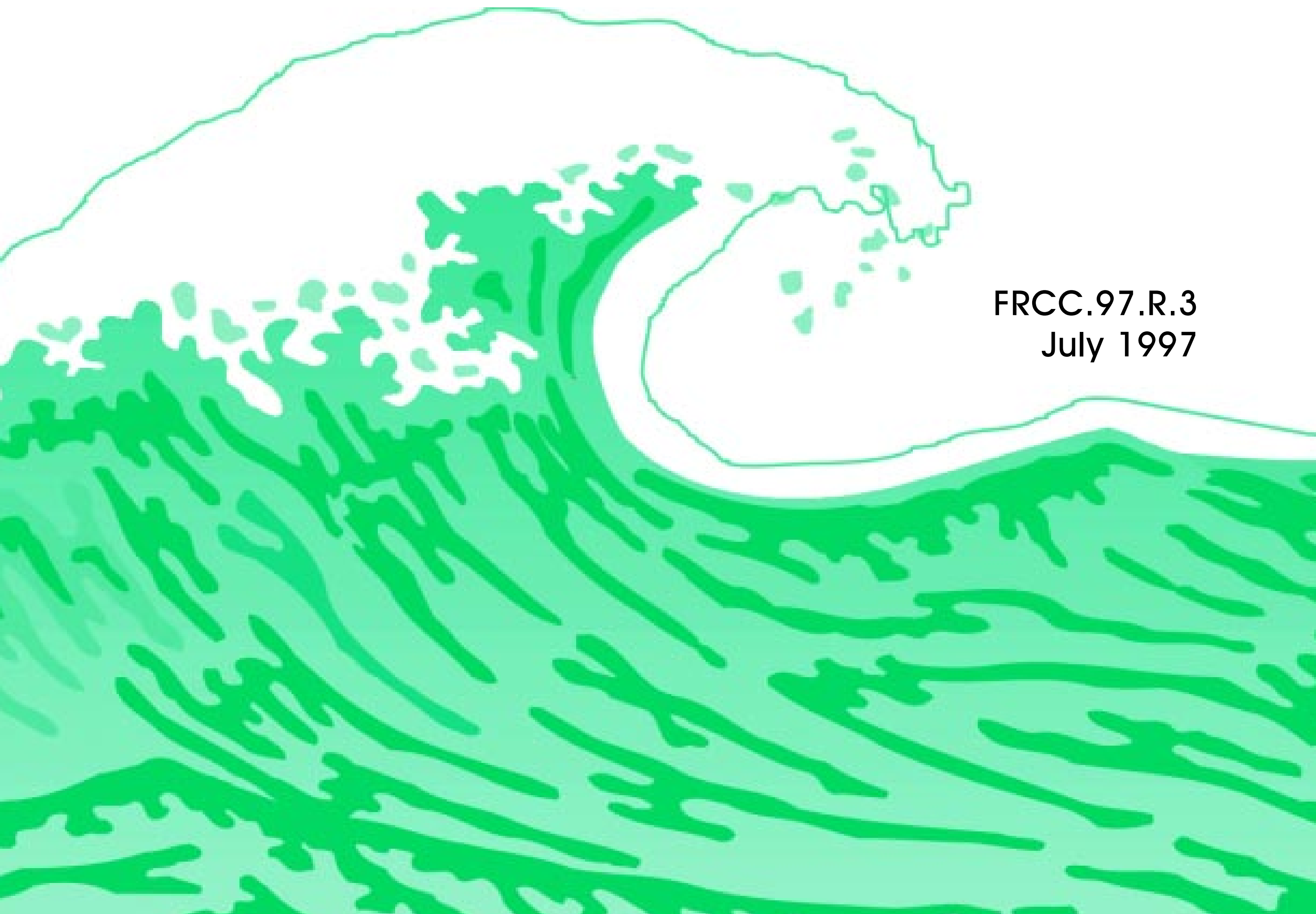
Fisheries
Resource
Conservation
Council

A Groundfish Conservation

Report to the Minister of Fisheries and Oceans



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1. Introduction

Why a groundfish conservation strategy?

