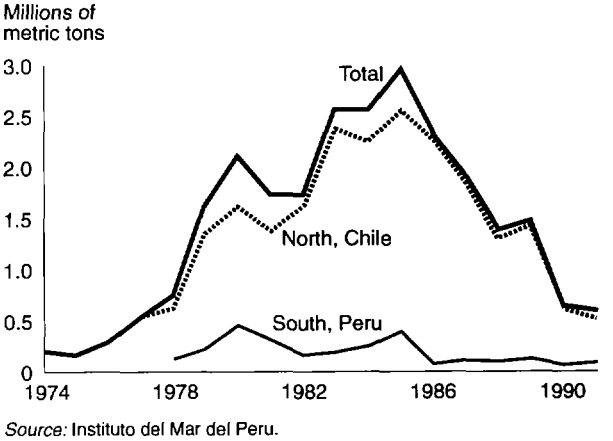
Source: Instituto del Mar del Peru.

Figure 11.5 Sardine landings, north and central stocks, Peru, 1980-91



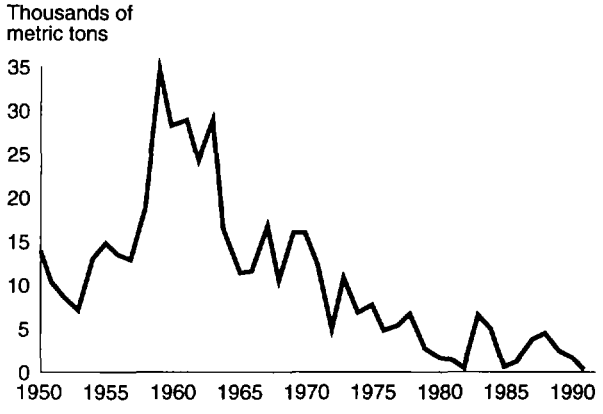
Source: Instituto del Mar del Peru.

Figure 11.6 Sardine landings, south stock, Peru, and north stock, Chile, 1974-91



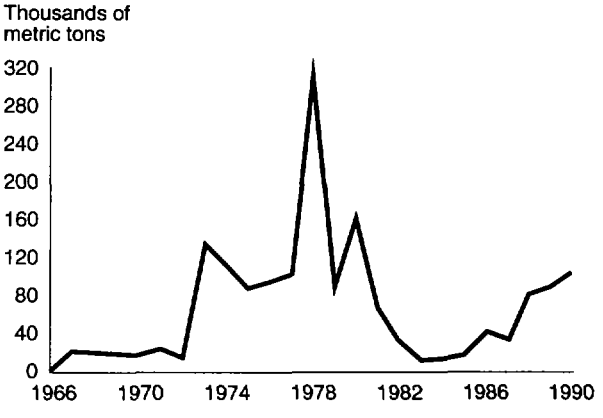
Source: Instituto del Mar del Peru.

Figure 11.7 Tuna landings, Peru, 1950-90
(yellowfin and skipjack)



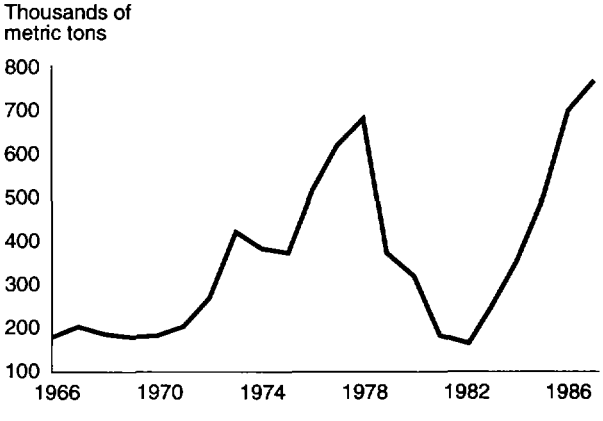
Source: Instituto del Mar del Peru.

Figure 11.8 Hake landings, Peru, 1966-90



Source: Instituto del Mar del Peru.

Figure 11.9 Biomass of hake, Peru, 1966-87



Source: Instituto del Mar del Peru.

ure 11.9). Depending on environmental conditions, exploitation strategies, and the abundance of, and hake's interaction with, other species, the potential yearly harvest of hake could be 100,000 to 180,000 metric tons. Recent years have seen a sharp decline in the hake catch. Throughout most of the 1980s the harvest had stood at about 50,000 metric tons a year, largely as a result of reduced fishing effort, but between 1987 and 1990 the hake catch climbed from 32,000 to 127,000 metric tons. The resource is now considered to be somewhere between lightly and fully exploited. There is thus potential to increase the catch, especially if management action is taken to cut back on the harvest of juveniles and to better distribute the fishing effort.

Peru's total catch of other demersal species ranges from 30,000 to 60,000 metric tons a year (figure 11.10). Most of these stocks are classified as lightly to fully exploited, though there is concern about some stocks that are growing slowly. One of these is the dogfish, which is harvested along with hake and thus subjected to the same fishing intensity. There appears to be some potential for expanding the fisheries of these other demersal species, especially if new zones deeper than those currently being worked can be explored.

Inshore resources

The inshore species of interest in Peru are the striped mullet (*Mugil cephalus*), South Pacific bream (*Seriolella* spp), croaker (*Sciaena* spp), silverside (*Odontesthes regia*), grunt (*Isacia* spp), and ladyfish (*Ethmidium* spp). These species are harvested almost exclusively by artisanal fishers.

Peru's total inshore catches have ranged in recent years from 40,000 to 80,000 metric tons a year (figure 11.11). The exploitation of these species could probably be stepped up, perhaps even to twice the current harvest. Each of these inshore stocks consists of a number of subpopulations that in most instances are being lightly exploited, although near the larger landing points they may be overexploited.

The exploitation of the inshore stocks could be improved considerably without enlarging the fleet if existing vessels had more autonomy and better facilities for catching the fish, for on-board handling and storage, and for landing and marketing the

product. Expansion of the fisheries would also require management measures to ensure that the fishing effort is not overly concentrated in spawning or breeding periods or areas and that juveniles and spawning stock are spared. And efforts are needed to alleviate the pollution near ports and urban centers that may threaten inshore fish stocks.

Invertebrates

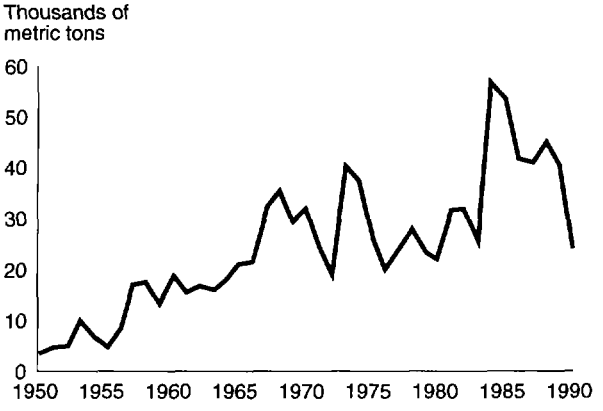
Peru's catch of mollusks and crustaceans has expanded fairly steadily over the past three decades, peaking at about 70,000 metric tons in 1985 (figure 11.12). The crustacean of primary interest to Peru's fishing industry is the shrimp (*Penaeus* spp). The annual shrimp harvest, from fishing and aquaculture together, is generally about 5,000 metric tons. In 1983, however, because of the positive effects that El Niño had on the shrimp fishery, the Peruvian fleet landed a record 9,700 metric tons of shrimp, nearly double the normal harvest of fishing and aquaculture combined.

Peru's shrimp stocks are at risk because of their heavy exploitation by commercial fishers and because of coastal pollution. Some particularly worrisome sources of contamination are the pesticides used by farmers in the north and the degradation of coastal areas. Particularly serious is the destruction of mangrove swamps by urban encroachment and the development of agriculture and aquaculture. A further cause for concern in shrimp fisheries is the collection of shrimp larvae to serve as seed stock for shrimp farming operations. The full implications of this practice have yet to be determined, however.

Two other crustaceans of interest in Peru are lobsters and crabs. Although the potential catches of these species are limited, the high prices they command at home and abroad make them attractive for development in some coastal areas.

