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Managing Fish

Ten Case Studies from Canada's Pacific Coast

Managing Fish

Ten Case Studies from Canada's Pacific Coast

Laura Jones

with Miriam Bixby

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About the authors

Laura Jones

Laura Jones is Vice-President, British Columbia and Yukon, the Canadian Federation of Independent Business (CFIB). Prior to joining the CFIB, she was Director of Environment and Regulatory Studies at The Fraser Institute, which she joined in 1996 to develop the Institute's policy on the environment. She has written a number of public-policy studies including *Canada's Regulatory Burden* and *Crying Wolf? Public Policy on Endangered Species in Canada*, and was co-author of four editions of *Environmental Indicators*. She has edited five books including *Safe Enough? Managing Risk and Regulation* and *Fish or Cut Bait! The Case for Individual Transferable Quotas in the Salmon Fishery of British Columbia*, and co-ordinated The Fraser Institute's annual survey of mining companies. She has also published articles in *The Vancouver Sun*, the *Ottawa Citizen*, and the *National Post* and testified before Parliamentary and Congressional committees on proposed legislation. Ms Jones received her B.A. in Economics from Mount Holyoke College in Massachusetts, and her M.A. in Economics from Simon Fraser University in British Columbia. In addition to her work at The Fraser Institute, for the past nine years she has taught introductory economics at several colleges including the British Columbia Institute of Technology and Coquitlam College.

Miriam Bixby

Miriam Bixby has a B.A. in Political Science with a minor in Economics from the University of Calgary, an MA in Economics, with a specialization in the environment, from the University of Toronto, and is now working towards a Ph.D. in Resource Management and Environmental Studies at the University of British Columbia. She was an intern at The Fraser Institute in the summer of 2000 and worked there as a Research Economist until July 2001.

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Foreword

by David R. Boyes, MSc
Master, CFV Fearless II

A chance encounter with a high school friend in 1977 led me into a career in fishing. After catching up a bit over a beer or two, he said, "Are you working?" and, when I said, "No," asked, "Want to go roe herring fishing"? "What's that?" and then "Why not?" and here I am, still doing it.

In those days one roe herring licence allowed you to fish all the openings you could make, "weather be damned," from one end of the coast to the other. Prices were just starting to spike for the first time and, as the fishery became increasingly lucrative, effort ramped up and the DFO began to respond with controls to rein in the catch, which usually exceeded area TACs. Gear limitations, area restrictions, shorter openings, licence stacking—each year more measures to limit the catch and each year fishermen responding with innovations so they could stay competitive. It was a pattern repeated in all fisheries on Canada's Pacific coast throughout the '80s but, in '77, all I saw was an exciting and possibly lucrative way of life. The competition for the fish was fierce, and intoxicating, for a young man. Coming in with a good load, you felt like a king. Of course, there were the bad trips as well, but "pain has no memory" and we tend to remember only the triumphs. A lot has changed in the fisheries of British Columbia since those days, including my opinions on management systems, as I'll relate.

I got into salmon trolling that same year out of Ucluelet with a little old fixer-upper, the *Fortune*, powered by a chronically ailing Chrysler Crown and found that fishery just as exciting. The little towns on the west coast of Vancouver Island were buzzing with gleaming trollers coming and going; everyone was making money and the season was almost eight months long. Not any more. Declines in the stock (now reversing themselves dramatically) and

the coming of farmed salmon, which hammered prices, as well as reallocation of Chinook and Coho to the sports-charter sector humbled this once proud fleet. Along the way, the usual succession of regulations to limit effort and, thereby, catch came in year by year until by 2000 trollers had a season measured in days. Marketing the fish is now one of the key problems in the salmon fishery: our present system of "openings" lasting a few days or hours depending on the gear type, tends to glut, and then starve, the market with fish that are often of mixed quality as a result of the panic to catch them before the next guy. This worked, after a fashion, before salmon farming brought a seamless supply of cosmetically perfect fish to the marketplace. Now it's just dumb.

I started fishing halibut as a deckhand in '85 or 86. Stocks were rebounding after a period of low catches caused by several factors and the decline in salmon revenues were causing fishermen to concentrate on other species. With better electronics (to locate the fish), more and better gear (circle hooks), and bigger crews, the halibut fishery went down the well-trodden path to shorter and more and more frantic seasons. In the end, we were down to a few days for the year, gear wars were intense on the most productive spots, prices had plunged as buyers struggled to deal with millions of pounds of fish delivered all at once, and no one was making much. Fishermen had no choice but to sail, no matter what the weather, and the storm of 1986, which sank five boats and drowned ten men, was the final straw. Some of the more perceptive fishermen—I was not among them—began to ask if there wasn't a better way, if controls on catch rather than on fishing time might not return some sanity, safety, and profitability to the halibut fishery. On the radio, the docks, and in the coffee shops, fishermen chewed over the shape of a new way of doing business.

Luckily, at that time DFO's groundfish manager was Bruce Turris, an innovative, energetic, and courageous bureaucrat who was willing to champion a major change in management methodology from effort (input) controls to catch (output) controls in the halibut fishery. Sablefish was on a parallel course and in 1990 management by ITQs (individual transferable quotas) was introduced to both fisheries on a pilot basis. This was a very contentious change at the time, engendering bitter debate, but a vote of licence holders gave it a narrow pass. Several years later, when another vote was held to assess satisfaction with the new system, some 90% approved and 13 years later the program continues, with the results detailed in the case studies below, and complete industry support.

The roe herring fishery—where all this started for me—was meanwhile winding down its own path to competitive fishing calamity. Gillnet fishermen were using nets with smaller and smaller mesh, which would catch juvenile as well as adult fish. Roe yields per ton were falling as a result, because only the adults have full-sized, mature roe; the price was falling, of course,

in lock-step. Fishermen continuing to use nets of legal size found themselves coming up short of the average catch rate. Bigger and faster skiffs were built each year in an effort to get to the fish first. Profits were slim and often dissipated in capital upgrades. The roe herring seine fishery had its own problems, going chronically over its quota even with openings that were as short as 15 minutes at times. Years of rancorous debate in the Herring Industry Advisory Board and an ultimatum from DFO Ottawa regarding ongoing catch overages led to a pilot gillnet ITQ fishery in Barclay Sound in 1997. The success of this pilot for fishermen and management alike led to the adoption of ITQ management for the fishery at large and, although some mourn the dash and excitement of the derby style fishery, few wish to revisit it.

The 2002 season saw the first pilot salmon IQ projects—seines in Barklay Sound and trollers in area H. These are continuing in 2003 and, although salmon by its nature is more difficult to manage with output controls than the groundfish fisheries, I have no doubt that all three gears will be fishing IQ coastwide in a few more years, the last major finfish fishery to come on board.

I've related these little stories of mine to illustrate one fisherman's conversion from an ardently competitive "derby-style" fisherman to one who advocates the IQ philosophy. I've seen both sides of the fence in a number of fisheries from the perspectives of both a fisherman and a board member of numerous advisory and management groups. No management system is flawless but IQs are, in my experience, a big step forwards in the key areas of conservation and stewardship, economic viability of the fleets, and safety. The proof is there, for all who will see it, laid out in the case studies that make up this book.

Managing Fish

Ten Case Studies from Canada's Pacific Coast

Introduction

Headlines about fisheries fiascos in Canada are nothing new: the fisheries that have been historically most important, salmon on the west coast and cod on the east coast, have been in trouble for years. In 1991, the cod stocks collapsed and a fishing moratorium, which has yet to be lifted, was declared. Before the collapse of the cod stocks, it was clear that there was substantial over-capacity and over-fishing in the Atlantic fisheries. It has been estimated that in the near-shore Scotia-Fundy fleet alone there was four times the fleet capacity required to harvest the total catch (Grafton 1996: 2). On the Pacific coast, fears that salmon stocks were headed towards a similar collapse led the Minister of Fisheries and Oceans to introduce the Pacific Salmon Revitalization Plan in 1996. The plan restricted fishing areas and bought out over 40% of the existing licenses. Despite the 1996 initiative, conservation concerns about some stocks of Chinook, Coho, and Sockeye salmon continue.

Economic woes also plague Canada's highest-profile fisheries. On the Pacific coast, poor salmon returns, fleet over-capitalization, and a fall in salmon prices due to the increased supply of farmed fish and wild fish from Alaska, have led to substantial economic losses in the fishery. This decline in income translated into increases in Employment Insurance (EI) payments to fishermen. Estimates from Human Resources Development Canada indicate that $1.85 was paid out for every $1 in premiums collected in the Pacific Region fishing sector in the early 1990s. On the east coast, the situation was more dire: before the cod closure, fishermen were receiving an average of $26 in EI payments for every $1 paid in premiums (Grafton 1996: 1). These and other problems, such as unresolved disputes among aboriginal, sports, and commercial fishermen over how much fish each group should be allowed to harvest, have brought the competence of our fisheries managers into question.

What have not made the headlines, however, are management changes that have saved many of Canada's smaller fisheries. In many of those cases, desperation forced fisheries managers and fishermen to make a radical change in management: rather than controlling the catch through regulations that applied to fishermen on the fishing grounds, the catch is allocated before boats set out, giving fishermen a more direct stake in their fisheries by giving them a share in the catch. These shares are often called "individual quotas" (IQs or, sometimes, just "quotas").[1] This book explains the use, and evaluates the effectiveness, of individual quotas in fisheries on Canada's Pacific coast through case studies of each fishery where individual quotas have been implemented. In each case (with the exception of the herring spawn-on-kelp fishery, which started under a form of IQ management), we evaluate whether introducing stronger property rights led to an improvement or deterioration in the management of the fishery by gauging conservation, economic viability, and working conditions before and after the introduction of individual quotas. In the conclusion, we examine the main criticisms of individual quota systems, assess how relevant those criticisms have been for fisheries on the Pacific coast of Canada, and make some policy recommendations.

The evolution of fisheries management

From the late 1800s to the middle of the twentieth century, Canadian fisheries were completely unregulated—anyone who wanted to fish could and the only limit on catch was human ingenuity. This system is known as "open access." As long as the ability to catch fish is not so great as to threaten the future of fisheries under open access, conservation is not a concern. But, by the beginning of the twentieth century overfishing was threatening the survival of many species. Open access also created an economic problem, as economist Dr. Peter Pearse explains:

> As long as access was uncontrolled, profitable fisheries would attract more fishers and more catching power, even if fleets were already greater than needed to harvest the available catch, until profits were dissipated in higher costs. Thus fishing industries were condemned to a kind of Malthusian equilibrium, evidenced in the almost universally low incomes of fishermen. (Pearse 1996: 3)

As conservation and economic problems in unregulated fisheries in Canada and in other countries around the world became increasingly obvious, governments began to intervene by restricting entry into fisheries. In the late 1960s, the Canadian government restricted entry to the salmon fishery by

issuing licenses only to existing salmon fishermen. By the middle of the 1980s, limited-entry licensing applied to all major fisheries on both coasts of Canada (Pearse 1996: 4).

Limiting entry was not enough to resolve fisheries problems, however, because it does not address the underlying problem in the open-access fishery. Fishermen still face the short-term incentive to catch as many fish as possible before someone else does. To improve their prospects in this race to claim fish, fishermen maximize the power of their boats and industry-wide over-investment results, as operating costs increase without any corresponding increase in revenue. In most industries, competition is seen as beneficial, bringing lower prices and higher quality to consumers. In the fisheries, however, catches are limited so that, beyond a certain point, more powerful boats and more sophisticated equipment do not add to the total catch. Any additional time and effort spent on the fishing grounds that does not add to the catch is clearly wasteful, as it could be put to use on some other productive endeavour. Over-capitalization, then, has two negative effects: it reduces the profitability of a fishery and it increases the likelihood of overfishing. To control the catching power of over-capitalized fleets, fisheries managers in Canada and in other fishing nations around the world have introduced a host of additional regulations aimed at reducing or restricting fishing effort.

In Canadian fisheries, managers have shortened seasons, restricted fishing areas, imposed limits on the harvestable size of various species, introduced limitations on boat length, regulated gear and equipment, and bought back licenses. This strategy of trying to control the effort that goes into fishing has proved ineffective and wasteful as fishermen have found ways around new regulations. For example, when length limits were imposed on boats in an attempt to reduce the number of fish a boat could take in, boats with wider and deeper hulls came into use. As seasons got shorter, the size of crews increased. Regulations aimed at limiting fishing power tend to reduce the number of fish caught only temporarily, during the lag between the time a new regulation is introduced and the time fishermen find an innovative way around the new regulation.

As fishermen have learned to circumvent restrictions and as technology has continued to improve, fisheries managers have responded by increasing restrictions on fishing—including shortening seasons or openings. Shorter fishing periods exacerbate economic problems in fisheries by creating supply gluts, which lead to low prices for fishermen and limited availability of fresh fish for consumers. Further, shorter fishing periods negatively affect product quality as less care is taken when handling the catch. The race for fish in short seasons has also created safety problems in many fisheries as fishermen feel compelled to fish in unsafe weather conditions so as not to lose the opportunity to get a share of the catch.

Property rights—a promising solution?

Fisheries managers and fishermen around the world have recognized that depleted stocks, high fishing costs, and low prices for landed fish are a direct result of the poor incentives created by trying to regulate the effort that goes into fishing. As a result, managers in many fisheries have switched from indirect control of the number of fish harvested through restrictions upon effort to direct control of the number of fish caught by allocating property rights to the fish, in the form of an individual quota, *before* they are caught. Although there are variations in the way individual quota systems are set up (and slight variations in the names given to these systems), the basic idea is to give participants a right to a portion of the total allowable catch (TAC).[2] The total allowable catch is the quantity of fish that biologists determine can be sustainably harvested in a season. Once the TAC for the industry is set, each license holder is allocated a portion of the total catch. With secure access to a share of the resource, fishermen are not competing with other fishermen to maximize catch in a short period of time and, as long as there is adequate enforcement, there is no longer a need to race for the fish. This has several important theoretical implications.

1 Individual quotas eliminate inefficient capitalization and increase profitability. Instead of working towards maximizing their ability to catch a lot of fish in a short period of time before other fishers catch them, fishermen can concentrate on maximizing their profits by increasing the value of their catch and keeping their costs low. The value of the catch is determined by a number of variables including quality, selectivity, product form and timing.

2 Quotas usually mean fishermen can get higher prices for their catch as they spend more time marketing their product. In addition, the longer fishing seasons that often accompany quotas mean that fish can be landed over a longer period of time and sold fresh rather than frozen. The profit margin on fresh fish is generally higher.

3 Directly setting a limit on the number of fish that each fisherman can take is a more effective way to conserve resources than indirectly limiting the number of fish caught through effort controls. Giving each fisherman a direct stake in the industry also gives him an additional incentive to conserve fish and to invest in new research initiatives. IQs create an incentive to increase or maintain the value of the fishery over time because the value of the fishery directly affects the value of the IQ.

4 A system of individual transferable quotas can help eliminate the need to subsidize fisheries. First, since individual quota shares can be bought and sold,

the most efficient fishers will acquire more fishing rights (IQs) from less efficient fishers. This is preferable to having unprofitable fishermen stay in the industry courtesy of Employment Insurance subsidies from taxpayers or be bought out through a government buy-back program funded by taxpayers.

5 Fishing seasons are safer under a quota system. Because fishermen are guaranteed a portion of the catch, they can fish at a more leisurely pace and do not feel compelled to fish in dangerous weather conditions.

6 Once an initial quota allocation has been made, there is a market mechanism to resolve disputes among commercial, sports, and aboriginal fisheries. These sectors can buy quotas from each other. This will reveal where the highest value lies and will eliminate political fights over fishing rights and create more certainty for those in the industry. IQs could also facilitate treaty negotiations as they give a clear sense of what is being allocated.

Despite these benefits, management via property rights remains controversial. Its critics include academics, environmental groups, local community groups, union representatives, and even fishermen themselves. Their concerns include conservation, reduced employment, corporate concentration, and the creation of large "windfall gains" for some fishermen. These concerns will be discussed more fully in the conclusion (page 0000).

Ten case studies on the management of fisheries on Canada's Pacific coast

The use of property rights to manage fisheries

The theoretical benefits of individual quotas have been put to the test since the early 1970s when their use began to spread. Individual quota systems are now used to manage over 200 ocean fisheries around the world (Arnason 1996: 3). Iceland, for example, first introduced a quota system for their herring fishery in 1975. Since the early 1990s, all major fisheries in Iceland have operated successfully under individual quotas (Runolfsson 1996: 34). Four other fishing nations, Australia, Greenland, the Netherlands, and New Zealand, also use quotas to manage most of their fishing activity. Other countries, including Canada, now use individual quotas to manage many of their fisheries.

The use of property rights in ten fisheries on Canada's Pacific coast

Some form of property-rights management has now been used in ten fisheries on the Pacific coast of Canada: herring spawn-on-kelp (SOK) (1975); abalone (1979); geoduck (1989); sablefish (1990); halibut (1991); green sea

urchins (1994); red sea urchins (1994); sea cucumber (1995); groundfish trawl (1997); and roe herring (1998). The impetus for the change in management for most of these fisheries was the same: the failure of management by control of effort. The movement away from effort control towards property rights has been piecemeal and is usually the result of fishermen within a specific fishery requesting it. In one case, it was not until fishermen had temporarily taken over the management of the fishery by implementing their own voluntary individual quota program that the Canadian government's Department of Fisheries and Oceans (DFO) agreed to a change in management.

In this book, we assess the use of individual transferable quotas (ITQs) and other forms of management based upon property rights through case studies of the ten fisheries listed above. Each case study starts with some general information and a brief history of the fishery. The case studies are presented in chronological order with the exception of spawn-on-kelp herring, which is discussed at the end since it started under a form of IQ management and we cannot, therefore, make a comparison of its condition before and after the introduction of IQs. To determine whether changing from effort control to management based upon property rights was beneficial, several criteria are analyzed in three main categories: conservation, economic viability, and working conditions.

Conservation

The basic conservation problem in any fishery is over-fishing. To assess whether the introduction of individual quotas has reduced overfishing, we compare the total allowable catch (TAC) to actual harvest levels before and after the introduction of individual quotas in each fishery where data are available. A discussion of monitoring and enforcement is included under conservation to assess whether reported catches are accurate. Information on scientific research is also reported where information is available as it affects understanding of the fishery, including the appropriate setting of TACs. Two other issues, related to overfishing, that are often cited as conservation concerns are "high-grading"—dumping less valuable fish at sea so they are not counted as part of the catch; and "by-catch"—the incidental catch of non-target species. Where relevant these are discussed.

Economic viability

The main criterion for evaluating whether the economic viability of the fishery has improved since the introduction of management based on property rights is profitability, which will be affected by revenues and costs. The introduction of individual quotas often brings about an increase in the quality of the product because longer seasons give fishermen time to handle fish more carefully and, in some cases, to serve markets better. This tends to increase

prices and revenue. There is evidence that the introduction of individual quotas also tends to reduce operating costs by eliminating excess capital and labour from the fishery, again a result of the slowed fishing pace.

For a fishery to be economically viable, the income from fishing should cover management and operations costs, including fishermen's incomes. Prior to the introduction of individual quotas, many fisheries in Canada were subsidized as license fees did not completely cover the DFO's management costs and, in some cases, fishermen's incomes were supplemented by employment insurance payments.

The introduction of individual quotas often raises management costs in the fishery since it is usually accompanied by increased monitoring and enforcement activities. We discuss the information available on the extent to which the fishery is covering its management fees, as this provides an indication of whether the fishery is being subsidized.

Of course, the profitability of a fishery will be affected by factors other than the management system used. Landed prices, which directly affect revenue, will change not only with product quality but also as global supply changes. Harvests, too, are subject to natural variability, which will affect revenue.

Working conditions

The introduction of individual quotas dramatically changes working conditions in a fishery. The most critical indicator of improved working conditions is whether a fishery is considered safer. Fishing is one the most dangerous occupations in Canada and fishing in stormy weather, on over-crowded boats, without adequate sleep increases the danger. The elimination of the race to catch fish makes seasons longer and more relaxed, which reduces the number of people employed in the fishery, increases the length of employment for those remaining, and improves safety.

It is important to note that we do not consider a reduction in the numbers of workers employed a negative indicator as it often indicates that there was too much labour in the fishery before the introduction of property rights. This is economically inefficient because, if the same amount of fish can be caught with less effort, then some labour can be freed up to engage in other productive work. The short-term adjustment for fishermen leaving the industry may prove difficult and some may require social assistance. However, avoiding this short-term employment dislocation only serves to perpetuate the problem of "too many fishermen chasing too few fish." As we know from the experience on the east coast of Canada, using fisheries to create or maintain employment can come at the expense of conservation, which can ultimately reduce employment to nothing when the fishery collapses.

Notes

1 Individual Quotas (IQs) are sometimes called ITQs, where the "T" stands for "transferable," indicating that the shares can be traded. IQs or ITQs are also called IVQs, where the "V" stands for "vessel," indicating that the quota share is attached to a vessel.

2 The Canadian government does not consider IQs (or fishing licenses) a right of access to the resource but rather a privilege. In Canada, therefore, IQs are really only quasi property rights. This is discussed further in the conclusion.

Abalone

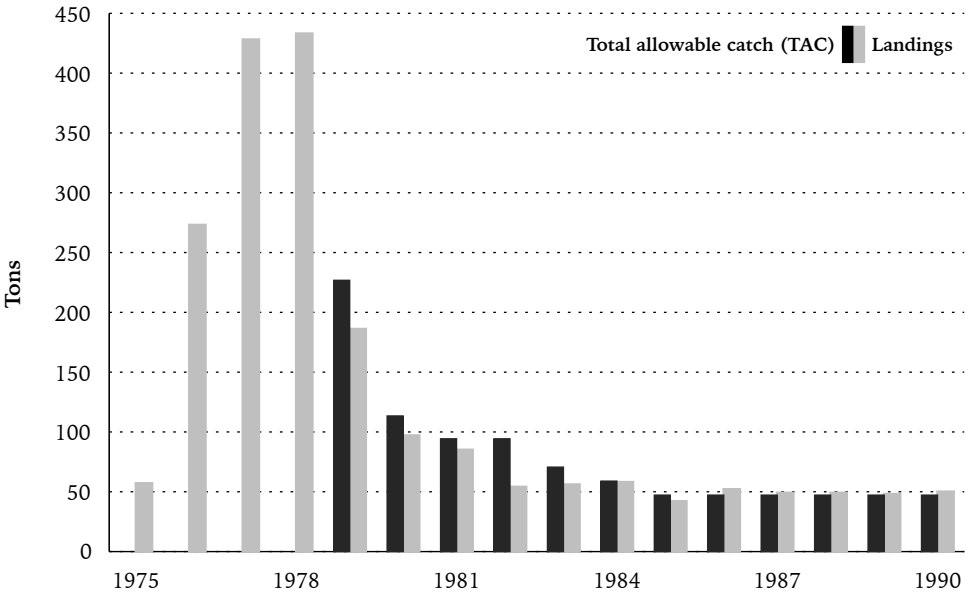
Abalone is a type of marine snail, related to other molluscs including scallops, squid, and clams (DFO 2000b). Northern or "pinto" abalone (*Haliotis kamtschatkana*), the only abalone species found on the Pacific coast of Canada, is one of over 90 varieties found around the world (Fedorenko 1982: 4). Abalone is found close to shore and is harvested by divers for its meaty "foot," which is considered a delicacy in many Asian countries. Most of the abalone harvested on Canada's Pacific coast prior to the 1990 fishery closure was sold to Japan. Northern abalone is found off the west coast of North America from Baja California to Alaska.

A brief history of the fishery

Although commercial abalone harvesting in British Columbia began in the early 1900s, harvests prior to the early 1970s were low and somewhat variable (Sloan and Breen 1988: 23). Between 1952 and 1971, catches fluctuated between a low of .091 tons recorded in 1968 and a high of 57 tons in 1964 (figure 1.1). Regulation of this fishery prior to 1976 was limited to imposing a minimum size for catch and a few closures. Access to the fishery was open to anyone with a fishing license and obtaining a license was not difficult (Sloan and Breen 1988: 28).

By the early 1970s, however, catches were significantly higher than in most previous years. Several events contributed to the increased fishing activity. The salmon and roe herring fisheries had become more restricted and fishermen in those fisheries were looking for new fishing opportunities. The restrictions on salmon and roe herring fishing also meant new entrants to fisheries were more attracted to fisheries that still had unrestricted access such as abalone. Rapid increases in the price of abalone in the 1970s, which coincided with increased sales to the Japanese market, also made abalone

Figure 1.1: Abalone—TAC compared to actual catch, 1975–1990



Source: Muse 1998a.
Note: Limited entry was introduced in 1977, individual quotas in 1979.

fishing more attractive. Finally, changes in technology such as on-board freezers, which allowed boats to fish more remote areas, and dry diving suits, which allowed divers to stay in the water longer, increased harvests (Sloan and Breen 1988: 24). By the fall of 1976, catch had reached an astonishing 273 tons, almost five times the amount caught in the previous year, and the Department of Fisheries and Oceans (DFO) closed the abalone fishery due to conservation concerns (Sloan and Breen 1988: 23).

In 1977, the fishery was reopened and new regulations were introduced to control catches. Entry to the fishery was no longer unrestricted and 29 licences were issued to individuals who had landed a minimum value of $2,000 of abalone in any given year prior to 1977 (Fedorenko and Sprout 1982: 19). This reduced the number of boats in the fishery by half. In order to receive a license, fishermen were also required to sign a document stating that more than 50% of their income in any one year prior to 1977 was earned from abalone fishing (Muse 1998a: 4). Licences were non-transferable and each licence holder was restricted to operating one vessel, with a limit of three divers.

Other new restrictions on fishing included shortening the season to eight months in 1977 and to three months in 1978, an increase in minimum size limit from 2.5″ to 4″, an increase in area closures, and a requirement that fishermen submit logbooks recording fishing location, hours of diving, and catch (Sloan and Breen 1988: 28–29).

Limiting entry and introducing new fishing regulations into the abalone fishery did not resolve conservation concerns. Despite these new measures, fishing effort and harvests remained high, which was a concern since there was a critical lack of information about the biological cycles and stocks of the northern abalone. In 1978, catches reached a new high of over 400 tons.

Individual Quotas (IQs)

In 1979, in a further attempt to control abalone fishing, the DFO's managers introduced coastwide catch-limits (total allowable catch or TAC) and the first individual quota system on the Pacific coast of Canada. The total allowable catch (TAC) was initially set at 226.8 tons in 1979, 44% lower than the previous year's catch (Muse 1998a: 5). During the first year of the program, the TAC was divided into two equal shares, one allocated to a short, competitive fishery confined to two weeks in the spring and the other to fishing under individual quotas throughout a seven-month fishing season between April and November (Sloan and Breen 1988: 29).

It is interesting that part of the rationale for introducing individual quotas to the fishery was to protect smaller operators. According to a DFO report:

> The 1979 management policy attempted to accommodate operators of small vessels which lacked freezing facilities, and to provide for fresh local markets, both of which would have been seriously impaired by a short, open fishery. These regulations also supported the Minister's policy of providing some protection to the operators of small vessels, many of whom pioneered the fishery. (Fedorenko and Sprout 1982: 23)

Each of the 26 license holders was initially given a quota to harvest 4.5 tons of abalone during the 1979 fishing season. In 1980, the TAC was cut in half and the entire TAC was allocated for IQs. From 1980 to 1985, the TAC was further reduced each year, as biologists learned more about abalone stocks. The TAC was set at a low of 47.2 tons from 1985 to 1990 (Muse 1998a: 6). Although IQs for abalone were non-transferable, fishermen were allowed to lease and stack licences (up to four licenses or up to 15% of the TAC could be fished off of the same vessel). The DFO set TACs and managed the fishery with IQs until it was closed in 1990 due to concerns about declining stocks. The fishery remains closed today.

Assessment: Did individual quotas improve management of the abalone fishery?

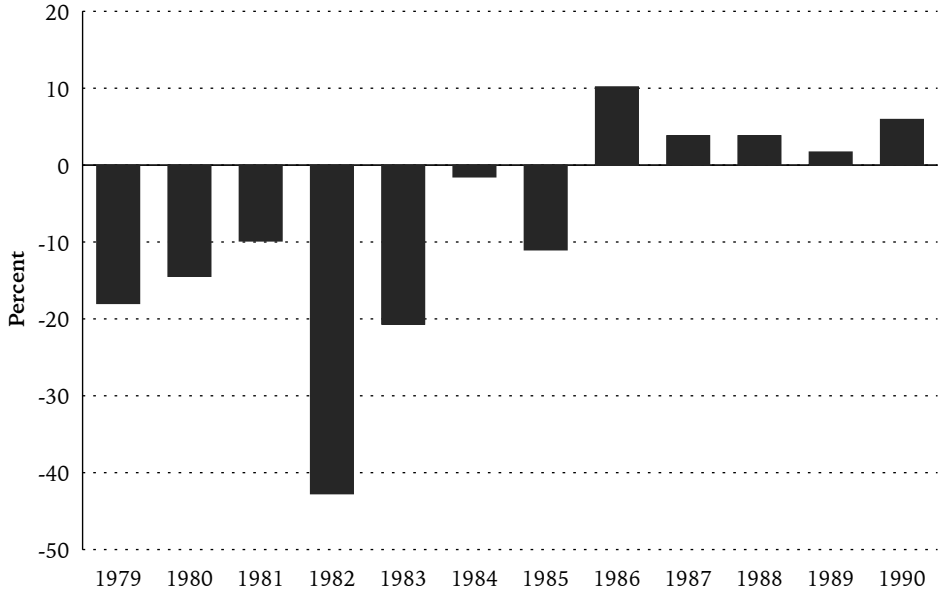
Conservation

Since no TACs had been established for the abalone fishery prior to 1979, there is no benchmark catch limit allowing a comparison of allowable catches with actual catches (catch "overages" or "underages") in the fishery before and after the introduction of IQs. We do know that legal catches increased under open access and limited entry and decreased dramatically with the introduction of total allowable catches and IQs in 1979 (figure 1.1).

Between 1979 and 1985, reported landings also remained below the total allowable catch each season (figure 1.2). From 1986 through 1990, however, overages averaged 5.2% of the TAC. Although reported catches had fallen significantly since the introduction of individual quotas and overages were not dramatic, the DFO closed the fishery in 1990 due to serious conservation concerns arising from declining numbers of legal and sub-legal abalone found at index sites in the north coast (Rick Harbo, Senior Management Biologist, Invertebrate Species, and former Manager for Abalone, DFO, personal communication, February 2001).

The DFO continued to manage all monitoring and enforcement activities for the pinto abalone fishery once quotas were introduced. New requirements under the program included "hailing in" and "hailing out" (fishermen

Figure 1.2: Abalone—catch overage or underage (percent)



Source: Muse 1998a.
Note: Limited entry was introduced in 1977, individual quotas in 1979.

alert monitors that they are coming in from, or going out, fishing) and "port validation" (monitors check and weigh or count catch). However, there were no on-board observers in the abalone fishery due to financial constraints as well as the remote fishing areas that the small vessels frequented.

DFO managers and industry participants believe that lack of adequate monitoring led to widespread poaching before and after the introduction of individual quotas. Poaching included harvesting abalone that were smaller than legal limits, harvesting in closed areas, and exceeding quota (Sloan and Breen 1988: 26; Muse 1998a: 9; DFO Abalone Homepage). A DFO report published in 1980 acknowledged:

> Major weaknesses in the present fishery regulations include the potential for overharvesting of specific areas; low or insufficient enforcement of commercial and sport fisheries, and poor enforcement in those areas where "poaching" of abalone is known to occur; inconsistent monitoring of commercial catches when landed; incomplete records of total commercial landings and of CPUE [catch per unit of effort]; and lack of catch information on the recreational and Indian food fisheries. (Fedorenko and Sprout 1980: 54)

Rick Harbo, DFO manager for several west-coast invertebrate species, explains that there are strong incentives to poach because abalone are valuable, easily harvested in shallow waters by divers, and found in remote areas where it is difficult to patrol (Rick Harbo, Senior Management Biologist, Invertebrate Species, and former Manager for Abalone, DFO, personal communication, July 28, 2000).

While there are no certain estimates of how serious poaching was (and likely still is), anecdotal information from license holders suggest it was significant. Some fishermen and managers believe that illegal landings were as high as two to four times the legal catch limits by the time the fishery was shut down in 1990 (Muse 1988: 7). Recent stock-assessment studies indicate that, since the closure of the fishery, abalone stocks have continued to decline. Continued illegal fishing is considered to be the key factor in this decline and is a concern for the rebuilding of stocks during the fishery's closure. According to surveys done by the DFO total abalone density declined 43.75% between 1993 and 1997 (DFO Abalone homepage).

Since the closure of the abalone fishery, there has been occasional consultation between industry participants and the DFO managers. A conference held during February of 1999 in Nanaimo, British Columbia, focused on the rebuilding of abalone stocks that may eventually lead to the development of a strategy for a native food fishery and possibly aquaculture or commercial fishery opportunities. However, many former abalone fishermen and DFO managers remain pessimistic about any future prospects for a commercial

fishery given that there is significant evidence that illegal abalone fishing continues on Canada's Pacific coast and is causing what may be irreversible damage to abalone stocks (Muse 1998a: 9).

Economic viability

Prior to the introduction of individual quotas, competition to catch abalone created the incentive for harvesters to increase their catching power, resulting in shorter, more intense, fishing seasons. Individual quotas had the effect of lengthening the fishing season for abalone from three months in 1978 to seven months in 1979 (March through November). In many IQ fisheries, longer seasons allow fishermen to reduce their costs by reducing over-investment in fishing gear. In this case, however, it is not clear whether longer seasons allowed fishermen to reduce their costs since enforcement was so weak that effectively an illegal "race for fish" continued.

