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**Improvements to the Management System
for Scotia-Fundy Groundfish**

by

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ABSTRACT

Sinclair, M., D.L. Burke, R.N. O'Boyle, and P. Partington. 1996. Improvements to the Management System for Scotia-Fundy Groundfish

The first workshop on Scotia-Fundy Groundfish Management (Angel et al. 1994) was held in December 1993. The aims were retrospective in nature, searching for understanding of the underlying causes of the deficiencies in groundfish management between 1977 and 1992. One conclusion on the causes of management failure was the existence of multiple and, sometimes conflicting, objectives. A follow-up workshop held in October 1995 addressed what improvements could be made to the management system in spite of conflicting objectives at the strategic level. An industry/DFO Steering Committee concluded that the focus of the second workshop should be on four categories of tools by which fishing effort can be controlled to meet the conservation objectives of management (quota, days-at-sea, closed areas, and restrictions on harvesting technology). Initial presentations addressed the DFO Ottawa perspective (i.e., headquarters) on the present government's objectives as they relate to groundfish management. The implications of the term "conservation for sustainable use" were discussed. Subsequently, representatives of the fishing industry identified a range of issues that they felt were important for the improvement of the management process. This was followed by the presentation of 16 technical papers on diverse aspects of the tools for controlling fishing effort. The workshop ended with a discussion on whether there was a consensus on the need for modifications to the present management system. It was concluded that quota management should continue to be the core control mechanism of fishing effort, but that days-at-sea needed to be monitored on a real-time basis. A two-level monitoring system (quota and days-at-sea) should allow improved identification of at-sea discarding practices and misreporting, which would help in deployment of enforcement activities. Increased use of seasonal closed areas were considered a useful tool for the protection of spawning components. With respect to restrictions on harvesting technology, a key conclusion was the need for a more responsible attitude on the part of industry, rather than a change in present regulations. The Steering Committee made 32 recommendations grouped by eight interlinked components of a fisheries management model (strategic planning, resource analysis, business analysis, management planning, fishing entitlements, catch and effort monitoring, enforcement, and service delivery). The recommendations are discussed with respect to the theme of management under multiple objectives.

Introduction

Although the overall annual landed values for the marine fisheries of the maritime provinces of Atlantic Canada (Nova Scotia, New Brunswick, and Prince Edward Island) have been relatively stable at about \$800 million (constant 1994 dollars Canadian) annually since 1987, the value and landings of the groundfish fishery have been steadily declining (Figure 1). The fishery has been closed for several cod stocks since 1993. We will focus on the management of the groundfish fishery off Nova Scotia.

Multiple objectives have been a feature of the management of groundfish fisheries in Atlantic Canada (see Angel et al., 1994, p. 15 to 17 for a brief summary). Although they have evolved, there have consistently been four categories of objectives -- conservation, economic performance, employment, and Canadianization. The conservation objectives have been to prevent both growth and recruitment over fishing. The economic performance objective has been to maintain an economically viable industry on an ongoing basis where viability implies an ability to survive downtimes, with only a normal business failure rate and without government assistance. The employment objective is that jobs should be maximized subject to the constraint that those employed receive a reasonable income through earnings and fishery-related transfer payments. The Canadianization objective has been to maximize fish harvesting and processing by Canadians without competitive interference from foreign activities.

The strategy adopted to meet the conservation objectives was to fish at a constant level of effort over time, the level of effort to be that needed to harvest at the F0.1 level (for cod this is an exploitation rate of about 20%). The main tactic, or tool, to achieve constant effort at the target exploitation level was single species quotas by management areas. The linkage between the conservation objectives and the tactic of quota management is established under Item 8 of the basic principles of the annual groundfish management plan. This states the rules for setting the Total Allowable Catch (TAC) for groundfish management units off Atlantic Canada.

- 8.1 If the stock assessment provides evidence of levels of spawning stock biomass likely to endanger recruitment, fishing effort in the coming year will be reduced to all immediate growth in spawning stock biomass.
- 8.2 Where the F0.1 level for the next year differs 10% or 10,000t from the current year TAC, the following formula would apply:
 - a) 50% rule;
 - b) for larger reductions -- twice F0.1 rule.

The first point addresses prevention of recruitment overfishing, the second prevention of growth overfishing.

The strategies and tactics for the other categories of objectives are summarized in Angel et al. (1994). Licensing measures, gear and vessel size restrictions and other input controls have been used to support other objectives. The restrictions were often aimed at

Maritimes Total Landed Values, Constant 1994 \$Mil

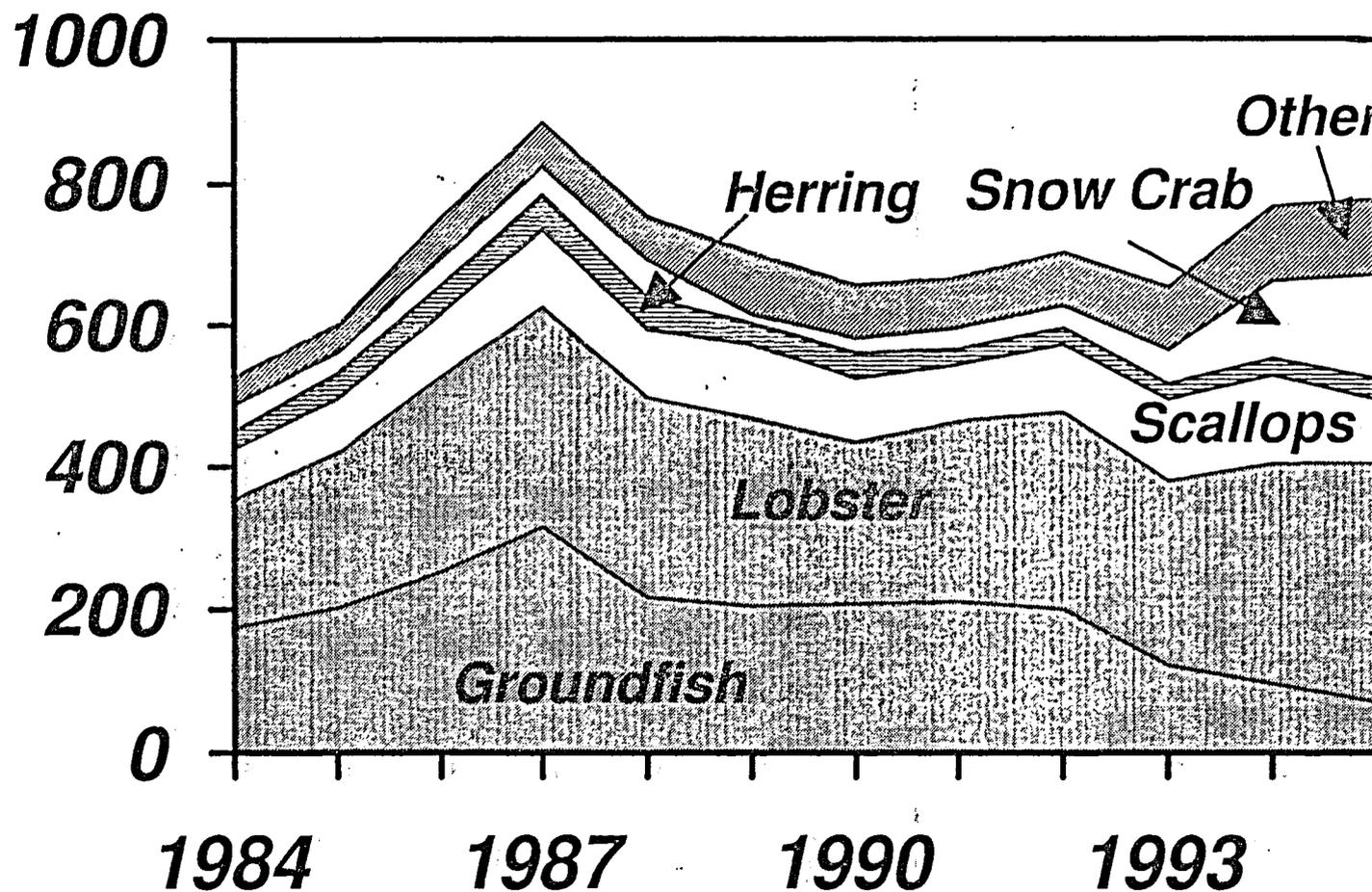


Figure 1. Trends in the total landed value in millions of dollars from 1984 to 1995 for marine fisheries of the Maritime provinces of Atlantic Canada (Nova Scotia, New Brunswick, and Prince Edward Island).

constraining or limiting the growth in capacity of the fishing industry. Programs delivered by other federal or provincial departments have also impacted the fishery. The federal and provincial expenditures through these programs in support of both the harvesting and processing sectors for the overall Atlantic Canada fishery are shown in Figure 2. The unemployment insurance payments to fishers and workers in the processing sector, as well as other subsidies, have tended to encourage the growth of fishing and processing capacity and to maintain high levels of employment in the fishery. As a result of Unemployment Insurance (UI) benefits, the average income for Nova Scotian fishers has been higher than the average income for other workers (Figure 3). This has encouraged participation in the fishery. The subsidies have also artificially reduced the costs of fishing to the participants. Not to put too fine a point on it, one part of government has been attempting to control fishing effort at a constant and low level to meet conservation objectives, whereas other parts of government have been enhancing the capacity to increase fishing effort to achieve the economic performance, employment, and Canadianization objectives. The government activities in support of, respectively, fisheries development and management have therefore been in conflict.