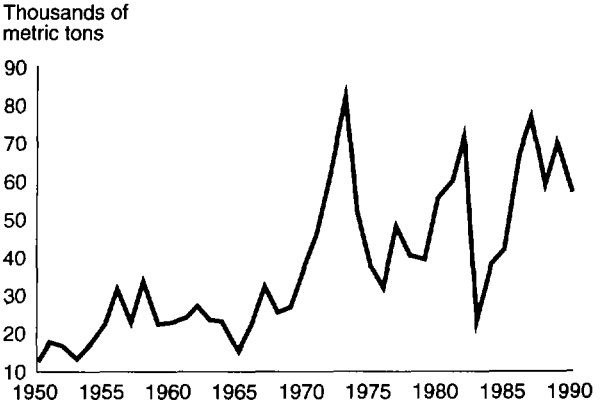
The scallop (*Argopecten purpuratus*) generated high expectations in Peru in the wake of the 1983 El Niño, when stocks swelled and landings rose, reaching a high of 47,500 metric tons in 1985. With the scallop catch again falling below 5,000 tons a year, many in the industry are calling for research and investment to rebuild the fishery. But they fail to take into account that the boom in the stock in 1983 and its subsequent decline are largely a re-

Figure 11.10 Landings of main demersal species, Peru, 1950-90
(drum, rock bass, croaker, rays, and dogfish)



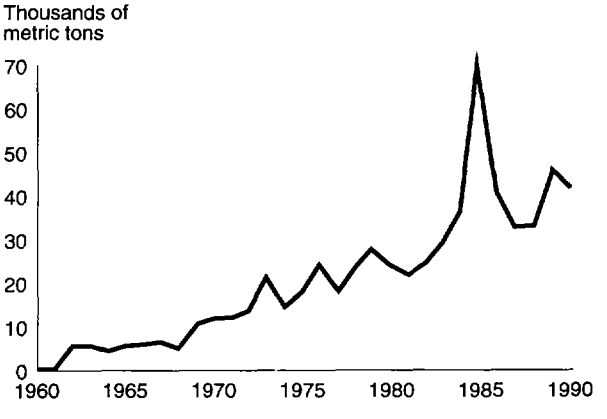
Source: Instituto del Mar del Peru.

Figure 11.11 Landings of main inshore stocks, Peru, 1950-90
(including grunt, bream, mullet, croaker, and scad)



Source: Instituto del Mar del Peru.

Figure 11.12 Landings of main invertebrate species, Peru, 1960-90
(including crab, mussel, scallop, and snail)



Source: Instituto del Mar del Peru.

sult of natural fluctuations, aggravated by unchecked increases in capacity and intensified fishing pressure.

The scallop fishery could perhaps be expanded if suitable culture methods and sound management measures are instituted, and, most important, if the natural factors that favor the growth and expansion of the species are present, as they were in 1983-84. To capitalize on the confluence of these natural factors—if they should recur in the future—a more effective exploitation and management program needs to be put into place to take better advantage of—and prolong—upswings in the stock of scallop.

Another commercially valuable mollusk with development potential is the mussel (*Aulacomya ater*). This species has lately been yielding catches ranging from 3,000 to 15,000 metric tons a year.

New opportunities—The giant squid

A mollusk species that has received a great deal of attention lately as offering good potential for expansion is the giant squid (*Dosidicus gigas*). Before 1990 only a few thousand metric tons of squid were harvested each year off Peruvian shores, but the catch climbed to 8,000 tons that year and soared to about 60,000 tons in 1991.

Most of that catch was landed by foreign squid boats operating under licensing arrangements, thus leaving potential room for investment by Peru's industry. But a very careful study would need to be conducted before the industry invests in specialized infrastructure and vessels. The resource is extremely variable, and there is no guarantee that the huge stocks reported recently will last long enough to warrant long-term investments.

Structure and capacity of Peru's fishing fleet

Peru's fishing fleet includes more than 6,000 vessels, with an aggregate hold capacity of close to 180,000 metric tons (table 11.3). The fleet's capacity is considerably smaller than it was in the early 1970s, but it still exceeds the maximum potential catch of the country's principal known fishable stocks.

The industrial fleet, which accounts for approximately 90 percent of the country's nominal installed harvesting capacity, lands mainly pelagic and demersal fish. Artisanal fishers, who work mostly inshore, account for the other 10 percent.

Purse seiners built in the 1960s and early 1970s make up 85 percent of the industrial fleet that fishes along the coast. More than 80 percent of the fleet is over twenty years old, in poor repair, and fitted with outmoded gear. The boats cannot handle or store their catch properly, and their operating costs are high. The fleet thus has trouble competing on the domestic and export markets in the high-quality products that could bring acceptable profits. This problem is especially evident in the trawler and seiner fleets, whose catch is intended for direct human consumption.

The fleet needs to be modernized, and its capacity reduced, through regulatory action, to bring it into line with the resources. With a reduced capacity, fewer bans on fishing and other restrictions would need to be imposed on the fleet.

Table 11.3 Structure and capacity of the fishing fleet operating in Peru, 1989

Type of fleet	Vessels	Hold capacity (metric tons)		Theoretical catch capacity (thousands of metric tons)	
		Total	Average	Minimum[a]	Maximum[b]
Industrial fleet	782	189,641	204.1	19,674.7	29,992.5
Purse seiners for fish meal	373	87,800	235.4	14,487.0	21,072.0
Purse seiners for food fish	286	84,777	122.0	8,825.5	5,842.5
Coastal trawlers	87	7,051	81.0	775.6	1,184.6
High-seas trawlers (domestic)	11	5,900	536.4	324.5	495.6
High-seas trawlers (foreign)	20	21,963	1,098.2	197.7	307.5
Tuna vessels	6	2,150	358.3	64.5	90.8
Artisanal fleet	5,362	16,426	3.1	1,806.9	2,759.6
Total	6,144	176,067	28.7	21,481.6	31,752.0

a. Assumes 220 fishing days a year and 70 percent utilization of hold capacity on each trip for fish meal and 30 percent for food fish.
b. Assumes 240 fishing days a year and 75 percent utilization of hold capacity on each trip for fish meal and 25 percent for food fish.
Source: Data from Ministry of Fisheries of Peru, Directorate General for Extraction.

Fishery development: Objectives and strategy

Peru's government is revamping the legal and institutional framework of the country's fishery sector. As it does so, it is filling in gaps and otherwise improving earlier laws and regulations. It is bringing its fishery policy into conformity with the social market economy thrust of the country's new economic policy, grounded in Articles 118 and 119 of the Constitution. And, in drafting the new Fishery Act, it is bringing together, in a single, consistent, consolidated legal text, all of the laws and technical regulations reflecting official policy and governing the industry's activities under the new fishery regime. This last is a vital step for the development of a stable fishery sector.

Peru's efforts to develop its fishery sector can be organized around a general objective and a set of specific objectives. The general objective is to enhance the contribution made by fisheries and aquaculture to the country's socioeconomic development. The specific objectives are the following:

- To generate positive foreign exchange flows
- To increase the supply of fish and fish products on the domestic market
- To create new jobs in the sector
- To contribute to regional development.

The policy guidelines adopted by the government dictate that the philosophy of the social market economy is to shape the legal strategy for achieving these objectives for the fishery sector. This philosophy envisages unfettered competition but strict adherence to the principles of sustainable fishery and aquaculture development, emphasizing conservation of fish stocks and environmental protection.

Entry control options

It is generally acknowledged that some excess capacity in a fleet and the onshore infrastructure is warranted if a fishery resource is to be fully exploited. But the margin of overcapacity must be controlled and adjusted as local conditions and needs evolve, to keep stocks from being overexploited and to avoid the other socioeconomic repercussions that overcapitalization brings.

An excessively large fleet exerts too much fishing pressure on the resource. Overinvestment has been cited, in FAO reports, by more than forty countries as the leading cause of the collapse of fisheries—and of the resulting need for subsidies to help fishing communities survive. The tendency of fleets is to press fishery authorities to allow them to fish more at all costs, even if a fishery is in danger of collapse. A particular difficulty here is that the effects of overfishing are not felt at once; three, five, or more years may go by, depending on a species's life cycle, before the harm is noticed.

If a country allows unlimited access to limited fish stocks, its fisheries will necessarily become inefficient and uneconomic, and fishers, processors, and everyone else associated with the industry will suffer. Regulation is often the solution. Imposing size limits on fish caught and restrictions on a fleet's harvesting capacity improves the overall net economic return of a fishery. And for individual vessel operators, it protects income and economic yields, lessens the risk of overcapitalization, and can avert the threat of competition from other investors and ship owners who could bring in new vessels.

As we have seen, the capacity of Peru's industrial fishing fleet far exceeds the maximum allowable catch for Peru's primary marine resources. It also is too large for the existing intake and processing facilities, which can handle an estimated 18 million metric tons a year. Thus, in tandem with the program to upgrade the country's fishing fleet, it will be essential to review regulations and procedures governing access to fish stocks. Such a review is in fact already under way. Some options for controlling entry to fisheries are licensing arrangements, vessel quotas, and other compensation schemes, which recognize the value of a more or less exclusive right to exploit a common resource, with guarantees of a restricted number of competitors.

In such a system it would be wise to provide access only to vessels that are in good running order, and not to boats that are obsolete or out of service, or that exist merely on paper. This would discourage the type of speculation that can flourish when owners of old vessels, or vessels only on paper, hang on to licenses in hopes that they will become scarcer, and a boat plus license therefore more valuable. It would hold down harvesting capacity to a suitable level. And it would avert a situation in which a portion of the allowable catch has been allocated to a licensee who cannot be expected to land it in

a foreseeable time frame, but who suddenly begins to operate his vessel and upsets the balance of the fishery.