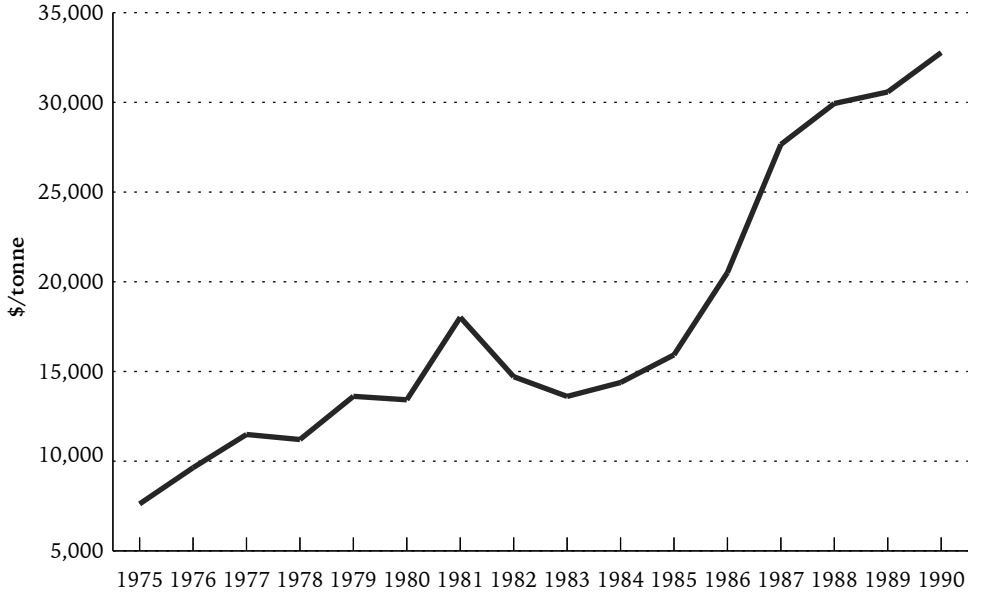
The introduction of IQs to a fishery can also have the effect of increasing landed prices when seasons are extended since a greater portion of the catch can be sold fresh. But landed prices for abalone have not followed a typical pattern for IQ fisheries (initially low and increasing with longer seasons and increased ability to meet market demands). Landed prices in the abalone fishery were increasing even before the introduction of quotas. From 1975 to 1977, the price for a ton of abalone increased in real terms from $2,316 to $4,049. During the stage of limited entry to the west-coast fishery for abalone, the landed price increased from $4,049 per ton in 1977 to $4,305 per ton in 1978. Once individual quotas were introduced in 1979, the landed price rose from $4,305 in 1978 to $5,710 in 1979 and continued to rise until they reached an amazing $26,940 per ton in 1990, immediately preceding the closure (figure 1.3).

There was so much illegal fishing that Asian markets may have been supplied with fresh abalone year round prior to the introduction of individual quotas. It is not likely, therefore, that IQs were responsible for much of the price increase observed in the market. Abalone prices have continued to rise even ten years after the official closure of the abalone fishery (Muse 1998a: 9).

Revenues in the fishery increased with prices and the catch just prior to the introduction of individual quotas in the late 1970s. Although prices continued to rise over the next ten years, revenues declined substantially, due to lower catches, before increasing slightly in the mid- to late 1980s (figure 1.4).

Unlike many other IQ fisheries on Canada's Pacific coast, the abalone fishery did not incorporate a comprehensive cost-recovery program into its IQ strategy. License fees remained the same ($200 annually) from the time limited entry was introduced, without significant tonnage or additional monitoring fees. Fisheries on the Pacific coast that went to individual quota

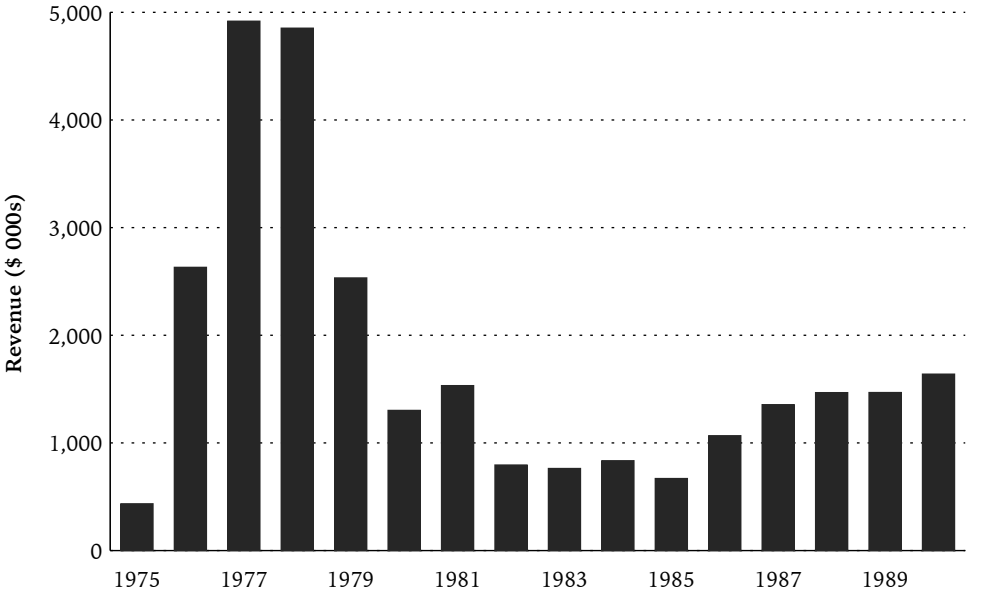
Figure 1.3: Abalone—real landed price, 1975–1990 (adjusted for inflation)



Source: Muse 1998a.

Notes: Numbers adjusted for inflation using 2000 as the base year. Limited entry was introduced in 1977, individual quotas in 1979.

Figure 1.4: Abalone—real revenue for fishery, 1975–1990 (adjusted for inflation)



Source: Muse 1998a.

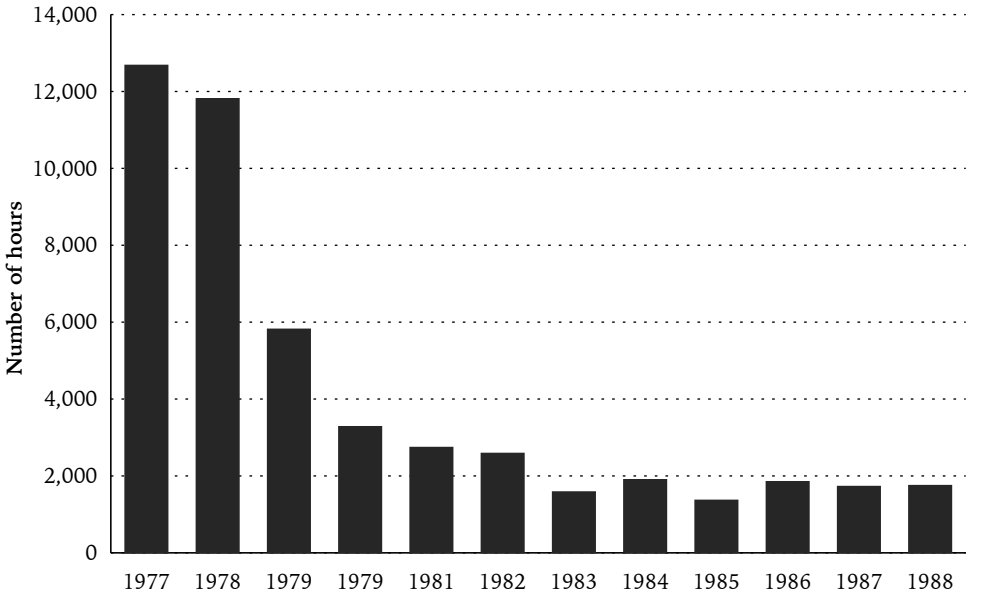
Notes: Numbers adjusted for inflation using 2000 as the base year. Limited entry was introduced in 1977, individual quotas in 1979.

systems after abalone saw increases in fees to cover additional monitoring and enforcement activities. However, because the DFO implemented only limited enforcement and monitoring, the costs of running the fishery did not increase appreciably after the introduction of quotas. But, since monitoring and enforcement spending were low, the enforcement system itself was weak, leading to high degrees of non-compliance (Muse 1998a: 6).

Working conditions

Direct employment in the abalone fishery primarily consists of divers. Since 1977, DFO has kept track of diver hours (figure 1.5). According to DFO manager, Rick Harbo, the DFO's attempts to limit the number of divers in the fishery prior to individual quotas was futile (Rick Harbo, Senior Management Biologist, Invertebrate Species and former Manager for Abalone, DFO, personal communication, July 28, 2000). This made conditions at sea crowded and often unsafe. Once individual quotas were imposed, the number of diver hours fell from 11,812 in 1978 to 5,816 in 1979. After the TAC was cut in half in 1980, the total number of diver hours fell to 3,282. From 1980 through 1990, diver hours continued to fall, reaching approximately 1800 in the late 1980s. The reduced activity in the fishery eliminated the crowded conditions.

Figure 1.5: Abalone—diver hours for fishery, 1977–1988 (aggregate of all hours for all divers in a given year)



Source: Muse 1998a.
Note: Limited entry was introduced in 1977, individual quotas in 1979.

Overall assessment

Abalone was the first fishery in British Columbia to be managed under individual quotas. Since the fishery had to be closed in 1990, 12 years after the management change, critics have contended that individual quotas were responsible for the failure of the fishery.

The closure of the fishery was not, however, the result of an inherent flaw in the idea of allocating shares of the catch to individual fishermen before they go out on the fishing grounds. For a system of individual quotas to be effective, monitoring and enforcement must be strong. This was not the case in the abalone fishery, where participants and managers believe that poaching was widespread before and after the introduction of individual quotas. Natural factors and large legal harvests just prior to the introduction of individual quotas may also have played a role in the decline of stocks that ultimately led to the closure of the fishery.

Although the fishery was closed in 1990, the introduction of an individual quota system was clearly a more effective way to control the legal harvest than the regulations used to control effort in the years immediately preceding the introduction of individual quotas. Legal harvests remained much lower under individual quotas than under the previous system of regulations designed to control fishing effort.

There is no evidence that individual quotas improved the economic viability of the fishery. Since illegal fishing appears to have been rampant, it is unlikely that extending the legal season would have had much impact on the availability of fresh abalone and, therefore, on prices. Ultimately, for the fishery to be economically viable much more money would have had to be spent on enforcement, which would have meant large increases in the fees fishermen were paying and might have resulted in a smaller number of people participating in the fishery. Working conditions in the legal fishery, however, do seem to have improved due to the slowed pace as a result of the longer season.

Overall, the evidence suggests that individual quotas were a better way to manage the fishery than effort controls, mainly because it was a more effective way to control the legal catch. The success of the program in the longer term, however, was hampered by an inability to control illegal fishing, a problem that existed before the introduction of IQs and still persists today, after the fishery has been closed for over ten years.

Geoduck

The Pacific geoduck clam (pronounced "gooey duck") is one of the largest native clam species on North America's Pacific coast. Geoduck (*Panope abrupta*) are unusual looking—they have an extended hose-like neck or siphon that extends up to four feet past the end of their clam shell. Geoducks typically weigh 2 pounds or 1 kilogram and can live over 100 years (DFO 2000a Geoduck). The Pacific geoduck is found from California's southern coast up to Alaska's northernmost waters.

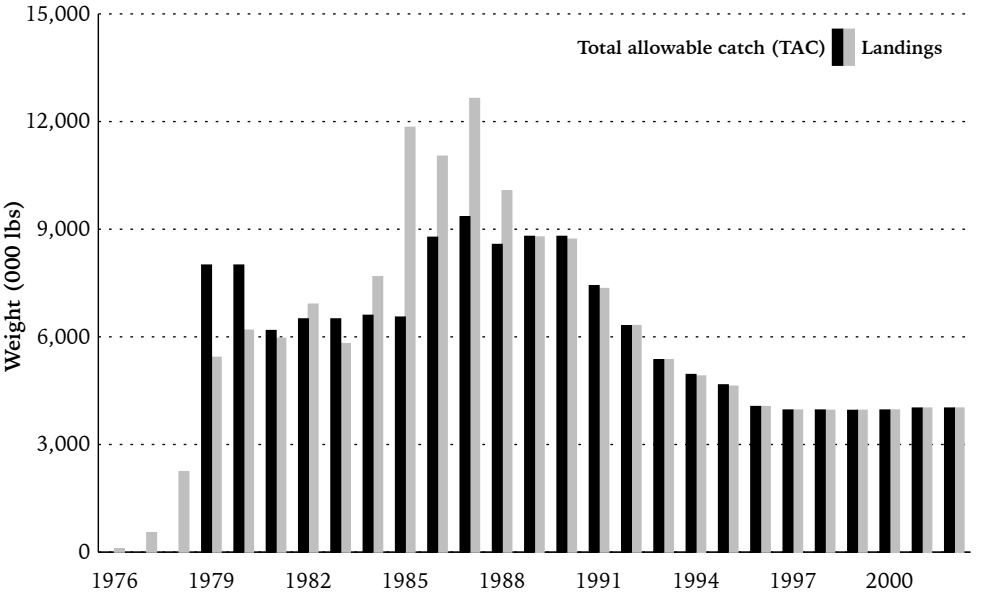
Divers harvest geoducks using a high-pressure water hose (known as the "stinger") to loosen the buried clams from the sand and remove them alive and attached to their shell (Heizer 1999). Harvested geoducks are primarily shipped live to Hong Kong and The People's Republic of China.

A brief history of the fishery

British Columbia's commercial geoduck fishery began in 1976 when seven fishermen were given special permits to harvest the clams in the Strait of Georgia (Muse 1998b: 3). In 1977, the Department of Fisheries and Oceans (DFO) eliminated the special permits and opened the fishery to anyone who wanted a license. There were only a few simple regulations to comply with at this time—all fishermen were required to send in their geoduck sales slips weekly and to submit harvest logs and harvest locations (Heizer 1999: 2). There was no limit on the catch. The number of licenses issued increased quickly under this system from 30 in 1977 to 101 in 1979 (Heizer 1999: 3). Harvests rose even more dramatically—over 5000%—from 97,000 pounds in 1976 (under the special permit system) to 5,430,000 pounds in 1979 (Heizer 1999) (figure 2.1).

To control the increasing catches in the fishery, in 1979 the DFO introduced catch limits and announced that no new fishing licenses would be is-

Figure 2.1: Geoduck—TAC compared to actual catch, 1979–2002 (all weights reported in round weight)



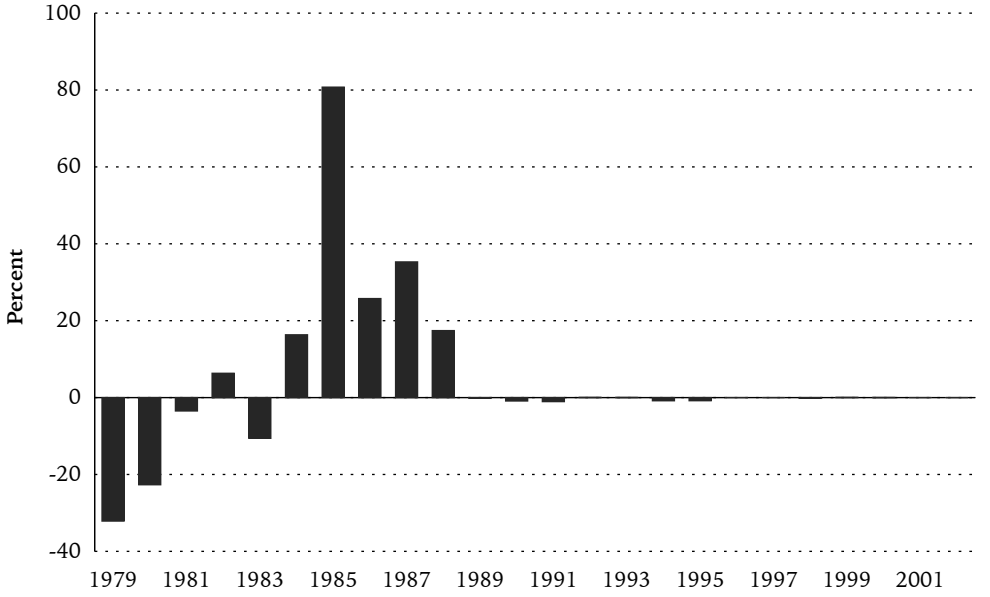
Note: Limited entry was introduced in 1979, individual quotas in 1989.
Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, August 27, 2003.

sued. In 1980, the DFO reduced the number of licenses in the fishery to 95. The current geoduck licensing program came into effect in 1983, when the number of licenses was further reduced, based on past landings, to 54 (Heizer 1999). After one successful appeal, the number of licenses was increased to 55 in 1985 and remains at 55 today.

Catches were fairly stable in the early 1980s, just after the DFO began restricting entry to the fishery, but by the mid-1980s catches began to rise again, hitting a high of 12.6 million pounds in 1987 (figure 2.1). Between 1984 and 1988, problems with fisheries management were becoming increasingly evident as actual catches exceeded allowable catches by as much as 80% (figure 2.2). During this time, managers shortened the fishing season and fishermen began referring to the geoduck fishery as a "shotgun" fishery as effort expended during the increasingly short openings was high (Heizer 1999). The "shotgun" openings led to supply gluts during the short fishing times and reduced the availability of live product throughout the rest of the year. Fishermen had two other concerns about the short openings: safety and foregoing a substantial portion of their annual income if unforeseen circumstances forced them to miss an opening (Muse 1998b: 7).

The geoduck industry association, the Underwater Harvesters' Association (UHA), asked the DFO to implement an individual quota program in 1988 in an attempt to improve conservation, safety, and supply of the product (James

Figure 2.2: Geoduck—catch overage or underage, 1979–2002 (all weights reported in round weight)



Note: Limited entry was introduced in 1979; Individual quotas in 1989
Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, August 27, 2003.

2000). DFO imposed the condition that monitoring costs associated with the individual quota program be paid by industry. Industry agreed to pay these additional costs as, after the experience in the abalone fishery, everyone understood the importance of a strong monitoring program (Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, August 27, 2003). The DFO agreed to implement Individual Vessel Quotas (IVQs) in the fishery on a trial basis for the 1989 and 1990 seasons (Heizer 1999: 4). The use of individual quotas continued after 1990 and remains in place today.

Individual Vessel Quotas (IVQs)

The geoduck quota program was set up as an individual vessel quota (IVQ), which means that the individual quota is attached to the boat rather than the license. Under the IVQ system, the TAC continues to be set each year after research determines the biomass of the geoduck fish stock (generally the harvest is about 1% of the total biomass). The TAC is divided into 55 equal shares, which are allocated to license holders. The coastal harvesting region is divided into three areas (the North Coast, the West Coast of Vancouver Island, and the waters inside Vancouver Island) and license holders are permitted to harvest in only one of the three areas each season (Heizer 1999). Although individual quotas for geoducks can be transferred (up to three quotas per vessel), quotas cannot be divided into smaller shares.

Assessment: Have individual quotas improved management of the geoduck fishery?

Conservation

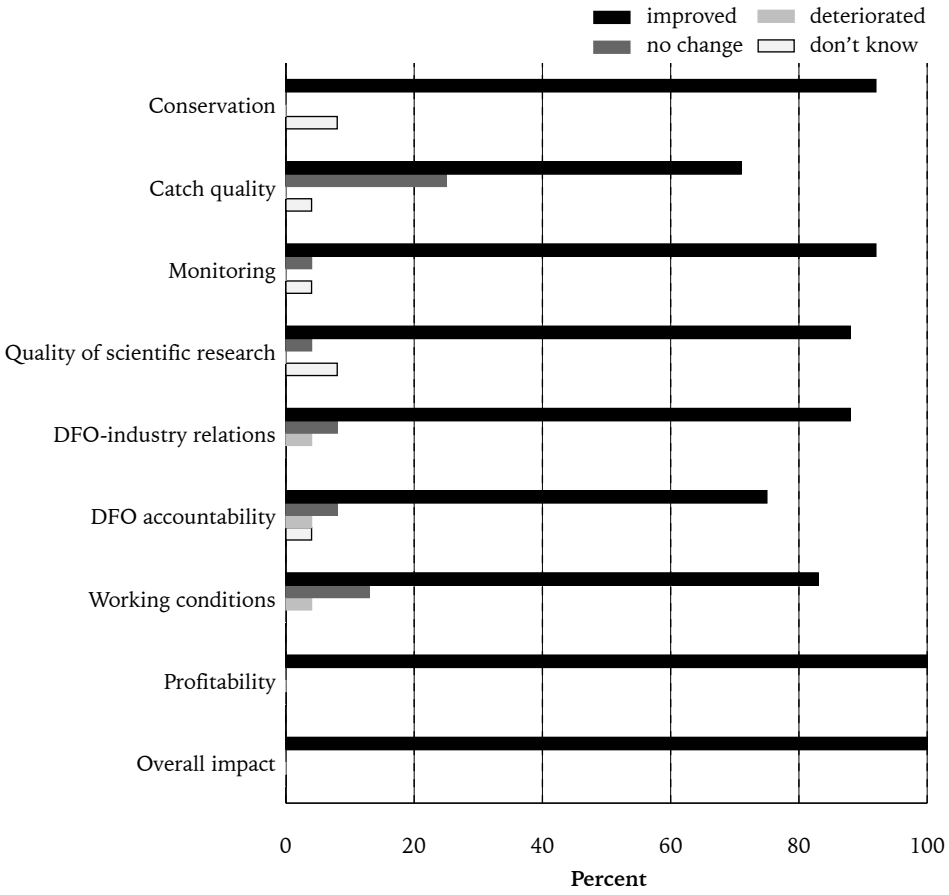
Most license holders believe that the move to individual quotas has led to improved indicators of conservation in the fishery. Our survey of individuals representing 38 of the 55 licenses in the fishery revealed that 88% believed the quality of scientific research in the fishery had improved, 92% believed that overall monitoring in the fishery had improved, and 92% believed that overall conservation in the fishery had improved since the introduction of individual quotas (figure 2.3).

Available data support the licence holders' overwhelming endorsement. In six of the ten years preceding the introduction of IQs, harvests exceeded the TAC by an average of 30%. In the 12 years following the introduction of IQs, there have been catch overages in four years but these overages have averaged less than 1% of the TAC (figures 2.1 and 2.2). The introduction of individual quotas was also accompanied by a reduction in catch limits, which means that fewer geoducks are now harvested (figure 2.1). According to Andrew Milne, Director and former President of the Underwater Harvesters Association (UHA), British Columbia's geoduck fishermen are now harvesting at an extremely conservative rate—half the rate of harvest conducted by geoduck fishermen in Washington State (Andrew Milne, Director, Underwater Harvesters Association, personal communication, August 2000).

Monitoring and enforcement also changed dramatically after the introduction of individual quotas. Prior to the change in management, the DFO's monitoring and enforcement activities were considered inconsistent and ineffective (Muse 1998b: 17). Once quotas were introduced, geoduck harvesters paid for an independent third party, Archipelago Marine Research, to enforce "hailing in" and "hailing out" (the act of a fishing vessel announcing when it is leaving and returning to port at the beginning and the end of fishing activities), to validate and monitor catches, and to monitor fishing grounds to encourage proper fishing practices in the remote north-coast region, where the DFO had identified compliance violations (Rick Harbo, Senior Management Biologist, Invertebrate Species, DFO, personal communication, July 28, 2000). Since license holders pay directly for monitoring under the individual quota system, they have a strong incentive to ensure that it is effective. According to Stephen Heizer, a senior DFO manager, they have succeeded: the industry-funded, independent monitoring system has "introduced control structures which have made illegal activities (poaching, harvesting without a license) more difficult" (Heizer 1999: 7).

The industry's approach to dealing with the issues of high-grading and poaching in the fishery illustrates their active involvement in addressing conservation concerns. The geoduck fishery is susceptible to the problem of

Figure 2.3: Geoduck—survey of license holders on the effect of IQs on geoduck fisheries management



Source: Survey conducted by The Fraser Institute in 2001; 22 individuals representing 38 of the 55 licenses in the fishery filled out the survey.

high-grading since Asians will pay a premium to buy a light-coloured rather than a darker-coloured siphon. In order to eliminate the incentive for fishermen to discard darker geoducks, fishermen have agreed to sell each pound that they land to buyers at a given price, rather than have the buyer pay different prices for the differently coloured geoducks (James 2000: 2). In order to address concerns about poaching, the industry association has hired private investigators who monitor plants and restaurants on the Pacific coast as well as monitoring markets in Hong Kong (Muse 1998b: 10).

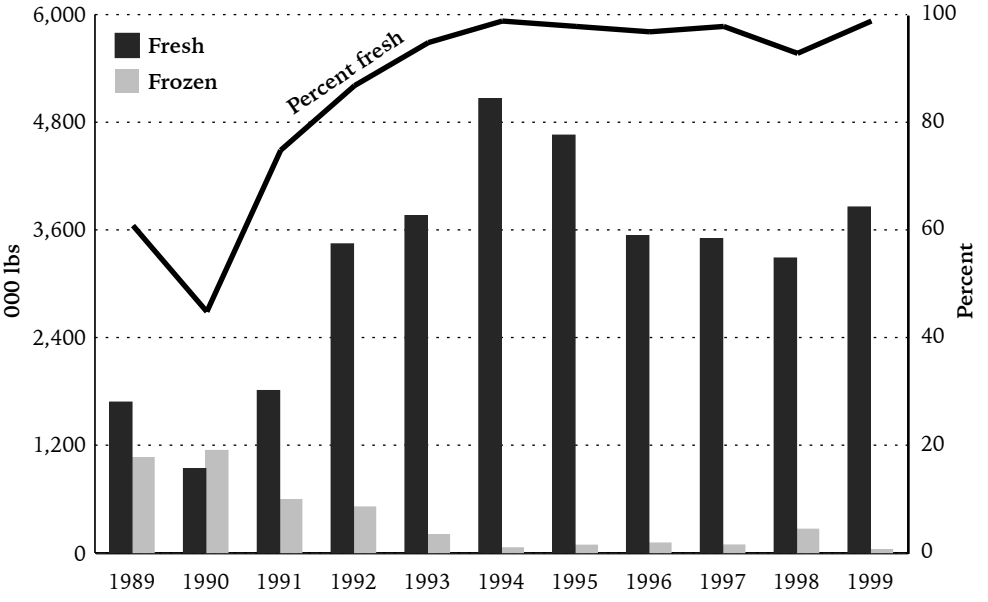
Prior to the establishment of the UHA and the implementation of IQs, the industry had very little involvement with the economic or biological management of the fishery. Through the UHA, the industry now funds a number of conservation initiatives that include investigating poaching, sampling water, and conducting biological research. For example, the UHA is involved in the

reseeding project in the gulf of Georgia that is scheduled to produce 30% of the annual harvest quota of 4 million pounds. The project, which began in 1994, is one of the first of its kind in the world (Coastal Community Network 2001).

Economic viability

Prior to the introduction of Individual Vessel Quotas (IVQs) in 1989, most harvesting took place immediately following the official opening of the fishery each year, a result of the intense race to capture a share of the TAC. Once IVQs were introduced, this dynamic changed: since each participant was granted a share of the catch, there was no longer a need to engage in a harvesting race. Longer openings had important implications for revenues, costs, and profitability in the fishery. Prior to the introduction of IVQs, geoduck fishermen were unable to respond to consumer demand for live product of high quality year-round and only 40% of all geoducks were sold live on the wholesale market. Since the introduction of IVQs, however, more than 80% of geoducks are sold live (figure 2.4). Eliminating supply gluts and selling more of the product live increased average prices. In 1988, the year before IVQs were introduced, geoduck sold for $1.29 per pound. Just one year later under IVQs, geoduck sold for $1.82 per pound (figure 2.5). From 1989 to 1995, the inflation-adjusted price for geoducks increased from just under $2.00/pound to over $10.00/pound. Although since 1995 prices have

Figure 2.4: Geoduck—exports of fresh product compared to exports of frozen product



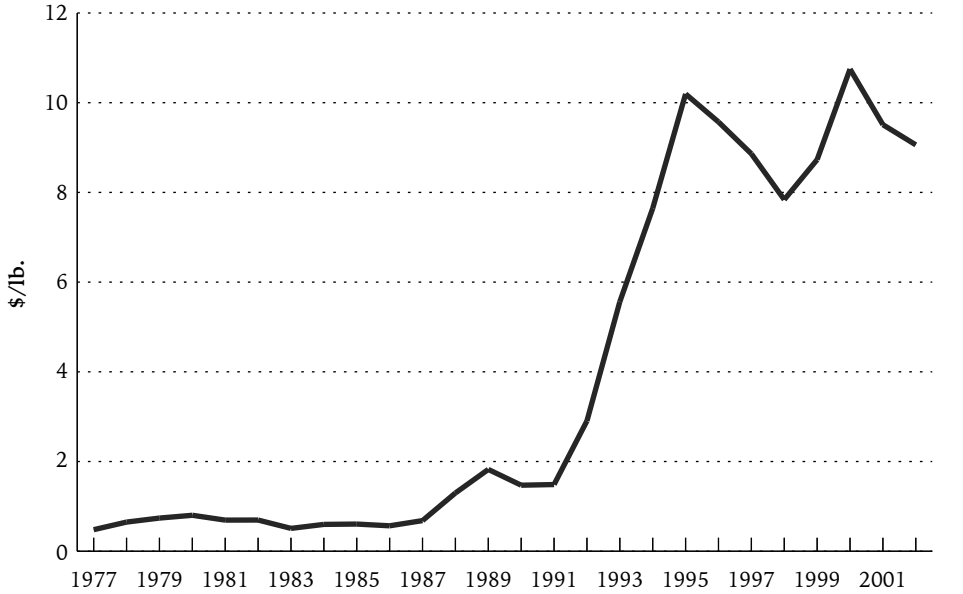
Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, August 2000.

dropped—likely the result of the increased supply from the state of Washington—they remain well above pre-IVQ prices. The market price for one pound of geoduck in 2002 was $9.06 and the average price for 2003 is expected to be particularly low due to SARS, which greatly reduced demand for geoduck from restaurants in China (Michelle James, personal communication, August 27, 2003).

The increase in geoduck prices has increased revenues for geoduck fishermen, even though catch levels have fallen. In 1988, the year prior to the introduction of individual quotas to the fishery, industry revenues were approximately $13 million (figure 2.6). The following year under individual quotas, industry revenues increased to $16 million. In 2002, revenues reached $36 million.

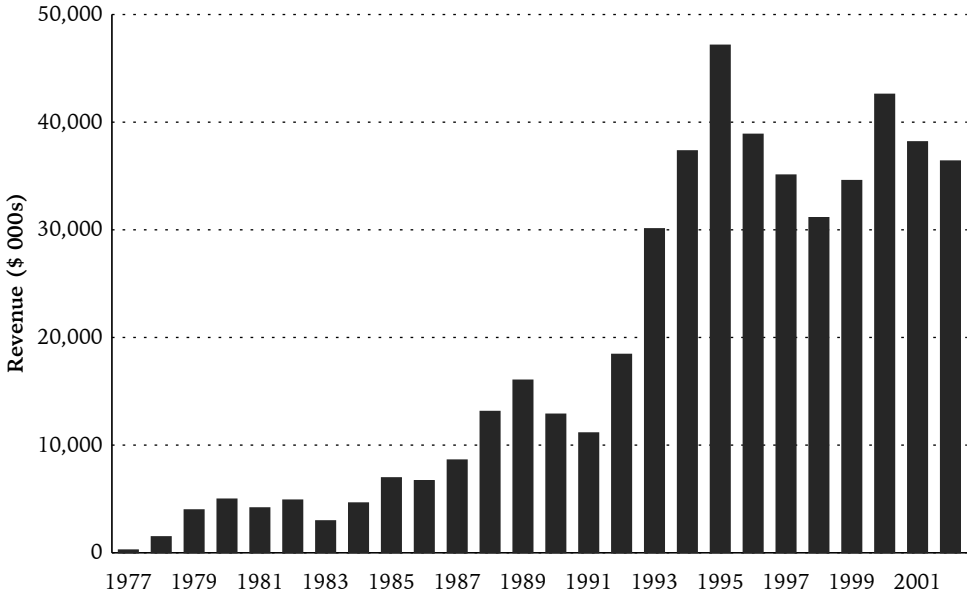
The introduction of IVQs to the geoduck fishery also reduced both the capital and labour costs in the fishery (Muse 1998b: 11–12; Andrew Milne, personal communication, August 2000). According to a 1991 DFO report evaluating the impact of IQs, "[c]ost savings have been identified in the areas of vessel fuel consumption and labour/material used in harvesting" (Muse 1998d: 12). The reduction in costs is a direct result of eliminating the race to capture a share of the geoduck harvest, which created a strong incentive for fishermen to overcapitalize. Unfortunately, there are no data identifying the magnitude of these cost savings.

Figure 2.5: Geoduck—average landed price, 1977–2002



Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communications, July 5, 2000 and August 27, 2003.
Note: Prices adjusted for inflation using 2000 as the base year.

Figure 2.6: Geoduck—total revenue, 1977–2002



Notes: Prices adjusted for inflation using 2000 as the base year. Limited entry was introduced in 1979, individual quotas in 1989.
Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, July 5, 2000.

The improved financial performance of the fleet has meant that the fishery is covering a larger portion of its management costs. Prior to the introduction of IQs, the only fee geoduck harvesters paid was a $10 annual license fee to the DFO and this revenue was "barely covering the cost of issuing the license, let alone covering the costs of managing the fishery" (Andrew Milne, personal communication, August 2000). Upon the introduction of IQs, industry agreed to pay for additional costs of monitoring by third parties. To cover these costs, the the Underwater Harvesters' Association (UHA) collects an annual membership fee from geoduck license holders (fishermen must pay the annual fee in order to get the logbooks that the DFO requires them to have before fishing). In 1989, this fee was $4,530 per license. Over time, this fee increased as the UHA began paying for additional management and research including private investigations into poaching, water sampling, biomass surveys, enhancement projects, and management by the DFO (Muse 1998b: 11). By 2001, the UHA had a budget of $1,808,000, which was raised in 55 portions of $32,8844 from each license holder.

