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2001

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# The Atlantic Sea Scallop Fishery in the U.S. and Canada: A Natural Experiment in Fisheries Management Regimes

Robert Repetto

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# The Atlantic Sea Scallop Fishery in the U.S. and Canada: A Natural Experiment in Fisheries Management Regimes

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## Abstract

The Atlantic sea scallop fisheries in the U.S. and Canadian offshore waters provide a natural experiment in fisheries management regimes. Starting in 1986, in side by side areas of George's Bank, Canada adopted a rights-based approach while the U.S. continued with effort controls. Analysis of their experiences shows that the resource has been better maintained in Canada with lower fishing effort, that the Canadian fishing industry has become more prosperous and innovative relative to that in the U.S., and that the Canadian co-management regime is more cooperative. These results suggest that systematic evaluation of actual experience with rights-based fishery management regimes is needed as the basis for policymaking.

**FOREWORD****James Gustave Speth**

Dean, Yale School of Forestry &amp; Environmental Studies

Many significant fisheries in the United States and around the world are over-exploited, with harvests at unsustainable levels and resource stocks far beneath their economic or biological potential. Some fisheries have collapsed, with uncertain recovery prospects. Many more fisheries are now generating much less income for fishermen, coastal communities, and national economies than they could be, because of excessive and inefficient fishing patterns and excessive destruction of by-catch and fishing habitats.

These problems are not matters of serious debate. What to do about them, however, is highly contentious. The merits of different fishery management approaches are debated within the halls of industry, within fishery management councils, in legislatures, and in the courts. Ideology, interest, and insecurity intensify these disputes. What is often missing, unfortunately, is a factual record of experience with different fishery management regimes in practice. The lack of systematic evaluation of actual experience opens the way for unsupported and often distorted predictions and allows misperceptions to persist unchallenged. The lack of adequate analyses of actual experience, at a minimum, makes rational deliberation more difficult, and, at worst, can stymie much-needed efforts to bring about improvements in flawed management systems.

This paper by Robert Repetto, Professor in the Practice of Economics and Sustainable Development at Yale's School of Forestry & Environmental Studies, compares the long-run experience of the Atlantic sea scallop fisheries in the U.S. and Canada, which have operated under two different management regimes for fifteen years. Canada operates a flexible harvest quota system, while the U.S. maintains effort controls. The two fisheries operate side by side on the George's Bank, using similar gear, but have experienced strikingly different results, which this paper documents for the first time.

This report continues the long-standing tradition of the School of Forestry & Environmental Studies of promoting research that provides the knowledge base for sustainable management of natural resources. It also marks a new initiative at the School, namely, making research that is timely and policy relevant available in easily accessible working paper formats published quickly. If you would like to respond to the author of this paper, or obtain more copies, please avail yourself of the contact information on the inside front cover. We hope that this working paper, and others to follow, will stimulate comment and discussion, and will contribute, ultimately, to improved conditions for people and environments in the United States and around the world.

## INTRODUCTION

Most commercial fisheries in the United States suffer from over-fishing, inefficient harvesting, or both (National Marine Fisheries Service 2000). As a result, hundreds of millions of dollars in potential income are lost to the fishing industry, fishing communities, and the general economy (Mitchell 1998). Prices to consumers and seafood import quantities are higher than they would be if U.S. fisheries were managed more successfully. In addition to these economic losses, excessive fishing effort has resulted in higher rates of unintentional by-catch mortality of non-targeted fish, seabirds, and marine mammals and more ecological damage than necessary to benthic organisms from trawls, dredges, and other fishing gear (National Research Council 1999b).

These documented losses underscore the nation's failure to manage its fisheries efficiently or sustainably. The fundamental problems stemming from open access to fishing resources have been addressed through a wide variety of regulatory controls over entry, effort, gear, fishing seasons and locations, size and catch. Yet, the Sustainable Fisheries Act of 1996 emphasized the continuing need to stop over-fishing and to rebuild stocks. How best to achieve this turnaround is unclear. In the management councils of specific fisheries, there sometimes is bitter debate about the course of action.

Particularly contentious are management regimes based on the allocation of rights over portions of the total allowable catch to eligible participants in a fishery – so-called rights-based fishing management systems. Best known among rights-based regimes are Individual Transferable Quota (ITQ) systems, in which individual license holders in a fishery are assigned fractions of the total allowable catch (TAC) adopted by the fishery managers. These quotas are transferable among license holders by sale or lease.

Proponents of such systems argue that they promote conservative harvesting by assuring quota holders of a share of any increase in future harvests achieved through stock rebuilding. Proponents argue that such systems also promote efficiency by allowing quota holders flexibility in the timing and manner of harvesting their share to reduce costs or to increase product value. Proponents also contend that ITQ systems reduce excessive effort by providing a compensated exit strategy for license holders in overcrowded fisheries, and stimulate technological progress by increasing the returns to license holders of investments in research or improved fishing technology.

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**Opponents of ITQ regimes argue that such systems lead to monopolization of the resource through consolidation, force out small operators, encourage discard of by-catch and high-grading of the resource to maximize the value of quota, and exacerbate problems of enforcement (Jennings 1999).**

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Opinion on the merits of rights-based management regimes is divided among fishermen, fisheries managers, politicians, academics, and environmentalists. Within a single fishery, some operators strongly favor shifting to a rights-based regime and other operators strongly oppose such a move. Among academic experts, economists

generally favor the adoption of such systems for their promise of greater efficiency and stronger conservation incentives, but other social scientists decry the potential disruption of fishing communities by market processes and the attrition of fishing jobs and livelihoods. Some environmental groups, notably Environmental Defense, advocate rights-based fisheries management as consistent with their model of market-friendly environmentalism. Others, notably Greenpeace, argue vehemently against it. These divisions are reflected in the political arena. The U.S. Senate, responding to constituent concerns in some fishing states, used the 1996 Sustainable Fisheries Act to impose a moratorium on the development of ITQ systems by any Fisheries Management Council and on the approval of any ITQ system by the National Marine Fisheries Service. A recent committee report from the National Research Council, *Sharing the Fish*, which attempted to examine these controversies, generated only a carefully balanced exposition of pros and cons, although the committee did recommend that Congress rescind its moratorium (National Research Council 1999a). Despite support from some senators, the recommendation has not been adopted and the moratorium has recently been extended.

Partly because these controversies have blocked adoption of rights-based systems, there is very little actual experience with ITQ regimes on which to base positive or negative judgements. Only three U.S. marine fisheries operate under such regimes: the mid-Atlantic surf clam and ocean quahog fishery, the Alaskan halibut and sablefish fishery, and the South Atlantic wreckfish fishery. In all three, there are too few years of data from which to draw firm conclusions regarding the long-term consequences. Some other fishing nations, notably Iceland and New Zealand, use rights-based regimes to manage nearly all their commercial fisheries. Still others, such as Canada and Australia, use such regimes in quite a few of their fisheries.