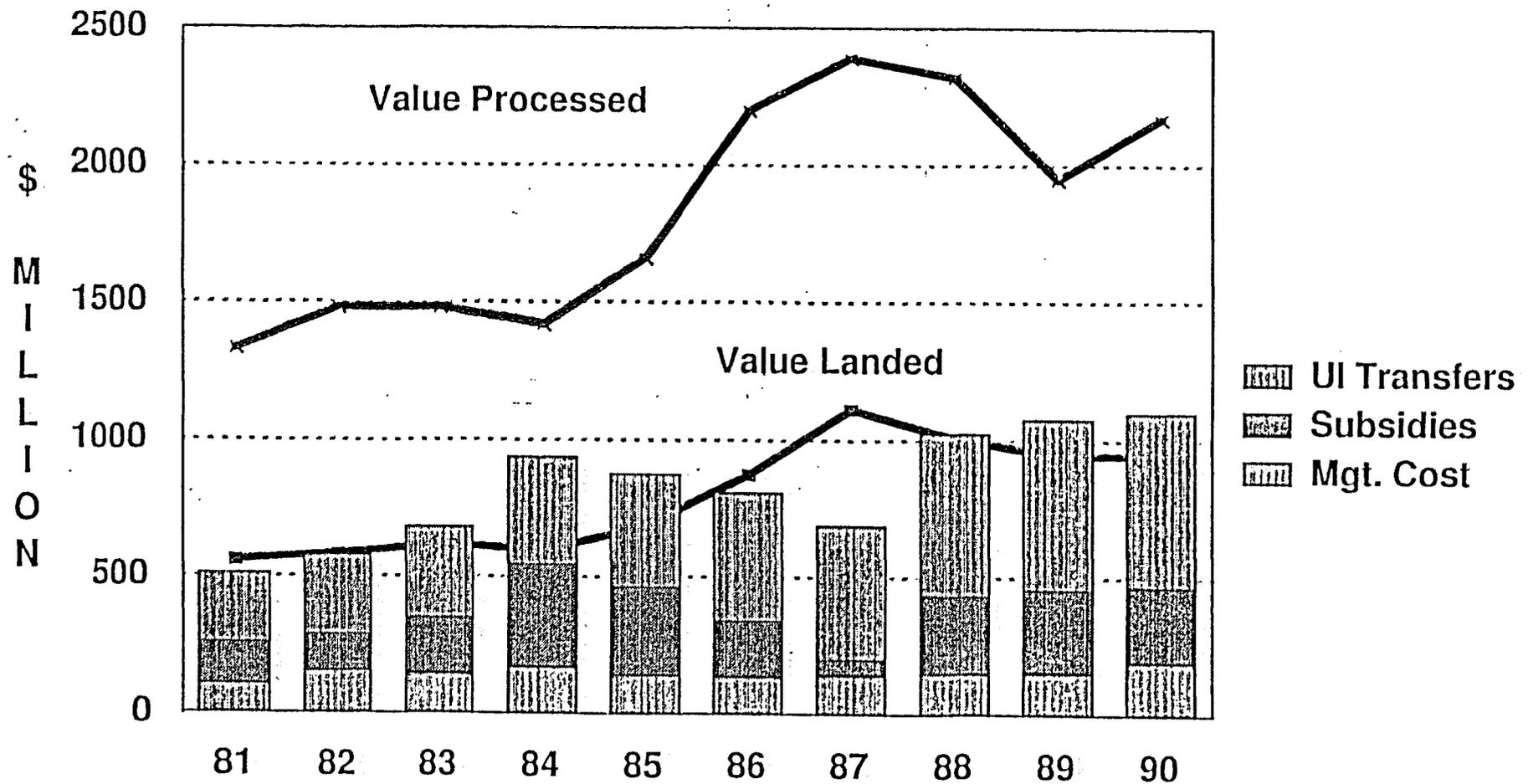
Results of Management Under Multiple Objectives (1977 to 1992)

Two management units, 4VsW and 4X cod, are used to illustrate the degree to which the conservation objectives have been met under management with multiple and conflicting objectives between 1977 and 1992. The two areas, although contiguous, have very different ecosystem characteristics. The management areas are shown in Figure 4.

The effort trends (numbers of trips) for three gear sectors are illustrated in Figure 5. The aggregate effort for groundfish in 4X increased steadily from 1977 to 1992. The predominant gear sector is the small dragnets (less than 65ft in length). Groundfish Management units in 4X for cod and haddock were not closed and thus the reductions in fishing effort since 1992 have been the result of more rigorous implementation of quota management. In 4VsW, fishing effort peaked in 1989, declined gradually until 1992, and then fell dramatically to very low levels with the closure of the cod fishery in this area in September 1993. The major gear sector in this area (with respect to fishing mortality) has been the large trawlers.

The trends in the exploitation rates for 4VsW and 4X cod are shown in Figure 6. Under the F0.1 strategy adopted by Canada in 1977, the target exploitation rate for these two management units is about 20%. With increasing effort over time, the exploitation rates rose gradually between 1977 and the late 1980s, and then climbed sharply in the early 1990s until management actions were taken to reduce fishing effort. The spawning stock biomass for 4VsW cod (Figure 7) has been declining steadily since the early 1980s due to a combination of sustained poor recruitment (Figure 8) and high exploitation rates. The stock is presently at historically low levels and is not showing signs of rebuilding since the fishery closure in September 1993. The spawning stock biomass for 4X cod is at moderate levels and recruitment during the past decade is similar to the earlier decades (1960s, 1970s), for which there are estimates.

FEDERAL* AND PROVINCIAL OUTLAYS IN THE ATLANTIC FISHING INDUSTRY VS REVENUES



*DFO, CEIC, ISTC, and ACOA

Figure 2. Trends in processed value and landed value of marine fisheries in Atlantic Canada as well as government expenditures in support of fisheries. The costs of fishing and processing by industry are not included.