In addition to their UHA fees, license holders are paying higher license fees to the DFO. The licensing fee rose from $10 per year through 1995 to $3,615 dollars in 1996 to the current $7,345 per year in 2001 (table 2.1). Although the amount that license holders are contributing to covering manage-

Table 2.1: Geoduck—management fees ($) paid by industry to the DFO and to the Underwater Harvesters Association, 1980–2003

	DFO Fees (55 licenses)	UHA Fees (55 licenses)		DFO Fees (55 licenses)	UHA Fees (55 licenses)
1980	550	0	**1992**	550	292,991
1981	550	0	**1993**	550	462,617
1982	550	0	**1994**	550	771,028
1983	550	0	**1995**	550	1,079,439
1984	550	0	**1996**	198,825	1,635,420
1985	550	0	**1997**	193,644	1,637,000
1986	550	0	**1998**	193,644	1,637,000
1987	550	0	**1999**	396,825	1,637,000
1988	550	0	**2000**	396,825	1,787,600
1989	550	249,150	**2001**	403,975	1,808,600
1990	550	249,150	**2002**	403,975	1,901,000
1991	550	250,635	**2003**	378,679	1,901,000

Note: Limited entry was introduced in 1979, individual quotas in 1989
Source: Michelle James, Executive Director of the Underwater Harvesters Association, personal communication, August 27, 2003.

ment costs has clearly increased dramatically since the introduction of IQs, it was impossible to say whether these fees were covering all costs of managing the fishery as the DFO did not estimate these costs. However, in 2003, the UHA signed a five-year "Joint Project Agreement" with the DFO that outlines the responsibilities of both the DFO and the UHA for co-managing the geoduck fishery and provides estimates of how much these responsibilities are likely to cost. For 2003, the total cost to the DFO of managing the fishery is estimated to be $522,400; fees paid to the DFO by the UHA and through licenses are estimated to be $585,479—more than enough to cover all management costs (James 2003: 11).

The increase in management costs has likely been greater that the cost savings on labour and capital. However, the increase in revenues after the switch to individual quotas has more than compensated for this. Every license holder that we surveyed indicated that profitability in the fishery had improved after the introduction of individual quotas (figure 2.3).

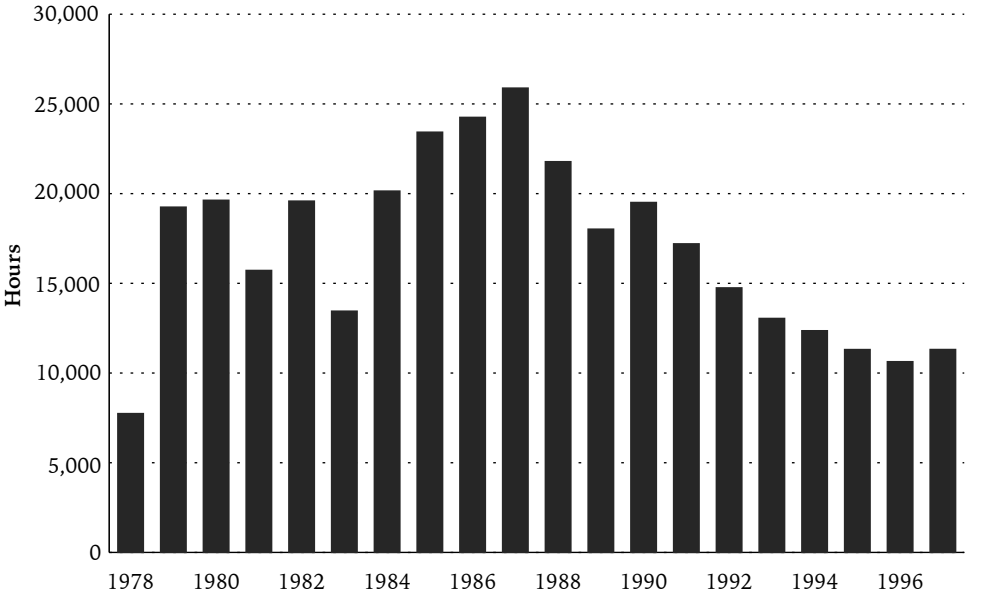
Working conditions

Before the introduction of individual quotas to the geoduck fishery, openings were short and the pace was frantic—not ideal conditions to promote safety. The lengthened fishing season under individual quotas allows divers and vessel operators to conduct harvesting activities under safer and more stable conditions. As Heizer writes: "the number of accidents involving divers has also decreased as fishers feel much less pressure to dive deeper, to make de-

compression dives, or to violate dive protocols" (1999: 8). Milne agrees that under IQs "divers don't have incentives to push harder, dive harder, go deeper—there is no pressure … In recent history, there has been a decrease in accidents" (Andrew Milne, personal communication, August 2000). License holders support these views: 83% of the fishermen surveyed believe that working conditions for those remaining in the fishery have improved (figure 2.3). Many fishermen indicated that one of the best things about moving to a quota system was the improvement in safety brought about, particularly, because they no longer felt compelled to fish in dangerous weather.

The introduction of IQs coincided with a reduction in employment in the fishery. Prior to 1989, there were approximately 200 people employed in the harvesting of geoduck clams. By 1997, the number of harvesters had dropped to 120 (Muse 1998b: 13). Diver hours in the fishery fell by 58% from 26,784 in 1988 to 11,316 in 1997 (figure 2.7). Most of the decline in employment is likely the result of the lower total allowable catch in the fishery although the reduction in fishing intensity under quotas may also have had an effect. A evaluation study conducted in 1991 by the DFO indicated that those fishermen who left the industry when IQs were introduced tended to be less active part-time workers (Muse 1998b: 16). This suggests that the rationalization within the fishery has improved labour efficiency. Longer fishing openings and the corresponding reduction in fishing intensity has had the effect of improving income security for the remaining crew (Heizer 1999: 8).

Figure 2.7: Geoduck—diver hours for fishery, 1978–1997



Note: Limited entry was introduced in 1979, individual quotas in 1989.
Source: Muse 1998c.

Overall assessment

Allocating individual fishermen a share of the catch through individual vessel quotas has transformed the geoduck fishery. Prior to the change the fishery was described by fishermen as a "shotgun" fishery with short seasons, supply gluts, harvests exceeding the TAC, and unsafe fishing conditions. Today it is considered a model for other fisheries. An incredible 100% of the license holders we surveyed indicate that the overall impact of individual quotas on the fishery has been positive. Most agree that it has improved conservation, catch quality, monitoring, relations between the DFO and industry, the accountability of the DFO; all agree it has improved profitability (figure 2.3).

A key reason that individual quotas have been so successful in the management of geoducks is the active involvement and participation of industry. Not only did industry suggest the program but they paid for the increased monitoring and enforcement that the program required. This has effectively controlled poaching and high-grading. One of the most striking things about the introduction of individual quotas is how it changed license holders' attitudes. As one fisherman describes it: "I am a custodian of my fishery not a miner of resources." Another fisherman explains that "as the crews and vessel owners have matured and invested in the fishery, working closely with DFO we are becoming more like stewards of the resource."

Sablefish

Pacific sablefish (*Anoplopoma Fimbria*), is a charcoal-hued finfish found from Baja, California up through Alaska. Sablefish, also known as black cod, are bottom-dwellers. They can live to be over 70 years old and can grow to lengths of over one metre. Longlines and traps are used to catch sablefish. Most of the harvest is exported to Japan.

A brief history of the fishery

Fishermen have caught sablefish off the coast of British Columbia since the early 1900s but, until the establishment of Canada's 200-mile Extended Economic Zone in 1977, domestic catches were relatively small. Canadian fishermen, recognizing the financial potential of exporting sablefish, established a directed fishery in the late 1970s (Turris 1999: 1). Domestic harvests grew exponentially in the late 1970s and early 1980s as more fishermen entered the industry and as fishing technology improved. In an attempt to slow the pace of the fishery, The Department of Fisheries and Oceans (DFO) limited entry into the fishery in 1981 and issued 48 licenses to active sablefish fishermen.

As in other fisheries, limited entry regulations intensified the race to catch fish. To remain competitive, fishermen invested in bigger boats and more crew. They began fishing 24-hour days and using extra gear and traps (Turris 1998a: 2). To control the more powerful fleet, DFO shortened seasons from 245 days in 1981 to 45 days in 1985 and to 14 days in 1989 (Neher 1992: 26). As a result, large quantities of fish were landed in a short window of time and the quality of the product and prices suffered.

Fishermen became increasingly concerned that the fishery, as it was operating, was not economically viable. Fishing costs were escalating at the same time shortened seasons were causing supply gluts that drove down

prices. Vessel breakdowns, at the wrong time, could cost license holders their season's earnings. Safety was also a concern as boats were overloaded with gear and fishermen were working long hours.

On October 24, 1989, the Pacific Blackcod Fishermen's Association (PBFA), an organization representing the majority of the blackcod vessel owners, proposed an individual quota plan to the DFO. After much consultation, the DFO mailed out a program proposal to all sablefish license holders and asked them to vote. The proposal received an overwhelming endorsement with 46 of the 48 license holders supporting it. On April 21, 1990, just 6 months after industry's initial request, the DFO opened the fishery under ITQs for a two-year trial period (Turris 1999: 5).

Individual Transferable Quotas (ITQs)

The sablefish ITQ program is simple. Each of the 48 license owners in the sablefish fishery is annually allocated a share of that year's allowable catch. The allowable catch is determined by DFO. The individual allocation formula, recommended by license holders, is based 70% on catch history and 30% on vessel length (Turris 1999). Each license holder is permitted to go 10% over or under his individual quota and add or subtract the amount from the following year's allocation.

Upon completion of the two-year trial period, the DFO consulted with industry and agreed to make the ITQ system permanent. When the trial sablefish ITQ system was first introduced in 1990, the DFO limited quota transfers to annual transfers of "whole" quota share. Since 1993, the DFO has adopted a more flexible transferability rules. There is no annual limit on either the total number of transfers or the total quantity transferred. Transfers beyond one year are not permitted by DFO although license holders have agreements that effectively get around this regulation (Turris 1999). The ability to transfer quota has reduced the active fleet by nearly 50%.

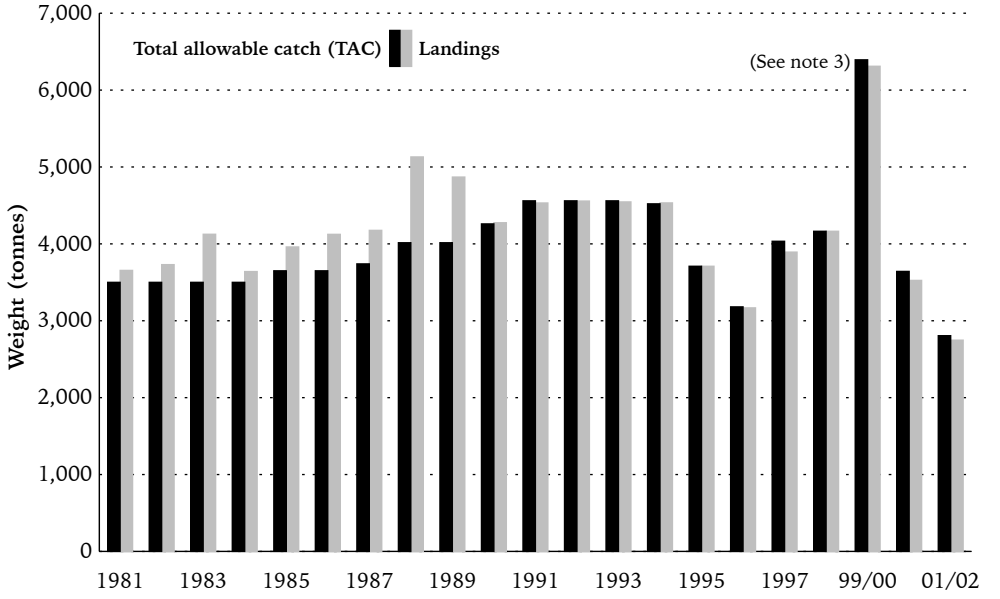
Assessment: Have individual quotas improved management of the sablefish fishery?

Conservation

Evidence clearly shows a dramatic improvement in conservation after the introduction of individual quotas to the blackcod fishery. Prior to the implementation of ITQs in 1990, DFO managers were unable to keep fishermen below the TAC—allowable catches were exceeded every year between 1981 and 1989. In the two years prior to the introduction of IQs, TACs were exceeded by over 20%. Since the introduction of ITQs actual catches have remained at or below allowable catches (figures 3.1 and 3.2).

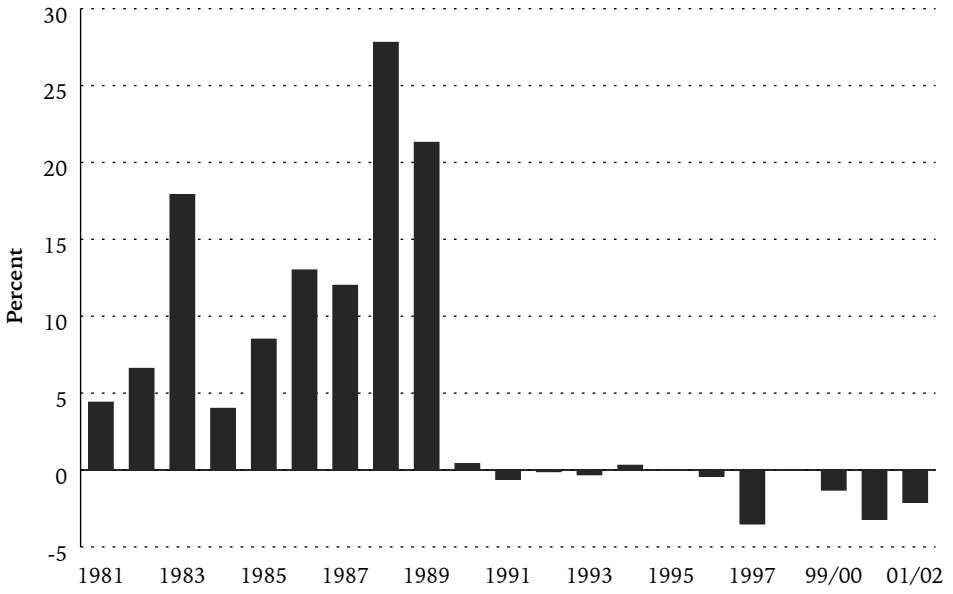
A new monitoring program was implemented when the fishery changed management. Prior to the introduction of quotas, the Department of Fisheries and Oceans did not monitor landed catch, had no enforcement specifically dedicated to sablefish, and only used minimal air and sea surveillance (Turris 1998a: 9). Monitoring was so limited that there were rumours that some license holders were fishing out of season (Turris 1998b). Under ITQs, industry pays for a private company to conduct dockside monitoring of landed

Figure 3.1: Sablefish—TAC compared to landings, 1981–2002



Notes: (1) Limited entry was introduced in 1981, individual quotas in 1990. (2) From 1996, Archipelago Marine Research includes allowable overages and underages in the TAC. (3) 1999/2000 had a 19-month season as in 1999 there was a transition from seasons running from January to December to seasons running from August to July.
Sources: 1981–1989: DFO Catch Statistics; 1990–2002: Archipelago Marine Research Ltd.

Figure 3.2: Sablefish—catch overage or underage, 1981–2002



Notes: (1) Limited entry was introduced in 1981, individual quotas in 1990. (2) 1999/2000 had a 19-month season as in 1999 there was a transition from seasons running from January to December to seasons running from August to July.
Sources: 1981–1989: DFO Catch Statistics; 1990–2002: Archipelago Marine Research Ltd.

catches and collect data. In 1993, the DFO concluded that compliance within the sablefish fishery has improved. License holders have also indicated that there has been an improvement in the enforcement and monitoring methods as well as in accountability.

The change in fisheries management also changed attitudes. License holders see themselves as stewards rather than miners of the resource. Their relationship with DFO is more positive and frequently referred to by both industry and DFO as a co-management arrangement. In a joint DFO and industry presentation, the following message was delivered: "Co-management in the commercial sablefish fishery has been a positive experience, has benefited both DFO and the PBFA [Pacific Blackcod Fisheries Association], and has improved the overall research, assessment, monitoring, enforcement, and management of the fishery" (Turris 1998b). Actions support the reality of this new attitude. For example, to protect stocks, fishermen agreed to reductions in the allowable catch of 18% in 1995 and of 13% in 1996. They also voted to close large areas of the coast that were known to be grounds for smaller, younger fish (DFO 1995).

Industry funds all research and stock assessments. The annual budget for scientific research for sablefish is $800,000 (Canadian Sablefish Association 2000a). The budget includes salaries as well as research programs

and new initiatives (Turris 1999: 6). There are two major stock-assessment programs currently underway for sablefish. These programs, along with a tagging system and a biological sampling program, are all co-managed by the DFO and industry.

In addition to research on annual stock assessments, funding is also available to study long-term science (such as the impact of climate) and the effectiveness of more selective harvesting to reduce juvenile mortality. A good example of the latter is the research done in 1997 on the use of escape rings for sablefish traps that have been introduced to reduce juvenile sablefish bycatch. The results of this research were impressive enough that by 1999 fishing traps were required to have two escape rings (Turris 1998b: 6).

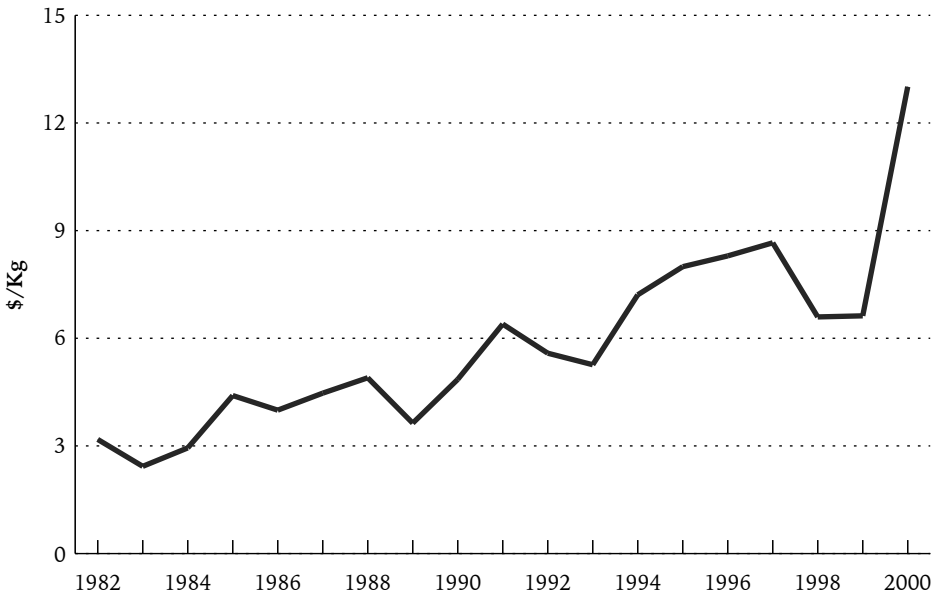
Conservation has also been improved by reducing or eliminating the loss of fishing gear. The frantic pace of the fishery before 1990 meant that it was not uncommon for gear to be lost or left on the fishing grounds, where it continued to catch fish, reducing future catches. The change to ITQs has largely eliminated this problem.

Economic viability

With the introduction of ITQs, the length of the season increased substantially, from 14 days in 1989 to over 250 days in 1990. The sablefish fishery is now open year-round. The lengthened season for the sablefish fishery dramatically increased the quality of the product. The frantic pace of the fishery before ITQs meant most fishing time was spent setting and hauling. Now there is time to bleed, dress, ice, freeze, and store the catch (Turris 1999: 6). Providing a product of higher quality and providing it year round rather than in one short two-week window increased landed prices for Canadian sablefish. In 1989, the year before the change, the price was $3.63/kg. In 1990, the price rose by more than $1/kg to $4.85/kg (figure 3.3). The increase in prices led to an increase in revenues despite a decrease in landings (figure 3.4)

Although other factors besides quality and length of the season will affect prices, comparing the average landed prices of Canadian sablefish (under an ITQ system) and the average landed prices of Alaskan sablefish (under limited entry at the time) isolates the effect of the ability to serve markets better that results from the introduction of quotas. There was an increase in the average landed price for Canadian sablefish between 1988 (pre-ITQs) and 1991 (post-ITQs) of $0.89 per pound (an increase of 56%) whereas, over the same time period, the average landed price for Alaskan sablefish declined by $0.08 per pound. According to DFO's interviews with license holders, two-thirds indicate that quality increased with ITQs and reported that the increase in time available to handle the fish was an important factor in the increase; 64% said that the increased ability to freeze at sea positively affected quality and prices; and 73% believed that choosing fishing times over a 12-month season eliminated supply gluts and increased prices (Turris 1998a: 6).

Figure 3.3: Sablefish—landed price, 1982–2000 (adjusted for inflation)

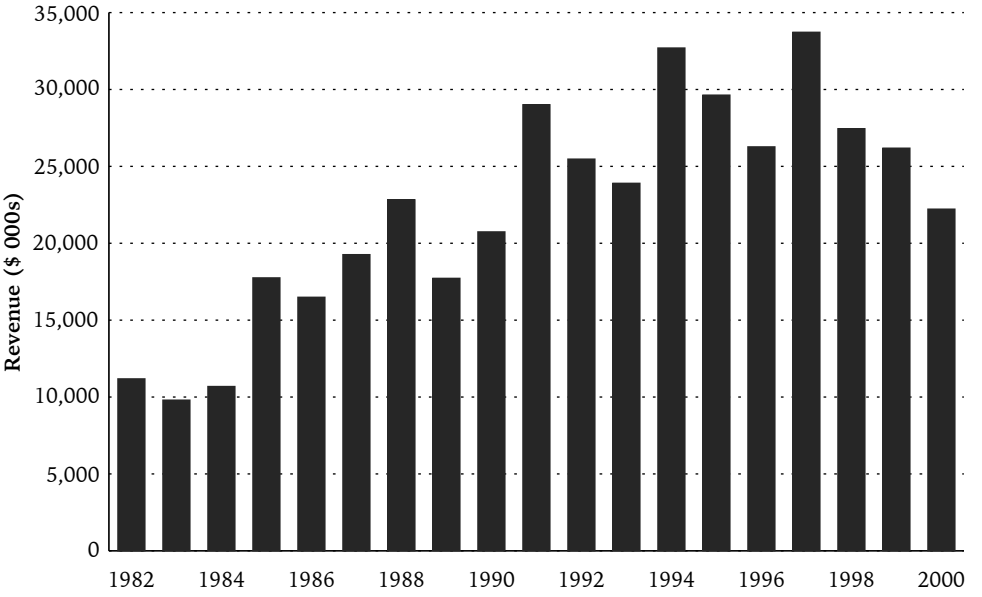


Note: (1) Limited entry was introduced in 1981, individual quotas in 1990. (2) Numbers adjusted for inflation using 2000 as the base year.
Source: DFO-Pacific 2001d: 5; 2000 Price: John Davidson, Catch Statistics Unit, DFO, personal communication, May 16, 2001.

Fishing costs also declined under ITQs, which further improved the economic viability of the sablefish fleet. During the derby-style fishery, fishing costs consistently increased as capital investment became necessary to ensure one's minimum catch. As Turris explains, ITQs for sablefish have "remove[d] the incentive for a fisherman to invest in the hope of increasing his catch share" (Turris 1998b: 5). The increase in revenues and decrease in operating costs improved the profitability of the fishery despite industry's paying for additional management costs.

The clearest indication of the improved economics of the fishery is the willingness and ability of fishermen to cover their management expenses. Prior to the adoption of quotas for the sablefish fishery, each license holder was required to pay only a nominal licensing fee of $10 annually. This fee was grossly insufficient to cover existing management costs, which increased when the introduction of quotas added new costs for monitoring and enforcement: DFO salaries and benefits, operating costs for fisheries managers such as computer equipment and vehicles, contracts with third party monitors, and research and development initiatives (Turris 1998). Yet, both the old and the new costs are now paid entirely by industry. License holders pay a flat fee of $500 annually combined with a per-tonnage fee for their catch

Figure 3.4: Sablefish—revenue for fishery, 1982–2000 (adjusted for inflation)



Notes: (1) Limited entry was introduced in 1981, individual quotas in 1990. (2) Numbers adjusted for inflation using 2000 as the base year.
Source: DFO-Pacific 2001d: 5; 2000 Value: John Davidson, Catch Statistics Unit, DFO, personal communication, May 16, 2001.

(Bruce Turris, Manager, Canadian Groundfish Research and Conservation Council, personal communication, August 31, 2000). In total these fees are now around $1 million a year (table 3.1), likely more than sufficient to cover all costs associated with managing the sablefish fishery.

Working conditions

As in other fisheries, changing to ITQ management resulted in a reduction in the number of crew employed in the sablefish industry. Between 1988 and 1991, the number of crew fell by approximately 322 individuals. Remaining fishermen work longer, more consistent schedules with greater security of income. More importantly, remaining crew enjoy safer fishing conditions (Turris 1999: 6). Prior to the change in management, the reality of fishing in shortened seasons meant safety was a low priority. Crew would often fish around the clock and sleep deprivation impairs judgment and reflexes. Adding to this danger, boats were overloaded with equipment and crew and would go out regardless of weather conditions. Individual catch allocations (IQs) and year-round fishing has eliminated the need to fish in hazardous weather, overload boats, or work unreasonable shifts.

Table 3.1: Total sablefish fees paid to the DFO by license holders, 1982–2000

Total fees paid		Total fees paid		Total fees paid	
1982	480	**1989**	480	**1995**	480
1983	480	**1990**	480	**1996**	864,000
1984	480	**1991**	480	**1997**	1,080,000
1985	480	**1992**	480	**1998**	1,080,000
1986	480	**1993**	480	**1999**	1,080,000
1987	480	**1994**	480	**2000**	960,000
1988	480				

Source: Russell Mylchreest, Senior Economist, Policy Branch, DFO Pacific Region, personal communication, June 5, 2001.

Overall assessment

Individual transferable quotas unquestionably improved conservation, economic viability, and working conditions in the fishery. The year before the change in management, fishermen could only fish for 14 days. If individual quotas had not been introduced, the 1990 season would have been reduced to just nine days. Such short seasons created extremely stressful working conditions—boats were overloaded with gear and crews were working 24 hours to make the most of the time available. Needless to say, fish were not handled carefully and product quality suffered. Poor product quality and supply gluts meant low landed prices. Meanwhile, to stay competitive in the race against other fishermen, costs were escalating as license holders added additional equipment, crew, and technology to their boats. License holders recognized that this was not a formula for success.

As in many other cases, the introduction of individual quotas created a future for the fishery. Fishermen can now fish year round, which allows more time for marketing and for managing the quality of the product. As a result, prices have gone up. The slower fishing pace has reduced costs and improved working conditions. The most important change has been improved conservation. Not only are allowable catches no longer exceeded, license holders are working cooperatively with DFO to ensure that monitoring is effective and that important research is conducted. The devolution of many management responsibilities including drafting annual and long-term commercial sablefish management plans, overseeing the dockside monitoring program, and funding all management and research costs has increased industry's sense of having a long-term stake in the health of the fishery.

Halibut

Pacific halibut (*Hippoglossus stenolepis)* is one of the largest and most economically important commercial species of finfish inhabiting British Columbia's northern waters. Halibut have flat, diamond-shaped bodies. They generally weigh less than 50 pounds and measure under four feet, although they can reach 8 feet in length and weigh as much as 500 pounds (Coughenhower 1997: 4). They are found along the continental shelf in the North Pacific and the Bering Sea, from Santa Barbara, California to northern Alaska (DFO 2000e; IPHC 2000). Halibut fishermen use hook-and-line gear.

A brief history of the fishery

Commercial halibut fishing began in the late 1880s. The fishery operated as an unregulated, open-access fishery until 1923 when, following nearly 30 years of unmonitored fishing, the Canadian and American governments formed what eventually become known as the International Pacific Halibut Commission (IPHC).[1] The IPHC's role was initially limited to enforcing a three-month fishing moratorium, implemented to protect stocks. In 1930, however, Canadian and American representatives agreed to extend the IPHC's management tools to include setting international catch limits and imposing gear restrictions (Gislason 1999: 9). The IPHC continues to set the TAC each year, after estimating the biomass and adjusting for incidental mortality.

In 1953, an amendment to the 1930 convention was accepted, which allowed Canada and the United States control over the starting dates and duration of their respective fishing seasons. To gain further control over the management of its halibut fishery, Canada initiated a 1979 protocol to the

1953 amendment, which allowed Canadian and American governments to regulate their halibut fisheries independently. Immediately following the 1979 protocol, Canada imposed limited entry on its halibut fleet.[2] The Department of Fisheries and Oceans (DFO) issued 435 licenses, representing all of the active fishermen at that time. The same number of halibut licenses are issued by the DFO today (Gislason 1999:3).

During the 1980s, fishing power increased dramatically in the halibut fishery as fishermen hired additional crew and began using electronic gear, more efficient circle hooks, and automatic baiters (Casey, Dewees, Turris, and Wilen 1995: 14). In 1980, halibut fishermen took 65 days to catch 5.7 million pounds of halibut. Just ten years later, advances in fishing technology and increases in productivity enabled fishermen to catch over 8 million pounds of halibut in only six days (Macgillivray 1997: 108). To control the size of the catch, managers shortened seasons but, by the end of the 1980s, there were serious questions being raised about the viability of existing management. Fishermen were unhappy with the shortened seasons as they led to decreased fishing safety, reduced revenue, and longer periods of unemployment each year. Biologists were worried about TAC exceedences, halibut mortality from gear that was left or lost on the fishing grounds, and unrecorded bycatch that was being thrown overboard. There were also rumours that fisheries regulations were being violated as the DFO did not have adequate resources to monitor fishing activity effectively (Casey et al. 1995: 215). In 1988, a small group of license holders approached the DFO to ask that individual transferable quotas be introduced to the fishery (Gislason 1999: 3).

Individual Vessel Quotas (IVQs)

Two years of consultation between industry and the DFO culminated in an agreement to implement a two-year trial period of non-transferable individual vessel quotas starting in 1991.[3] Individual vessel quotas (IVQs) were given to the 435 existing licence holders based on an allocation formula of 70% catch history and 30% vessel length. At the end of the two-year trial period, industry strongly endorsed the individual quotas—91% of the vessel owners participating in an evaluation survey supported continuing the program (Macgillivray 1997: 111). As a result, industry and the DFO decided to make the program permanent.

Although there was no "stacking" of licences (more than one quota licence on a single vessel) permitted during the trial period, DFO agreed to limited transferability in 1993 on a temporary basis at the industry's request. Starting in 1999, both permanent and temporary quota transfers were allowed but no individual vessel can carry more than a 1% share of the TAC.[4]

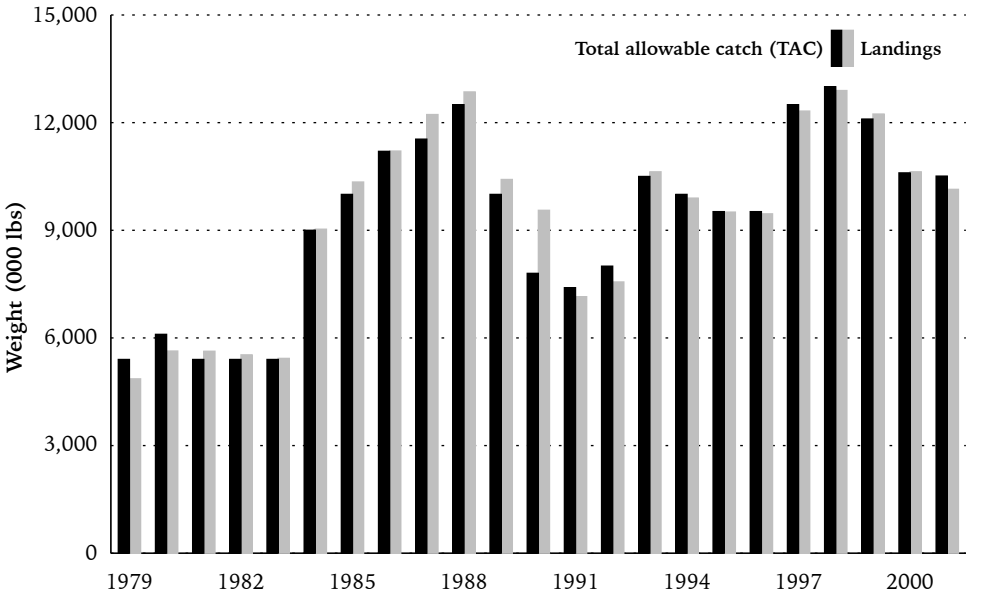
Assessment: Have individual quotas improved management of the halibut fishery?

Conservation

In the ten years preceding the introduction of IVQs, fishermen's catches consistently exceeded the TAC (figure 4.1). If one makes the reasonable assumption that the IPHC's TAC limit represents a good estimate of the sustainable level of halibut catches in a given year, actual catches that exceed this level may threaten conservation.[5] In 1990, the last year that the fishery was managed under limited entry, the actual catch exceeded the IPHC's limit by over 22%. Since the implementation of IVQs in 1991, catches, when adjusted for year-to-year carry-over allowances,[6] have never exceeded the TAC, with the exception of 1993 and 1999, when the TAC was exceeded by just over 1%, and 2000, when it was exceeded by .2% (figure 4.2).

Since the fishery was open longer under individual quotas, the change in management required additional monitoring to ensure that fishermen adhered to the TACs. With the implementation of the quota system, therefore, the DFO and the industry agreed to adopt new regulations guiding "hailing-

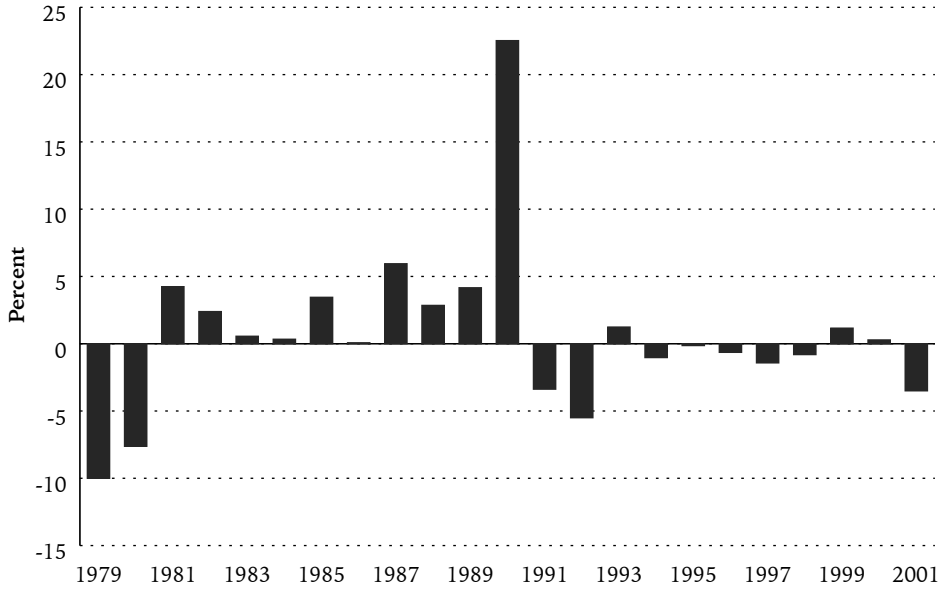
Figure 4.1: Halibut—TAC compared to actual catch, 1979–2001



Notes: Limited entry was introduced in 1979, individual quotas in 1991. All weight in dressed, rather than round, weight.