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**However, there has never been an evaluation of actual experience of all ITQ systems worldwide, using up-to-date data and an adequate, comparable assessment methodology.**

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Because so little evidence is available, debate continues in a speculative, but heated, fashion about the possible positive and negative effects of adopting ITQ systems. Too little information exists to resolve these disagreements and to allow an informed debate about whether the expected effects are consistent with U.S. fisheries management objectives.

This lack of definitive information makes it imperative to study carefully all available experience that sheds light on the likely consequences of adopting rights-based fishing regimes. Fortunately, a rare naturally occurring experiment in the U.S. and Canadian Atlantic sea scallop fisheries provides such an opportunity. Fifteen years ago Canada adopted a rights-based system in its offshore sea scallop fishery while the U.S. continued to manage its scallop fishery with a mix of minimum harvest size and maximum effort controls. A side-by-side comparison of the evolution of the commercial scallop fishery and of the scallop resource in the U.S. and Canada illuminates the consequences of these two very different approaches to fisheries management.

The Atlantic sea scallop fishery is especially suitable to such a comparison. Scallops are not migratory. After dispersing widely on ocean currents for about a month in the larval stage, juvenile scallops settle to the bottom. If they strike favorable bottom conditions, they remain relatively sedentary thereafter while growing rapidly. The fishing technology is quite uniform in both countries: a high percentage of the scallop harvest is caught in dredges towed along the bottom. The recreational fishery is negligible. Both Canada and the United States draw most of their harvest from the George's Bank, across which the International Court of Justice drew a boundary line in 1984 separating the exclusive fishing grounds of the two countries. This ended the competitive fishing of George's Bank by United States and Canadian vessels, which had devastated the resource in the disputed areas in the previous years. Finally, though some Canadians might disagree, there are not large differences in the cultural backgrounds, legal traditions, or fishing histories of the two countries. All these similarities enhance the value of the comparison of U.S. and Canadian sea scallop fisheries as a natural experiment in fisheries management.

Scallops make an interesting case study for other reasons as well. The fishery has consistently been among the top ten in the United States in the value of landings. After they are first recruited into the fishery at about age three, scallops quadruple in size by age five, so harvesting scallops at the optimal age brings large rewards. Spawning potential also increases substantially over these years – scallops four years old or older contribute approximately 85% to each year's enormous fecundity, which can allow stocks to rebound fairly quickly when fishing pressure is reduced. At the same time, high rates of natural mortality and the variability of weather and currents during the larval stage introduce a large random fluctuation into annual stocks of new juvenile scallops. This phenomenon puts a premium on accurate assessment of upcoming year classes and prudent management to stabilize biomass in the face of fluctuating recruitment.

The U.S. and Canadian scallop fisheries have been compared by collecting biological and economic data pertaining to each one for periods before and after the Canadians adopted rights-based fishing in 1986<sup>1</sup>. This quantitative information was enriched through interviews carried out in Nova Scotia and in New England during the summer of 2000 with fishing captains, boat owners, fisheries scientists and managers, consultants and activists involved with the scallop fisheries in the two countries.

The questions that are most important to address in this comparison of alternative fishery management regimes are:

- What has happened to the scallop resource in Canadian and U.S. waters?
- What has happened to the commercial fishery and to its people?
- What other ecological impacts have resulted?
- What have been the effects on the management regime itself, including advances in the application of scientific knowledge and the achievement of cooperation among participants, managers and other stakeholders?

The unusual natural experiment that has played out on George's Bank provides a rare opportunity to answer these questions.

<sup>1</sup> The quantitative data sources underlying figures and tables are listed in the references at the end of the paper. For the United States fishery, these sources include: National Marine Fisheries Service (1996,1997); New England Fisheries Management Council (1993, 1998, 1999, 2000a, 2000b); and Rago, Lai, and Correia (1997). For the Canadian fishery, data sources include: Brander and Burke (1994); Robert (2000); Govt. of Canada, Dept. of Fisheries and Oceans (1997, 1999a, 1999b, 2000); as well as additional data made available by the Department of Fisheries and Oceans.

## THE EVOLUTION OF THE U.S. AND CANADIAN MANAGEMENT REGIMES

### The U.S. System

The Atlantic sea scallop fishery extends from the Gulf of Maine to the mid-Atlantic. The National Marine Fisheries Service has managed all but the Gulf of Maine stocks as a single unit. From 1982 through 1993 the principal management tool in place was an average “meat count” restriction, which prescribed the maximum number of scallop “meats” that could comprise a pound of harvested and shucked scallops. Since scallops are shucked at sea and packed in ice for the remaining voyage, this restriction encouraged the practice of allowing the shucked scallops to soak excessively in ice water, taking on some weight but losing flavor. In any case, this approach was inadequate to prevent either recruitment or growth over-fishing.<sup>2</sup> Entry into the scallop fishery remained open. Fishing effort fluctuated with the abundance of the new recruits but remained too large to sustain fishermen’s incomes or the scallop resource.

Limited entry was introduced through a moratorium on the issuance of new licenses in March 1994.

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**After applicants were qualified and appeals settled, more than 350 license holders remained, including just about anyone who could document any significant scallop catch in the preceding years. This many licenses were estimated at the time to exceed the capacity consistent with stock rebuilding by about 33% (Edwards 1999).**

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Restrictions that still remain were introduced on the transferability of licenses: licenses could be transferred only through sale or transfer of the vessel to which it was attached, and a license could not be disengaged from its vessel and “stacked” with other licenses on another vessel. This measure impeded consolidation of the fishery and took on greater significance when limits were put on the amount of days any license holder could be at sea fishing scallops.

Because of excessive capacity, additional measures to control fishing effort were also adopted. The allowable days at sea were scheduled to drop from 200 in the initial year to 120 in 2000, which was estimated to be barely enough to allow a full-time vessel to recover its fixed costs, under normal operating conditions (Edwards 1999). A maximum crew size of seven was adopted, an important limitation since shucking scallops at sea is very labor-intensive. Minimum diameters were prescribed for the rings on scallop dredges to allow small scallops to escape and minimum size restrictions were retained. In other words, the U.S. adopted a system of stringent effort controls, to be enforced through compulsory monitoring and enforcement.

In December 1994, another significant event for scallop fishermen occurred: three areas of the George’s Bank were closed to all fishing vessels capable of catching cod or other groundfish, a measure necessitated by the collapse of the groundfish stocks. Scallop dredges were included in this ban, cutting the fishery off from an estimated five million pounds of annual harvest and shifting fishing effort dramatically to the mid-Atlantic region and other open areas.<sup>3</sup> These area closures created a second U.S.-based natural experiment within the broader natural experiment. Area closures pro-

<sup>2</sup> Growth over-fishing means harvesting the scallops too young and too small, sacrificing high rates of potential growth. Recruitment over-fishing means harvesting them to such an extent that stocks are reduced well below maximum economic or biological yield because the reproductive potential is impaired.