In assessing entry control options, a clear distinction must be made between industrial-scale fisheries and artisanal fisheries. And when placing a value on licenses, vessel quotas, and other payment or compensation arrangements for access to fish stocks, the following points should be considered:

- The potential profit margin and estimated benefits that will accrue to the fisher, ship owner, industrialist, or investor given the right to exploit one or more fishery resources. Some elements that should be factored into the calculation are the market price of the target species, harvesting cost, distance to the stocks and ease of harvesting, and the infrastructure and ancillary services available.
- Possible returns to the community, such as job stability, new jobs, investment in land, new infrastructure and public services, and contribution to local development.
- The community's and nation's right to share in the income and benefits generated by the exploitation of a public good such as fisheries, which are acknowledged to be part of the national patrimony.
- The need to defray the costs to a country of conserving fishery resources and ensuring that they are exploited rationally. These costs include research, training, oversight, management, and planning for the development of fisheries. These activities should be considered part of the cost of exploiting the resource and should therefore be paid for by those who benefit directly from the fisheries.

A renewal and modernization of the industrial fishing fleet may well trigger a radical shift in the current cost-productivity ratio between capital (boats, equipment, gear) and labor. New vessels clearly will require fewer, but more specialized, crew members. As jobs disappear and better-trained, specialized workers come to be needed, compensation patterns may be altered as well.

Experience has shown that where there has been free access to fish stocks, restrictions—seasonal bans or closure of fishing areas, catch quotas, gear restrictions, controls on the landing of juveniles—can sometimes forestall the depletion of stocks. But inevitably harvesting capacity will become excessive, evidenced by progressively shorter fishing seasons as an ever-increasing number of new vessels, landing their annual quota more and more quickly, enter the fishery. Thus, for a country wishing to develop its fisheries, there are very solid grounds for adopting a management policy that limits or restricts access to its fishery resources.

Much of my discussion has centered on the excess capacity of the industrial seiner fleet that provides raw material for meal and oil plants. But I would hasten to add that underexploited and lightly exploited fisheries also require management schemes. Efforts to institutionalize the management system at the outset of the development process can ensure that the fleet will remain an appropriate size.

Trends in Fishery Management

Rögnvaldur Hannesson

12

The need to manage fisheries arises from two conditions. First, there is a need to limit the harvest to what the fish stocks can sustain. Second, property rights to fish stocks are difficult to establish. As a rule, governments have assumed the responsibility for managing fish resources, in the absence of any private ownership.

The relative abundance of fish was one reason most fish stocks remained international common resources until recently. The amount harvested did not threaten the viability of the stocks, and signs of increasing scarcity—such as increasing fishing costs and declining yields—were slow to appear. In addition, international law was for a long time hostile to the idea of exclusive national fishing zones. Peru and other countries in Latin America were the first to establish a 200-mile fishing limit. This limit is now accepted in international law as the 200-mile exclusive economic zone.

After World War II the pressure on the world's fish resources increased substantially, and signs of their increasing scarcity became ever more obvious. This increasing scarcity was the main driving force behind the establishment of the 200-mile economic zone. The world catch of fish grew steadily by about 6 percent annually until about 1970, but this growth was due in part to the exploitation of new species and new areas. In the 1970s this growth stopped abruptly; in the 1980s it resumed, but at a slower rate.

The first reaction to increasing pressure on fish stocks—perhaps a natural one—was to limit the amount caught. The initial fishery management methods have almost invariably been biological in nature. Biologists have been called upon to assess the stocks and make recommendations as to how much should be caught. They have usually recommended adjusting the catch to achieve a stock level that maximizes sustainable yield. The methods used to do this have been either directly limiting the catch to allow depleted stocks to recover, or limiting fishing activity (trawling days, number of nets) to achieve the same goal.

The basic fault with this approach is that it ignores the economic aspects of the problem. Fishing is only one of many activities to which people can devote their productive efforts, thus the returns that it provides must be seen in relation to what could be achieved by using the manpower and equipment in a different way. It is therefore not obvious that a purely quantitative goal, such as the maximization of sustainable yield, makes any economic sense.

A more serious consideration, perhaps, is that fishery regulations based on a purely biological rationale are often devised in such a way that the fishery becomes unnecessarily costly. When there are quantitative controls on catch, fishers are often allowed to compete for the fish until the allowed catch has been taken. This typically leads to ever-shorter fishing seasons as more and more boats enter the fishery, and the available catch is often taken by many more vessels, and over a much shorter time span, than necessary. When the harvest is controlled by restraining fishing activity, artificial curbs are put on the use of vessels. Sometimes their fishing power is restrained by rigging the engine or limiting the amount of gear, and sometimes they are forced to remain in harbor for a specified number of days.

People have gradually become aware of the wastefulness of these practices, and remedies have been sought. Perhaps the most obvious and sensible approach is to try to limit the cost of the fishing operations necessary to take the amount of fish it is reasonable to take. An obvious way of doing this is to limit the number of vessels allowed to participate in a fishery, through license limitation programs, for example. These programs have been implemented in a number of places around the world, including Canada, Norway, and the United States, and many are still in force.

As experience with license limitation programs was accumulated, it became clear that they were not easily implemented in ways that would ensure that costs would be minimized for any given level of catch. Fishing capacity, it turns out, is like a many-headed monster; if you chop off one head, two new ones appear. Fishers and boat designers cooperate to circumvent regulations on fishing vessels, increasing fishing capacity through new designs that satisfy the restrictive rules while including new fish-finding devices and better gear. This has led to growing disappointment with license limitation programs.

A new regulatory device, individual transferable quotas (ITQs), has come into fashion and is being implemented in countries around the globe. Where individual transferable quotas have not been implemented or put on the agenda, they are very much at the center of discussion.

This chapter looks briefly at experience with ITQs in selected countries. The discussion focuses on the advantages and disadvantages of ITQs, the way they have been implemented, and the reasons that they have been rejected in some countries.

The advantages of individual transferable quotas

The advantages of ITQs are obvious. The sum of ITQs for a stock constitutes the amount that can be taken from the stock, the total allowable catch (TAC). Setting a total allowable catch for each fish stock can protect the stocks from depletion. Dividing the TAC among all vessels participating in a fishery prevents a self-defeating race for the largest possible share of the total catch. And making the vessel quotas transferable makes it possible to minimize the cost of taking a given catch. In the short term, transferability ensures that the least efficient fishing vessels will not be used, as their quotas can be bought by the owners of more efficient vessels at a price that benefits both buyer and seller. In the long term transferability means that the owners of fishing vessels can adjust their fishing capacity to the amount they may expect to be able to take, or vice versa. This can be done even if the TAC fluctuates from year to year. If the ITQs are defined as shares of the TAC, the catch quotas of individual boats will fluctuate in proportion to the TAC, and the boat owners will have to make a well-educated guess as to how the TAC will fluctuate and how much they can expect to be allowed to fish in the future.

No less important, ITQs can be designed to satisfy criteria of fairness. Two aspects of fairness are particularly relevant in this context—fair treatment of individuals at a point in time, and fair treatment across generations. Fair treatment of individuals at the time ITQs are implemented can be achieved through an appropriate design of the initial allocation of quotas. Free trade among quota holders can then achieve efficiency and allow the gains to be shared between buyer and seller. This system may, for example, allow old or indebted fishers to retreat gracefully from an industry in which they have no future. Suppose that John Smith is a middle-aged fisherman who faces bankruptcy because his declining health does not allow him to fish as intensively as he thought he could when he bought his new boat. Allocating to him a right to take a certain proportion of the annual catch of fish gives him an asset that he can sell in order to pay his debt and retire.

But there are future John Smiths to come. Those who received ITQs as a gift would be able to sell them and obtain a windfall gain. But those who want to become fishers after an ITQ system has been put into place must buy their way in. For them the value of the ITQs is a cost they can hope to recover when they leave the fishery. Thus, under the system the gains from the ITQs end up with the first generation of fishers, who acquired the ITQs at no cost—a result likely to be at odds with the criterion of fairness across generations. To avoid this result, it would be necessary to sell, lease, or tax the ITQs—all actions that would be judged appropriate for a resource owned by the public, such as offshore oil. Taxes on such resources are likely to be less distorting than other forms of taxes.

The most far-reaching experiments with ITQs have been conducted in New Zealand and Australia. In New Zealand the ITQ system covers most of the fisheries, while in Australia only a few fisheries are involved, one of which is the fishery for southern bluefin tuna. In 1992 ITQs were introduced in the trawl fishery in southeastern Australia.

The experience of New Zealand and Australia with ITQs highlights some of the major issues they raise. In both countries the ITQs were defined as perpetual rights. This was presumably done to make the system as firmly entrenched as possible, an important point since it is an institutional innovation and a controversial one. Transferable perpetual rights eliminate all problems that otherwise might arise when a lease of a temporary right runs out, and they provide the best possible environment for long-term planning. Transferability led to short-term gains particularly quickly in the Australian southern bluefin tuna fishery (Robinson 1986); since the quota system was introduced in 1984, the number of participating vessels has been reduced by 80 percent.

How the ITQs are defined is not trivial. An ITQ, even if it is valid in perpetuity, is not a property right in the fish stock itself, but a right to harvest from it. If we make a comparison with agriculture, we might say that a similar right would be a right to harvest plants that grow naturally on the land, or to cull a flock of animals that grazes there. New Zealand made the mistake of defining these rights as rights to harvest a certain tonnage of fish. This would be comparable to defining rights to harvest a certain number of cubic meters of timber or to kill a certain number of animals, with the state obliged to make up the difference if nature falls short. Not only the vagaries of nature but the variability of markets and changes in costs and technology make such an undertaking a doubtful proposition. Because the yield potential of the fish stocks was in some cases grossly overestimated, the government had to rescind its undertaking and redefine the ITQs as share quotas. The industry protested the redefinition and took the case to court, where it still is.

