HAULING AWAY THE "FISHERY OF THE FUTURE":

A POLITICAL ECOLOGY OF THE LOBSTER FISHERIES IN ATLANTIC CANADA

BY

MARK A. MANZER

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF ARTS

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Abstract

This thesis investigates how the Atlantic Canada shellfishery is being managed to prevent overfishing and avoid an ecological collapse of shellfish resources. The thesis examines certain issues in shellfishery management in Atlantic Canada using A political ecology approach to the analysis of federal government fisheries management documents. It also uses the traditional anthropological technique of cross-cultural comparison, with the example of the lobster fishery in the state of Maine (USA). This thesis examines the role of actors in the shellfishery drama, including the state (both federal and provincial), business, fishers, and lobsters. It also investigates the ecological effects of various fishing methods and of different sources of pollution in the Atlantic Canada shellfishery. It critically examines the management practices in the Atlantic Canada lobster fishery, interrogating the use of the "Tragedy of the Commons" model and the "Precautionary Approach". Similar issues are investigated and compared in the Maine lobster fishery to the Canadian lobster fishery. Key issues of comparison between the two fisheries are the "commons" versus "private property" approaches and centralized versus local management practices. The thesis concludes that it is important to be aware of the synergistic effects on management of the activities of all actors, as well as fishing methods and pollution. Finally, the thesis illustrates that the debate surrounding management strategies of common and open- access resources is continuing. The management of fisheries resources has been based on Hardin's explanation of why resources are depleted. The thrust of Hardin's argument was based on what he called "common" resources, but in actuality, the focus of his argument is more accurately called 'open-access' resources. Both cases under investigation in this thesis, the Canadian management system, which is based on government intervention, and the Maine management system, where resources are managed partly under a private property regime, have led to unacceptable solutions for, and a destruction of, the resources in the groundfisheries. There is an inherent conflict as ecological problems can only be solved over the long term whereas contemporary politics operates in the realm of the short –term. Therefore, current government regulation strategies for managing fisheries resources will not likely conserve these resources over the long term.

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Chapter One: Hauling Away the "Fishery of the Future"

1.1 Introduction

In 1980, the Canadian government, ignoring the needs and advice of Newfoundland inshore fishermen to restrict predatory technologies and overfishing, introduced a policy that limited the access of individual fishermen to inshore fisheries and favored the more "efficient" boats of the offshore trawler industry. These policies led to the complete collapse of the cod fishery in 1992 and the unemployment of 25,000 fishermen (Kunzig 1996).

The coastal way of life of the people of the Atlantic Provinces of Canada has been transformed in the latter part of the twentieth century by major technological developments in the fisheries. Medium sized vessels known as "longliners" appeared in the 1950s and 1960s, and began putting pressure on those who still used smaller traditional boats of thirty feet or less. Between 1947 and 1960, 125 longliners and 34 draggers were built in Nova Scotia with government assistance (Rogers 1995:49). With their greater size and electronic sophistication, longliners were able to manage 100 to 150 nets with only a small crew and they could fish much further offshore. However, this did not prevent them from fishing in the inshore waters, which added to the competition with smaller boats. Another threat to the coastal fishery was posed by the rise of the offshore trawler fleet.

My purpose in my thesis is to investigate how the Atlantic Canada shellfishery is being managed to prevent overfishing and avoid an ecological collapse of shellfish resources. A political ecology analysis of the fishery might offer solutions so that it might continue to provide a livelihood for fishers and stability for fishing villages in the Atlantic region. This thesis also stems from my long interest in the fisheries and Atlantic Canada where I lived for more than a quarter century.

I attempt to show that management measures undertaken in the Atlantic Canada shellfishery, and the New England fishery are designed to promote short-term economic growth rather than long-term ecological sustainability. As a result, these policies contribute to overfishing and may cause yet another ecological collapse. The objective of this research is to use the example of fisheries in Atlantic Canada to show that ecological mismanagement leads to economic collapse and social disorganization in fishing villages.

The research goals include understanding trends over time; therefore I have attempted to collect data that spans a number of years. At the international, national, and regional levels, government publications are utilized. I attempted to integrate qualitative and quantitative sources of data in the research methodology. The intended approach consists mainly of an etic methodology to analyze etic facts, such as fish catch, number of licenses issued and the number of boats as well as emic facts such as policy statements or opinions of fishers. One of the methodological tools typical of anthropology is a cross-cultural comparison which in this case shall be the example of New England fisheries. A significant advantage of the cross-cultural comparison is that it can provide us with a more precise assessment of the ecological, economic, and political causes and consequences of alternate fishing policies and regulations.

1.2 Rationale

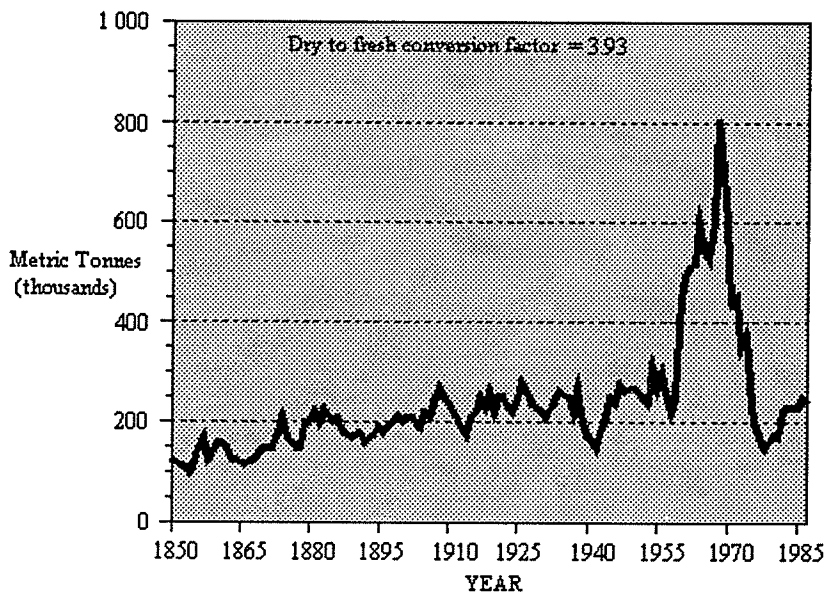
I document in the following work how the processes of economic expansion lead to neglect of conservation measures and an ecological collapse of Atlantic Canada's most valuable fishery. Also, I argue that conservation and sustainability policies can only be as good as the knowledge of the relevant ecosystems and the carrying capacity. The knowledge of Atlantic Canada's fish and shellfish resources is incomplete and inaccurate because of the difficulty in calculating the ecological consequences of such factors as by-catch, pollution, and coastal contamination. By investigating the Atlantic Canada shellfishery over a twenty year period, beginning in 1977, I argue that the crisis in Atlantic Canada fisheries are not exclusively fishery problems but rather problems of global economic relations. This has serious consequences for the people and villages that depend on fish resources for a livelihood, and have no alternative way of making a living.

In Atlantic Canada, fishing is not only a dominant part of the economy, it is also a way of life that has been threatened by severe crises. To compensate for the collapse of the cod fishery, more fishers with larger boats are now turning their attention to shellfish. The present economic success of this new strategy raises the specter of more growth and possible collapse of this industry.

Since 1976, the commercial dollar value of fish landed in Atlantic Canada has steadily increased from $200 million to more than $1.2 billion in 1998 (all values are in Canadian dollars unless otherwise stated). This increase of total dollar value is more remarkable because the total catch decreased substantially in 1990. The explanation of this paradox is that from 1989 to 1997 the catch of shellfish has increased and the dollar value of shellfish increased substantially, making up for the loss resulting from the fall in groundfish catch. The number of fishing licenses issued from 1988 to 1997 has remained relatively constant indicating that the same number of fishers is involved in the Atlantic fishery today as there were in 1988. The numbers of licenses issued for crab, scallop, squid and lobster have increased slightly. The total number of vessels involved in the Atlantic fishery has declined with the largest percentage change in the 35 feet and under class. The collapse of the cod fishery and the subsequent rise in lobster catch can be seen graphically in Charts 1.1 and 1.2.

Chart 1.1

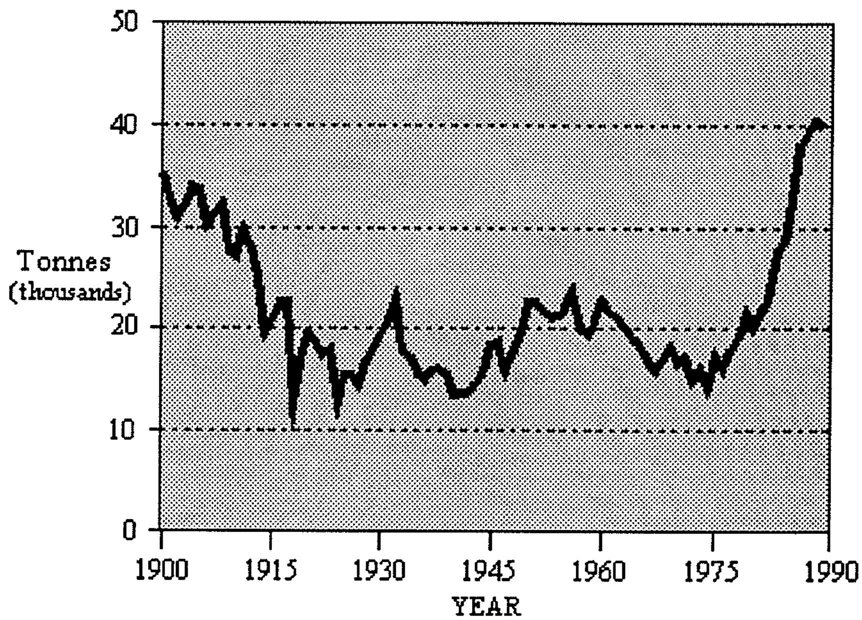
Cod Landings 2J3KL (Northern Cod) - 1850-1987



Source: Eaton et al. 1994a: Ch. 4-107.

Chart 1.2

Lobster - Reported Catch - Atlantic Region - 1900-1990



Source: Eaton et al. 1994a: Ch.. 4-102.

There have been warnings from ecologists claiming that continued expansion in consumption rates cannot be supported indefinitely. Ecologists claim that the fishing techniques now practiced have an impact on 1) non-target species; 2) predator/prey relationships; 3) genetic diversity; and the 4) condition of the sea floor. There are a large number of factors that plague attempts at adequate assessment. Misreporting is an error factor. Information comes from the fishing industry that fails to report catches or provides inaccurate statistics. Quotas based on Maximum Sustainable Yield (MSY) give fishers an incentive to discard smaller and less valuable fish that are then not accounted for in the figures. This results in a waste of by-catch. By-catch is fish from one species caught and thrown overboard by vessels targeting another species. By-catch is not usually included in any equation of MSY for the target or by-catch species. The quantities of discarded fish and what species were caught cannot be measured because of insufficient data collected by the Department of Fisheries and Oceans. This neglect of by-catch limits the ability to measure the impact of fishers upon the shellfish biomass.

The method of fishing can have negative effects on the marine ecosystem of Atlantic Canada. Boats using trawler nets can have serious impact on the habitats in which shellfish live. Trawler nets drag over the seafloor churning and uprooting plants, which serve as food and shelter for shellfish. Trawlers using nets to catch one species are indirectly affecting other stocks of commercial shellfish by destroying the marine habitat. The side effects of overfishing can be more serious than the damage done directly to target shellfish stocks. Overfishing can result in a form of ecological degradation in which the shellfish community changes from one dominated by large shellfish, to one characterized by small species of considerably less value (Regier and Baskerville 1986:89).

Fishery managers attempt, as a matter of principle, to extract maximum yields from a natural resource, on the assumption that, if they get it wrong one year, they will be able to get it right the next. This balancing act can only succeed if the calculations upon which decisions are made are infallible. Throughout this thesis I present various examples that challenge the infallibilities of management models.

The Federal Fisheries Minister, as the custodian of the resource, makes decisions about access to the resource based on economic and political realities. The economic, political, ecological, and technological realities of the shellfishery throughout the 1990s seem to be disturbingly similar to those of the now defunct cod fishery.

The Atlantic Canada shellfishery has both increased production and landings since the closure of the Atlantic Canada groundfishery in 1992. Landings are the total amount of shellfish being brought to shore. Production is the number of shellfish under exploitation for commercial export. The prospects for further increases are clouded by uncertainty of the amount of shellfish biomass that presently exists. The size of the shellfish biomass is difficult to evaluate because of incomplete knowledge of biological processes and problematic production models used in management. The shellfish industry is managed as a capitalist enterprise where global economics and politics dictates the amount to be supplied to markets without regard to the carrying capacity of the Atlantic coastal ecosystem.

Ecologists have claimed that overfishing leads to ecological destruction of marine ecosystems. The story of the Atlantic cod clearly demonstrates that overfishing in the industry caused ecological destruction. In effect, too many fish went to market. This is a clear example of how economic objectives took precedence over ecological sustainability. Resource management was based upon economic goals and political strategy rather than ecological knowledge. Therefore, one of the problems is that the current state of shellfish management, based on biological and economic models and the theory of common property, will lead to overfishing in the shellfish industry and will inevitably result in a collapse of the resource.

1.3 Theoretical Framework

1.3.1 Political Ecology

The two main theoretical thrusts in political ecology are political economy, with its insistence on the need to link the distribution of power with productive activity, and ecological analysis, with its broader vision of bio-ecological relationships. Political ecology originated in the 1970s but did not emerge as a research field until the 1980s.

The field came out of calls for "an analytical approach integrating environmental and political understanding in a context of intensifying environmental problems" (Bryant 1992:12). This approach will provide a broader understanding of the causes and consequences of ecological change. There are various ways in which political ecology has been applied to the study of empirical problems. Studies have largely avoided theory in favor of empirical analysis (Peet and Jordan 1993:239). The areas of inquiry are broadly similar in so far as a different approach to the subject matter have been utilized and thirdly, an understanding of political ecology as predicated on the assumptions and ideas of political economy.

There are two basic issues that seem to be prevalent in political ecology work. First, ecological problems are not simply a reflection of policy or market failures (World Bank 1992), but rather are manifestations of broader political and economic forces such as, the rise and expansion of globalization. However, ecological problems cannot be explained by the process of globalization alone. The state plays a key role: it may intervene in economic activity to promote ecologically destructive activities. Ecological problems are very complex and therefore belie "quick fix" technical policy solutions. Thus, political ecologists generally agree that far-reaching changes to local, regional, and global political economic processes are needed. This does not come easily, as this requires the transformation of highly unequal power relationships upon which the present system is based.

There is no classic work defined as the foundation of political ecology but Eric Wolf (1972) did include political ecology in the title of an article. Although not dealing specifically with political ecology, Wolf did stress the need for more analysis of human-ecological interactions. The slow development of political ecology in the 1970s may have resulted from the opposition of the political left to the pessimism of the works of

Ehrlich (1968) and Garrett Hardin (1968). These scholars claimed that social and ecological catastrophes would result from population growth and high consumption levels and thus a 'Leviathan' was needed in order to enforce the "limits to growth" (Meadows et al. 1972). The political solutions prescribed allowed for the work of Ehrlich (1968) and Hardin (1968) to be called political ecology from time to time.

The cultural ecology approach of anthropology in the 1960s and 1970s influenced the evolution of political ecology. Cultural ecology sought to explain the link between cultural forms and ecological management practices in terms of adaptive behavior within a closed system (Bennett 1973; Orlove 1980; Ellen 1982). Cultural ecologists focused on energy modeling of closed systems but this led them to ignore the wider economic and political structures of which the biological communities they studied were but a small part. This led during the 1980s to many criticisms of cultural ecology. For example, Grossman (1984) and Hjort (1982) argued that there was a need for anthropological insights about human-ecological interaction in the context of an appreciation of the wider political economic structures that influence activity in a particular village. Thus, anthropological local research and political economic structural analysis became key concerns of political ecology.

To understand, as well as to be in a position to solve, the Atlantic Canada ecological crisis is to appreciate the ways in which the *status quo* is an outcome of political interests and struggles. Therefore, politics and ecology are everywhere and thoroughly interconnected. The Atlantic Canada fishery has recently suffered crises. The explanation of the crises has so far ignored or under-emphasized the economic and political factors that led to the ecological problems.

Central to the approach is that ecological problems cannot be understood in isolation from the political and economic contexts within which they are created. Political ecology begins with the premise that ecological change is not a neutral process amenable to technical management. Ecological crises have political sources, conditions, and ramifications that impinge on existing social and economic inequalities and political processes (Bryant 1992).

Political ecologists assume that an unequal distribution of ecological costs and benefits reinforces or reduces existing social and economic inequalities (Redclift 1987). This assumption reiterates the point that ecological and "development" concerns are inseparable and that any change in ecological conditions must affect the political and economic status quo and vice versa.

Another issue raised by political ecologists is the role of different actors in efforts to resolve ecological problems at local, regional, or global scales. The state tends to act in a "stewardship" role in society. States usually adopt a technical problem-solving approach. This entails the abstraction of ecological problems from the political and economic contexts in which they have been created or exacerbated and then states propose generic solutions based on standardized assessments of the problems. The avoidance of political and economic contexts may come from the state's close association with economic activities that have been major contributors to ecological problems. This demonstrates how scale, ecological problems, and actors are potentially interrelated.

The theory of cybernetics, which is the study of communication and control mechanisms in complex biological, electromechanical, and social systems, is applicable for the analysis of management practices. These systems govern themselves according to the same principles. All such systems operate via a recurrent feedback loop, detecting external influences and internal changes, making adjustments, and monitoring the results. To function effectively, therefore, all such systems must have effective communication among their constituent subsystems and efficient control mechanisms to regulate their operations (Rappaport 1974).

1.4 Outline of chapters

Chapter Two is a discussion of the influence and participation of different actors in the Atlantic Canada shellfishery drama. This includes the Federal government, the provincial governments, the business sector (processors and marketing), fishers, and the shellfish. The interactions between these different actors and technological changes in the industry explain a number of recent trends in the exploitation of shellfish resources and the de-emphasis of conservation concerns.

The Department of Fisheries and Oceans is a centralized administration responsible for fisheries for which jurisdiction is granted by the Fisheries Act to matters relating to coastal and inland fisheries, hydrology and marine science, fishing and recreational harbours, and policies and programs retaining to oceans. The Fisheries Act defines the Minister as having "absolute discretion" for decision-making.

The provincial governments are largely "policy takers" as the Federal government dictates how much can be harvested. The provinces are responsible for type, number, and location of processing plants which is predicated on the legal harvest available.

After WW II, the fishery began to industrialize. There are a number of plants along the coast and the number of plants increased from 1980 to 1988. There are two main processors, National Sea Products and Fishery Products International. These companies provided many jobs as three quarters of all communities in Atlantic Canada have a connection to the fishery. Fish buyers and marketers are under an umbrella of various trade associations.

There are over 100,000 people employed in the fisheries of Atlantic Canada. Labour markets are local for fishers who usually hire family and friends, as does the processing sector. Fishing skills are not easily transferable and inshore, nearshore, and mid shores vessels are individually owned. Corporate vessels fish the offshore. The size and location of shellfish is highly dispersed geographically. Because of the cod collapse and corporate restructuring, there has been an increase in industrial concentration. On larger vessels, employment is gained through formal recruitment channels based on skill and qualifications. Smaller vessels have informal recruitment channels. Employment in small processors consists of family and friends, as in larger processing plants, but in the latter, work is specialized and semi-skilled and routine. Their workers receive consistent employment and higher wages than their smaller counterparts. Unemployment insurance subsidizes the seasonal income from fisheries and there are few alternatives. In small and intermediate scale fisheries there is little division of labour and control, whereas in large-scale fisheries, there is a clear division of labour.

Chapter Three is an exploration of the setting where the actors play out their drama. The setting consists of the vast offshore area where wind and currents affect the shellfish populations and their movement. Marine ecosystems and coastal ecosystems are analyzed with the intention of demonstrating the differences in ecosystems throughout the area. Estuaries are discussed because of their importance as nursery areas for shellfish populations as well as their sensitivity to effects of fishing and pollution. The impacts of fishing and fishing gear on ecological processes and ecosystems are described. Pollution also has an important role to play in the health of shellfish populations. Greater quantities and types of chemicals are being dispersed in the coastal ecosystems where a vast majority of the population in Atlantic Canada lives and the synergistic of pollutants may cause the most damage.

Chapter Four is an analysis of the management of the Atlantic Canada shellfishery, and more specifically the lobster fishery, to understand current trends. My objective is to analyze different models and concepts that have been applied to either evaluate or direct the exploitation of shellfish and other resources in Atlantic Canada. This includes an analysis of models such as the "precautionary approach" or "precautionary principle" and the model of the "Tragedy of the Commons" (Hardin 1968:).

The "tragedy of the commons" model attempts to show how people are locked into a system in which they are destroying the resources on which their livelihood depends. For the fisheries, this leads to overexploitation and all its effects. Fishers, accordingly, cannot and will not limit their own exploitative efforts in the interest of conservation. Regulation by government is necessary.

I also analyze the assumptions on which these models are based. This includes an investigation of theories that incorporate the common property aspect of the fishery's resource management. I investigate the policies that have directed the Atlantic Canada shellfishery since 1977, which includes the intended objectives of the industry. The purpose of this chapter is to chart the course of the failure of conservation measures in practice, in a way that contributes to the theoretical discussions of sustainability. I focus on the links between conservation strategies of the Atlantic Canada shellfishery and the strategies for global resource conservation. In order to make clear the connection between the two, I analyze the relationship between regulation and exploitation, beginning with the open access nature of the fishery before 1977, then through the period of national management, and then with objectives to privatize shellfish stocks.

This will illuminate the relationship between property rights and management approaches. I investigate the assumptions that endorse the management of natural resources in a capitalist economy, which offers explanations of the failures of conservation.

Chapter Five is an evaluation of the implications and effects of various management strategies in Maine. I briefly describe the recent history of the fisheries of New England. The New England fishery has experienced stock declines in the recent past for species such as cod and haddock and it exports most of its catch. The management of the lobster fishery is organized differently than that of Atlantic Canada shellfishery. New England and Atlantic Canada have nevertheless equally suffered from ecological mismanagement of ocean resources. I shall explain why, in spite of the differences, these two separate fisheries have the same ill fate.

This chapter complements the previous chapter as the arguments put forth in this thesis benefit from the traditional anthropological technique of cross-cultural comparison. The U.S. management from 1976-1992 is investigated showing similar trends to that of Canada's groundfishery. Specifically, the lobster industry of Maine is examined as the management of the resource in a "private property" regime. The Maine lobster fishery provides an excellent example for comparison with the Atlantic Canadian shellfishery. New England fisheries have experienced ecological crises of commercial species from overfishing since World War II. The Maine lobster fishery can be compared to the Atlantic Canadian shellfishery's approaches to the management of marine resources in order to avoid ecological destruction while maintaining a livelihood for thousands of fishers. An understanding of the results of different approaches to resource management may provide solutions to the sustainability of Canada's fishery as well as the United States shellfishery.

Chapter Six, as the concluding section of this thesis, ties together what has been outlined and argued in previous chapters and offers some suggestions for the implications of this research on shellfishery management.

Chapter Two: Actors in the Shellfishery Drama

2.1 Introduction

To understand the workings of a politicized environment is to appreciate the complex ways in which actors interact over ecological questions. Central to research in political ecology is the suggestion that power is at the heart of this politicized environment and that it is the unequal power relations between actors that is paramount (Doyon 2002:84). The aim in this chapter will be to explore the role of selected actors in ecological management and conflict so as to evaluate the distinctive political contribution of each type of actor to human-ecological interaction in the Atlantic Canada shellfishery. The actors discussed will be the state (both federal and provincial), business (fish processors and marketing), fishers and fish workers, and lobster populations of Atlantic Canada.

To appreciate the ways in which ecological change is politicized in the Atlantic region is to understand how the state has sought to manage the peoples and ecosystems within its jurisdiction. The section explores the role of the state in ecological conflict and management in the Atlantic Canada region. The power held by the state derives largely from this actor's claim to act in the national interest. In theory, the need for an institution such as the state is well established, but there are practical dilemmas in terms of integrating economic development and ecological conservation. The state's role as both developer and protector of natural resources may produce possible contradictions both within states and between states. A more specific review and analysis of state or federal govemment management of the fisheries will follow in Chapter Four.

2.2 The State: Department of Fisheries and Oceans

In Canada, managing the fisheries is a federal responsibility. Management decisions and policies are made within relatively centralized administration structures in which bio-economic perspectives shape the policy.

At present, formal authority for managing the fisheries is divided between the federal government and its provincial counterparts, through jurisdiction and resources are heavily concentrated at the federal level (Parsons 1993). The power and functions of the federal Minister of Fisheries originate in the British North America Act (the Constitution Act of 1867) and they were reaffirmed in the subsequent legal framework of management of the fisheries. However, this has been the focus of jurisdictional conflicts and disagreements between federal and provincial governments since at least the late 1800s.

The Constitution Act of 1867 gave the federal government of Canada more or less exclusive authority for the management of Canadian fisheries, a prerogative confirmed in the first Dominion Fisheries Act of 1868 when the Cabinet was given authority to manage both seacoast and inland fisheries (Parsons 1993:19). Licensing and leasing fishing rights were the 'tools of the trade' at that time, but they were mainly used for statistical purposes (Parsons 1993: 19). Even if the tasks and measures of management were limited in their implementation, legislation put the authority to manage firmly in the hands of the federal government.

This authority and jurisdiction of the federal government has been repeatedly challenged in the courts. Put briefly (see Parsons 1993), court judgments have confirmed the authority of the federal government to manage the fisheries with reference to social and economic as well as conservation objectives.

For nearly a decade as Minister of Fisheries (1974-1982), Romeo Leblanc was touted as the fisher's friend while he was actually overseeing the demise of certain fisheries. Following his departure, there has been a rapid succession of federal fisheries ministers. Adding to the confusion is the question of jurisdiction, encapsulated in the expression: "Live fish are federal, dead ones provincial". For the most part, the federal government controls the harvesting of fish while the provincial governments license processing. There are some exceptions to this distribution of powers. Until recently, the province of Quebec had its own jurisdiction over harvesting. The federal government owns Fisheries products International and the Canadian Saltfish Corporation which encompasses virtually all of Newfoundland's processing and marketing capacity. This should not be surprising as the provinces only appear to control processing through their licensing capacity. In fact, the federal level has control through trade export and standards. The question of the jurisdiction over labour legislation in the fisheries is more complicated. The federal government has pursued Anti-Combines and Restraint of Trade actions not against the fish companies, but against the unions.

The Fisheries Act provides extensive powers to the Minister of Fisheries and Oceans. For the fisheries within the jurisdiction of the federal government, the Minister has the power to decide who fishes, how much fish can be harvested, the fishing methods to be used, and the timing of the fishing season. In 1997, the Oceans Act was enacted which widens the scope of the DFO responsibilities for fisheries management within the broader context of other ocean activities.

It has been suggested that the level of ministerial discretion regarding the Canadian fisheries "would surprise fishermen and managers from other nations" (Lamson and Hanson 1984:4). This, by and large, reflects the central position of the

Department of Fisheries and Oceans (DFO) in matters of management policy. The management functions of DFO include all matters within the jurisdiction of the Parliament of Canada that have not, by law, been assigned to other departments, boards, or agencies. The Minister's jurisdiction is furthermore derived from the Fisheries Act and includes matters relating to coastal and inland fisheries, hydrology and marine sciences, fishing and recreational harbours, and the coordination of policies and programs pertaining to oceans. The federal government is by and large the most powerful public sector player in the fisheries. Provincial departments are, by comparison, policy 'takers', not policy makers (Pross and McCorquodale 1987:80).

2.2.1 Provincial Responsibilities

The Newfoundland and Scotia-Fundy regions in Atlantic Canada account for a large proportion of Canada's financial and human resources devoted to fisheries management. Fisheries account for only a minor part of Canada's Gross National Product (GNP) and total employment, but the fishing industry is a major employer in both Newfoundland and the Scotia-Fundy region.

The provincial governments are mainly responsible for the type, number, and location of processing plants. Federal-provincial and inter-provincial issues are dealt with by a special committee at the deputy minister level and through the Atlantic Council of Fisheries Ministers (Kirby 1982:340). The provincial ministries, however, lack both the jurisdictional authority and the spending power necessary to make a decisive impact on policy. However, they do have a recognized influence on fisheries policy and can, on occasion, challenge or reinforce federal policies (Pross and McCorquodale 1987:65-67). Provincial responsibilities are limited to the land-based aspects of the fishery, development and regulation of aquaculture, industrial financing, as well as development and registration of processing facilities. Each province will be discussed relating to their jurisdiction in ocean related activities.

Fisheries in Prince Edward Island (PEI) are regulated by the Department of Fisheries and Environment. The provincial government is responsible for representing the interests of the fishing industry and the province in consultations in fisheries management, assisting in the advancement of marine fishery harvest opportunities, assisting the processing sector in business and marketing opportunities, licensing with fishing industry on all fisheries matters, and enforcing the PEI Fisheries Act and the Fish Inspection Act.

The PEI Fisheries Act authorizes the licensing of buyers and processors of fish and fish products in the province. The Fish Inspection Act authorizes the province to implement regulations to ensure that seafood is processed and marketed under sanitary conditions and sets compulsory standards for facilities used in these activities.

In New Brunswick (NB), the Department of Fisheries and Aquaculture represents fisheries issues at the provincial level. The department's principal responsibilities are to assist fishers by way of direct loans to purchase and operate fishing vessels and equipment, provide safety training and introduction of new fishing methods, management advice to DFO and industry, providing inspection services for the regulation of the fish processing industry, and seeking expanded marketing opportunities.

The NB Fisheries Act empowers the department to issue licenses, determine the species for which the license is valid, and inspect processing facilities. The NB Fish Inspection Act allows for the inspection of processing plants and products and, where applicable, enforcement of penalties. The NB Fisheries Development Act provides financial assistance to aid and encourage the establishment of development of fisheries in the province.

Provincial responsibilities of fisheries in Nova Scotia (NS) are the responsibility of the Department of Fisheries and Aquaculture. The core functions of the department are representing the NS fishing industry at all levels of fisheries management, providing marketing information, developing new species fisheries, administering licenses and leases, administering loans, and providing training programs.

The purpose of the NS Fisheries Organizations Support Act is to strengthen fisheries organizations and provide a procedure to enable accredited fisheries organizations to collect mandatory dues from license holders. The Fisheries and Coastal Resources Act in Nova Scotia authorizes programs and projects to sustain and improve the fishing industry. The department's responsibilities also include servicing, developing, and optimizing the harvesting and processing segments of the fishing industry, as well as increasing the productivity and competitiveness of the processing sector.

At the provincial level, fisheries in Newfoundland are administered by the Department of Fisheries and Aquaculture. The department provides technical support, marketing and promotion services, quality assurance in processing, management of infrastructure support, and management of development initiatives.

2.3 Business: Fish Processors and Marketing

In this section I seek to explore the contribution of business in Atlantic Canada to ecological change and to conflict with respect to the fisheries. The growing power and influence of business today is linked to the development of a global capitalist system.

The role of business in the Atlantic Shellfishery will be examined to determine if that system has been promoting economic practices that contribute to ecological destruction and social inequality.

After World War II, the primary impetus to industrialization of the Atlantic fishery came from processors who wished to regularize, rationalize, and maximize their processing capacity. Inshore fisheries can operate only a few months of the year, while offshore fisheries can operate virtually year-round, thus forming a continuous source of product. As the large processors concentrated on the fresh/frozen fish market and undertook to produce a continuous supply, they were required to enlarge their offshore source of product. Initially, this increased demand was met by wooden side trawls, some of them owned by the captain, crew, and shareholders. The costs of these ships, including their expensive maintenance and financing, drew more and more of them into company ownership. Company ownership became the dominant form after steel stem trawlers were introduced to replace the smaller and less stable wooden side trawlers. These ships were worked on by trawler crews. When the fishery changed from salt to fresh fish, payments to crews were made before the next voyage instead of after the fish were eventually sold.

Fish and food processing plants play an important role in the economy of the four Atlantic provinces. They provide jobs in large and small centers throughout the region and are the mainstays of many local economies. Regional fish and food processing plants generated $4.65 billion worth or products in 1987 (Eaton et al. 1994:176).

Fish processing plants numbering in the hundreds are located all along the Atlantic coast of Canada. The number of these plants increased substantially after 1977 in response to a dramatic growth on offshore harvesting capacity stimulated by Canada's designation of a 200-mile territorial limit. In 1988, 329 plants employed 23,478 people (Eaton et al. 1994:176-177). This is an increase over the 258 plants employing 17,736 people in1980 (Eaton et al. 1994:176-177). The provinces license fish and shellfish processing plants. However, in response to the growth in harvesting capacity, both Newfoundland and Nova Scotia put moratoriums on the building of new processing plants. In Nova Scotia, applications for the construction of new plants require a case-by-case review. Overcapacity remains in the processing sector of the Atlantic fishery.