On July 2, 1992, the Minister of Fisheries and Oceans declared a moratorium on the harvesting of northern cod (NAFO division 2J3KL). One of the greatest renewable marine resources in the world had collapsed. Subsequently, most of the groundfish fisheries north and east of Halifax, Nova Scotia would be under moratorium. All of this happened under a management regime that was supposed to be a model for the world. The collapse of groundfish fisheries caused one of the worst social and economic disasters in Canadian history, threatening coastal communities throughout Atlantic Canada and Québec. The fishery crisis had heavy social costs as well; around 40 000 jobs have been lost or endangered, making the collapse of the Atlantic groundfish fishery one of the largest industrial layoffs in Canadian history. The affected communities had relied on the fishery for their existence, and the livelihood of their people, for centuries. The fact that Atlantic groundfish stocks collapsed to such an extent, should serve as a warning — the fishery of the future should not mirror the fishery of the past.

The failures and abuses of the past must be addressed. All participants must be prepared to change.

We must address the failures and the abuses that led to this path of destruction: over-estimation of the biomass; over-estimation of recruitment; failure to recognize environmental changes and their impact on the groundfish fishery; failure of the management system to recognize the impact of technological change; under-estimation of foreign overfishing; pressures of our own Canadian industry which led to misreporting, dumping, discarding, and high-grading; and, failure of the political system to make the necessary conservation decisions when the red flags did go up.

Groundfish fisheries in Atlantic Canada are still facing a major crisis. Twenty-one stocks, among the fifty-two considered by the Fisheries Resource Conservation Council, are still closed to direct fishing; most others face reduced quotas of 30 to 90% by volume when compared to 1990. Since the implementation of the EEZ, in 1977, until the first moratorium, in 1992, annual groundfish landings averaged 670 000t, creating jobs for an equivalent of 60 000 persons per year. Cod landings, which represented around 40% of the total Atlantic landings by volume during the period 1980-1990, now represent less than 3%. For several groundfish stocks, scientists recognize that the biomass is at the lowest levels ever observed. Despite drastic actions, there are but few signs of improvement and the recruitment indices remain low.

Recent history demonstrates that, collectively, we failed at managing and preserving the resource and the associated economic activities. We have to learn lessons from past errors and, gradually, by progressive reopenings of closed fisheries, to start a new conservation-based fishery.

It is clearly unwise to continue to manage the groundfish resource as we have in the past. Basic changes are necessary in the manner by which we manage and conduct fisheries.

The lessons from the past

The groundfish crisis is the result of numerous factors including: excessive harvesting and processing, uncertain biological stock assessments, and ineffective fisheries management.

The fishery crisis cannot be related to a single cause or blamed on a single group: it is the failure of our whole fisheries system.

From the mid fifties to the early 1970s, there was a rapid increase in fishing effort by European fleets off the shores of North America. Stock assessment at the time indicated that many stocks were experiencing very high fishing mortality and were depleted quickly. After Canada extended its jurisdiction to 200 miles, in 1977, we believed that fishing mortality would be tightly controlled through precise stock assessment and stringent enforcement, and stocks would be rebuilt quickly and permanently. And in fact, some rebuilding was observed and commercial catch rates increased rapidly until the early eighties, fueling optimism.

Despite repeated warnings, large investments were made, with incentives from federal and provincial government programs, to build new, more powerful and efficient vessels, as well as an expanded and more efficient processing industry. The result was "institutionalized overfishing", induced by economic pressure to ensure the profitability of the industry and to maintain high employment levels.

As a result of "institutionalized overfishing", most stocks suffered from non-conservationist fishing practices, (including misreporting, under-reporting, high-grading, discarding). The processing sector was also involved; for instance, in its acceptance of undersized fish to process.