<sup>3</sup> Two small areas in the mid-Atlantic region were subsequently closed to protect juvenile scallops.



vided evidence in subsequent years about the potential of scallop stocks to rebound when fishing pressure was removed. This has generated significant new ideas about managing the U.S. scallop fishery, which will be discussed later on.

The U.S. scallop fishery was also strongly affected by provisions in the Sustainable Fisheries Act of 1996, which required fisheries management to develop plans to eliminate over-fishing and to restore stocks to a level that would produce the Maximum Sustainable Yield (MSY). Since scallop stocks were estimated to be only one-third to one-fourth that size, these provisions mandated a drastic reduction in fishing effort.

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**The plan adopted in 1998 provided that allowable days at sea would fall from 120 to as little as 51 over three years, a level that would be economically disastrous for the scallop fishery.**

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In response, the Fisheries Survival Fund, an industry group, formed to lobby for access to scallops in the closed areas, a relief measure that was opposed by some groundfish interests, lobstermen, and environmentalists. Industry-funded sample surveys found that stocks in the closed areas had increased 8 to 16-fold after four years of respite. On this evidence, direct lobbying to the federal government secured permission for limited harvesting of scallops in one of the closed areas of George's Bank in 1999. Abundant yields of large scallops were found. In the following year, limited harvesting in all three closed areas of George's Bank was permitted. This rebuilding of the stock, together with strong recruitment years, revived the fortunes of the industry and made it unnecessary to reduce allowed days at sea beneath 120 days per year, since average fishing mortality on the larger stocks became consistent with rebuilding targets. Today, all the effort controls on U.S. scallop fishermen remain. In addition, they are subject to additional limitations on days they can use fishing in the closed areas and catch limits on each allowable trip. These additional restrictions are intended to prevent them from quickly depleting the rebuilt stocks in those areas.

### **The Canadian System**

Canada, which harvests a much smaller scallop area, introduced limited entry as far back as 1973, confirming 77 licenses. The only additional management tool was an average size restriction. During the next decade of competitive fishing with the U.S. fleet, stocks were depleted, incomes were reduced, and many Canadian owner operators voluntarily joined together in fishing corporations. This resulted in considerable consolidation, so that by 1984 there were only a dozen companies fishing for scallops, most of them operating several boats and holding multiple licenses.

In 1982 an enterprise allocation system was introduced in the Canadian groundfish fishery. In an enterprise allocation system, portions of the catch are awarded not to individual vessels but to operating companies, which can then harvest their quota largely as they think best. Since many of the scallop license holders also held groundfish licenses, they had an opportunity to learn from this experience. One lesson was the folly of lobbying the fisheries management agency for too large a total allowable catch, an error that contributed to the collapse of Canadian groundfish stocks.

In 1984, after the adjudication of the Hague Line, the Canadian offshore operators began to develop a similar enterprise allocation (EA) system for the scallop fishery. The government supported this effort, accepting responsibility for setting the TAC with industry advice but insisting that the license holders work out for themselves the initial quota allocation. After almost a year of hard bargaining, initial allocations were settled, based largely on each license holders' historical catch. Allocations were awarded to nine enterprises in the form of percentages of the annual total allowable catch. Restrictions were adopted on quota transfers. Permanent transfers are allowable only if the entire enterprise changes hands and if the ministry approves. Temporary transfers of quota within a fishing season are limited to no more than 25% of a quota and also require government approval. Despite these restrictions, the government has approved a sale of quota in parts, allowing new entry and temporary transfers of quota also to take place.

Also in 1986, to support this system, the government achieved a separation of the inshore and offshore scallop fisheries, demarcating fishing boundaries between the two fleets. From 1986 to 1989, the inshore scallop harvest rose several-fold as the result of an unprecedented recruitment bloom first observed in the Bay of Fundy in 1986, and the number of active vessels doubled. Most of the increased effort stemmed from operators holding dual groundfish and scallop licenses, who concentrated on the scallop bonanza, and from double-crewing to fish round the clock (Brander and Burke 1994). Some of the captains and crews who were displaced from the offshore fishery entered the inshore scallop fishery.

### **Why Did the Two Regimes Diverge?**

The two nations adopted different management regimes for their similar scallop fisheries for several reasons. The Canadian fishery was much smaller and had already undergone considerable consolidation into fishing enterprises by the mid-1980s. There were fewer than twelve companies involved in the negotiations over the initial quota allocation. All these enterprises were located in Nova Scotia, where the fishing community is relatively small and close-knit, with a history going back centuries. By contrast, the U.S. fishery was much larger, comprising more than two hundred active vessels operating from ports spread from Virginia to Maine. When limited entry was introduced, more than 350 licensees resulted and the industry consistently rejected measures that would facilitate consolidation, such as license transferability or license "stacking."

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**The numbers and geographical dispersion of U.S. scallop fishermen would have made the negotiation of a rights-based system difficult, particularly the initial allocation of quotas.**

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In fact, though it had been suggested as an appropriate option in the 1992 National ITQ Study (Sutinen *et al.* 1992), the ITQ option was rejected early in the development of Amendment 4 on the grounds that negotiating initial allocations would take too long (Edwards 1999). There were also fears that an ITQ system would lead to excessive concentration within the fishery.

Moreover, Atlantic Canada had already started moving in the direction of rights-based fishing with an experimental system for groundfish. By contrast, this approach was strongly opposed in all New England fisheries, where the tradition of open public access to fishing grounds has been extremely strong. Various effort and size restrictions were preferable in New England to restrictions on who could fish. The management goals in the U.S. fishery seem to be to maintain as many livelihoods in the fishery as possible and to share fairly the resulting financial pain.