Sales for the two main processors on the Atlantic coast in 1981 were $314 million for National Sea Products and $175 million for Fishery Products (Wood 1985:85-86). On the east coast, National Sea Products is the largest processor, emerging out of a complex restructuring and from the takeover of H. B. Nickerson & Sons. In 1980, National Sea Products had a fleet of 50 trawlers that supplied over half of its raw material and twenty-two plants (twenty in Atlantic Canada and two in the United States), of which, twelve operated year-round. Fisheries Products International had sixty-one trawlers and thirty processing plants in Newfoundland as well as twelve scallop vessels in Nova Scotia and two secondary processing plants in the United States. It employed over 17, 000 plant workers and fishers.

Fish buyers and marketers are well organized under the umbrella of various trade associations, including the Fisheries Council of Canada which has a nation-wide membership. Provincial associations are more or less significant factors depending upon the strength of the provincial fisher's organizations, since these associations provide both marketing assistance for companies and industry-wide bargaining when fishers are unionized.

The New Brunswick Fish Packers Association, which represents about 55 companies with about 85 percent of the provincial production, does not negotiate prices or labour agreements. The association dates back to 1918 as part of the Canadian

Manufacturers Association and was called the Maritime Canned Fish Section until 1946 when the New Brunswick and Nova Scotia sections separated. The Seafood Producers Association of Nova Scotia represents 22 companies and about 85 percent of the production in the province. It does not have a part in 'industrial relations', although it does become involved in setting herring processing in southwest Nova Scotia. The Fisheries Association of Newfoundland and Labrador negotiates with a union, the Newfoundland Fisherman, Food and Allied Workers' Union, for labour rates in processing, prices for inshore fish, and a combination of per diem and fish processing for the trawler crew.

No matter how powerful processors are vis-à-vis fishers, they themselves are in a chain of dependence. Connors Brothers Limited, on the Atlantic Coast, is a subsidiary of George Weston Limited, a giant Canadian food conglomerate. Virtually all processors on the Atlantic coast have become wards of the banks, governments (through loan guarantees), and/or highly concentrated export markets. Approximately 95% of landed catch is exported and 75% of that export is sent to the United States (DFO 1999b:10). Just as small processors depend on larger ones to market their fish, the large processors are dependent on ties to financial and marketing arrangements.

Processors are squeezed by the market on one hand and the costs of production on the other. According to Gus Etchegary, the head of Fisheries Products International, "In the last three years, doing the same volume of fish, our energy costs went from $3.5 million to $11 million. The cost of interest jumped from $7 million to $18 million" (Anonymous C 1983:F1). The trawler fleet had been burdened by high interest rates because it is so capital intensive. Among these ships, "$1.7 of capital is required to produce $1 in output in comparison with $0.7 in the inshore fleet" (Mitchell 1980:6). After the 200-mile limit was announced in 1977, the banks 'opened their vaults' to the fisheries, thus intensifying the boom period and making inevitable the subsequent bust.

Taking a somewhat wider view of the Atlantic processing industry, the bulk of the production of fish is located in Newfoundland (42 percent), although Nova Scotia has the largest share of the value of fish (47 percent) while New Brunswick has about 10 percent of the production and value, and Quebec has about 8 percent. Prince Edward Island has only 3 percent of volume but 6 percent of the value (Kirby Report 1982:10). Since 1946, lobster has surpassed cod and all other species in landed value.

The importance of fishing is indicated in the statement of the Economic Council of Canada where "during the 1970s, 75 percent of all the communities in the Atlantic Provinces had some connection with the fishery, and 20 percent of them had no other local industry" (Munro 1981:89). The Kirby Commission inquiry into the Atlantic fishery found that "about 700 processing facilities are located in 440 fishing communities throughout the region. The jobs provided by these plants employ about 21 percent of the labor force in those communities" (Kirby 1982:12). Licensed fishers in Atlantic Canada increased from 36,500 in 1974 to 53,500 in 1981. The number of fishers who actually used their licenses in 1981, however, numbered only 23,400 full-time and 17,455 part-time (Munro 1981:31-32). It is estimated that the part-timers are actually equivalent to about 4.360 full-timers and therefore "a total of 27,794 active fishers whose primary source of earning is fishing activity" work in Atlantic Canada (Munro 1981:48).

Shore workers can be divided into tender workers who collect fish either at sea or on the docks, and plant workers who process the fish. Plant workers can either be full- or part-time, depending upon whether they work in a year-round plant supplied by offshore fisheries or in a seasonal plant supplied by seasonal fisheries. Within the plants there tends to be a clear division of labour between men and women. Another important division is whether or not the plants are union organized (Parsons 1993:433).

Fish and shellfish processing plants have a discernable impact on Atlantic Canadian ecosystems. A detailed account of their impacts is discussed in Chapter Three.

2.4 Fishers and Fish Workers.

2.4.1 Employment

The fishery has an important role in Atlantic Canada's economy. For example, the industry provides for approximately 65,000 permanent and seasonal jobs for fishers (Table 2.1) and 33,000 jobs in the processing sector. Total production was valued at $2.2 billion in 1988. The total catch for all species was about 1.3 million metric tonnes. Groundfish accounted for 60 percent of landings and 40 percent of landed value. Shellfish, including lobster, scallops, crab, and shrimp were the most valuable species as, in 1988, landings of 200,000 tonnes were worth $533 million.

Table 2.1

Fishery Profiles by Province - 1983 and 1988

1983	NS	NB	PEI	QUE	NFLD	Atlantic
No. of registered fishermen	12,543	6,567	3,182	6,676	28,074	57,024
No. of registered vessels	6,266	2,820	1,488	3,681	16,520	30,775
No. of plant workers (PY)	9,700	6,481	1,356	1,843	10,620	30,000
Landings (000t)	426	108	40	78	456	1,108
Landed value ($ million)	277	79	43	56	167	622
Production value ($ million)	499	315	86	119	456	1,475
1988						
No. of registered fishermen	16,321	7,903	4,929	6,808	29,830	65,791
No. of registered vessels	6,288	2,735	1,471	2,847	17,149	30,490
No. of plant workers (PY)	10,900	7,080	1,440	2,340	11,160	32,920
Landings (000t)	489	150	40	88	551	1,317
Landed value ($ million)	436	116	65	99	300	1,016
Production value ($ million)	801	380	90	210	710	2,191

Source: Eaton et al. 1994a: Ch. 4-102.

Dependency on the fishery varies by province, but one quarter of all Atlantic Canadians live in small fishing communities. Nova Scotia fishers, on average, earn the highest annual incomes of all fishers in the region, grossing over $28,000 per fisher. Newfoundland fishers, whose seasons are shorter and whose access to high-value species is more restricted, averaged less than $11,000 in 1988. Income for plant workers also varies, depending upon location, species processed, and type of production. In 1988, earnings for Nova Scotia plant workers averaged between $12,000 and $13,000 (DFO 1989).

The fishing industry is central to the economy of Atlantic Canada, where it accounts for about 15 percent of GDP in the major fishing provinces of Nova Scotia and Newfoundland (DFO 1991a). Processing and harvesting accounted for almost 16 percent of Newfoundland employment in 1990 and over 6 percent of employment in Nova Scotia (Cashin 1993). In that year, there were almost 16,000 full and part-time registered fishers in Nova Scotia and almost 29, 000 in Newfoundland (Cashin 1993). In the processing industry in 1988, 7000 persons were employed in Nova Scotia and over 11,000 persons were employed in Newfoundland. The industry is highly seasonal so that approximately half of the fishers and a substantial fraction of the processing labour force in both provinces work part-time.

The bulk of the Canadian North Atlantic fishing fleet is located in Newfoundland (55 percent) and Nova Scotia (21 percent), with smaller concentrations of vessels in Quebec (10 percent) and New Brunswick (10 percent). Newfoundland and Nova Scotia dominate the industry, accounting for 78 percent of all fish landings, 77 percent of the value of the catch, 75 percent of processing employment, 70 percent of all registered fishers, and 58 percent of all registered fish plants (DFO 1991a).

There are some large offshore vessel ports in Atlantic Canada. Lunenberg, Nova Scotia, a town of about 4,000 people, located fifty miles from Halifax, is the largest of these ports. It is home port to about 900 fishers and is the 'flagship' port for National Sea Products which has the largest processing plant in the region (Raymond 1985). Lunenberg also has a marine sales and repair sector that services much of southwest Nova Scotia (Pross and Heber 1982:3). Altogether, fishing and processing in Lunenberg County provides about 1,700 full-time equivalent jobs and accounts for about 10 percent of the county's labour force (Hache 1989:21). Lunenberg has achieved a certain degree of economic diversity, with manufacturing accounting for about 40 percent of employment and the business and personal services sector providing another 25 percent (Raymond 1985:10).

Atlantic Canada is also dotted with many small and medium sized ports, almost all of which are fisheries dependent. For example, of the 364 ports in Nova Scotia, all but six had populations of 2,500 or less, and over 80 percent had populations under 500 in 1976 (Kirby 1982:53). A typical medium-sized port might have a population of about 650, with half or more of the labour force employed in highly seasonal fishing and processing (Raymond 1985:13).

Labour markets in the industry are essentially local. Crew members for independently owned vessels in Atlantic Canada are recruited from family and friends, as is much of the labour supply for Canada's offshore sector (Jorion 1982:514; Ilcan 1985:8). Processing also draws primarily from local labour markets, expect for the largest processors which have the highest wages and thus draw labour from a wider area.

Few fishing skills are transferable to other occupations and, with the exception of some part-year crew on inshore vessels; fishers tend to have little work experience outside the fishing industry. Those fishers with outside work experience usually have been employed in other primary-product industries, such as forestry or farming, or sometimes in tourism-related industries (Doeringer, Moss, and Terkla 1986a, 1986b).

Offshore fishers tend to work year-round and they are relatively better paid than inshore fishers, who work fewer weeks a year. Distinctions between inshore and offshore earnings are particularly pronounced in Atlantic Canada, where surveys show that earning of offshore crews are more than twice those of inshore fishers (Thiessen and Davis 1988).

Processing employment is semi-skilled and fluctuates with the level of landings. After the 200-mile limit was established, the increase in landings drove processing employment up by 64 percent in Nova Scotia and 68 percent in Newfoundland between 1977 and 1980 (DFO 1991a).

2.4.2 *Inshore, Midshore, and Offshore Fleets*

The distinction between the inshore and the offshore fleet is important in Atlantic Canada because it defines a series of differences between the fleets in terms of ownership, regulatory practices, and the types of product markets served. The traditional definition of 'inshore' vessels for management purposes in Canada is "vessels less than or equal to 100 feet in length (or approximately 170 tons)" (Parsons 1993:123). The inshore fleet, according to this definition, comprised 98 percent of all Canadian vessels in 1986.

Recently, Canadian managers have adopted a definition of 'inshore' that corresponds more closely to the United States definition, classifying vessels less than 35 feet in length as 'inshore, vessels 35-65 feet long as 'nearshore', and vessels 65-100 feet as middle distance or 'midshore' (Kirby 1982; Hache 1989).

Almost all inshore, nearshore and midshore vessels are individually owned and operated. Most of the offshore fishing vessels greater than 150 tonnes are owned by the two major Canadian processing firms. Corporate ownership allows the location and the timing of the fleet's fishing activity to be coordinated among vessels, rather than being left to the decision of the individual captains. This coordination has enabled the processors to distribute vessel landings among plants along the cost throughout the year in response to prices, catch availability, and considerations of efficient capacity utilization.

The size and location of Canadian shellfish stocks make the industry highly dispersed geographically. Historically, large processing centers have been spread along the coast, from Quebec and New Brunswick through western and southwest Nova Scotia and around much of Newfoundland. The restructuring of the corporate sector in the 1980s, followed by the cod stock collapse, has led to many plant closings and increased geographic concentration of plants.

2.4.3 Industrial Concentration

The industrial concentration of Canadian fish processing has been increasing in recent years. In 1968, the six largest companies accounted for just over 50 percent of total fish sales, including sale for fish for some off the smaller processing companies (Kirby 1982). By 1980, the top four firms accounted for 63 percent of the fish processed and almost 70 percent of the fish marketed as smaller companies came to rely on the larger ones to market their products.

Concentration was further increased by government action in the early 1980s. The growth in landings and capacity in the late 1970s, which had followed the establishment of the 200-mile limit, led to rapid expansion. Large processing firms relied upon debt financing to expand much of their processing capacity. Facing financial collapse, the processing companies turned to the Canadian government for assistance. Fifteen million dollars were granted to the five largest companies on the condition that they merge into two corporations. An additional US$142 million in federal funds was used to purchase a 20 percent interest in the Nova Scotia company National Sea Products and a 60 percent interest in Fisheries Products International in Newfoundland. Similar equity purchases were made by the provincial governments.

The sharp decline in Canadian landings of fish again began to put pressure on the large processing companies. Both have downsized their operations, closing all but one or two plants, and operating levels in the remaining plants have been substantially reduced. In 1989, National Sea Products reported a loss of $32.4 million and Fishery

Products International reported a loss of $22.2 million (Parsons 1993:378).

2.4.4 The Harvesting Labour Market

Workplace human resource practices in the harvesting sector vary widely according to the size and ownership of vessels. Large, corporate-owned vessels to adopt relatively formal practices, whereas family owned and smaller vessels have informal employment systems that are often governed by kinship considerations.

Larger vessels tend to rely on formal recruitment channels, and crews are often selected on the basis of skill and formal qualifications rather than kinship (Andersen 1972:182). Even on large vessels, family recruitment networks can play a part of the staffing process. On smaller vessels, families are often the major source of labour. Crews are recruited through kinship networks, augmented by friends and others from the community (Jorion 1982; Doeringer, Moss and Terkla 1986b).

Differences in size and gear necessarily affect the specific content of work, but fishers on all types of vessels work in teams with relatively little hierarchy or formalized work rules (Binkley 1990; Clement 1984). Captains pilot the vessels and supervise the crew. The crew ranges from one to four members on small vessels to twelve of more members on large offshore vessels. Crew members deploy gear, haul, sort, and clean the catch as well as store the catch on ice. These functions remain basic to the industry under all technologies. Crew members learn their skills on the job from friends and relatives or other experienced fishers. Crewing on a father's vessel remains the primary training ground for most fishers (Thiessen and Davis 1988:605).

An unusual feature of the harvesting labour market is the 'lay' system, under which vessel revenue is apportioned among capital, operating costs, and payments to labour. Under the lay or share system, labour earnings are calculated as a percentage of the value of the catch after a vessel's operating costs are deducted and shares for the captain and capital costs for the vessel are provided (Sutinen 1979:153). Earnings, therefore, reflect the productivity of the vessel and its crew, the efficiency of the vessel in terms of its operating costs and crew size, and the prices of the species harvested.

Lay systems differ somewhat by vessel and port. On small family vessels, shares may be calculated informally, while the deductions for operating expenses and the apportioning of revenue between capital and labour are more formally defined on larger vessels (Kirby 1982; Doeringer, Moss and Terkla 1986a).

2.4.5 Unions

Prior to the mid 1970s, fishers in Canada were classified as 'co-adventurers' rather than as employees and they had no legal bargaining rights (MacDonald 1980:18). Although unions were voluntarily recognized from time to time by the large employers such as National Sea Products and Fisheries Products International, systematic recognition by these companies did not occur until after a major strike in Newfoundland in the mid 1970s (Clement 1984:26; Steinberg 1974:645).

Bargaining has raised compensation in Canada, at least during periods when unions were strong (MacDonald 1980:19) and it has affected various other management prerogatives. Bargaining in Canada has also altered the structure of compensation by introducing per diem compensation guarantees, bonuses, quality premiums, and negotiations over the operation of the lay system (Binkley 1990:403). In the case of the lay system, Canadian collective agreements specify both the share formula and a detailed structure of accounting 'prices to be used each year for valuing catch according to species, size, and quality.

2.4.6 *Processing Plant Employment*

Small processors often recruit their labour through kinship and friendship networks. In Atlantic Canada friends and relatives of the owner are the usual sources of labour recruitment (Ilcan 1985:7). Large processors also recruit labour through community and kinship networks, although those that are part of multi-plant corporations may also allow transfers among plants and may resort to formal recruiting methods outside the immediate community.

Large processors divide work into relatively specialized and semi-skilled jobs and work is largely routine. Jobs are less specialized in small and medium sized plants and workers are more broadly skilled because they are expected to perform different kinds of work (Apostle and Barrett 1987:87; Giasson 1992:63). In both types of plants, skill levels are much like those in other kinds of light manufacturing and skill needs are met easily through on-the-job training.

Hourly wages rather than piece-rates are the dominant form of compensation, although incentive pay is also used in fish-cutting operations and in the smallest processing plants (Apostle and Barrett 1987:88). Large processing plants pay higher wages and are more likely to operate year-round than small plants because they draw on catch from they year-round offshore fleet.

These differences in wages and weeks worked translate into annual earnings differentials. In Nova Scotia, annual earnings in 1989 in firms with fewer than 100 employees are about 40 percent of those in larger firms with 250 or more employees. In Newfoundland, employees in smaller firms earn 32 percent of what employees in larger firms earn (Cashin 1993:77).

Less than 10 percent of the processing plants in Atlantic Canada are unionized, but because they tend to be larger processors, a much higher fraction of employment and production is affected by collective bargaining. Estimates for Nova Scotia suggest than over 40 percent of the processing workforce is covered by collective bargaining agreements (Apostle and Jentoft 1991:107).

Wage rates and fringe benefits in unionized plants in Atlantic Canada are the highest in the industry, especially for women, and they set the wage pattern for the larger non-union plants (Apostle and Barrett 1992:23).

Viewed from the perspective of the workers, most large processing plants are industrial factories. There are still many small, seasonal plants in the Atlantic region employing few workers who are often unrecognized. In general, the industry has been subject to centralization, which has meant the closing of smaller plants and the shifting of processing to larger, more populous locales.

An understanding of processing plant workers is necessary to an understanding of the fishing industry. The Kirby Commission reported that "in the Atlantic region as a whole, processing plants create as many jobs (and almost as much income) as fishing itself" (Kirby 1982:67). Moreover, there is at least one fish plant worker for every fisher household, especially in New Brunswick and Newfoundland. The erosion of their jobs has been frightening for shore workers because, "the degree of upgrading of Atlantic coast fish products has been declining since 1975" (Kirby 1982:97). In other words, the secondary processing of fish is being done elsewhere. Ninety-five percent of Canadian fish products are exported and the processing of frozen blocks of fish and fillets takes place outside of Canada to avoid trade barriers.

2.4.7 *Unemployment Insurance*

Surveys of fishers routinely report a strong commitment to fishing as 'a way of life', and inshore fishers tend to live in small, rural ports where there are few employment alternatives and where attachment to occupation and community are thought to be highest (Apostle, Kasdan and Hanson 1985:261; Pollnac and Poggie 1988:893). Unemployment insurance payments contribute further to this attachment by subsidizing seasonal incomes from fishing and processing. Seasonality is even greater in Atlantic Canada where studies indicate that the average full-time fisher experiences about twenty weeks of unemployment per year and the average part-time fisher experiences about twenty six weeks of unemployment per year.

The regular Canadian unemployment insurance program applies to 'wage earners' who are largely fishers employed in the offshore fleet and processing workers (Kirby 1982:59; Cashin 1993:83). There is also a special unemployment insurance program for self-employed inshore and nearshore fishers which covers the bulk of the fisheries workforce (Employment and Immigration Canada 1991:6). The Kirby Task Force reported that unemployment insurance constituted 16 percent of the pre-tax income of full-time fishers and about 13 percent for part-time fishers (Kirby 1982:59).

Unemployment insurance is very important to the survival of Atlantic coast villages and the fisher's household. According to a detailed investigation carried out by the Kirby Commission, "[o]n average, full-time fishers received $2466 in UI benefits in 1981, while part-time fishers received an average of $1483" (Kirby 1982:61). Although unemployment insurance payments constituted 32 percent of the average fisher's income in northwestern Newfoundland, in western Nova Scotia it made up only 6 percent (Kirby 1982:61). Plant managers complain, however, that fishers concentrate their catch and delivery in short periods in order to maximize the payments they receive, thus, at times causing gluts and at other times, causing gaps when fishers could be catching fish, albeit with marginal returns. Processors want the catch to be spread over as long a season as possible. The costs of this insurance program were high as "benefits totaling $135 million were paid to workers in the east coast fishery in 1980 - $72 million under the 25-year-old fisherman's unemployment insurance program. And $63 million in regular unemployment benefits to fishplant workers" (Anonymous-A 1983:9). Changes in the insurance regulations following the Kirby Report addressed this problem by calculating benefits on the basis of the best ten weeks, rather than the last fifteen weeks. However, the recommendation to dismantle the program and replace with an income stabilization plan was not accepted. Unemployment benefits are still an important means of supplementing the incomes of these workers and, in doing so, ensure the reproduction of the fisheries labour, even with depressed prices.

2.4.8 Small, Intermediate, and Large Scale Fisheries

Production units (boats) in Atlantic Canadian fisheries can be divided into three distinct categories, in which each has different divisions of labour. Small-scale producers had a low division of labour and control over their immediate labour processes. Intermediate-scale producers have a clear division between the skipper and the crew, but within the crew there is little division of labour, and tasks are often rotated among the crew. Everyone is involved in all aspects of production and has equal shares of labour and responsibility (Cashin 1993:3). Large-scale producers have a clear division of labour, demarcating the captain, mate, engineer, cook, trawler crew, and deck hands. Whereas supervision is implicit in intermediate-scale operations, it is explicit in large-scale operations (Cashin 1993:4-5).

Small-scale fishers, usually one to three hands, are those working alone or in de facto partnerships and occasionally employ a helper (Cashin 1993:3). On the east coast, these would typically be inshore fishers who trap lobster or crab and fish on a daily basis from their home ports. In the Atlantic region, these would include lobster fishers who tend traps on their own or with a partner/helper close to shore. They are under strict governmental controls regarding seasonality and the number of allowable traps. Few of them fish only for lobster. They combine lobster fishing with other fisheries such as gillnetting for herring or small-scale scallop dragging. Off-season responsibilities include boat and trap maintenance. Lobster fishers usually fish inshore, but there are a few offshore lobster fishers sailing out of southwestern Nova Scotia in highly specialized boats.

The most common fishers in the intermediate category are those using shrimp boats, small scallopers, crab boats or draggers. Fishers may go out daily from a home port, such as in southwestern Nova Scotia and the Gulf, or venture out for over a week, such as in Newfoundland. This mobile fleet typically has a crew of five and has sleeping facilities under the bow as well as an enclosed wheelhouse with electronic equipment (Cashin 1993:3). The aft workdeck is adapted for a particular fishery, but usually contains hydraulic equipment and a large hold. Unlike most small-scale boats, which are fisher-owned, these tend to be both company and skipper owned. Often the processor has ownership shares in individual boats.

The boats in the large-scale category best known on the east coast are trawlers and scallop draggers and they are part of the offshore fleet. Virtually all these boats are company-owned and can fish year-round. These boats average 45 metres in length and have a crew of approximately eighteen members. Trips can last from ten to twenty days.

A stern trawler costs about $7 million to construct. Although there are fewer than 150 trawler-sized vessels on the Atlantic coast, they land almost half of the volume of fish.

2.4.9 Fishing Gear

Fishing gear has evolved to fit resource characteristics and local conditions. Sedentary species such as lobster and crab are caught with traps or pots set out on the ocean floor. Traps and weirs are designed to catch schooling fish that follow prey species that migrate to shallow inshore waters. Other techniques such as gillnetting, purse seining, longlining, and trawling are used in deeper waters.

Fishing pressure in the northwest Atlantic is substantial. Recent estimates suggest that the Canadian fleet of offshore vessels (vessels greater than 65 feet LOA) that includes approximately 60 offshore scallop draggers and 100 groundfish trawlers, annually sweeps a seabed area of about 30,000 km^{2}. This represents a decline from 1989 figures where there were 300 scallop draggers and 700 groundfish trawlers (Messiah et al. 1992:31). The DFO is researching the possible impacts of mobile fishing gear such as otter trawlers, scallop rakes, and clam dredges on benthic habitat (Bedford Institute 1992:12). Fisheries managers are attempting to use these results to develop mobile fishing gear regulations that will minimize the impact of gear on the habitat of key resource species (Bedford Institute 1992:12). The ecological impacts of fishing gear are discussed extensively in Chapter Three.

2.5 Lobster Background and Life Cycle

Not only is an understanding of the human actors (governments, industry, and fishers) necessary to an analysis of the lobster fishery, so too is an understanding of the lobsters themselves. This section provides a brief overview of the biological characteristics of lobster populations.

The lobster grows following the molt of its hard outer shell. Male lobsters usually mate within hours of the female molt. The relative size of the sexes may be important for breeding success as small males tend not to mate with larger females. Sperm from the male is attached to the female and carried until the female extrudes the eggs the following summer. The eggs remain on the underside of the female lobster for 10 to 12 months (Bliss 1982:155).

Eggs hatch into planktonic, free-swimming larvae between July and October. Development time in the three larval phases to juvenile stage decreases with increasing temperature. Late summer larvae may not have sufficient time to develop into post-larvae before temperature declines.

Lobsters reach minimum legal size of 81 mm carapace length (CL) in Canadian waters at age 6 to 9 years (DFO 1998a:1), though time-to-recruitment may be longer in colder waters in the Bay of Fundy. Most female lobsters reach minimum legal catch size prior to sexual maturity.

2.5.1 Distribution and Ecology

Lobsters occur in commercial numbers along much of Canada's coast south of Labrador at depths generally less than 35 metres. Yields vary greatly from area to area. Lobsters occur on a variety of combined bottom types from mud and silt through sand and rock to bedrock and rock.

Lobsters found along the outer Scotian Shelf and upper slope and in the Gulf of

Maine deep basins are commercially fished by the offshore fleet. Offshore lobsters are found in canyon wall burrows, and more generally in shallow depressions, on open sand or gravel bottom (Bliss 1982:51-53).

The American lobster, *Homarus americanus*, is distributed in the Northwest Atlantic from Labrador to Cape Hatteras, from coastal regions out to depths of 700 metres. Lobsters are locally abundant in coastal regions within the Gulf of Maine, and off southern New England. The Gulf of Maine is a semi-enclosed coastal sea bounded by New England on the west and north, by New Brunswick and Nova Scotia on the east and north, and by Georges Bank at the shelf break. Inshore, lobsters are most abundant from Maine through New Jersey with abundance declining from northern to southern areas. Coastal lobsters are concentrated in rocky areas where shelter is readily available, although occasional high densities occur in mud substrates suitable for burrowing. Coastal lobsters undertake movement of up to 25 km whereas offshore lobsters can migrate up to 300 km (Idoine 2002; Lincoln 1998:31). Lobsters are solitary and territorial, living in a variety of habitats as long as there is a burrow or crevice in which they can take cover. Females hatch their eggs from mid-May to mid-June when water temperatures rise to about 60 degrees Fahrenheit.

Offshore populations are most abundant in the vicinity of submarine canyons along the continental shelf edge. The deep water associated with the offshore also serves as a broodstock area and 30-40 percent of lobsters migrate annually into shallow water off south New England (Lincoln 1998:31).

2.5.2 Food

The diet of lobsters in the larval and post-larval stages includes the wide variety of phytoplankton and zooplankton. As the lobsters at this stage are constrained by the inability of locomotion they are opportunistic feeders. The juvenile and adult lobsters' diet consists of mussels, crabs, sea urchins and other lobsters (Lincoln 1998: 23-24). Lobsters reach market size in about five to seven years, depending on water temperature (ASMFC 2002). Juvenile and adult lobsters eat live prey such as crabs, mussels, sea urchins, marine worms, periwinkles, sea stars, fish and seaweed's and scavenge dead animal matter. The diet of lobsters in the larval phases is unknown as they are opportunistic feeders at these stages.

2.5.3 Movement

In a tagging study throughout the 1940s and 1950s lobsters were released from Northeast Nova Scotia and recaptured to estimate the distance traveled by lobsters. Lobsters in this study migrated between 1 to 6 kilometers. Gulf of Maine tagging studies indicated that mature lobsters migrated significantly further, from up to 100 kilometers to 256 kilometers (Harding 1992:2). Such migration results in interchange between lobsters from different areas. The movement of larvae throughout the region is difficult to calculate, as the currents are responsible for their movement.

2.5.4 Growth

Growth rate is a function of both molt frequency, which is dependent on temperature, and size increase at molt. Lobsters reach legal size after 15 to 20 molts. Lobster longevity is not known due to the inability to age lobsters (DFO 1998a:1).

2.5.6 Natural and Fishing Mortality

Lobster mortality rates are difficult to obtain because of the discontinuous growth and the lack of demographic data. Natural mortality would seem to be highest during egg and larval stages, and lowest following sexual maturity. Fishing is the dominant method of control of recruit-sized lobster density. Exploitation rates vary from about 50 percent along Atlantic Nova Scotia to 90 percent in parts of Newfoundland. (Pringle et al. 1993:96).

2.5 Summary

This chapter has described the some of the characteristics and functions of certain key actors in the Atlantic Canadian fisheries, and more specifically, the lobster fishery. The fishery is a complex system with contributions from federal and provincial governments, industry, fishers and fish workers, and the lobsters themselves. The next chapter outlines some of the impacts that these actors have on Atlantic Canadian ecosystems.

Chapter 3: Impacts of Fishing Practices and Pollution on the Atlantic Canadian Shellfishery

3.1 Introduction

The quality of the ecosystems in the Atlantic region is a result of the complicated relationships between its living and non-living components. Throughout the past century, however, human activities have stressed those relationships and influenced ecological quality in the region.

Over time a balance developed between the living and non-living components of ecosystems in the region. Within this balance, the life cycles of shellfish populations are nurtured by essential nutrients and elements, and are driven by the sun's energy. Oxygen, carbon and nitrogen are the keystones in these cycles, and arise largely from the living world itself to be used and recycled in natural life processes. This balance has been shifted, from time to time, by "natural" phenomena such as global cooling and warming, volcanic activity and perturbations of the earth's orbit around the sun. Such shifts were generally slow, bridging thousands of years, or they were brief and localized events, but not chronic. The structure and functioning of ecosystems are sustained by synergistic feedbacks between the organism populations and their biotic and abiotic environments. The physical environment puts constraints on the growth and development of the biological subsystem. The ecological system is in a dynamic process of self-organization and self-maintenance or homeostasis.

There is no question, however, that at this point in the evolution of the planet, humans are exerting a profound influence on this balance. In other words, human activities are affecting the quality of the ecosystems, and some of the changes that are occurring are rapid and global. Pollution is one such example. Pollution may be defined as any physical, chemical, or biological alteration or air, water, or land that is harmful to living organisms.

The shift or change in the balance between the living and the non-living parts of an ecosystem is caused by stresses of one kind or another. These include toxic chemicals in the air and water, encroachment of human activities, excessive harvesting or misuse of renewable resources, destruction or manipulation of fish habitat and disposal of human wastes into the ecosystems. Most living organisms have a large degree of adaptability and can adjust to many natural stresses but the greatest change or damage to ecosystems are caused by stresses that are newly introduced into the ecosystem (such as manufactured chemicals), or that are occurring so fast that they overwhelm the adaptive capability of nature (such as overexploitation, habitat destruction, wastes). Most of the stresses that are causing adverse ecological change are directly related to human activities. Humans are the only species that are able to have such a drastic effect on the balance of nature through their ability to manipulate living systems and through their use of natural resources and the consequent generation of waste. The structure and function are sustained by synergistic feedbacks between human populations and their environment. These interactions are complex, poorly understood and potentially bi-directional. What follows is first a discussion of the ecosystems of Atlantic Canada, second, an examination of the effects of various fishing practices on those ecosystems, and finally, a review of various sources of pollution and their effects of Atlantic Canadian ecosystems.

3.2 The Atlantic Canadian Ecosystems

When discussing ecosystems not only living populations in the system (biotic community) have to be investigated but also physical features such as the continental shelf, currents, upwellings and ice (abiotic components). The eastern Canadian offshore, or the Northwest Atlantic, covers an immense area extending from the Gulf of Maine, shared by Canada and the United States in the south, to the northern Labrador Sea. The principal physical feature of this offshore zone is the wide Continental Shelf. Delineated by the 200-metre bottom contour, the Shelf is approximately 200 kilometers wide off Nova Scotia, reaches out 500 kilometers on the Grand Banks southeast of Newfoundland, and then narrows to less than 100 kilometers along the coast of Labrador. Most prominent in the region are the Scotian shelf, the Grand Banks of Newfoundland, and the Labrador banks (Hildebrand 1984).