In both Australia and New Zealand the preparations for achieving a fair initial allocation were carefully thought through and elaborate. This is, of course, extremely important; the legitimacy and stability of the system hinges in no small way on how fair the initial allocation is considered. In New Zealand the initial allocation was based on fishers' historic catches, and an elaborate appeal mechanism was established. In the southern bluefin tuna fishery in Australia the fishers agreed on a formula for weighting the catch history and the investment commitment in making the initial allocations (Robinson 1986).

Achieving equity across generations appears to have been given little consideration in New Zealand and Australia. The quotas were initially distributed for free, and there is limited taxation of catches or of quotas held. In New Zealand previous plans to impose a resource rent tax on the fishery have been shelved, and the fishery now pays only a part of what it costs to manage it. In Australia, that the fishery should pay for its own management is a stated policy objective.

Undesirable side effects of transferability

Given the availability of such a marvelous system as the ITQs, why have not all fishing nations implemented it? In some countries the conditions for a well-functioning ITQ system are simply not in place; in others the expected side effects have persuaded people to modify the ITQs, or discouraged them from implementing the ITQs. And in some countries ideological or political reasons stand in the way.

The undesirable side effects of ITQs arise as a consequence of free and unrestricted transferability. When quotas can be transferred with no restrictions, they will gravitate toward the companies and areas that can utilize them most efficiently. The concentration of ITQs in the hands of one or a few companies will give these companies some market power. The companies may be expected to take advantage of this, charging a higher price than otherwise for their fish if they have market power on the production side, and offering lower wages than otherwise to their employees if they have power in local markets, such as in fishing communities with few alternative employment opportunities.

Geographic concentration, or dislocation, may also be an important and uncomfortable side effect of unrestricted transferability. Fishing vessels are mobile workplaces that can work out of any suitable harbor. A company could buy ITQs from another company operating out of a fishing community with a single plant and land the catch in a different place,

leaving that community without its means of existence. Such a development might be desirable from a long-term perspective, but it would leave a trail of economic and social problems in its wake in the short term.

A problem that ITQs will not solve concerns the interdependence of fleets harvesting fish of different age groups from the same stock. The fleet taking the young fish imposes an extra cost on the fleet taking the older and bigger fish, because the first fleet reduces the number of fish available for the second fleet. The first fleet has no incentive to take these costs into account, and a situation could easily arise in which it finds it profitable to buy quotas from the other fleet, even if it is less profitable when all costs are taken into account.

The ITQ system to be implemented in Alaska imposes restrictions on the transferability of quotas and the length of tenure, presumably in response to some of these problems. The North Pacific Fishery Management Council (1991) has recently approved ITQs for halibut and sablefish caught with fixed gear, to be implemented no sooner than 1994. The quotas are defined as shares of the total allowable catch and are to be allocated to individuals and companies on the basis of their recent catch history. The fleet is divided into two main groups, freezer long-liners and catcher boats, with catcher boats subdivided into three groups. The individual fishing quotas, as they are designated in the management plan, may not be transferred outside the vessel group or between management areas. The share of the total quota that may be held by one company is limited to 1 percent for sablefish and 0.5 percent for halibut.

The quotas are defined as a "harvest privilege" in the fishery management plan and are said to be valid indefinitely. But they can also be modified or revoked at any time without compensation. In this respect, the system is similar to the system in Iceland, in which the question of duration has been left open so that quota allocations remain valid unless changed by law. The security of tenure necessary for long-term planning is thus nowhere near what it appears to be in New Zealand's or Australia's system—although it must be acknowledged that when New Zealand's system came under stress, it was fundamentally altered without compensation to quota holders.

Cases in which ITQs have been rejected

Fishery policy has been the subject of much debate in both Norway and the European Community, and both have recently published official reports discussing their future fishery policy (Norway 1992; and CEC 1992). The debate in Norway has centered on ITQs, and influential people in both the public administration and the industry have advocated adopting them, with certain limits on their transferability. The government has nevertheless rejected ITQs and instead adopted regulations such as common quotas, a device that has in every case turned out economically disastrous. The quotas have been rejected for both political and ideological reasons. The political reason resides in the clear majority among fishers opposed to ITQs. Why they oppose ITQs is not entirely clear, but ideological reasons, the fear of side effects, and misunderstanding all play a role. The ideological opposition among some people is the use of a market mechanism to allocate a resource that up to now has been commonly owned and to which access has been free. That some people could enrich themselves by selling a privilege they got for free appears repulsive to some people. Similar sentiments are common elsewhere, including Iceland.

Among the side effects feared is the concentration of fishing quotas, both geographically and in the hands of a few large companies. There is strong sentiment in Norway that favors maintaining the small fishing communities scattered along the entire coast. These communities are likely to be at a disadvantage in the competition for ITQs.

In a recent European Community policy document (CEC 1992) on fisheries, ITQs are not discussed at all. Yet they would seem to be precisely the tool that the Community needs to deal with the problems in its fishing industry. The Community's fisheries are plagued by a formidable overcapacity, financed in part by Community grants that did not take into account their long-term consequences. And tradable quotas would seem to be the way to reconcile the principle of not discriminating among citizens of the Community on the basis of nationality with the principle of fair allocations among nations. Quotas could be allocated initially on the principle of fairness, and thereafter the fish could be taken anywhere (provided it is from the right

stock), or quotas could be transferred temporarily or permanently.

The reason that ITQs are not mentioned in this document probably has to do with the problems the Community has had in implementing the national quotas that are a part of its present fishery policy. For the past ten years the Community's fishery management policy has been to set a total allowable catch for each stock and to allocate the catch among its member states according to a formula based mainly on historical catches in 1983, when the policy was first put into place. This system has been notorious for its weak enforcement. Some national authorities, in collaboration with local fishers, have refused to cooperate with the authorities in Brussels in providing timely and correct landing statistics. It is widely recognized that the landing statistics for some species are grossly incorrect. In addition, the conditions in a fishery often make it difficult to implement a quota policy. For example, incidental catches of groundfish are common in the pelagic fisheries providing raw material for the fish meal industry, and in the groundfish fishery many species are typically caught indiscriminately.

The Community proposes dealing with its overcapacity problem by licensing fishing vessels. A restrictive licensing policy could be used to limit the number of vessels. The pitfalls of this policy are well known, however; fishers are good at finding ways to increase the fishing power of the vessels for which they have obtained licenses. To some extent this can be overcome by licenses with detailed specifications (cargo capacity, engine power, amount of gear allowed). An advantage of this method is that monitoring is easy. Fishing vessels can be measured and counted, and their movement and, to some extent, their activity at sea can be monitored by radio transmitters. Even with all its imperfections, a licensing system could be preferable to an ITQ system that cannot be controlled and enforced.

Enforcement and monitoring are thus key considerations in evaluating an ITQ system. If enforcement and monitoring are difficult, such as in small-scale fisheries in which the catch can be landed with no elaborate landing or harbor facilities (by moonlight on a beach, for example) and sold to local consumers, an ITQ system would be useless. Another type of fishery in which ITQs would seem to be a poor choice is one in which it is difficult to make reasonably accurate predictions of the future size of the fish stock, with the stock "revealing its abundance" only as the fishing proceeds. In such circumstances it might be better to opt for real-time, on-the-spot management, monitoring the catch per unit of effort to gauge the size of the stock and thereby the allowable catch (provided the catch per unit of effort is a good indicator).

Under the present fishery policy of the European Community, member countries have considerable leeway in how they manage their fisheries. The national quotas are allocated at the Community level, but each member state can decide how it will use its quota. Denmark and the United Kingdom have both considered whether the ITQ system would be an appropriate choice of management system, and both have decided that it would not. In Denmark the opposition to ITQs came mostly from the fishers, who feared that ITQs would result in concentration of ownership and absentee ownership. The United Kingdom has plans to introduce transferable fishing licenses. An interesting aspect of the United Kingdom's management policy is that it allocates a part of the national fishing quota to the producer organizations—fishers associations that enjoy certain privileges within the EC system (price support, for example)—which then allocate the quota among their members.

Conclusion

The active debates being conducted on fishery management around the world, and the novel methods being tried, originate from the simple fact that the old order of free access is completely inadequate for managing fish resources in the modern world. Open access is certain to lead to the depletion of stocks, possibly beyond recovery, as appears to have happened in the case of the Atlanto-Scandian herring. Access to fish resources must be limited by some means.

It is not surprising that so radical an institutional innovation as limiting access to resources considered commonly owned is controversial. Some people seem to have difficulty even in grasping the need to do so. To better understand this viewpoint, it may be helpful for those of us who take private ownership of agricultural land for granted to look at a case in which private landownership is being established

in an unsupportive environment. Recently there was a report in the *Financial Times* (May 13, 1992) about a person who had bought a piece of land in the former Soviet Union. After he had planted grass on the land, the farmers from the neighboring collective farm drove their cows to pasture on the land, expressly refusing to recognize private ownership by tearing down signs that proclaimed it. This reaction is perhaps not surprising in a place in which a couple of generations have been brought up to believe that private land ownership is a characteristic of a system built on exploitation and doomed to collapse because of greed. The perspective of many people in the fishing industry with regard to fishery resources is not altogether different, although many would steadfastly deny any "collectivist" thinking in other areas.