In the mean time, high foreign fishing effort and poor fishing practices of the foreign fleet outside the 200 mile limit, severely affected transboundary stocks, such as 3NO cod, Greenland halibut, plaice and flounders; different views about conservation on both sides of George's Bank induced a severe decline of stocks in this area. Even if corrective action had been taken, and drastic measures implemented, in the late eighties, much of the damage had already been done.

As domestic fishing capacity increased, so did the difficulties in controlling the fleet. Along with Total Allowable Catches, other measures were put in place, according to gear type, season, geographical areas, etc. The end result was, by the early 1990s, a complex and intricate set of management rules which proved very difficult to monitor and police at the same time as governments and industry were experiencing reduced human and financial resources.

In parallel with the implementation of the 200 mile limit, the Department of Fisheries and Oceans put in place a stock assessment system within its science sector to provide recommendations on TACs. The idea was to get accurate information, revised by an internal peer-review process (which is the basis of reliability of scientific advice). Despite the apparent coherence of the process, the result was disappointing as it was not able to ensure a sustainable fishery nor to prevent the collapse.

While the most advanced techniques and mathematical models were used, scientists became too confident in their tools, placing too much emphasis on commercial fisheries data (actually unreliable due to the poor value of reported information) and too little on fishermen's knowledge. It appears now that mathematical models overestimated some stocks' levels. TACs were also set too high. Both factors have contributed to excessive fishing mortality.

There have been serious under-estimating of fishing mortality rates in the years between 1977 and 1989".
(Harris Panel, 1990)

In addition to problems in managing the fishing industry, and problems in assessing stocks, the natural environment was changing as the Canadian Atlantic faced harsh environmental conditions: over the past decade, temperatures have been lower than the long-term average, and ice coverage has been wider and remained longer than usual. Difficult environmental conditions could have had a detrimental effect on recruitment and on fish growth. On the one hand, the severe oceanographic conditions may have reduced the survival capacity of fish, and, on the other hand, mortality rates may be dependent on the abundance of prey (e.g. capelin for cod) or of predators (as may be the case with the increasing seal population).

Standard fisheries models are insufficient to assess and predict natural fluctuations of stocks or even to integrate variations of the environment into the forecasting of the resource.

Looking at the past, several lessons can be learned. We have to accept that humans cannot control nature. The overall limits to the productivity of the stocks are set largely through nature's influence. Because nature plays such a predominant, unpredictable and potentially devastating role, very cautious target exploitation rates should be set to allow for unexpected periods of low productivity.

We have also to realize that human behaviour is difficult to control. We have to match the harvesting capacity of the fleets to the productive capacity of the resource. Nature fixes the parameters within which we operate and it is our duty to estimate these parameters as best we can, while prudently managing the fishing fleets in such a way that humans will not push the resource outside the limits set by nature. The current size of the fleet, and the inability to deal effectively with rampant over-capacity, does not allow for natural protection of the stocks. Given the many advances in fishing technology and gear design, even if the resource is very scarce, we can find it and fish it; in fact "fish have no place to hide, anymore".

The lessons from the past:
- Humans cannot control nature; the overall limits to the stocks' productivity are set through nature's influence;
- human behaviour is difficult to control; the harvesting capacity of the fleets must match the productive capacity of the resource;
- current over-capacity of fleets and advanced fishing technology do not allow for natural protection of stocks;
- the forces which led to past failures are still in action

Finally, the forces which led to past failures are still in action. It will take considerable effort to recognize old pitfalls when they appear under new guises in the future. A new start is necessary. As we begin to ponder the questions associated with reopening closed fisheries, the need for change has never been greater. We must have a conservation strategy that will form the blueprint for rebuilding groundfish stocks and maintain a sustainable fishery for the future. A strategy is a series of actions organized in order to achieve pre-defined objectives. The present report intends to define those objectives and to describe the actions necessary to attain them.