Three currents dominate the oceanography of the waters off Atlantic Canada. The Labrador Current is a stream of cold, Arctic water from Baffin Bay and Hudson Strait, flowing southward past the eastern Newfoundland and down the eastern edge of the Grand Banks. Subsidiary branches enter the Gulf of St. Lawrence through the north side of the Cabot Strait and the Strait of Belle Isle. The Gulf Stream, warm and highly saline, is the northwest sector of the clockwise gyre of currents that dominates the North Atlantic. It flows up the East Coast of the U.S.A., across the southern Grand Bank, and off towards Europe. The Nova Scotia current is a cool, relatively fresh flow out of the Gulf of St. Lawrence, towards the Gulf of Maine. Currents connect populations of fish spawning grounds to nursery grounds and transport the larvae. Fish populations are affected by currents and the currents are affected by the wind. Wind has an effect on fish populations by limiting fishing effort, and hence fish mortality, through foul weather.

Upwellings occur when surface water is swept by wind away from the coast and is replaced by deeper water rising to the surface. Upwellings and "fronts" at the boundaries of these currents, and their flow across shallow submerged banks, bring up stored nutrients from the bottom to the surface. They enrich the biological productivity that supports a diverse and prolific food web, beginning with the small, unicellular plants known as phytoplankton, the basis of life in the sea.

3.2.1 Ice

Another prominent feature of the eastern offshore is ice. Icebergs are produced continuously in the north, most from the West Coast of Greenland. They drift south with the Labrador Current and usually melt when they meet the Gulf Stream. However, most sea ice comes from seawater that freezes off Labrador or in the Gulf of St. Lawrence. Labrador pack ice reaches the northern Grand Banks, but St. Lawrence ice rarely travels south of Cape Breton.

The cold water, with or without ice, delays the start of spring in Atlantic Canada until May- much later than at comparable latitudes on the West Coast and in Europe. It is also responsible for a pronounced cooling effect during the summer, and a moderating effect on winter temperatures. These influences in turn have profound effects on marine populations.

Marine species are sensitive to changes in temperature. These changes in temperature affect photosynthesis, the growth of phytoplankton, and algae. Temperature changes may also affect shellfish populations, whereby shellfish at a particular sensitive stage in their life may suffer a reduction of their food supply at the same time, resulting in devastating impacts on the Atlantic Canada shellfishery production.

Historical data indicates that Northwest Atlantic catches have been subject to sharp fluctuations. Records of lobster catches in the past 100 years illustrate rapid and largely unexplained shifts between strong years (late 1890s and late 1980s), and record low years (1917,1924,1941-42) (DFO 1989). When lobster catches for the same period are compared across management regions, more localized variations become apparent. Scientists suspect that such ecological factors as temperature, wind, freshwater runoff, and tidal action may affect lobster recruitment in coastal waters. The position of different water masses, Gulf Stream eddies, and large-scale circulation patterns may be more important in offshore waters. In addition, ecosystem changes, such as changes in species composition, predator-prey relations or health of the ecosystems, may also influence stock abundance at local or regional levels (DFO 1989).

3.2.2 Marine Ecosystems

The Gulf of St. Lawrence is biologically productive due to warm summer water temperatures and mixing of deep nutrient-rich waters with surface waters. The Gulf is known for its lobster, scallops, groundfish and herring fisheries. Whales and mammals are also abundant, especially near the north shore. There is considerable vessel traffic through the Gulf to the Great Lakes.

The Scotian Shelf, off Nova Scotia, is another productive offshore area. At the southwest end of the Shelf, strong tidal currents cause a clockwise flow around shallow banks, an action conducive to the survival of larval fish. Near the coast, tidal mixing and upwelling of nutrient-rich deep waters produce the richest finfish and lobster fisheries in the Region.

The Bay of Fundy is both physically and biologically unique. The Bay has the world's highest tides. The strong water movement brings deep, nutrient-rich water to the surface, but the heavy load of sediment stirred into suspension limits the penetration of light and thus biological productivity. Therefore, the Bay's upper reaches have rather low productivity, although the mudflats are important feeding areas for migrating shorebirds. The mouth of the Bay, however, is an important area for scallops and herring.

Linked to both the Scotian Shelf and the Bay of Fundy, the Gulf of Maine is a semi-enclosed sea, almost entirely cut off from the northwestern Atlantic by underwater banks (primarily Georges Bank and Browns Bank). The Gulf waters show temperature and salinity differences from the rest of the Atlantic. Productivity in the Gulf is greatly enhanced by the introduction of terrestrial nutrients from a number of rivers in Canada and the U.S.A. Two currents dominate circulation in the Gulf: a counter-clockwise gyre over Georges Bank and a clockwise gyre north of Georges Bank in the Gulf (Dobbs 2000:142). The Gulf provides habitat for a number of finfish and shellfish stocks.

Straddling the border between Canada and the U.S.A. is Georges Bank, which has high biological productivity due to tidal mixing and circulation. Bank waters support important stocks of sea scallops. A World Court decision in the mid-1980s led to an adjustment of the Canada/U.S.A. boundary, and a larger portion of the rich scallop ground on the northeast peak of the Bank came under Canadian jurisdiction.

3.2.3 Coastal Ecosystems

The Atlantic provinces have 40,000 kilometers of coastline, extending from about 43 degrees North in the Gulf of Maine to 60 degrees North at the northern tip of

Labrador. The estuaries and coastal areas of the Region provide habitat for large populations of a wide variety of seabirds, shorebirds, marine mammals, and commercially important finfish and shellfish. There is great variety in the topography of the Atlantic coast. Moving south along the coast of Labrador, deep fjords cutting into coastal mountains give way to lowland fjords in a rugged shoreline indented with many bays and inlets in eastern and southern Newfoundland. Western Newfoundland and the northern Gulf of St. Lawrence have a lower rocky shoreline with some fjords (Owen 1989).

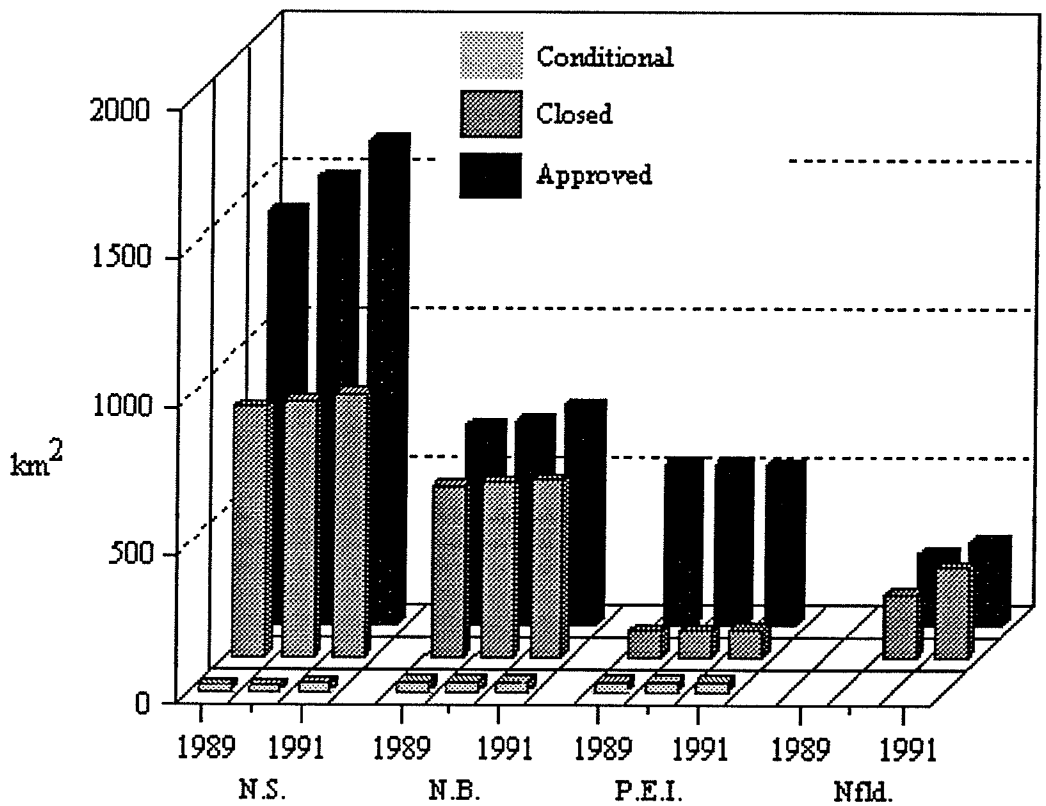
Newfoundland's coastal zone is generally characterized by large fjord-type estuaries and limited zones of small protected estuaries. Insular Newfoundland has approximately 1000 freshwater streams and rivers discharging to the sea, 93 percent of which cover distances of less than 32 kilometers. On average, the watersheds cover an area of 270 square kilometers. Large rivers, such as the Churchill and Eagle, have a combined drainage area of 140,600 square kilometers (Beanlands 1983:123). In Newfoundland, the combination of the steep coast and a subdued tidal range produces limited intertidal zones with restricted intertidal habitats.

In contrast, the Maritime provinces are each characterized by many small, protected estuaries. The southern Gulf of St. Lawrence is a broad lowland area with many shallow estuaries and embayments, fringed by the most extensive barrier island system in Canada. The Atlantic coast of Nova Scotia is a low, rocky shoreline with large embayments and almost 4000 offshore islands with many lagoons and extensive marshes in sheltered sections. The shoreline of the Bay of Fundy is characterized by red sandstone cliffs and hard volcanic rocks. There are wide tidal beaches of mud and sand up to 5 kilometers wide in the upper bay (Owen 1989).

The coastal zone is a favored habitat for humans. Many of the region's settlements are on or near the coast since traditionally we depend on the coastal waters for transportation, food and recreation. Unfortunately, the coastal waters are also the recipients of the wastes (both treated and untreated) from many residences, institutions and industrial processes. Approximately half of all major industrial effluents discharged in the Atlantic Provinces enter untreated into estuaries or the sea (Well and Schneider 1975). Perhaps the most noticeable consequence of the use (or misuse) of the coastal zone is the closure of shellfish harvesting (Chart 3.1), as a result of the contamination of the most productive estuaries of the Region by municipal sewage, and agricultural and industrial waste. (Menon 1988:684).

Chart 3.1

Shellfish Area Classification Trends - Atlantic Region (1989-1991)



Source: Eaton et al. 1994a :Ch. 4-58.

3.2.4 Estuaries

Estuaries, where fresh river waters mix with saline seawater, are productive habitats. They serve as "nursery areas" for the planktonic larvae of many benthic invertebrates such as mollusks and crustaceans, as well as juvenile fish. For example, the estuaries of the Gulf of Maine are thought to be vital to about 70 percent of the fish species of commercial importance along the Gulf Coast (Van Dusen and Hayden 1989).

Seventy-five percent of the Maritime's rivers have an annual discharge of less than 14 m^3/sec and drainage basins that are less than 60,000 hectares. There are 536 estuaries one hectare in size or greater in the 3 Maritime Provinces. Two-thirds of the estuaries are less than 100 hectares in extent. The other third includes mainly complex estuaries (i.e. more than one freshwater flow) that average close to 500 hectares each (Beanlands 1983:124).

The characteristic intertidal vegetation on the rocky, exposed coasts of Atlantic Canada is kelp and seaweed. This provides shelter and food for a diverse community of marine animals that include such familiar residents as mussels, lobsters and crabs. Among the higher predators are seals, dolphins and porpoises, cormorants, eiders and black guillemots.

By contrast, the low-lying beaches, salt marches and tidal flats of the Upper Bay of Fundy, and the southern Gulf of St. Lawrence, are dominated by burrowing crustaceans. This habitat is the product of the huge tidal fluctuations in the Upper Bay of Fundy, which reach over 15 meters.

The Atlantic Canadian ecosystems play a vital role in the maintenance of the chemical and biological balance of life in the area. The process of photosynthesis provides food for the food webs. Phytoplanktons, which are microscopic plants, take carbon dioxide and convert it to useable oxygen and simple sugars, which are consumed by marine animals. Therefore, the phytoplanktons provide the foundation to which all other marine populations depend.

It is very important to keep healthy the water bodies that surround the Atlantic Canada region. The health of Atlantic ecosystems is essential to support the economy and the well being of those who utilize their resources. The problem is that the ecosystems may be close to or perhaps past their natural limits. For example, the cod that had existed in the area long before the first European explorers has now been so overfished that the Atlantic Canada cod fishery was closed in 1992.

Coastlines are threatened by human activities. Fishing, pollution, and coastal development can have serious consequences for the overall health of the ecosystems and in turn may negatively affect the shellfish populations and the human activities which depend on them. Marine ecosystems provide biological diversity and they also perform vital functions such as oxygen production, nutrient cycling, storm protection, and climate regulation. Marine biological activity is concentrated along the coastlines and in upwelling systems.

The threats to the ecosystems and shellfish populations of Atlantic Canada are largely anthropogenic and **synergistic**. For example, fishing has drastically changed marine food webs and altered marine habitats. The coastal zone utilized for fishing is also utilized as a waste receptacle. The combination of fishing and pollution has affected the populations of shellfish and has threatened the livelihoods of the people that depend on this resource.

In the previous chapter the main biological characteristics of shellfish populations were described. It was noted that the information was lacking and had high uncertainty. But in this chapter factors that affect negatively the size of populations and well being of these shellfish populations will be briefly described. Major factors that are considered are the competing users of the coastline as both a garbage receptacle and as a food source as well as the intensifying of fishing activities.

3.3 Effects of Fishing

Estuaries and coastal waters in Atlantic Canada waters support numerous essential fisheries, but estuaries are among the most modified and threatened of aquatic ecosystems. Almost all of the aquatic ecosystems in the Atlantic region have been affected by human beings in some way. Fishing is one activity in and close to estuaries that has had a variety of impacts on shellfish and fish populations.

The biological importance of estuaries relates especially to their function as nursery areas for a wide variety of marine organisms and fishing in estuaries may have impacts on offshore fisheries. Fishing may destabilize these ecosystems as a result of its effects on ecological processes. The decimation of target and non-target shellfish populations, disturbance of nursery functions, and habitat change greatly affect ecosystems in the Atlantic Canada region.

The coastal fisheries of the Atlantic coast are fully exploited or overexploited as a result of the increase in numbers of fishers, higher production efficiency of gear, and the increased mechanization of boats. The effects on shellfish can include a decline in abundance, change in age structure, change in size, and a change in species composition.

There are conflicting views about the effects of mobile fishing gear on the ecosystem. Research from the North Sea suggests that areas with a soft bottom or low tidal flows are more likely to be affected by bottom trawling than areas with hard bottoms and strong tidal currents or turbulence. Changes in abundance and species composition have been attributed, in part, to the movement of trawls over the seabed. The effects of scraping and penetration of trawl gear into sediments are most likely to be related to the frequency of disturbances and degree of pressure applied (ICES 1988:12).

Trawling is a threat to the marine habitats of the Atlantic region. Trawling involves the dragging of nets and chains on the ocean floor. It has been claimed that as a result the ocean floor of the Gulf of St. Lawrence resembles a desert. This method of fishing is a major cause of habitat degradation, trawling disturbs bottom dwelling species such as scallops and lobster as well as localized species diversity and food supplies.

Recent estimates suggest that the Canadian fleet of offshore vessels (vessels greater than 65 feet LOA), which is comprised of approximately 60 offshore scallop draggers and 100 groundfish trawlers, annually sweeps a seabed area of about 30,000 km^2. This represents a decline from 1989 figures of 300 scallop draggers and 700 groundfish trawlers (Messiah 1992:32).

In Canada, the otter trawl, a small trawler with a cone-shaped net, is the more commonly used type of trawler. Some research, mostly by industry, has been conducted to assess the impacts of otter trawling on the seabed. This has revealed that sediment clouds are a result of movement across the sandy and muddy bottoms, but the clouds are temporary and have not adversely affected catch rates when trawls over the same ground were made within the next twenty-four hour period (Riley 1985:7).

Scallop dredging lifts sediments into suspension, overturns rocks embedded in sediment, and roughens the bottom appreciably. The nets and chains dig into the seabed and kill sea urchins, starfish, worms, crustaceans, and other shellfish which severely damages the ecosystems (Lindeboom 1990:14). Studies that observe the interactions of dredge gear and scallops in the Gulf of St. Lawrence indicated mortalities of 13-17 percent per tow due to shell breakage (Caddy 1973:175). The long-term effects on benthic biota, however, are not fully understood.

Concerns about the potentially harmful impacts of scallop dredging on lobster stocks have been addressed by survey research in the Gulf of St. Lawrence and St.

Mary's Bay (southwest Nova Scotia). Although biologists noted that study results are area and time specific, their findings suggest that scallop dredging is not likely to interfere with lobster stocks since lobster and scallops tend to occupy different types of ocean bottom (Jamieson and Campbell 1984:580; Robichaud et al. 1986:13).

Longlining is generally regarded as being an ecologically benign fishing technology because the bottom is not disturbed and the gear is more selective. In addition, the operational costs of longlining are less than those incurred by most mobile gear technologies such as trawling (i.e. reduced energy costs). Although longlining may be a harvesting option for some sectors of the commercial fishing fleet, the gear is not suitable for catching some species, such as shrimp, and therefore is not likely to replace trawling gear altogether.

Irish moss and rockweed are harvested by hand or by mechanical raking. Ecological concerns associated with drag rakes include over-harvesting of immature plants, removal of the algae canopy used by other biota, the capture and/or injury of marine species, and disruption of habitats (Riley 1985:8). Research conducted in PEI in the early 1970s indicated that raking could disturb lobster habitat and subsequently bans on raking were imposed in some areas (Scarratt 1972:5).

The impacts of harvesting seaweed, in Atlantic Canada, may also effect shellfish populations. Seaweed provides shelter and foraging opportunities for numerous species. The leaves provide habitats for invertebrates such as crabs and lobsters which are the prey for larger fish. Harvesting of seaweed on a large scale may have serious impact on marine populations. It may also have indirect impacts, because seaweed leaves are used for food by marine organisms and the harvested seaweed may contain fish eggs.

In Atlantic Canada, many invertebrate bait organisms are collected from soft substrata by digging, affecting the target populations, the structure of the substratum, and its community. Dredging and trawling may create a water-column oxygen demand that has the potential to form a barrier, which may hamper the migration and movement of populations.

Inshore clams are harvested almost exclusively by hand, but off shore clams are harvested by hydraulic equipment that shoots water onto clam beds. The pressurized water changes the niche from a solid to a fluid state and, since clams are light, the clams float to the surface where they are easily collected. Mortalities may result from breakage, by deep burial, or increased exposure to predators. The potential for long-term damage is greatest in coarse, compact substrates and in shallow waters where wave energy is minimal.

Fishing gear that is lost or abandoned may continue to catch fish and marine mammals for many years. This phenomenon, known as 'ghost fishing', is of particular concern in the gillnet fishery because monofilament gillnets can exist in the marine ecosystem for many years. A fifty-day research survey conducted off the coasts of Newfoundland in 1975 retrieved 148 lost or abandoned nets containing 10,087 pounds of fish (Way 1976:8).

A 1986 study in the Bay of Fundy calculated incidental catches of harbour porpoise by gillnets at approximately 105 animals per year. Since harbour porpoises are slow to reproduce and are usually short-lived, continuing mortality from gear entanglement could potentially threaten the population (Read and Gaskin 1988:519). However, results from a 1991 survey of harbour porpoises in the Bay of Fundy and Gulf of Maine indicate that the population is substantially larger than previously thought. The present by-catch levels of harbour porpoises therefore represent in this location at least lower percentages than previously assumed, but remain at levels that approximate the annual rate of population growth. Canadian fishers are responsible for less than 10 percent of the porpoise by-catch (Bedford Institute 1991:13).

Lobster traps are also responsible for ghost fishing. A recent study of the United States east coast lobster fishery estimated losses could be as high as 5 percent of total landings. Estimates of losses due to ghost fishing in the Scotia-Fundy region were valued at approximately $1.4 million in 1987. To address this problem, regulations requiring the use of biodegradable insert panels to allow trapped lobsters to escape were put into effect (DFO 1989:16).

Fishing poses a serious biological threat to the ecosystems of Atlantic Canada. The resulting reduction in genetic diversity of spawning populations may make it more difficult to adapt to future ecological changes. For example, the cod in Atlantic Canada may have been fished down to the point where future recovery is in jeopardy. Moreover, declines in one species may result in an alteration of predator-prey relationships and making these ecosystems susceptible to invasive species.

Estuaries and coastal ecosystems function as a *nursery* for a variety of marine populations. Fishing in or near these areas may have far reaching effects. Fishing for shrimp involves trawling and the utilization of a mesh net. When dragged through the water the net becomes full of every species of fish in its path. This causes the problem of by-catch. The amount of fish caught will always be larger than what is landed. Also, the weight of discards is always higher than that of landed catches. In shrimp fisheries, the by-catch is as much as eight times the weight of shrimp that are kept (Berrill 1997:69).

One major effect of trawling on non-target species is by-catch. Despite the growing human demand for shellfish, vast quantities are wasted because the shellfish are undersize, a non-marketable species or sex, or are by-catch. Fishing near these areas may also affect the floating larvae. These larvae are utilized by the entire ecosystem to maintain its productivity. The use of a net for shrimp fishing near these nurseries can affect populations.

The estuarine mudflats in the Atlantic region have an important role to fulfill as nursery and feeding areas for marine fish. The loss of habitat especially through land reclamation has impacts on shellfish populations such as the two causeways built in Canso, Nova Scotia and in southern New Brunswick. The construction of causeways changes the circulation patterns. This ultimately alters oceanographic parameters, temperature, salinity, and sedimentation rates (Eaton et al. 1986:80). The change to the integrity of the habitat and the loss of disproportionately rich feeding areas may ultimately affect nursery functions.

The ecosystems may change if fishing directly removes or reduces the populations representing specific trophic levels, such as predators and prey, or indirectly changes the physical nature of the habitat by such practices as dredging or trawling.

Not only do these trends in gear change have ecological consequences, they also have social consequences as well. The welfare of a number of fishers who depend on fishing for an income is severely threatened. As the fish disappear, fishing villages that depend on the shellfish resources in the Atlantic region are threatened. Small-scale fishers suffer the most, as they are not able to compete with the large-scale vessels or the changing technology.

3.4 Pollution

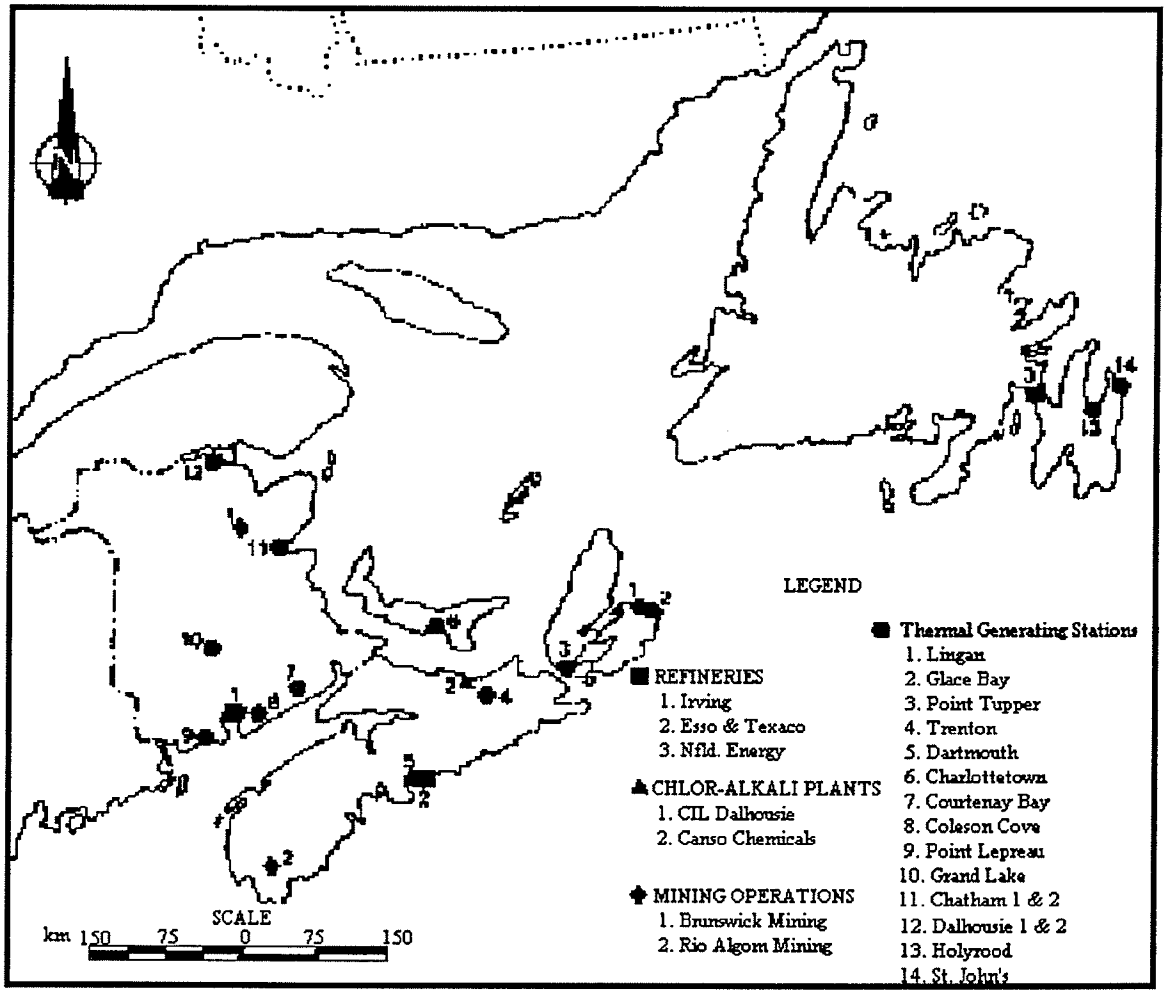
Human activities on land cause a large portion of marine contamination. Marine pollution can develop from effluent flowing down the rivers to the tidal estuaries where it effects shellfish populations and then flows out to sea. The waste of Atlantic Canadian society ends up circulating in the marine ecosystems from nutrient rich sediments, fertilizers, sewage, toxic heavy metals and synthetic chemicals.

The conditions that make coastal areas of Atlantic Canada so productive for shellfish, proximity to nutrients and tidal mixing also make them vulnerable to human interference. Almost all of the major cities in the Atlantic region are on the coastline or on a waterway that flows to the ocean. The major cities in the region all have been increasing in population and thus the marine ecosystems are continuously under attack from more concentrated effluent. A summary of the locations of industries in can have ecological impacts in Atlantic Canada are shown in Maps 3.1and 3.2.

This section will discuss pollution discharged into the Atlantic Canada ecosystems by different industries and its effects or potential effects on shellfish populations. The industries investigated are petroleum refinery production, chlor-alkali plants, fertilizer production, wood preservation, pulp and paper, mining, sewage, and fish and food processing.

Map 3.1

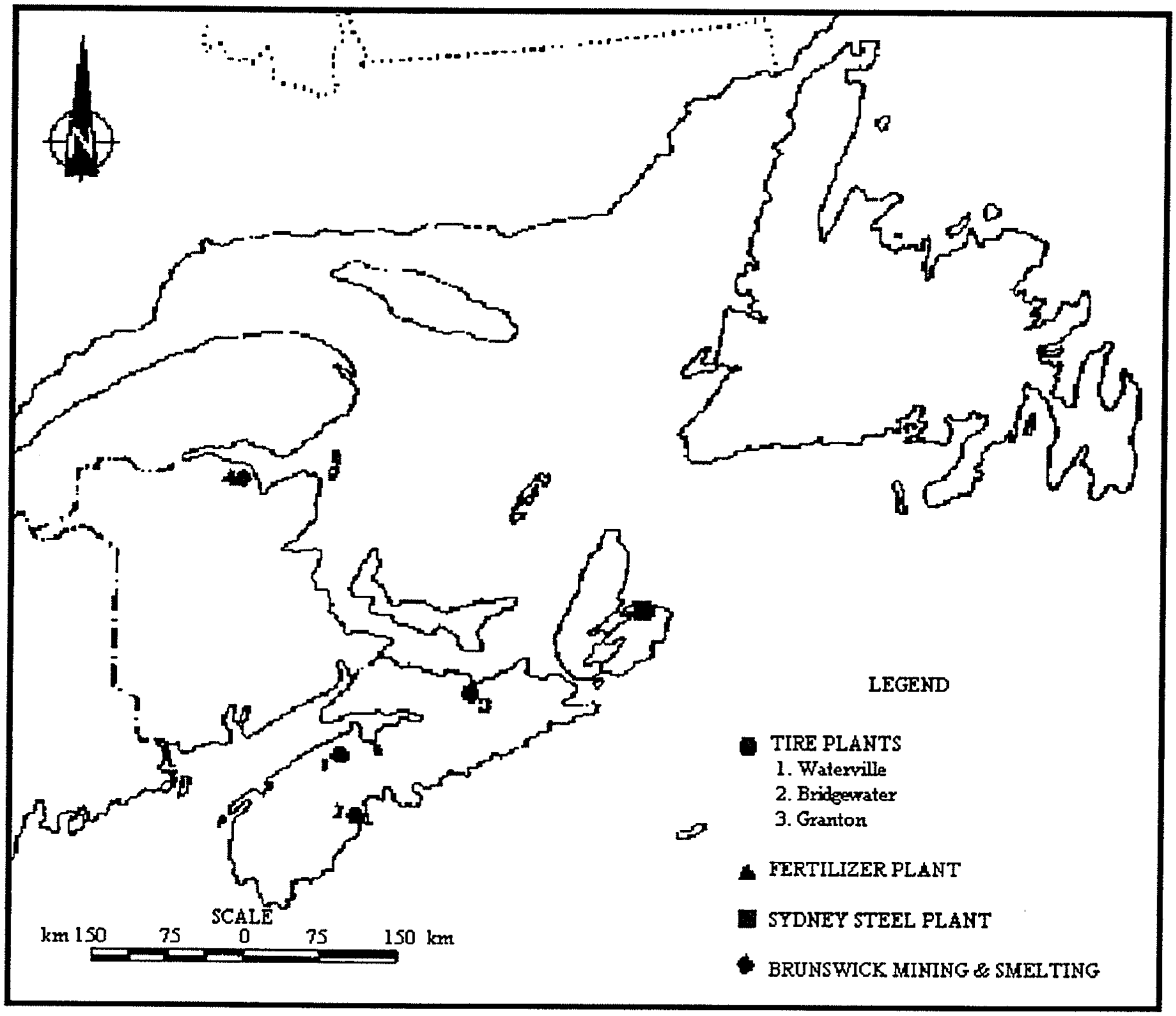
Industrial Process Releases - Atlantic Region - Map 1



Source: Eaton et al. 1994a:Ch4-28

Map 3.2

Industrial Process Releases - Atlantic Region - Map 2



Source: Eaton et al. 1994a:Ch4-41

3.4.1 Petroleum Refineries

There are four refineries in the Atlantic region. Two are located in Dartmouth, Nova Scotia, one in Saint John, New Brunswick, and one in Newfoundland. These refineries are all located on the coastline due to the utilization of large tankers for transport of the product. From 1983 to 1987 there was an increase in production at the plants (Eaton et al. 1994:164). From 1983 to1987 the net petrol discharges increased in the region. There was a seven percent increase in oil and grease effluent. The mill in Newfoundland had a 372 percent increase in net discharge (Eaton et al. 1994:164). The effluents discharged into the Atlantic coastal ecosystems are oil, grease, suspended solids, phenols, sulfide, and ammonia nitrogen (Eaton 1994:163). These effluents can be fatal to fish populations (Eaton1986:62). Also, the effects of these effluents have not been investigated to any great extent (Eaton et al. 1994:164).

3.4.2 Chlor-alkali Plants

There are two chlor-alkali plants operating in the Atlantic region. These plants produce chlorine and caustic soda for the pulp and paper industry by passing a brine solution over mercury cells. The major contaminant released in this process is mercury. Not all the mercury used in the process remains in the plants. Between 1976 and 1987 the plant located in Dalhousie, New Brunswick discharged 5,327 kg of mercury and the other plant in Abercrombie, Nova Scotia discharged 1,122 kg of mercury (Eaton 1994:167). This effluent contaminates estuary sediments and biota (Eaton 1986:68). There is also the threat of bio-accumulation. Bio-accumulation is the process by which chemicals are taken up by organisms from the air or water, directly or through the consumption of food, leading to a concentration of the substance in organism tissues.

3.4.3 Fertilizer Production

The only fertilizer plant in the region is located at Belldune, New Brunswick and it is situated on the Baie des Chaleurs. The plant discharges 20,000 m3 of effluent daily (Eaton 1994:4).