If fishing is to survive and develop further as an industry that contributes efficiently to our material well-being and utilizes to the full the benefits of modern technology, it is imperative that access to fish resources be limited in a cost-efficient way. To secure public acceptance of restricted access, care must be taken to limit access in a way that ensures fairness both among individuals and across generations. This is a challenge, but a challenge that ITQs, if they can be implemented at all, seem capable of meeting. Indeed, the resistance to ITQs on pure equity grounds is somewhat surprising and it indicates that many who oppose them have not recognized their potential for ensuring fairness.

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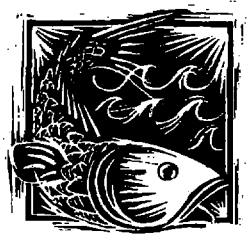


The Maritime Surveillance System of Nova Scotia, Canada

Paul E. Vandall, Jr.

13

For a fishery management regime to be effective, it must have a monitoring, control, and surveillance system. There are two primary reasons for this need:

1. A fishery management regime, by its nature, imposes restrictions, whether through licenses, quotas, or limits on gear.

2. Fishers the world over are a fiercely independent group of enterprising individuals. They search constantly for ways to get around restrictions and to enhance their incomes and profits. Their independence and enterprise were instrumental in developing fisheries. But where there has been free and open access to fisheries, these traits have led to cheating and illegal activity, and where access has been restricted, they have led to unfairness.

Most fishing nations agree that some portion of the economic rents provided by a fishery management regime should be used to ensure fairness and an equitable distribution of the available rents. This means that monitoring, control, and surveillance are required to enforce rules, regulations, and laws. Monitoring, control, and surveillance are also required to obtain the information needed to measure the effectiveness of a fishery management regime and the attainability of its objectives.

Having established that monitoring, control, and surveillance are an essential part of a fishery management regime, the next issues are who should carry out those tasks, and what should be done. The answers depend principally on the following:

- The type of fishery management system
- The government's organizational structure
- The availability of financial resources.

Financial resources should not be a problem if the fishery management regime is optimizing economic rents; the monitoring, control, and surveillance system should be able to sustain itself financially through licensing and fines if the revenues and costs are balanced, or through some redistribution of the economic rents.

In Canada, where the fishery management regime has called for quotas, restrictive licenses, seasonal closures, and gear limitations, there is a need for an extensive monitoring, control, and surveillance system. The system on Canada's east coast monitors quotas, catch, landings, activity, and gear. Some of this monitoring can be done on shore, but some needs to be done at sea during the fishing activity. Because of the cost of running a monitoring, control, and surveillance system at sea using ships, the at-sea component of monitoring has normally been split into ship-based and the more cost-effective aircraft-based monitoring.

Before Canada's fishery management regime was extended over its 200-mile exclusive economic zone, the Canadian Navy provided the aerial component of the monitoring, control, and surveillance system and the federal Department of Fisheries and Oceans provided the ship- and shore-based component. Soon after the introduction of the 200-mile limit, the Navy ceased to provide the aerial surveillance because of escalating costs, due to an aging fleet of Tracker aircraft, and a military reorganization that led to a reduction in aircraft. For a few years no aerial surveillance was carried out. To partially compensate for this, a fishery observer program was instituted for the foreign industrial fleet and the number of monitoring ships was increased. The

observer program involved placing an observer on board each foreign vessel for the entire time the vessel was active in the Canadian exclusive economic zone. The observers were financed through the sale of licenses to the vessels' countries of origin, and the observers carried out all the required monitoring functions while on board.

Within a few years, however, it was realized that an aerial surveillance system was once again needed. The existing monitoring, control, and surveillance system was not providing adequate surveillance of the domestic fleet, and the incidence of illegal activity was on the rise. The Department of Fisheries and Oceans began searching for a new solution. The Navy (now part of the unified Armed Forces) was ruled out as a provider of the services for two reasons. First, it did not have the required aircraft or surveillance equipment. And second, even if the Armed Forces had the right equipment, fishery surveillance would not receive the necessary priority, and the Department of Fisheries and Oceans would have little control over the timing and coverage of surveillance flights—as was the case when the Navy had performed the task in earlier years.

The Department of Fisheries and Oceans decided to contract out the aerial surveillance when it realized that the private sector had the capability to provide it. Atlantic Airways, a division of Provincial Airlines, was selected for the surveillance work about five years ago and has since been operating three aircraft off Canada's east coast.

Surveillance system

The Atlantic Airways surveillance system consists of five major components:

- The aircraft—Super King Air 200
- Search radar—Litton APS-504(V)5
- Precise navigational system—integrated Global Positioning System (GPS) and Loran system
- Reconnaissance camera—Agiflite
- Data management system—Atlantic Airways Airborne Data Acquisition and Management (ADAM) system.

Aircraft

The Super King Air 200 was selected because it has a proven offshore capability, its payload is sufficient to carry all necessary equipment, and it provides an efficient work environment for a crew of six. The King Air (see photo) is capable of handling the worst maritime weather; it operates regardless of icing, freezing, precipitation, or fog. The Super King Air 200 can be counted on for routine surveillance in any weather in which fishing takes place, even with visibility reduced by fog to 100 meters. This aircraft combines fast dash speed with high-altitude operation (up to 11,000 meters) and excellent low-altitude performance (down to 15 meters), which is essential for identifying fishing vessels. The King Air 200 has an outstanding reputation for dispatch reliability. Over the past five years, only one surveillance flight has been delayed and then only for an hour.

Search radar

The Litton APS-504(V)5 incorporates a military anti-submarine watch technology to produce excellent small detection capability with a 370-kilometer range in high seas (the radar antenna dome can be seen in the first photo, on the underbelly aft of the wings, and the radar controls and output displays can be seen in the second photo). This lightweight, state-of-the-art radar has all the essential features for fishery surveillance:

- Ability to scan different sectors of the compass
- Ability to scan sixteen frequencies randomly
- High resolution
- High detection capability in high seas
- Digital readout on scope
- Navigation System Interface
- Data Management System Interface.

One of the more valuable features of the APS-504(V)5 is its ability to make use of all flight time. Within minutes of takeoff it is providing surveillance data. In five minutes the aircraft can climb to 3,000 meters, giving the radar a 220-kilometer range.

Integrated navigation system

A computer-controlled navigation system, the CCNS-4 (see forward of the copilot in the third photo), is interfaced with the radar, the data management system, and the cockpit navigation system. The CCNS-4 provides the precise positional accuracy essential for fishery surveillance. The CCNS-4 is ca-

pable of integrating navigational sensor inputs from GPS, Loran, Rho/Rho, and Loran C hyperbolic and providing an absolute positional error of less than half a kilometer.

The CCNS-4 was designed for airborne navigation and is used in applications, such as aerial photography, in which precise positional accuracy is required. It has also been used and proved effective in many remote areas of the world.

Camera

The fishery surveillance aircraft can be equipped with a variety of still and video cameras. The primary camera system is the Agiflite specialist aerial camera (see diagram), the only photo reconnaissance system in the world designed to be hand-held, and tested to full military specifications. The Agiflite is interfaced with the navigation and data management system and provides the visual record of fishing activity required for successful prosecutions. All photographs are annotated with time and position from the CCNS-4.

Data management system

The Airborne Data Acquisition and Management (ADAM) system, designed and built by Atlantic Airways, is the heart of the entire surveillance equipment package (see photo). The system was developed to handle all the data and information requirements of the aircrew and the fishery inspectors, both in the air and on the ground. With digital interfaces with the surveillance radar, navigational equipment, and photographic equipment, the ADAM system now acts as the information exchange on board the surveillance aircraft, providing real-time data for flight management.

The ADAM system provides the flight crew with a real-time Mercator projection map, displaying all contacts in relation to various land masses as well as other important geographic features, such as depth contours, fishing zones, and closed fishing areas (see appendix). These and other vector-based graphical overlays are essential for determining and identifying the contacts acquired by the surveillance radar and navigational equipment. The ability to view the identified and unidentified contacts in this computer graphic form helps the flight crew to better determine whether a vessel is in an area in which fishing activities are illegal. In addition, the computer operator has the option of viewing the navigational and contact information in a tabulated format, which permits a quick overview of the precise contact positions (see detailed navigation report in the appendix).

The ADAM system eliminates the need to spend time manually plotting all of the radar contacts acquired. As contacts are identified, they are automatically added to the computer's data base through a direct digital communication link to the radar's current cursor position. This allows the quick and accurate positioning of all contacts. In addition, the system produces maps and tabulated reports in hard copy in real time. These reports and maps provide flight crews with an overview of the flight thus far. These reports can be faxed, using a high-frequency facsimile transceiver, to other support facilities, such as surface vessels or a shore base.