Sources: International Pacific Halibut Commission; 2000 TAC: http://www.iphc.washington.edu/halcom/newsrel/2000/nr20000417.htm; 2000 Catch: www.iphc.washington.edu/halcom/commerc/fishery00.htm.

Figure 4.2: Halibut—catch overage or underage (percent), 1979–2001



Notes: Limited entry was introduced in 1979, individual quotas in 1991. All weight in dressed, rather than round, weight.
Source: International Pacific Halibut Commission 2001.

out" and "hailing-in" (the act of a fishing vessel announcing when it is leaving and returning to port at the beginning and the end of fishing activities). Independent, industry-funded, monitors now check each vessel at port to record its catch and ensure there are no catch overages (DFO-Pacific 1996).

DFO also contracts with a third party to conduct on-board monitoring of rockfish bycatch in the halibut fishery. Since on-board monitors observe all fishing activity on a vessel, their presence also likely discourages high-grading. However, on-board monitoring only covers between 5% and 10% of the halibut fleet at any given time. According to one halibut fishermen, any high-grading that may still occur pales in comparison to the loss of gear and the resultant mortality of fish that prevailed before the introduction of individual quotas.

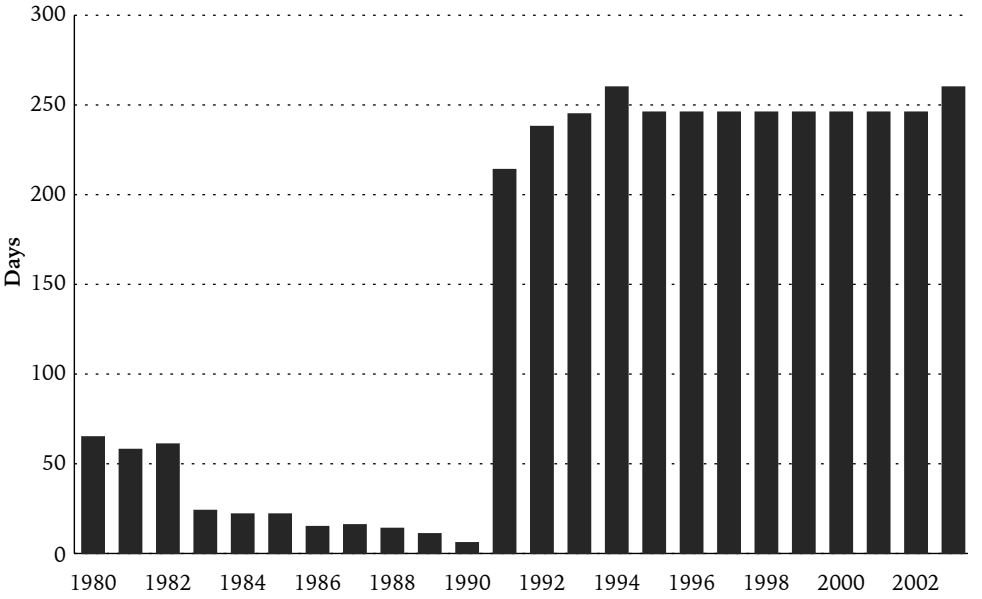
Halibut harvesters also enhance the DFO-mandated enforcement and monitoring program by funding a tagging plan. Each halibut that is caught gets tagged with a serial number that enables monitors to confirm that the landed catch is legitimate. Tagging identifies not only the fish but also the vessel of origin, which provides a greater sense of accountability for the consumer who can now hold a specific vessel owner responsible for fish of subpar quality (Boyes, halibut fisherman, personal communication, June 12, 2000). The tagging system is an example of how the introduction of quotas has increased the responsibility and contribution of vessel owners to managing the resource.

Prior to the introduction of IVQs, biologists were also becoming increasingly concerned about fish killed by abandoned or lost long-line gear, which continues to catch fish (Casey et al. 1995: 215). The gear was left or lost on the fishing grounds due to the hectic pace of the fishery. The introduction of quotas has all but eliminated this problem because fishermen now have time to keep track of, and recover, their gear.

Economic viability

The most striking economic impacts of the adoption of IVQs were a result of the immediate lengthening of the halibut fishing season from 6 days of active commercial fishing in 1990 to 214 days in 1991 (figure 4.3). The lengthened season eliminated supply gluts and increased the availability of fresh fish, which increased landed prices. In 1990, the year before the introduction of IVQs, halibut sold for $6.77/kg. Following the introduction of quotas in 1991, halibut sold for an average of $7.74/kg (figure 4.4). Further evidence that landed prices increased as a result of the IQ program can be found by comparing British Columbia and Alaska (table 4.1). In 1991, before Alaska adopted an IQ program, their halibut was selling for US$2.00/lb, while halibut caught on Canada's Pacific coast was selling for US$2.64/lb. Despite the higher prices in the fishery, during the first two years of the IQ program revenue remained fairly constant due to a decrease in landed catches. Comparing revenues in 1989 and 1993, two years where catches were similar,

Figure 4.3: Halibut—length of season (days) for fishery, 1980–2003

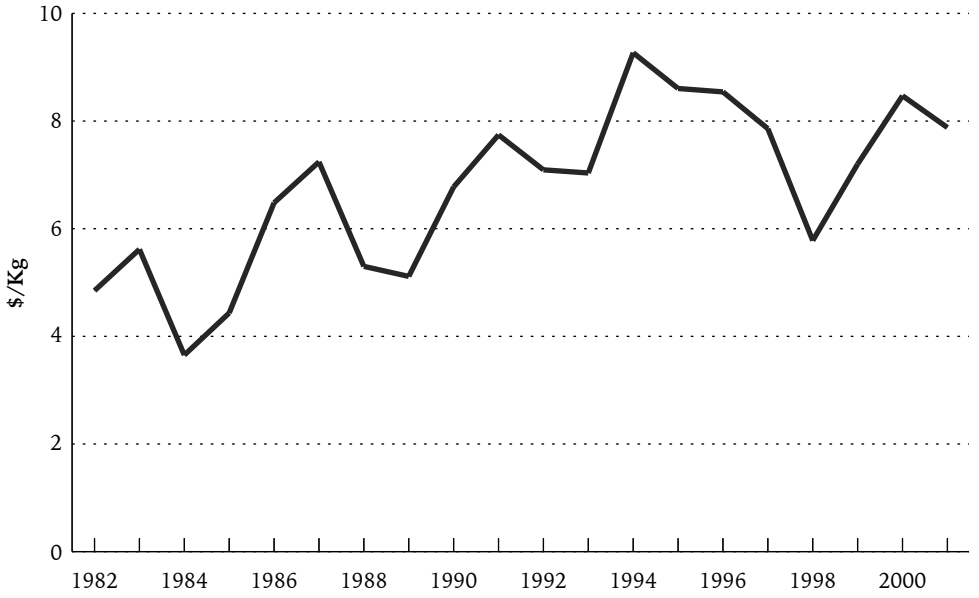


Note: Limited entry was introduced in 1979, individual quotas in 1991.
Source: Fisheries and Oceans Canada, Halibut Management Plan, various years.

shows that inflation-adjusted revenue in the fishery increased by 41% from $23,842,650 to $33,705,490 after the introduction of individual quotas. By 2001, industry revenues had increased to $36,273,000. (figure 4.5)

Eliminating the race for the fish also reduced fishing costs. Harvesting costs decreased by an estimated $440,000 in 1991 after the introduction of quotas. Most of the decrease in costs can be attributed to decreased payments to crew as there were fewer active vessels and crew members (Macgil-

Figure 4.4: Halibut—real price, 1982–2001 (adjusted for inflation)



Note: Limited entry was introduced in 1979, individual quotas in 1991.
Source: 2000 Halibut Integrated Fishery Management Plan, page 6; 2000 Price: estimate from International Pacific Halibut Commission.

Table 4.1: Price differential between BC Halibut (IQ) and Alaskan Halibut (non-IQ)

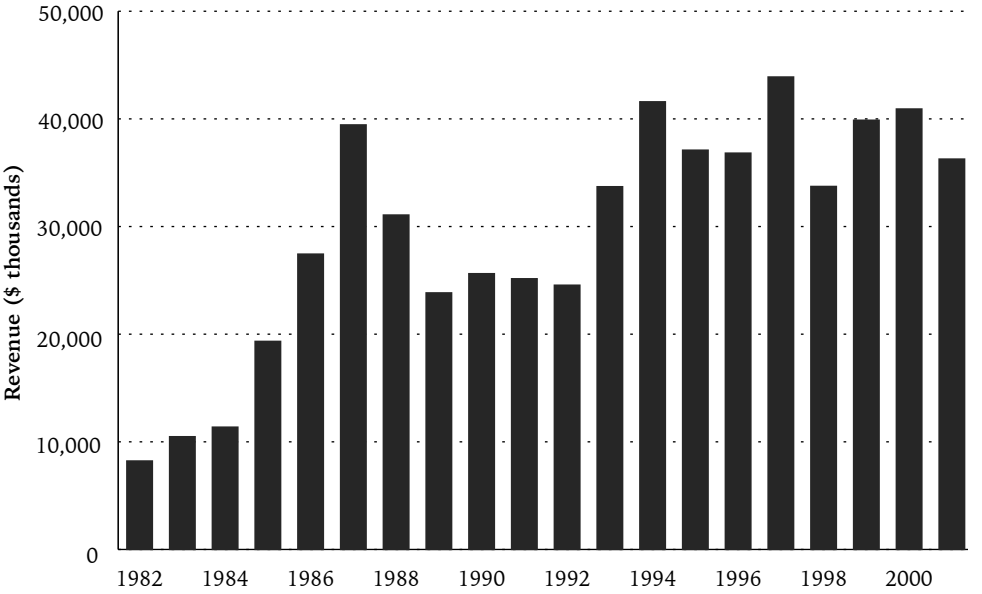
	US average ex-vessel price (US$/lb)	BC average ex-vessel price (US$/lb)	Price Differences	Price difference attributed to IVQs
1988–1990	1.50	1.72	.22	
1991–1993	1.41	2.40	.99	.77
1991	2.00	2.64	.64	.42
1992	.98	2.31	1.33	1.11
1993	1.25	2.22	.97	.75

Source: Casey, Dewees, Turris, and Wilen (1995). *The Effects of Individual Vessel Quotas in the British Columbia Halibut Fishery,* Marine Resource Economics Volume 10, p.218, USA.

livray 1997: 110). Part of the decrease in costs, however, was due to a reduction in loss of gear on the fishing grounds. It has been estimated that the net income earned by the halibut fleet in 1991 increased by about $4 million as a result of the increase in landed prices and reductions in costs attributable to the IVQ program (Macgillivray 1997: 110).

The increase in income that the introduction of quotas has afforded halibut fishermen increased their willingness and ability to cover additional management costs (table 4.2). Prior to the introduction of individual quotas, each license holder paid a flat $10 license fee and DFO collected a total of $4,350. These fees were clearly inadequate to pay for the cost of managing the fishery. To pay for the additional cost of managing the fishery under individual quotas industry agreed to a license fee of $250 and a fee per tonne of TAC (this fee was finally set at $144.70/tonne in 1995). The year individual quotas were introduced total fees collected increased 17,394% from $4,350 to $761,000. These new fees pay for a monitoring program run by third parties, the majority of the enforcement officers' salaries, and some fisheries research and development costs (DFO 1996). In addition to these cost-recovery fees, DFO began collecting an additional quota fee of between $220.30 and $310.00 per tonne of TAC in 1996 to recover some resource rents (Gislason 1999:5). The total of the cost and rent-recovery fees collected in the halibut

Figure 4.5: Halibut—real revenue for fishery, 1982–2001 (adjusted for inflation)



Note: Limited entry was introduced in 1979, individual quotas in 1991.
Source: DFO-Pacific 2000g: 6; 2000 revenue: estimate from International Pacific Halibut Commission; 2001 revenue: BC Ministry of Agriculture, Food, and Fisheries 2002.

Table 4.2: Halibut—management fees ($) paid by all license holders, 1980–2002

	Flat Rate License Fee	Management Levy	Rent Recovery	Total Fees
1980	4,350			4,350
1981	4,350			4,350
1982	4,350			4,350
1983	4,350			4,350
1984	4,350			4,350
1985	4,350			4,350
1986	4,350			4,350
1987	4,350			4,350
1988	4,350			4,350
1989	4,350			4,350
1990	4,350			4,350
1991	109,000	652,000		761,000
1992	109,000	652,000		761,000
1993	109,000	697,000		806,000
1994	109,000	620,000		729,000
1995	109,000	625,000		734,000
1996	109,000	625,000	951,000	1,685,000
1997	109,000	820,000	1,249,000	2,178,000
1998	109,000	853,000	1,298,000	2,260,000
1999	109,000	794,000	1,200,000	2,103,000
2000	109,000	696,000	1,491,000	2,296,000
2001	109,000	1,255,000	not available	—
2002	109,000	1,400,000	not available	—

Note: Limited entry was introduced in 1979, individual quotas in 1991. There are 435 halibut licenses.
Source: Gislason 1999: 4; 2000 data: DFO 2000h:19.

fishery for 2000 amounted to $2,296,000, which is roughly 5.6% of the landed value for halibut that year. Since industry is now paying for management costs, they have a stronger incentive to ensure that management is effective. This has led to better communication with the DFO and has made the department more accountable to fishermen.

Working conditions

The nature of employment in the halibut fishery changed after the introduction of IVQs. Fewer people were needed when the race to catch fish was eliminated: the number of crew working in the fishery fell by 300 between 1990 and 1991.[7] Those crew remaining in the fishery are working longer seasons, earning more, and working under better conditions (Sporer 1998). Dave Boyes, an active halibut fisherman, describes some of the safety prob-

lems with the pre-IVQ, derby-style fishery: "[some of the crews would work] for four days straight [with] no sleep, hyped up on drugs—caffeine being the least of their worries. [They were] zombies walking around in the middle of the night with hooks flying around" (Boyes, personal communication, June 12, 2000). Given this account, it is no surprise that licence holders and crew members rated improved safety as the single most important benefit of the halibut IVQ program according to a 1992 survey (Halibut IVQ Program: 9).

Overall assessment

There is no question that the change in management to individual quotas improved conservation, economic viability, and working conditions in the halibut fishery. Prior to the introduction of individual quotas, short seasons were being used to control harvests. Not only was this an ineffective strategy but it reduced the prices fishermen could get for their product and led to unsafe fishing practices. Individual quotas allowed managers to lengthen the season, which improved the fleet's profitability and, although fishing is still dangerous, the overall consensus is that IQs have made the fishery safer. An important result of the individual quota program is that industry now pays for all of the management costs.

Notes

1 The IPHC was originally known as The International Fisheries Commission.

2 The United States continued open access, which allowed any interested fishers to harvest the resource, until 1995.

3 The restriction of non-transferability limited transactions between existing license holders only; any new entrants could purchase an IVQ from an existing license holder.

4 This rule applies to all boats except the few "grandfathered" halibut vessels operating in the fishery, each of which had an historic catch of more than 1% of the TAC.

5 The TAC may vary from year to year depending on changing biological conditions and as the science of stock assessment becomes more sophisticated over time.

6 Carry-over allowances: a fisherman is allowed to exceed the TAC in one year up to a certain amount, which is then subtracted from his IQ in the following year.

7 The introduction of IVQs did create some new employment opportunities like validation, enforcement, and observation in coastal communities.

Red Sea Urchin

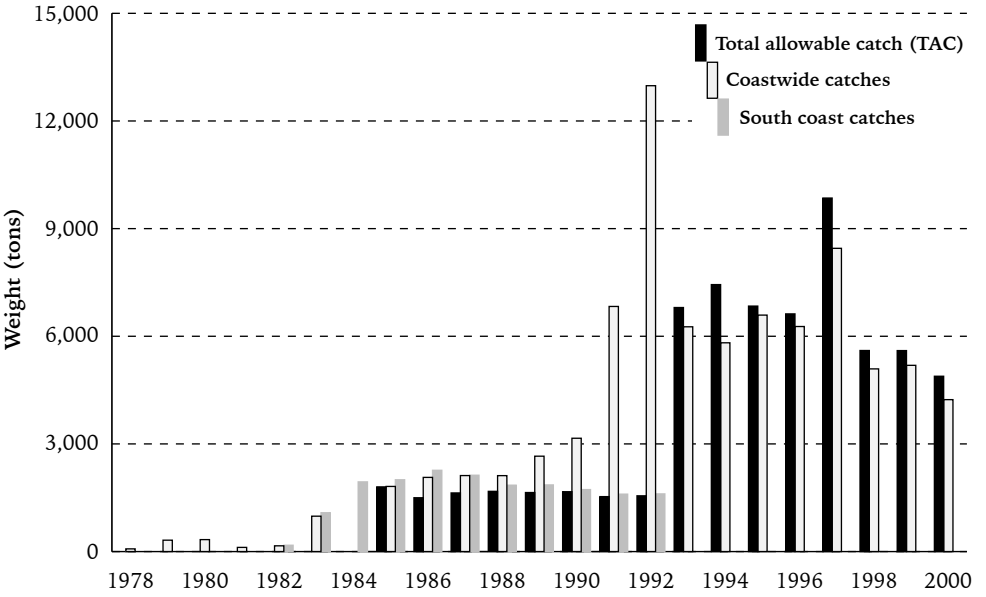
The red sea urchin (*Srongylocentrotus franciscanus*) is covered with sharp spines, which protrude from its ball-shaped shell, called a "test." Both the test and spines are generally a deep reddish-purple (DFO-Pacific 1999e). Red urchins grow up to 7 inches long and can live for more than 100 years. The red sea urchin is typically found on rocky surfaces in fairly shallow water with moderate to strong currents and from Baja, California up to Alaska (DFO 1999d). They are harvested by divers and processed for their roe, which is sold in Japan and North America.

Brief history of the fishery

Commercial fishing for red sea urchin began in 1971 but harvests remained small until 1978, when fishing along the southern part of Canada's Pacific coast began to expand (Muse 1998d: 3). During the 1980s, prices for sea urchin rose steadily and the number of active vessels in the fishery increased more than six-fold from 18 in 1980 to 115 in 1989. Over the same time period, coastwide catches increased eight-fold from 333 tons in 1980 to 2,658 tons in 1989 (figure 5.1). Much of the increase from the mid- to late 1980s was due to the expansion in fishing activity off the northern part of Canada's Pacific coast.

Although commercial fishermen were required to hold a registration card and vessel licence in 1978, entry in the fishery remained virtually unlimited until 1991. There were, however, other restrictions on fishing effort. During the early 1980s, the DFO set a minimum size for harvestable sea urchins and introduced seasonal closures and some area TACs for the southern part of the coast. The fishery off the northern part of the coast was restricted to the minimum size but had no TACs or area closures until 1990.

Figure 5.1: Red Sea Urchin—TACs compared to total catch



Notes: Up to 1992, south-coast catches are compared to south-coast TAC because northern TACs were not set until 1993; from 1993 to 2000 coastwide catches are compared to coastwide TACs. Limited entry was introduced in 1991, voluntary IQs in 1994, and DFO IQs in 1996. Data on catches originate from two separate sources, which accounts for some discrepancies such as the south-coast landings exceeding the coastwide landings in some years in the 1980s.

Sources: Muse 1998d; DFO-Pacific 2000c; DFO-Pacific 1999e; John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000, May 2001.

In an attempt to control the increasing size of the catches in the fishery, the DFO limited licensing in 1991 and reduced the number of licenses issued to 102 from the 188 issued in 1990 (DFO 2000c: 10; Muse 1998d: 5). Following several licensing appeals, the number of licences was finally set at 110 in 1994 (Muse 1998d: 5). Licences were issued selectively to harvesters who had landed 75,000 pounds of red sea urchin from 1987 to 1989, had recorded 20 days of harvests during this same three-year period, or had landed 5,000 pounds of red sea urchin in any year in the north-coast area between 1987 and 1989 (Muse 1998d: 5). Native harvesters qualified under less restrictive guidelines. Licences were non-transferable though long-term leasing was permitted.

Limited entry did not reduce the catch. In 1992, harvests reached its highest level of 12,983 tonnes, an increase of 90% over the previous year. This dramatic increase was mainly due to additional harvesting off the north coast, where TAC limits had not yet been established. In 1993, managers imposed catch limits for the north coast. Although the coastwide harvest fell

below the coastwide TAC in 1993, this was accomplished with short "derby" style openings, which led to the supply gluts and safety concerns common in other limited-entry fisheries. Shortly after the fishery opened in 1994, something extraordinary happened. Fishermen voluntarily stopped fishing and met in Prince Rupert to discuss a solution to the problems created by the intense fishing during the short openings (Muse 1998d: 6). After a week of negotiation, they developed a plan for a voluntary individual quota program (Muse 1998d: 6).

Individual Quotas (IQs)

In 1994, the Pacific Urchin Harvesters Association (PUHA) divided the remaining 1994/1995 coastwide TAC equally among the 110 licences and managed industry's voluntary IQ program. Licence holders were united in their belief that individual quotas would improve fisheries management and every licence holder agreed to participate in the voluntary program (Mike Featherstone, President, Pacific Urchin Harvesters' Association, personal communication, July 10, 2000). The industry allowed limited transfers of quotas although transfers were not permitted between the north coast and the south coast. The voluntary IQ program lasted through two fishing seasons, from 1994 to 1996.

At industry's request, the DFO replaced the voluntary program with a two-year "pilot" program of individual quotas (IQs) in 1996. This official IVQ management strategy also entailed dividing the coastwide TAC equally across all 110 licences. The initial individual quota allocation in 1996 was 132,763 pounds of red sea urchin for each licence, north or south coast (Muse 1998d: 8).

The DFO restricted the transferability of quotas, permitting up to three licences to be transferred to a single vessel and prohibiting quota transfers separate from the licenses. In the first year of the official IVQ program, there were 21 licence holders for the south coast and 89 for the north coast. "Rolling openings" were implemented with the IQ program to spread the catches out throughout the entire season by opening different areas at different times. This allowed harvesters to meet market demand and earn a higher ex-vessel price (Muse 1998d: 9).

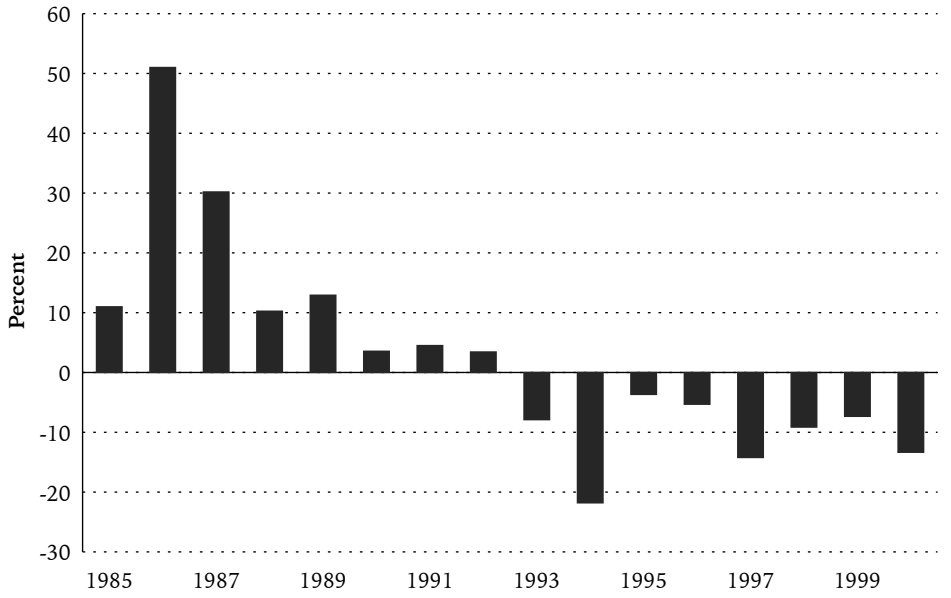
Assessment: Have individual quotas improved management of the red sea urchin fishery?

Conservation

The use of individual quotas in the red sea urchin fishery stabilized catches and kept them within set TAC limits (figure 5.1). TACs have not been exceeded since the introduction of individual quotas (figure 5.2). Prior to quotas, TACs for the south coast were regularly exceeded and, while TACs for the north coast were not established until 1993, catches were rising at an alarming rate.

When industry agreed to introduce a voluntary IQ program, they also agreed to pay to have landings independently monitored by D&D Pacific Fisheries Limited. Fishermen reported to D&D before they went fishing and each landing was weighed and validated. The industry hired on-ground monitors (i.e., monitors who monitor the fishing grounds independently from their own vessels) for the north coast in 1995 (Muse 1998d: 7). Under the DFO's IVQ program, industry continues to contract out enforcement and monitoring duties to D&D through the Pacific Underwater Harvesters As-

Figure 5.2: Red Sea Urchin—catch overage or underage (percent)



Notes: Up to 1992, south-coast catches are compared to south-coast TAC because northern TACs were not set until 1993; from 1993 to 2000 coastwide catches are compared to coastwide TACs. Limited entry was introduced in 1991, voluntary IQs in 1994, and DFO IQs in 1996.

Sources: Muse 1998d; DFO-Pacific 2000c; DFO-Pacific 1999e; John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000, May 2001.

sociation (PUHA). D&D on-ground observers continue to patrol the north coast during fishing times to deter any illegal activities. Fisheries managers believe that the on-ground observers act as a strong deterrent to illegal activity (Rick Harbo, Senior Fisheries Management Biologist, Invertebrate Species, personal communication, July 28, 2000). All landings are still monitored by an independent validator, "hailing-out" and "hailing-in" (the act of a fishing vessel announcing when it is leaving and returning to port at the beginning and the end of fishing activities) are required at least 24 hours prior to arrival and departure, and landings have to be made at designated landing ports where they are reported in log books (Muse 1998d:10).

The industry has taken a hard line on catch overages. A penalty system that requires all licence holders with overages of more than 150 pounds in a given season to relinquish the proceeds from the sale of the overage to the DFO has been agreed to by industry and the DFO. During the 1997 season, in addition to relinquishing the proceeds, the licence holder also had the amount of the overage deducted from his 1998 quota allocation (Muse 1998d:11).

Under the individual quota (IQ) program, biological research has improved. Industry has funded biomass surveys and aquaculture research (Mike Featherstone, personal communication, July 10, 2000). They also pay for an independent biologist who works jointly for the DFO and the industry. One interesting result of this research was to change the minimum size at which red sea urchins could be harvested. Previously, sea urchins could not be harvested on Canada's Pacific coast until they reached 106 mm in length despite the preference of the Japanese sushi-market consumer for urchins of 76 mm to 99 mm. Following careful ecological assessments of sea urchins on Canada's Pacific coast, the DFO stock-assessment biologists presented industry with the option to change the size limit to 90 mm in exchange for a 12% reduction in quota. By meeting Japanese demand better, the industry commands a higher price for its product and will be in a much better position to compete in the international sea-urchin market (Mike Featherstone, personal communication, July 10, 2000).

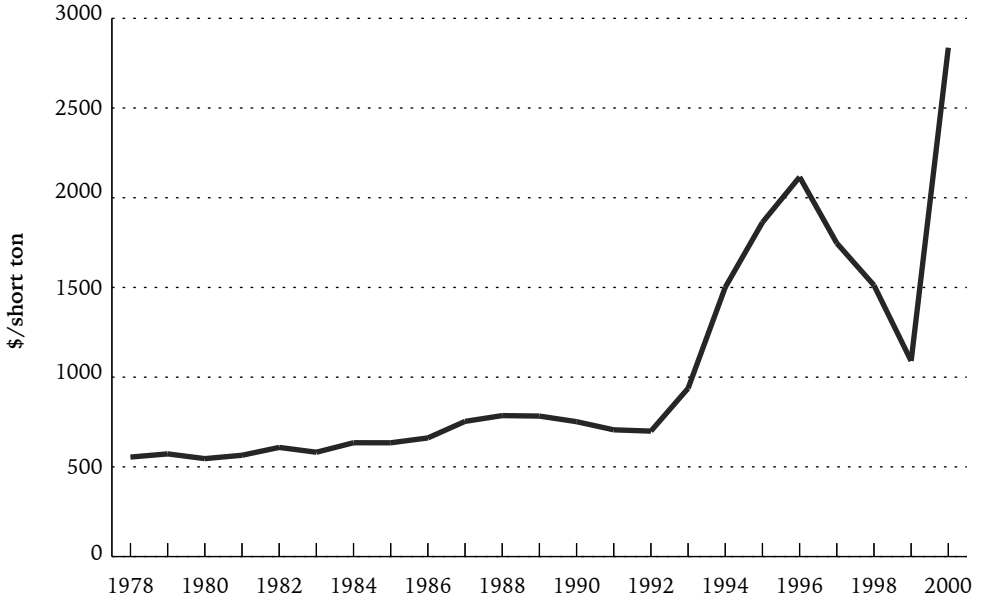
Economic viability

Although red sea urchins can be harvested all year, the best time to harvest is in the winter months when roe yields are highest. Prior to the implementation of IQs, the fishing season for red sea urchins was limited to short openings during this period. Although fishing activity is still concentrated in the winter, the implementation of IVQs and rolling openings has meant that urchins are now fished throughout the year. The security of access that is afforded with individual quotas has changed the incentives facing the harvesters—they now search for quality (urchin with more and better roe) as opposed to quantity (the poundage of whole urchins) (Mike Featherstone, personal communication, July 10, 2000).

The improved quality appears to have had an affect on prices. Although inflation-adjusted landed prices were slowly increasing even prior to the introduction of IQs, they began to increase more quickly once quotas were introduced. In the three years prior to the introduction of individual quotas, landed prices began to rise but remained under $1000 per ton (figure 5.3). In 1994, the year individual quotas were introduced, the price increased 60% from $938 per ton in 1993 to $1,501 per ton. Total revenues in real terms also increased during the first several years under IQs due to higher prices (figure 5.4). In 1993, industry revenues were $5,873,485 compared to $8,733,360 in 1994 and revenues continued to increase until 1997 when they reached a plateau at over $14 million. Prices and revenues fell in 1998 and 1999 as a result of decreased demand for red sea urchin in Asia but rebounded in 2000.

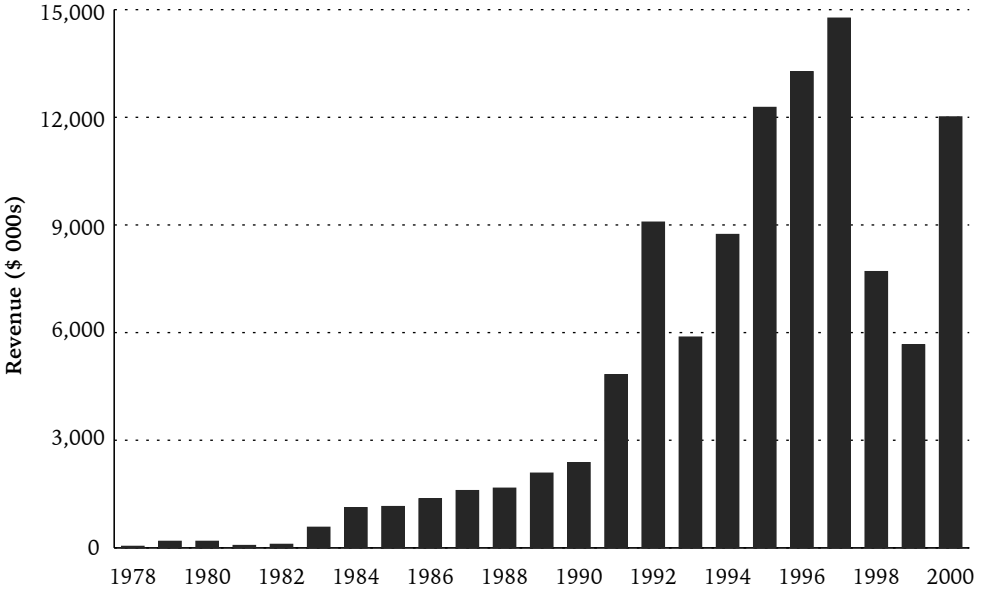
In addition to the increased revenues in the fishery, eliminating the race for the fish has reduced fishing costs in the industry. As in other fisheries, the move to individual quotas has meant that fishermen are paying additional management and monitoring costs. Prior to IQs for red urchins, the fishery was managed by the DFO with limited industry input. Fishermen were required to pay a nominal annual licensing fee of $50 as well as an industry-initiated research fee of $250 annually. Prior to the introduction of IQs, the

Figure 5.3: Red Sea Urchin—landed prices, 1978–2000 (adjusted for inflation)



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and DFO IQs in 1996.
Source: personal correspondence with John Davidson, Catch Statistics Unit, DFO, August 2000, May 2001.

Figure 5.4: Red Sea Urchin—real revenue for fishery (adjusted for inflation)



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and DFO IQs in 1996.
Source: personal correspondence with John Davidson, Catch Statistics Unit, DFO, August 2000, May 2001.

management costs within the fishery were not being covered but now an estimated 80% of the management costs are being recovered by industry (Mike Featherstone, personal communication, July 10, 2000). A two-part cost-recovery system was put into place for red sea urchins following the introduction of IQs. The flat licensing fee increased from $50 to $530 annually. The DFO uses these fees to pay for certain management and operational costs.

As well, there is an industry-initiated fee that pays for on-grounds monitoring, port validation, science and research, and PUHA's administration, website and newsletter. The annual fee is set and the budget approved at the PUHA's annual general meeting; in 2002, this fee was $0.04 per pound, which worked out to be over $5,500 per license. Thus, the majority of the management costs in the fishery are recovered through direct payments from participants (table 5.1).