3.4.4 Wood Preservation

There are eleven plants in the Atlantic region that are involved in wood preservation and protection. These plants protect the wood from the growth of sap-staining organisms and protect the wood from decay. The plants utilize copper arsenate, pentachlorophenol, or creosote. From 1920 to 1986, plants in northern New Brunswick drained their wastes into a tributary of the Miramichi River which contaminated sediments with polycyclic aromatic hydrocarbons (PAHs) (Eaton et al. 1994:4). A study in 1988 confirmed that the wood preservatives used at the plant had contaminated the soil and groundwater near the site. The plant in Northern New Brunswick is no longer treating wood but the Nova Scotia plant is still in operation (Eaton et al. 1994:193).

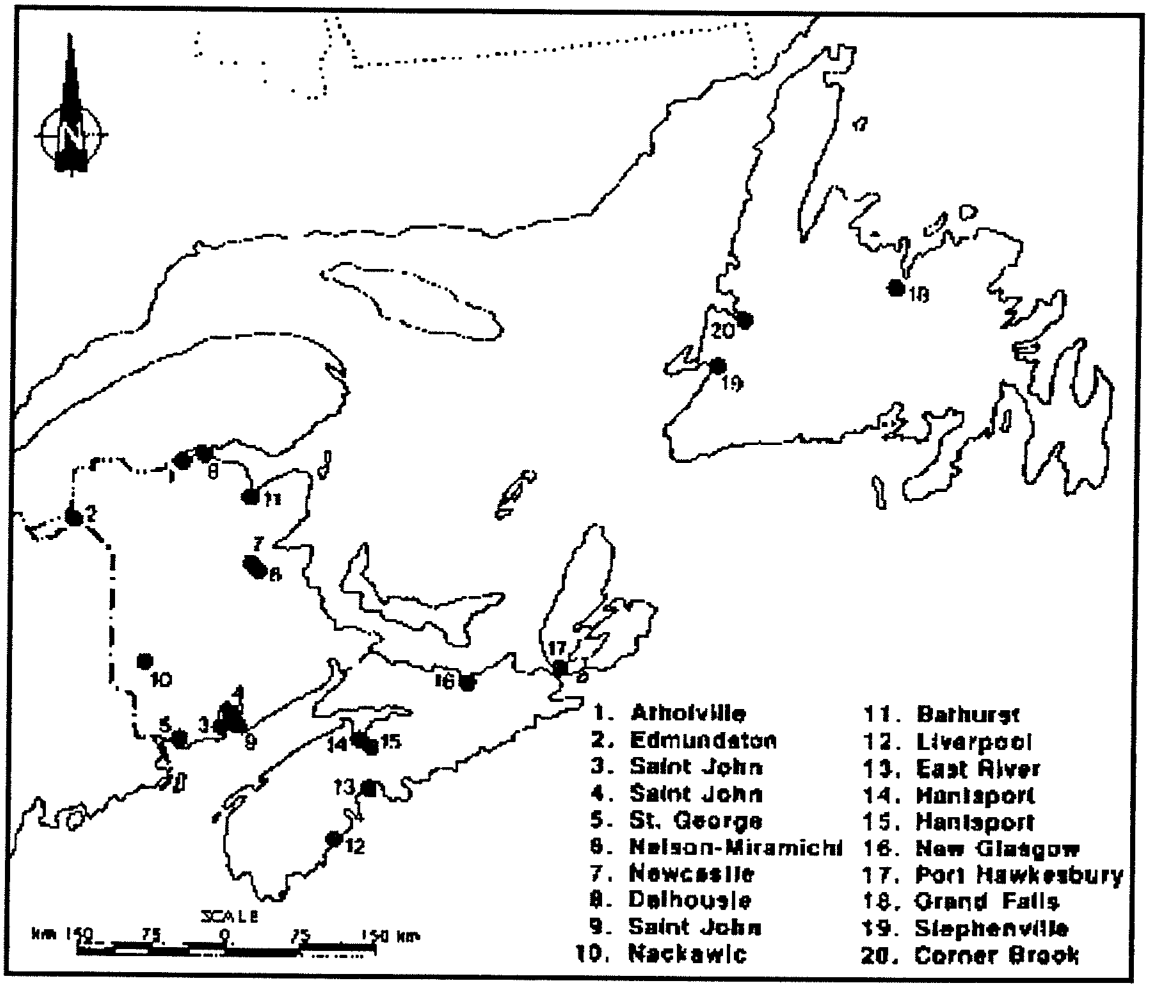
3.4.5 Pulp and Paper Mills

In 1984, there were twenty pulp and paper mills located throughout the Atlantic region (Eaton et al. 1986:59; Eaton et al. 1994:4). New Brunswick has eleven pulp and paper mills and there are six in Nova Scotia, and three in Newfoundland. In 1984, half of the plants still had toxic discharges (Eaton et al. 1986:61). In 1992, effluents from 12 of the 20 plants were acutely lethal (Eaton et al. 1994:143). In 1994, seven of these mills used chlorine bleaching which is highly toxic to marine populations. These mills emit large quantities of various toxic wastes and suspended solids into coastal waters. The effect of these effluents is a physical smothering of the benthos and a change in the benthic habitat as well as oxygen depletion (Eaton 1986:59). A dramatic example of this danger was at a fish kill at the Scott Maritimes plant in 1990.

In the late 1960s the Lake Utopia and Paper Ltd. started construction of a pulp and paper mill located near the estuary of the upper L'Etang River in southern New Brunswick. The mill was completed in 1971. In 1967 a causeway was built to connect St. Stephen with Saint John, New Brunswick. In 1972 both the upper and lower portions of the river were oxygen depleted. This had drastic effects on the scallop populations and as a result, catches declined. In 1972 the federal government issued shellfish closures that affected 6-13 percent of New Brunswick's total soft shell clam resource. In 1976 oxygen depletion in the river was measured 3 km below the causeway (Wilson et al. 1980:28). There are mills on the Nepisiquit, Restigouche, and Miramichi rivers. The mill on the Nepisiquit River, owned by Consolidated Bathurst, has been releasing effluent since 1915 into the mouth of the river (Wilson et al. 1980:31). The locations of pulp and paper mills can be seen on Map 3.3, and the Average Annual Effluent Discharges is summarized in Table 3.1.

Map 3.3

Location of Pulp and Paper Mills - Atlantic Region



Source: Eaton et al. 1994a:Ch4-24

Table 3.1

Average Annual Effluent Discharges by Mill and Receiving Water

Atlantic Region 1989

Mill	Estimated Amount Discharged m3/yr	Treatment	Receiving Water
New Brunswick:			
Atholville Pulp	19,214,793	Primary	Restigouche River Estuary
Fraser Inc	32,221,449	Secondary	Saint John River
Irving Pulp and Paper	26,274,105	Nil	Saint John River
Irving Tissue	---	Nil	Saint John Municipal Sewer
Lake Utopia Paper Ltd.	2,150,577	Secondary	L'Etang Harbour
Miramichi Pulp & Paper Inc. (Nelson-Miramichi)	2,696,031	Primary	Miramichi River
Miramichi Pulp & Paper Inc. (Newcastle)	24,249,186	Secondary	Miramichi River
NBIP Forest Products Inc.	19,663,772	Primary	Baie Des Chaleurs
Irving Paper Ltd.	15,016,833	Primary	Saint John Hbr.
St. Anne-Nackawic Pulp Company Ltd.	26,337,285	Secondary	Saint John River
Stone Consolidated Inc.	11,846,952	Secondary	Nepisiquit River to Bathurst Harbour
Nova Scotia:			
Bowater Mersey Paper Company Ltd.	14,643,720	Nil	Liverpool Bay
Canadian Pacific Forest Products Ltd.	999,297	Secondary	Mahone Bay
Minas Basin Pulp & Paper Company	---	Nil	Minas Basin
Canadian Keyes Fibre Inc.	---	Nil	Minas Basin
Scott Maritimes Ltd.	29,493,477	Secondary	Northumberland Strait
Stora Forest Industries Ltd.	30,671,433	Primary	Strait of Canso
Newfoundland:			
Abitibi-Price Inc. (Grand Falls)	55,065,933	Primary	Exploits River
Abitibi-Price Inc. (Stephenville)	9,244,987	Secondary	St. Georges Bay
Corner Brook Pulp & Paper Ltd.	31,463,289	Nil	Humber Arm

Note: Effluent discharges calculated as follows: (Average Daily Effluent x 351 days), Based on 1989 data

Source: Eaton et al. 1994a:Ch4-25

3.4.6 Mining

Mining activities have damaged ecosystems in the Atlantic region. Mining processes cause high levels of heavy metals, suspended solids, high acidity, and large quantities of waste rock to be disposed of in the marine ecosystems. These pollutants can affect lobsters and lobster habitats. There were 112 mines in operation in 1989 in the Atlantic region and which are summarized in Table 3.2.

Table 3.2

Mines by Type Currently in the Atlantic Region - 1989

Province	Gold	Base Metals & Iron Ore[1]	Non-metals[2]	Structural Materials[3]	Coal
Newfoundland	1	3	7	1	0
Nova Scotia	7	1	19	10	9
New Brunswick	2	4	13	9	1
Prince Edward Island	0	0	0	25	0
Region	**10**	**8**	**39**	**45**	**10**

[1] Base metals include antimony, bismuth, cadmium, copper, lead, silver and zinc.
[2] Non-Metals includes gypsum, peat, potash, Labradorite, fluorspar, limestone, barite, silica, salt.
[3] Structural Materials includes clay, lime, sand and gravel, stone.

Source: Eaton et al. 1994a:Ch4-33.

Base metal mining, primarily for lead, zinc, and copper, was very active in northern New Brunswick and Newfoundland in the late 1960s and early 1970s. When mining for lead, zinc, and copper, these metals plus other contaminants associated with them are released in large volumes of water associated with the mining and milling process. Metals are also released from waste rock dumps and tailings ponds at both active and abandoned mines. Many of these metals are toxic to aquatic organisms, including invertebrates and fish.

Most of the metals discharged move downstream until they reach the freshwater/saltwater interface. As these metals are insoluble in salt water, the sudden drop in solubility at the interface may result in high sediment concentrations in estuaries. For example, the Bathurst Harbour in northern New Brunswick has been the recipient of the effluents from the base metals mines. Dredging was required in the main channel to keep it clear, but since 1976 dredging has stopped due to the high levels of cadmium, lead, copper, zinc, and mercury in harbor sediments.

According to a summary (Eaton et al. 1986:71-72) of treatment facilities and liquid effluent quality for individual metal mines in 1982, most mines exceeded the allowable amount of discharge. The low pH (high acidity) in the receiving ecosystems can disrupt life and may increase the toxicity of the metals present. For example, most invertebrates, plants and fish vanished from the South Little River for several kilometers below the Brunswick No. 12 mine/mill near Bathurst, New Brunswick.

There are four locations in the region where base metal ores and concentrates are loaded onto ships for transport. Lead and zinc are loaded in Dalhousie, New Brunswick, zinc at Hawkes Bay in Newfoundland, and lead, copper and zinc ore are loaded at Tilt Cove, Newfoundland and Botwood, Newfoundland. At each site, heavy metal contamination has resulted from the loss of ore/concentrate directly into the water by spillage, through site runoff, or through contaminated windblown dust. At Dalhousie, New Brunswick, losses of the ore/concentrate to the harbour was substantial (Eaton et al. 1986:73). This, combined with the siltation of the Restigouche River and heavy loadings of organic matter from an adjacent pulp and paper mill, created a dredging and disposal problem. This harbour was continuously dredged but lead, zinc, and cadmium concentrated in the sediments and dredging was limited.

Base metal ores from the Brunswick mines in northern New Brunswick are shipped to the lead smelter in Belledune, New Brunswick. Cadmium, which is a waste product of the refining process, is the major contaminant and large quantities of it have entered the local ecosystems through air, surface runoff and direct discharge to Belledune Harbour. As a result, Belledune Harbour and the surrounding coastal waters, sediment, lobsters and blue mussels are heavily contaminated with cadmium. The high concentration of cadmium in resident lobster muscle and tomalley, the mid-gut glands of the lobster, have made them unsafe for human consumption. In 1980, the DFO closed the harbour to lobster fishing and established a 7 km control zone around the harbour. Also, concentrations of cadmium in blue mussels are above background levels up to 20 km downcurrent of the harbour (Eaton et al. 1986:74).

The operation of the Sydney Steel plant for over 80 years resulted in what are known as the Sydney Tar Ponds. The plant discharged toxic and ecologically hazardous wastes into the South Arm of Sydney Harbour and nearby to the Muggah Creek. There is a complex mixture of hazardous chemicals accumulated in the Tar Pond, but the most prominent are polycyclic aromatic hydrocarbons (PAHs). The ponds contain an estimated 3.5 million kg of polycyclic aromatic hydrocarbons (PAHs), largely from the coke oven operations on the site (Eaton et al.1994:5). The area is tidally influenced and movement of the toxic materials to the South Arm has occurred. The coking operation of the plant was closed in 1988 but the continuous discharge of PAH-contaminated wastes and the leaching of the Tar Pond through tidal action, led to severe contamination of the South Arm sediments and biota. For example, sediment values were as high as 20 times the highest levels found in the Boston Harbour, and South Arm lobsters were 26 times the background levels in Atlantic coastal lobsters (Eaton et al. 1986:67).

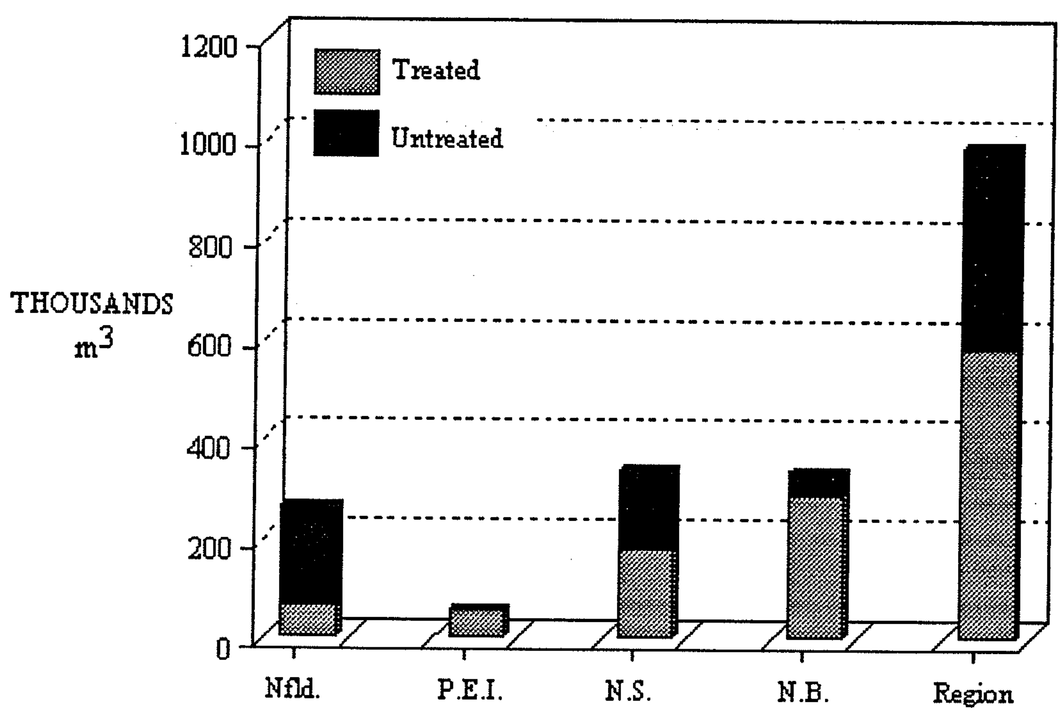
3.4.7 Sewage

The installation of sewage treatment facilities in Atlantic Canada has lagged far behind other regions in Canada. The amount of sewage being released into the coastal ecosystems has increased. In 1985, 358,000 m3 of untreated sewage was discharged on a daily basis. In 1994, the average daily amount of sewage discharged was 980,000 m3. Major populated cities such as Halifax, Nova Scotia and St. John's, Newfoundland are still without sewage treatment facilities (Table 3.3). Halifax discharges daily 150,000 m3 of untreated sewage into its harbour (Eaton et al. 1994:7).

The sewage discharges contain oxygen demanding wastes, plant nutrients, heavy metals, and synthetic organic chemicals. These discharges have serious ecological effects that can affect shellfish populations. Sewage discharges are the major cause of contamination of shellfish growing areas in the region.

Table 3.3

Daily Sewage Flow - Atlantic Region



Source: Eaton et al. 1994 :Ch4-57.

Excessive discharge of organic wastes in a coastal zone may result in the depletion of oxygen. This affects shellfish, as oxygen is an essential and limiting element. Respiration is limited and the activity of the organism declines. Therefore greater amounts of energy are required in simple biological maintenance. This effect on organisms is not limited to one specific trophic level. With the increase in plant nutrients for the algae, either naturally or artificially by sewage, pollution creates algal "blooms". The number of blooms has been increasing since the 1940s. In 1940 there were less than 50 shellfish closures due to blooms. In 1979 there were 237 and by 1983 there were 262 (Wilson et al. 1980:36; Eaton et al. 1986:76). Many heavy metals, such as mercury, cadmium, lead, zinc, are discharged into the coastal ecosystems through sewage discharge. In large quantities they cause massive fish kills. In smaller quantities they can accumulate in the populations and food web. For example, lobsters in the Belledune Harbour have high levels of cadmium. Synthetic organic chemicals such as detergents and household chemicals get discharged improperly and can cause fish kills.

Excessive nutrient loading can make the coastal systems look sick. Nitrogen and phosphorus are necessary for life, but in limited quantities. Excessive nutrient build up and create conditions that are conductive to outbreaks of algal blooms or "red tides". The outbreaks of algae are caused by the release of nitrogen and phosphorous waste water and agriculture run-off. These blooms block the sunlight, absorb dissolved oxygen, and disrupt food web dynamics. The frequency and severity of red tides has increased over the past thirty years in Atlantic Canada.

3.4.8 Fish and Food Processing Plants

There are over 300 fish and fish meal processing plants throughout the region

Table 3.4). The Saint John River in New Brunswick, the Barbara Weit estuary in Prince Edward Island, and the Cornwalis River in Nova Scotia are utilized by the plants to dispose of the waste (Eaton et al. 1994:5). Fish processing plants and fish meal plants release liquid effluents which are highly oxygen demanding. The waste discharged by these plants contain particles of fish, blood, slimes, bacteria, and other contaminants such as suspended solids, oil and grease, fecal bacteria, and other organic/inorganic contaminants. These effluents degrade water quality, deplete oxygen, and contaminate sediments in the small harbours where plants are typically located.

Table 3.4

Fish Processing Plants in the Atlantic Region -1988

Province	Plants	Employees
New Brunswick	76	4,093
Nova Scotia	121	7,364
P.E.I.	20	997
Newfoundland	112	11,024
Region	**329**	**23,478**

Source: Eaton et al. 1994:Ch4-38.

Fish and food processing plants play an important role in the economy of the four Atlantic Provinces. They provide jobs in large and small centers throughout the region and are the mainstays of many local economies. Regional fish and food processing plants generated $4.65 billion worth of products in 1987. As with most industrial processes, however, they also have the potential to degrade the ecosystem, and in many cases they do cause ecological damage.

Fish and shellfish processing plants, and particularly fishmeal plants, stress the ecosystem by releasing liquid effluents which are highly oxygen-demanding. Shellfish plants also generate large quantities of fish waste requiring ocean or land disposal. An estimated 3,000,000 tonnes of fish wastes is produced annually in the Atlantic region (Messiah 1992:32).

Wastewater discharges from fish plants, containing particles of fish, oil, blood, slimes, bacteria, and other bacteria cause concern in some locations. These effluents degrade water quality, deplete dissolved oxygen, and contaminate sediments in the small harbours and coves where fish processing plants are typically located. The solids in the wastes can also accumulate as anoxic sediment on the bottoms of coastal receiving waters (Messiah 1992:30). In some cases, these sediments contain elevated concentrations of organic substances such as polychlorinated biphenyls (PCBs) of which fish tissue is one of the likely sources, amongst others. Most marine fish contain small qualities of PCBs in their tissues. Organochlorines are synthetic organic compounds such as DDT and PCBs. These compounds accumulate in the fat tissues of fish that are then consumed by predators. The effect of such concentrations of PAHs on shellfish populations in Sydney Harbour has not been studied. The carcinogenicity of PAH compounds in human species has been known for some time and therefore it can be assumed that effects on shellfish populations are occurring. Thus, oil and wastewater from the cleaning and processing could carry the PCBs into the harbour and ultimately into the sediment where they can remain and accumulate. Similar conclusions were found in a study conducted by Environment Canada (Wiltshire 1978).

While fish plant effluents tend not to be particularly toxic compared to those from other types of processing facilities in the region (Well and Schneider 1975), the potential presence of coliform and salmonella bacteria in fish meal plant effluents gives cause for concern. Salmonella bacteria are pathogenic and can be transmitted from this source and cycled through the ecosystem to humans along two potential pathways: through fishmeal used as feed for domesticated animals and through fish and shellfish harvested from coastal waters contaminated by fish plant effluents (Menon and MacDonald 1978:12) The fish wastes provide a medium for the growth of these bacteria. There have been a number of shellfish areas, such as Black's Harbour, New Brunswick in the 1980s closed and remain closed due to fish plant wastes (Eaton et al. 1994:178)

Fishmeal plants play a role in the fishery by processing waste fish tissue that would otherwise become a land or ocean disposal problem. In the Atlantic region, about 60 percent of the fish waste generated by fish processing plants is processed into fishmeal and oil (Messiah 1992:31).

Unfortunately, the capacity of fishmeal plants is still not large enough to process all the waste fish produced by the industry. In fact, it appears that while the fishmeal plants are busy processing herring waste during the season, other types of fishmeal are often illegally disposed of by fish processors in other ecologically unacceptable ways, such as off the end of wharves, in ditches and in landfills (Eaton et al. 1994 179).

The potato processing plant currently owned by Cavendish Farms, at New Annan, Prince Edward Island, opened about 25 years ago and is one of the largest private employers in the province. But the plant discharges more than four million litres of treated wastewater per day into the Barbara Weit Estuary. The estuary was once recognized as one of the best trout fishing rivers in the province and rich in clams, oysters, quahogs, and eels. Pollution has decimated these marine populations (MacAndrew 1991:8).

3.5 Summary

In this chapter the main marine ecosystems and some of the main types of human activities that affect them directly or indirectly were described. While the direct contribution of fishing to the reduction of fish and shellfish populations seems evident, new technologies such as trawling also have indirect effects, including the destruction of the habitat of many species and the production of high levels of "by-catch" that affect the marine food chain. In addition, the untreated waste of large human populations, the wastes from agricultural production and that of different industries, including fish and shellfish treatment facilities, cause further injuries to the marine ecosystems. The synergistic effect of the activities of these different actors is much greater than the addition of their respective depredations of the marine ecosystems. The fishers are the first to suffer from the resulting scarcity and declining quality of fish and shellfish. They find their activities constrained by the action of other actors, such as fish markets and processing plants, but also by government regulations. Local and federal governments have long attempted to regulate and manage the fisheries, using different strategies based on different premises. The discussion of these policies will be the focus of the next chapter.

Chapter 4: Management of the Canadian Shellfishery

4.1 Introduction

Nowhere have the consequences of managerial espousal of the "Tragedy of the Commons" model been more starkly illustrated than in the crash of the cod stocks off Canada's East Coast. In 1980, the Canadian government, ignoring the needs and advice of inshore fishers to restrict predatory technologies and overcapacity in the fishing fleet, introduced a policy which limited the access of individual fishers to inshore fisheries and favored the more "efficient" boats of offshore trawler industry. These policies led to the complete collapse of the cod fishery in 1992. These policies and their concomitant effects, it is argued in this chapter, persist in the management of the shellfishery. This chapter examines fisheries management prior to and after 1992, the year of the collapse of the cod fishery. It focuses specifically on lobster fishery management, management strategies generally, and the role of the precautionary approach in management.

4.2 Fisheries Management Until 1992

Fisheries have existed on Canada's East Coast for hundreds of years. The current Fisheries Act, which is the primary legislative base for fisheries management, is itself over 100 years old.

The Canadian Atlantic fishery has two principal components: the offshore and the inshore sectors. The offshore consists of mainly large firms that own and operate trawler fleets and need a secure supply of fish year-round to remain viable. Trawler trips can last from eight to ten days, although most offshore companies have shortened their fishing trips to three to seven days since groundfish stocks declined in the 1980s. Freezer trawlers, however, can remain at sea for three to eight weeks.

The inshore sector consists of independently owned vessels, mostly under 65 feet length overall (LOA). Prior to the 1980s, these vessels typically fished relatively close to the shore and returned to home port each night. Current economic pressures now compel many small boat operators to venture further from port as some vessels are fishing 100 miles or more from land.

The Atlantic fishery is also subdivided by gear types and license limitations. Prior conditions of open or unrestricted access to fishery resources were virtually eliminated through regulations introduced in the 1970s and 1980s that stipulate who can fish where, with what gear, as well as when and how to fish. Resource managers collect data on catches and landings of all species by fleet, type of gear, and individual company. Offshore vessel operators must report their catches daily and at the end of each trip. Inshore fishers must also keep records of their activity.

Prior to the mid 1960s, the Federal government considered most fisheries open to anyone who wished to fish and applied for a fishing license. Ralph Matthews (1993:40-41) claims that a shift in policy direction occurred with an acceptance that the economic theory of common property applied to fisheries. Until that shift, although licenses were required in some fisheries, there were no restrictions on who could hold licenses or how many license holders could operate in a given fishery. In addition, there were no direct or significant restrictions on catch levels or fishing capacity.

4.2.1 *Tragedy of the Commons Model*

Among the major theories explaining why problems arise in certain fisheries, the best known is the one linked to the Tragedy of the Commons model. It suggests that the root cause of the problem is a fishery's status as common property and maintains that when tenure to marine resources is unspecified, a tragic situation will almost inevitably develop as more and more competitors enter a profitable fishery. The theory constitutes a model for explaining overexploitation and overcapitalization and is easily understood and very persuasive.

The idea that commons are subject to problems is an old idea in Western thought (McKay and Acheson 1987:2). The idea gained widespread attention with the publication of Garrett Hardin's (1968) paper "The Tragedy of the Commons". Defining what he meant by "tragedy", Hardin (1968:1244) cited Whitehead's (1948) observation that "the essence of dramatic tragedy. . . resides in the solemnity of the remorseless working of things". Hardin's model has become so paradigmatic that it is, as Godwin and Shepard (1979:265) claim, "the dominant framework within which social scientists portray environmental and resource issues."

The tragedy of the commons that Hardin refers to is the presumably inevitable collapse that natural ecosystems, and the human economic enterprises that exploit them, will undergo when their key resources are common property, and the effort that is applied to producing them continues to increase. Acute competition, overcapitalization, and resource depletion are integral aspects of this tragedy. The model is thus predicated on certain assumptions about human behavior under some specified conditions.

With regards to fisheries, the theory suggests that once the number of competitors is sufficient to bring about declining yields for a given amount of effort, individual fishers, rather than exercising restraint to conserve the stocks, will instead increase or intensify their efforts. Even as their margin of profit declines towards zero they will increase their efforts, taking what fish they can today on the assumption that there will be even fewer fish to catch tomorrow. In this theory, though increasing effort in the face of declining yields seems "rational" from each fisher's point of view, such behavior is collectively ruinous, or tragic, for all participants in the fishery. In Hardin's (1968:1244) words, "the individual benefits as an individual from his ability to deny the truth even though society as a whole, of which he is part, suffers."

Hardin's solution is governmental action. Hardin claims that we cannot ask people to voluntarily restrain their use of any commons with any hope of success and "coercion" is necessary. The coercion should be "mutually agreed upon" (Hardin 1968:1247), by which he means some sort of management by government enforceable by law and perhaps not very democratically imposed.

Those who have become disenchanted with state imposed regulatory regimes have increasingly proposed a different solution for solving or preventing the tragedy, namely, privatization (DeGregori 1974; Peters 1987). The privatization of common property, they claim, would provide more compelling incentives for fishers to restrain fishing effort amongst themselves, as well as make them more responsible for bearing the cost associated with the managerial effort. These scholars also see the tragedy in common property fisheries as closely associated with "open-access", which is assumed to be an attribute of most common property regimes. McKay and Acheson (1987:34) claim that " by equating common property with open access, the tragedy of the commons approach ignores important social institutions and their roles in managing the commons." Also, when the approach to managing a commons ignores or supersedes local management approaches, and instead emphasizes either government intervention or privatization, the change can substantially weaken or destroy local institutions that were effective in preventing the "tragedy" and may actually encourage it (see Berkes et al. 1989). Thus the proponents of privatization conclude that the tragedy could be avoided if common property fisheries were converted to private property, and that a private property model would result in more efficient use and conservation of resources and greater increases in wealth than do less exclusive forms of property (Johnson 1972:259). These benefits are received from the fact that private property rights do away with what economists call "externalities". Gaining property rights, as economists have defined it, is a process of internalization of benefits and costs.

The research completed on fishers suggests that the model as it is usually conceived is too abstract and generalized to provide much understanding of particular common property fisheries. The "commons" does not mean the same thing in all fisheries, and the behavior of fishers does not always conform with what the model predicts.

Vayda (1988:6) claimed that without an understanding of local actors it is erroneous to assume that people harvesting common property resources must inevitably become involved in a tragedy of the commons. While etic analysis may identify resources as common property, an emic analysis of the local actors might show that these resources may or may not be identified as such from the point of view of these users. This type of analysis could help in the development of management strategies that reflect the local institutions already in place for use of the resources.

There are other defects that have become apparent in the model. Few users of common property are devoid of societal restraints that they can behave as selfishly as the model predicts (McKay and Acheson 1987:35).

The assumption that private property will always be more diligently conserved by its owners may be an erroneous assumption. Private property status afforded to a resource does not necessarily provide absolute assurance that it will be conserved (Acheson 1989:364).

Another defect in the model is that it ascribes the causes of ecological destruction and economic deterioration "to the nature of property rights instead of acknowledging the role of more complex features of socioeconomic systems" (McKay and Acheson 1987:9). The depletion of resources that have till now been associated with common property rights may in fact be more a result of capitalistic policies or of modernization. For example, Franke and Chasin (1980:120-122) attribute much of the tragedy in the management of common property resources in the Sahel to the loss of a traditional local "bioethic", or self-sufficiency, with the transition to colonial production modes.

It seems that intense and increasing competition more than any inherent flaw in the character of fishers themselves compels the behavior associated with the tragedy of the commons. Local fishers will feel compelled to abandon local practices prescribing restraint when they become caught up in capitalist systems that put their very survival at risk.

4.2.2 Fisheries Management

Because of the reliance on the Tragedy of the Commons model, the solution in fisheries management throughout this period was to limit entry into a fishery by restricting the number of fishers and boats. Limited entry licensing was introduced into the Atlantic lobster fishery in 1967. The Atlantic groundfishery, in the 1970s, utilized quota management by establishing a total amount of the resource that is allowed to be harvested in a given period. Between 1970 and 1974, the International Commission for the Northwest Atlantic Fisheries (ICNAF) issued catch quotas (TAC) and national allocations for all major international groundfish stocks.

Matthews (1993:43-44) claimed that certain assumptions led to the acceptance of the common property perspective in fisheries policy. First, there was the total and universal acceptance that a common property, in open-access fisheries leads to overcrowding and the depletion of fish stocks. Secondly, there was the general agreement that measures were deemed necessary to move excess labour out of the fishery and to prevent additional labour. Thirdly, there was concern over the means of regulating the fishery through some form of property rights. And therefore, it was thought that limited entry regulation was necessary.

The federal government's initial acceptance of the "tragedy of the commons" model can be found in 1976, when the Policy for Canada's Commercial Fisheries was developed in anticipation of the extension of the fisheries jurisdiction to 200 miles and was partly in response to a need to "rationalize" the management and use of fishery resources (Matthews 1993:50). Canada extended its fisheries jurisdiction in 1977.

Following the extension of jurisdiction to 200 miles, conflicts between the processing and harvesting sectors arose over who would control access to the resource. Harvesters were concerned that processors should not be allowed to own harvesting operations while processors were looking to integrate harvesting and processing. This led to the Fleet Separation Policy in 1979 where the harvesting and processing sectors of the industry were separated and prevented fish processors from holding fishing licenses for vessels less than 65 feet. Also in 1979, the federal government reviewed the Canadian fishery policy and instructed C.R. Levelton to prepare a report on the role of licensing in the groundfish fishery (Matthews 1993:51). The Levelton Report concluded that three different categories of non-transferable license should be issued to "regular fishers, apprentices and casual fishermen" (Levelton 1981:83-85). The fisheries Minister endorsed the Levelton report in 1980 and limited access became the key part of the Canadian government response to overfishing, although licensing remained beyond community control (Matthews 1993:11).

In 1981 an economic recession gripped North American and two major processing companies asked the federal government for financial assistance. Michael Kirby chaired the Task Force on Atlantic Fisheries to recommend how to achieve and maintain a viable Atlantic fishing industry. The federal government combined the processing operations into two corporations (Parsons 1993: 68-70).