Employment Income and UI Benefits Fishing and Non-Fishing Sectors

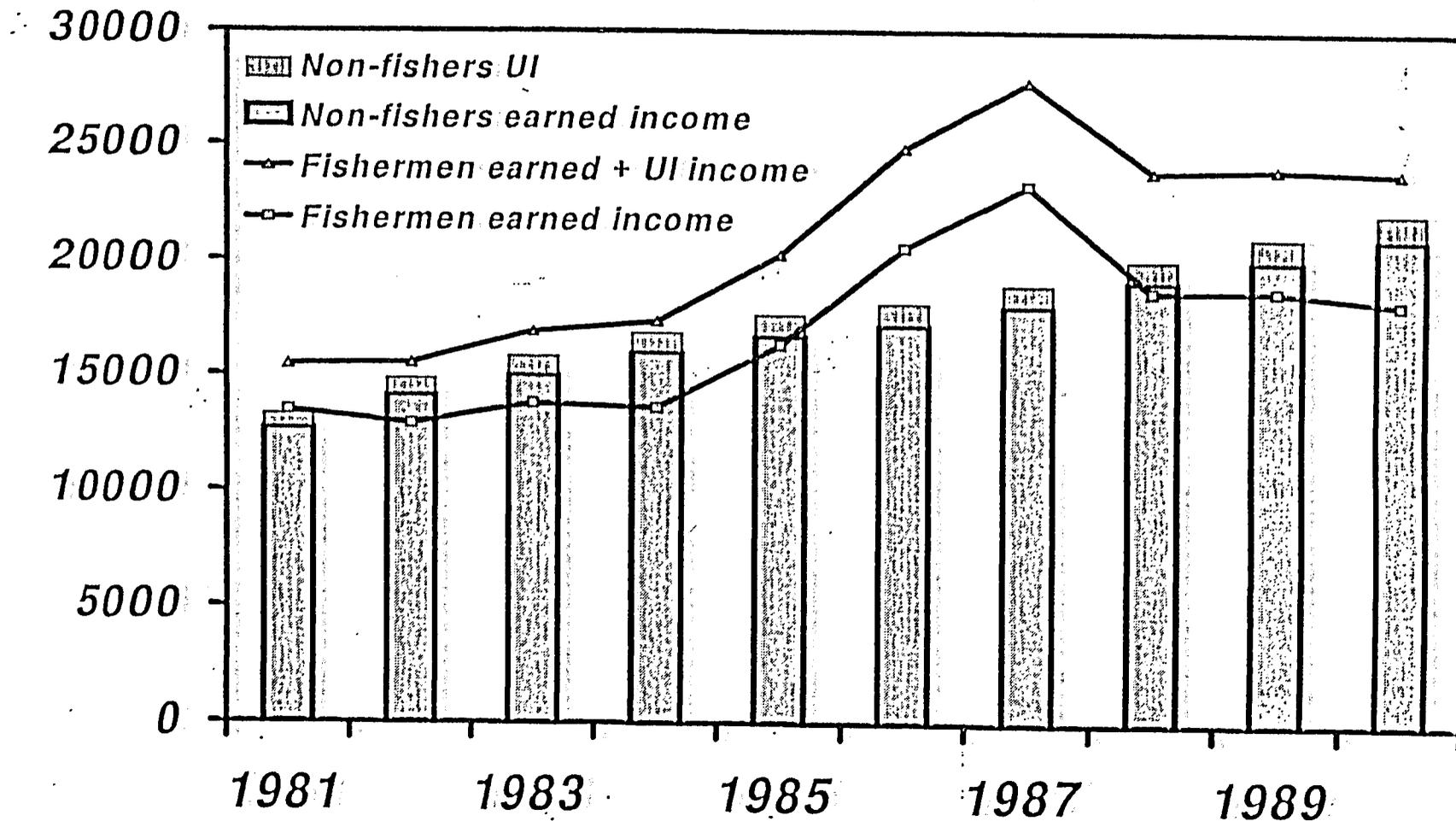


Figure 3. Trends in annual income and unemployment insurance benefits for Nova Scotia workers and fishers between 1981 and 1990.

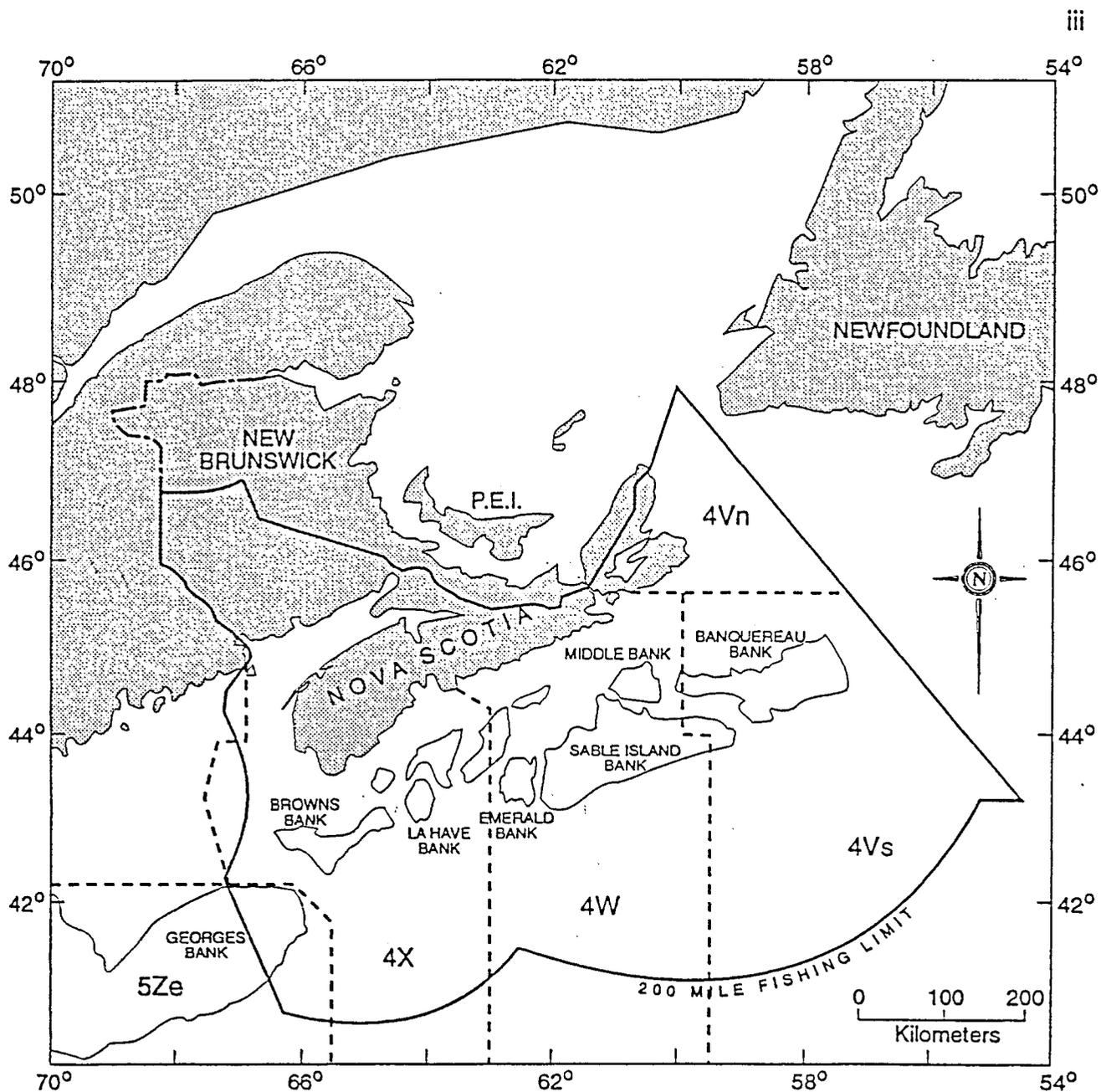
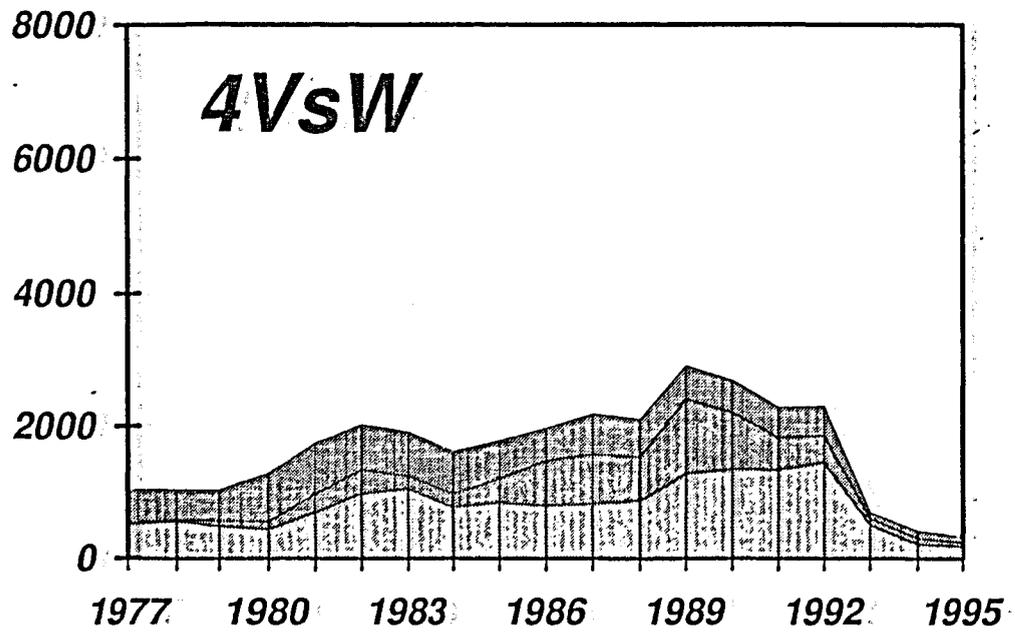


Figure 4. Map of the Atlantic Provinces of Canada showing the boundaries of the Scotia-Fundy area of the Department of Fisheries and Oceans, and the NAFO Statistical Areas (4V, 4W, 4X and 5Ze).