Working conditions

Safety in the fishery definitely improved under IQs. In the effort-control fishery, "fishermen were forced by competitive pressures to operate in poor conditions with insufficient regard for safety" (Muse 1998d: 6). The pre-IQ, competitive environment led to many boats sinking whereas, since the quota system has been implemented, there has been a huge decrease in accidents

Table 5.1: Red Sea Urchin—management fees ($) paid by license holders to the DFO and to the industry association, 1974–2002

	DFO Fee	Industry Association Fee		DFO Fee	Industry Association Fee
1974	50	250	**1989**	50	250
1975	50	250	**1990**	50	250
1976	50	250	**1991**	50	250
1977	50	250	**1992**	50	250
1978	50	250	**1993**	50	250
1979	50	250	**1994**	530	5,000
1980	50	250	**1995**	530	5,000
1981	50	250	**1996**	530	5,000
1982	50	250	**1997**	530	5,000
1983	50	250	**1998**	530	5,000
1984	50	250	**1999**	530	5,000
1985	50	250	**2000**	530	5,321.36
1986	50	250	**2001**	530	5,500
1987	50	250	**2002**	530	5,500
1988	50	250			

Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and DFO IQs in 1996.
Sources: Mike Featherstone, President of the Pacific Urchin Harvesters' Association, personal communication, May 2001, September 2003; DFO-Pacific 1999e: 28.

as everyone co-ordinates their harvests in accordance with market demand without having to operate under adverse fishing conditions (Mike Featherstone, personal communication, July 10, 2000).

With the advent of individual quotas, there has been a rationalization of fishing inputs that includes a decrease in the number of active vessels and the number of divers actively participating in the fishery. From 1988 through 1992, the number of divers increased in each fishing season, from 152 in 1988 to 303 in 1992. However, once coastwide TACs were imposed in 1993, the number of divers fell to 258 in the first year and this was followed by continuing decreases, due in part to the adoption of the IQ system in 1994, until there were 177 divers in 1996 (Muse 1998d: Appendix). Prior to the introduction of IQs, although there were more employees, each one worked only part time and was earning only a fraction of what the employees are earning today. These employees have security in their jobs and more income, since they work full time, and are able to provide for their families year round (Mike Featherstone, personal communication, July 10, 2000).

Overall assessment

One of the most interesting aspects of the IQ program in the red sea urchin fishery is that it was initiated by those working in the industry, who recognized that trying to control effort in the fishery with shorter openings and increased regulations was not working. Rather, it was causing market gluts, low prices, poor product quality and unsafe diving conditions. Most importantly, it was not proving an effective way to control catches. The small number of license holders made it possible for people to get together and decide on a new management structure. In the red sea urchin fishery, the move to individual quotas had the effect of improving conservation, improving economic viability, and improving working conditions in the fishery. Changes in the red sea urchin fishery proved to be a model for the green sea urchin fishery.

Green Sea Urchin

The green sea urchin (*Strongylocentrotus droebachiensis*) has a spiny exterior similar to that of a hedgehog and an olive-green test (shell). The green sea urchin is harvested for its gonads, or roe. Unlike red sea urchins, which are generally sold processed, green urchins tend to be sold whole and live to Asian markets. Green sea urchins are hand gathered by divers in order to ensure a high-quality product and to minimize the amount of ecological disruption to surrounding areas (DFO-Pacific 1999d).

Green sea urchins have a circumpolar range, inhabiting areas in both the eastern Pacific and western Atlantic oceans. The patchy distribution of the green sea urchin extends throughout the eastern Pacific from as far north as Point Barrow, Alaska, down to Washington State.

A brief history of the fishery

Commercial fishing for green sea urchins in British Columbia began in 1987, when fishing permits were issued to 38 boats. Entry into the fishery initially was not limited but harvesting was restricted to the times when market demand was highest: from October to December and January to February. Limits on the size of sea urchin that could be caught were initially set at 40mm (0.16 inches) in order to allow the urchin to spawn at least once before being harvested (DFO-Pacific 2000a: 6).

Between 1987 and 1990, before entry into the fishery was restricted, the number of licenses increased by over 300% from 38 to 155 (table 6.1). Other indicators of increased fishing activity over this period of time include a sizeable increase in the number of days that boats are out on the water fishing ("vessel fishing days"), the number of divers in the fishery, and the hours those divers spent harvesting urchins (table 6.1). Not surprisingly, the amount harvested also increased substantially, from 120 tonnes in 1987

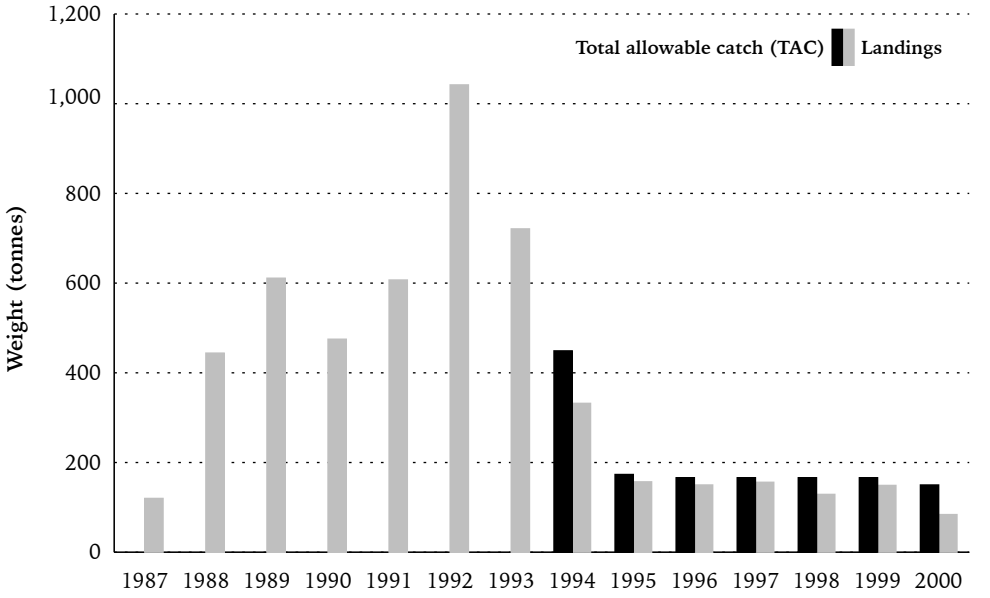
to 474 tonnes in 1990 (figure 6.1). Fisheries managers attempted to control the catch by increasing size limits to 55 mm and restricting the time that could be spent fishing and the areas that were available for fishing (Muse 1998d: 17). In a further attempt to control fishing activity, limited entry licences were introduced in 1991. To qualify for a licence, each harvester must have landed at least 20,000 pounds of sea urchin between 1988 and 1989. Following appeals, 49 vessels received licences. The licences were only transferable to a vessel of equal or lesser length than that of the originally licensed vessel.

As in other fisheries, restricting entry and introducing new restrictions on harvesting did not stop effort in the fishery from increasing. Although in the first year of limited entry the number of licenses fell, the number of vessel fishing days hardly changed and the number of diver hours increased from 3,568 to 5,972 (table 6.1) (Muse 1998d: 18). Catches increased in 1991 and hit a high of 1,042 tonnes in 1992. Managers responded by further restricting fishing times. In 1994, catch limits (TACs) were introduced in response to increasing concerns about conservation. In the fall of 1994, harvesters of green sea urchins agreed to implement a voluntary individual quota program similar to the one that had been introduced to the red sea urchin fishery earlier that year. Initially, the program was independent of the DFO. In the fall of 1995, DFO supplanted industry's voluntary program with its own IQ program.

Individual Quotas (IQs)

When industry participants organized their own IQ system in 1994, they divided the TAC equally, allocating 15,700 pounds to each licence holder who volunteered to be part of the program (most licence holders took part) and licence holders could transfer parts of their individual quota to other licence holders (Muse1998:19). An equal allocation formula is also used under the DFO's IQ program, which was first implemented on a two-year trial basis the following year. The DFO's program prohibited transfers of licences, although it permitted up to three licences to be stacked on a single vessel at any one time (a case likely to arise if several licensed fishermen were to fish off the same vessel). Under the IQ system, overages of sea urchin up to 100 pounds can be transferred to other licence holders who are at least 100 pounds below their own quota.

Figure 6.1: Green Sea Urchin—TAC compared to actual catch, 1987–2000



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and official DFO IQs in 1995.
Source: DFO-Pacific 2000a; Muse 1998d; John Davidson, Catch Statistics, DFO, personal communication, August 2000, May 2000.

Table 6.1: Harvesting effort in the Green Sea Urchin fishery on Canada's Pacific coast

	Management Style	Number of Licences	Number of Vessels with Landings	Vessel Fishing Days	Diver Hours	Divers
1987	unlimited	38	20	248	729	29
1988	unlimited	89	68	690	2544	123
1989	unlimited	191	110	1394	2997	153
1990	unlimited	155	90	1352	3568	158
1991	limited entry	47	47	1348	5972	133
1992	limited entry	49	49	2096	11412	200
1993	limited entry	49	53	1631	8623	190
1994	individual quotas	49	48	969	4771	136
1995/96	individual quotas	45	41	551	2185	88
1996/97	individual quotas	49	30	455	2305	77

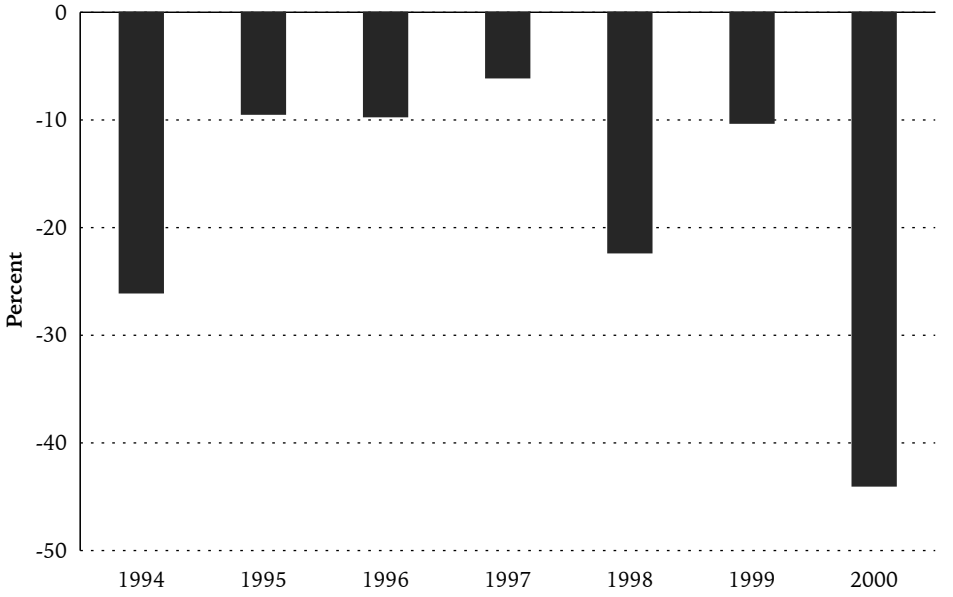
Source: Muse 1998d:18.

Assessment: Have individual quotas improved management of the green sea urchin fishery?

Conservation

Several indicators suggest that conservation has improved since quotas were introduced to the green sea urchin fishery: catch limits were introduced and have not been exceeded, total catches decreased, monitoring improved, and new stock assessment initiatives were undertaken. Scientists from the DFO began determining sustainable stock levels and setting limits on the allowable catch for the green sea urchin fisheries in 1994, the same year individual quotas were introduced. The total allowable catch (TAC) for the fishery was first set at 449 tonnes (figure 6.1). In the following seasons, the TAC was significantly reduced due to concerns about the sustainability of the population. In 1995, the TAC was 173.4 tonnes and stayed at 166.1 tonnes from 1996 through 1999 (DFO-Pacific 2000a: 6). Catches have remained well below TACs since the introduction of individual quotas into the fishery (figure 6.2). In 2000, catch was over 40% below the TAC because prices fell when the Russians added to the world supply of sea urchins (Dave Kensall, Director, West Coast Green Urchin Association, personal communication, May 1, 2002).

Figure 6.2: Green Sea Urchin—catch overage or underage (percent)



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and official IQs in 1995.
Source: DFO-Pacific 2000a; Muse 1998d; John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000, May 2000.

Monitoring in the fishery improved with the introduction of individual quotas. Prior to the introduction of IQs, monitoring was carried out by the DFO and as one observer describes "was something of a hit and miss mission, not carried out with any great purpose or reliability" (Michael Callow, personal communication, May 29, 2001). Management was restricted to limits on the size of urchins that could be harvested and on the time spent at sea fishing.

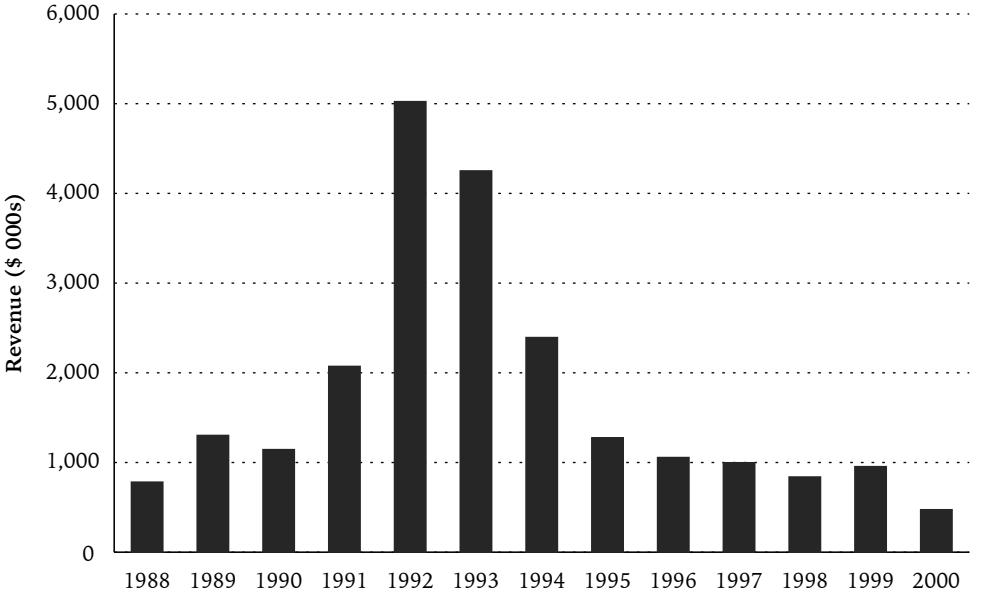
When industry independently changed management of the fishery to individual quotas, they increased and improved monitoring by hiring a private firm to monitor the fishery. At that time, the DFO made it a requirement that license holders report to the private monitoring firm 24 hours before fishing and 24 hours before landing urchins. This requirement remains in place today. In addition, the private firm checks catches at designated landing ports and is required to report any evidence of dumping or illegal bycatches. The fishery for green sea urchins, however, has no observers on board fishing vessels or on the fishing grounds monitoring the fishing area independently from their own vessels[1] (DFO 2000e: 16). Paying directly for monitoring gives licence holders a strong incentive to make sure that the monitoring is effective. Under the individual quota program, the monitoring process is constantly being refined and improved through discussions between licence holders, monitors, and the DFO (Michael Callow, personal communication, May 29, 2001).

Economic viability

To make sure the fishery would be sustainable, catches were reduced dramatically—by roughly 80%—after the introduction of individual quotas. In the green sea urchin fishery this reduction in the catch had the effect of reducing revenue. In 1993, the last year of limited entry before the voluntary IQ program was adopted, industry revenues were $4,251,644 compared to $2,393,915 for the first year of the voluntary IQ program in 1994 and to $1,276,266, the first year of the DFO's IQ program in 1995. Revenues in 1999 fell to $955,002 (figure 6.3).

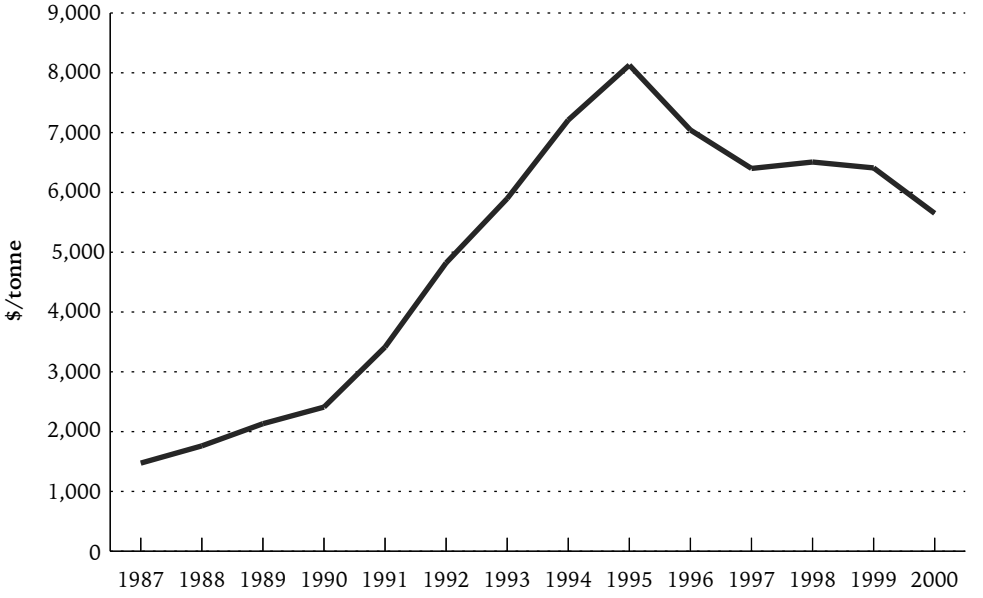
In some other fisheries, such as the geoduck, the change to individual quotas increased fishery revenues *despite* a decrease in catches because an increase in price due to increased catch quality, market conditions, or both, more than made up for the reduction in the size of the catch. Clearly this is not the case in the green sea urchin fishery. Although, as in other fisheries, the adoption of individual quotas has shifted the industry's focus from fishing for quantity to fishing for quality (Mike Featherstone, President, Pacific Urchin Harvesters' Association, personal communication, July 10, 2000) it is not clear that this had much effect on prices since prices for sea urchins had been rising prior to the adoption of individual quotas (figure 6.4). We do know, however, that individual quotas allow fishermen to time their harvests

Figure 6.3: Green Sea Urchin—real revenue, 1988–2000 (adjusted for inflation)



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and official IQs in 1995.
Source: John Davidson, personal communication, August 2000, May 2001.

Figure 6.4: Green Sea Urchin—real landed price, 1987–2000 (adjusted for inflation)



Note: Limited entry was introduced in 1991, voluntary IQs in 1994, and official IQs in 1995.
Source: Muse 1998d; John Davidson, personal communication, August 2000, May 2000,

better to coincide with periods where prices are higher. In recent years, prices have been falling due to the increase in supply of green sea urchins from Russia (Dave Kensall, personal communication, May 1, 2002). Although revenues in the fishery have declined since IQs were implemented because of the reductions in the size of catches, there has also been a decrease in operating costs as there has been a decline in the number of active vessels, divers, and diver hours in the industry (Muse 1998d: 20).

The introduction of IQs into the green sea urchin fishery has meant that industry now pays for most, if not all, of its management costs. Prior to the implementation of the DFO's permanent IQ program into the green sea urchin fishery at the end of the 1996 season, each license holder paid an annual fee of $50. According to William Leung, lead agent at the Pacific Fisheries Licensing Unit in Nanaimo, British Columbia, the aggregate licensing fees collected by the DFO prior to IQs was not even enough to cover the cost of the fishing licenses (William Leung, personal communication, September 15, 2000). In 1996, under IQ management, the DFO's licensing fee rose to $430 per license. In addition, industry now pays a fee for monitoring as well as a fee to the association that pays for surveys of the stock (table 6.2).

The green sea urchin fishery under individual quotas is a smaller fishery. This has had the effect both of reducing revenues and reducing operating costs. Management costs have increased as they have in other quota fisheries since more monitoring is required and industry is now paying for these costs. The introduction of individual quotas is not thought to have changed profitability for individual fishermen (Dave Kensall, personal communication, May 1, 2002).

Employment and working conditions

As in many other fisheries, the nature of employment in the sea urchin fishery changed with the introduction of individual quotas. The number of divers involved in the green sea urchin fishery fell from 190 in 1993 to 136 in 1994, and has consistently been under 100 individuals since the 1995 season (Muse 1998d: Appendix). As well, the number of diver hours has fallen from 8,623 hours in the final year of limited entry to 2,305 hours in 1997. Although more people were employed in the fishery prior to the introduction of individual quotas, employees now work longer and are paid more (Mike Featherstone, personal communication, July 10, 2000).

The improvement in safety in the green sea urchin fishery is similar to that observed in the red sea urchin fishery. Prior to introducton of IQs, the fishermen would begin their excursions the moment the season was officially opened, regardless of the weather. Since the quota system was implemented, there has been a significant decrease in accidents as everyone co-ordinates their harvests in accordance with market demand without having to operate under adverse fishing conditions (Mike Featherstone, personal communication, July 10, 2000).

Table 6.2: Green Sea Urchin—annual management fees ($) paid by each license holder to the DFO and to the Green Sea Urchin Association

	DFO License Fees	Association fees (monitoring, validation, research, and other costs)		DFO License Fees	Association fees (monitoring, validation, research, and other costs)
1974	50	0	**1989**	50	0
1975	50	0	**1990**	50	0
1976	50	0	**1991**	50	0
1977	50	0	**1992**	50	0
1978	50	0	**1993**	200	0
1979	50	0	**1994**	200	0
1980	50	0	**1995**	430	1570
1981	50	0	**1996**	430	1570
1982	50	0	**1997**	430	1570
1983	50	0	**1998**	430	1570
1984	50	0	**1999**	430	1570
1985	50	0	**2000**	430	1570
1986	50	0	**2001**	430	1570
1987	50	0	**2002**	430	1570
1988	50	0			

Note: Limited entry was introduced in 1991, voluntary IQs in 1994, official IQs in 1995.
Source: Michael Callow, President, Green Sea Urchin Harvesters Association, personal communication, May 29, 2001; September 9, 2003.

Overall assessment

Prior to the introduction of individual quotas in the green sea urchin fishery, managers were unable to control the amount of effort that went into fishing and conservation was increasingly becoming a concern. As one license holder remarked: "fish stocks were going to suffer permanent damage if the DFO did not change its management methods" (Dave Kensall, personal communication, May 1, 2002). The introduction of individual quotas to the green sea urchin fishery had a number of positive, stabilizing influences on the fishery. It permitted the introduction of a workable conservation strategy, brought about the end of the first-come, first-served mentality, allowed harvesting to be better timed to coincide with market demand, and encouraged cooperation between the DFO and fishermen (Dave Kensall, personal communication, May 29, 2001). In addition, licence holders now pay for their management costs and the fishery is considered safer. Unlike the situation in some other fisheries managed with IQs, profitability for individual fishermen did not likely change much. Revenues and profits overall declined as the fishery itself became smaller in order to be sustainable.

Notes

1 Rick Harbo, the DFO's manager for invertebrate fisheries, explains that this is likely due to a combination of factors. First, the green sea urchin industry has not historically seen a lot of by-catch or high-grading problems and, second, the industry is too small both in the number of days and the economic value for on-board observers to be necessary or financially viable.

Sea Cucumber

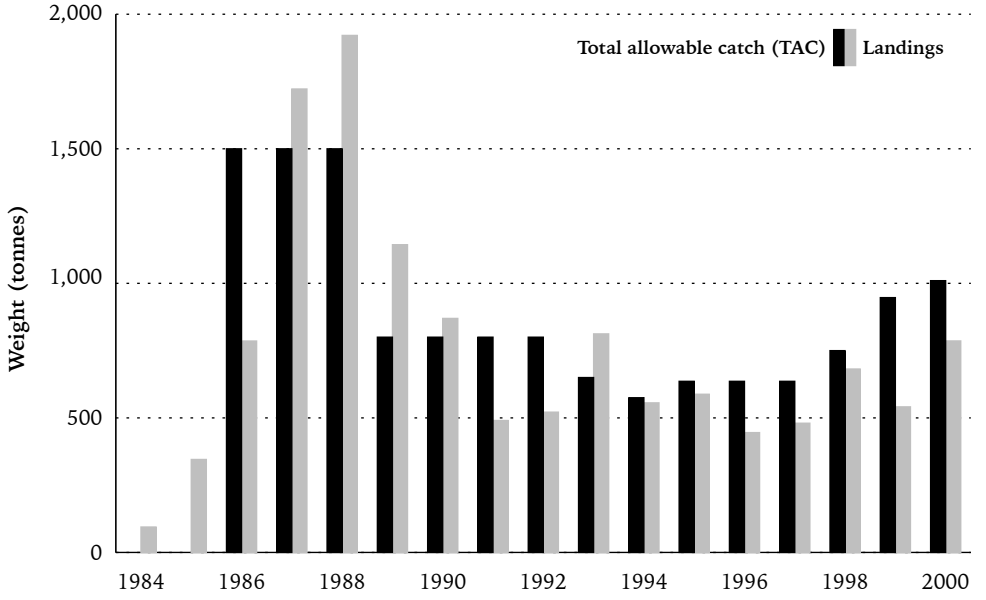
The giant red or California sea cucumber (*Parastichopus californicus*) is a worm-like creature, typically reddish brown in colour, with spiny knobs covering its surface (DFO 1999c). California sea cucumbers can grow to nearly two feet and weigh up to 1 kilogram and are found all along North America's Pacific coast from the Gulf of Alaska to southern California. Divers harvest sea cucumbers for the strips of muscle on the inside of the body wall, which are frozen, and for the whole body wall, which is dried. Most of the sea cucumber harvested is exported to China where it is considered a delicacy.

On Canada's Pacific coast, sea cucumbers spawn between June and August. After the spawning season, the internal organs of the sea cucumbers atrophy until the spring when they begin feeding again and recover their body weight. This cycle affects the timing of the fishing season, as fishermen prefer to harvest during the fall and winter when the internal organs have atrophied since, at this time, more meat (which comes from the muscle of the sea cucumber) is harvestable, processing is easier, and the meat and skin are considered of higher quality (Muse 1998c: 2).

A brief history of the fishery

Commercial harvesting of sea cucumber on the Pacific coast of Canada began in 1971 and continued on a small scale for ten years. Throughout the 1970s, the sea cucumber fishery remained under an open-access regime with required, but unlimited, licences for fishing boats and registration cards for all crew aboard each vessel. In 1983, the DFO issued personal licences to boat owners to complement vessel licences. These licences were also unlimited. During the 1980s, prices and catches increased (figures 7.1 and 7.3). The DFO started setting total allowable catches (TACs) for the sea cucumber fishery in 1986 and adopted a limited-entry licensing policy in 1991. Initially,

Figure 7.1: Sea Cucumber—TAC compared to landings, 1984–2000



Note: Limited entry was introduced in 1991, IQs in 1995.
Source: Muse 1998c; DFO-Pacific 1999a; personal communication with John Davidson, Catch Statistics Unit, DFO, August 2000.

78 licences were issued but, following appeals and the issuing of special licences to First Nations bands, the number of licences was increased to 85, which represented a reduction of roughly 60% in the number of licenses in the fishery (Muse 1998c: 5). Harvesters with at least 50,000 pounds of landings or 20 days of recorded harvests in any one year over the three-year period before limited entry was implemented (1987–1989) were awarded a non-transferable limited-entry licence. However, as in other fisheries, fishing power continued to intensify despite limited entry and further restrictions on the fleet such as shorter seasons, reduced TACs, and area rotations and closures to allow for stock recovery in off years.

In 1994, the Pacific Sea Cucumber Harvester's Association (PSCHA), an industry body representing those holding licences to harvest sea cucumber, proposed a voluntary individual quota program for the 1994 fishery. The DFO was willing to accommodate the plan but it fell through when one of the license holders decided not to participate (Muse 1988c: 8). The next year, the DFO implemented a two-year pilot project for individual quotas due to "continuing conservation concerns in some areas, the difficulty in managing the fishery to specific area quotas, the rapid, intensive and often dangerous nature of the fishery and quota over-runs in many areas in most years" (DFO 1999c: 6).

Individual Quotas (IQs)

Under the IQ program for the sea cucumber fishery, 2% of the allowable catch is allocated to First Nations and the remaining catch is divided equally among the 85 license holders in the fishery. The program includes a provision requiring harvesters to establish a self-funded monitoring and enforcement plan (DFO-Pacific 1999a: 6). As well, each vessel can carry a maximum of three licenses. The IVQ program for sea cucumbers allows license holders to transfer their annual overages from one vessel to another provided that the latter vessel had sufficient unused quota. This provision, referred to as the "quota overage transfer limit," allows harvesters to work together to achieve their optimal quota shares. Area licensing was introduced with individual quotas. Canada's Pacific coast was divided into five license areas and managers set allowable catches in each area. Each license holder is assigned to an area (Muse 1998c: 8).

Assessment: Have individual quotas improved management of the sea cucumber fishery?

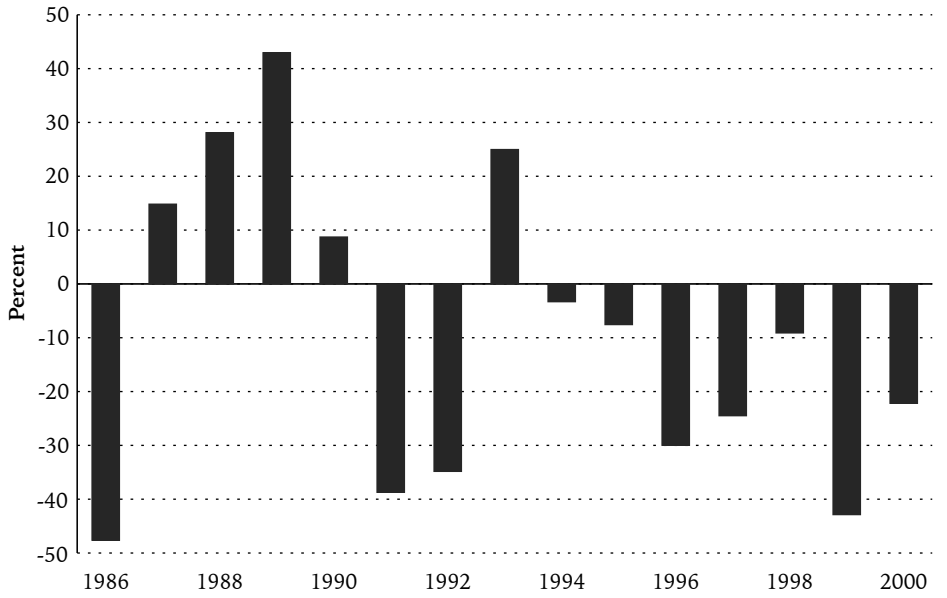
Conservation

As in other fisheries, the introduction of individual quotas helped managers ensure that actual harvests remain at or below allowable harvests. In the years prior to the introduction of IQs, harvesters frequently exceeded allowable catches despite shorter seasons and other regulations designed to control fishing power: actual catches exceeded allowable catches by as much as 42%. Since IVQs were implemented in 1995, the coastwide actual landings have remained below allowable catches (figure 7.2).

Part of the success of the IVQ management strategy in conserving the stock can be attributed to the "quota overage transfer limits." License holders are able to co-operate with one another to transfer quota overages in order to attain the overall coastwide total allowable catch. Although some area TACs have been exceeded in some years under individual quotas, the coastwide TACs were met in all years due to the quota overage transfer limits (Muse 1998c: 13).

High-grading and unintentional by-catch are not issues in this fishery as there are no size limits and divers handpick the sea cucumbers. However, there is some concern that divers may illegally harvest abalone (DFO 2002: 15).

Figure 7.2: Sea Cucumber—catch overage or underage (%)



Note: Limited entry was introduced in 1991, IQs in 1995.
Source: Muse 1998c; DFO-Pacific 1999a; John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000.

When the IVQ system was adopted for sea cucumbers, the PSCHA contracted Archipelago Marine Research, a private firm, to conduct monitoring and enforcement. Unlike some other fisheries on Canada's Pacific coast that operate under IVQs, the sea cucumber industry does not finance on-board observers. However, all catches have to be validated by Archipelago and all vessels must "hail-out" and "hail-in" (i.e., announce when it is leaving and returning to port at the beginning and the end of fishing activities) at least 24 hours prior to the departure or the return of a fishing vessel. License holders must also fill out a detailed dive log when they land their catch. These measures help maintain an accurate account of sea cucumber harvests, increase fishermen's accountability for their actions, and ensure negligible coastwide catch overages (Muse 1998c).

Since the introduction of individual quotas, the DFO and commercial license holders have collaborated to develop research programs, which are managed by a committee with representatives from industry and government (DFO 1999c: 9). Funds come from license fees and the sale of test-area sea cucumbers harvested for scientific purposes. They are used for surveys and stock assessments that have led to more appropriate catch limits being set in the fishery (Terry Keith, President of the Pacific Cucumber Harvester's Association, personal communication, July 20, 2000).

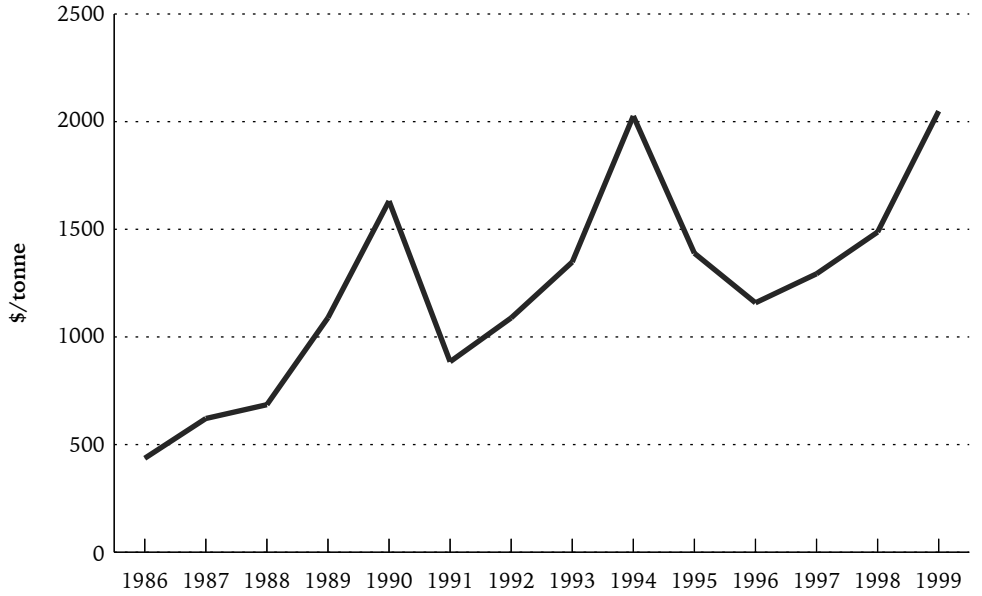
Economic viability

Biological limitations restrict the fishing season for sea cucumbers to a maximum of roughly one month.[1] Under IQs, harvesters are able to make use of most of the harvesting season. In 1994, just prior to the introduction of individual quotas, the fishing season for sea cucumbers lasted one to six days, depending on the fishing area. In 1995, the first year under individual quotas, the season was extended to between 13 and 20 days (Muse 1998c: 11). Currently all areas are open for around 20 days, starting in early October (DFO 2002: 9).