Since 1977, Canada has had a 200 mile management zone and has dramatically increased its catch, which rose from 895,000 metric tonnes in 1976 to 1.1 million metric tonnes in 1980. This represented an increase in Canada's share of fish taken within this area from 42 percent to 75 percent over that four year period. Outside this zone, Canada participates in the Northwest Atlantic Fisheries Organization (NAFO), formed in 1977, which arbitrates disputes concerning additional access to fishing grounds.

By evicting the foreign fleets, Canada then proceeded to replace the fleets with large boats of their own and fished at what they considered to be Maximum Sustainable Yield, but this was well beyond what fish stocks could sustain, as evidenced by the eventual collapse of the cod fishery. Federal intervention into the Atlantic groundfishery with the restructuring of the processing sector cost $246.37 million (Parsons 1993:375). But, by 1984 the catch rate of the Canadian trawlers peaked (Parsons 1993:376). By the end of the 1980s, the fishing fleets were far larger than necessary to catch the available fish and the vessels were high-tech trawlers that caught far more fish far more efficiently than the old shore fishers had ever done. Fish populations are affected by both fishing pressure and naturally occurring ecological factors. Both are spatially and temporally variable. For example, fishing pressure is a function of both the spatial and temporal intensities of effort. Fluctuations in the physical ecosystem add uncertainty and variability to the management problem.

In 1989, the Atlantic fishing industry began to experience serious problems, largely as a consequence of over capacity, groundfish stock declines, too many fish going to market, and weakened export markets. Fish plant closures occurred in every province while many fishers, due to reduced quotas and lower prices, struggled to meet escalating operating costs.

This led to the collapse of the Canadian cod fishery. In 1992 Canada announced a two-year moratorium on cod fishing in Canadian waters and thousands of fishers and fish workers lost their jobs. The collapse of the fishery in itself provided evidence of the failure of the limited entry policy pursued by the federal government. The collapse of the fishery was in keeping with warnings that stocks were being depleted by offshore draggers and the use of new inshore technology.

4.3 Management After 1992

In 1992, Richard Cashin claimed that the collapse of groundfish populations in Atlantic Canada region was " ... a calamity that threatens the existence of many of these communities throughout Canada's East coast, and the collapse of a whole society" (Cashin 1993:2). In 1992, John Crosbie, then Minister of Fisheries, declared a two year moratorium on fishing for northern cod in many areas of Atlantic Canada. Since 1992, area closures expanded and the moratorium's time frame was extended into the 2000s.

After the collapse of the cod fishery, the federal government set up a task force on Incomes and Adjustment in the Atlantic Canada fishery, chaired by Cashin, to look into the causes of the collapse and what that collapse would mean for Atlantic Canada's fishing communities. In setting out the problems, the Task Force claimed that the resource has always been subject to fluctuations, such as ecological changes that affect fish reproduction and survival, water temperature and salinity changes, food supply changes that affect the populations of other species, and changes in predator populations (Cashin 1993:5-6). These problems were outlined before any mention of the human exploitation of the resource. The Cashin report then stated that in 1990 there were 28,000 boats registered, employing 64,000 people in Atlantic Canada, together with 800 processing plants employing 60,000 people. There was no mention that these activities may have had a large role in affecting fish populations.

The Cashin Report discussed human exploitation of the resource as "overdependence on the fishery, pressure on the resource, and industry overcapacity, all interacting in a vicious cycle" (Cashin 1993:14). From the perspective of the Cashin Report, overdependence means "there are more people and capacity than the fishery can maintain." It is caused by "a social tradition of the right to fish among Atlantic Canadians," by a "lack of economic alternatives," as well as "the use of the fishery as the employer of last resort" (Cashin 1993:14). Pressure on the resource means that:

> ... while the resource is finite, human populations keep growing. Ignorance is another factor. This includes our lack of adequate knowledge of the resource, its habitat, the interaction among species, and other ecological factors. In addition, fishing technology keeps improving. Pressure also comes about from mismanagement of the resource - the failure too control, to enforce limits, and the lack of meaningful partnership with the users of the resource. And it comes from wasteful harvesting practices (Cashin 1993:14).

The third aspect of this cycle is overcapacity and the results in a situation where:

Too many harvesters use too many boats with too much gear trying to

> supply to many processing plants by finding and catching too few fish. The results are low and unstable incomes, problems with income assistance, especially unemployment insurance, and a generally unprofitable industry, characterized by persistently under-financed operations. The net effect exacerbates the problems of overdependence and pressure on the resource. And the cycle continues (Cashin 1993:14).

The report then claimed that the cause of this cycle is the common property nature of exploitation in which "everyone wants as much of the resource as possible" (Cashin 1993:15). This argument is linked with prior reports by the federal government that identified common property as the problem in the fishery.

Since 1994, the DFO has been pursuing the "Fishery of the Future" strategy, to make fisheries "economically and ecologically sustainable; stable and capable of providing adequate levels of income; and self-reliant, competitive and viable without subsidization". In certain decisions, the DFO has not always adhered to the Fishery of the Future strategy. Allocation decisions have been made to support political objectives. In 1997 and 1998, for example, the shrimp allocation in one region of Newfoundland was given to several community-based Labrador corporations in an attempt to provide inshore vessels with a catch. These corporations chartered or sold the allocation to offshore license holders (Auditor General 1999:4-10). In another region in Newfoundland's shrimp fishery, an allocation of 3,000 tonnes was given to a community-based corporation that had the goal of developing a shellfish processing facility on the Northern Peninsula. In both years the corporation contracted others to fish and process the allocation (Auditor General 1999:4-10). In 1995, the Minister authorized the establishment of two "exploratory snow crab fishing zones" in the Gulf of St Lawrence area, to be fished by groundfish dependent fishers who do not hold snow crab licenses. An "exploratory fishery" is one which is attempting to determine whether a stock can sustain a commercially viable operation, as well as collect biological data for information on stock abundance and distribution.

In 1997, the DFO reported to the Minister that these two fisheries no longer met the requirements of an exploratory fishery as scientists had determined that the zone had no resident stocks. The snow crab in the exploratory zone was found to be a migrating stock from an adjacent zone. The DFO recommended that the fisheries be closed. The Minister chose to keep the zones open in 1998.

The 1998-1999 DFO Report on Plans and Priorities stated that the overall departmental objectives include, among other things, undertaking policies and programs in support of Canada's economic, ecological and scientific interests in the oceans and inland waters and providing for the conservation, development and sustainable economic utilization of Canada's fisheries resources for those who derive their livelihood or benefit from these resources. The specific objective of fisheries management is: ...[to ensure] the conservation and protection of Canada's fishery resource and, in partnership with stakeholders, to assure its sustainable utilization (Auditor General 1999:4-12).

4.4 Shellfish Management

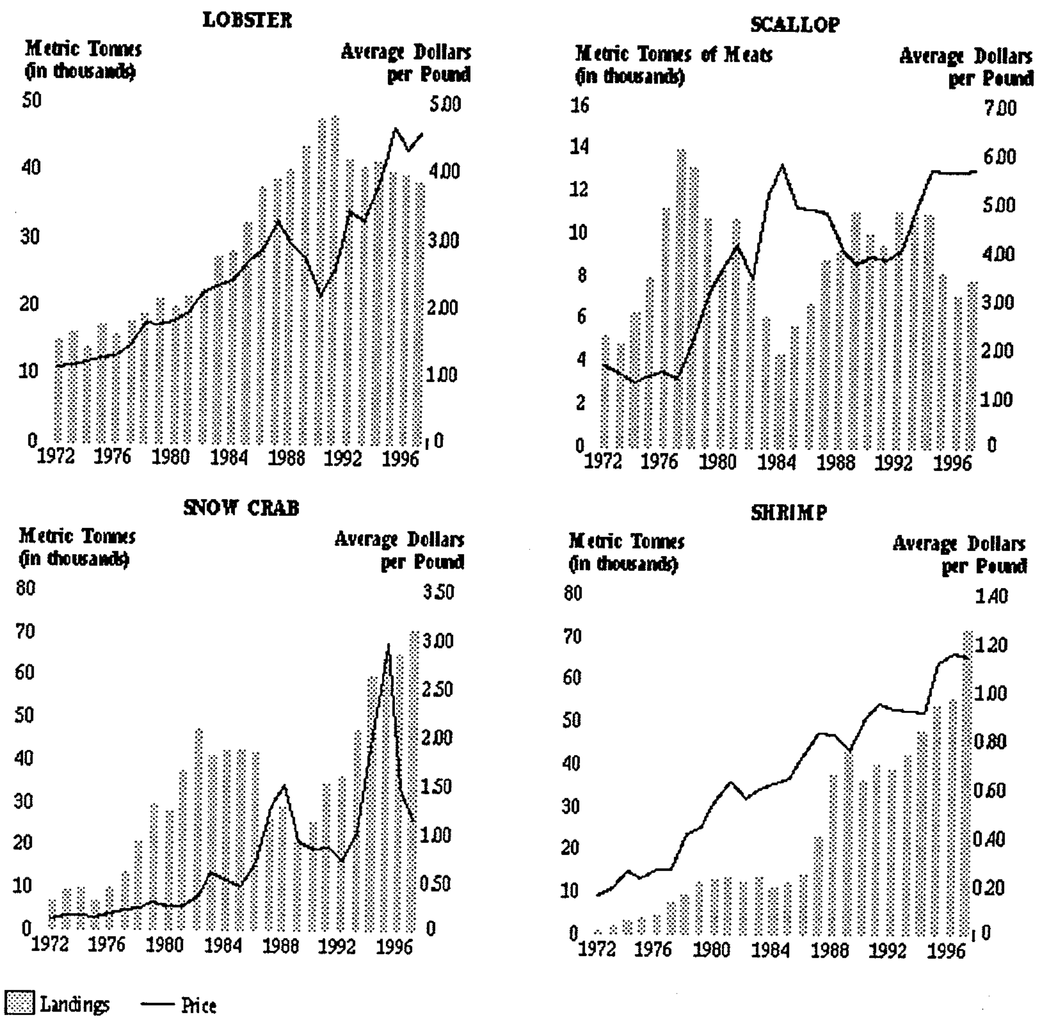
The fisheries in Atlantic Canada have been beset with complex problems. The department has often claimed that these problems are a result of "too many fishermen, too few fish". Total Allowable Catches (TACs), quotas, licensing and vessel registration are utilized to control access to the fishery and fishing effort.

In the 1990s, Atlantic Canada witnessed a virtual collapse of its commercial groundfish fishery. In the same period, however, there was a general rise in the value (Chart 4.1) of shellfish landings (lobster, scallop, crab and shrimp). In 1997, the landed value of all shellfish in Atlantic Canada was $920 million, which represented 81 percent of the landed value of all fish landed in the region.

Chart 4.1

Trends in Landings and Prices for Lobster, Scallop, Snow Crab and Shrimp

Atlantic Canada



Source: Auditor General 1999:8

The objective of the DFO is conservation, or protecting the productive capacity of the natural resource that supports the fishery. In 1998, DFO indicated that it is not responsible or accountable for social outcomes (Auditor General 1999:4-15-16).

In fact, shellfish landings from 1984 to 1997 rose in weight by 238 percent, from 131,000 to 312,000 tonnes. Since the early 1990s, landings of lobster and scallops have declined but crab and shrimp landings have increased, most notably in Newfoundland and Labrador. The change in landings may be attributable to unknowable levels of both ecological variability and fishing effort.

At the same time, the rising demand of shellfish has increased prices received by fishers. Declines in the groundfishery notwithstanding, the landed value of all Atlantic Canadian fish reached $1.34 billion in 1995. When adjusted for the impact of inflation, this represents the second highest annual landed value ever in the region.

The incomes of fishers in the shellfish sector have provided a stark contrast to those of fishers who depended on groundfish for a living. The 1990s saw a variety of government programs designed to provide groundfish fishers with income support and opportunities for other employment, and they have become dependent in a large part on these programs for a substantial portion of their income.

The American lobster occurs in commercial concentrations from southern Labrador, Canada to New Jersey in the United States. The major concentrations of lobster in Canada are in the Northumberland Straight and off the southwest tip of Nova Scotia. The Canadian lobster is common property under the jurisdiction of the federal government. Regulations in the lobster fishery have existed since 1878, with the intent of protecting and enhancing the resource.

Lobster yields, nevertheless, had dropped to record lows in the late 1960s. A task force was set up in 1974 to investigate the fishery (Fisheries and Oceans 1975).

The report recognized the diverse structure in which the lobster fishery existed, its importance to local economies and its monetary returns to fishers. Recommendations were made but many of the recommendations had not been implemented (Pringle et al. 1993). This failure to act may have spawned the problems that exist presently as the Auditor General of Canada, in 1999, claimed that the shellfishery was in crisis (Auditor General 1999:1).

4.4.1 Brief History of the Lobster Fishery

Lobster landings were relatively constant from the mid 1940s to the early 1980s. In the early 1980s, the Department of Fisheries And Oceans (DFO) divided the Maritimes into two regions, Scotia-Fundy (S-F) and Gulf of St. Lawrence (Gulf). Both New Brunswick and Nova Scotia are represented in each region giving each both cold (S-F) and warm (Gulf) water lobster production areas. The ecological differences between the two regions have created quite different harvest strategies leading to different marketing problems. The colder waters of S-F, with the exception of LFA 27 in northern Nova Scotia, dictate a larger minimum legal size than that of the Gulf. Lobsters in the cold waters of the large production states of Maine and Massachusetts have similar ecological conditions, thus the similar minimum legal size. In addition, water transport to United States markets is more viable for S-F landings and the presence of ice free ports in southwestern Nova Scotia provides the potential for year-round landings. These characteristics permitted the S-F industry to market the more profitable live lobsters during periods when demand was high.

By contrast, the Gulf lobster industry processes most of its catch because minimum legal size was below that of the United States. Furthermore, a five-month winter ice cover dictates that seasons be open during periods of high supply. Distance prevents the water transport of product.

4.4.2 Resource Management

The 1975 Task Force noted that no individual in the management hierarchy was responsible for the lobster fishery. The unit of management in the lobster fishery is the Lobster Fishing Area Advisory Committees (LFAAC). Industry is represented by elected fishers and processors. DFO members include a biologist, an economist, the local fishery officer, the Regional Senior Advisor for Invertebrates and a Chairperson (usually a DFO Area Manager). Each committee meets a minimum of once yearly to advise the Regional Directors-General on all issues impacting the lobster fishery. LFA management plans are modified only after discussions with the respective committees.

Each LFAAC elects one fisher to the Regional Lobster Advisory Committee (RLAC), which is chaired by a senior DFO advisor. The remainder of the committee resembles that of the LFAAC. The RLAC meets at least twice yearly to advise on Regional or Atlantic Zonal matters.

The committee biologist provides each LFAAC with an annual stock assessment. The economist provides information on fishery and market performance. Biological and economic advice, along with advice from the advisory committee process and other levels of government, are combined to develop each LFA's annual management plan and to modify regulations as required. This advice can impact seasons, trap limits and other effort related measures. A licensing unit administers the annual issuance of licenses, their transfers and conducts licensing appeals hearings. Fishery officers promote, monitor and ensure compliance with Acts, Regulations, policies, management practices and specific fishing plans applicable to lobster.

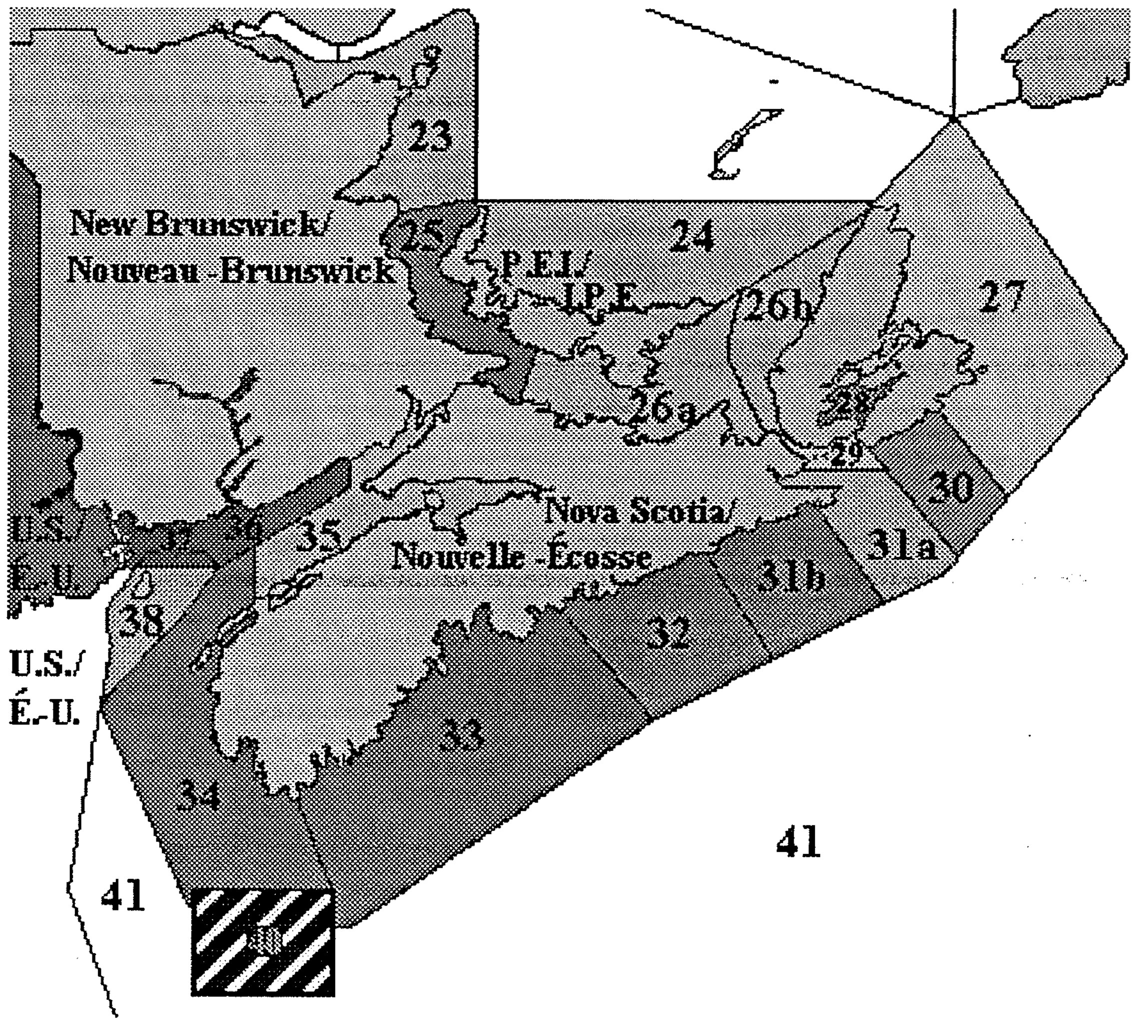
4.4.3 Management controls

The coast of the lobster fishery is divided into Lobster Fishing Areas (LFA). Each LFA has a management plan tailored to its characteristics. The LFAs vary in both length of coastline and in level of lobster harvested. The locations of the LFAs can be seen in Map 4.1.

Effort is controlled by limited entry licensing, by limiting the number of traps, and by limiting maximum number of days fished within an open season. A license is issued annually to each fisher who held one the previous season. A licensed fisher can operate a vessel of unlimited size (except in LFA 34) within the boundaries of the LFA.

Map 4.1

Lobster Fishing Areas in the Maritime Provinces



Source: DFO 2002

The maximum legal trap number per fisher varies amongst LFAs in accordance with overall lobster harvest, fisher density, and historic circumstances. The number is higher than optimal (DFO 1989). Trap limits are controlled by issuance of trap tags, which are equal in number to the licensee's trap limit. A trap, to be legally set, must be tagged. The number of days per open season varies among LFAs, as does the occurrence of the open season.

The only regulation aimed at optimization of yield-per-recruit is the minimum legal size (MLS). This regulation, along with prohibition on the possession of berried females, is designed to prevent recruitment overfishing. There are four minimum legal carapace lengths (CL): 63.5, 70.0, 76.00 and 81.0 mm, each of which apply in different LFAs.

There is one offshore lobster fishery which is called LFA 41 (DFO 1999b:7). The number of licenses was limited to eight in 1975. The TAC was set at 720 tonnes and presently, Canadian corporation Clearwater Fine Foods Ltd. holds seven of those licenses which comprises 87.5% of the total TAC. The remaining license and 12.5 % of the TAC is held by Donna Rae Ltd. Since 1990, the total allowable catch has only been exceeded twice and in all other years the TAC was not reached (DFO 1999b:9). This would indicate that perhaps there are not enough lobsters to catch. The TAC was maintained at 720 tonnes as DFO officials claimed that the lower landings were "due to problems with the logistics of the harvesting operations and not related to a resource problem" (DFO 1999b:9).

4.4.4 Stock Assessment

Estimating the biomass of the resource is conducted by utilizing the traditional fisheries approach and by employing fishery statistical data. However, the use of biological information is not applicable to lobster population estimates. Because basic biological knowledge of the lobster, such as methods of aging and sexing lobsters, is insufficient and unknown, effective management is difficult at best.

Fisheries catch and effort data, utilized in other fisheries, are unavailable for the lobster fishery. Data gathering consisted of a logbook system involving volunteer fishers, from selected ports, to record daily traps hauls and catch. Information on the frequency of both undersized lobsters and berried females is also recorded.

4.4.5 Management Objectives

Prior to the late 1960s, fishery regulations focused on the animal harvested, thus lobster regulations dealt with the minimum legal size (MLS) and the protection of broodstock. As the number of fishers increased and modern fishing techniques enhanced fishing power, there was a need to regulate effort and catch levels.

The Lobster Fishery Task Force of 1974 (Fisheries and Oceans 1975) sought to attain a viable, self-sustaining fishery, which would be managed in response to local needs with input from industry and which would have greater access than in the past to biological, economic and technological knowledge. Later, Kirby (1982) called for creation of an economically viable industry that remained Canadian-based, with maximum employment, subject to the provision of economically reasonable returns to participants. These objectives have guided fisheries management and continue to do so.

4.4.6 Harvesting

The lobster fishery in Atlantic Canada is primarily an inshore, small boat fishery with landings concentrated in the southern Gulf of St. Lawrence (Gulf Region) and Scotian Shelf (Scotia-Fundy Region). The fishery occurs along the entire coast, in some LFAs up to 90 km from shore, although in most areas the lobster grounds extend only a few kilometers from coast. A small offshore sector exists in the northern Gulf of Maine, beyond 90 km from shore, in LFA 41and is concentrated on Georges Bank and Browns Bank. This offshore sector began in 1971 with six vessels. Since 1985, the offshore fishery has been managed with both total allowable catch (TAC) and an enterprise allocation (EA) plan.

Following the introduction of limited licensing in 1967, the industry entered a period of low landings and low prices. The Lobster Task Force (Fisheries and Oceans. 1975) recommended that licenses be reduced both to decrease effort and to increase incomes. To assist this process, licenses were categorized into "A" (full-time) and "B" (part-time) based on economic dependence on the fishery. The "A" license holders were able to fish the maximum trap limit permitted in the LFA and the licenses were made transferable. By contrast, "B" license holders fish a reduced number of traps and the license retires with the fisher. Lobster landings underwent consistent yearly increases throughout the 1980s, increasing from 20,949 tonnes in 1981 to 44,963 tonnes in 1990 (Pringle et al 1993:104).

Lobsters today are the backbone of the inshore fishery in Nova Scotia, New Brunswick and PEI. In most LFAs, lobsters provide the base of a mixed fishery supplemented with groundfish, herring, and other species. Commercial fishing is performed exclusively by baited traps which are set in one of three different configurations. Up to twelve traps are hooked sequentially to a main line which is anchored at either end and buoyed from above. Traps are hooked together either in pairs to a common buoy or one trap per surface buoy. The traps are made from either wood or wire mesh. Several technological advancements have emerged including more powerful diesel engines, hydraulic trap haulers, and enhanced navigational equipment.

These improvements to the way lobsters are harvested have caused significant increases in costs. These cost increases were sustainable while the landing values were rapidly increasing prior to 1987. Since then, the value of landings has decreased substantially. Lobster fishers find it more difficult to finance the new equipment they purchased during the prosperous 1980s (Pringle et al. 1993:104).

4.4.7 Processing

The lobster industry's on-shore sector receives and sorts lobsters at more than 1,000 ports, for either live or processed markets. Recent studies of concentration levels indicate that Scotia-Fundy's top ten buyers accounted for 34 percent of purchases, the next 68 buyers accounted for 56 percent, and the 102 smallest buyers accounted for 10 percent of purchases (DFO 1989). The top ten Gulf Region buyers account for 30 percent of purchases.

About 90 percent of lobster from Scotia-Fundy, and 30 percent from Gulf are marketed live (Pringle et al. 1983:107). Live lobsters must be marketed through a network of "ponds and tanks". The industry has developed five types of holding facilities. The holding technology is relatively specialized and the costs, including the losses due to mortality, must be factored into retail prices.

Lobsters from the Gulf Region, are processed into a number of products. Some of these are meat-in-shell products such as tails. The price of these products reflects the shell weight and the processing cost. Shucked meat can be put into hermetically sealed cans. These non-shell products have a higher price per pound.

4.4.8 Stock Status

The Department of Fisheries and Oceans in attempting to determine the number of lobsters available for harvesting have divided the LFAs into reports, based on geographic location, on the population's status. These are known as stock status reports.

In 1995, the Fisheries Resource Conservation Council (FRCC) presented a review of the status of the Atlantic Lobster fishery. The report claimed that the present fisheries were operating at high exploitation rates, and harvesting primarily immature Lobsters (FRCC 1995). Thus, if lobsters decrease in abundance, recruitment overfishing occurs, as legal minimum size is substantially below that at which most lobsters become sexually mature. As mentioned previously, lobsters reproduce more often as they become larger, therefore smaller lobsters results in fewer eggs being released.

The lobster fishery in the Gulf Region is the most important source of revenue for the largest number of fishing enterprises (DFO 1999a:2). The lobster fishery in the Gulf is practiced in five LFA units. These fishing areas do not correspond to biological entities of the lobster population in the southern Gulf but to groups of fishers from different communities along the coasts of eastern New Brunswick, PEI and the Gulf shore of Nova Scotia. From 1915-1973 commercial lobster landings for the Gulf fluctuated between 5,000 tonnes and 10,000 tonnes per year. Since 1974 lobsters harvests increased substantially from 5,211 tonnes to 22,215 tonnes in 1990, which is a 400 percent increase in landings (DFO 1999a:3). Landings have steadily declined by an average of 25 percent since 1990, with the most severe being in LFA 26a, which has decreased by 50 percent since 1988 (DFO 1999a:4). The Gulf accounted for 40 percent of the Canadian landings in 1997 (DFO 1999a:5). In 1997, the Southern Gulf Region Lobster fishery harvested 16,568 tonnes (DFO 1999a:3). Exploitation levels by LFA range from 60 percent to 80 percent (DFO 1999a:6).

The situation in the Southern Gulf of St. Lawrence lobster fishery seems undesirable. The overall catches in the region have been slowly declining since the 1990 record landings. Most of the new catch consists of new recruits. There is no evidence of V-notching, and exploitation rates are high. Also, a revised analysis suggests that the stock is heavily fished and recruitment overfished (DFO 1998c:1).

The lobster fishery in eastern Cape Breton is practiced in 4 LFA units. Landings and catch rates have declined in these LFAs. After peaking from 1982-1992, landings declined in each LFA. In 1997, landings declined by 13 percent in LFA 30, and 33 percent in LFA 29 (DFO 1998b:2). Catch rate (kilogram per trap haul) has declined in all areas since 1992 (DFO 1998b:3).

The lobster fishery in eastern and south shore Nova Scotia is practiced in 3 LFA units. Landings in LFA 32 and most of LFA 33 have stabilized in the last few years, but continue to fall in LFA 33 and over the last ten years catch per trap haul has decreased in all areas. These are consistent with the previously discussed LFAs, as landings peaked in all three areas in 1990. Since then declines in recorded landings have been 65, 30, and 40 percent in LFAs 31, 32, 33 respectively (DFO 1998b:2).

The lobster fishery in southwest Nova Scotia is one LFA unit. Landings in this area remained level in the 1990-1991 season. However a higher percentage of the lobster landings are occurring earlier in the season, which is consistent with an increase in fishing effort. Landings may have remained high, in part, due to increased fishing in the mid-shore region. Landings in 1996-1997 were 10,415 tonnes, which was the second highest this century and 2.8 times the average for 1971-1980 (DFO 1998d:4).

The lobster fishery in the Bay of Fundy exploits four LFAs. Landings have increased dramatically over the past two years and are well above average levels. The mean size of the catch in the upper Bay has declined. From 1988 to 1994, total landings appeared to stabilize at approximately 100 tonnes. Landings then increased by 300 tonnes each fishing season and reached 1,893 tonnes in 1997 (DFO 1998a:3). The mean size of lobsters sampled in Alma, New Brunswick in the 1990 season show a 10 mm decrease in mean size of these lobsters (DFO 1998a:5).

4.5 Management Strategies and Dilemmas

A fishery's overall management policy and management regime usually bring into play a mixture of disparate management strategies, each of which presents managers with an array of choices, or sub-strategies, on how they will be implemented. But every management regime ought to have one common feature: some mechanism that gives managers the flexibility to juggle the emphasis given to one strategy or another and to add or drop a strategy as changing conditions require. As previously shown, fishers in the offshore LFA (41) were not able to catch their quotas in eight of ten years, though the total allowable catch (TAC) was maintained. Fisheries managers have not aligned the TAC with changing biological conditions.

It is not only human activities and considerations that prompt the managerial dilemmas so often associated with most strategies. The unpredictable ocean itself, with its marine populations fluctuating in response to dynamics that are still unpredictable, frequently confounds managerial policies and regimes as much as a fishery's human participants. This unpredictability is still underestimated by fishery managers, partly because of the short time horizons with which they often have to work and partly because they often do not have good data on marine resource levels.

By investigating a fishery over the long term, it becomes apparent that fishers are also subject to fluctuations. First, a few small scale fishers enter a fishery then as the years pass some prosper enough to become the employers of other formerly independent producers. Meanwhile, vessel sizes increase and capture technologies become more effective. Then, sometimes without warning, the bio-economic equilibrium point is reached and there is a large exodus of fishers from the fishery. Thus, the fishers in a particular fishery may be comprised of certain classes who are at the same stage or at stages of expansion. Fishery managers must understand not only the complex dynamics of marine populations, but also the population dynamics of the fishers they seek to manage, appreciating that both undergo changes that are sometimes difficult to predict (FAO 1983:11-12). Acheson (1988:63) claims that changing target fisheries is one of the most common adaptive strategies fishers employ. This adaptive strategy "means that regulations to reduce effort on a given species often means nothing more than shifting that effort to other fisheries which can cause problems in those fisheries in the future".

At the most basic level, the process of fisheries management involves solving two fundamental problems. The first is conservation: deciding what quantity of shellfish can be harvested on a sustainable basis. The second is allocation: deciding who benefits, in what ways, and to what extent (Smith 1988: 132). There are seven basic strategies employed to satisfy both concerns. They are: closing areas, closing seasons, restricting gear and technology, establishing aggregate quotas on total allowable catch, attempting to stimulate fisheries growth or to control fishing effort through monetary measures such as subsidies and taxes, limiting entry, and instituting various forms of private property rights. What follows is an examination of each of the seven strategies now employed, with special attention to both costs and benefits as well as drawbacks for fishery managers.

4.5.1 Closing areas and seasons

Indirect methods for reducing fishing effort like closing areas or seasons and placing restrictions on fishing gear were among the first strategies to be utilized in Canada's fisheries management. These methods are fairly easy to implement and enforce because they are straightforward and perceived as applying more or less equally to all producers in a fishery.

Closed areas or seasons are generally imposed when fish stocks are down or in poor condition, during down markets, or when nursery grounds and juvenile stocks are in need of protection. Areas can be closed for essentially political concerns, to reduce conflicts, in the interest of socio-economic equity, and because of national policy concerns. Closures are also sometimes used for safety purposes during seasons of unstable and bad weather (FAO 1983:7). The main objective is usually conservation.

The main advantages of this strategy are twofold: the policy is easy to implement and it is flexible. Both areas and seasons can be opened and closed fairly quickly as updated information about the stocks suggest. However, the main disadvantage is that if employed exclusively, this strategy does nothing to discourage the development of overcapacity.

There are two types of closed season regimes. The first type is to close a fishery during certain time of the year when juvenile members of the stock would be too easily caught. The second type of closed season regime entails closing a fishery when catch size or the catch composition per unit of effort falls below some desired level. This type of regime is more complicated and expensive than the first as it requires close and continual monitoring of catches. Also, it is only useful when there is a strong correlation between overall catch or catch composition and fishing effort (Beddington and Rettig 1984:11).