## **SUSTAINABLE HARVESTING: WHAT HAS HAPPENED TO THE RESOURCES?**

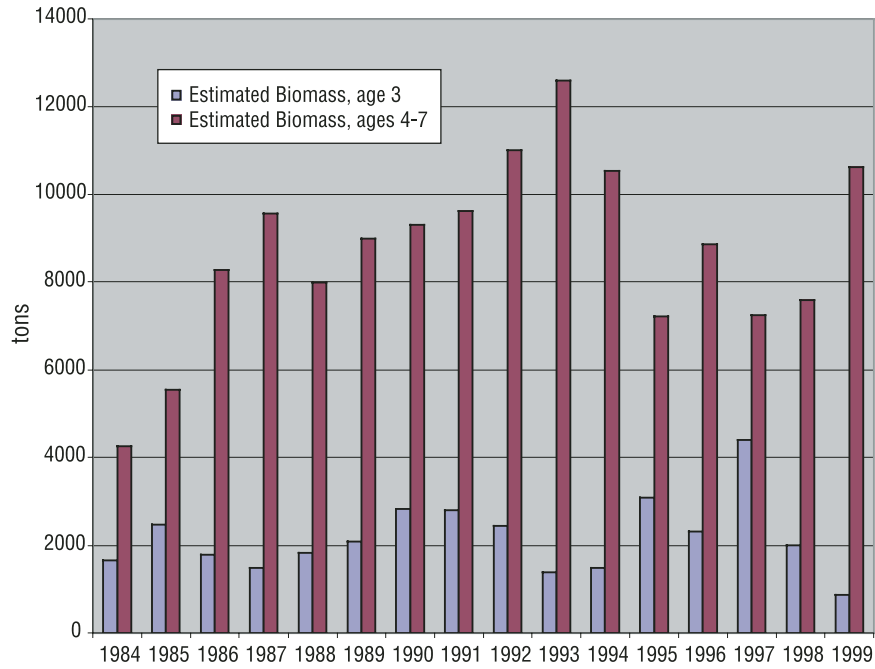
Interviews in Canada reveal that a strong consensus has emerged among quota holders, the workers' union, and fisheries managers in favor of a conservative approach to setting the overall catch limit. Stability in the harvest is preferred to boom and bust fluctuations in the fishery. In recent years the annual TAC has been set to stabilize the harvest in the face of fluctuating recruitment in accordance with scientists' recommendations. If sample surveys at sea detect weak incoming year classes, which would lead to lower recruitment into the commercial fishery two or three years later, then the TAC is adjusted downward to conserve more of the existing harvestable stock for later years. There is a clearly understood link between this year's harvest and next year's availability.

This understanding has been fostered by the industry-financed government research program, which closely samples the abundance of scallops in various year classes and analyzes the results to present the industry with an array of estimates relating the next year's TAC to the consequent increase or decrease in harvestable biomass. Faced with these choices, the Canadian industry has opted for conservative overall quotas in the knowledge that each quota holder will proportionately capture the benefits of conservation through higher catch limits in subsequent years. Internalizing the returns to conservation decisions is one of the characteristics of rights-based fishing regimes.

As a result, as Figure 1 indicates, the Canadian fishery has succeeded in rebuilding the stock from the very low levels that were reached during the period of competitive fishing in the early 1980s. It has also succeeded in smoothing out fluctuations in the biomass of larger scallops in the face of large annual variations in the stock of new three-year-old recruits in the 90-100mm size range.

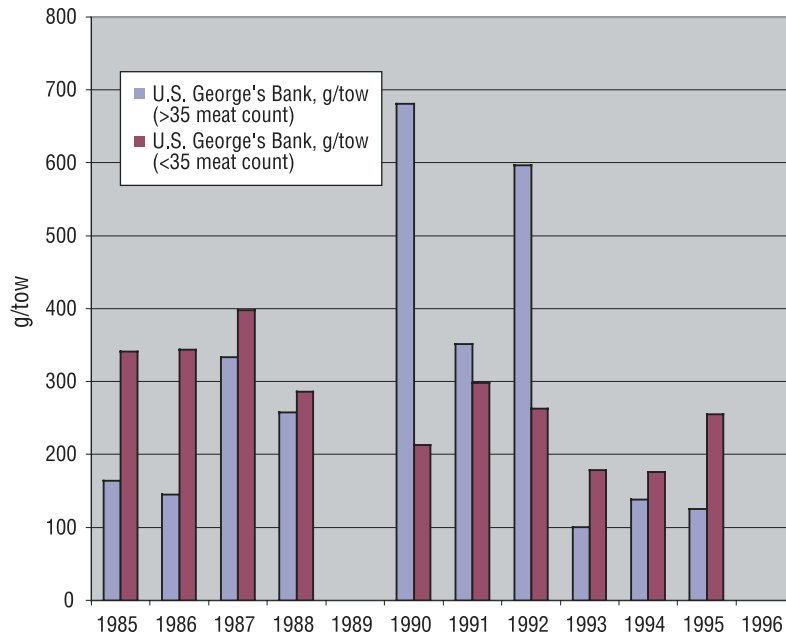
In the United States, there has generally been opposition to measures requiring effort reductions needed to rebuild stocks. Such measures were accepted only when seen to be absolutely necessary. The effort controls adopted in 1994 were driven by the need to reduce fishing mortality by at least one-half to forestall drastic stock declines. Those embodied in Amendment 7 to the Fisheries Management Plan in 1998 responded to a requirement in the Sustainable Fisheries Act of 1996 to eliminate over-fishing and to rebuild stocks to the level that would support the maximum sustainable yield. This was estimated to require a three or four-fold stock increase. Amendment 7 engendered a strong and successful industry lobbying effort to forestall the effort reductions by

**Figure 1 Estimated Biomass: Canadian George's Bank**



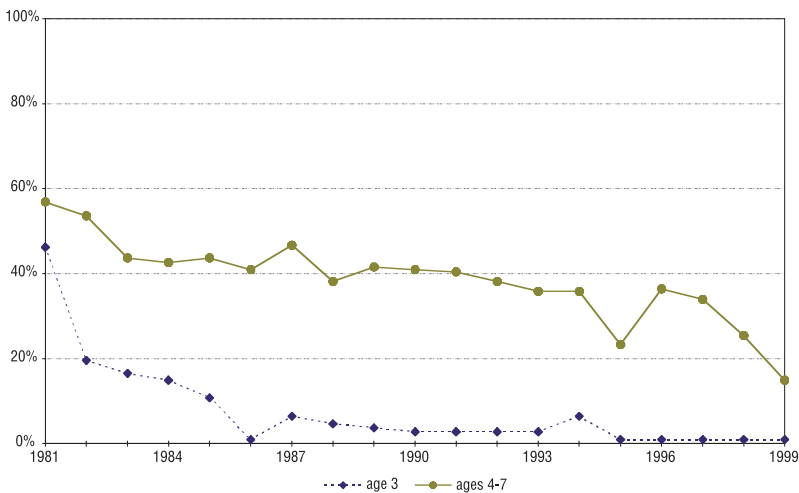
gaining access to the groundfish closed areas. As a result of such resistance, as Figure 2 shows, resource abundance in the U.S. fishery has fluctuated more widely in response to varying recruitment and a larger fraction of the overall resource consists of new three-year-old recruits, because of heavy fishing exploitation of larger, older scallops.

**Figure 2 Abundance Indices, U.S. George's Bank**



Overall, because of its success in maintaining its scallop stock at a higher level, the Canadian fishery has maintained harvest levels with less fishing pressure. The exploitation rate on scallops aged 4 to 7, which is the age class targeted in the Canadian fishery, has fallen from about 40% at the time the EA system was adopted to 20% or less in recent years. Even more significantly, the exploitation rate on 3-year-old scallops has fallen almost to nil, as Figure 3 indicates. Industry participants state unanimously that it makes no economic sense to harvest juvenile scallops because the rates of return on a one or two year conservation investment are so high. Not only do scallops double and redouble in size over that span but the price per pound also rises for larger scallops. Reflecting that realization, the industry has supplemented the official average meat count restriction with a voluntary program limiting the number of very small scallops (meat count 50 or above) that can be included in the average. Industry monitors check compliance with this agreement. However, there is no incentive to violate it because license holders know that because of the EA system they and they alone reap the returns of this conservation investment.