The lengthened fishing season allows fishermen to harvest a product of slightly higher quality and to respond to market demand better (Terry Keith, personal communication, July 20, 2000). The landed price of sea cucumbers has increased slightly since IQs were implemented, from an average of $1219.60/ton between 1990 and 1994 to an average of $1399.90/ton between 1995 and 1999 but it is not clear how much of this increase can be attributed to quotas (see figure 7.3). Revenues in the fishery initially declined due to an initial fall in prices and lower catches but have since increased (figure 7.4).

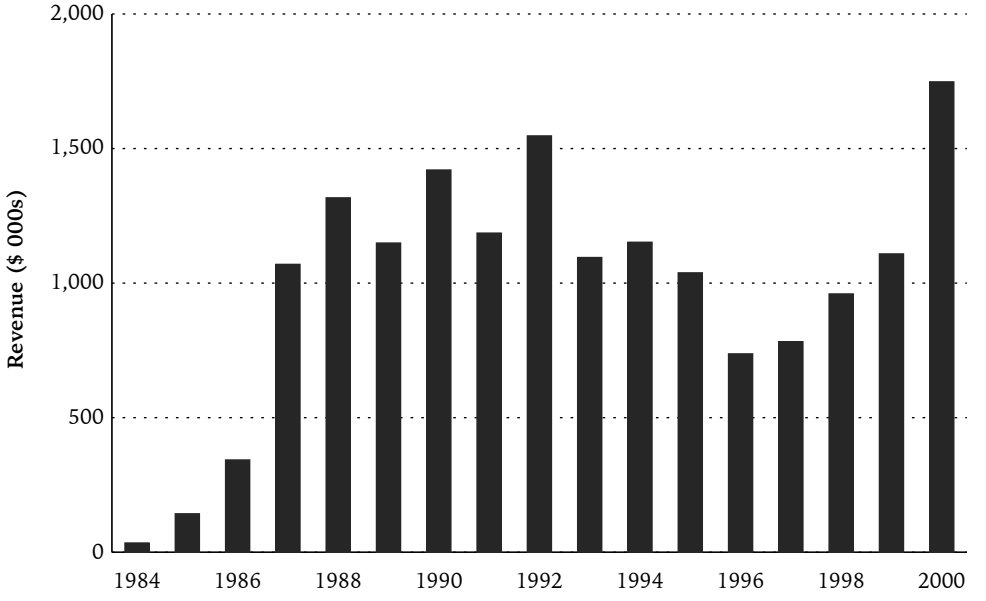
The cost of administering the sea cucumber fishery is now fully recovered and the fishery is efficiently managed as the validation and management activities are primarily conducted by industry through the Pacific Sea Cucumber Harvesters Association (PSCHA) (Sheila Wood, Coordinator, Pacific Sea Cucumber Association, personal communication, September 12, 2000).

Figure 7.3: Sea Cucumber—landed price, 1986–1999 (adjusted for inflation)



Note: Limited entry was introduced in 1991, IQs in 1995.
Source: 1986–1995: Muse 1998c; 1996–1999: John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000.

Figure 7.4: Sea Cucumber—revenue, 1984–2000 (adjusted for inflation)



Note: Limited entry was introduced in 1991, IQs in 1995.
Source: John Davidson, Catch Statistics Unit, DFO, personal communication, August 2000.

Once IQs were introduced, in addition to the $100 annual license fee paid to the DFO, the 85 licensees each contributed $750 annually to PSCHA to invest in research and development and to pay a third-party validator (either Archipelago Marine Research or D & D Pacific Fisheries Ltd.) to conduct monitoring and enforcement (table 7.1). This additional fee is now $1,000, In 1999, Archipelago's costs amounted to approximately $40,000 annually while the remaining $23,750 in management fees was used by PSCHA for research. Since this expense is fully financed by the sea cucumber license holders, there is no additional cost to the DFO (Muse 1998c: 10).

Working conditions

A longer season for harvesting sea cucumbers has improved working conditions in the fishery by allowing license holders more flexibility in determining when and how they will conduct their fishing activities. Lengthened seasons have relaxed the derby-style race that characterizes effort-controlled fisheries and have made the fishery safer. Since they can now choose when to fish, fishermen are able to avoid storms as well as to focus each excursion towards a particular consumer demand (Muse 1998c: 12).

Now that licencees can transfer quota overages, the size of the fleet and the number of crew and divers working in the industry have been reduced. In 1994, there were 71 vessels with landings compared to only 41 in 1997 under IQ management. Rationalization of the fleet led to fewer boats, the majority of which were carrying more than one vessel license: in 1995, there were 22 vessels with one license each; by 1997, there were only 15 vessels carrying one license each. As vessels acquired more than one license, the number of crew and divers needed in the industry declined. In 1994, prior to the intro-

Table 7.1: Sea Cucumber—license fees and industry association fees ($), 1986–2000

	License Fees	Association Fees		License Fees	Association Fees
1986	100	0	**1994**	100	0
1987	100	0	**1995**	100	750
1988	100	0	**1996**	100	750
1989	100	0	**1997**	100	750
1990	100	0	**1998**	100	1,000
1991	100	0	**1999**	100	1,000
1992	100	0	**2000**	100	1,000
1993	100	0			

Note: Limited entry was introduced in 1991, IQs in 1995.
Source: Terry Keith, President of the Pacific Cucumber Harvester's Association (PSCHA), personal communication, May 2001.

duction of IVQs, there were approximately 160 divers in the sea cucumber industry. By 1997, the number of divers employed had fallen by over 50%, to approximately 70 (Muse 1998c: 11). The rationalization suggests a more efficient fishery. Although there has been a reduction in the overall number of divers employed in the industry, those remaining are making a better living (Terry Keith, personal communication, July 20, 2000).

Overall assessment

The introduction of individual quotas to the sea cucumber fishery was welcomed by most license holders, many of whom had observed the positive impacts of the change in management in other fisheries that employed divers. Generally, mangagers have also considered the change to be positive. According to the Department of Fisheries, the IQ program has resulted in a more "orderly" fishery (DFO 2000i: 12). The two most obvious improvements are that actual catches now fall below allowable catches rather than exceeding them and that the increase in the length of season has relaxed the pace of fishing, improving both safety and the license holders' ability to spend time marketing their product. The impact on the economic viability of the fishery is less dramatic than in some other cases such as geoduck, although in recent years prices and revenues have increased. As in other fisheries where IQs were introduced, fishermen are now paying a much larger fraction of the cost of administering the fishery. Prior to the introduction of IQs, license holders were paying a nominal fee to renew their licenses. Now, they pay a license fee as well as an association fee that covers the costs of monitoring and research in the fishery.

Note

1 There is a three-week span in September and October during which the sea cucumbers are at their most valuable commercially since they have lost their internal organs and are in a hibernation period.

Groundfish Trawl

There are over 70 species of groundfish off Canada's Pacific coast. Also known as "demersal" fish, most groundfish dwell on or near the ocean floor. Groundfish trawl fishers use a specialized type of net (the trawl) to harvest their catch.[1] Pacific groundfish can be found from the southernmost tip of California up to Alaskan waters.

A brief history of the fishery

The trawl fishery on Canada's Pacific coast has been in existence since the early 1940s. The fishery was open to anyone until 1976 when the DFO issued 142 limited-entry licenses. Other than limited entry, there were very few restrictions on fishing activity throughout the 1970s (Turris 99: 2). In 1980, the DFO began consulting with industry through its Groundfish Trawl Advisory Committee (GTAC) to prepare annual groundfish trawl management plans (DFO-Pacific 2000b: 4). The 1980 plan imposed restrictions on the size of mesh used in the "cod ends" (narrow, pointed ends) of the nets and put TACs in place for some groundfish species.

Throughout the 1980s and early 1990s, fishing power increased as boats used more horsepower, more effective gear, new electronic devices for finding fish, improved hydrographic charts and stern trawls (Turris 1999: 2). In order to keep the fishery open year round so that domestic processors could retain access to markets, new restrictions including trip limits and monthly limits were introduced. Despite increasingly restrictive regulations, harvests continued to increase and catch discarding at sea and misreporting became more serious problems (Turris 1999: 3). At a recent conference in Australia, Bruce Turris, a member of the Groundfish Trawl Advisory Committee (GTAC), described the situation in the mid-1990s.

> By 1995, fishing capacity had increased so dramatically, and fishing limits declined to such small [*sic*] levels, that discarding was a major concern and the ability to stay within annual TACs (based strictly on landed catch) was proving extremely difficult for several key species. In September of 1995, due to significant TAC overages, the British Columbia groundfish trawl fishery was closed for the first time. (Turris 1999: 3)

The fishery remained closed for nearly five months, re-opening in early 1996 under new DFO regulations, which included mandatory on-board observers for all bottom-trawl trips, mandatory monitoring of all landed catches, and the establishment of species-specific limits. These additional monitoring costs, which averaged $21,000 per vessel, were largely paid for by industry (Turris 1999: 3). In addition, the DFO increased license fees from an average of $10 to over $7,000 per vessel. These additional costs forced the industry, already struggling with low landed prices and shrinking markets, to consider other management changes in order to regain economic viability. In 1997, the DFO and industry agreed to implement an Individual Vessel Quota (IVQ) system in the commercial groundfish trawl fishery.

Individual Vessel Quotas (IVQs)

Groundfish trawl is the most complex IVQ fishery on the Pacific coast of Canada, with fully transferable quotas set out for 55 different species area groups (DFO-Pacific 2000b: 4). When the individual quota program for groundfish trawl was being considered, six explicit conservation, economic, and social objectives were established: (1) maintaining existing processing capability, (2) stabilizing employment in the groundfish industry, (3) encouraging economic development in coastal communities, (4) allowing fair treatment of crews, (5) allowing for a controlled rationalization to create an economically viable fleet, and (6) avoiding leasing and quota concentration (Sporer 2001: 3). These goals influenced the initial allocation formula for the groundfish trawl fishery and made it more complicated than allocations in other fisheries. Recommendations for the initial allocation were made by an independent arbitrator who received hundreds of recommendations throughout the consultation period in 1996.

Each year, 80% of the TAC is allocated to owners of vessels in the groundfish trawl fleet as IVQs. The remaining 20% of the TAC is divided equally between Groundfish Development Quota (GDQ) and Code of Conduct Quota (CCQ). Each vessel's initial quota was based on catch history (70%) and vessel length (30%). IVQs allocated to licensed trawlers can be transferred from one licensed vessel to another subject to cap limitations.

The Groundfish Development Authority (GDA) was established to make recommendations to the Minister of Fisheries and Oceans on how to allocate

the 20% of the TAC that is to go to the Groundfish Development Quota and the Code of Conduct Quota. Groundfish Development Quota is allocated to groups of processors and vessel owners whose proposals best meet the GDA's objectives. The purpose of the GDA is to aid regional development, attain market and employment objectives, support sustainable fishing practices, and ensure a fair treatment of crews and safe operation of vessels in the groundfish trawl (Turris 1999:4). GDQs are non-transferable.

Code of Conduct Quota is meant to encourage the fair and equitable treatment of crew members. CCQs are allocated to all vessels in proportion to each one's ITQ holdings. Any formal complaints of poor treatment of crew to the GDA may result in the expropriation of a certain amount of CCQ, depending on the severity and nature of the claim. CCQs are transferable.

Each vessel is permitted to carry a catch overage or underage into the following season if it is not more than 37.5% of the ITQ for that vessel. To limit the amount of quota stacking (the accumulation of quota permitted on a single vessel), the DFO imposed holdings caps of about 2% and species caps of 4% to 10% per vessel (Turris 1999: 4). The fishing season runs year round, beginning on April 1.

Assessment: Have individual quotas improved management of the groundfish trawl fishery?

Conservation

Individual quotas have only recently been introduced to the groundfish trawl fishery. However, early indications suggest they have considerably reduced the threat of stock depletion that was becoming a concern prior to the introduction of quotas due to the expanding fishing capacity of the fleet and the incentives to catch as many fish as possible in the limited-entry derby. The Groundfish Trawl Advisory Committee conducted a review of the IVQ program in 1999. They found that conservation targets were being met as the fleet was adhering to TACs and bycatch targets (GSIC 1999: 7). They also found that fishing practices were becoming more oriented towards conservation. For example, the elimination of the race for fish means that individuals are more likely to share information and strategies that allow the harvest of target species while avoiding bycatch species (GSIC 1999: 7). Fishermen are also adopting the practice of making a short, sample tow to assess the suitability of the mix of species when entering a new area. The report also indicates that investments in gear and electronics aimed at winning the race for fish have been replaced by investments in gear that allows for selective harvesting.

Murray Chatwin, a member of the Groundfish Trawl Advisory Committee argues that the introduction of IVQs and on-board observers into the groundfish fishery has unambiguously achieved the DFO's conservation goals (Murray Chatwin, Groundfish Trawl Advisory Committee, personal communication, September 12, 2000). According to Chatwin, while overages were common prior to the introduction of quotas, since 1997 catches for most groundfish species have consistently been below the TACs. Available data on catches support Chatwin's view and indicate that, since the introduction of quotas, catches for most species are below their TACs.

Prior to the introduction of IQs, coastwide TACs were being exceeded by greater amounts each year. By September of 1995, for example, three quarters of all coastwide TACs had been exceeded, with three months still left in the season. Since the introduction of IQs, TACs (including allowable over/under provisions) have not been exceeded (see table 1) (Bruce Turris, Groundfish Trawl Advisory Committee, personal communication, August 19, 2003).

Fishing practices in the groundfish fishery are closely monitored. Vessels that are engaged in bottom trawling must carry an "at-sea" observer to record location, towing time, and discards, and to collect biological samples. All trawl landings are also validated at the dock. The dockside weights are then compared to the estimates of the at-sea observer to determine how much to subtract from the vessels various ITQs (Turris 1999: 4). Barry Ackerman, a DFO representative, points out that, since the introduction of IVQs, any high-

Table 8.1: Groundfish Trawl—Percent of Quota TACs Harvested

	1997/1998	1998/1999	1999/2000	2000/2001
Rockfish	76%	84%	101%	80%
Pacific Ocean Perch	91%	95%	100%	93%
Sole	66%	68%	79%	67%
Lingcod	42%	36%	49%	58%

Source: Bruce Turris, Groundfish Trawl Advisory Committee, personal communication, August 19, 2003

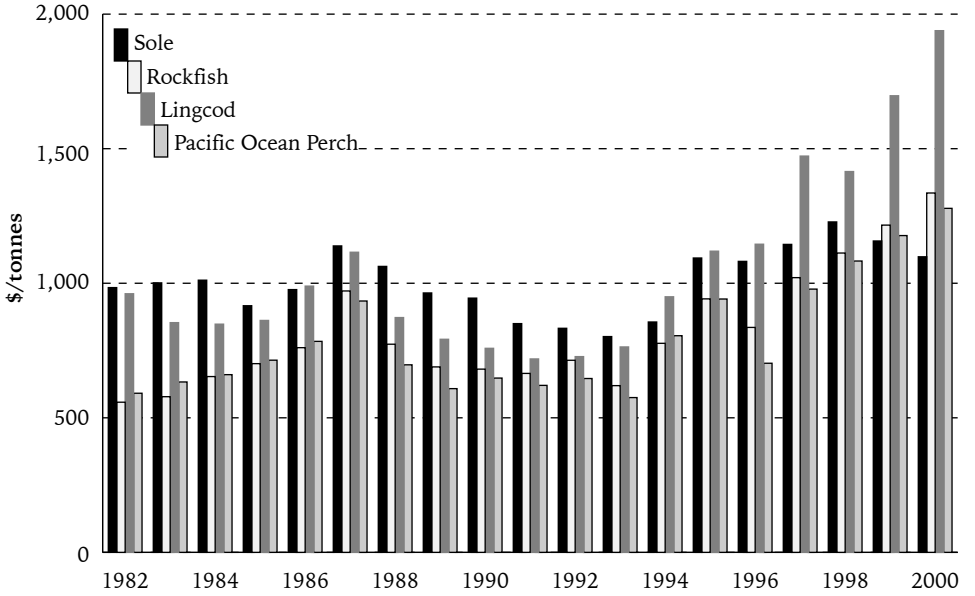
grading that occurs causes little mortality since it is so closely monitored that the fish are being returned to the water immediately (Ackerman, DFO, personal communication, July 28, 2000). By-catch is now within targets and both by-catch rates and mortality have declined since the introduction of IQs. For example, halibut by-catch mortality is down to 300,000 lbs from the pre-IQ amounts of 2 million pounds (Bruce Turris, personal communication, August 19, 2003). Fishermen who do not adhere to individual quotas and bycatch limits are penalized by having to forfeit catch, losing quota in the following year, or by being "kicked off the bottom," that is, being restricted to mid-water trawling (GSIC 1999: 8). These penalties along with the strict individual monitoring have ensured that the DFO's conservation objectives have been met since the implementation of IVQs (DFO-Pacific 2000b).

Although the introduction of the IVQ program is still relatively recent, there are already indications that fishermen are adjusting their attitude and behaviour towards meeting long-term conservation goals. For example, the industry's concern over the lack of adequate research into stock assessments by the DFO led them to establish the Canadian Groundfish Research & Conservation Society (CGRCS) to work on stock assessments (Turris 1999: 6). The "at-sea observer program" (ASOP), introduced into the groundfish fishery just prior to the beginning of the IVQ program, has also increased the amount and quality of available information regarding the stocks and biology of groundfish. This, in turn, will help in setting TACs.

Economic viability

According to the GSIC's review, crew and vessel earnings have increased since the introduction of individual quotas despite the increase in monitoring costs. The IVQ program has enabled industry participants to target quality as opposed to quantity: "By focusing increasingly on quality and servicing the market with the appropriate volumes and species-mix, industry has generated some positive changes under the plan" (GSIC 1999: 10). These changes include an increase in the amount of fresh groundfish available to the market (as a result of the year-round fishing season) and an increase in the landed prices that groundfish attract as a result of this increased quality and fresh-

Figure 8.1: Groundfish Trawl—landed average prices for key species (adjusted for inflation)



Notes: (1) Limited entry was introduced in 1976, IQs in 1997. (2) Data for 1996–2000 is from a DFO survey of a sample of fish-slips; data for sole and rockfish are averages for all respective species.
Source: John Davidson, Catch Statistics Unit, DFO, personal communication, July 2000; May 2001.

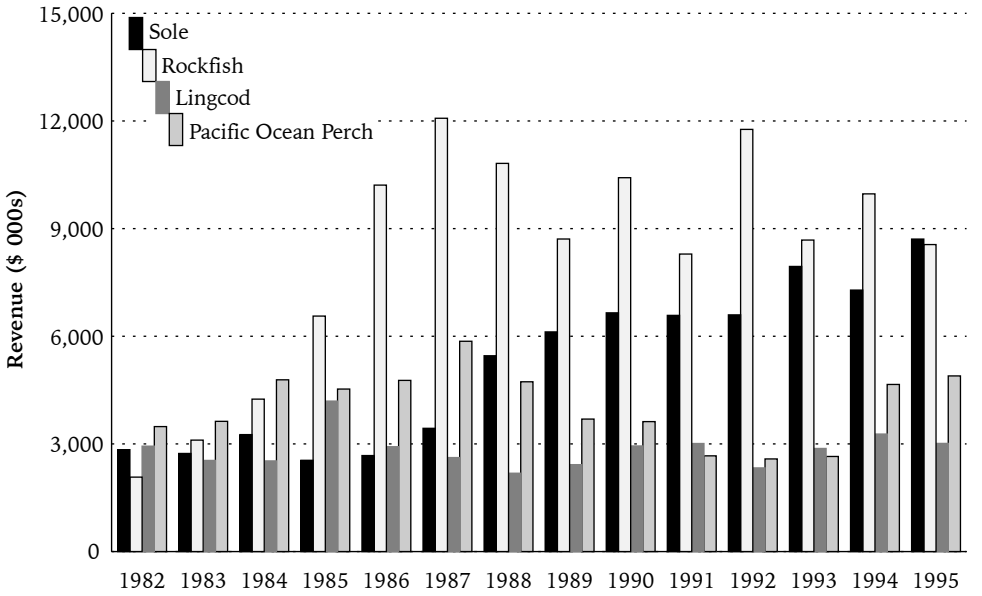
ness (GSIC 1999:10) (figure 8.1). The increase in landed prices have resulted in higher revenues (figure 8.2). Eliminating the race for fish has enabled fishermen to reduce their capital investments into the fishery and earn higher returns given secure landings, stable prices and lower operating costs.

Prior to the introduction of IVQs, management of the groundfish fishery was heavily subsidized. The nominal $10 annual license fee barely covered the DFO's management expenditures. Although it is not clear that the cost of managing this fishery is completely recovered today, license holders are contributing much more towards management. Each licence holder now pays a flat fee rate of $500 annually, accompanied by an additional fee per tonnage that varies depending on the type of groundfish the licence holder harvests.[2]

Working conditions

The IVQ system for groundfish trawl resulted in vessel owners to make more rational investments in catching capacity. As a result, there was a 20% reduction in the number of crew in the fishery. However, the remaining crew were able to reap the benefits of a safer and profitable fishing environment (Turris 1999:6).

Figure 8.2: Groundfish Trawl—revenue for key species (adjusted for inflation)



Notes: (1) Limited entry was introduced in 1976, IQs in 1997. (2) The DFO has not collected fish-slips with value information since 1995; data for sole and rockfish are aggregates of all respective species.

Source: John Davidson, Catch Statistics Unit, DFO, personal communication, July 2000; May 2001.

Prior to the adoption of IVQs, the groundfish fishery operated as a "race for fish." To remain competitive in the fishery, vessel owners and crew extended their fishing trips over several long days and nights, often in unfavourable weather, with the result that conditions were unsafe and gear was lost. IVQs have enabled harvesters to avoid inclement weather and 24-hour fishing, so that crews get more sleep than in the old derby-style fishery (GSIC 1999: 17).

As well, a more predictable fishing season gives the crew and owners of the vessels time to plan the fishing excursions carefully to ensure good weather and economic benefit. GSIC explains that this "translates into a more stable supply of fish into the marketplace, and more safe and stable employment for crewmen and shore-workers" (GSIC 1999: 10).

Overall assessment

Most industry participants believe that the groundfish trawl fishery was not sustainable in economic or biological terms before the introduction of individual quotas and view the change to management by IVQs as a positive step (Turris 1999:6). Even those usually critical of individual quota systems are

supportive of the IVQ program implemented in the groundfish trawl fishery. According to John Radosevic, president of the United Fishermen and Allied Workers Union, the IVQ/GDA plan "represents a turning point in the way that the DFO conducts business." He points to the plan as one of the first real successes in terms of achieving a co-operative management program incorporating labour, capital, and boat owners although he believes that more work needs to be done to realize a true balance of these interests (personal correspondence with John Radosevic, July 27th 2000).

The change to management by individual quotas improved conservation, the economic viability of the fleet, and working conditions for those remaining in the industry.

Notes

1 The trawl is a towed net with a wide opening at the mouth and an end (the cod end) closed by a special knot. The size of the opening tends to be large in order to minimize water resistance during towing. The trawl is designed in a smooth cone-like shape to guide the fish into the narrower, cod end. A large horizontal beam is typically used to keep the mouth of the trawl net open. Trawlers used for groundfish are generally referred to as "bottom trawlers," dragging the trawl net along the ocean floor to ensure that the groundfish are captured (Encyclopædia Britannica 2000).

2 The variable licensing cost ranges from $4.00/tonne for Hake up to $16.00/tonne for Sole and Lingcod (DFO-Pacific 2000b: 18).

Roe Herring

Pacific herring (*Clupea pallasi*) have silvery bellies and olive-coloured bodies. They are an abundant, short-lived species (most herring live less than eight years). Two different types of fishing vessels, "seines" and "gillnets," are used to harvest herring commercially.[1] Northern pacific herring is harvested from the southern tip of Baja, California, to the Siberian Arctic (DFO 2000f). Herring are harvested in a number of fisheries including spawn on kelp, food and bait, and the largest, roe herring. In the roe herring fishery, herring are caught before spawning for their eggs or "roe," which are considered a delicacy in Japan. The fishery takes place from late February to early March off the southern part of Canada's Pacific coast, and from mid-March to mid-April off the northern part of Canada's Pacific coast.

A brief history of the fishery

The Pacific roe herring fishery in British Columbia was opened in 1972, following the recovery of the previously over-exploited herring stocks—herring was processed into low-value products such as fish oil until 1967 when the fishery was closed due to conservation concerns. Access to the roe fishery was unlimited for two years until 1974, when entry was limited to existing license holders willing to pay higher license fees, $2,000 for each seine licence and $200 for each gillnet licence. Despite this financial deterrent, the DFO's objective of issuing 150 seine and 450 gillnet licenses was greatly exceeded—270 seine and 1,400 gillnet licenses were issued—and fishing capacity far exceeded what was necessary to harvest the available catch (Peter Pearse 1982: 104). Currently, there are 252 seine licences and 1,260 gillnet licenses in the fishery (DFO-Pacific 2002).

Throughout the 1980s and 1990s, the DFO implemented a number of rules, such as restrictions on gear and fishing time, designed to control fish-

ing power. The DFO also introduced area licensing in 1981 to restrict the number of boats participating in each herring opening. Area licensing subdivided the coastal region and limited the licensee's fishing privileges to one of the areas in a season, which significantly reduced the number of vessels participating in each opening. In 1994, DFO managers started requiring boats to have two or more licences (called double licensing) in order to be eligible to fish in most areas.

By the mid-1990s, it became apparent that the existing approach to managing the fishery was not working. Harvests were consistently exceeding catch targets and illegal use of gear in the gillnet sector of the fishery was becoming more prevalent (Dave Boyes, personal communication, May 9, 2002). The season in 1997 was particularly embarrassing for the DFO's managers as there were large overages in many of the area openings. In response, David Anderson, minister at the time, indicated that there would be changes and the department distributed a discussion paper outlining several options. One option was to place additional restrictions on fishing time and reduce roe herring openings to short "pulse" fisheries: a 15-minute opening was suggested for the seine fishery off the west coast of Vancouver Island (DFO 1997). After other options were debated in consultation with industry, it was decided that a "pooling" system would be used in the 1998 fishery. This management strategy remains in place today.

Pooling

Pooling is similar to a system of individual quotas in that each license is assigned a share of the total allowable catch. However, license holders in common regions must group, or "pool," their licenses and share of the TAC. In the roe herring fishery, the allocation is made by dividing the available harvest equally among licenses. Fishermen who had catches that were higher than average were not happy with this initial allocation, which did not take past fishing success into account. Under the current system, roe herring license holders are required to work within a pool with a minimum of eight seine licenses or four gillnet licenses (there is no maximum) to be eligible for their TAC share.

Each pool manages its own harvesting details (DFO 1998). The group jointly determines catch allocations for individuals within the group. Pools also elect a representative from among the licence holders to act as coordinator for the pool and to represent the pool to the DFO. Pool representatives and a DFO facilitator determine specifics of the fishery's management each year, such as fishing areas and fishing times. During the fishing season, catches in excess of individual pool targets are shared with those pools in the same management area that do not achieve their catch quota (DFO 2000f).

Assessment: Has pooling improved management of the roe herring fishery?

Conservation

Prior to pooling, conservation targets in the roe herring fishery were not being met. Between 1992 and 1997, overall roe-herring catches exceeded the DFO's target every year—sometimes by as much as 25% (figures 9.1 and 9.2). The year 1997 was particularly embarrassing for the DFO as catch overages for the central coast fishing area were over 100% of the target catch (table 9.1).

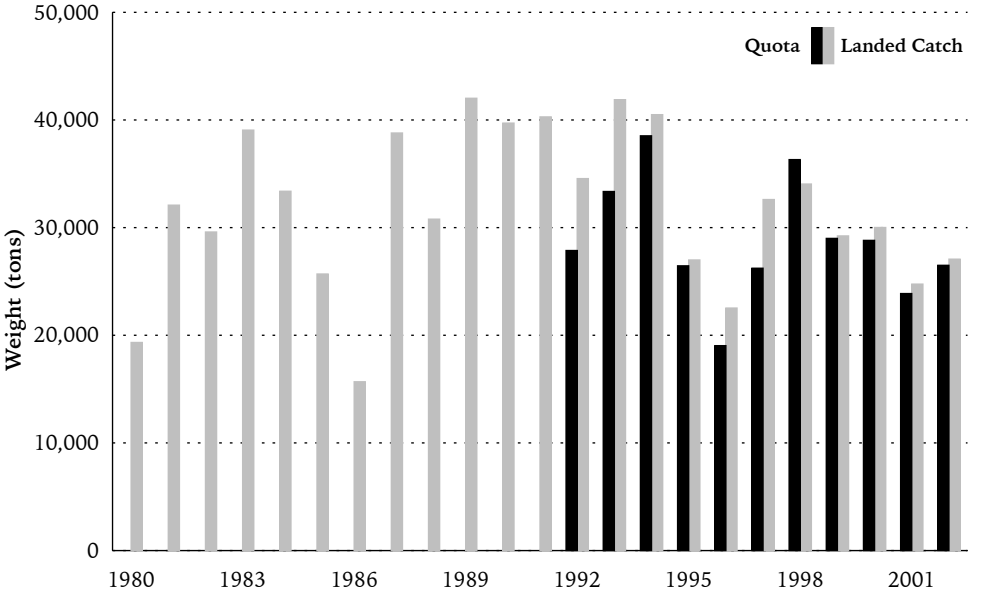
Conservation was also increasingly threatened by the use of nets with a mesh tighter than was legal in the gillnet fishery. Since fishery openings were only hours long and fishermen were paid by weight, the incentive was to catch as many fish as possible as quickly as possible. Fishermen using nets with a tighter mesh could catch more fish. The DFO did check some nets on the fishing grounds but it was difficult to convict violators since the difference between the size of the legal mesh and that of an illegal mesh—an eighth of an inch—looked too small to be significant to judges. The tighter mesh made a big difference on the fishing grounds, however, and, as one gillnet fishermen said, "you began to feel like a real fool using legal gear and watching the other guys get all the fish" (Dave Boyes, personal communication, May 9, 2002).

Conservation was the main reason for changing management in the fishery. According to the DFO's discussion paper outlining alternative management options for the fishery, "the conservation and protection of Canada's fish stocks is the Department's over-arching objective and catch overages erode the public's confidence in DFO's ability to manage the herring resource" (DFO 1997: 6).

When pooling was introduced in 1998, conservation in the fishery improved. In 1998, catches fell below DFO targets for the fishery for the first time in nine years. Although small catch overages were recorded in 1999, 2000, 2001, and 2002 (figures 9.1 and 9.2), these overages were small compared to those recorded in the fishery before pooling was introduced. Unlike other IQ fisheries, the roe herring fishery has no penalty for an overage: the fish are simply forfeited and allocated to other pools that are under their allowed catch. Since there is no incentive to stay under the allowable catch, overages are more common in this fishery and this is a short-coming in the design of the IQ program for roe herring.

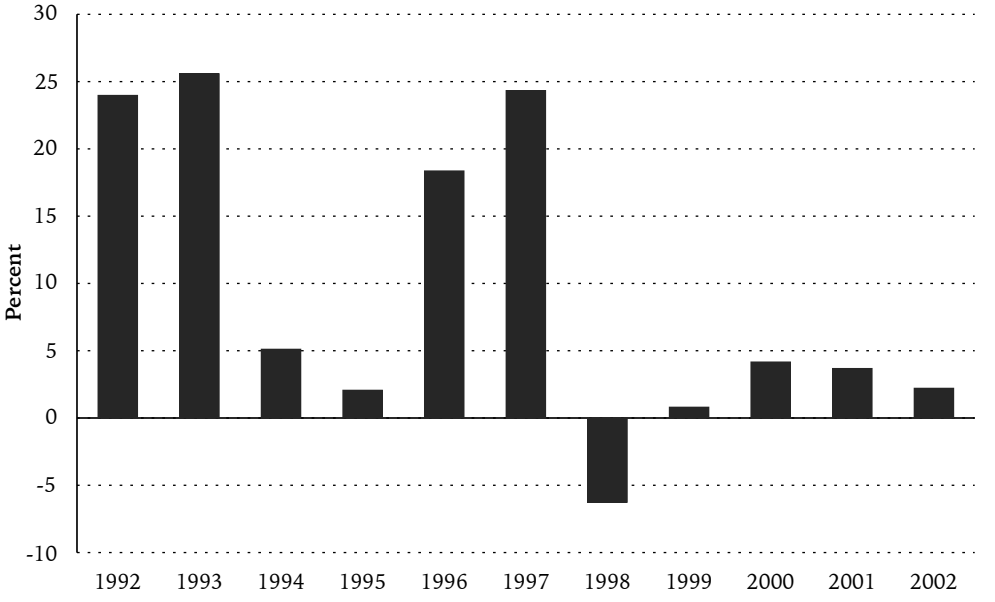
Under pooling, gillnet fishermen are no longer tempted to use illegal gear because they have an incentive to maximize the *quality* of their share of the catch rather than the volume of the catch. Since larger herring contain more roe and are more valuable, it would not make sense to use nets with a tighter mesh (Dave Boyes, personal communication, May 9, 2002). This change in incentive has eliminated the need for on-grounds monitoring since by-catch and high-grading are not problems in this fishery.

Figure 9.1: Roe Herring—Quota and Landed Catch for 1980–2002



Note: Limited entry was introduced in 1974, pooling in 1998.
Source: DFO 2001c: tables 4 & 6 (Appendix).

Figure 9.2: Roe Herring—Catch Overage or Underage for British Columbia's Roe Herring Fishery: 1992–2002



Note: Limited entry was introduced in 1974, pooling in 1998.
Source: DFO 2001c: tables 4 & 6 (Appendix).