Closed seasons are a way to protect vulnerable stocks, but the strategy falls short by perhaps encouraging overcapacity. Fishers may strive to maximize their production during the open season by investing in more expensive and effective fishing vessels and fishing technology to extract as much as they can from the fishery. The results are an increasingly short fishing seasons and disrupted markets because of severe discontinuities in supply. There may also be a fall-off in quality of the product reaching consumers because of the intensity with which the fish are caught and the haste with which they are brought to market (Beddington and Rettig 1984:12). In Alaska, there are 48-hour seasons annually for groundfish and no limit on number of fishers and boats (Chodkiewicz 2002).

In sum, closed areas and seasons are useful strategies for meeting conservationist objectives, but if utilized independently from other strategies they may promote overcapacity. Moreover, when areas are closed in the interest of protecting an overexploited or vulnerable species, fishing for other species that are neither overexploited nor vulnerable is shut off (FAO 1983:8).

4.5.2 *Gear and Technology Restrictions*

Fishing gear and technology are typically restricted by setting minimum sizes on net meshes, particularly in trawls and gill nets, requiring escape gaps in fish traps and pots, particularly in crab and lobster fishing, and limiting vessels engines to a certain size or horsepower.

This strategy has been clouded with controversy. The strategy appeals to fishery managers because it is easy to explain to fishers, easy to implement and enforce, and usually effective in accomplishing its intended biological objective, generally to see that only the larger fish are caught. Fishers may be opposed to this strategy as it may mean retiring still useful equipment and purchasing new expensive gear. Technological restrictions may be criticized by economists and policy makers, as well as by fishers, on the grounds that they constitute mandated inefficiency.

This strategy is appropriate where it is important to ensure a certain age at first capture by permitting juvenile stocks to mature and become marketable. This strategy is introduced in fisheries with a high rate of gear replacement or in fisheries undergoing rapid rates of technological change and innovation. This strategy may help prevent the development of overcapacity because it can attack the problem directly.

Fishers may oppose the enactment of mesh regulations because catch rates inevitably fall when they first go into effect. This may be a serious problem unless the targeted species are short-lived and fast growing.

4.5.3 Total Allowable Catch (TACs)

Regulating a fishery by establishing a Total Allowable Catch (TAC) for a fishing season is a very complicated and involved process. First, on the basis of biological statistics derived mainly from sampling and the monitoring of catches, scientists must estimate the total catch a fishery can sustain in future fishing seasons. Then working groups and committees of scientists, fishery managers, policy makers, and fishers must negotiate and eventually agree on the TAC for the forthcoming season. In this stage, political and economic considerations are often more influential in determining the TAC than biological considerations. Next, policy decisions have to be made on how to divide up the TAC among the producers, and once this is accomplished, various regulations have to be established defining permissible means of access, fishing times, and methods or gear. Finally, enforcement systems and systems for monitoring production must be established, so the custodian knows when the TAC is reached and time is reached to call a halt to fishing. Because the main aim of establishing a TAC is biological conservation, the strategy by itself will not prevent the development of overcapacity. Management emphasizing TACs requires considerable scientific and technical manpower and has been called an "information hungry" regime (Caddy 1984:3).

Determining the TAC is similar to determining a fishery's maximum sustained yield (MSY). The most significant problem is obtaining an accurate assessment of the size and biological structure of the targeted stocks. Methods rely on random samples of catches brought on board research ships, acoustic surveys, and remote sensing by aircraft. The most common indirect method of collecting data is catch-monitoring. Other methods include relying on dynamic models such as the Virtual Population Analysis model or on models that estimate the stock's future size and age structure based on catch data (Beddington and Rettig 1984:8).

Whatever the techniques used, ensuring the accuracy of the data is problematical. Even direct methods may yield inaccurate information. Acoustic surveys conducted over shallow shoals populated by several species may yield data impossible to interpret. The quality of the data on catches tends to deteriorate over time as fishers find more ingenious ways to misreport or cheat.

Other problems arise when fishers do not conform to the regulatory regime. For example, the TAC is defined as the point at which the by-catch reaches a certain proportion of the catch. At that point fishing should cease, but fishers circumvent this regulation by throwing away the by-catch before it can be measured. Alternatively, when a fisher's quotas are expressed in terms of a total allowable catch for a particular species, they may throw away the less valuable smaller fish of that species so they can continue fishing, thus wasting large quantities of the targeted species.

Once a fishery's TAC is determined, there remains the equity problem of how to allocate it equitably among the various producers. Fishers attempt to take all the stock they can before a TAC is reached and the fishery closed, using ever-larger and more powerful vessels to get to the fishing grounds as quickly as possible so as to maximize their production. The TAC will be reached in ever-shorter periods of time, causing severe dislocations in markets and in fishers' employment patterns.

4.5.4 Limited Entry

Probably the single most effective strategy for preventing the problem of overcapacity and for bringing fishery effort under direct control is to limit access to the fishery. Fishers vigorously oppose the limited entry strategy and most attempts to implement this type of strategy have been met with resistance, especially in highly developed fisheries. In fisheries already nearing overcapacity, the mere threat of limiting entry into the fishery may cause fishers to engage in greater excesses of fishing.

When the time comes for the government to decide the crucial question of who will qualify for entry and who will not, political considerations may overwhelm equity. Some of the methods relied on to settle the question are selling licenses to the highest bidder, giving precedence to producers who have historically worked the fishery, and favoring full-time fishers over part-time fishers. It is also necessary to decide whether to limit the entry of vessels or only the entry of fishers. There are three sub-strategies for limiting entry. First, imposing various types of licensing requirements that limit the number of fishing vessels or fishers, or that limit the size of vessels or power plants, or otherwise restrict the type of fishing gear being utilized; second, allocating transferable quotas to individual fishers or fishing enterprises; and third, limiting entry through monetary measures, such as the imposition of taxes. Licensing programs are best undertaken while a fishery is still developing, thus avoiding the problem of forcing out existing participants. Limited licensing programs are regarded as useful supplements in TAC regimes.

Licensing regimes that merely limit entry to a certain number of vessels or fishers cannot by themselves prevent the expansion of overcapacity and depletion, since increases in the size and effectiveness of vessels and gear or intensified effort by fishers would still move the fishery toward depletion. When deciding whether to utilize it, the policy makers must ask questions with reference to licensing schemes. These questions refer to how many licenses to grant, who will get the licenses, and whether the licenses will be transferable. As Waugh (1984:135) claims, "these three questions involve considerably more than economics and are often exercises in politics, industrial relations and law." In general, licenses tend to be issued to vessels rather than to individual fishers.

The first question cannot be resolved until fishery managers have the best possible data on both the natural marine population under exploitation and the fishing fleet. The manager's first task is to make an estimate of the MSY of the main stocks. Then, on the basis of the catch rates of the vessels currently in the fishery, the total allowable number of vessels can be determined. Managers must estimate the total number of allowable vessels with caution since the productivity and efficiency of the fishing fleet will often increase through time. These considerations become much more complicated when diverse types of fishers exploit a fishery and vessels having widely different productive capacities (Beddington and Rettig 1984:13-14).

The implementation of licensing programs requires prior research and data gathering, as well as considerable collaboration, mediation, and negotiation among the participants in the fishery. This causes this strategy to be rather costly to administer and enforce.

The other two sub-strategies for limiting entry, quota systems and monetary measures are utilized less often. In the quota system, the MSY is determined and then divided into parcels and sold to the highest bidder. But this approach has two insurmountable problems. First, like all quota systems, it is expensive to administer and difficult to enforce, and second, it is vigorously opposed by less-affluent fishers as unfairly favoring those who can push the bid price up (Waugh 1984:138-140). Limiting entry by taxation is a way of helping governments receive economic benefits from the fishery and bringing fishing effort under control. Taxes are usually levied on landings or other measurable units of fishing effort. However, as discussed in the section on monetary measures, limited entry by taxation is an ill-advised strategy if the purpose is to control fishing effort, because tax regimes are characteristically unable to respond quickly to changing conditions in a fishery.

4.5.5 Private Property

The main appeal of a system of property rights is that fishers who consider certain stocks or fishing grounds their own property may voluntarily restrain their fishing effort and develop greater concerns for conservation and management. Property rights are the main means used to limit access to terrestrial resources around the world (FAO 1983:19). These tendencies toward voluntary restraint may reduce the cost of management, and certainly the cost of enforcement. Other benefits may also be obtained if fishers are working in a less intense and unhurried manner; their fish are landed in better condition and over a longer season. And because capital costs are kept lower, the savings are passed along to the consumers.

Social equity considerations are crucial when implementing this strategy since to confer property rights to some is also to deny them to others who may have interests in the fishery.

There are several common sub-strategies for institution property rights in marine fisheries. Exclusive rights to harvest a certain species may be conferred, or fishers may obtain a license giving them other special rights. Fishers in a particular community may be granted a share of the TAC.

The common property system sets the stage for disaster in many fisheries. Fishery managers could not really address this core structural-institutional flaw because of political considerations. Unable to attack the problem at its source, managers often resort to more politically acceptable strategies such as closed seasons and areas, gear restrictions, and aggregate quotas. Yet, even as these strategies are employed, depletion and overcapacity come about anyway.

By removing extensive sea territories from the realm of "the common heritage of mankind", the Canadian EEZ system opened up the changing fisheries to other institutional bases. However, as an increasing number of nations are coming to see, without further internal changes, *the system has merely converted fisheries within their 200 mile limits to national rather than international commons.*

Private property regimes are much easier to implement in single species fisheries than they are in developed fisheries that already have a multiplicity of fleet types as well as several fish species. Ascribing property rights is also an effective means of deregulating a fishery, often effecting a greater economy of managerial effort by shifting much managerial responsibility downward, from central administration down to those holding the right.

4.5.6 Sources of Uncertainty

Fishing for shellfish in the Atlantic Canada region is an unusual economic activity in that no one knows how much of the resource is available in a given year, what amount of product should be harvested, or what effect that production will have on the future availability of shellfish.

Among non-human sources of uncertainty, the most obvious results from our ignorance of the size of the shellfish stock (biomass or numbers). This is in contrast to the fisheries literature on uncertainty where the most widely discussed type is the uncertainty inherent in stock-recruitment relationships, both in terms of random fluctuations around the underlying deterministic relationship and uncertainty in the parameters of the relationship itself. There are many other sources of uncertainty, such as the age structure and the natural mortality of target populations, as well as multi-species interactions such as predator-prey relationships. Spatial complexity such as spatial heterogeneity, stock concentration and migration patterns, and the impact of ocean conditions on shellfish populations are as yet insufficiently known. Further complicating the matter is the fact that these sources of uncertainty interact with one another in a synergistic process: *we do not know what we do not know about.*

Sources of uncertainty on the human side of the fishery are much less well studied and more difficult to analyze. Fish prices, fishing costs, discount rates as well as uncertainties in market structure are indications that can be investigated but the more challenging forms of uncertainty such as technological change, its impact and adoption, management objectives and fisher objectives and differing perceptions of stock status are more difficult to observe.

4.5.7 Types of Uncertainty

A wide variety of uncertainties arise in fishery systems from biological, fishery and management sides. This section reviews three forms of uncertainty and how these may be categorized. To explore this, the example of the stock-recruitment relationship utilized in fishery science and shellfish stock assessment will be analyzed. Assume that a particular fishery is blessed with a long time-series of reliable data on the shellfish stock. Then, after suitable analysis, managers could be quite confident that they have correctly deduced the structure of the stock-recruitment relationship and that they have correctly estimated all parameters of the relationship. However, there remain fluctuations inherent in the stock-recruitment relationship that are intrinsic to the behavior of the system. This randomness produces what Francis and Shotton (1997:1701) term "process uncertainty". Random fluctuations have a frequency of occurrence that can be determined from past experience.

In reality, the parameters of the stock-recruitment relationship cannot be estimated with certainty. For example, parameter estimates are often made through statistical fitting to what are typical highly different sets of data. Thus, imprecise estimates reflect both "observation uncertainty", which is measurement and sampling error arising in the process of collecting data, and "model uncertainty" concerning the parameters of the analytical model being used (Francis and Shotton 1997:1701). This is compounded by "estimation uncertainty", arising from the statistical process of estimating the stock-recruitment relationship. Not only is an estimate inherently uncertain, in addition there may be fundamental errors underlying the statistical method. This greatly compounds the difficulties involved in stock assessment (Francis and Shotton 1997:1701-1702).

It was assumed above that the structure of the stock recruitment relationship could be known with certainty. This will not be the case in practice, since the true nature of the relationship is unknown. There will be uncertainties with respect to appropriate variables to be included, the set of relevant components and the underlying model structure of the stock-recruitment relationship. Such uncertainties can be grouped as "model uncertainty" (Francis and Shotton 1997:1701). This type is the most challenging form of uncertainty, reflecting basic ignorance about the nature of fishery systems, its components, its dynamics, and its inherent internal interactions.

Francis and Shotton (1997:1701) use the term “model uncertainty” to refer to the technical aspects of parameter uncertainty. They also use the term in reference to a fundamental lack of knowledge concerning the structure of the fishery system, whether relating to the stock-recruitment relationship function or other key aspects of the fishery such as species structure, fleet structure, spatial complexity, fish-fish interactions, fish-ecosystem interactions, and technological change.

From the specific perspective of choosing a desired "model" to use in the management of a fishery, it is theoretically possible to view uncertainty in model structure as merely 'parameter uncertainty' in a 'super-model' (Francis and Shotton 1997:1701). In reality the fundamental uncertainty involved here goes well beyond the problem of choosing a mathematical model to include challenges arising from very basic ignorance about the system.

From the managers' perspective, this uncertainty may appear as uncertainty regarding the extent to which management measures can be implemented successfully, or specifically, "the degree of control over the harvest accompanying a particular management decision" (Rosenberg and Brault 1993:244). The very nature of this form of uncertainty is due in large part to the limited nature of communication between managers and fishers.

Interactions among those in the management system may develop uncertainties and, in particular, uncertainties relating to how fishers and others adapt to new management institutions and the societal/ management objectives being pursued in the fishery (Francis and Shotton 1997:1702).

Most of the uncertainties addressed above are based on randomness, imprecise parameter estimates and uncertain states of ecosystems. The difficulty encountered is that these uncertainties are not quantifiable. As mentioned above, uncertainty by its very nature is a fundamental lack of knowledge about fishery systems and is therefore difficult to implement in any relevant fishery management models. Because of this problem and the difficulty in finding solutions, uncertainties have been addressed primarily through the practice of fishery management. The implementation of a precautionary approach to management decision making, in order to ensure that we make a proper allowance for uncertainty in our decisions, is part of a management framework within which uncertainty can be addressed.

4.5.8 The "Precautionary approach"

Within the Atlantic Canada shellfishery management system, all decisions must be made under uncertainty. For example, shellfish stock sizes are never known precisely within a given year and from year to year and the impacts of fishing methods on the shellfish populations and the ecosystems cannot be predicted exactly. Given this inherent uncertainty, decisions must always be made by balancing risks. For example, managers balance the risk of stock and ecological collapse with the risk of lost economic benefits if conservation measures are overly protectionist resulting in lower harvests. Nollkaemper (1991:107) notes that " the elimination of detrimental effects remains a utopian ideal and can only aim to reduce, and not eliminate, the detrimental effects."

The "Precautionary approach" was one of the goals outlined in the Oceans Act in 1997. The precautionary approach guides fishery scientists and managers into a mode of *erring on the side of caution* in the presence of uncertainty. As FAO (1995:6) noted:

> Management according to the precautionary approach exercises prudent foresight to avoid unacceptable or undesirable situations, taking into account that changes in fisheries systems are only slowly reversible, difficult to control, not well understood, and subject to change in the environment and human values.

Precautionary management involves explicit consideration of undesirable and potentially unacceptable outcomes and provides contingency and other plans to avoid or mitigate such outcomes. Undesirable or unacceptable outcomes include over exploitation of resources, over-development of harvesting capacity, loss of biodiversity, major physical disturbances of sensitive biotypes, or social or economic dislocations. Undesirable conditions can also arise when a fishery negatively influenced by other fisheries or other activities and when management fails to take action in the face of shifts in the external conditions affecting, for example, the productivity of fish stocks.

Canada (Canada 2001:2) supports the statement in Principle 15 of the 1992 Rio Declaration on Environment and Development: "In order to protect the environment , the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation." The *Oceans Act* requires the government to promote the wide application of the precautionary approach to the conservation, management and exploitation of marine resources in order to protect these resources and preserve the marine ecosystems. Although seemingly a straightforward approach, the precautionary principle suffers from the "absence of a precise and consistently held definition" (Stebbing 1992:289).

One of the difficulties of this approach which has received attention in the last few years has been the operationalization of the precautionary approach. The focus has been on technical matters, specially, determining and setting TACs, effort limits and harvest rates. Essentially, managers are attempting to adjust exploitation levels in order to take uncertainty into account in some manner. However as Dethlefsen (1989:54) notes, the "implementation of regulatory measures depends upon exact and accepted definitions of these crucial terms" and without these definitions, the "criteria for the acceptability or effects are chosen rather arbitrarily". These technical adjustments are an important component of the precautionary approach for managers and would be verified, for example, by adjusting harvest levels to reflect the magnitude of uncertainty in fish stock sizes.

The precautionary approach also calls for adjustments to the assumptions and approaches underlying fishery decision-making. This involves reversing the burden of proof. For example, instead of requiring scientists, the public and others to prove that harvesting levels or methods are harmful, the FAO (1995:6) claims that "often, the precautionary approach has been taken as requiring that human actions are assumed to be harmful unless proven otherwise (reversal of burden of proof)."

A related term is the "standard of proof", which means the extent to which the effects of an action or a natural or induced process must be known to be considered acceptable. This relates to "the responsibility for providing the relevant evidence and criteria to be used to judge that evidence" (FAO 1995:6). In addition "the standard of proof to be used in decisions regarding the authorization of fishing activities should commensurate with the potential risk to the resource, while also taking into account the expected benefits of the activities". This implies that "although the precautionary approach to fisheries may require cessation of fishing activities that have potentially serious adverse impacts, it does not imply that no fishing can take place until all potential impacts have been assessed and found to be negligible" (FAO 1995:6).

Another concern that limits the operationalization of the precautionary principle is what Roy Rappaport describes as the problems inherent in regulatory hierarchies. Rappaport (1974:385) claims that systems, such as biological systems, may be affected by four main types of maladaptation. They are the resistance to notice changes in variables, the excessive delay of information concerning some variables, the loss or distortion of information and the failure of regulators to understand the information being presented. According to Rappaport, these processes lead to two major types of maladaptive behavior: overcentralization, in which poorly informed central regulators over-regulate distant parts of the system, and usurpation, in which a sub-system overwhelms central controls ("What is good for General Motors is good for America").

To examine whether the precautionary approach has been applied in Atlantic Canadian fisheries three examples will be discussed. These are examples of the precautionary approach and standard of proof concepts.

The first hypothesis is that reducing the spawning stock will tend to produce fewer recruits. The stock-recruitment relationship is a particular fundamental part of fishery science. Essentially, the future size of a fish population will depend functionally on how many new fish are born and eventually recruit to the fishery, which in turn depends on the number of adult fish spawning in the present year. A key implication is that catching too many fish this year means that too few will have the opportunity to reproduce, which will be detrimental to the future of the fish stock.

However, given the fluctuations in and inherent complexities of ocean and fish stock dynamics, together with uncertainties in the corresponding data available to scientists, it is not very easy to prove that a spawner-recruit relationship exists in any given fishery. Lacking such proof, the logical connections between spawning stocks and the resulting young fish have not always been taken into account in the stock assessment that determines allowable catch. Atlantic Canada has seen an increase in shellfish catches. For example, quotas have increased in Atlantic Canada, most notably, in the shrimp and crab fisheries in Newfoundland. In fishing area 6, off the northwest coast of Newfoundland and east of southern Labrador, quotas were increased from 11,050 tonnes in 1996 to 46,200 tonnes in 1998 (Auditor General 1999:14). Also, the Newfoundland snow crab fishery increased its quota by 9.5 percent from 1997 to 1998

(Auditor General 1999:13). This problem of increasing quotas may result in recruitment overfishing which arises from overestimates of the amount of fish that could safely be caught, which in turn, may produce long term socioeconomic consequences as has been seen in the case of the Atlantic Canada groundfishery.

The second hypothesis is that substantially increasing harvests will deplete fish populations. In fishery research there is a long history of debating and analyzing whether fishery collapses are caused by overfishing or ecological change. There is also the tendency to blame non-human factors. For example when Atlantic Canada's cod stock collapsed in the early 1990s, the government issued an initial press release that made no mention of human impacts on the resource or problems with the fishery management process. Further, the Cashin Report stated that:

> The reasons for the collapse are complex, and not well understood -- but the consequences are all too clear: devastation for those who live by the groundfish.
>
> Groundfish stocks have always been subject to cyclical swings. There are ecological changes and anomalies that affect their reproduction and survival, such as changes in water temperature and salinity. Changes in their food supply can have a major impact, especially on cod. The impact of predators such as seals is also a major factor. When a forage stock such as capelin declines, cod will prey on less nutritious feed, including smaller cod (Cashin 1993:5-6).

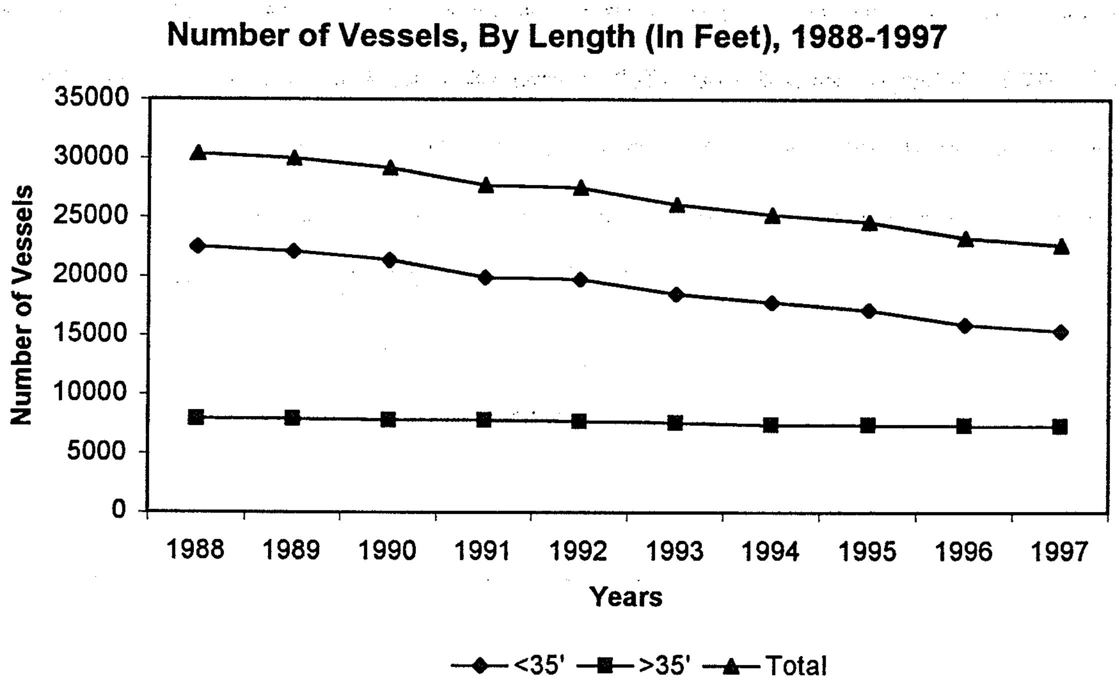
The burden of proof often appears to be placed on non-human causes.

It may seem likely that changing ocean conditions may have acted as a trigger to initiate a stock collapse but the principal underlying cause of collapse was more likely to have been high levels of resource exploitation. Although the dynamics of collapses and the connections between fish populations and ecological change are complex, there does seem to be a general pattern. When ocean conditions are favorable to the growth of fish populations, fundamentally unsustainable harvest levels may appear to be sustainable. Inevitably, and quite naturally, ocean conditions change at some point, so that heavily harvested fish populations become subjected to additional stresses. For example, temperature changes affect the growth and reproduction of lobsters. Faced with intense fishing pressure and a trigger in the form of adverse ecosystemic changes, the fishery might collapse. This pattern has been recognized in a number of fisheries, such as the Pacific herring fishery in the 1960s (Hourston 1978), the 1972 Peruvian anchovy fishery, and the Atlantic Canada groundfishery in the 1990s (Taggart et al. 1994).

The final hypothesis is that fishing gear pulled along the ocean floor damages the habitat. There are two factors that are assumed. Firstly, there is certain knowledge that trawling has impacts on the habitat and, secondly, there is a high level of uncertainty about the implications, whether positive or negative, of those impacts. Uncertainties in the ocean ecosystems make it impossible to prove or disprove any negative impacts on the habitat, the food web, and productivity. There is, according to Dethlefsen (1989:54) "insufficient knowledge" and an "inability to explain large scale changes on fish or plankton populations, fish disease occurrences and water quality". Without proof, there are various responses to the issue of impact. Responses could include a complete or selective ban on trawling, a reduction in such activities, and improved efforts to reduce impacts. Actions involving the removal or reduction of trawling activity are rarely chosen. Instead, the chosen response has been to maintain the status quo, despite a lack of evidence indicating the absence of negative impacts. In 1988 there were 30,390 vessels engaged in Atlantic Canada fisheries, but only 22,643 in 1997. This appears to be a dramatic reduction but 92.4 percent of the vessels eliminated were those which were less than thirty-five feet in size (DFO 1998e) and can viewed diagrammatically on Chart 4.2. Side-trawlers in the Northwest Atlantic increased from 560 in 1953 to 1316 in 1965

(Rogers 1995:46). A more effective vessel, the stern-trawler, replaced the side-trawlers and led to 'exponential' growth in the fishing effort index (Rogers 1995:46). The harvesting capacity of the northern shrimp fishery also increased dramatically. In 1997 and 1998, 3,000 tonnes of shrimp were allocated to Area 6, just off the north coast of Newfoundland. The TAC in Area 6 doubled in 1997 and doubled again in 1998. The TAC in 1996 for Area 6 was 11,050 tonnes, and in 1998, it had risen to 46,200 tonnes. This increased harvesting capacity included 208 new shrimp trawlers and 150 vessels enlarged or replaced (Auditor General 1999:12-14).

Chart 4.2



Source: DFO 1998e

In 1995, the DFO opened two snow crab exploratory fishing zones in the Gulf of St. Lawrence. In 1997, the DFO told the minister that the zones no longer met the requirements of an exploratory fishery and recommended that the zones be closed. Nevertheless, in 1998, the Minister kept the zones open as "exploratory". This means that fishers were not required to follow scientific protocols (Auditor General 1999:10).

In the Newfoundland snow crab and northern shrimp fisheries, fisheries management allowed fishing in an area known as a nursery area in 1996 and 1997. During this time the DFO also proposed increasing the TAC 6.7 percent but the Minister increased the TAC by 9.5 percent (Auditor General 1999:19-22). In compiling strategies for upcoming seasons information is essential but in 1997 data on lobster landings was still not available. These data were only compiled in December of 1998 (Auditor General 1999:25).

Another issue complicating uncertainty in the shellfishery is foreign fishing. Aerial surveillance is heavily concentrated on fishers near international boundaries but with limited coverage on shellfish sector. The midshore and offshore shellfish areas have little or no coverage by patrol vessels (Auditor General 1999:25).

4.6 Summary

Proponents of the precautionary approach are in essence calling for the implementation of a paradigm shift in resource management. It is a shift that makes caution, doing the least harm, and conservation priorities over economic development and re-election of politicians in the management of resources. It requires a political and popular commitment to make its implementation a priority, similar to Canada's commitment to socialized health care which is a prioritized value and decisions to maintain such a health care system are made, and its expense covered, by taxpayers. The arrival of the precautionary approach in resource management is an attempt to incorporate an ideal into statistical models and to guide the implementation of the results generated by imperfect models. Indeed, as Gray (1990:174) notes, the "acceptance of the precautionary principle is entirely an administrative and legislative matter". However, this is confounded by Nollkaemper (1991:108) who claims that the precautionary principle is "mostly [a] legally non-binding norm, operating within the framework of particular agreements".

One of the difficulties with the precautionary approach is the matter of its implementation or operationalization. The "Precautionary Approach" is too vague a concept to become a guiding principle, it cannot be operationalized. Therefore it remains a slogan rather than a principle. The resource managers must make cost/benefit decisions that balance competing interests. The precautionary approach requires that the managers use the approach as a guiding principle when making those decisions. As has been described above, the implementation of the approach in the management of various resources has been inconsistent and, in some instances, although managers purport to be guided by the precautionary approach, the actual decisions made would seem to indicate otherwise.

Another problem with the precautionary approach is that it is difficult, if not nearly impossible, to measure with any certainty the effectiveness of its implementation. A major assumption with the approach is that its implementation could reduce the amount of uncertainty. However, the imperfect knowledge and uncertainty in resource management decisions that provided the impetus for using the approach still affect the ability to quantify the effects of its implementation. As an example, if one was guided by the precautionary approach and with the aim of conservation of stock levels was to make a decision to reduce the total annual catch of a species of fish in a particular area, one would not be able to determine ten years hence with much certainty if the stock levels at that point were adversely or positively affected or not affected at all as a result of that decision to reduce the total catch.

The Fisheries Act provides the Minister and the DFO with the dual roles of protecting the productive capacity of the natural resources that support fisheries and allocating the resource to those licensed to fish. In reports to the public and media, the Department emphasizes protection as its first role. In practice, the day-to-day activities of fishery managers deal for the most part with the second role, allocating the resource.

There is a contradiction between the roles of protecting resources for future use and allocating resources for current use. Political and economic pressures on the DFO and the Minister generally led to the allocation of resources for current use. These pressures are hardest to manage when DFO has limited knowledge to prove how much of the stock must be left unharvested to protect the resource. When the knowledge about stocks is incomplete, the Oceans Act requires that the precautionary approach be applied, or in other words, to err on the side of caution. The precautionary principle has yet to be effectively operationalized.

Resource allocation and licensing decisions have important political and economic consequences. The Fisheries Act gives the Minister of Fisheries and Oceans absolute discretion to make such decisions. Historically, in making these decisions the Minister, and the DFO in support of the Minister, have considered a number of factors. These factors include fishers' proximity to the resource, historical attachment to the stock and historical provincial share.

Decisions that adhered to these factors are sometimes overturned by the Minister. For example, the Gulf shrimp fishery has historically been fished by Quebec, New Brunswick, and Newfoundland fishers. In 1998, the Minister approved the allocation of 150 tonnes of Gulf shrimp to Nova Scotia and PEI fishers. The union which represents offshore scallop vessels requested that the Minister grant it a percentage of the offshore scallop quota. The DFO indicated that the request could not be granted independent of a license, meaning that a new offshore scallop license would have to be issued. This would mean making an exception to the limited entry policy that has been in effect since 1973. The allocation has not been granted. In contrast, however, in 1997 the Gulf crab fishery, with a landed value of $5 million, was allocated to companies set up and controlled by fisher's organizations and unions. These companies were issued new licenses to fish crab. Also, the Minister allocated 2,000 tonnes of shrimp in the northern shrimp fishery to the union representing Newfoundland fishers and a fishers cooperative, even though they were not license holders. This occurred as well in 1999 when a company from PEI was allocated 3,000 tonnes in the shrimp fishery (Anonymous B 2000:B5).

The decisions made by the Minister of Fisheries and Oceans are not, however, unconstrained. There are certain limiting factors to fisheries management decisions such as First Nations treaty rights and Supreme Court decisions. A current example is the Marshall Supreme Court of Canada decision (*R. v. Marshall*) and the subsequent attempts to negotiate the Burnt Church village's integration into the lobster fishery. The introduction of a new group of fishers, exploiting a resource that is already in peril, is a decision that is not aligned with the precautionary principle, but a clear example of political maneuverings shaping fisheries management policy.

Numerous examples show the inability or unwillingness of the government to utilize a precautionary approach dedicated to the long-term survival of fish and shellfish stocks. Shellfish landings in the Atlantic region continue to increase. In 1984, there were 131,000 tonnes of shellfish landed; in 1997, 312,000 tonnes were landed (Auditor General 1999:7). Bearing in mind that the shellfishery might already be considered over-exploited, and remembering lessons from the collapse of the cod fishery, one might safely suggest that any increase in landings seems to be anti-precautionary.

The definition of the precautionary approach is unclear and the uncertainties involved make its implementation difficult. The examples cited in this chapter seem to support the argument that the precautionary approach is at this time little more than a political slogan.

Chapter 5: Management of the Maine Lobster Fishery

5.1 Introduction

The previous chapter was an evaluation of the implications and effects of various management strategies in Canada. The argument would benefit from the traditional anthropological technique, cross-cultural comparison. The state of Maine, in the United States, is very close to the Canadian border, and at one time shared the resources of Georges Bank with Canada and thus seems to be a relevant example. It shares the same ecological setting but is subject to different laws and management strategies.