Figure 3 Exploitation Rates, Canadian George's Bank

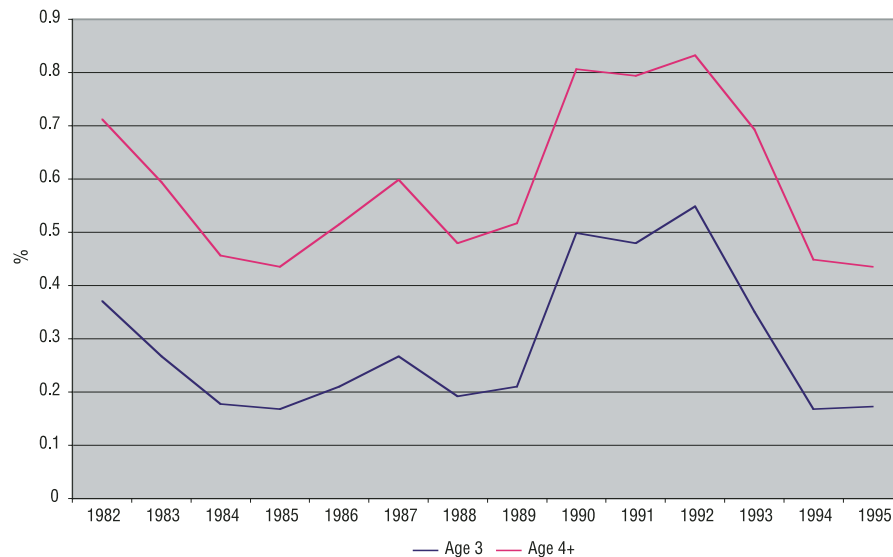


In the United States, the exploitation rates have been much higher. Exploitation rates on larger scallops rose throughout the period 1985-1994, peaking above 80% in 1993. Only the respite of the closed areas gave the stock some opportunity to rebuild in subsequent years. Exploitation pressures have also been heavy on 3-year-old scallops despite the heavy economic losses this “growth over-fishing” imposes. Exploitation rates have consistently exceeded 20% and rose beyond 50% when effort expanded substantially during the early 1990s in response to one or two strong year classes (see Figure 4).

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**Because there is no assurance in the competitive U.S. fishery that fishermen acting to conserve small scallops will be able to reap the subsequent rewards themselves, the fleet has not exempted these undersized scallops from the harvest.**

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**Figure 4 Exploitation Rates: U.S. George's Bank**

In summary, under the EA system the Canadian fishery has maintained the stock at a higher level of abundance, closer to the levels consistent with the maximum biological and economic yields. The Canadian system has also been able to deter the premature harvesting of under-sized scallops and to avoid the heavy economic losses such growth over-fishing entails. By contrast, before the scallop grounds were closed to harvesting, the U.S. fishery management regime resulted in substantially higher rates of exploitation, even on under-sized scallops, and led to lower levels of stock-abundance, far below those consistent with optimum yield. The closure of substantial parts of the resource area because of groundfish restrictions allowed scallop stocks to rebuild rapidly in those areas and in the last few years has permitted a limited harvest of large scallops with lower overall fishing mortality.

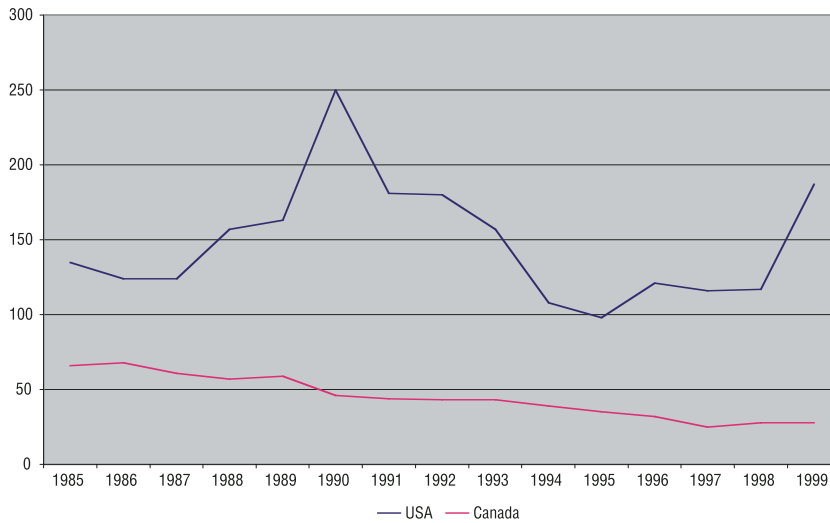
## WHAT HAS HAPPENED TO THE FISHERY?

### Static Efficiency

It is notoriously difficult to persuade fishermen to report or to talk about how much money they are making, but there are reasonably reliable indicators of their economic success. The first is capacity utilization. An equipped fishing vessel represents a considerable investment that is uneconomic when idle. Considerable excess capacity was already present in the U.S. fleet when license limitations were initiated in 1994. This enabled the number of active vessels to expand and contract in response to stock fluctuations. Some consolidation in the number of license holders has taken place because those who exit the fishery typically sell their license and boat to one of the larger fishing enterprises. However, restrictions on license holders' freedom to stack multiple licenses onto a single vessel have prevented any significant consolidation in the size of the fleet.

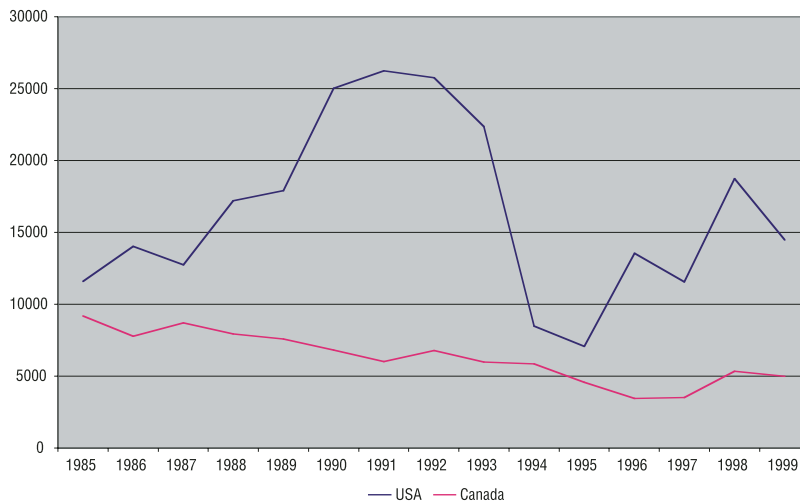
In Canada, there has been a steady and gradual reduction in the size of the fleet. When the EA system was introduced, license holders began replacing their old wooden boats with fewer larger, more powerful vessels – thereby maintaining or increasing fishing capacity. The stability afforded by the EA system reduced license holders’ investment risk and enabled them to finance these investments readily. Overall, the number of active vessels in the Canadian fishery has already dropped from sixty-seven to twenty-eight (see Figure 5). The process continues. Two Canadian companies are investing in larger replacement vessels with on-board freezing plants in order to make longer trips and freeze the first-caught scallops immediately, thereby enhancing product quality.