Efforts Trends

Large Trawlers
Small Draggers
Longliners

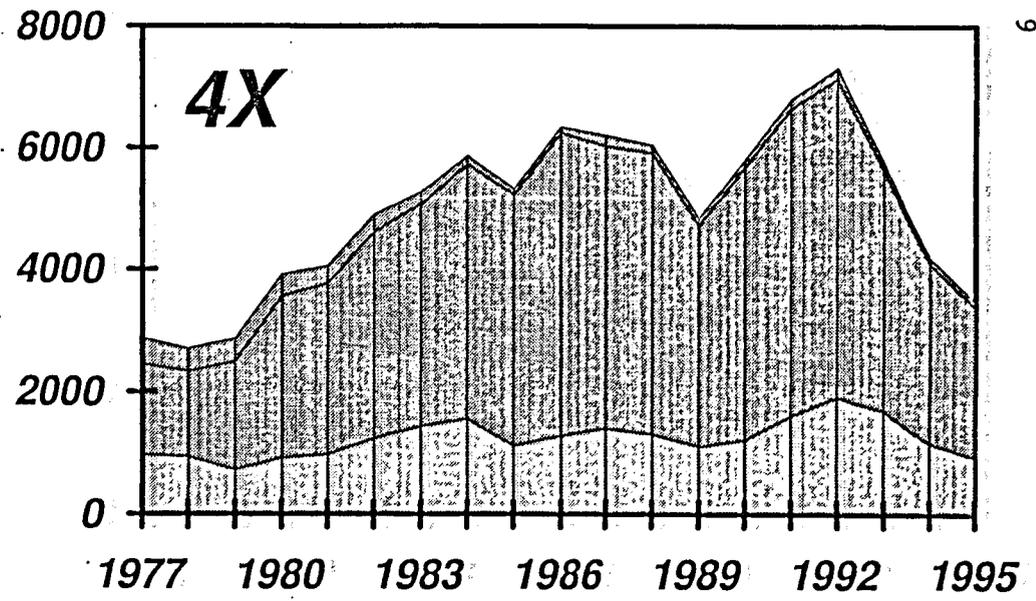


Figure 5. Trends in numbers of groundfish trips between 1977 and 1995 for large trawlers, small draggers, and longliners in 4VsW and 4X.

Exploitation Rate Trends

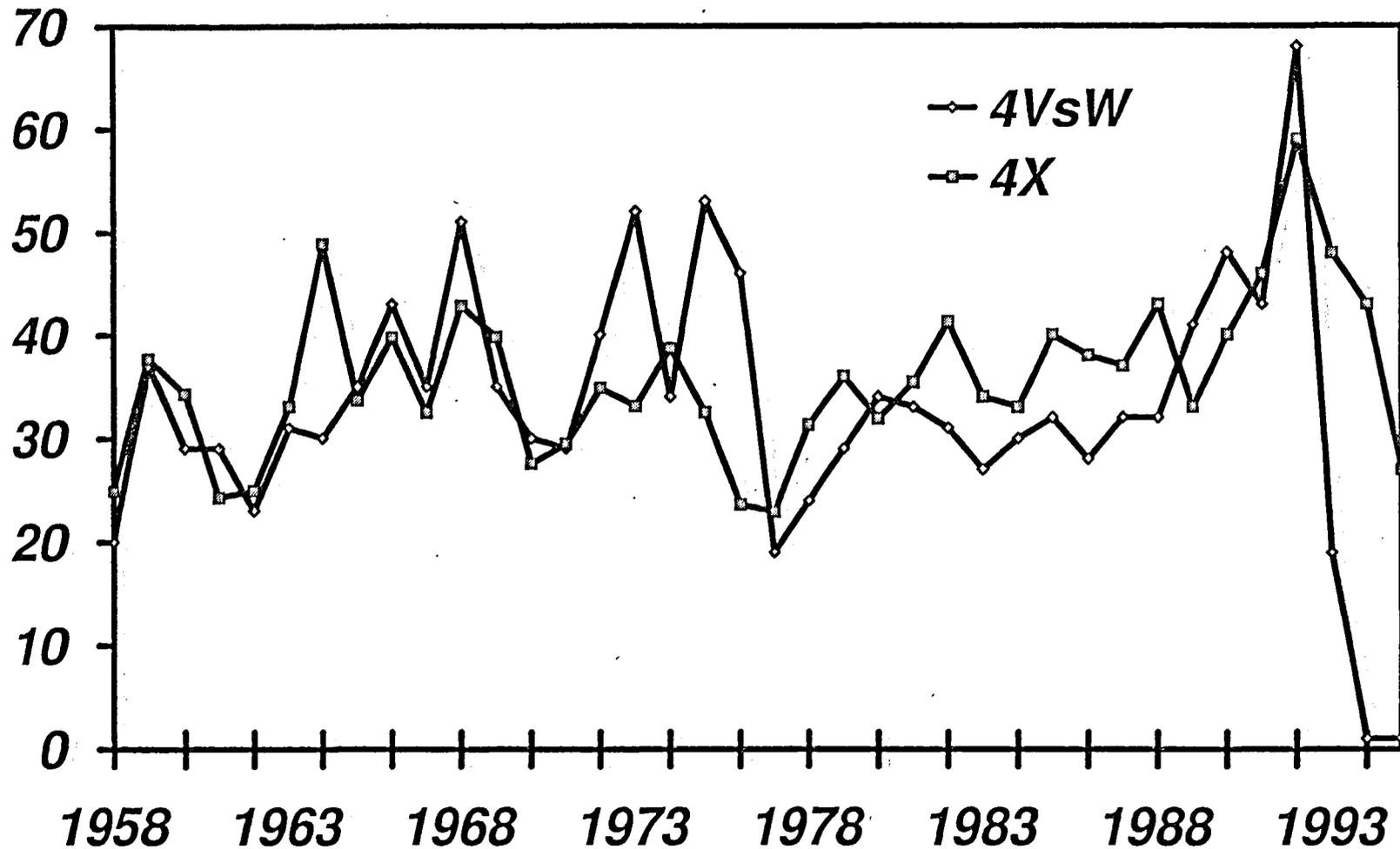


Figure 6. Trends in estimates of exploitation rate (%) for 4VsW and 4X cod between 1958 and 1994. The $F_{0.1}$ target for these two management units is about 20%.