The commercial fishing industry in New England is in a state of crisis (St. Martin 1999:1). Given current fishing effort, several species of commercially valuable fish are at low population levels and risk collapse (Parsons 1993:658). This crisis of resource scarcity and depletion due to overuse and pollution threatens an industry that supports not only thousands of individual fishers, but entire towns and shore-side related industries in New England.

5.2 The New England Lobster Fishery

The lobster fishery of Maine is the most valuable fishery on the Atlantic coast of both the United States and Canada. U.S. landings in recent years have been in excess of 30000 metric tons, with a dockside value of US$250 million (Allen 2002). Of this catch, approximately 80 percent are caught from zero to three miles from shore (ASMFC 2002). Lobsters have been fished commercially in this area since the middle of the 19th century. By the late 1800s, lobsters were so scarce in nearshore waters that the federal

Fish Commission established a Committee to Study the Extinction of the Lobster and Soft Shell Clam Fisheries. Conservation measures were established at that time, and the fishery remained relatively stable at around 9,000 metric tons through the mid-1900s. However, during the past 20 years, lobster fishing effort and lobster landings increased dramatically.

The principal gear used to catch lobsters is the trap. Lobsters are also taken as by-catch with otter trawls. The offshore fishery is managed under the New England Fishery Management Council's Lobster Fishery Management Plan, while fisheries within 3 miles of shore are managed by the various states under the Atlantic States Marine Fishery Commission's Interstate Fishery Management Plan for American Lobster (Idoine 2002).

5.3 United States Fisheries

The fishery in the United States exploits many fish species over a large geographical area. In 1999, The U.S. ranked sixth among countries in total harvest (NMFS 2001:iv). In terms of quantity landed in the U.S., in 2000 finfish were leaders, whereas in terms of value, shellfish, such as, shrimp, crabs, and lobster, lead in value. Shrimps are fished throughout the Gulf region of the southern U.S. and in the Pacific region. Crabs are fished in the Mid-Atlantic, South Atlantic, Gulf, Pacific, and North Pacific regions. Lobsters species caught are the spiny lobster and the American lobster. The spiny lobster fishery is located in the South Atlantic region. The American lobster fishery is concentrated in the New England region. The two leading states in lobster landing are Maine and Massachusetts. In the year 2000, Maine landed sixty-nine percent of the total lobster landings (NMFS 2001:xii).

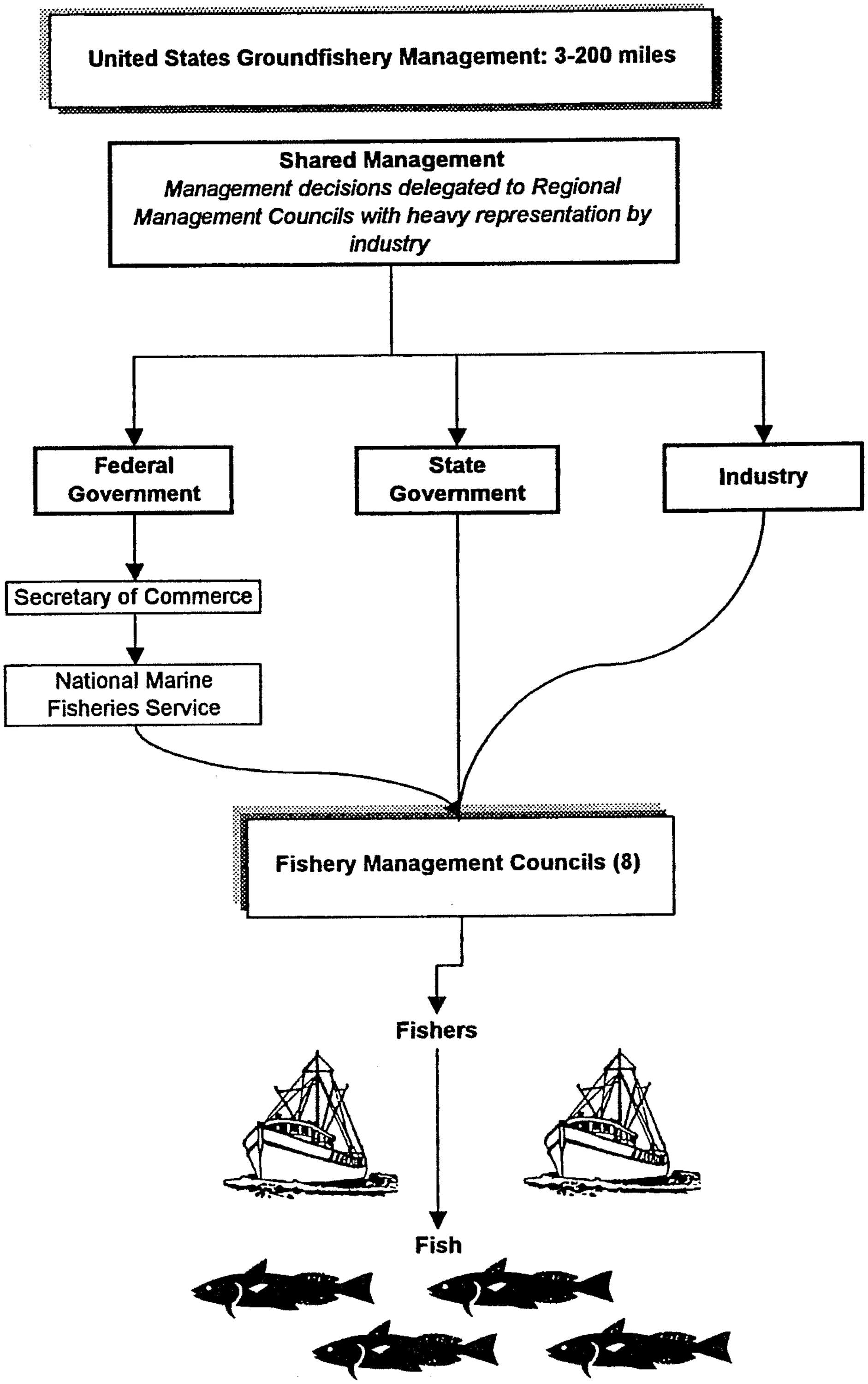
As examined earlier, management of Canada's groundfisheries over the last three decades can be seen as a failure, made obvious by the collapse of the cod fishery. The U.S. has experienced similar problems with their fisheries. What follows is a brief description of the major trends in fisheries management in the state of Maine from the mid-1970s when the U.S. exclusive economic zone (EEZ) was put into place. Like in Canada, this was an example of enclosure of the commons by the exclusion of foreign fishing within a 200-mile limit.

As mentioned above, the U.S. is one of the leading fishing nations ranking in the top six in landings since the 1970s. With the extension of the 200-mile EEZ, the U.S. jumped to fourth in landings throughout the 1970s and most of the 1980s.

5.4 United States Fisheries Management from 1976 to 1992

In 1976, the U.S. Congress passed the Fishery Conservation and Management Act (FCMA), later renamed the Magnuson Fishery Conservation and Management Act (MFCMA). This act governs the conservation and management of ocean fishing within the U.S. EEZ. It also provides for fishery management authority over continental shelf resources and anadromous species beyond the EEZ, except when they are found within a foreign nation's territorial sea fishery conservation area, to the extent that this zone is recognized by the U.S. (NMFS 2001:97). The EEZ extends from the seaward boundary of each of the coastal states (3 nautical miles) to 200 nautical miles from shore. Chart 5.1 illustrates the management of the ground fishery for this area.

Chart 5.1



United States Groundfishery Management: 3-200 miles
Shared Management
Management decisions delegated to Regional Management Councils with heavy representation by industry
Federal Government
State Government
Industry
Secretary of Commerce
National Marine Fisheries Service
Fishery Management Councils (8)
Fishers
Fish

Management at the national level is far less effective than Garrett Hardin (1968) would have us believe. As mentioned in the previous chapter, the case of the cod in Atlantic Canada confirms this statement. The fisheries in the U.S. have been divided into eight regions. These regions consist of the New England Fishery management council, Mid-Atlantic fishery management council, South Atlantic fishery management council, Gulf of Mexico management council, Caribbean fishery management council, Pacific fishery management council, Western Pacific fishery management council, and the North Pacific fishery management council. The New England fishery management council has jurisdiction in Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

Under the Magnuson Act, eight regional fishery management (Map 5.1 and Chart 5.2) councils were responsible for preparing Fishery Management Plans (FMPs) for the fisheries needing management within their area of authority and to achieve **optimum** yield. Optimum yield is a level of yield consistent with the biological capacity of the stock, which takes into account economic, sociological, and ecological factors. It is a concept that relies on "optimum" being given specific meaning. Optimum represents a compromise between different interests, such as conservation, economics, cultural and social considerations.

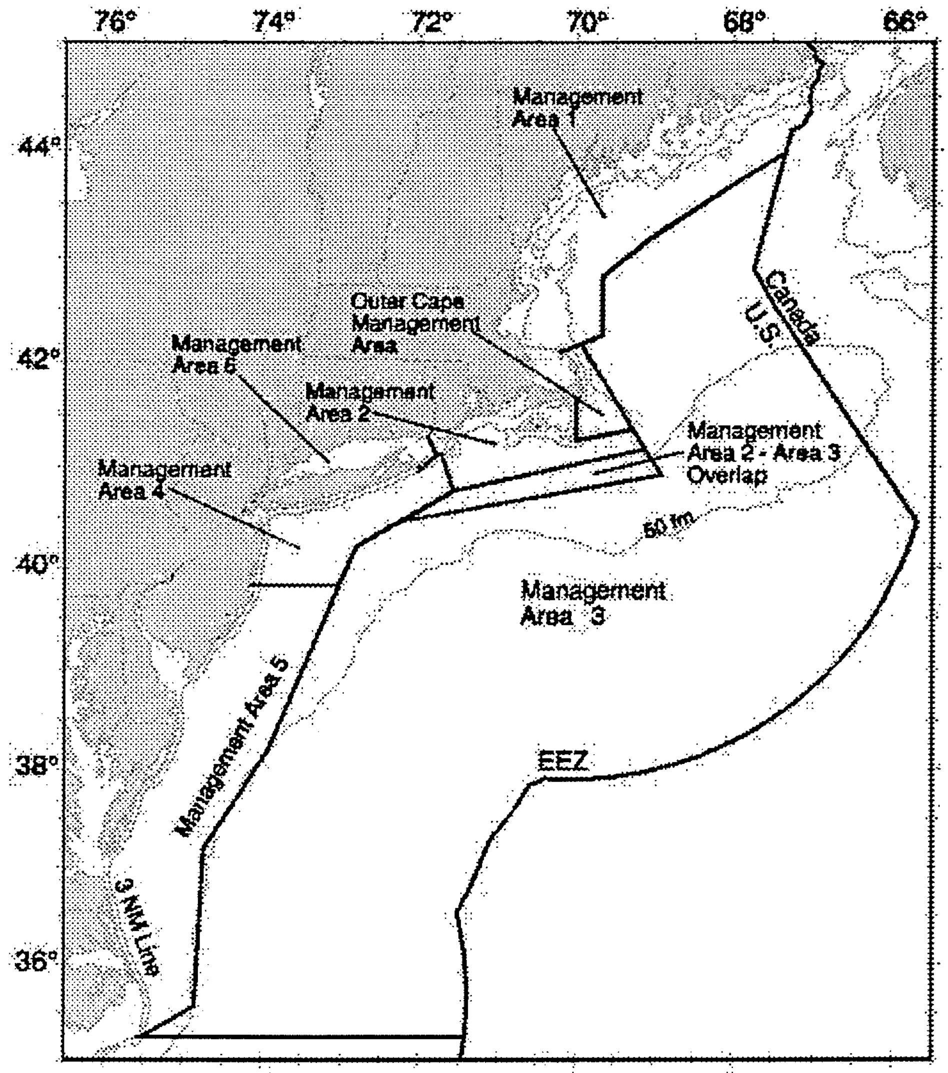
In the late 1970s, the U.S. federal government had enforced quota regulations for the groundfishery off the New England coast. The result was a "quota race" which led to massive investment in catch technology. As well, these more powerful boats were catching a larger percentage of the catch. Ultimately, the groundfish fleet of New England was capable of overfishing more than ever before (Acheson 1989:370). Under intense fishing pressure the groundfish stocks continued to decline. Fishing mortality on many stocks reached record levels, doubling from 1977 to 1986 (Parsons 1993:659).

Overall, there was a 65 percent decline in abundance of groundfish stocks off the New England coast from 1977 to 1987 (Parsons 1993:659). The decline in abundance is reflected in the decrease of catch per effort of otter trawls from 1976 to 1986 in the Georges Bank, the Gulf of Maine, and in the Southern New England region (Parsons 1993:660).

Map 5.1

Lobster Management Areas in Maine

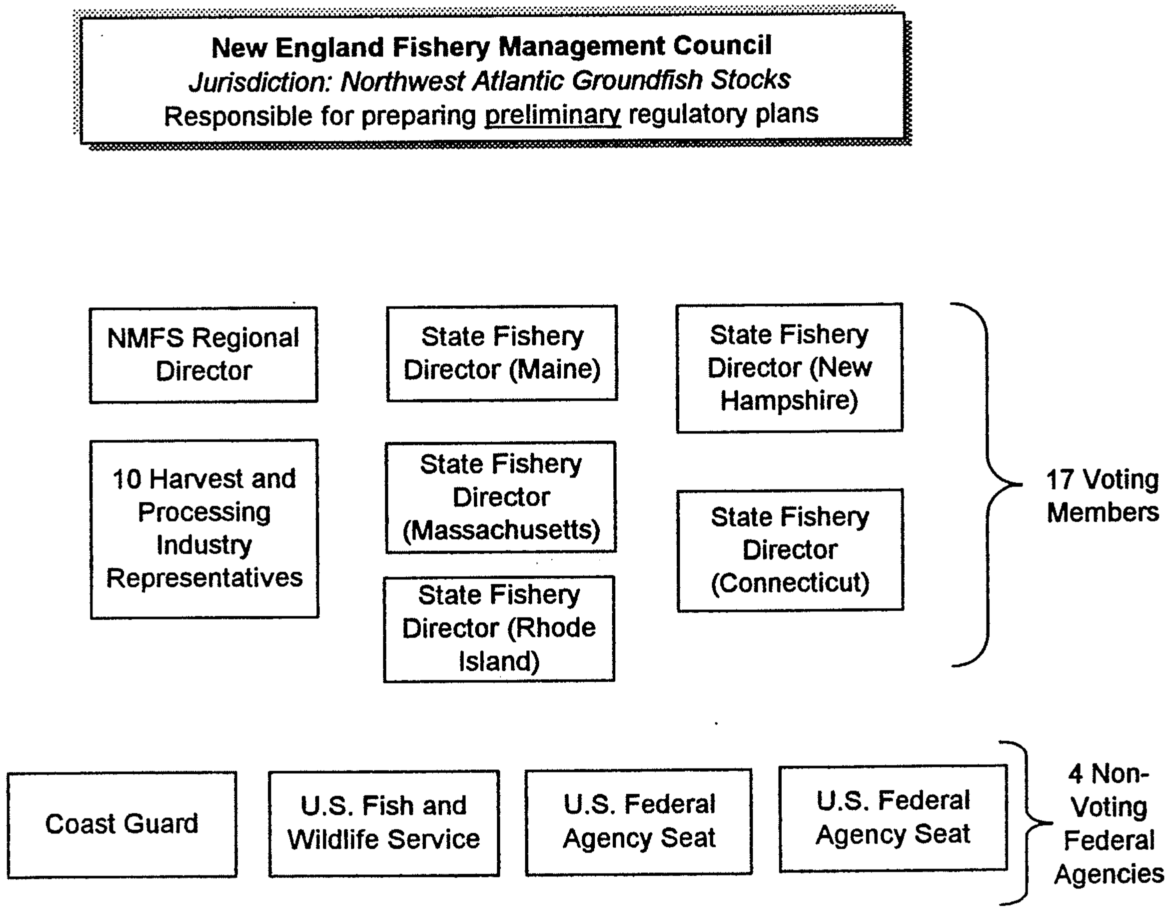
American lobster Management Areas established for the purpose of regional lobster management.



NOAA Fisheries
Northeast Regional Office
Gloucester, MA

Source: NOAA/National Marine Fisheries Service 2002

Chart 5.2



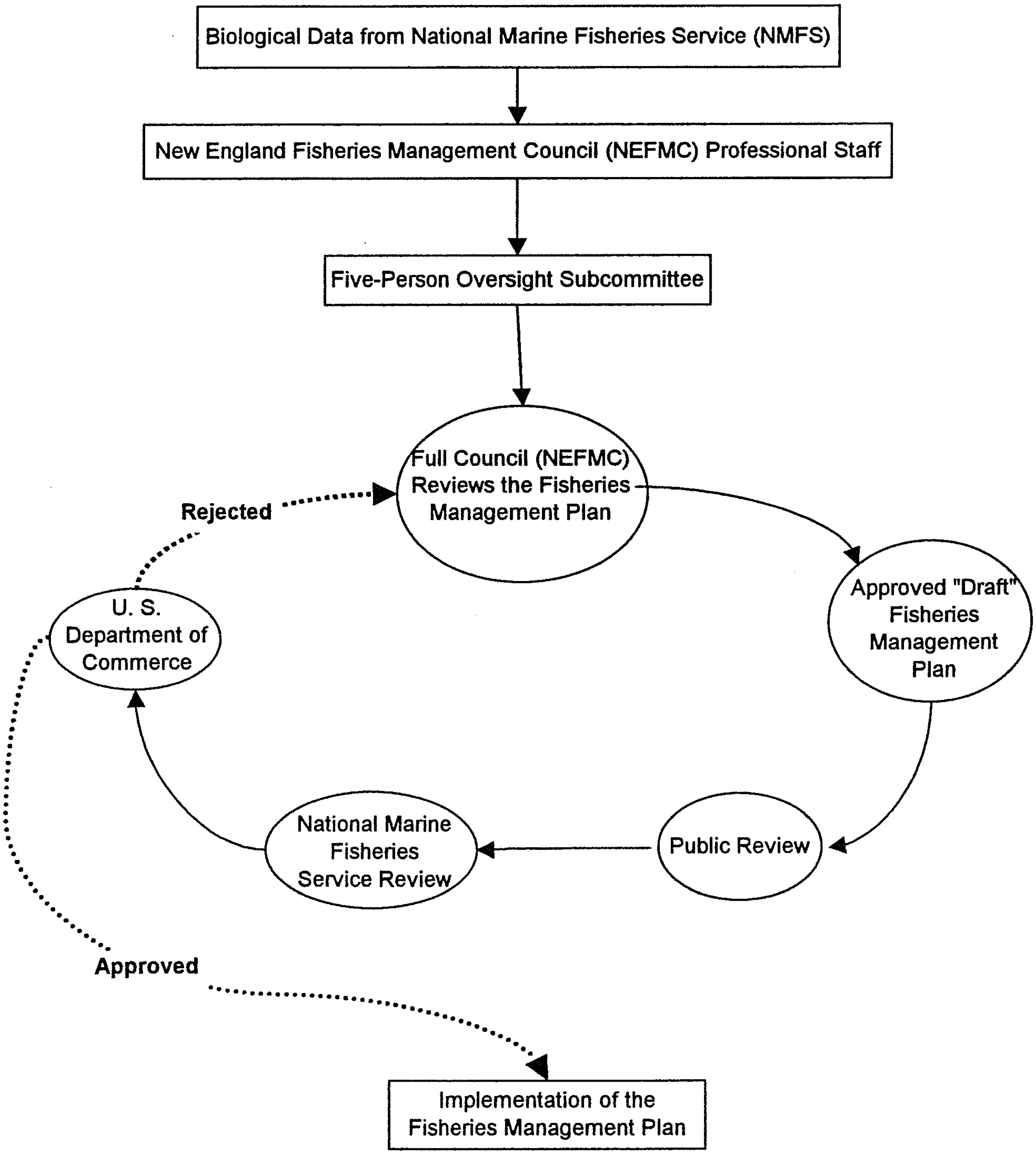
In the New England groundfishery the extended jurisdiction brought about great expectations about the benefits for local fishers. This was exemplified by a very rapid expansion of the fishing fleet during the late 1970s. The number of vessels increased from 825 in 1977 to 1,423 in 1983 and then declined to 1,334 by 1987 (Parsons 1993:659). From 1977 to 1983, the number of fishing trips increased forty-seven percent. The total number of days fished by otter trawls increased seventy-three percent from 1976 to 1986. There was a 100 percent increase in the Gulf of Maine, a 57 percent increase on Georges Bank, and an 82 percent increase in southern New England (Parsons 1993:659). There was also an increase in the average size of vessels in the groundfishery.

For both the conservation of stock population and the economics of the fishery, the results of these changes for the New England groundfishery have been disastrous. Groundfish stocks are at historically low levels (NEFSC 1992) and fishing capacity is far more than what is required to harvest the available resource (ASMFC 2002). This is an example of how tragedies of the commons certainly exist. The fisheries of the Gulf of Maine, overfished by foreign fleets in the 1960s, then taken under the management of the federal government in the late 1970s, ended up with a situation very similar to the results of federal government management in Atlantic Canada. These similar examples demonstrate how the institutions governed by federal management of the resource were ineffective.

Bioeconomics dominated scientific inquiry in the New England groundfisheries and strongly influenced management initiatives. The result was a centralized authoritarian management informed by numeric models of fish populations and insistent upon regulations that simulate privatization of the resource as can be seen in the flowchart of New England Groundfish Management Plan Development since 1977 on Chart 5.3.

Chart 5.3

New England Groundfish Management Plan Development, Since 1977



5.5 United States Lobster Fishery Management 1978 to the Present

The Atlantic States Marine Fisheries Commission (ASMFC) was established in 1942 to assist in managing and conserving the shared fishery resources of the 15 Atlantic states. With the increased harvest landings in the early 1970s the ASMFC prepared a Fishery Management Plan for the American lobster in 1978. This early plan called for effort limits, an increase of the minimum carapace size to 3 ½ inches, a prohibition on possession of egg bearing (berried) lobsters, and a prohibition on landing lobster parts. The New England Fishery management Council's Lobster Fishery Management Plan was implemented in 1983.

In 1993 the ASMFC passed the Atlantic Coastal Fisheries Cooperative Management Act, which provides a mechanism to ensure state compliance with mandated conservation measures in the Commission-approved fishery management plans (NOAA 2002c). One of the species managed under this program is the American lobster. The Act requires the development, implementation and enforcement of coastal fishery management plans to promote interstate conservation and management of Atlantic coastal fishery resources.

The 1996 Act makes a special provision for American lobster.

> Notwithstanding any provision of the Magnuson-Stevens Fishery Conservation Management Act, this Act or a fishery management plan to the contrary, persons holding valid licenses from the state of Maine may engage in commercial fishing for American lobster in certain areas designated as federal waters, if the fishing is conducted in accordance with all other applicable federal and state regulations. This exemption from federal fishery permitting requirements may be revoked or suspended by the Secretary in accordance with the Magnuson-Stevens Act for violations of that Act or this Act. (United States 2002).

In 1996, Congress amended the Act when it passed the Sustainable Fisheries Act. One change was the name of the Act as it was renamed the Magnuson-Stevens

Fishery Conservation and Management Act. The purpose of the Act is to...

> take immediate action to conserve and manage the fishery resource off the U.S. coasts and anadromous species and Continental shelf; support the implementation and enforcement of international fishery agreements for the conservation and management of highly migratory species; promote domestic commercial and recreational fishing under sound conservation and management principles; provide for preparation and implementation of fishery management plans to achieve and maintain to optimum yield of each fishery on a continuing basis; establish Regional Fishery Management Councils to protect fishery resources...; encourage the development of underutilized fisheries; explore, develop, conserve, and mange fishery resources adjacent to Pacific Insular Areas for the benefit of the people of the area and the U.S. (United States 2002).

In December 1997, The Commission adopted Amendment 3 to the FMP for American lobster. The major provisions of the Amendment are: 3 ¼ -inch minimum carapace length; prohibition on the possession of berried or scrubbed lobsters (females with the eggs removed); prohibition on possession of lobster meat; prohibition on possession of lobster parts; mandatory escape panels and vents on pots to allow lobsters to escape from old, lost pots; prohibition on spearing lobsters; prohibition on possession of female v-notched lobsters; limits on landings with non-trap gear to 100 lobsters per day, up to 500 lobsters per day for trips 5 days and longer; and maximum trap size. Amendment 3 establishes seven lobster management areas. Lobster Conservation Management Teams (LCMT), composed of industry representatives, were formed for each management area. The LCMTs are charged with advising the Lobster Management Board and recommending changes to the management plan within their area (ASMFC 2002).

The primary conservation regulations in the lobster fishery have been a minimum legal size, a prohibition on taking egg-bearing females, and in Maine, a maximum size limit and a prohibition on taking females lobsters that have been marked with a "v-notch" on their tail to indicate that they are proven breeders, having been marked when they were bearing eggs. As yet, there are no quotas, or limits on the numbers of lobsters that can be harvested commercially. In recent years, the Atlantic Coast states and the federal government established limits on the number of traps that each fisher can have in the water.

The legal minimum size of 3 ¼ inches refers to the length of the hard back-shell or carapace. Lobsters at the legal minimum size weigh approximately one pound. Scientists have not discovered any method to determine the age of a lobster, but lobsters have been known to grow to a weight of over 40 pounds. It is impossible to tell the age of a lobster because all of the hard parts of the body are lost when the lobster molts. Most lobsters are caught within one year from the time that they reach the legal minimum size, at a weight of less than 1 ½ pounds.

According to the Atlantic States Marine Fishery Commission Amendment #3 to the Interstate Fishery Management Plan for Lobster (1983), the definition of overfishing is: "the lobster resource is overfished when it is harvested at a rate that results in egg production from the resource, on an egg-recruit basis, that is less than 10 percent of the level produced by an unfished population" (ASMFC 2002). In other words, the average female lobster should be allowed to live long enough to produce at least 10 percent of the eggs that she would produce if she were allowed to live her natural life.

While it may seem impossible to judge the egg production from an unfished population, considering that the lobster populations have been heavily fished for over 100 years, it should be easier to calculate the egg production from a female that lived a natural life span. If the frequency of female egg production were known, as well as how many eggs she produces each time and how many years she is likely to live, then how many eggs she would produce over her lifetime could be calculated. However, these variables are always in flux and therefore cannot be accurately measured or used as a constant in an equation.

A report by the Northeast Fisheries Science Center's Stock Assessment Workshop (SAW-16) concluded, in 1994, that the lobster fishery, as a whole, was overfished. Amendment 5 to the American Lobster Fisheries Management Plan published in 1994, revised the definition of overfishing for the species to specifically include the issue of recruitment overfishing. The current definition is:

> The resource is recruitment overfished when, throughout its range, the fishing mortality rate (F), given the regulations in place at the time under the suite of regional management measures, results in reduction in estimated egg production per recruit to 10 percent or less of a non-fished population [F10%] (NMFS 2002).

This means that fishing mortality rates above the F10% in the definition do not necessarily imply that a stock collapse is imminent. Rather it means that fishing mortality rates below the F10% contained in the definition maintain a spawning biomass with a low risk of collapse. However, under U.S. law the Fisheries Management Councils cannot operate a fishery with an F above the overfishing definition over the long term. Fishing mortality rates (F) for the Gulf of Maine and Southern Cape Cod to Long Island Sound were estimated to be 0.65 and 1.47, respectively. Corresponding Fmax or F10% estimates for these two stocks is 0.62 and 0.68, respectively and thus, they are overfished (NMFS 2002). For mathematical purposes, fishing mortality rates are expressed as "instantaneous rates", which are not identical to the percent of the stock removed on an annual basis. Table 5.1 below provides a conversion between F rates and the annual percentage removal.

Table 5.1: F Rate Conversion Table

Instantaneous Fishing Mortality Rate - F	Annual Percentage Removal
0.05	5
0.1	10
0.5	40
1.0	64
1.5	78
2.0	87
2.5	92

Source: Allen 2002

It is difficult to decisively state the level of government involvement in the management in the Maine lobster fishery. The rules concerning territoriality are generated and enforced by the fishers. The government does not officially know about that system.

One of the key tenets of the common property model has been that "the exploitation of collectively owned resources can be halted only by either instituting private property or the government taking action" (Acheson 1989:358; Hardin 1968). As discussed in the previous chapter, the Canadian government's management of the codfish and the present situation of the Atlantic Canada lobster seem to demonstrate that in practice, government management cannot halt the overexploitation of natural resources.

5.6 Private Property and Conservation

There are many examples of institutions and rules created to limit exploitation. The Maine lobster fishery is an example where property rights are said to limit exploitative effort by gear and seasonal restrictions, restrictions on size and sex of animals sought, prevention of more effective technology, and secrecy. Therefore, are private property rights effective in conserving resources?

It would seem that an owner of a resource would want to conserve their own property for their own best interest. McCay and Acheson (1987:9) claim that "resource conservation is not always ensured by private property status of resources". For example, farmers in Maine do not necessarily contour plow or practice other strategies to conserve the soil. Reforestation programs are based on planting single species of fast growing trees and the dust bowl conditions of the 1930s were caused by irresponsible soil management practices (Acheson 1989:364). Alternatively, under certain conditions it is rational for the owners of a resource to use them up very rapidly and to disregard future benefits. This occurs when the growth rate of a resource is less than the interest rate.

James Acheson claims that:

> there is at least one case where hard quantitative data exist to demonstrate that enforcing property rights not only conserves the resources but also has many of the favorable economic effects predicted by the economists interested in the common property question (1989:366).

For Acheson, this case is the lobster fishery in Maine. Lobster fishers from each harbor along the coast of Maine claim inshore fishing rights to certain areas. These territories are held jointly and all fishers from each harbor are allowed to fish anywhere within the entire range of their territory. These *de facto* claims of property ownership of lobster territories are unrecognized by the state or federal government, but are defended by the lobster fishers with violence (Acheson 1989:366).

Acheson describes two kinds of fishing areas: nucleated areas and perimeter-defended areas (Acheson 1989:366). The inshore fishery of Maine is located from the shoreline to 3 miles out to sea. In the nucleated areas, ownership is very strong from the mouth of the harbor and then gets weaker as it moves farther from the harbor. At the outer point there is no sense of ownership and mixed fishing is practiced, where two or more fishers from different harbors may place traps in the area.

The second kind of fishing territory Acheson describes is the perimeter-defended area. Within this area there is strong ownership out to the boundaries and these boundaries are sharply drawn and defended to the yard. There is no mixed fishing within the perimeter-defended areas. Ownership rights are maintained in both types of territories. Whereas access is easier in nucleated areas, perimeter-defended areas are far more controlled (Acheson 1989:367). The perimeter-defended areas are found around islands that have been controlled by a few of the old established families, who reserve all the fishing rights to themselves.

The exploitative effort by fishers in the perimeter-defended areas is lower than in nucleated areas. Also, because access to these areas is denied there is less competition for the fishers and they attain more fishing area per boat than fishers in nucleated areas. Acheson also claims that some fishers practice conservation measures (Acheson 1989:367). Acheson uses an example of fishers from two islands (out of the many thousands of islands) who voluntarily limited the number of traps. He claims that this will reduce costs and reduce the "ghost trap" problem (Acheson 1989:367). The logic is that a fisher with fewer traps will tend them more often and not lose as many. This will lower the mortality of lobsters since those in lost in traps die, and when traps are pulled in, the molting lobsters that would have been eaten by their fellows are released and have a better chance of survival.

Acheson (1989:367) claims that the perimeter-defended areas along the coast of Maine have both economic and biological benefits. As there are fewer fishers fishing in these areas there are fewer to share in the catch. Also, because exploitative effort is lower in these areas lobsters have a greater chance to survive to larger sizes. Fishers in these areas catch more and bigger lobsters with less effort. Acheson (1989:367) notes that in every season, the number of lobsters caught per trap and the mean size are larger in perimeter-defended areas than in nucleated areas.

Lobster fishers in the perimeter-defended areas also earn significantly more money than nucleated area lobster fishers. The larger number of lobsters in perimeter-defended areas allows for a greater number of lobsters extruding more eggs into the water. As more lobsters are conserved, more lobster eggs float throughout the region.

Acheson (1989:367) also claims that there is no reason to believe that perimeter-defended areas are inherently richer in lobsters but that the better catches and bigger sizes of lobster are due to the practices of lobster fishers. Acheson concludes that because perimeter-defended areas restrict access more than nucleated areas, the Maine lobster fishery supports the claim that at least under certain conditions property rights help conserve the resource (1989:368). However, Acheson later modified his assertion about the relationship between private property rights to the lobster fishery (which he renamed as the "traditional territorial system") and conservation, arguing instead that access to good fishing grounds, achieved through territorial or boundary conflict, was more important to fishers than was conservation (Acheson and Brewer 2000:1-2, 11-12).