Table 1: Actual and Target Catch (Tons) in the British Columbia Roe Herring Fishery, 1996–1997

	Type of Boat	1996 Target Catch	1996 Actual Catch	1996 Percent Difference	1997 Target Catch	1997 Actual Catch	1997 Percent Difference
Queen Charlotte Islands	Seine	closed	closed	closed	closed	closed	closed
	Gillnet	closed	closed	closed	closed	closed	closed
Prince Rupert	Seine						
	Gillnet	2,612	3,344	28.0	6,011	6,007	0
Central Coast	Seine	3,183	3971	24.8	1292	2805	117.1
	Gillnet	300	342	14	300	333	11
Straight of Georgia	Seine	6,272	7519	19.9	8,449	9410	11.4
	Gillnet	5,654	6,570	16.2	6,142	6,294	3
West Coast of Vancouver Island	Seine	1,014	870	−14.2	4,035	6893	70.8
	Gillnet						
Subtotals	Seine	10,469	12,360	18.1	13,776	19,107	39
Subtotals	**Gillnet**	8,566	10256	19.7	12,453	12,634	2
Totals for Seine and Gillnet		19,035	22616	18.8	26,229	31,742	21

Source: DFO 1997: 4.

When pooling was introduced, "validating," recording catch volumes at the docks, became the focus of monitoring activity. Validating is done by a third party but, unlike the situation in other fisheries where the validating is paid for in cash, in the roe herring fishery the monitoring is paid for in fish (DFO 2000f: 26). While there is suspicion that some fishermen are harvesting more than their share and circumventing the validating process, this is considered to be a relatively small problem and overall the monitoring is working reasonably well in both the gillnet and seine fisheries (Dave Boyes, personal communication, May 9, 2002; John Lenic, roe herring fisherman, personal communication, May 9, 2002).

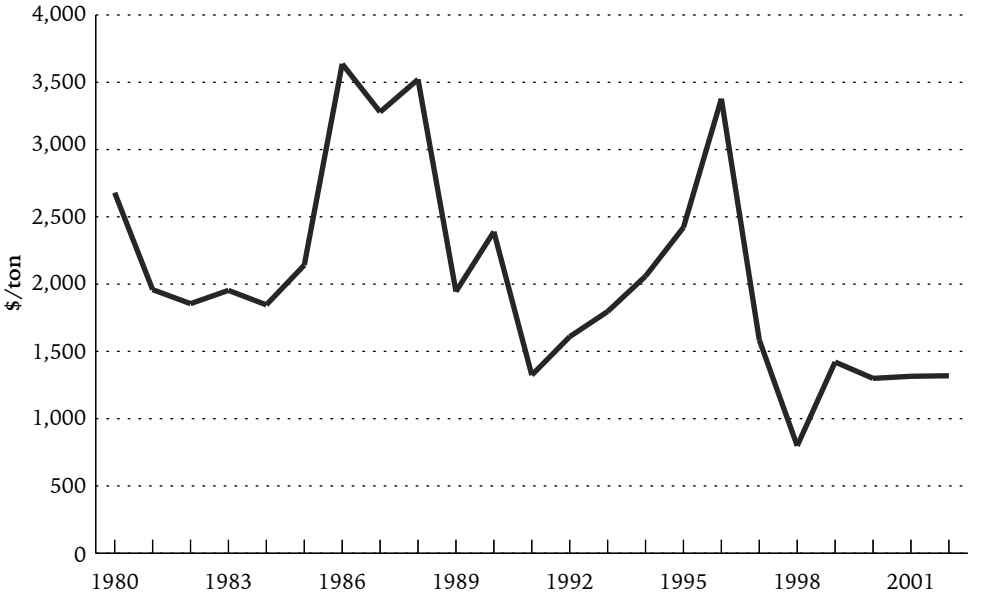
Prior to the introduction of pooling, in 1995, the Herring Industry Advisory Board (HIAB) members agreed to the formation of the Herring Conservation and Research Society (HCRS). The HCRS currently receives an allocation of herring to fund test fishing, which is carried on before an opening to determine when roe herring should be harvested to maximize the quality of the roe. This allocation is part of the TAC and is taken off the roe herring quota. Under pooling, industry funding of this program has increased, which has enabled the HCRS to pursue research that previously had been too expensive. HCRS funding for 1999 totalled $528,000 and was allocated to several key projects such as biomass sampling, DNA analysis, coded-wire tagging, and some funding to the DFO for the salary of a management technician. In 2001, the HCRS had a budget of $827,000 to cover various biological studies.

Economic viability

Pooling in the roe herring fishery coincided with the slowdown in the Asian economy in the late 1990s and since virtually all of the roe herring harvest is sold to Japan, prices and revenues fell sharply in the fishery (figures 9.3 and 9.4). As a result, landed values and prices are still far below their pre-1997 levels. However, there is general agreement that the fishery would be much worse off if pooling had not been introduced. By its nature, the roe herring fishery is short but pooling has slowed the frantic pace of the free-for-all fishery and allowed fishermen to concentrate on quality as they can now spend several days harvesting what was previously taken in a matter of hours (Dave Boyes, personal communication, May 9, 2002).

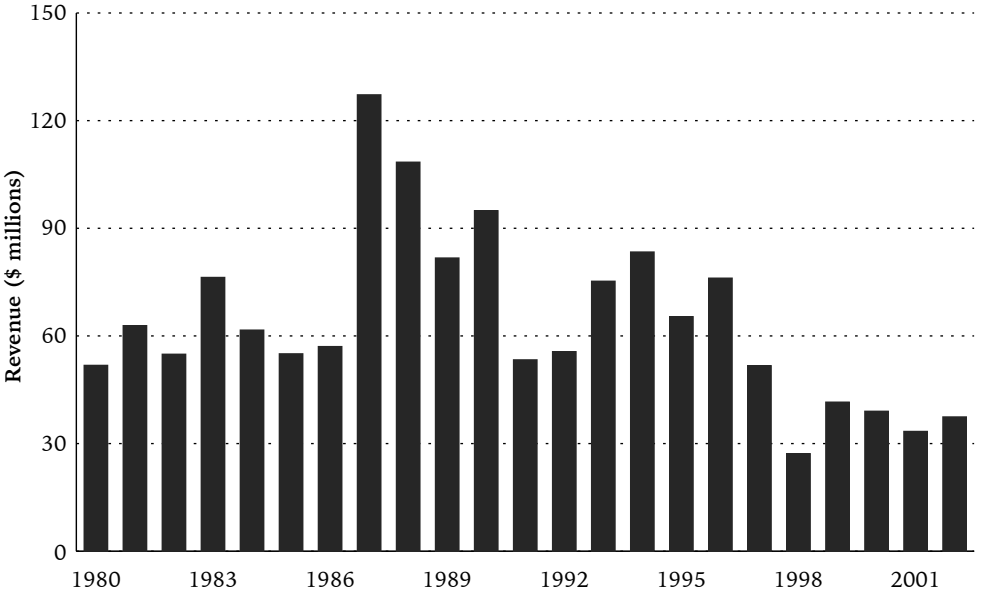
Pooling has eliminated the need to over-capitalize fishing equipment and vessels since each pool has a secure right to its share of the TAC. For example, prior to pooling, it was not uncommon for fishermen to equip their herring skiffs with 600 horsepower engines in order to gain some advantage in the race to catch fish. Under pooling, some fishermen have returned to using smaller, more efficient, engines and older, smaller skiffs, which, although perfectly serviceable, were uncompetitive in the last years of the derby-style fishery (Boyes, personal communication, July 28, 2003). The cost of fishing has decreased in other ways like using fewer crew and patching nets instead of

Figure 9.3: Roe Herring—real landed price, 1980–2002 (adjusted for inflation)



Note: Limited entry was introduced in 1974, pooling in 1998.
Note: Price was calculated as total value of landed catch ($) divided by landed catch (t).
Sources: DFO 2001c: tables 4 & 6 (Appendix); DFO-Pacific 2003.

Figure 9.4: Roe Herring—real landed value, 1980–2002 (adjusted for inflation)



Note: Limited entry was introduced in 1974, pooling in 1998.
Sources: DFO 2001c: tables 4 & 6 (Appendix); DFO-Pacific 2003.

using new ones each season (Boyes, personal communication, May 9, 2002). The DFO agrees: "The new strategy has provided the added benefit of increasing profitability in the roe industry by limiting overhead costs (fishing gear, license lease costs, packing costs) and by improving quality" (DFO 2000g).

The change in management did not increase the contribution fishermen make to covering management costs in this fishery as much as it did in some other fisheries. The flat-rate annual fee of $200 for gillnet licences and $3,980 for seine licenses stayed the same (licenses are issued to natives at lower fees: gillnet, $100 and seine, $1,990). These license fees go into the DFO's general revenue, making it impossible to assess what portion of the management costs of the fishery are covered. Monitoring, however, which is one of the larger costs in fisheries management, is now paid for directly by the industry (DFO 2000f: 26).

Working conditions

Safety in the fishery under IQs improved as the length of the season increased from openings that could be less than an hour long to openings that lasted several days. The longer openings have meant that fishermen do not fish in bad weather and they do not overload their boats (as the quality of the fish would suffer) (Dave Boyes, personal communication, May 9, 2002). As in other fisheries managed with individual quotas, employment in the fishery fell after the change in management.

Overall assessment

In 1997, just prior to the change in management to pooling, the roe herring fishery was in a crisis: fisheries managers were unable to control catches, use of illegal gear was widespread, fishing was becoming increasingly expensive as boats had to be bigger, faster, and better equipped to compete in the short derby-style openings, and working conditions were often unsafe.

Pooling changed the incentives in the fishery for the better and improved indicators of conservation, economic viability, and safety. Some fishermen also believe that pooling has improved the working relationship between the DFO and the industry. Now that fishermen know ahead of time how much they are allowed to catch, there is no longer an incentive to lie to the DFO on the fishing grounds about the catch rate as was the case in the derby-style fishery (Dave Boyes, personal communication, July 28, 2003). It is also because under the old system fishermen were looking to "take advantage of any screw up that DFO managers would make" (John Lenic, personal communication, May 9, 2002). Under pooling, there is a more cooperative relationship between the DFO and the industry. Most fishermen agree that the move to pooling has been positive: "Although a few guys say the old fishery was more exciting, no one would say it was a better business" (Dave Boyes, personal communication, May 9, 2002).

Notes

1 Seiners carry giant nets with surface floats on one edge and weights on the other. The nets are towed around a school of fish by a small net boat while one end of the net remains fastened to the main vessel. Once the desired number of fish is within the net's borders, the bottom of the net is closed and tightened around the catch. The gillnet fishermen, in contrast, harvest their roe herring using a large commercial fishing net that is suspended vertically in the water in order to catch fish around their bellies (MSN Encarta 2000).

Herring Spawn on Kelp

Pacific herring (*Clupea pallasi*) are small fish with silver bellies and olive-coloured bodies. They are an abundant, short-lived species (most herring live less than eight years). Herring are harvested in a number of fisheries including roe herring, food and bait, and spawn on kelp. Spawn-on-kelp fishermen wait for herring to spawn and then harvest the eggs using closed or open ponding. In closed ponding, harvested kelp is suspended from frames in an enclosed area into which seined herring are released to spawn onto the kelp. Open ponding involves suspending kelp from log frames or cork lines and, rather than the captured herring being brought to spawn in the log frames, the log frames or cork lines are brought as close as possible to natural spawning grounds. The spawn-covered kelp harvest is processed and exported to Japan, where it is sold in high-end restaurants and gift stores. The spawn-on-kelp fishery takes place between February and June.

A brief history of the fishery

The spawn-on-kelp (SOK) fishery has a long history in British Columbia—aboriginal groups traded herring spawn on kelp to the Japanese in the early 1900s. The commercial spawn-on-kelp fishery began in 1975, when the DFO issued 13 licenses. The first licences—with individual quotas—were issued to fishermen with experience in the roe herring fishery and to people living in smaller, outlying communities, especially aboriginals. One of the DFO's objectives in developing the commercial SOK industry on the Pacific coast of Canada is to create opportunities for economic development among Aboriginal bands. Aboriginal SOK fishermen hold 37 of the 46 SOK licences (24 are held by bands and 13 are held by individuals) (DFO-Pacific 2000f: 14–15).

The spawn-on-kelp fishery is unique in this set of case studies as it is the only commercial fishery to be managed with individual quotas from its inception. Another unique feature of this fishery is that the DFO has not stopped issuing new licenses. In 1976, 1977, 1978, 1990, 1993, and 1998, the DFO issued additional licenses, many of them to Aboriginal bands.[1] The DFO's representatives have given no indication about whether they will continue to issue licenses or increase individual quota for some licence holders in the future and this has created a considerable degree of uncertainty about supply and prices in the fishery. Currently, there are 46 SOK licences issued annually.

The initial allocation formula gave each licence holder an equal share of the annual TAC, which is determined after the Pacific Scientific Advice Review Committee (PSARC) makes stock forecasts for herring and harvest recommendations for both the roe herring and SOK fisheries. Between 1978 and 2001, each license was allocated 7.26 tonnes of spawn-on-kelp.[2] In 2001, without consulting the existing license holders in the fishery, the DFO negotiated a separate harvest agreement with the Heiltsuk band to operate their nine licences with increased quotas and outside the coastwide monitoring program. The increase was substantial—a 70% increase in quota from 144,000 lbs. or the equivalent of nine licenses to 240,000 lbs or the equivalent of 15 licenses—and was done without buying out existing individual quota from other license holders. The change has created two separate and unequal management systems within the same fishery (Gina Johansen, Executive Director, Spawn-on-Kelp Operators Association, personal communication, May 15, 2002).

Assessment: Have individual quotas been a successful way to manage the herring spawn-on-kelp fishery?

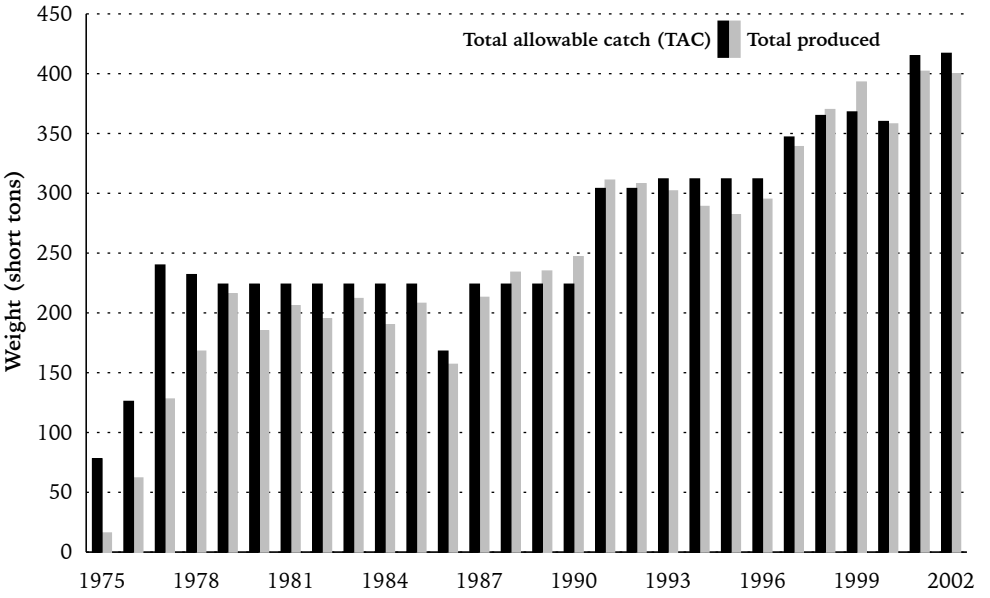
Conservation

Fish mortality in the SOK fishery is incidental and the industry is working on improving the handling of the fish so there is no mortality (Gina Johansen, personal communication, May 15, 2002). As a result, the fishery, at current levels, poses no threat to herring stocks.[3]

License holders in the fishery have never gone significantly over the total quota in the fishery. Since 1975, there have only been small catch overages, averaging 4% of the TAC, in seven out of 28 seasons (figures 10.1 and 10.2). These overages are not considered a problem since license holders are allowed an overage of 1000 lbs. each season. Any overages are subtracted from the individual quota the following year.

The monitoring and enforcement program in the SOK fishery is comprehensive. It involves at-sea observers, searches of vessels before hail-out, dockside monitoring, highway patrols checking transport vehicles for suspect product, air surveillance, and fishery patrol vessels for enforcement at sea.

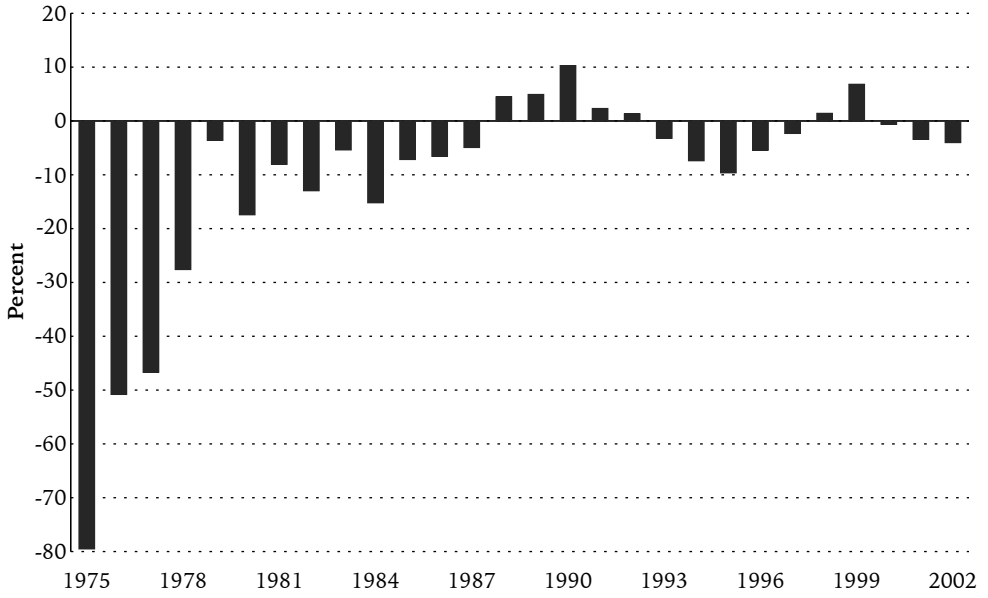
Figure 10.1: Herring SOK—TAC compared to total produced, 1975–2002



Notes: (1) The SOK fishery has always operated under IQs (since 1975). (2) Before 1988, quota refers to processed weight; from 1988 to 2000, quota is maximum allowable landed weight. (3) Total produced is processed weight.

Sources: Russell Mylchreest, Senior Economist, Policy Branch, DFO, personal communication, May 2001; Gina Johansen, Executive Director, Spawn-on-Kelp Operators Association, personal communication, September 8, 2003.

Figure 10.2: Herring SOK—catch overage or underage (%)



Note: The SOK fishery has always operated under IQs (since 1975).
Sources: Russell Mylchreest, Senior Economist, Policy Branch, DFO, personal communication, May 2001; Gina Johansen, Executive Director, Spawn-on-Kelp Operators Association, personal communication, September 8, 2003.

This system was designed by the DFO with input from industry participants (DFO-Pacific 2000f).

While overall conservation targets are being met in the fishery, there is one conservation issue that industry is concerned about. When DFO increased the individual quota for the nine Heiltsuk licenses, they also allowed the Heiltsuk to opt out of paying for, and participating in, the on-grounds monitoring program. The industry association, which until 2000 was responsible for all monitoring activities, refused to monitor the Heiltsuk licenses under laxer rules than the rest of the fishermen so DFO has taken over the dockside monitoring that is still required for these licenses. The inconsistency in monitoring requirements removes continuity in data collection and imposes costs and conservation requirements on some license holders and not on others. In 2001, the SOK industry association asked DFO to exempt all licenses from on-grounds monitoring, which would save license holders money and make the rules the same for everyone. DFO refused the request (Gina Johansen, personal communication, May 15, 2002).

Economic viability

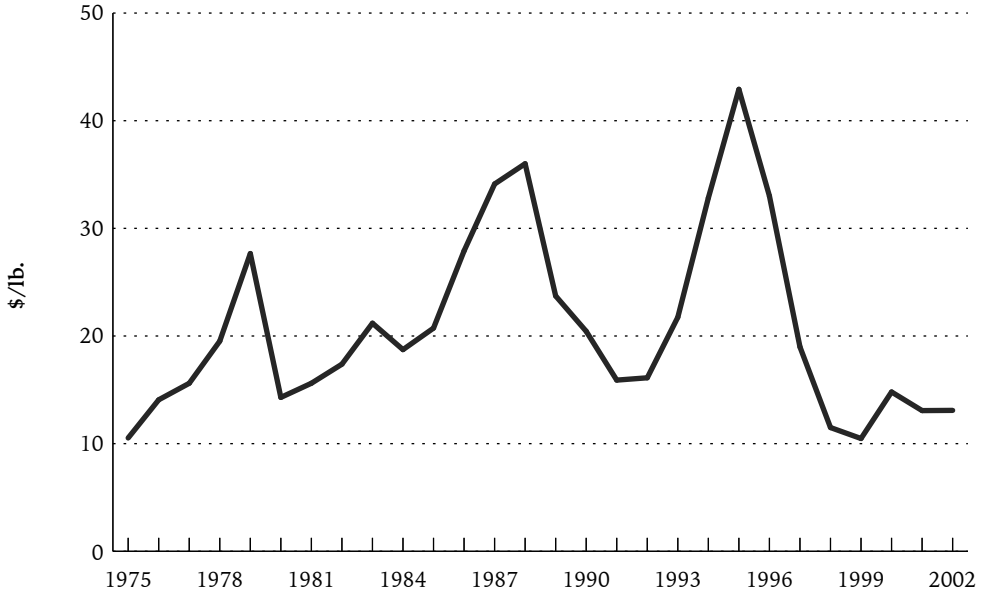
In recent years, many license holders in the spawn-on-kelp fishery have struggled to make a living. The fishery is not as lucrative as some other fisheries.

A recent presentation to the DFO by the Spawn-on-Kelp Operators Association puts the net profit of an owner-operator in the fishery between $50,000 and $60,000 while many native band licenses that were obtained by purchasing and retiring roe-herring licences are currently losing over $25,000 per year (SOKOA 2000).

Landed prices in the fishery are high relative to other fisheries, never falling below an average of $10/lb., but also variable, increasing to over $40/lb. in the mid-1990s before falling back to just over $10/lb. more recently (figure 10.3). Revenues have followed a similar pattern (figure 10.4). Since British Columbia supplies between 50% and 75% of the world output of SOK herring, the volume of production influences the world price. The decline in prices since the mid-1990s is blamed on an increase in the supply of the product from the additional quota issued in 1997, 1998, and 2001 and a fall in demand from Japanese buyers (DFO 2000h; Gina Johansen, personal communication, May 15, 2002) (see figure 10.5).

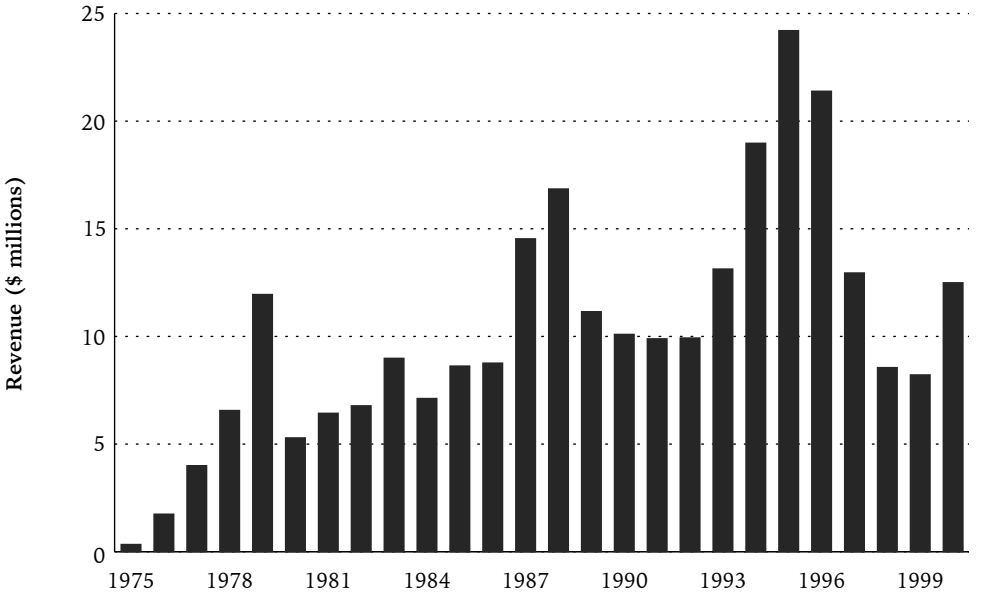
Between 1975 and 1995, each license holder was required to pay license access fees of $2000 to the DFO (these fees were only $10 for Aboriginal fishermen) (table 10.1). It is not clear whether these fees were enough to cover the costs of managing the fishery. In 1996, after the DFO reviewed license fees in many of the fisheries it managed, the fees went up dramatically to

Figure 10.3: Herring SOK—Landed Prices for BC Herring SOK: 1975–2002 (adjusted for inflation)



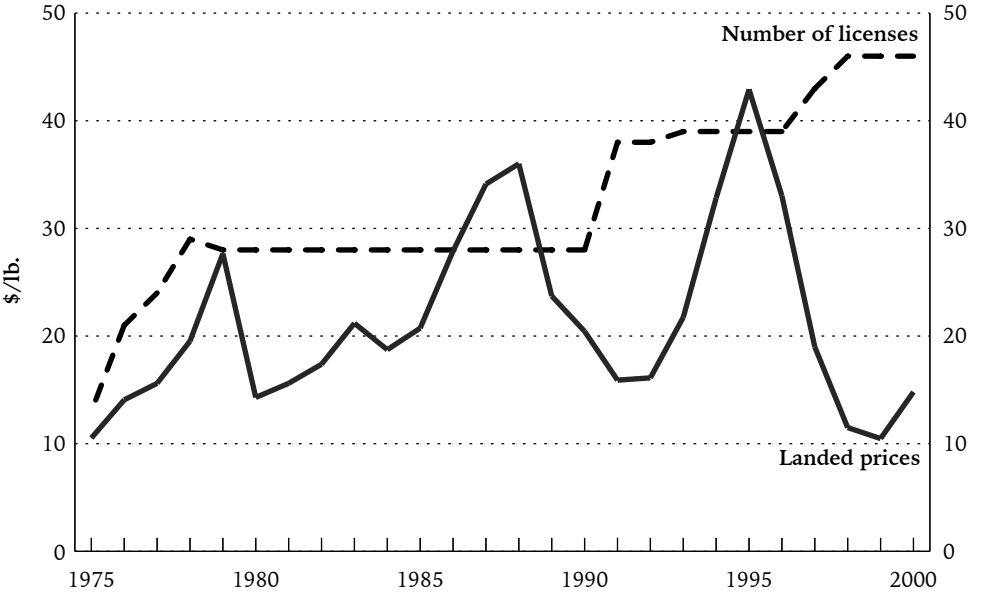
Note: The SOK fishery has always operated under IQs (since 1975)
Source: Russell Mylchreest, Senior Economist, Policy Branch, DFO, personal communication, May 2001.

Figure 10.4: Herring SOK—revenue, 1975–2000 (adjusted for inflation)



Note: The SOK fishery has always operated under IQs (since 1975).
Source: Russell Mylchreest, Senior Economist, Policy Branch, DFO, personal communication, May 2001.

Figure 10.5: Herring SOK—landed prices and number of licences, 1975–2000 (adjusted for inflation)



Note: The SOK fishery has always operated under IQs (since 1975).
Source: Russell Mylchreest, personal communication, May 2001.

$12,850 per license. The DFO also required license holders to form an industry association to manage fisheries monitoring and a fee of $5,000 per license holder was agreed on to cover these costs. The fee structure was based on 46 licenses paying but, since the DFO has now exempted the nine licenses held by the Heiltusk band from paying for monitoring, and down-loaded more co-management costs to license holders, these fees are no longer adequate to cover monitoring and management costs. The SOKOA and the DFO have been negotiating a new policy for co-management of the fishery for the last three years (Gina Johansen, personal communication, September 4, 2003).

Table 10.1: Herring SOK—fees ($) paid by each license holder

	Licensees	(Aboriginals)	Association
1975	2,000	(10)	0
1976	2,000	(10)	0
1977	2,000	(10)	0
1978	2,000	(10)	0
1979	2,000	(10)	0
1980	2,000	(10)	0
1981	2,000	(10)	0
1982	2,000	(10)	0
1983	2,000	(10)	0
1984	2,000	(10)	0
1985	2,000	(10)	0
1986	2,000	(10)	0
1987	2,000	(10)	0
1988	2,000	(10)	0
1989	2,000	(10)	0
1990	2,000	(10)	0
1991	2,000	(10)	0
1992	2,000	(10)	0
1993	2,000	(10)	0
1994	2,000	(10)	0
1995	2,000	(10)	0
1996	12,850.20	(12,850.20)	5,000
1997	12,850.20	(12,850.20)	5,000
1998	12,850.20	(12,850.20)	5,000
1999	11,850.20	(11,850.20)	5,000
2000	11,850.20	(11,850.20)	5,000
2001	11,850.20	(11,850.20)	5,000
2002	11,850.20	(11,850.20)	5,000

Note: As of 2000, Heiltsuk licenses, unlike other Aboriginal licenses, did not pay any fees.
Sources: Gina Johansen, Executive Director, Spawn-on-Kelp Operators Association, personal communication, June 5, 2002; Russell Mylchreest, Senior Economist, Policy Branch, DFO, personal communication, June 5, 2001.

Working conditions

Since fishermen know their allocation before going out on the grounds, SOK fishing has never had the safety problems other fisheries where fishermen are racing to capture an unknown share. As one SOK fisherman put it, "there is no reason why any fishermen would conduct fishing activities under unsafe conditions, given the security of access to the resource." Weather, however, can make fishing dangerous as operators must carefully coordinate kelp harvest and herring capture with spawning times or full IQ shares may not be harvested. In addition, pond frames require careful attention by crew members and operators to keep them safe.

Overall assessment

In many ways the SOK fishery is a well-managed fishery. It has not suffered the problems of over-capitalization, unsafe fishing practices, and poor product quality that have plagued other fisheries where harvesters compete for a share of the catch. Product quality is high, fishing practices are safe, and there is no incentive to over-capitalize. Monitoring is generally considered effective. The nine licenses of the Heiltsuk Band, however, are exempt from on-grounds monitoring. Fishermen in the fishery are also contributing a considerable amount in license and association fees, although these do not cover the costs of managing the fishery entirely.

Although there are many positive indicators in the fishery, there are also a number of problems. Lower prices for SOK has meant that the fishery is less lucrative than it used to be—in fact, many license holders are currently losing money. In addition, the recent decisions by the DFO to issue more licenses or increase individual quotas without purchasing the licenses from within the fishery has contributed to lower prices, created uncertainty about future supply, and brought about tension among fishermen and between the industry and the DFO. According to Adrian Redford, an SOK fisherman, the DFO's interference with the IQ license allocation for SOK has resulted in falling prices and "if [it] continues, it will devastate the entire industry."

Notes

1 In 1990, for example, 10 licenses were issued to native bands. DFO required that roe herring licenses be surrendered in order to acquire these licenses.

2 The only exception to this practice was in 1986, when the threat of reduced herring stocks resulted in lower quotas of only 5,443 kilograms per licence.

3 The fishery may in fact enhance stocks as trimmings from the kelp and fish nets provide additional spawning areas for herring (Gina Johansen, personal communication, May 15, 2002).

Conclusions and policy recommendations

How should fisheries management be judged? Officially, the Department of Fisheries and Oceans emphasizes conservation:

> Our mission is to work toward safe, healthy, productive waters and aquatic ecosystems for the benefit of present and future generations by maintaining the highest possible standards of service to Canadians. [Our specific goals include] conservation and sustainable resource use, scientific excellence, and marine safety and environmental protection (DFO Homepage 2000).

While conservation goals must be met in order for a fishery to be successful, two other important criteria are considered in the case studies presented in this book: economic viability and working conditions in the fishery. The economic sustainability of the fishery is important for obvious reasons: it is desirable for fishermen to make a living at their chosen occupation and it is undesirable to have that living subsidized by taxpayers on an on-going basis. Working conditions are considered because fishing is a relatively dangerous job and clearly, if management changes have the effect of improving safety, this is also a desirable outcome.

Since the 1970s, managers of some of the fisheries on Canada's Pacific coast have experimented with giving fishermen a greater stake in their fisheries by introducing management systems that give them shares of the catch before they go out on the fishing grounds. Using these shares, usually referred to as individual quotas (IQs), have dramatically transformed these fisheries for the better. Despite this evidence, using individual quotas in

fisheries management is not universally applauded. Critics contend that using IQs can create conservation problems such as an incentive to high-grade or that IQs are unfair or impractical for some fisheries.

Conclusions from the case studies

Conservation

Concerns that fish stocks are being depleted often provide the impetus for fishermen and fisheries managers to consider different approaches to management. This is certainly the case in fisheries studied in this book. One of the most remarkable features of the transition to management by means of IQs is its positive effect on conservation indicators in these fisheries. In eight of the nine fisheries that changed to IQ management, conservation indicators showed improvement after the introduction of individual quotas (see table C1). In these fisheries, actual catches are close to or below allowable catches, third-party, industry-funded monitors have been hired, and more fishermen think of themselves as stewards of the resource.

In many cases, the improvement was dramatic. For example, in the "shotgun" geoduck fishery, catches exceeded those targeted by the DFO by as much as 80% in the years preceding the introduction of individual quotas. Since the introduction of IQs to the fishery, actual catches have only exceeded the limits set by DFO in four years and these have been minor, averaging

Table C1: Assessment of changing to management based on property rights

Fishery	Date of Change	Conservation	Economic Viability	Working Conditions
Abalone	1979	=	=	=
Geoduck	1989	+	+	+
Sablefish	1990	+	+	+
Halibut	1991	+	+	+
Green Sea Urchin	1994	+	+	+
Red Sea Urchin	1994	+	+	+
Sea Cucumber	1995	+	+	+
Groundfish Trawl	1997	+e	+e	+e
Roe Herring	1998	+e	+e	+e
Spawn on Kelp*	1975	N/A	N/A	N/A

Note *: There was no management change for herring spawn on kelp, which began as a fishery managed under individual quotas.
Legend: **+e**: early indications are that the change has been positive but data are limited; **+**: positive impact; **=**: neutral impact; **−**: negative impact

less than 1% of the allowable catch. In another example, license holders in red sea-urchin fishery were so concerned about the future of their fishery that they voluntarily left the fishing grounds in mid-season to negotiate a quota management program amongst themselves. Since the introduction of individual quotas, actual catches have not exceeded allowable catches in this fishery.