Spawning Stock Biomass Trends

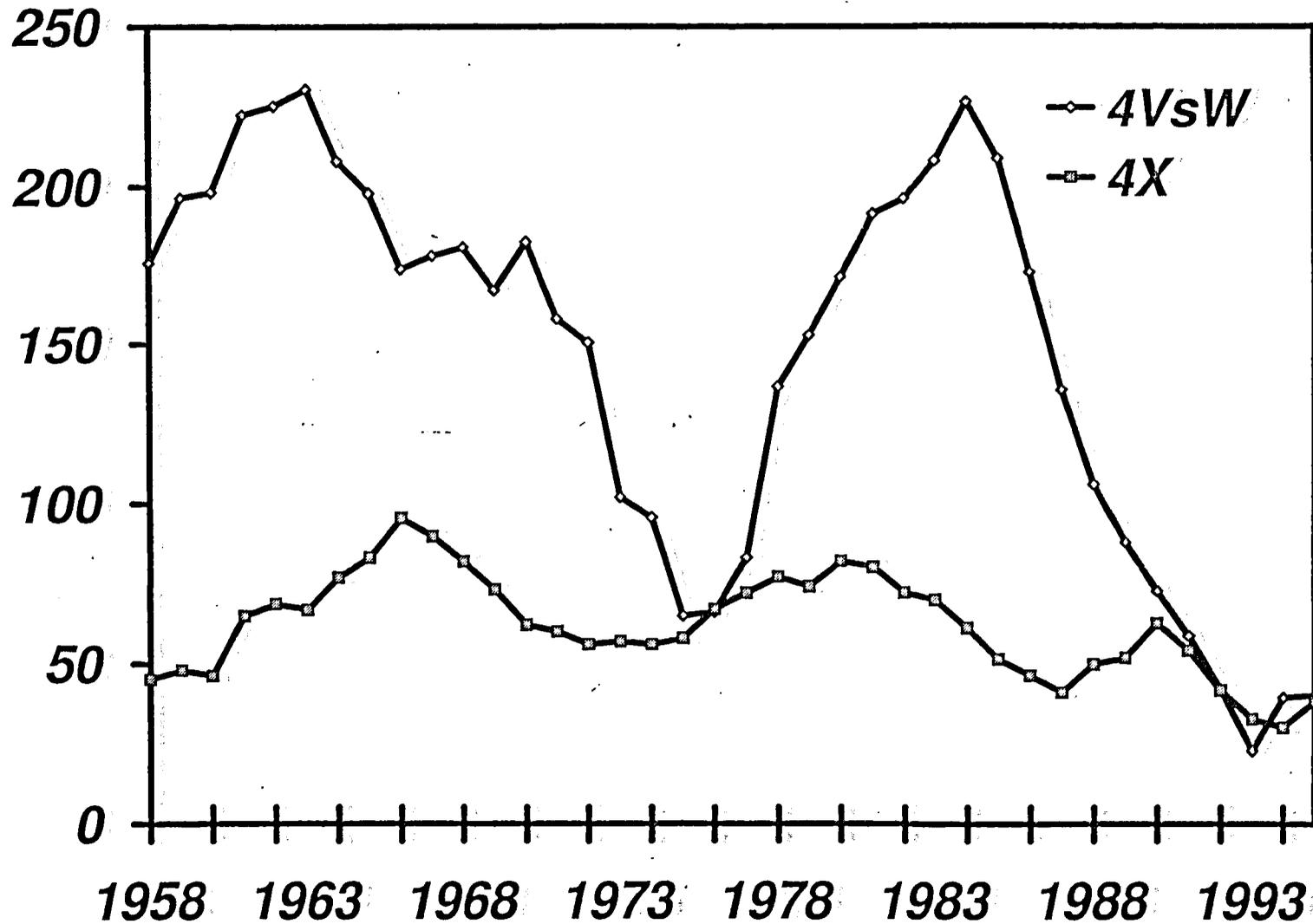


Figure 7. Recruitment (in millions) of 4VsW and 4X cod as a function of spawning stock biomass.

Recruitment Trends

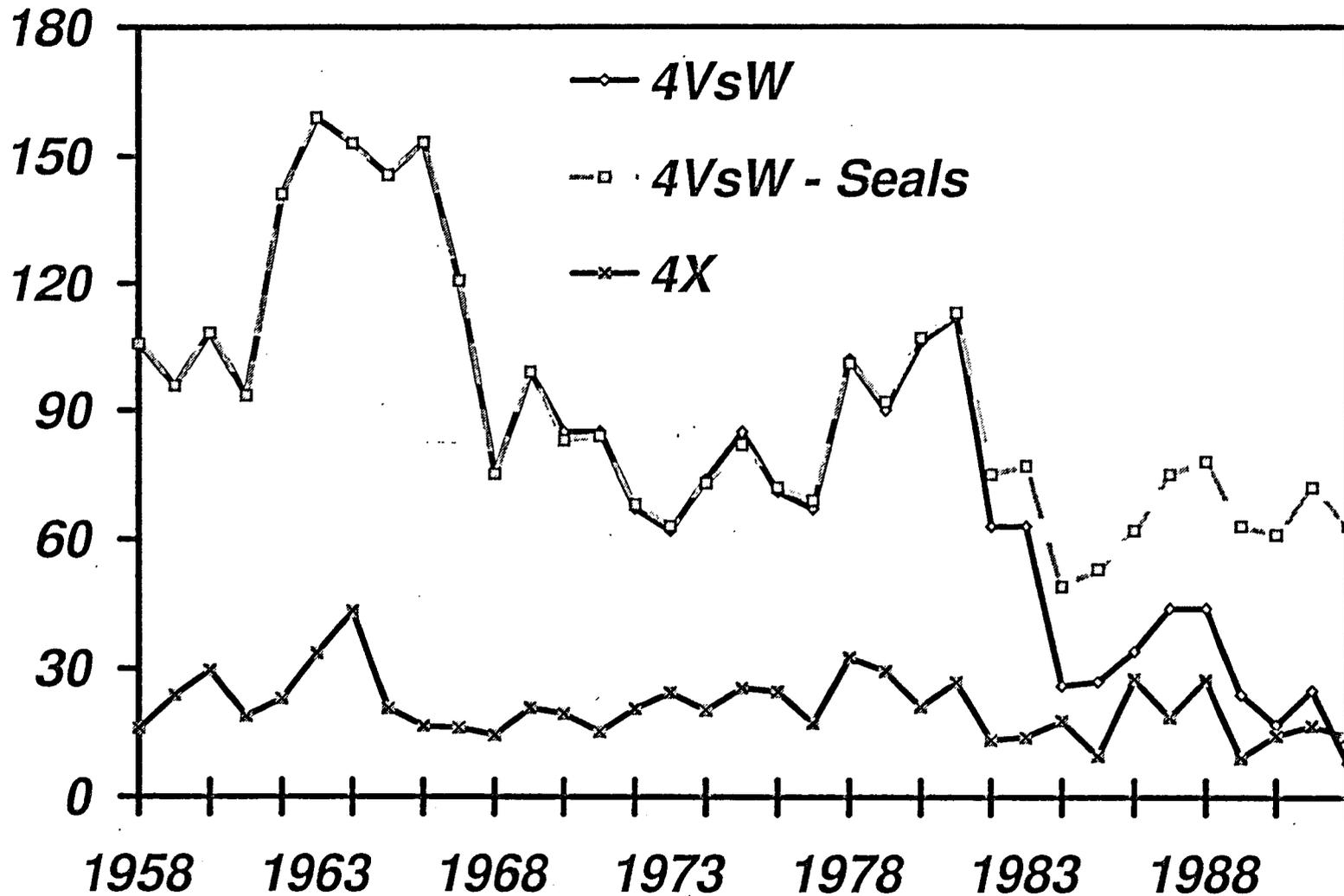


Figure 8. Trends in estimates of recruitment (abundance at age 1) for 4VsW cod and 4X cod from 1958 to 1992. The upper line (boxes) shows estimates of 4VsW recruitment without seal consumption. The feeding model assumes that seals consume a constant proportion of their diet as cod and that natural mortality other than that due to seal predation is 0.2.

In summary, under a management regime characterized by multiple and conflicting objectives, fishing effort was not held constant at the appropriate level to meet the target exploitation rate. Actions in support of socio-economic objectives frequently took precedence over the needs for conservation (Angel et al., 1994). As a result there has been growth overfishing for both management units since the early 1980s, and recruitment "failure" for the 4VsW cod since the mid-1980s. There is, however, uncertainty concerning the relative roles of fishing, seals and unfavourable environmental conditions on the decline in recruitment since 1983. An estimate of the impact of the increasing population of grey seals on recruitment levels in 4VsW cod from the model of Mohn and Bowen (1996) is shown in Figure 8. There is also anecdotal information from interviews with fishers that the fleet concentrated on spawning components within 4VsW during the early 1980s. Several spawning components may have been lost due to this concentration of fishing effort (Young et al., 1996). Quota management between 1977 and 1992 under multiple objectives did not achieve the conservation objectives. In the short-term the employment objectives have been achieved, but they have perhaps been compromised for the long-term by the recruitment collapse in 4VsW. Angel et al. (1994) provide a detailed analysis of the management shortfalls between 1977 and 1992.

Recent Changes in Objectives and Management

The decline in the groundfish resources off Atlantic Canada, and the associated social costs, have led to a rethinking of the objectives of fisheries management in Canada. The changes are summarized by Parsons and Chamut (1996). The new role for the Department of Fisheries and Oceans is to ensure "conservation for sustainable use". The emphasis has shifted such that conservation is the core mandate of the Department. Also, the precautionary approach has been formerly introduced by Minister Tobin in 1995.

Steps are being taken to reduce fishing capacity through a combination of license reform, government funded buybacks, and the introduction of property rights for some fleet sectors. Also, the participants are being obliged to pay for a greater proportion of the costs of management through increased license fees, payment of at-sea observers, and industry funding of dockside monitoring programs for landings and effort information. On a voluntary basis some fleet sectors are funding resource surveys. Capacity adjustment is being transferred to industry. Effort control at target exploitation rates is the priority of the Department.

For the Scotia-Fundy area (Figure 4) a workshop was held in October 1995 to evaluate the need for changes in effort control. The workshop was planned jointly by fishing industry representatives and members of DFO. The focus was on the tools to control fishing effort at appropriate levels to meet the conservation objectives.

Recommendations From 1995 Workshop on Groundfish Management

In preparing material for the workshop selected participants were asked to consider the following questions:

- What are the strengths and weaknesses of quota control (IQ/EA and competitive)?
- Can effort management (access to time on the water) be a useful or complementary tactic?
- What could be the role of closed areas or sanctuaries as a tactic to meet conservation objectives?
- Are further restrictions on harvesting technology necessary to achieve conservation objectives? If so, which ones?

In addressing the above questions, the costs and benefits were to be considered to the degree possible.