**Figure 5 Vessels Fishing**

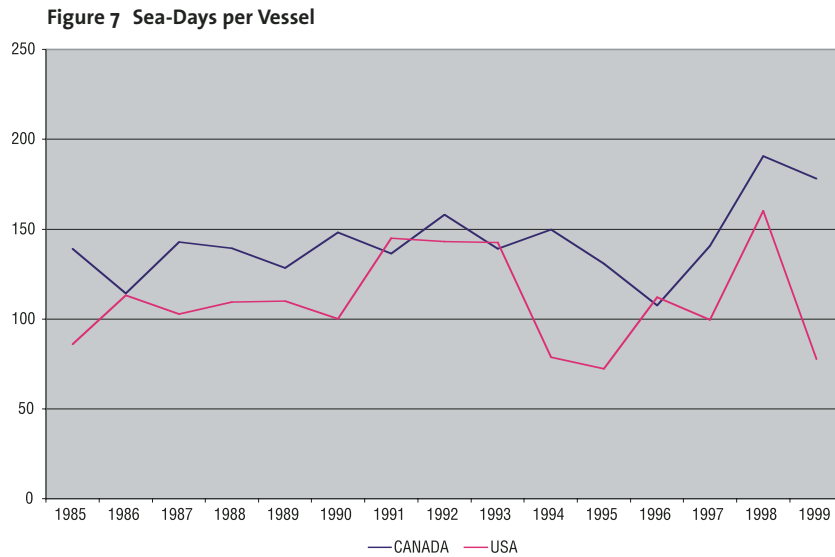


Trends in the number of days spent annually at sea are similar to those in the number of active vessels. In the United States, effort has risen and fallen in response to recruitment and stock fluctuations (see Figure 6).

**Figure 6 Days at Sea**



In Canada, there has been a steady reduction in the number of days spent at sea, reflecting the greater catching power of newer vessels, the greater abundance of scallops, and the increase in catch per tow. Consequently, the number of sea days per active vessel, a measure of capacity utilization, has consistently been higher by a considerable margin in Canada than in the United States (see Figure 7).

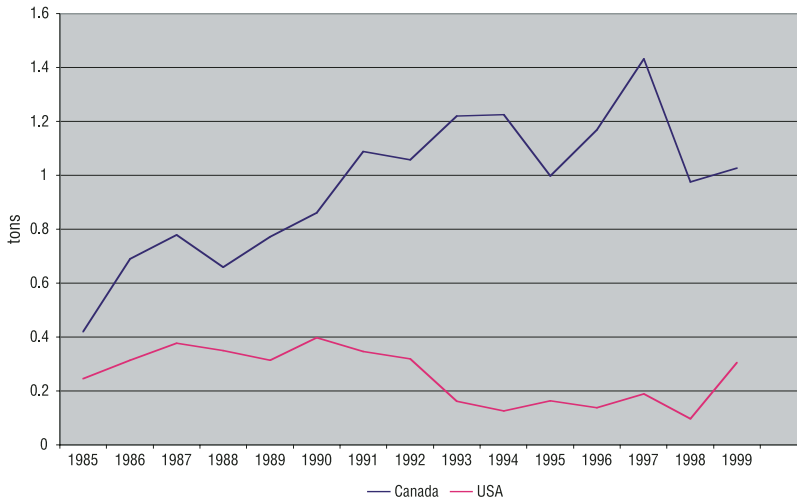


Because of the flexibility afforded license holders, and their ability to plan rationally for changes in capacity, the Canadian fishery has been able to utilize its fixed capital more effectively. In the United States, restrictions on allowable days at sea, now at 120 days per year, have impinged heavily on those operators who would have fished their vessels more intensively.

A second important indicator of profitability is the catch per day at sea. Operating costs for fuel, ice, food, and crew rise linearly with the number of days spent at sea. Therefore, the best indicator of a vessel's operating margin is its catch per sea day. In this indicator, the advantage of the Canadian scallop fleet is striking. Catch per day at sea has risen almost four-fold since the Enterprise Allocation system was adopted. On the Canadian side, overall scallop abundance is greater and the cooperative survey program has produced a more detailed knowledge of good scallop concentrations in the patchy bottom conditions. Little effort is wasted in harvesting the TAC. Moreover, fishing has targeted larger scallops, producing a larger and more valuable yield per tow. In the U.S. fishery, catch per sea day fell significantly over the same period because of excessive effort, lower abundance, greater reliance on immature scallops, and less detailed knowledge of resource conditions (see Figure 8).



**Figure 8 Catch per Sea-day**



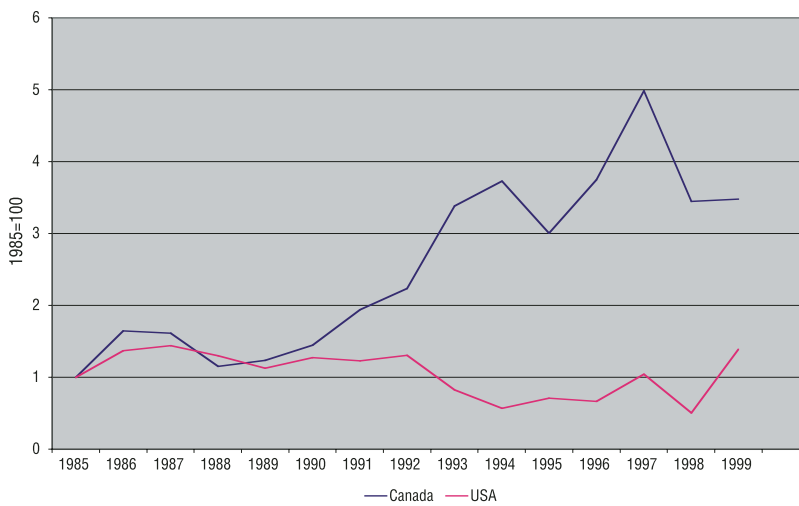

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**As a result of these diverging trends, catch per sea-day in 1998 favored the Canadian fleet by at least a seven-fold margin, though when the regimes diverged in 1986 the margin was only about 70%.**

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The harvesting of large scallops in the U.S. closed area in 1999 helped only somewhat to reduce this difference. An index of revenue per sea-day normalized to 1985 shows the same trend (see Figure 9). It is clear that the Canadian fleet has prospered and until the recent opening of the closed areas, the U.S. fleet has not.