Scope of the report

The Fisheries Resource Conservation Council's mandate focuses clearly on the conservation of fisheries resources. We use several general principles to guide our recommendations. The Council's approach is based on:

- CONSERVATION FIRST: the fundamental premise of erring on the side of caution reflects a precautionary approach that takes into account uncertainty in information;

- AN ECOSYSTEM APPROACH TO FISHERIES CONSERVATION AND MANAGEMENT: while it is not intended to try to manage the ecosystem, fish species must be seen as part of a whole system, where inter-species relationships and environmental factors play a major role in affecting fish stocks and where interactions between the harvesters and the fish have to be taken into account;

- PARTNERSHIP: stakeholders must be involved in a process with DFO science and management to set up enforceable, conservation-oriented fishing plans and ocean conservation measures.

The Council has emphasized these principles throughout its work. Its annual reports to the Minister of Fisheries and Oceans and special reports such as "Conservation aspects of Groundfish Gear Technologies in Atlantic Canada" (FRCC.94.TD4) and "Other Conservation Measures" (FRCC.94.TD2) reflect how the principles can guide sustainable fisheries. More recently, the report "From moratorium to sustainability: criteria for re-opening and sustainable harvesting" (FRCC.96.TD.1) highlights the need to determine key indicators of stock health, acceptable levels of those indicators and agreed-upon ways to measure them. The report on 1997 Conservation measures for Atlantic Groundfish "Building the Bridge" (FRCC.96.R2), emphasized the necessity of a cautious approach, including specific elements for each Conservation Harvesting Plan, and of a better knowledge of the resource involving industry-science joint ventures.

Each of these reports emphasized certain elements of a conservation strategy. The Minister of the Fisheries and Oceans challenged the Council to develop a comprehensive groundfish conservation strategy, the new conservation framework for groundfish fisheries.

As conservation is everybody's concern, the proposed Conservation Strategy is written for all people involved, at all levels, in groundfish fisheries:
- Ministers;
- FRCC
- Harvesters and processors;
- Managers;
- Scientists;
- Other stakeholders, including NGOs and the general Public.

- MINISTERS have the overall responsibility for marine resource conservation, on behalf of the Canadian People;
- FISHERIES RESOURCE CONSERVATION COUNCIL has the mandate to make recommendations on conservation measures to rebuild stocks, and, afterwards, to maintain stocks at healthy levels.
- HARVESTERS and PROCESSORS are on the front line and have to consider the impact their daily actions have on the groundfish resource, on other elements of the ecosystem (non-targeted species, habitat, etc.); if, traditionally, their actions were guided by regulations beyond their control, they now will have more and more responsibility for resource conservation;
- MANAGERS, whether government officials or fishery participants, have the duty to decide, implement and enforce harvesting rules and principles, in order to conserve both the resource and the corresponding socio-economic benefits;
- SCIENTISTS have to provide the necessary information about the resource to allow enlightened decisions;
- OTHER STAKEHOLDERS AS WELL AS NON GOVERNMENTAL ORGANIZATIONS AND THE GENERAL PUBLIC, are concerned about marine resources and the marine environment, in general. Other stakeholders include those not directly involved in the groundfishery, who derive their livelihood from the Ocean and whose activity may have an impact on ground fisheries.

The report includes, in Chapter 2, a review of the basic elements of the groundfish fishery (resource, harvesting, science and management) introducing the issues that have to be addressed. Chapter 3 presents the three basic elements of the strategy:

- a specific definition of groundfish conservation and of principles to be followed (section 3.1);
- the major tasks that have to be accomplished to ensure conservation (section 3.2);
- the responsibilities of each major stakeholders' groups and a list of concrete actions to be undertaken (section 3.3).

To address the issues raised in section 2, the Conservation Strategy suggests a series of steps and actions (section 3.3) for accomplishing specific conservation tasks (section 3.2). Tasks and related actions should achieve the conservation goals and abide by the principles described in section 3.1.

Finally, chapter 4 summarizes the proposed Conservation Strategy, while urging the building of a "Conservation Capacity"to safeguard our future.