- Benefits:
 - How well does the tactic achieve the conservation objective?
 - What are the tactic's shortcomings regarding conservation?
- Costs:
 - What are the information needs of the tactic?
 - How much does this information cost? to industry? to management?
 - What are the incentives to cheat? Can enforcement control this?
 - How much does this enforcement cost?

Sixteen papers were presented on the four categories of tools to control fishing effort. On the basis of the papers and the discussion, the steering committee made 32 recommendations. The recommendations were grouped under components of a fisheries management model (Figure 9). The full report of the workshop has recently been published (Burke et al., 1996). The recommendations are discussed below.

Strategic Planning

1. It is recommended that decision making on management be delegated closest to those most concerned with the particular management plan under consideration.

Fisheries Management Model

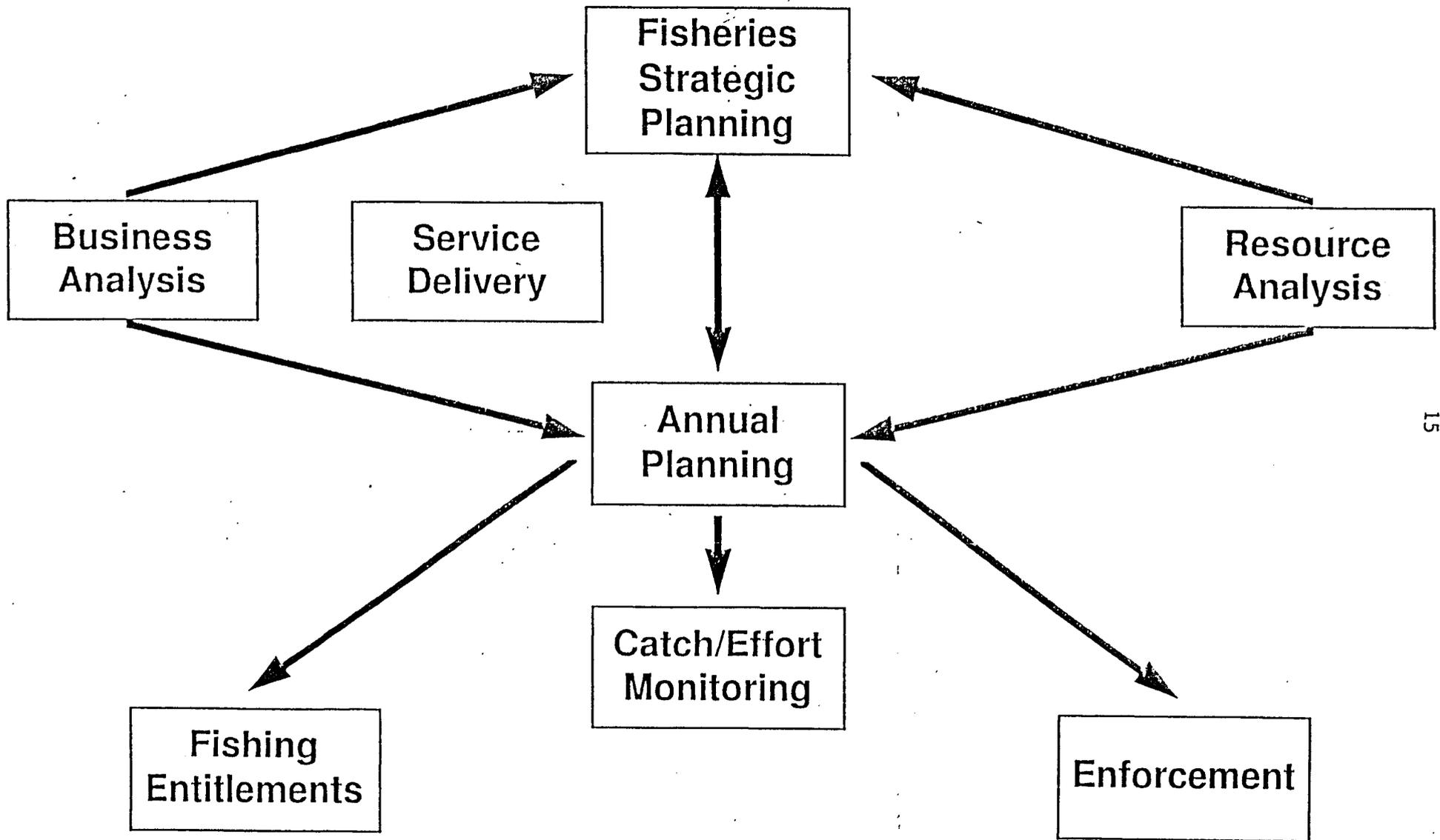


Figure 9. The activities of fisheries management are structured within eight boxes of a fisheries management model.

2. In order to transfer decision making to license holders, there is a need to define the process for the division of responsibility. It is recommended that the division of responsibility and authority be clearly defined as part of the consultation process.
3. It is recommended that quota management continue to be the core regulatory measure to achieve the conservation objectives, but that it needs to be more effectively complemented by additional tools such as closed areas, effort monitoring and gear restrictions.
4. It is recommended that a real time, two-level monitoring system using catch and effort be explored for a selected fishery. The intent is to allow tracking of catch and effort during the fishing year in order to identify problems in the stock assessment or misreporting.

Although the workshop was not structured to address strategic planning, issues of this nature did arise through industry statements on the future of the groundfish fishery and during the discussions. There is a need for delegation of decision making to the lowest level practical. With respect to the control of effort it was concluded that, even though quota management should continue to be the main regulatory tool, other monitoring and control measures should also be applied in a complementary fashion to increase effectiveness in meeting conservation objectives.

Management Planning

5. It is recommended that the existing spawning area closures be maintained and that new areas be defined to cover currently unprotected spawning components. The seasonal duration of the present closures on Browns and Georges Banks need to be reviewed with respect to optimal benefits.
6. It is recommended that there be no expansion of juvenile closures and that the Western/Sable Island closure be continued.
7. It is recommended that year-class quotas be explored for a fishery in which different fleet components harvest different age classes.

Again, there were no papers on the strengths and weaknesses of the present management planning process. As a result, the above recommendations are restricted to actions needed to include additional tools within the annual planning process. Subsequent discussion within DFO has focused on the need to improve the linkage between management actions and specific conservation objectives. Also, the plans themselves need to be peer reviewed in order that strengths and weaknesses can be evaluated and documented. Steps are being taken to include the analyses of the management system and of management plans within the Regional Advisory Process (RAP) that is used for peer review of scientific advice.

Fishing Entitlements

8. It is recommended that existing shares be respected in order to enhance the cooperative approach by industry towards meeting conservation objectives.
9. It is recommended that DFO and industry set criteria for carryover allocations.

These recommendations were a high priority for the fishing industry. It was felt that security of access to a particular percentage of the resource is a prerequisite to fruitful cooperation between gear sectors and to strengthening of a conservation ethic.

Catch and Effort Monitoring

10. It is recommended that industry-funded, independent dockside monitoring and logbooks, including data entry, be mandatory for all fleet sectors (i.e., "catch monitoring systems" should be replaced by full independent dockside monitoring).
11. It is recommended that a discard index from observer and other at-sea monitoring be used to estimate accumulated discards for possible reduction of the following year's TAC.
12. It is recommended that a real time, comprehensive effort monitoring system be undertaken in order to evaluate fleet dynamics.
13. It is recommended that DFO and industry develop a user friendly fishery information system to support real time management decision making by DFO and industry.

The information needs to effectively control effort for the highly efficient and powerful fleet sectors of the Canadian groundfish industry are substantial. There was broad consensus that improvements are needed in both the accuracy of the information on catches and effort, as well as on the timeliness with which the information can be accessed by both DFO and the industry.

Enforcement

14. It is recommended that the industry develop guidelines for administrative sanctions (penalties).
15. It is recommended that sanctions for repetitive serious infractions may result in lifetime suspension from the fishery.
16. It is recommended that a mechanism be established whereby industry can advise DFO on improvements to enforcement.

17. It is recommended that deviations from the expected mix of landings, and unreasonable differences between reported landings and days at sea, be used to target fishermen for observer coverage or possible fishery closure. It is recommended vessels that fish beyond what is reasonable for their allocation be obliged to carry an observer for the remainder of the year.
18. It is recommended that for a competitive fishery, that easily monitored regulations, such as vessels fishing on alternate times (i.e., days, weeks, months) based on CFV, be considered.
19. Given that not all gear technology regulations are readily enforceable, it is recommended that industry promote self-regulation through education, a code of conduct and peer pressure.