Inasmuch as Acheson claims that private property rights and community control as opposed to government intervention may be advantageous from both economic and conservation perspectives, the statistics in Table 5.2 demonstrate that landings have increased consistently and considerably. This may not be favourable for conservation, and thus the fishery economies will likely suffer in, at least, the medium term.

Table 5.2: United States Annual Atlantic Lobster Landings

Year	Metric Tons
1950-1959	12,327 (Annual Average)
1960-1969	12,393 (Annual Average)
1970-1979	14,634 (Annual Average)
1980-1989	20,404 (Annual Average)
1990	28,296
1991	29,072
1992	25,977
1993	26,290
1994	31,743
1995	29,759
1996	31,605
1997	38,357
1998	36,312

Source: Allen 2002

According to the Stock Assessment Summary in 1996, the total lobster landings have more than doubled since 1978. The increase in landings has occurred over a wide geographical area. It is estimated that the entire annual catch in the Maine lobster fishery could be harvested by 1,000 well equipped boats yet there are approximately 2,300 boats employed full-time and another 5,000 part-time (Acheson 1989:356). As well, there are too many lobster traps in Maine as fishers currently utilize between 400 to 650 traps (Acheson 1989:374). As many as ten traps may be connected to a buoy.

The lobster fishery of the state of Maine is experiencing some alarming trends. Lobster size is decreasing, the mean size of lobsters landed are within one molt or two molts of the minimum size regulations, and the fishery is heavily dependent on newly recruited animals. In regards to data accumulation, there has been an over-reliance on statistics and modeling with little or no spatial information on lobster populations. Landings are concentrated in a few areas. For example, Maine accounted for half of the total lobsters landed, while Massachusetts comprised 25 percent of that total (Lincoln 1998:66). Coastal fisheries accounted for 86 percent of U.S. landings in 1993.

Lobster landings are concentrated during a few critical months of the year. In 1996, 82 percent of the landings in Massachusetts were in July to November and September to October. This is a critical time period as this is just after lobsters have molted and just before the females extrude their eggs (these berried lobsters are protected from fishing). As a result a significant portion of lobsters are landed before they reach sexual maturity, which compresses spawning potential into an increasingly narrow size range and presumably age range as well.

Aquaculture is becoming an industry supplementing wild-catch fishery products. In Maine, salmon production rose substantially in 1998 and 1999. There are indirect effects on lobster populations from the waste produced by the enclosed salmon populations. Also of concern to lobster populations is the use of Nuvan, a chemical used to reduce sea lice, which has the indirect effect of softening the lobster's hard outer shell (Ross 1989:372). This can lead to increased lobster mortality by being damaged or by being eaten by fellow lobsters. Salmon farming also requires large inputs of industrial energy (oil, coal, electricity) to produce net pens and operate automatic feeders, aerators, pumps, boats, and other equipment to raise the juvenile salmon and produce the feed pellets. Cage-farming of Atlantic salmon requires 50 kilocalories of fossil energy input per kilocalorie of protein output (Folke 1992:10). By comparison, lobster fisheries require 192 kilocalories of fossil fuel energy input per kilocalorie of protein output (Folke 1992:10). This demonstrates that lobster fisheries are very energetically expensive and their economic rewards are linked to the internationally determined cost of fossil fuels. However, fish produced in aquaculture, such as salmon, are less resilient and very vulnerable to diseases, and incur economic losses due to pests and algae blooms. In such a system, the energy and nutrient flows of the surrounding system are radically modified and the whole system is severely affected when cultured species are harvested, with the risk of total system collapse. Furthermore, the risk for outbreaks and spreading of diseases and parasites substantially increases with intensification, expansion and decreasing distances between rearing facilities (Folke 1992:13).

The coast of the Gulf of Maine has over 7,000 miles littered with 4,500 separate islands. Lincoln (1998:38) claims that because of this geographical feature, conditions exist for enhanced productivity. Each island influences currents that help to mix, oxygenate, and enrich the water. The islands also cause local upwellings of deeper, colder, nutrient rich waters which are ideal conditions for lobsters. Therefore, Lincoln (1998:38) and Conkling (1995) conclude that Maine's largest lobster harvests are found along the sections of coast with the largest number of islands. This evidence contradicts Acheson's claim, because there seems to be considerable differences in habitat and preferred location of lobsters between nucleated and perimeter-defended areas, favoring the latter.

The difficulty in attaining an accurate picture of what fishing behavior is being practiced may lead to description that is far from reality. Acheson discusses the use of secrecy by fishers to exclude others from where the most abundant lobsters are temporarily located. Therefore, observational data are of key importance. These may be difficult to get an accurate description of as lobster fishers leave their traps for longer periods in areas they do not fish and sometimes fishers leave their traps on lobster grounds in order to preserve their territory and prevent others from fishing there. This can lead to the ghost fishing problem and a by-catch that is undeterminable (Lincoln 1998:58).

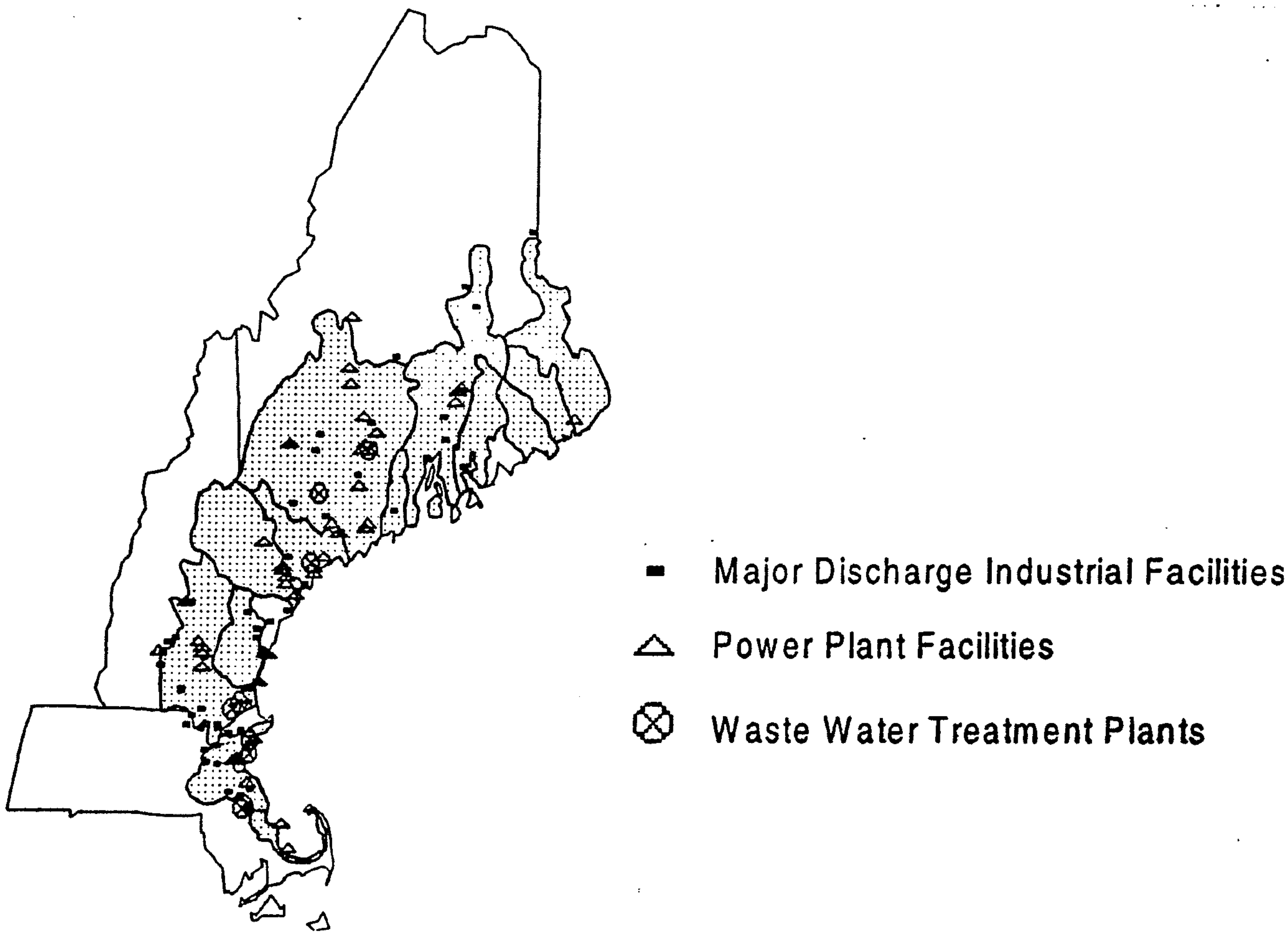
There are also types of human activities that affect shellfish directly or indirectly. As mentioned above, while the direct contribution of fishing to the reduction of shellfish populations seems evident, other technologies such as trawling also have indirect effects such as destruction of shellfish habitat and "by-catch". Between 1989 and 1994 there were 15,000 trawl and dredge tows in the Gulf of Maine (Lincoln 1998:63). In the trawled area, this activity causes the rocks to become bare and disturbed and both the complexity and productivity of the habitat are decreased. The inshore lobster populations are competing for a limited area for protection. This nucleated territory is exploited by mixed fishing, and therefore bottom trawling has a significant impact on these lobster habitats.

The Gulf of Maine is the third most densely populated coastal region in the United States. In 1988, 72 percent of Maine's population lived in coastal counties (Gottholm and Turgeon 1992). The U.S. Northeast estuaries have the largest input of nutrients from wastewater treatment plants (WWTP) (Gottholm and Turgeon 1992). The estuaries of the Gulf of Maine are fed by a vast watershed covering 178,000 square kilometers that empties 950 billion litres of freshwater into the nearshore ecosystems each year (Lincoln 1998:36). Much of this water comes from areas affected by acid rain. The melting of snow in the spring liberates in a few days great concentrations of acid that affect the survival and growth of eggs and hatchlings. Since the mid 1980s Maine has been losing wetlands and has destroyed 20 percent of the estimated original wetlands (Lincoln 1998:38).

Lobster populations are sensitive to chemicals and have been known to vacate areas that have become polluted. Human activities that lead to pollution and destruction of lobster habitats are landfills, dredging, dumping, industrial wastes, spills and sewage outfalls. Some of the point sources of pollution in the Gulf of Maine are industrial plants such as, pulp and paper mills, fish processing plants, textile mills, metal fabrication, municipal sewage treatment plants, and chemical and electronic factories. The number of point sources facilities by watershed and major point source category for the Gulf of Maine is presented in Map 5.2. Non-point sources of pollution consist of rainwater runoff containing pesticides from agricultural and forested areas with hydrocarbons, heavy metals and organics. Casco Bay (Map 5.3), at the southern end of Maine, offers an example as it is a primary area of nutrient input from industrial sources in the Northeast. Boston, Massachusetts is the only major city in the U.S. that does not treat its sewage beyond the primarily level (separation of sewage into effluent and sludge). The Boston Harbor has elevated levels and concentrations of PCBs and high copper toxicity (Gottholm and Turgeon 1992). The synergistic effect of the activities of these different types of pollution has not been properly investigated, but we can surmise that it is much greater than the addition of their respective depredations of the marine ecosystems. The best fisheries management policies do not, and could not, deal with these important determinants of the health and survival of fish and shellfish populations.

Map 5.2

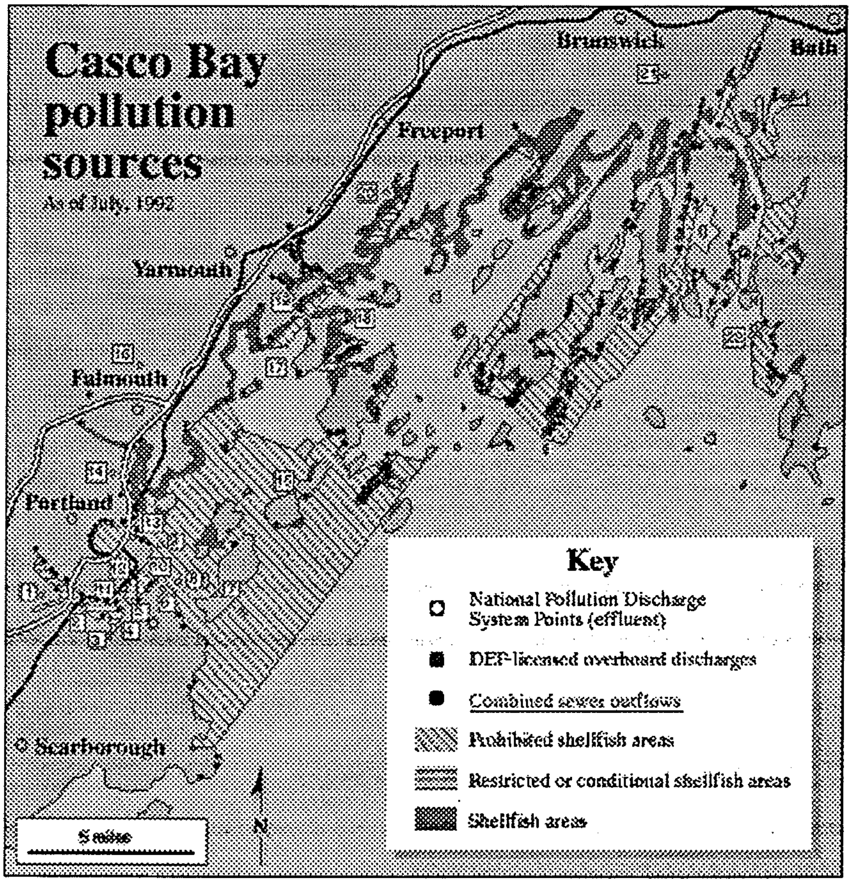
Sources of Pollutant Discharge - Maine



Source: Gottholm and Turgeon 1992:10.

Map 5.3

Casco Bay pollution sources



1. Clean Harbors-WIlliams
2. Koch Fuels
3. South Portland WWTP
4. Portland Pipeline Corp.
5. Central Maine Power, South Portland
6. Star Enterprise
7. Mobil Portland Terminal
8. Mobil Portland Terminal
9. Rockwood Systems Corp
10. Cumberland Farms Inc.
11. Sebago Oil and Ice
12. Marine Fisheries Corp.
13. Portland Water District
14. Falmouth Sewage Treatment
15. Phoenix Resources
16. Town of Falmouth
17. Central Maine Power, Yarmouth
18. Sea Meadows Subdivision Sewerage
19. Yarmouth WWTP
20. Freeport Sewerage District
21. Brunswick Naval Air Station

Source: Casco Bay 2002

5.7 Summary

The local level Maine lobster fishery has a system of management different from that of the Canadian federal government's management of the Atlantic Canada shellfishery. In the state of Maine, the system of local level control of resources seems closer to an ideal version of how resources should be managed, rather than by a centralized management authority. However, this management model is not without limitations. This chapter outlined some of the salient features of the Maine lobster fishery. This revealed that there is little evidence to support Acheson's (1989) claim that "private" management of the lobster fishery in the state of Maine is ecologically and economically successful and presents an alternative to the "commons" approach.

Chapter 6: Conclusions

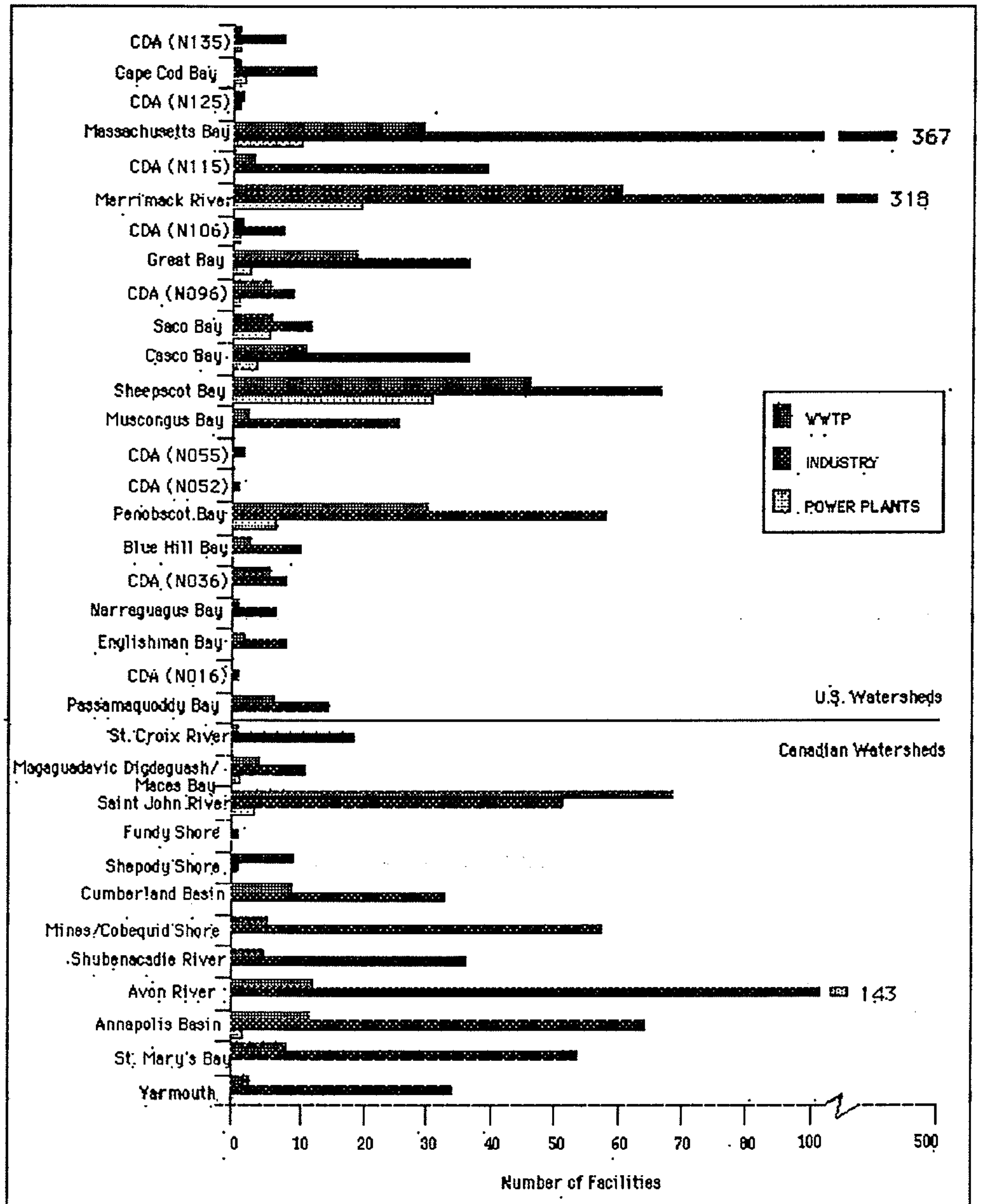
6.1 Analysis and Summary

There are many important issues that arise from the preceding chapters. The Atlantic Canada lobster fishery is comprised of many different actors with different priorities for the utilization of the resources. The actors are involved in a system where one actor, the federal government, has "absolute discretion" and thus the power to make any decision desired. The provincial governments, business, fishers, and fish all play a secondary role in the power distribution throughout the Atlantic Canada shellfishery. This concentration of power by the Minister of Fisheries and Oceans has led to decisions on resource harvesting and allocation based on ministerial, and thus political, priorities.

The chapter on the effects of fishing and pollution demonstrate the various ecological processes that are affected by human activities. A wide variety of pollutants are discharged into the aquatic ecosystems in the Atlantic region. The major problem associated with these activities is synergism. The combined effects of these disturbances are greater than the sum of them. Shellfish closures, due to contamination and discharge from different industry processes in the Atlantic region, have become increasingly frequent. This is a valuable indicator as changes in one species population will affect the remaining species and adjustment must occur. The problems identified in this chapter illustrate the difficulties that arise in identifying management solutions. The effects of these pollutants and fishing technologies on ecosystems and shellfish populations are not beneficial to either habitats or biotic communities. The overall message is that the habitats and shellfish populations are being stressed but that because of our ignorance of many key variables, the threshold between the maintenance of the status quo and collapse is undeterminable from an ecological perspective. The number of facilities that are point source pollutants on both Gulf of Maine and Canadian watersheds can be seen on Chart 6.1. This indicates not only the number of the facilities that exist, but also the quantity that empty into the ocean.

Chart 6.1

Number of Point Source Facilities by Watershed and Major Point Source Category in the Gulf of Maine Study Area, 1991



Note: There are 10 major and 16 minor point source facilities located in the U.S. portion of the St. John River watershed that discharge to Canadian waters.

Gulf of Maine Land-Based Pollution Sources Inventory

Source: NOAA 2002a

Chapter Four evaluated the management of the shellfish in Atlantic Canada with a specific analysis of the lobster fishery. There are four themes that should be re-emphasized in this analysis. Firstly, as indicated above, the federal government, and more notably the Minister of Fisheries and Oceans, hold much power in decision-making and thus the provincial governments and other actors are secondary in the decision-making process. Decision-making in shellfishery management occurs through a complex maze of proximal and distant individuals, committees, councils, and departments. Distilled and politically influenced information eventually makes its way up to the ministerial level. A schematic representation of these issues can be found in Charts 6.2 and 6.3, which are flowcharts of the Atlantic Canada Lobster Fishery Management system and United States Lobster Management system, respectively.

Chart 6.2

Atlantic Canada Lobster Fishery Management

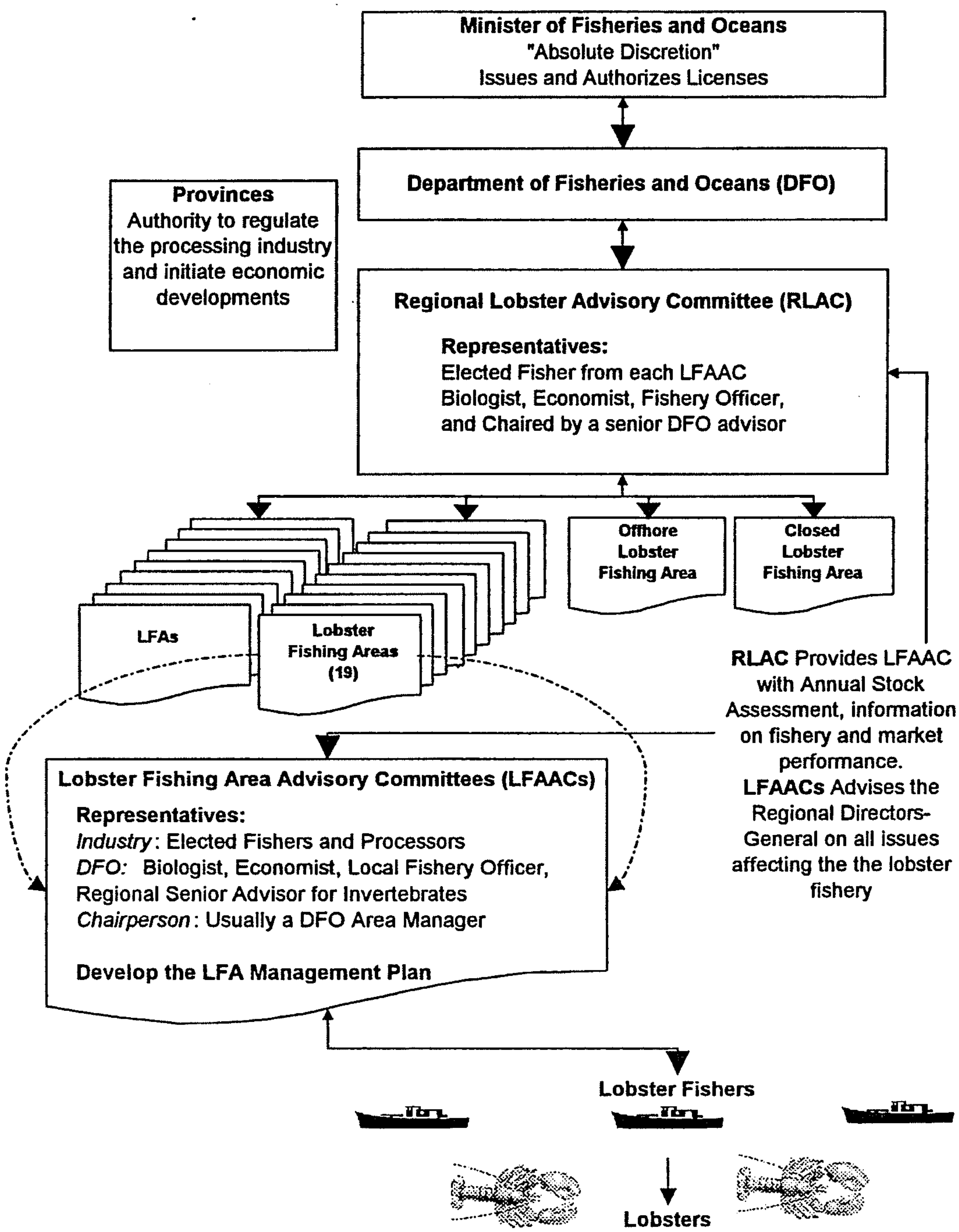
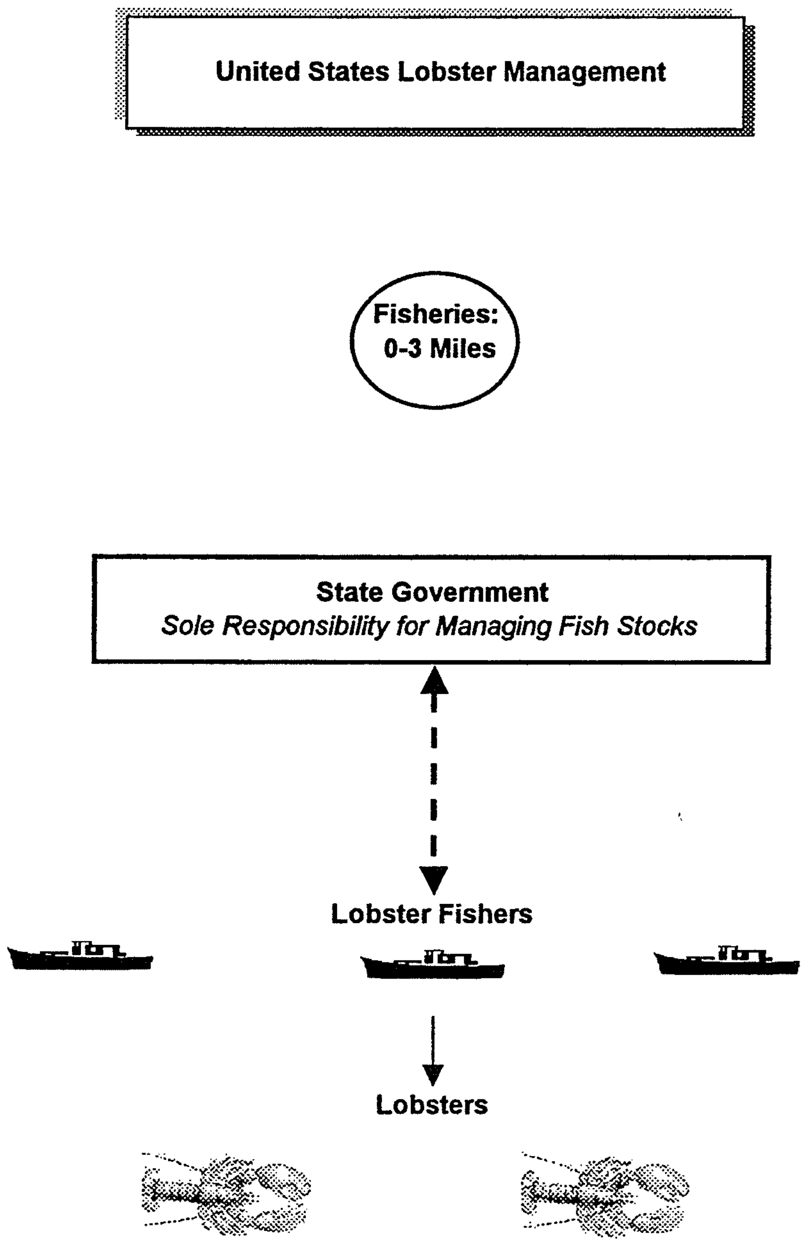


Chart 6.3


United States Lobster Management
Fisheries:
0-3 Miles
State Government
Sole Responsibility for Managing Fish Stocks
Lobster Fishers
Lobsters

Roy Rappaport's (1974) use of cybernetic analysis is useful here as he argues that ill-informed managers make incompetent decisions. Secondly, Ministers also have conflicting responsibilities. The responsibilities that they seek are re-election, economic development or employment, and conservation. A problem arises because, as Hardin (1968) claimed, these three variables cannot be maximized at the same time. Thirdly, policies that affect different species are made by different people and departments and not necessarily coordinated with a deep understanding of ecological processes. The trend in Atlantic Canada seems to indicate a preference for the creation of fisheries or industrial employment to garner votes rather than pollution control. Conflicting interests are again illustrated by the limited efforts made to make polluters pay for clean-ups. This in turn affects shellfish populations in their life cycle. Because water is polluted, the quality and quantity of the catch are undermined. Finally, scientists are often specialized in the study of a single fishery and policies are based in part upon this specialized knowledge. As illustrated earlier, this 'specialized knowledge' is very incomplete. For example, there is very little rigorous science on estimations of lobster biomass that has made its way into management decisions of this fishery in Atlantic Canada. Because they are specialized in one fishery they tend to ignore the effects of fishing one species upon other species in different parts of their life cycles and in different ecosystems. For example, dragging for scallops affects the habitats and other fisheries. The problem of by-catch is another significant example of the interference of one fishery with others. As mentioned earlier, by-catch is very often under-reported by fishers and the extent to which it is under-reported is largely unknown. For example, many have reported levels of by-catch that reach as high as eight times the weight of fish that are kept (Berrill 1997:69).

Neither the Maine nor the Canadian lobster fisheries are immune from black market sales. There is no dockside monitoring of catch in Canada, thus requiring Canada Customs and Revenue Service investigations into fishers and fish buyers unreported incomes (Foot 2002:A2). Lobster fishers in Maine also sell directly to tourists at dockside (Ingersoll 2002).

The implications of these confounding factors leads to suggestion that fishery policy might be better understood from a political ecology perspective which emphasizes the fact that decisions affecting ecological variables are predominately based upon economic goals and political expediency. In spite of the expertise of many dedicated DFO officials, the scientific basis for management decisions is often deficient and anyway it is often ignored.

While James Acheson's (1989) argument for a private property regime in lobster fishing seems persuasive, his supporting evidence is less than convincing. The local level Maine lobster fishery is a different system of management from the federal government management of the Atlantic Canada shellfishery. Management of resources by these smaller institutions is energetically expensive because policy decisions are constantly being made and re-evaluated. This contrasts with larger systems, such as in Canada, whose energy expenses are lower because changes come more slowly (Rappaport 1974). The advantage of the smaller system lies in that there is greater flexibility for short-term decision-making. Part of the energy expense is related to the flexibility of smaller systems. Local level management can react quickly to local systemic disturbances and it can make decisions on short-term demand, but as soon as the stressor(s) change, a new decision has to be made.

As an example, if there was a short-term stressor such as an oil spill, fishers would be allowed to fish a smaller number of traps. Smaller systems that are locally managed could alter the number of traps allowable to react to the stressor. This would be energy expensive, but larger systems could not react officially to such short-term stressors without affecting also many other areas that were not stressed on this occasion.

Neither the common property nor private property approach to management of the lobster fisheries will inherently be sufficient to conserve the resource. Neither a large system nor a small system approach to management of the fishery will inherently conserve the resource in all cases and in the long run. Only a management structure that has as an explicit goal of conservation and acts accordingly and consistently will conserve resources, regardless of property approach or system size.

What makes fisheries qualitatively different from any other production industry is that the production cannot be directly controlled. All that is possible is the management of its extraction from the ocean. Saplings can be planted, fish can be grown in aquaculture, and widgets can be constructed in a factory, but fish cannot be grown in the ocean. The only way to influence an increase in lobster populations is reducing the taking of lobsters, reduce pollution, and reduce the takings of lobster prey.

This thesis illustrates that the debate surrounding management strategies of common and open-access resources is not yet complete. The management of fisheries resources has been based on Hardin's explanation of why resources are depleted. The thrust of Hardin's argument was based on what he called 'common' resources, but in actuality the focus of his argument is more accurately called 'open access' resources. Both of the cases under investigation in this thesis, the Canadian management system, which is based on government intervention, and the Maine management system, where resources are managed partly under a private property regime, have led to unacceptable solutions for, and a destruction of, the resources in the groundfisheries. There is an inherent conflict as ecological problems can only be solved over the long-term whereas contemporary politics operates in the realm of the short-term. Therefore, current government regulation strategies for managing fisheries resources will not likely conserve these resources over the long term.

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