At the end of a mission the ADAM system automatically produces a flight data sheet, a patrol report, a navigational accuracy report, a closed area report, a target summary report for all identified or unidentified targets, a fishing vessel summary, a commercial vessel summary, and, finally, a violation report (see appendix for a selected sample). Historical data stored and archived by the ADAM system can be retrieved and analyzed for planning and management purposes. The data also can be called up during a flight to examine the geographical pattern and frequency of activity of any fishing vessel.

Costs

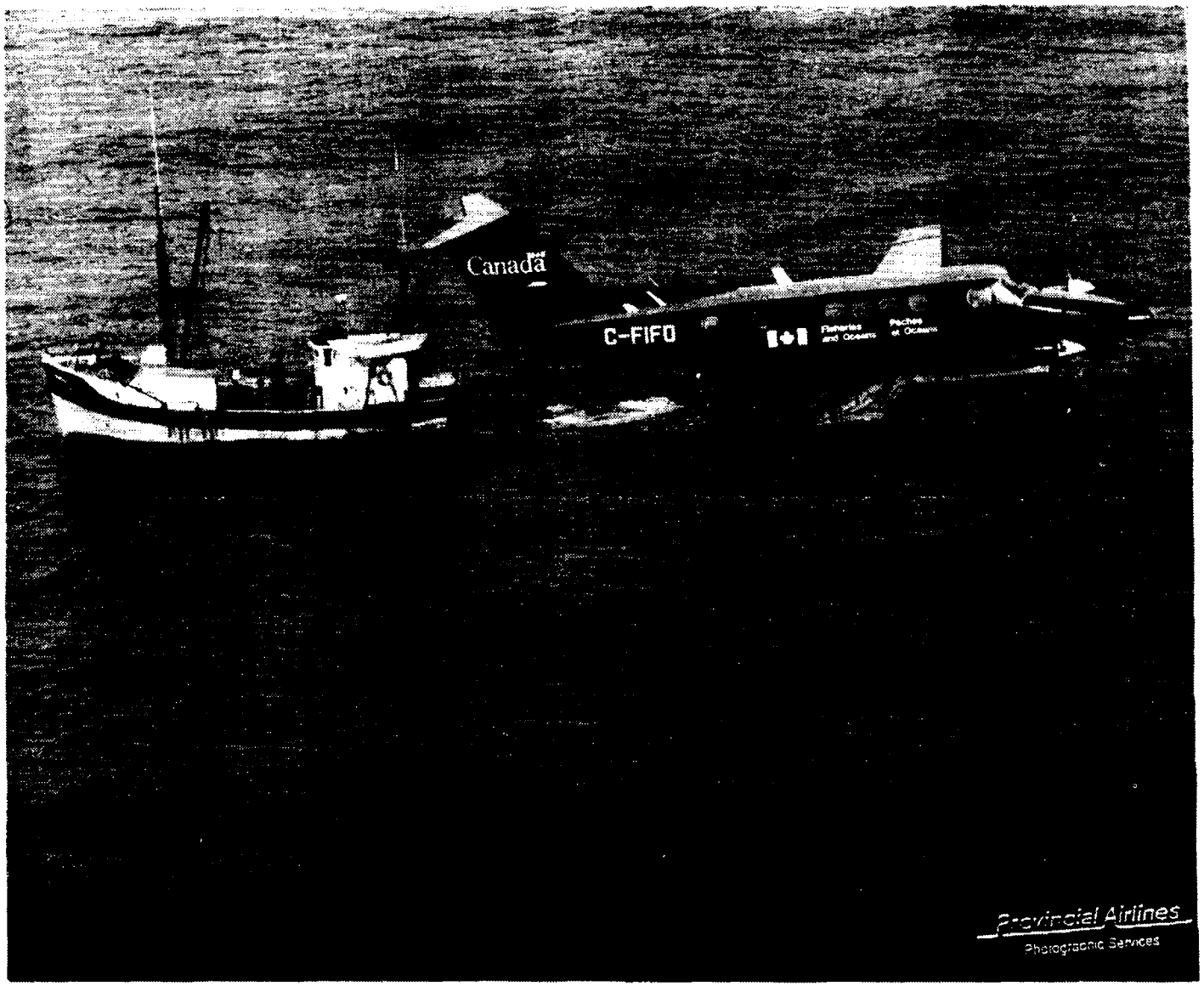
The aerial surveillance system in use off Canada's east coast involves three Super King Air aircraft, all equipped as described above. Each aircraft has a usable operating cycle of 2,000 hours a year and costs about Can$3,800 an hour to operate. Each aircraft requires a crew of about eight for flying and maintenance.

Success of the surveillance system

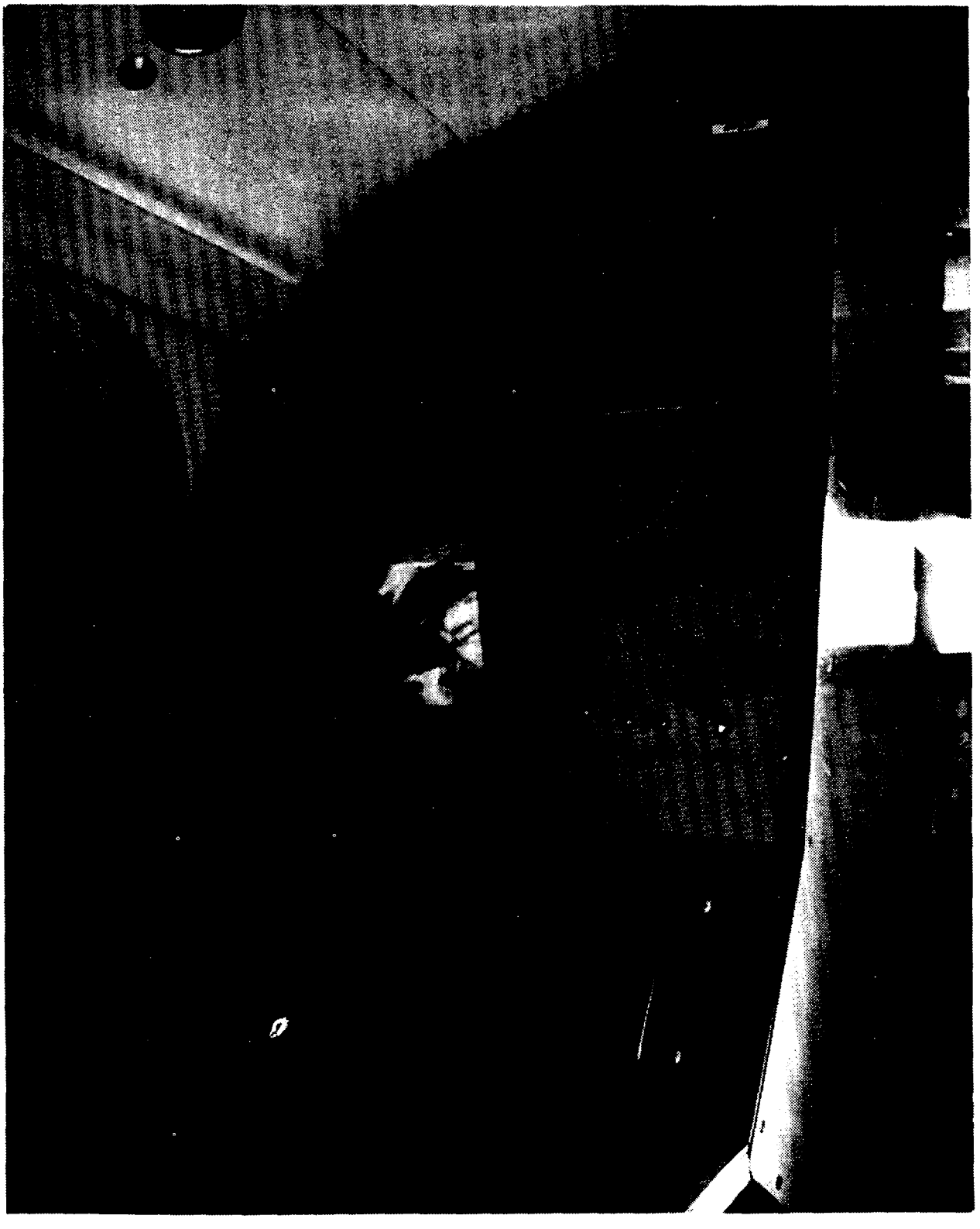
The surveillance system has been very successful at measuring catch effort, locating nursery areas, and locating specific fish stocks. The system also has been shown to be very effective at detecting the use of il-

legal gear, fishing in closed areas, fishing without a license by domestic and international vessels, illegal fishing activity, and illegal use of vessels. Each of the three aircraft has successfully prosecuted between 70 and 100 fishing violations a year, with the number of prosecutions decreasing with time. No legal case has yet been lost in the courts—the accuracy and quality of the data collected have survived all challenges.