**Figure 9 Index of Revenue per Sea-day**



This conclusion is reinforced by estimates made by the National Marine Fisheries Service economist Steven F. Edwards, based on an economic simulation model of the U.S. fishery. His estimates suggest that average profits per full-time vessel fell steadily from more than \$650,000 in 1977 to only about \$5,000 in 1992, and have been negative over the period 1993-1996, implying that the average full-time scallop vessel was not covering its fixed costs. Of course, some of the more productive and efficient fishermen continued to make money during this time but the fishery as a whole had completely dissipated the potential resource rents (Edwards 1999).

### **Dynamic Efficiency**

Striking as these comparisons may be, the differences in technological innovation in the two fisheries are perhaps even more dramatic. The Canadian industry has clearly recognized the value of investments in research. License holders jointly and voluntarily finance the government's research program by providing a fully equipped research vessel and crew to take sample surveys. This has permitted the research scientists to take samples on a much finer sampling grid, resulting in a more detailed mapping of scallop concentrations by size and age. In addition, scallop vessels contribute data from their vessel logs recording catch per tow, as well as Global Positioning System records, to the research scientists, facilitating even better knowledge of scallop locations and abundance.

In the United States, the government-funded research program lacks the resources to sample the much larger U.S. scallop area in the same detail. The coarser sample grid has led industry to complain that scientists have underestimated scallop abundance by missing dense but small concentrations. However, industry response has not been to finance government research, as in Canada, but to initiate a parallel sampling program, especially to monitor scallop abundance in the closed areas.

Recently, the Canadian industry has embarked on a new industry-financed program costing several million dollars to map the bottom of its scallop grounds using multi-beam sonar. This technique can distinguish among sand, gravel, rocky, and other bottom conditions, thereby pinpointing the gravelly patches where scallops are likely to be found. Ground-truthing of this information with experimental tows has confirmed that this mapping can enable vessels to harvest scallops with much less wasted effort, simply by towing where scallops are and not where they aren't.

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**Industry informants predict that they will be able to harvest their quotas with an additional 50% reduction in effort. Not only will this reduction in dredging increase the fishery's net rent considerably, it will also reduce by-catch of groundfish, gear conflicts with other fisheries, and damage to the benthic organisms on the George's Bank.**

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All three side effects are of great ecological benefit to other fisheries and to the environmental community.

### Equity Issues

Both the U.S. and Canadian fisheries have traditionally operated on the “lay” system, which divides the revenue from each trip among crew, captain, and owner according to pre-set percentages, after subtracting certain operating expenses. In Canada, for example, 60% of net revenues are divided among captain and crew and 40% goes to the boat. For this reason, all parties remaining in the fishery after its consolidation have shared in its increasing rents.

In both countries as well, barriers to entry were erected at the time of license limitation or moratorium, not by the adoption of an EA system. When licenses were awarded exclusively to boat owners, the decision was made to assign to the owners whatever resource rents the fishery might produce. In Canada, however, the government raised license fees in January 1996 from a nominal sum to \$547.50 per ton of quota, thereby recapturing some resource rents for the public sector.

Nonetheless, defenders of the present U.S. management regime uphold “a right to fish,” maintaining that fishing is a way of life and should be preserved. Interviews in New Bedford and in Nova Scotia shed interesting light on this point of view. In Lunenburg harbor, black granite obelisks stand in memorial to fishermen lost at sea over the past century. On them are inscribed the names of fishermen lost over the decades. The same family names recur and recur. Many of those same names – the Knickles, the Himmelmans, and the Moshers, for example – are current owners of scallop licenses. Yet, despite their heritage, the current generation of these families maintains that fishing is a way of making a living, not a way of life. They strongly defend the EA system. Similarly, one of the largest New Bedford scallopers, a third generation fisherman, explained that his father had urged him to go to college and learn a profession rather than to become a fisherman. Though he didn’t follow that advice, he gives it to his own son. Like his counterparts in Canada, he sees fishing as a business and favors adoption of a rights-based system. “Fishing as a way of life,” at the expense of an efficient management regime, does not command strong support even among long-time fishing families.

Although survivors in the Canadian fishery have done well, there has been a loss of employment amounting to about 70 jobs per year over the past thirteen years (Govt. of Canada, Dept. of Fisheries and Oceans, 1997). In the early years, many found berths in the inshore scallop fishery, which was enjoying an unusual recruitment bloom. More recently, the expanding oil and gas industry in Nova Scotia and the service sector have absorbed these workers with little disruption or overall unemployment.

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**The Canadian union representing many of the scallop workers supports the Enterprise Allocation system over a return to competitive fishing, favoring steady remunerative jobs over a larger part-time or insecure workforce.**

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The union has negotiated full staffing of crews, which comprise 17 workers in Canada (compared to 7 in the U.S.), as well as preference for displaced crew members in filling onshore or replacement crew jobs.

One fear expressed by U.S. fishermen about the consequences of adopting a rights-based regime is that small fishermen will be forced out by larger concerns. Though exit from a rights-based fishery would be voluntary, the fear is that small fishermen would not be able to compete, perhaps because of economies of scale or because of financial constraints and would have to sell out. Canada's experience provides some evidence about the process of consolidation (see Table 1).

COMPANY NAME	PERCENTAGE OF TAC, 1986	PERCENTAGE OF TAC, 2000
Adams and Knickle, Ltd.	9.77	9.77
Comeau Seafoods, Ltd.	15.42	15.42
Fishery Products Int'l	16.77	16.77
Mersey Seafoods, Ltd.	7.00	7.00
Scotia Trawler Equipment Ltd.	16.32	16.32
McLeod Fisheries Ltd.	7.14	
Pierce Fisheries Ltd.	13.43	
L. Sweeney Fisheries Ltd.	13.49	
Island Pride Fisheries	0.66	
Clearwater Fine Foods Ltd		31.06
LaHave Seafoods Ltd.		3.66

*Source: MPO-DFO, Govt. of Canada, Nova Scotia*

Over a fourteen-year period, there has been some consolidation. The number of quota holders has declined from nine to seven. Three medium to large quota holders sold out to Clearwater Fine Foods Ltd., a privately owned company involved in harvesting, processing, and distributing scallops and other sea foods. Clearwater is now the largest licensee, holding slightly less than a third of the total quota. The other entrant is the smallest licensee, which bought a part of the quota held by an exiting company. The remaining 65% of the quota remains in its original hands, including the shares held by two of the smallest original quota holders.

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**There is little evidence in this record that the smaller players have been at a significant competitive disadvantage or that a rights-based regime results in monopolization of the fishery.**

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## GOVERNANCE AND CO-MANAGEMENT

Another important issue is the effect of the regime on the process of governance and the success of co-management efforts. On this score, the Canadian record is clearly superior. Industry cooperatively supports government and its own research programs. Owners and operators speak respectfully about the scientists' competence and have almost always accepted their recommendations in recent years. The industry also bears the costs of monitoring and enforcement of the EA regime and of its own voluntary restrictions on harvesting under-aged scallops. Interviews reveal that fishermen feel that the system has

freed them from disputes regarding allocations or effort restrictions and has enabled them to concentrate on maximizing the value of their quotas through efficiencies and enhanced product quality.