This is the second category of recommendations for which there is broad consensus that additional measures are needed in order to improve the control of fishing effort at target levels. Industry is being encouraged to play a larger role in the definitions of appropriate sanctions for various infractions, as well as to provide input on how to increase effectiveness of expenditures on enforcement activities. If there is a real-time description of reported landings and effort, it is expected that this information can be used to identify those fishers who are persistently misreporting.

Service Delivery

20. It is recommended that DFO refine its planning and financial system so that the fishery-specific costs of management can be attributed to DFO and industry with more precision than is currently possible.

It has only been during the past couple of years that this function, with respect to the analysis of diverse business lines, has been recognized within DFO. With an increasing obligation on the part of industry to pay the costs of fisheries management, the Department needs to evaluate the costs of diverse activities in support of the various components of the overall mandate (or so-called business lines). In addition to the costing issues, there is a need for the Department to analyze the degree to which the organizational structure enhances or impedes the delivery of various services along business lines. That analytical function has been lacking until recently.

Business Analysis

21. It is recommended that a price monitoring system be developed with the buyers.
22. It is recommended that there be an industry/DFO analysis of the cost and effectiveness of enforcement.

23. It is recommended that there be an evaluation of the degree to which there has been capacity reduction under the IQ and EA systems.
24. It is recommended that the costs of closed area and season regulations be evaluated.
25. It is recommended that the costs of the real time, two level monitoring system (catch and effort) be evaluated.

The changes that are recommended in the tactics of effort control require ongoing social and economic analyses (or business analysis in the terminology of the model). The resources for this function are limited, and as a result many changes to management have been made without sufficient analysis of options and of results.

Resource Analysis

26. It is recommended that Science evaluate the optimal time during the annual planning cycle when to provide scientific advice on the status of the resource. The intent is to ensure that the resource prospects are based on the most up-to-date information available.
27. It is recommended that the data and monitoring needs for the year-class quota system be evaluated in support of recommendation no. 7.
28. It is recommended that Science provide estimates of minimum spawning biomass for as many of the management units as possible in order to 'prevent recruitment overfishing' (a key conservation objective).
29. It is recommended that closed areas and seasons to protect spawners be defined by Science in cooperation with industry in support of recommendation no. 5.
30. It is recommended that in order to reduce catch wastage, mortality incidental to the catching process, and negative effects of gear on habitat, a joint government/industry gear research program be established. This program would support the activities under recommendation no. 19.
31. It is recommended that indices of discarding be developed in support of recommendation no. 11.
32. It is recommended that, where possible, Science estimate the days at sea needed by fleet sector to catch the quota share in support of the two level monitoring system (catch and effort), stated in recommendation no. 4.

The recommendations for resource analysis flow directly from the recommendations for an expansion in the tactics for effort control (i.e., the use of days-at-sea and spawning area closures as a compliment to quotas).

Concluding Remarks

The strategy adopted by Canada to achieve the conservation objectives (i.e., constant effort at $F_{0.1}$ level) is still considered appropriate, with the caveat that spawning components, within the management unit comprising a population complex, need to be protected. If this strategy had been successfully implemented for 4X and 4VsW cod (given the recruitment levels estimated in Figure 8), the 4X cod stock would have been relatively stable at the 150kt tonnes level whereas the 4VsW cod stock would still have declined to historically low levels (less than 100kt) (Figures 10 and 11). Using the adjusted recruitment series to take into account grey seal predation (from Mohn and Bowen, 1996), the biomass would have been considerably higher under $F_{0.1}$ management. If fishing was not the cause of the 4VsW cod low recruitment since 1983, the $F_{0.1}$ management strategy would not have prevented the fishery collapse.

The experience of groundfish management in the Scotia-Fundy area, as documented by Angel et al. (1994), infers that multiple objectives of fisheries management contributed to growth overfishing; and in the case of 4VsW cod, possibly to fishery collapse. Because of a false sense that the groundfish resources are resilient to fishing mortalities around F_{max} , which has been the case for the groundfish resources in the northeast Atlantic and Iceland, short-term actions in support of economic performance and employment objectives sometimes took precedence over the need to reduce fishing mortality to the $F_{0.1}$ target level. In response to the shortfalls in management and the cod collapses, a new emphasis has been placed on the need to manage sustainably. A moratorium has been applied to all effort. There is a wider recognition of the need to reduce capacity and participation in the fishery by up to 50%. This is being pursued through a license buy-back, and reform of the licensing regime. Broader based government reforms and restructuring will greatly reduce the generosity of Unemployment Insurance and other subsidy programs, but they will continue to be available.

Once the moratorium is lifted, sustainability will still be at risk. This can be illustrated using the Gordon-Schaefer bio-economic model (Figure 12). Ongoing technological change increase the efficiency of harvesting and also lower the slope of the cost curve. Due to the lower slope, the open access equilibrium point occurs at a lower spawning stock biomass level. Thus, if effort is not restricted, long-term fishery collapse can occur.

Given these risks, it is essential that there be a fail-safe approach to the protection of reproductive potential and the control of fishing effort. The 1995 workshop concludes that quota management needs to be complimented by real-time effort monitoring and enhanced use of spawning area closures.

Impacts of Overfishing On 4X Cod Biomass

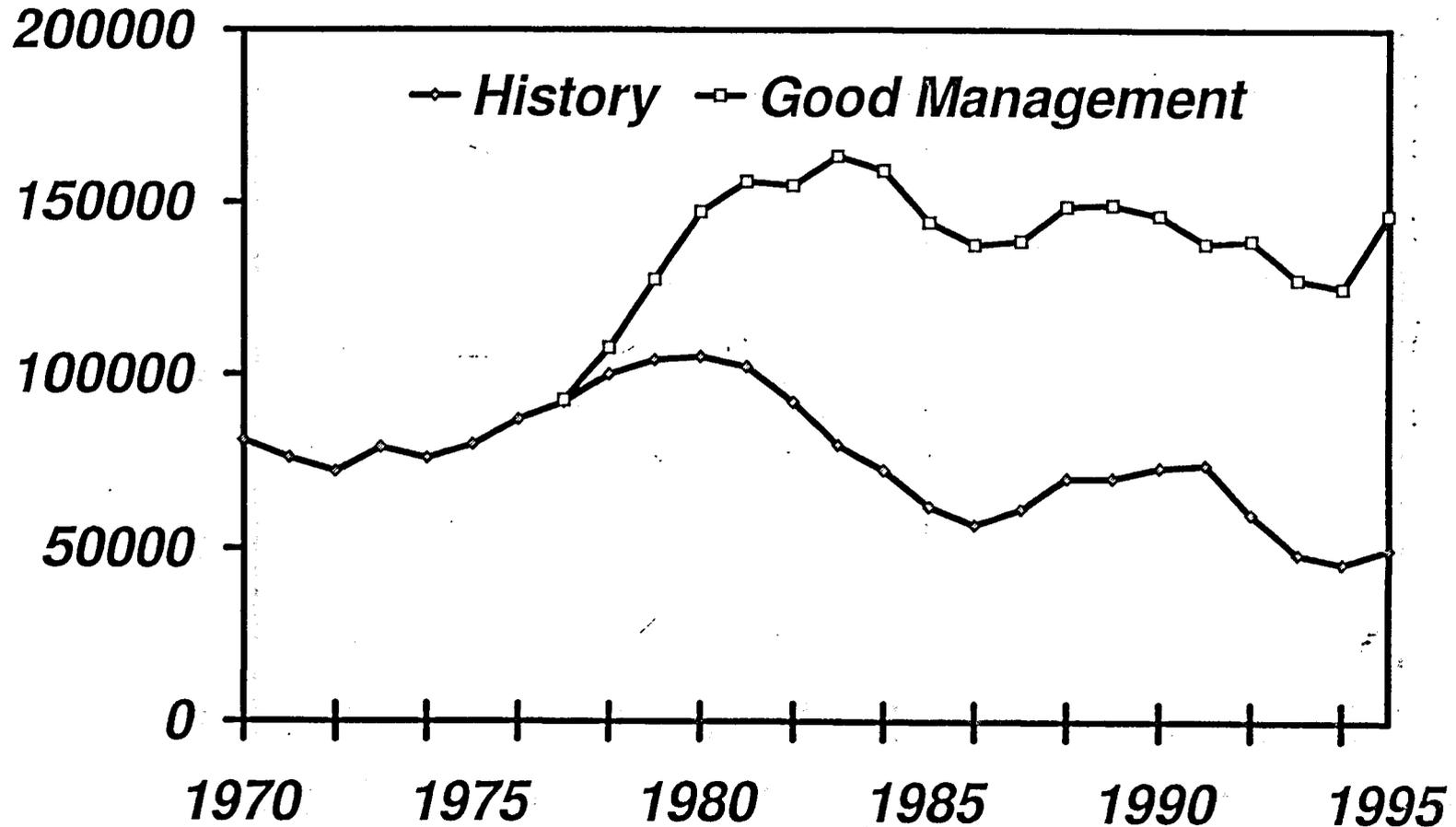


Figure 10. Impacts of fishing beyond the $F_{0.1}$ target on 4X cod biomass. The lower line illustrates the estimates of stock biomass (age 1+) at historical levels of exploitation. The upper line estimates the stock biomass that would have occurred if fishing had been restricted at the $F_{0.1}$ level assuming the recruitment trends in Figure 23.