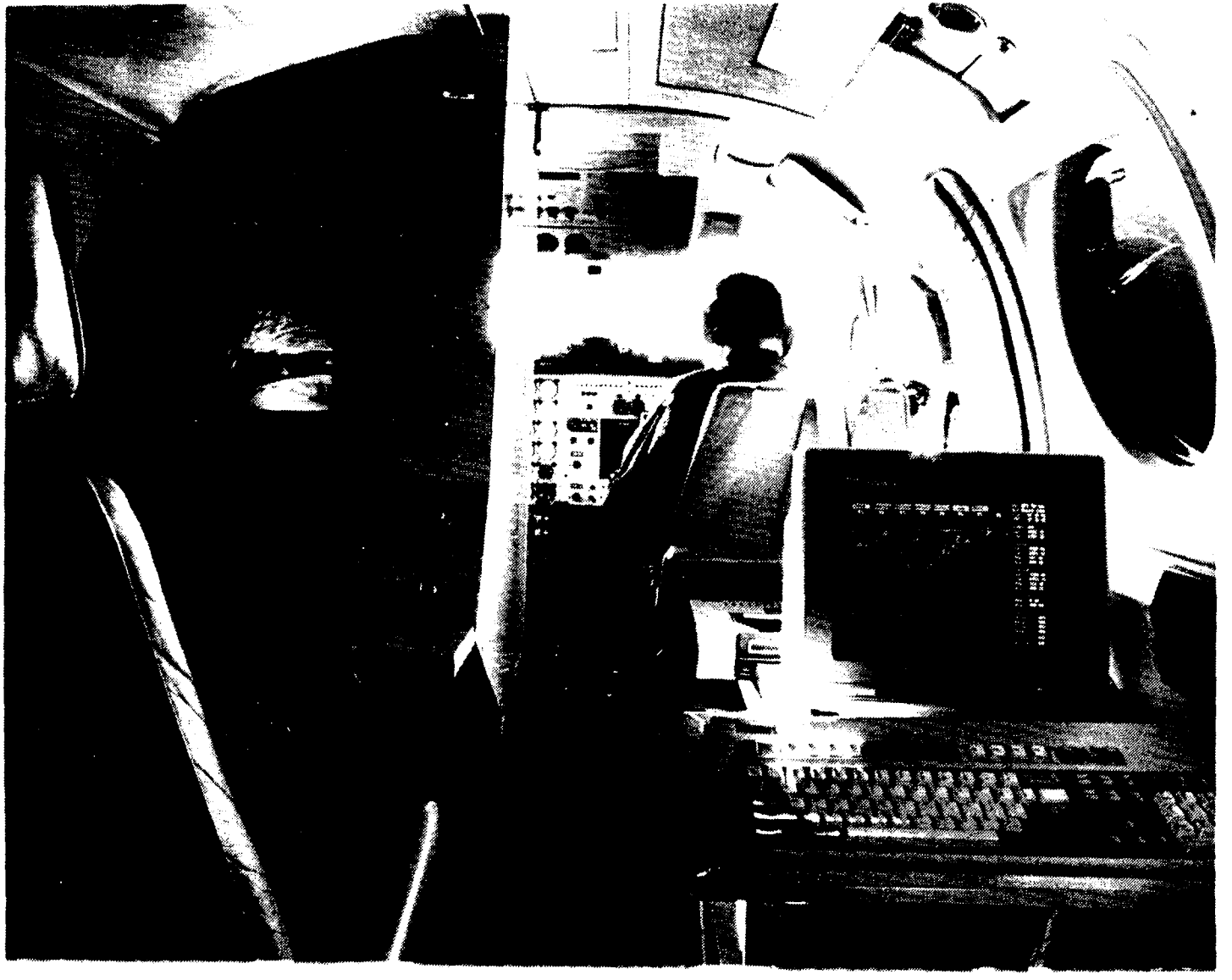
Super King Air 200 plane



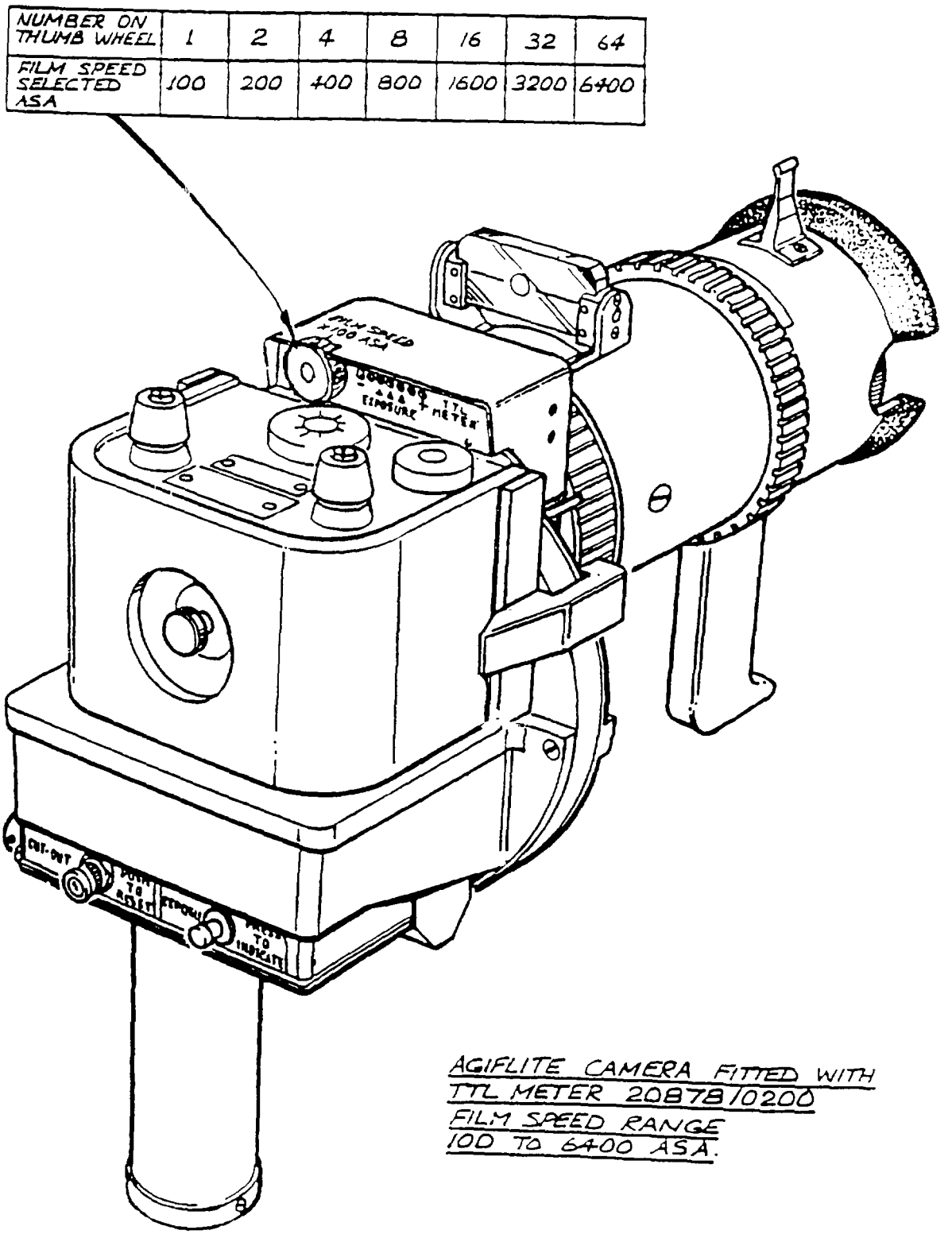
Radar controls and output displays in the Super King Air 200