A critical factor in the success of the management change in these fisheries is adequate monitoring and enforcement. In most cases, the introduction of individual quotas was accompanied by the introduction of third-party monitoring paid, at least in part, by fishermen themselves. This had two positive effects. It improved overall monitoring in the fisheries and, since fishermen were paying for it directly, they had a greater incentive to ensure that they were getting their money's worth and that the monitoring was effective. In the one case where conservation did not improve, the abalone fishery, third-party monitoring was absent and widespread poaching is considered to be a main part of the reason that the individual quota program was not able to turn around the failing fishery.

Economic viability

Switching to individual quota management also had a positive economic impact on most fisheries (see table C1). Eliminating fishermen's need to catch fish quickly in order to secure their share allowed fisheries managers to extend fishing seasons. This, in turn, means that fishermen can land fish over a longer period of time and, therefore, sell more of it fresh (usually for a higher price). In the geoduck fishery, the amount of product sold fresh doubled after the introduction of individual quotas. Another positive consequence of longer seasons is a reduction in fishing costs since over-equipping boats to catch fish before another fishermen does is no longer necessary.

In the geoduck fishery, an astounding 100% of the license holders surveyed indicate that profitability in the fishery improved after the introduction of individual quotas. The pace of fishing in the halibut fishery slowed dramatically: the fishing season went from six to 214 days after the introduction of quotas. As with geoduck, this meant higher prices for fish and lower fishing costs, leading to an estimated $4-million increase in net income by the fishing fleet the year IQs were introduced (Macgillivray 1997: 110). The impact of IQs on the sablefish fishery was similar: a dramatic increase in the length of the season accompanied by a corresponding increase in revenues and decrease in costs. A longer fishing season has also increased earnings in the groundfish trawl fishery (GSIC 1999). Pooling has lowered fishing costs in the roe herring fishery and is generally thought to have improved the quality of the product and profitability.

Abalone is the only fishery that did not benefit economically from the introduction of IQs. In the abalone fishery, IQs had the effect of lengthening

the fishing season from three months to seven months but it is not clear that this increased prices or allowed fishermen to reduce their costs by reducing their over-investment in fishing gear since enforcement was so weak that effectively an illegal race for fish continued.

With the introduction of individual quota programs, monitoring and the costs associated with it often increase and have been shifted from taxpayers to the fishermen. One of the most dramatic results of the shift to IQs has been the increase in fishermen's willingness and ability to pay these costs. Prior to the introduction of individual quotas, licence fees in most fisheries were far too low to cover the costs of managing the fisheries. Geoduck fishermen, for example, were paying a flat licence fee of $10. They now pay a licence fee of over $7,000 in addition to paying for third-party monitoring, private investigations into poaching, water sampling, biomass surveys, and other fisheries enhancement projects. In the halibut fishery, licence holders also went from paying a flat $10 fee to covering most of the costs of managing the fishery, including the monitoring program, the majority of salaries for enforcement officers, fisheries managers, and their support staff and some fisheries research and development. Sablefish fishermen used to pay $10 and now the cost of the fishery is completely recovered. Fishermen harvesting red sea urchins and green sea urchins also pay a significant fraction of the management costs of their fisheries. The groundfish trawl fishery prior to the introduction of individual quotas was heavily subsidized since the $10 licence fee barely covered any of the DFO's management expenditures. While it is unlikely that all costs of this fishery are recovered today, license holders are contributing more towards management—a $500 annual license fee and an additional fee per ton of groundfish caught. In the roe-herring fishery, licence fees did not change but fishermen are now paying for all third-party monitoring costs. The move away from subsidies by taxpayers towards having fishermen pay all management costs is an important indicator of economic sustainability in these fisheries.

Working conditions

Another dramatic change in many fisheries is an improvement in safety. Before the introduction of IQs, there were serious concerns surrounding the dangerous conditions under which harvesting was taking place in many fisheries including halibut, sablefish, geoduck, and groundfish trawl. Individual quotas stopped the race for fish in these hectic fisheries and replaced it with a stable, slower-paced fishing environment. Of the license holders surveyed in the geoduck fishery, 83% believe that working conditions have improved and a number of them indicated the best thing about moving to an individual quota system was the improvement in safety and, particularly, not feeling compelled to fish in dangerous weather. Similarly, license holders and crew members in the halibut fishery rated improved safety as the single most

important benefit of the halibut IQ program. The sablefish and groundfish trawl fisheries are also considered safer.

The improvement in safety in the red sea-urchin and green sea-urchin fisheries is dramatic. One observer describes how, prior to the introduction of IQs, urchin fishermen would begin their excursions the moment the season was officially opened, regardless of the weather. This competitive environment led to many boats sinking. Since the quota system was implemented, there has been a significant decrease in accidents as everyone co-ordinates their harvests in accordance with market demand without having to operate under adverse fishing conditions (Mike Featherstone, President, Pacific Urchin Harvesters' Association, personal communication, July 10, 2000). Even the roe-herring fishery, which still has short openings due to the nature of the fishery, is safer. Openings used to be just a few hours long; now they are several days. This difference has meant that fishermen do not have to fish in bad weather and they do not overload their boats.

Overall assessment

Experiments with management based on property rights in the fisheries on Canada's Pacific coast have been highly successful. In most fisheries, using IQs have improved conservation, economic viability and working conditions. Beyond these changes, IQs have had an impact on the attitude of many license holders. As one fishermen explained: "I am a custodian of my fishery, not a miner of resources." Evidence of such a change can be found in many fisheries, where participants now voluntarily contribute extra funds for research and enhancement projects. IQs have also changed license holders' relationship with DFO: over 80% of the geoduck license holders surveyed believe that relations between the industry and the DFO improved after the introduction of individual quotas and over 70% believed that the DFO is now more accountable. Fishermen in other fisheries also indicated that this was a positive outcome of the change in management.

Responding to the critics

Despite this success, many remain doubtful that individual quotas are a better alternative to the more traditional approach of regulating the effort that goes into fishing. The main criticisms of individual quota programs are examined below.

Quota busting

Dr. Parzival Copes, the foremost academic critic of IQs, lists in his paper, *A Critical Review of the Individual Quota as a Device in Fisheries Management* (1986), a number of problems that he anticipates will arise from the introduction of

individual quotas. One of his concerns is "quota busting." Quota busting occurs when fishermen exceed their individual quota allocation, which is more likely to happen if monitoring and enforcement are inadequate.

Experience with individual quotas in one fishery on the Pacific coast of Canada confirms this can be a problem: in the abalone fishery, the introduction of individual quotas did not significantly reduce the rampant illegal fishing that had been threatening the health of stocks. Overfishing could not be controlled since monitoring and enforcement continued to be weak. Essentially, a race for the fish continued alongside the quota program. The lesson from the abalone fishery is clear: for a quota program to succeed, it must be accompanied by a sound monitoring and enforcement policies.

There is no evidence to suggest that quota busting is a problem in any other fishery. In every other fishery on Canada's Pacific coast where individual quotas are used, monitoring (including dockside monitoring and, in some fisheries, on-board observers) have been introduced to ensure that fishermen do not exceed the allowable catch. The introduction of individual quotas has improved adherence to allowable catches in these fisheries. That fishermen pay directly for the additional monitoring likely contributes to its success. Not only do fishermen want to get value—in this case, good monitoring—for money but paying for it takes away the "us-versus-them" attitude that existed when the DFO conducted the monitoring.

High-grading

Another conservation problem that could arise in quota fisheries is "high-grading," or dumping less valuable fish. Copes explains the incentive problem created by individual quotas:

> A fishing operator whose catch is confined to a given individual quota will wish to obtain the greatest net value from that quota. Usually this means that he will want to fill the quota with the best quality of fish only. If fish of a particular size or condition (e.g., with or without spawn) fetch a significantly better price, he may well be induced to "high-grade" his catch by discarding fish of lesser quality (Copes 1986: 284–85).

High-grading does not appear to be a serious problem in any of the fisheries that we have studied. Fisheries that would be the most susceptible to high-grading have taken steps to ensure that it does not occur. High-grading in the groundfish trawl and spawn-on-kelp fisheries is closely monitored by on-board observers and is not considered a problem. The geoduck fishery is susceptible to the problem of high-grading since buyers in Asia will pay a premium for light colored siphons. To eliminate the incentive to high-grade, fishermen agreed to accept the same price per pound for all product regardless of the colour of the siphon.

By-catch

Some critics fear that individual quotas will increase by-catch, the inadvertent harvest of non-target species. It should be emphasized that by-catch is not a problem unique to fisheries managed by individual quota nor is there any legitimate reason to believe that by-catch problems would be exacerbated by IQs. For many of the fisheries examined in this book, including the dive fisheries or the herring spawn-on-kelp fishery, by-catch is not a concern since there is no incidental catch of non-target species. By-catch can be a problem in a multispecies fishery such as groundfish trawl where it can occur when a harvest limit for one species is reached before the limits for other species.

In the groundfish trawl fishery on Canada's Pacific coast, by-catch concerns in the fishery are being addressed with strict monitoring and enforcement. The slowed fishing pace under IQs has also helped reduce by-catch as fishermen are now making short, sample tows to assess the suitability of a species mix before fishing in a new area. In addition, investments in gear and electronics aimed at winning the race for fish have been replaced by investments in gear that allow for selective harvesting. The transferability of individual quota in the groundfish trawl fishery is working well to prevent by-catch from causing stocks to be over-fished and ensures that catches are recorded. In this fishery, there are thousands of transfers each year (Bruce Turris, President, Pacific Fish Management Inc., personal communication, August 25, 2003).

Two other fisheries in our set of case studies have potential by-catch problems. Halibut and sablefish fishermen sometimes inadvertently catch other fish, mainly rockfish. On-board observers help mitigate the problem, although on-board observers only cover a small fraction of each fleet at any given time. In 2000, the DFO began allowing combined fishing by fishermen holding both halibut and rockfish licenses. Prior to the change in regulations, rockfish caught by halibut fishermen had to be dumped as did halibut caught by the rockfish fleet (Chris Sporer, Executive Director, Pacific Halibut Management Association of British Columbia, personal communication, January 17, 2003). Not only was this practice wasteful but it made it difficult for the DFO to estimate by-catch in the fisheries, which is important in order to ensure that conservation targets are being met.

Halibut license holders are working with a monitoring company to monitor by-catch: they are experimenting with video cameras to monitor more of the fleet. Cameras were tested on 19 boats for the 2002 season (Chris Sporer, personal communication, January 17, 2003). Since the cameras are cheaper than on-board observers, it may be possible to use them for greater coverage of the fleet in the future.

While critics fear that by-catch may worsen in fisheries managed by IQs, the evidence from the case studies in this book suggests that the problem is

better managed under IQs. The slowed fishing pace and the increased sense of ownership felt by fishermen have led to innovative solutions such as the use of sample towing and video cameras in the groundfish trawl and halibut fisheries. In addition, the transferability that is made possible under IQs can help keep species under their target allowable catches.

Windfall gains

In theory, there are many ways to allocate individual quotas. In practice, however, in order to make an individual quota program palatable to fishermen, fisheries managers almost always give the individual quota to fishermen based on equal shares or a formula that includes past catch history.[1] This is true for all of the fisheries that we studied, with the exception of spawn-on-kelp, which started under IQs. Critics point out that having quota attached to your fishing license often raises its value, which means that fishermen "stand to gain a windfall worth millions from the public trust" (Jennings 1999: 6). The "windfall" refers to the dramatic increase in license values that can occur when prospects for a fishery's sustainability and economic viability improve. For example, crude estimates suggest that geoduck licenses that sold for two to three hundred thousand dollars before the introduction of individual quotas now sell for over a million dollars (Muse 1998b: 13). If fishermen anticipate an IQ fishery and increase capital investment in order to ensure a larger quota share, this further aggravates what some call the political race for quota (Leal 2000: 16).

Critics object to these increases in the value of licenses on two grounds. First, they argue that the increase is not fair as it was the change in management that changed the value of the licenses, rather than some increase in work or investment on the part of the license owner. Such "windfalls" or lucky breaks happen in other areas as well, such as when an unexpected change in zoning appreciably increases the value of someone's house.

While this argument has some validity, it must be weighed against the desire to have a sustainable fishery. The reason license values tend to be lower in fisheries managed by effort control is that the future of many of these fisheries is, at best, uncertain and, at worst, bleak. Changing to IQ management secures a healthy and more certain future for many fisheries, making a share of them more valuable. If the choice is between a failing fishery and a successful one where there are some windfall gains,[2] there is no question that the latter is more attractive.

The second objection to increases in the value of licenses is that, once a fishery has gone to individual quotas, it is no longer affordable for those who would like to become license holders to enter the industry.[3] The counter argument, however, is that it is actually more affordable as fishermen can buy differing amounts of quota and hire, rather than buy, a boat. The more certain future in an IQ fishery also makes such investments less risky.

Reducing employment and increasing concentration in the industry

Another criticism leveled at individual quota programs is that they have the effect of reducing employment in the industry and, because IQs can be bought and sold, increasing concentration in the industry. There was evidence to suggest that there was a reduction in employment in the fisheries considered in this book. While critics lament reductions in employment, they have the problem backwards: there were too many people in many of those fisheries to begin with. Excess employment in fisheries is not wise as it puts too much pressure on fish stocks.

There is no question that the short-term dislocation that may be caused by a reduction of employment in any industry can be wrenching. As the state of the cod industry on Canada's east coast illustrates, however, it is preferable to suffer this short-term adjustment rather than the collapse of a fishery. Furthermore, what the critics fail to point out is that the use of IQs often reduces the number of people in a fishery but increases the amount of time each person is able to work and generally leads to higher, more stable incomes.

Critics also fail to mention that IQ management, by slowing the pace of fishing, creates a safer working environment in an occupation that is relatively dangerous. These improvements are not trivial: in cases where license holders were asked, improved safety is rated as one of the best changes resulting from the introduction of IQs.

Concerns about corporate concentration are also overblown and, it should be emphasized, not unique to IQ fisheries. Most IQ programs put limits on the amount of quota that can be used from each boat, which reduces corporate concentration. To the extent that more efficient fishermen buy out less efficient ones, concentration is desirable. Remember that no one forces another to sell so, presumably, the transaction benefits both parties. While critics argue that IQ programs hurt smaller operators, in fact the reverse is likely to be true. In order to be successful in a fishery managed by effort controls, a license holder must have a powerful boat and many crew members to compete for his share. In an IQ fishery, since a share of the catch is assigned before the season starts, operators do not have to invest in more powerful equipment to make them competitive in the race. In fact, part of the rationale for introducing individual quotas to some fisheries was to *protect* smaller operators.

Individual Quotas do not go far enough towards establishing property rights

Many critics of individual quotas are opposed to the idea of granting license holders stronger property rights to a publicly owned resource. Some critics, however, argue that individual quotas do not go far enough in establishing rights. Elizabeth Brubaker, author of the book *Property Rights in the Defense of Nature*, argues that, while quotas are superior to weaker forms of property

rights, they do not always go far enough along the property-rights spectrum and that, therefore, there can be problems with enforcement. She favours sole ownership either by individuals, communities, associations or rights holders, or corporations.

> One of the strongest arguments for sole ownership is that it limits the opportunities for government interference in a fishery. Many quota systems maintain considerable government involvement … The government continues to set the total allowable catches, to manage fish stocks, to assign quotas and to assume responsibility for environmental protection. (Brubaker 1996)

Brubaker argues that fisheries will remain susceptible to political pressures until they are completely privatized. In Canada, individual quotas are a weak form of property rights because they are granted at the discretion of the Minister of Fisheries and Oceans. Creating a stronger property right would create even stronger incentives for fishermen to see themselves as custodians of the resource. Granting sole ownership to fisheries, however, is politically difficult and the change to IQs in fisheries on Canada's Pacific coast has been shown to be a move in the correct direction—it has gone far enough to improve management dramatically.

Policy recommendations

No fisheries management system is perfect and management by means of individual quotas, like management by effort controls, has its flaws. But experiments with IQ management on Canada's Pacific coast indicate that it is preferable to effort control: it better meets the goals of conservation, economic viability, and safer working conditions in the fisheries. Changing to IQ management turned many of the fisheries on Canada's Pacific coast from disasters to successes and should be considered for fisheries still managed by effort control.

Management by individual quotas can be improved, however. Following are some policy recommendations to move the management of fisheries on Canada's Pacific coast further along its successful course.

1 Fisheries still managed by effort controls should change to IQ management

Evidence from fisheries around the world, including those examined in this book, has demonstrated that, although individual quotas are not perfect, they are far superior to effort control in reaching the goals of conservation,

economic viability, and safer working conditions. In light of this evidence, fisheries on Canada's Pacific coast that are not currently managed by individual quota should change management. These fisheries include salmon, prawn by trap, rockfish by hook and line, shrimp by trawl, crab, krill (sold as food for fish farms and aquariums), and schedule-II fisheries (dogfish, lingcod. skate, etc.). In most cases, a change to IQ management should be fairly straightforward.

The salmon fishery is complex to manage under any system due to biology and the number of stakeholders. In this fishery, there are three different types of commercial boats (troll, gillnet, and seine) fishing for five types of salmon (Chinook, Chum, Coho, Pink, and Sockeye) from more than 8,000 genetically distinct stocks using 1,500 streams for spawning (Sprout 1996: 17). In addition, the abundance of salmon varies considerably from year to year and it is difficult to get an accurate idea of the biomass until the fish start returning to the rivers to spawn.

Despite these challenges, IQ management promises to be a more effective management strategy for salmon than effort control. Under effort-control management, the salmon fishery is suffering many of the same symptoms of other failing fisheries, over-capitalization, concerns over the health of certain stocks, and safety problems. In 1996, a group of fishermen spent a day designing a pilot IQ program for the salmon troll fleet (see Appendix, page 119). Since 1996, there have been several pilot projects introducing individual quotas to the salmon fishery. These projects, and progress towards using individual quotas to manage the entire salmon fishery should continue. It is apparent that the objectives of conservation and economic viability are not currently being met in the salmon fishery. While individual quotas will not be perfect either, it is hard to imagine a scenario where a well designed IQ program could accomplish less than current management.

2 *The DFO should keep track of management costs by fishery and license holders should pay all management costs*

One of the benefits to the public of an individual quota program is that it makes fisheries more economically viable. This means that fishermen are willing and able to pay a higher fraction of the cost of managing their fishery. Fishermen should be paying all of the management costs associated with the commercial fishery and, arguably, something for the privilege of fishing. In many fisheries, however, it is impossible to know whether management costs are being covered because the DFO does not break down these costs by fishery. Providing a breakdown of costs by fishery would allow an assessment of whether a fishery is truly covering all of its costs. In addition, the breakdown would make DFO managers more accountable to the license holders who pay their salaries.

3 License holders should have better security of access to the resource

Although, throughout this study, individual quotas have been referred to and treated as a type of property right, in reality IQs as currently used in the fisheries on Canada's Pacific coast confer only a quasi property right at best. Unlike the property right that one has to a house, car, or piece of furniture, an individual quota is an extremely precarious title, allocated annually with no security beyond that year. License holders must make financial decisions trusting that the DFO will re-allocate their IQ share the following year and their income stream will not be cut off. Participants in each of the ten fisheries dealt with in this study have emphasized the importance of extending the IQ allocation beyond one year. Without a guaranteed long-term asset, individual harvesters have difficulty securing financing and providing economic stability to their families. It is recommended that the DFO begin a process of negotiation with the relevant fisheries on Canada's Pacific coast to determine a reasonable length of ownership for IQ shares such that IQs in the future be correctly termed "property rights." In Iceland, for example, individual quota shares are permanent shares to the total allowable catch (Runolfsson and Arnason 1996: 44).

4 The DFO should stop issuing new quota and should have the same monitoring and enforcement policies for all fishermen

Creating new individual quota in a fishery dilutes the value of shares in quota now held, creates uncertainty, and fosters animosity among fishermen. It undermines the incentive for fishermen to invest in conservation and research initiatives since the ability to recoup those investments in the future becomes questionable. In the spawn-on-kelp (SOK) fishery, DFO has effectively created two fisheries by exempting Heiltsuk license holders from paying for, and participating in, the on-grounds monitoring program. The DFO should stop issuing new quota in the herring SOK fishery and make a commitment not to issue new fishing privileges in other fisheries. Enforcement and monitoring rules should be the same for all participants.

5 In the roe herring fishery, pooling rules should be more flexible and penalties should be imposed for going over quota

While pooling has effectively improved management of the roe herring fishery, it is still grossly inefficient. Currently, all roe herring boats participating in the pool must be on the fishing grounds fully equipped with a crew even though only one boat fishes. Since pools must consist of 10 licenses and each boat is limited to two licenses this means at least four unnecessary boats and crew are on the grounds. Obviously, this is wasteful of time and money.

License holders should decide for themselves how many boats and crew are needed to catch their allocation.

Another problem in the roe herring fishery is the lack of penalties for going over the allowable catch. In such instances, fishermen simply have to give the extra fish to another pool that is under the allowable catch or forfeit the fish to the government. Since there is no penalty, fishermen will likely go over the total allowable catch in an effort to maximize catch and avoid being under quota. Conservation goals would be better served with a penalty.

6 Sports fisheries should be allocated individual quota and trading between the sports and commercial fleet should be allowed

In fisheries such as halibut and salmon, there is a constant battle between sports and commercial fishermen over allocation. Currently, this battle is played out in the political arena—to no one's particular satisfaction. A superior solution would be to let the market settle the issue: once an initial allocation was made, if the sports sector wanted more fish, they could purchase additional quota from the commercial fleet. Not only is this the only way to ensure that fish allocations go to those who value them most but it also frees up resources currently spent on political lobbying for other, more productive, pursuits.

7 Trading individual quota among fisheries should be allowed

Allowing such trading would reduce wasteful dumping of by-catch. Currently, for example, license holders who fish for sablefish with traps are not allowed to keep any rockfish that they catch even though the rockfish will not survive. This problem could be reduced if sablefish license holders could purchase rockfish quota.

Final thoughts

Allocating individual fishermen a share of the catch through individual quotas has transformed fisheries management. Prior to the change, many fisheries were described by fishermen as "shotgun" fisheries characterized by supply gluts, harvests exceeding allowable catches, and unsafe fishing conditions. Today, many of these fisheries are considered models for other fisheries. Although individual quotas are not perfect, they are superior to alternative management systems. Harvesters in many of the fisheries on Canada's Pacific coast should be commended for having the courage to suggest and accept these management changes. The Department of Fisheries and Oceans should be commended for having the vision to implement them.

Notes

1 Auctioning off individual quota to the highest bidder has been recommended by some academics as a better alternative. There are several practical problems with this suggestion. Fishermen who have spent their whole lives fishing vehemently oppose the idea. They are often concerned that they will not be able to buy in and they argue that, since they have invested a career in the industry, they should not have to. Second, auctioning the rights to the harvest, particularly if the auction is done annually, leaves fishermen with little incentive and less money to contribute to scientific research.

2 When a fishermen sells his license, these gains are considered capital gains and are taxed by Revenue Canada.

3 Note that licenses in some fisheries were trading for over a million dollars even before the introduction of individual quotas. Thus, buying into a non-quota fishery may also not be affordable.

A Pilot Project for Individual Quotas in the Salmon Fishery

The following proposal emerged from a session at a workshop organized by The Fraser Institute to design a pilot project of individual quotas for the troll fleet. The workshop followed the Fraser Institute conference, Managing a Wasting Resource: Would Quotas Solve the Problems Facing the West Coast Salmon Fishery? at which experts from British Columbia, New Zealand, and Iceland met to discuss their experience with individual quotas. Two observations from that first conference made it logical to examine the idea of individual quotas more closely in a workshop.

First, it became clear that fisheries managed under individual quotas have been successful both in conserving stocks and in making fisheries economically viable. In the early 1970s, Iceland's herring fishery, for example, was suffering many of the same problems that the salmon fishery in British Columbia faces in 1997. Under a management system that controlled the number of fish caught through restrictions on fishing times, gear types and boat sizes, the herring fishery suffered from declining stocks and overcapitalization, and the situation became so serious that the fishery was completely shut down in 1972. It has been estimated that, since the fishery was reopened under an individual quota system in 1975, both catch and technical efficiency have increased tenfold. Because of this experience, all Icelandic fisheries are now managed under an ITQ system.

New Zealand introduced ITQs into all its major fisheries in 1986, and the quota system has since increased both catches and profitability. In addition,

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since the system was implemented, the government has moved to a policy of cost recovery, where all costs associated with fisheries research, enforcement and conflict resolution are paid for by the industry (see Arnason 1996).

Closer to home, the British Columbia halibut fishery offers another dramatic success story. During the 1980s, before the introduction of quotas fishermen increased the capacity of their boats by increasing crew sizes and using electronic gear and more efficient hooks. As a result, fishing seasons were shortened to limit the number of fish caught. Shorter seasons led to an increased propensity to fish in hazardous conditions and an increase in the number of sinkings. The quality of the fish declined because gluts in supply led to the freezing of most of the fish (see Casey et al. 1995). But, after the introduction of individual quotas (IQs), seasons lengthened from 6 days to 214 days, increasing the quality, availability and, therefore, the landed prices of the catch. These and other successes with individual quotas suggest that there is a viable alternative to the current ineffective style of management that attempts to control the amount of effort that goes into the fishery. Individual transferable quotas are an option for salmon management that clearly merits further investigation.

Second, it became clear at the conference that there were many unanswered questions about the correct design for a quota system for Pacific salmon. The salmon fishery has a number of unique characteristics, notably the large number of stocks and the difficulty in estimating run sizes before the season begins. A quota system for salmon requires, therefore, a more complex design than a quota system for groundfish (e.g., halibut) or shellfish.

The workshop was organized to grapple with the problems inherent in designing a pilot project for individual quotas for the salmon troll fleet.[1] The following proposal outlines the specific issues that need to be addressed in order to implement a pilot project for trollers and, as well, some of the conclusions arrived at by the participants in the workshop.

Goal of the pilot project

The goal of the pilot project is to provide further information about whether salmon can be better managed under a quota system. The pilot project would provide information concerning potential increases in income due to improved quality, better marketing, higher quality catch, and reduced fishing costs.[2] In addition, it can be expected that the pilot project would make a contribution to stock assessment if, as was suggested, the quota holders give daily reports to the Department of Fisheries and Oceans (DFO), providing information about areas fished, species and numbers of fish caught, and how fish are processed. It was also suggested that detailed records be kept on hours of labour, wages paid, fuel consumption, repairs, and gear purchases.

Specific questions to be evaluated during the course of the pilot project include:

- Does the individual quota system contribute to biological knowledge (stock assessment and run timing)?
- Would individual quotas return the troll fleet to solvency?
- Would individual quotas eliminate the need for government subsidies including employment insurance and the management, enhancement and research currently funded by the Department of Fisheries and Oceans?
- Does the quality of the catch increase under the pilot project?
- Does the way in which the fish are marketed change under the pilot project?
- Does the cost per pound to harvest salmon go down under the pilot project?
- What kind of management regime (catch monitoring, enforcement and validation) is needed for a general quota system in the troll fleet?
- Will a quota system create a more stable economic environment in small communities?[3]
- Will fishers and processors relocate to be closer to the resource?

Implementation

Participation in the pilot project

The most ambitious pilot project would include an entire licensing area and all licensed fishermen in the area would be required to participate.[4] This has the advantage of allowing an assessment of how individual quotas would contribute to conservation. It also would be more representative of how a system of individual quotas would work if implemented for the entire fleet.

An alternative would be to operate the pilot project within an existing licensing area on a strictly voluntary basis. In this case, participants in the pilot project would display an easily identifiable license on their boat that would allow them to fish until their quota was caught.[5] The North Coast statistical area 2W (West Coast, Queen Charlotte Islands) and West Coast statistical areas 21 to 27 (West Coast, Vancouver Island) were suggested as areas in which a pilot project with voluntary participation could be tried.

Species

There was no general agreement on how many species should be covered. The pilot could include Chinook and Coho, or it could include all five species—Chinook, Chum, Coho, Pink, and Sockeye.

Allocation

There are two fundamental questions about allocation. First, how are the salmon to be allocated between the pilot project for IQs and the free-for-all fishery, and among the fishermen participating in the pilot project? Second, should the allocations be measured in pounds or in numbers of fish, by fixed volume shares or by percentage shares, by individual species or in sockeye equivalents?

If the pilot project for IQs is to operate in the same license area as a free-for-all fishery, the allocation to the pilot project could be based on the historical catch of the participants. Alternatively, it could be the projected fleet average for that area multiplied by the number of vessels in the pilot.

The allocation to individual fishermen participating in the project could be distributed as equal shares of the total allocation, or a formula could be worked out based on catch history. At the workshop, equal allocation was favoured for the pilot project as less complicated to implement than an allocation based on catch history. If individual quotas are set on catch history, a review panel and appeal board must be set up to hear grievances. Equal allocation also avoids the problem that arises with boats that, in the past, may have targeted species not covered by the pilot project. For example, if the pilot project covered Coho and Sockeye, a fisherman who had been fishing for Chinook would not receive an allocation under an catch-history formula unless that formula was based on a system of Sockeye equivalents.[6]

Allocations could be made in pounds of fish or numbers of fish. An allocation made in pounds eliminates the incentive for fishers to "high-grade" or throw away smaller fish.[7] Allocations could be made by fixed volume shares or percentage shares of the total allowable catch (TAC). An allocation by percentage share would work only if the TAC for the pilot project was set at a low level initially, and adjusted during the season as information about the sizes of runs changed. This would allow the Department of Fisheries and Oceans more flexibility in responding to changing estimates of the sizes of the runs.

A separate allocation could be made for each species that the boat catches (see table 1) or allocations for each species could be made in Sockeye equivalents, relating all species to a standard. Differential multipliers could then be applied to each species by size and grade of quality to eliminate high-grading. Catch should not exceed quota for any species by more than 2%, and amounts caught in excess of that margin would be deducted from the quota of the following year. Similarly, up to 5% of uncaught quota could be transferred to the following year.[8]

Duration of Season

The free-for-all fishery will last, as usual, until the Department of Fisheries and Oceans estimates that the free-for-all allocation has been caught. There should be no closed season for the pilot project, however, and the quota

Table 1: Sample system of equal allocation based on each species for a pilot project fleet of 100 boats

	Number of fish	Weight (lbs.) per fish	Total weight (lbs.)	Weight (lbs.) per vessel
Chinook	20,000–40,000	20	400,000–800,000	4,000–8,000
Coho	200,000–400,000	5	1,000,000–2,000,000	10,000–20,000
Sockeye	300,000–1,000,000	6	1,800,000–6,000,000	18,000–60,000
Pink	700,000–2,000,000	3	2,100,000–6,000,000	21,000–60,000
Chum	50,000	7	350,000	3,500

fishery would remain open until all quota is caught, except when time and area closures are needed to protect weak stocks passing through an area. Boats should be marked to indicate that they are participating in the pilot quota fishery.

Duration of the Pilot Project

The general consensus was that the pilot project should last for at least two years in order to produce meaningful results.

Transferability

Because of the "pilot" nature of the project, transferability should either not permitted at all or limited to those in the program.[9] Those participating in the project could be permitted to transfer or lease quota for a maximum of one year. It is important to note that while it may be desirable to limit transferability under a pilot project due to uncertainty that the program will continue, transferability should not be limited if a quota system were adopted on a permanent basis. Quota transferability provides a means of allocating the resource to the most efficient fishermen, and it also allows fishermen to buy quota if they over-fish their allocations. Finally, if quotas were implemented on a wider basis, transferability would provide a market mechanism for re-allocating catch between gear types and the sports, commercial, and aboriginal fisheries.

Enforcement

The monitoring of catch under a quota system requires that fish be landed at designated stations, where port monitors would record catches. The port monitoring system in the halibut fishery could serve as a model. It is important that there be a deterrent to prevent the overfishing of quota. Penalties for overfishing or for not reporting could include the loss of all, or part of, assigned quota either on a temporary or permanent basis.

Conclusion

The Pacific salmon fishery is a complex fishery and difficult to manage under any system due to the biology of the fish, the large number of fishermen, the different gear types used in the commercial fishery, and the presence of recreational and aboriginal fisheries. This has been the central rationale for staying with the current system of management, which focuses on effort controls and which has been unsuccessful at meeting either conservation or economic targets. It was thought that there was no better way to manage salmon, but the evidence suggests otherwise. Individual quotas have been successful in fisheries all over the world and our proposal suggests that it is time to try a quota pilot for the troll fleet. The quota pilot, if implemented, would give fisheries managers valuable information about whether quotas are the best management option for Pacific salmon in the future.

Acknowledgments

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Notes

1 There are three different gear types used to fish salmon: seine, gillnet and troll. The workshop focused on establishing a pilot project for trollers.

2 The DFO estimates indicate that a troller's net operating income would increase by 24.6% to 40.2% if a quota program with no transferability were adopted. A quota program with transferability could increase incomes by 141.3% to 185.3%. See Assessment of Individual Quotas in the Salmon Fishery (DFO 1995b).

3 Although some argue that quotas would have a negative effect on coastal communities due to "corporate concentration," the evidence suggests that quotas have a positive effect on small communities. On the contrary, quotas may allow smaller fishing operations to compete more effectively with larger operations because eliminating the race for the fish eliminates the need continuously to finance new investments in catching power. Direct spending by both the halibut and the sablefish fleet increased in coastal communities and declined in the larger urban centres when quotas were introduced. See DFO 1995b.

4 Currently, each troll license entitles fishermen to fish in only one of three possible license areas.

5 Once quota holders catch their quota, they are no longer eligible to fish. They cannot reach their quota and then participate in the free-for-all fishery.

6 Sockeye equivalents relate the value of each species and grade of salmon in terms of sockeye units. For example, using average price data from 1991 to 1994, one sockeye is equivalent to .1 Pink, .48 Chum, 2.66 Chinook or .62 Coho.

7 An allocation made in pounds will not reduce the incentive to high-grade if there is a premium paid for larger fish.

8 This assumes that vessels, once enrolled, would continue in the program. There would have to be a formula to convert any amounts above or below quota for vessels should the program be terminated.

9 It was also suggested that fishing vessels with stacked licenses should not participate in the pilot project as they would also be participating in the free-for-all fishery in other areas. This, it was felt, would call for too much DFO supervision and administration.

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