In the U.S. fishery, the contrast is obvious. The industry created its own lobbying organization, the Fishermen's Survival Fund, to contest the decisions of the Fisheries Management Council and the National Marine Fisheries Service in maintaining area closures. The FSF has hired its own Washington lawyer and a lobbyist (a former member of Congress) to lobby Congress and the executive branch directly. It has hired its own scientific consultants in order to contest the findings of government scientists, if necessary, and is conducting its own abundance sampling. Fishermen in the industry and their representatives are openly critical of government fisheries managers and scientists and of one another. All informants complain about the time-consuming debates and discussions about management changes. None could clearly explain the decision process in the management regime – for example, what voting majority or other consensus it would take to adopt a rights-based regime. The larger fishermen complained repeatedly that smaller fishermen were motivated mainly by envy and were using the political process to try to hold others back. Adding further to the conflict, environmental groups that had won a place on the Fisheries Management Council, having failed to stop the Council's decision to resume limited scallop fishing in the closed areas of George's bank, have initiated a lawsuit to block the opening.

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**The “co-management” regime in the U.S. scallop fishery is conflicted, costly, and ineffective.**

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## **PROGNOSIS**

The Canadian scallop fishery is prosperous and largely content with its rights-based regime. Neither industry, nor government, nor unions desire to replace the EA system with any other. Though the industry regards the restrictions on transferability as anachronistic, there is little quota for sale in any case. The industry expects that its investment in research will substantially raise efficiency and profitability in the coming years, even with a stable TAC. The industry's investment in new freezer vessels will also enhance product quality and the value of the catch by enabling the operators to freeze first-caught scallops and market fresh the scallops caught on the last days of the voyage.

The prognosis for the U.S. fishery is less certain but more interesting. The natural experiments with closed areas have demonstrated how quickly scallop stocks can increase when fishing pressure is relaxed (see Table 2). They have also raised suspicions that the larger biomass of mature scallops in the closed areas may be responsible for the good recruitment classes of recent years. This would suggest that the fishery had been subject to recruitment over-fishing as well as growth over-fishing. Developments in the closed areas have created substantial support both in the Fishermen's Survival Fund and in the National Marine Fisheries Service for adopting a system of rotational harvesting, in which roughly 20% of the scallop grounds would be opened in rotation in each year. Rotational harvesting would largely eliminate

growth over-fishing by giving under-sized scallops in closed areas a chance to mature. This would improve yields in the fishery but would not resolve the problem of excessive effort. Rotational harvesting would also raise new management challenges in enforcing the closures and adjusting them with insufficient data on fluctuating geographical scallop concentrations.

**TABLE 2 SCALLOP ABUNDANCE IN CLOSED AND OPEN AREAS: U.S. SCALLOP GROUNDS, 1997-2000**

SURVEY BIOMASS/TOW (KG)	1997	1998	1999	2000
U.S. George's Bank closed areas	2.5	7.1	6.3	13.2
U.S. George's Bank open areas	0.6	0.8	1.1	3.0
Mid-Atlantic closed areas	0.8	2.9	6.3	9.2
Mid-Atlantic open areas	0.5	0.7	1.5	2.3

*Source: NE Fisheries Management Council, Scallop Plan Development Team, 2000 Scallop Fishery Management Plan SAFE Report (Stock Assessment and Fishery Evaluation), Gloucester, Mass. Sept. 8, 2000.*

Adopting a rotational harvesting regime would also lead toward a catch quota system. Already, limits on the number of trips each vessel may take into the closed areas and catch limits per trip amount to implicit vessel quotas on harvests in the closed areas. These would be formalized in a rotational harvesting plan. Then, perhaps, it might be only a matter of time before the advantages of flexible harvesting of quota and transfers of quotas are realized. Cross-hauls by the New England and Mid-Atlantic fleets to harvest quota in the others' respective regions would make little sense. Consequently, it seems quite possible that over the coming years the U.S. scallop fishery will move toward and finally adopt a rights-based regime, putting itself in a position to realize some of the economic benefits that the Canadian industry has enjoyed for the past decade.

## CONCLUSIONS

Much can be learned from experience. The Hague Line across the George's Bank separating the U.S. and Canadian fisheries should be as well known as the 38th parallel separating North and South Korea. Across both lines, contrasting economic regimes have brought spectacularly different results, prosperity for some and economic decline for others. However, before this paper there has been little discussion in the United States of the Canadian experience, relevant though it is. Other countries with rights-based fisheries regimes, such as Iceland and New Zealand, have also registered successes. In fact, no fishery that has adopted a rights-based regime has ever reversed the decision. There is a pressing need for a thorough evaluation of experience with these approaches throughout the world, using adequate assessment methodologies and up-to-date data, in order to provide U.S. fishermen and fisheries policy makers a more adequate basis for choice.

This study inevitably provokes the question whether or not commercial fishery resources should be managed efficiently like a business dedicated to producing as much sustainable income as possible.

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**If the current U.S. scallop fishery were a business, its management would surely be fired, because its revenues could readily be increased by at least 50% while its costs were being reduced by an equal percentage. No private sector manager could survive with this degree of inefficiency.**

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If fisheries are to be managed in the public interest, what party should be held accountable for this waste of resources and sacrifice of potential economic benefits—the Congress, NMFS, or the industry? In particular, why should the Congress impose and maintain a ban on the development of rights-based fishing regimes even in those fisheries in which participants favor them?

Alternatively, should fisheries be managed to protect a way of life, to keep as many fishermen on the water as possible? If so, why should public resources be devoted to this goal? To what extent, if any, should other economic and ecological values be subordinated to this goal? Why should fishermen be protected in this way, when loggers, miners, and hunters are not and the vast majority of the workforce is answerable to the marketplace for its employment? The comparison of the U.S. and Canadian systems raises fundamental questions about the proper objectives of fisheries management and about the tools for achieving them.

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Dr. Repetto is known for his writings and research on the interface between environment and economics and on policies to promote sustainable economic development. His recent work on environment and finance was awarded the Moskowitz Prize for 2000. He has served as a member of the National Research Council’s Board on Sustainable Development and as a member of the Environmental Economics Advisory Committee of EPA’s Science Advisory Board.

Earlier in his career, Robert Repetto was a professor at the Harvard School of Public Health, a World Bank official working in Indonesia, an economic advisor in Bangladesh, a Ford Foundation staff economist in India, and an economic analyst at the Federal Reserve Bank of New York. He holds a Ph.D. in economics from Harvard University and a M.Sc. degree from the London School of Economics.

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