Computer-controlled navigation system in the Super King Air 200



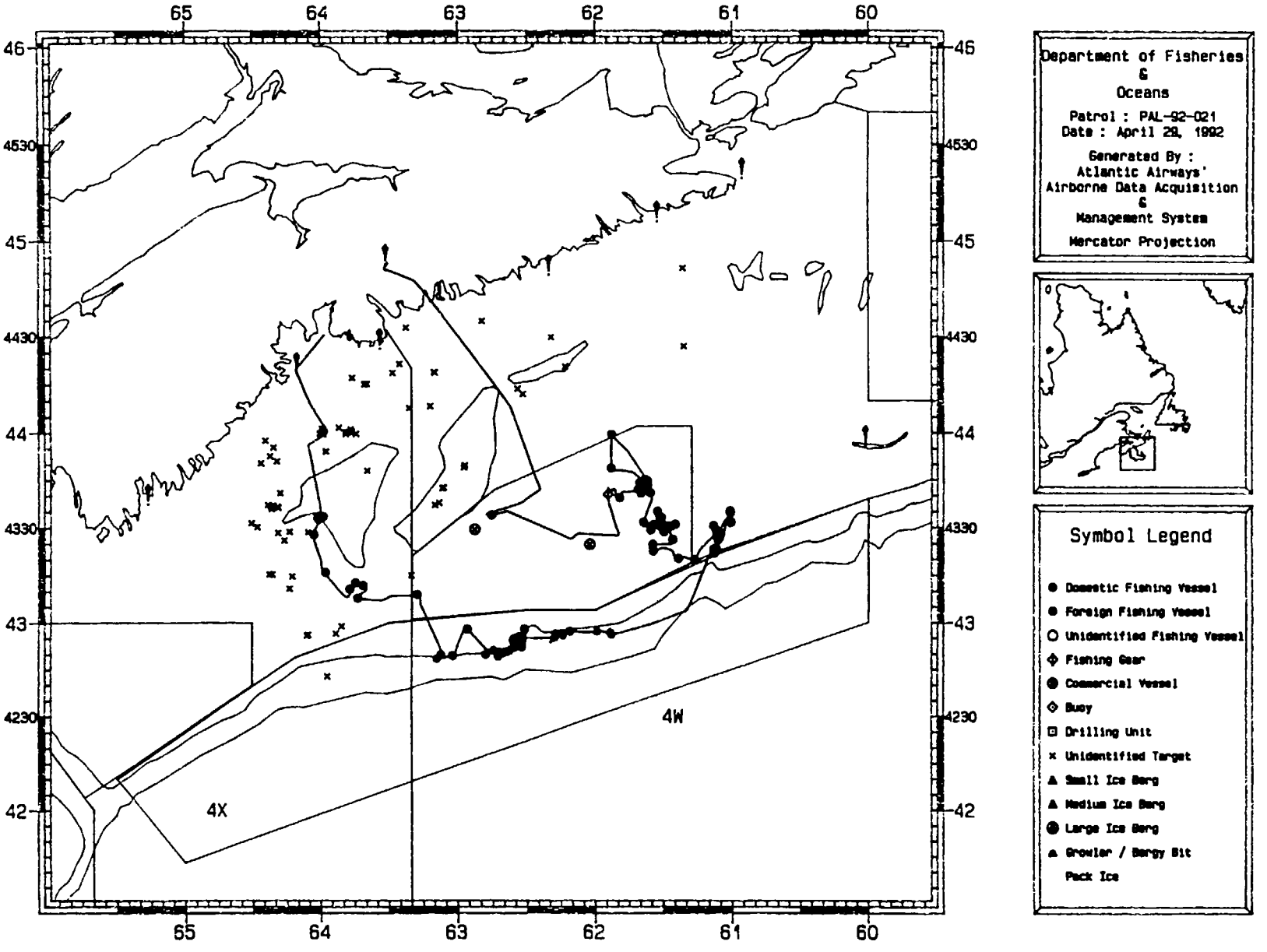
Agiflite specialist aerial camera



AGIFLITE CAMERA FITTED WITH TTL METER 20878/0200 FILM SPEED RANGE 100 TO 6400 ASA.

Airborne Data Acquisition and Management system

Appendix Reports produced by the Airborne Data Acquisition and Management system



Atlantic Airways, CCNS Detailed Navigation Report

Patrol: PAL–92–021
Tasked area: 4X/5ZE Date: April 29, 1992

System data		*GPS data*		*Loran C receiver*					
Date:	93/04/29	Time of ref:	13:43:50	GRI: 5930	TD	Mode	SWR	Step	ASF
		Position:	N 4330.18	M: (MTOA)	03790.24	4	67	N	
Time:	13:43:49		W 06127.03	V:					
		Altitude:	00021 m	W:					
Position:	N 4330.38	Ground speed:	064.8 m/s	X:	13520.66	4	78	N	+3.6
	W 06127.15	Track:	058.2°	Y:	29146.24	4	76	N	+2.9
				Z:	43080.09	3	03	N	+0.7
		Sat / Eph / SNR / FH: 1		GRI: 9960	TD	Mode	SNR	Step	ASF
		21 Y 7.5		M: (MTOA)	01123.01	4	61	N	
Ground speed:	068.5 m/s	14 Y 16.0		V:					
		15 Y 6.5		W:	11708.44	4	68	N	–0.4
Track:	061.1°	20 Y 19.5		X:	25271.50	4	67	N	+2.8
		25 Y 21.0		Y:	43938.55	3	07	N	–0.3
Air speed:	127.0 kts	13 Y 10.5		Z:	60324.01	3	00	N	–0.3

Target Id number: V026
Target Id string: VF–
Comments: PHT–026
Ruff & Ready
100350

Atlantic Airways, Department of Fisheries and Oceans, Closed Area Report

Patrol: PAL–92–021
Tasked area: 4X/5ZE Date: April 29, 1992

Closed area	*Georges*	*Brown*	*Nursery*	*Silver Hake*	*White Head*	*Total*
Time (hrs)			1.7	1.2		2.9
Domestic fishing vessels			27	5		32
Foreign fishing vessels				28		28
Unidentified fishing vessels			1			1
Commercial vessels			2			2
Fishing gear			1			1
Icebergs						0
Other identifications						0
Unidentified targets				1		1
Total	0	0	31	34	0	65

Comments:

Violation Report (No. 918)

Flight number: PAL–92–021
Tasked area: 4x/5ZE Date: April 29, 1992

Vessel information

Vessel name:	Ruff & Ready
Side Number:	100350
Callsign:	
Nation:	CA
Type:	LL–
Course – speed:	120–
Distance:	On top
Time (UTC):	134424
Vessel position	Latitude: N 4330.38 Longitude: W 06127.15
Corrected position	Latitude: N 4330.32 Longitude: W 06127.17 The navigation check at Cross Island, 163328 (UTC), was used to calculate the corrected position of the vessel.

Photograph information

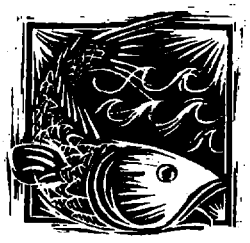
PHT.–026

Environmental information

Visibility: 15 NM+ Ceiling: Clear
Sea state: 1 Wind: 130–10

Navigation information

		Checkpoint position		*CCNS4 position*		*Correction*	
Reference checkpoint	*Time (UTC)*	*Latitude*	*Longitude*	*Latitude*	*Longitude*	*Range*	*Bearing*
Halifax survey	114108	N4452.60	W06331.27	N4452.59	W06331.24	0.02	295.20
Runway threshold 06	114544	N4452.15	W06331.50	N4452.11	W06331.54	0.05	035.30
Cross Island	163328	N4418.71	W06410.13	N4418.77	W06410.11	0.06	193.40



Conclusions and Recommendations

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The objective of this Symposium on Fishery Resources Management was to present and analyze the experience of a number of countries in managing their fishery resources, especially countries in which the sector's level of development or its problems are similar to those in Peru. It was intended that the results of this analysis could then be incorporated into the discussions on the legal framework for Peru's fishery sector.

Summary

The presentations at the symposium suggest that the exploitation of fishery resources in different parts of the world has followed a similar course. Initially, the fishing industry developed around an idea that the resources were so abundant that they were inexhaustible. The resulting free-for-all led to overexpansion of the industry and the overexploitation of fish resources.

The solutions to these problems have varied, but in general they have initially involved a reduction in activity, with the aim first of restricting exploitation and then of limiting catches directly. This kind of management has been called restricted access and takes different forms, including overall catch quotas, vessel quotas, and, finally, individual transferable quotas. A common denominator in each of these is an effort to avoid competition among vessel operators, which leads to overexploitation and overcapitalization.

The best solution to overexploitation is to give the responsibility for managing the resources to the fishery operators themselves, which promotes responsible management.

Peru's experience conforms to the general pattern of fishery development, although its fisheries have special features that make some aspects of the policies pursued in other countries not directly applicable in Peru.

The general picture that has come out of this symposium leads to the conclusions and recommendations outlined below.

Conclusions

1. Experience in different countries indicates that an effective fishery management system must include the following components:
   - An appropriate legal framework
   - Information on resources (research)
   - A monitoring, control, and supervision system.

2. Peru's fishing industry is young and diversifying, and it is exploiting new resources and areas. The organization of its fishing operations should be consistent with this state of development and with current trends in the sector.

3. Peru's fishery resources are part of the country's shared heritage, and both the state and the resource users have an important role to play in their integrated and rational management. These roles should be emphasized in the sector's management system.

4. Some countries have oriented their fishery sector activities mainly toward products with high

value added, focusing on exports in order to earn foreign exchange. This strategy could be appropriate for Peru, especially for its underexploited or potential resources.

5. The importance of managing fish stocks distributed over different national zones and in international waters must be recognized. And if the objective of conserving such shared resources while enjoying the benefits from their exploitation is to be attained, equity among the countries sharing the fish stocks must be ensured through international cooperative mechanisms.

6. Given the potential of the fishery sector to generate employment, food, and foreign exchange for Peru, and the need for integrated management of all sectors of the economy, fishery development in Peru must mesh with the country's general economic development. This linkage is essential to guaranteeing orderly, rational, and sustainable development of Peru's fishery resources in the twenty-first century.

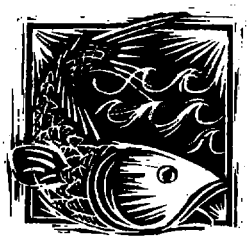
Recommendations

1. The new legal framework governing fisheries in Peru must provide for active participation by all those involved in the sector in the management of the fishery resources.

2. Because of the tradition and the significance of Peru's fisheries, the reorganization of the sector must take into account the particular problems of each kind of fishery and the characteristics of its resources. For this purpose, Peru should make use of all the relevant international experience that has been shared at this meeting and at earlier ones.

3. The suitability of individual transferable quotas for each type of catch should be examined on a case-by-case basis.

4. World Bank support for this meeting was important, and it is suggested that the Bank continue its useful and timely backing for the activities that will be necessary for the reorganization and development of Peru's fisheries.



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