Impacts of Overfishing On 4VsW Cod Biomass

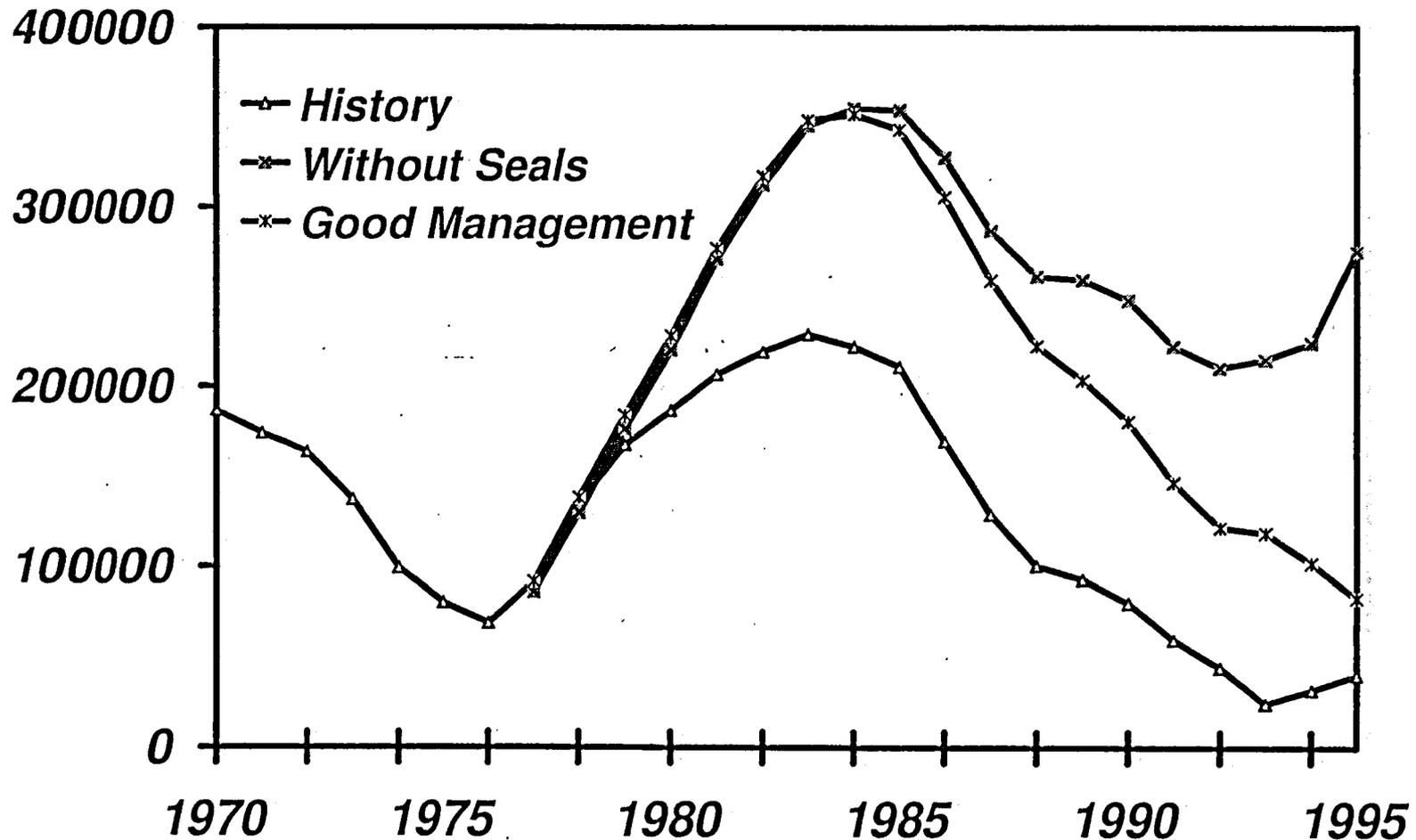


Figure 11. Impacts of fishing beyond the $F_{0.1}$ target and of seal predation on 4VsW cod stock biomass (age 3+). The lower line illustrates the estimates of stock biomass at historical levels of exploitation. The upper lines estimate trends in stock biomass with fishing at the $F_{0.1}$ level with and without seal predation on cod juveniles (i.e., assuming the recruitment trends for 4VsW cod shown in Figure 23).

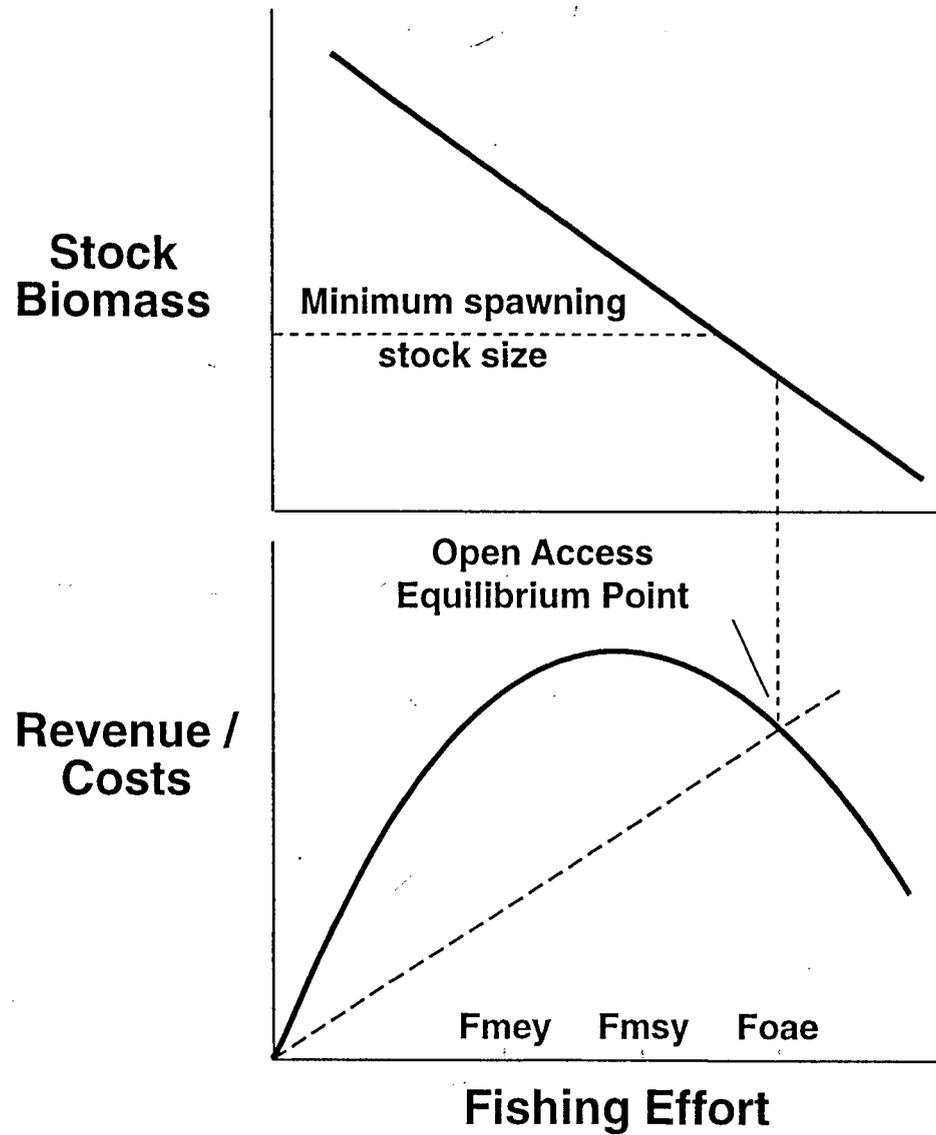


Figure 12. The relationship between minimum spawning stock size (MSB), fishing effort and the open access equilibrium point is illustrated using the Gordon (1954) and Schaeffer (1954) bio-economic model.

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