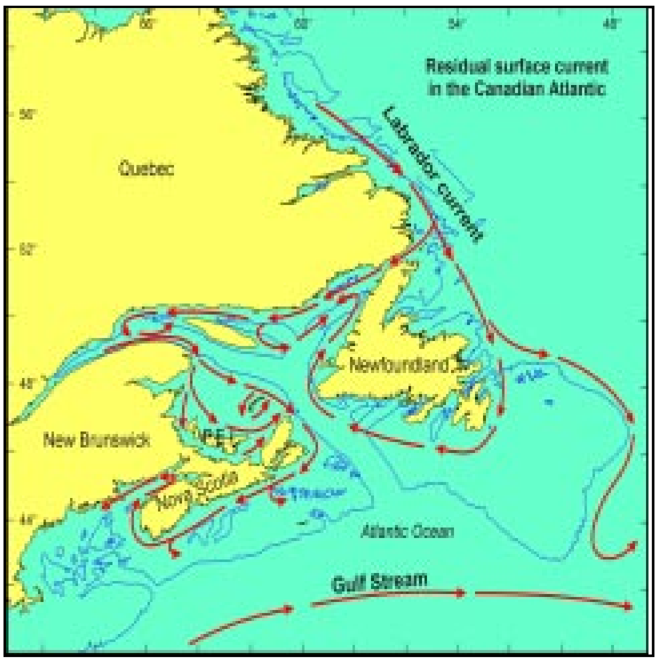
There was a window of opportunity, after the extension of the 200 mile limit, to plan a fishery for the future. We missed that window of opportunity. While several fisheries are now under moratorium, a window remains open, however narrow. If we miss this last window of opportunity, the failures of the past will be repeated again and again. This is the reason for a Groundfish Conservation Strategy — to seize this opportunity, to make real and lasting change.

2. THE CANADIAN ATLANTIC FISHERIES

2.1. THE RESOURCE

The environment

The diversity and life cycles of marine resources have been shaped, over geological times, by the natural environment. The productivity of the Canadian Atlantic is due to the wide area covered by the continental shelf and by the dynamics of ocean circulation.



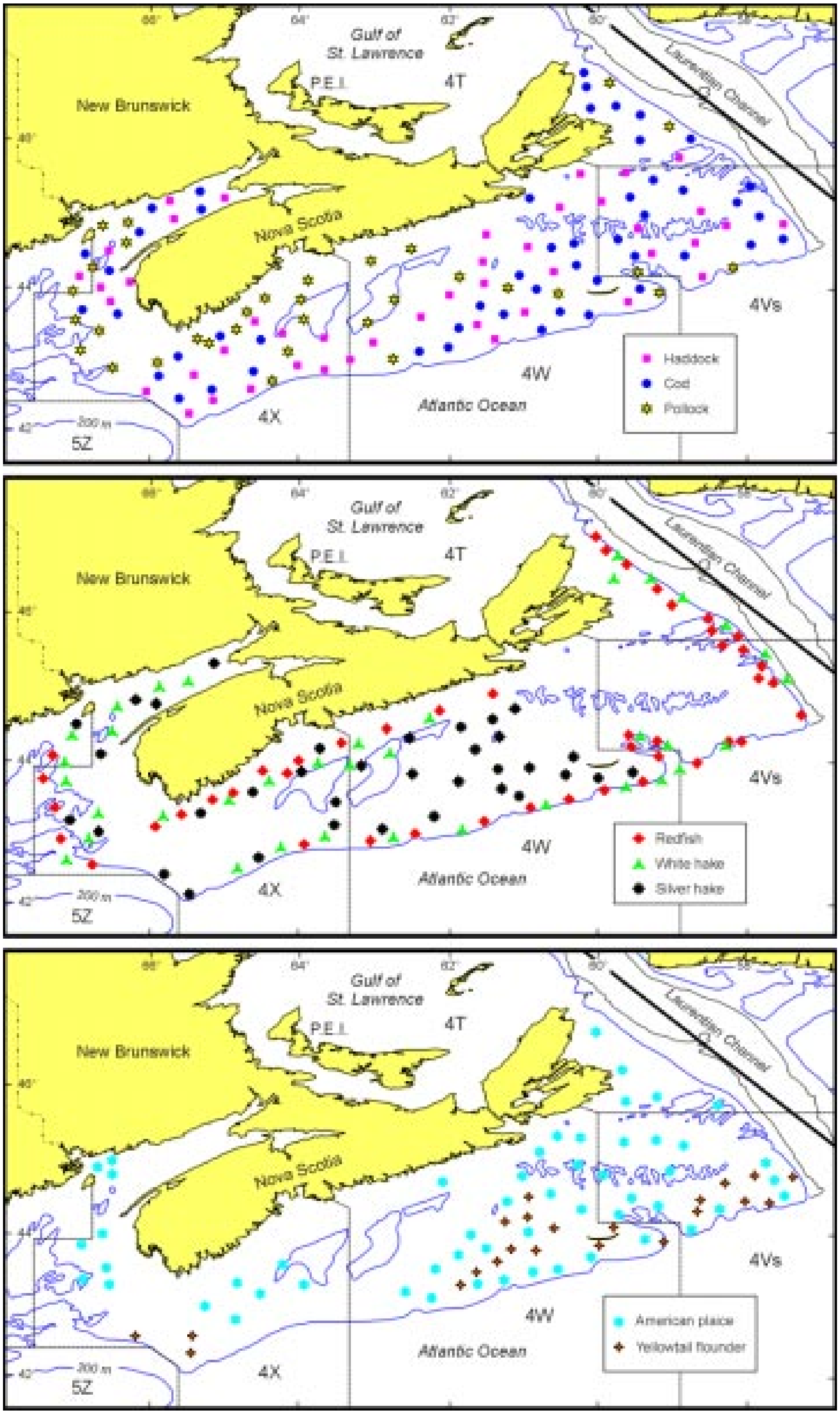
The Canadian Atlantic can be simply described in three major ecosystems:

- The Labrador and eastern and southern Newfoundland shelves, which are under the major influence of the Labrador current, carry cold water from northern regions; two branches enter the Gulf of St. Lawrence: one flows along the north shore, through the Belle-Isle Strait; the other one enters south, through the Cabot Strait, and moves northward along the Newfoundland coast;
- The Gulf of St. Lawrence is a semi-enclosed sea where hydrodynamics are dependent on the seasonally variable freshwater runoffs of the St. Lawrence river and from the rivers of the north shore; a deep layer is formed by the inflow of oceanic waters entering the Gulf in the Cabot Strait and moving slowly upstream through the Laurentian Channel;
- The continental shelf off Nova-Scotia is separated from the Newfoundland area by the Cabot Strait and the Laurentian Channel; the shelf is marked by depression, depths greater then 200m, and several shallow banks; the inner part of the shelf, between the banks and the shoreline, is influenced by waters originating from the St. Lawrence and flowing south; "warm slope waters" invade the deeper parts of the basins on the Scotian Shelf; the slope water is formed from a mixing, in variable proportions, of waters coming from the deeper part of the shelf from the Gulf Stream and from the Labrador current.

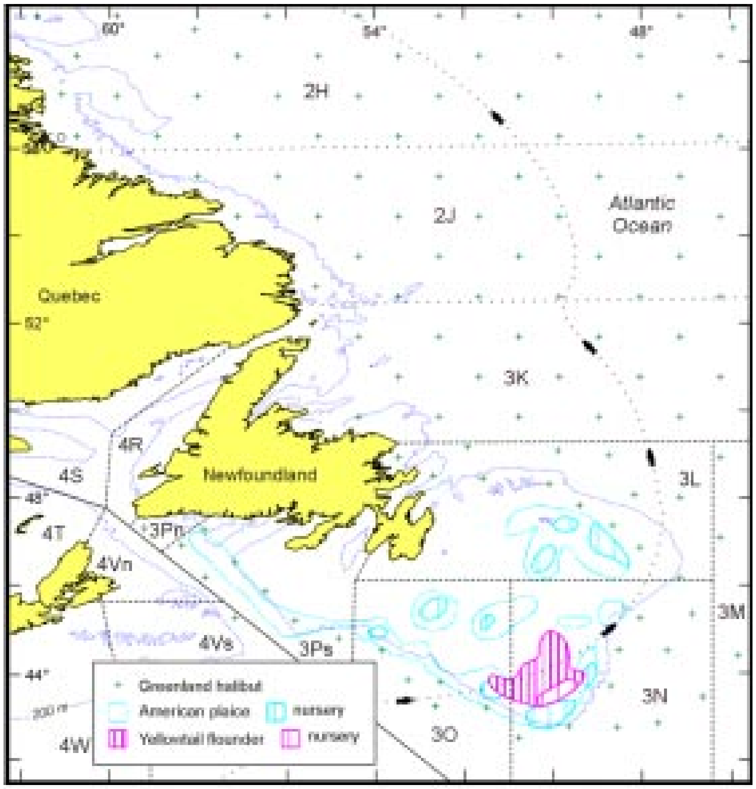
From the surface to the bottom, the water column is typically divided in three layers. The surface layer, to a depth of 40m, varies greatly in temperature and salinity with the season and may disappear in winter in the Gulf of St. Lawrence. The extent and the duration of ice coverage in winter may change both the salinity and the temperature from year to year. The Cold Intermediate Layer (CIL) follows down to depths from 150 to 200m. Its temperature may vary several degrees due to movements of the water masses and mixing with the surface layer in winter. This means that a cold winter may reduce the temperature of the CIL. The temperature and the thickness of the CIL are of great importance for the fish as the cold temperatures may represent a "barrier" to the migration of several species, such as adult cod. The bottom layer is warmer and more saline than the upper layer.

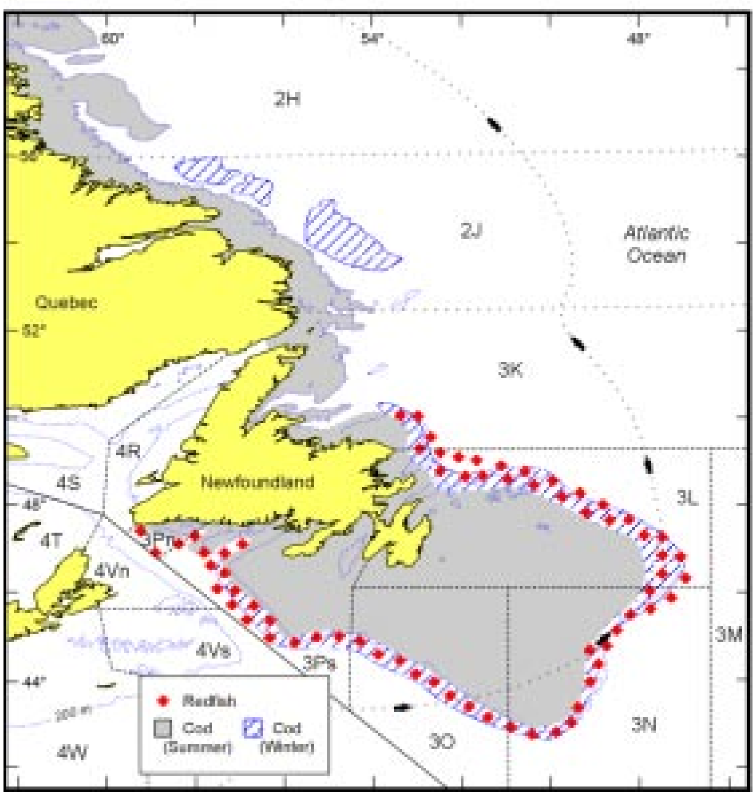
Since the early 1980s, cold air temperature and strong northwesterly winds resulted in harsh environmental conditions with early ice formation, greater aerial extend and longer duration of ice coverage, and a greater thickness of the CIL, its maximum having been observed in the early 1990s, with very low

Distribution of groundfish resources on the Scotian Shelf and in the Bay of Fundy

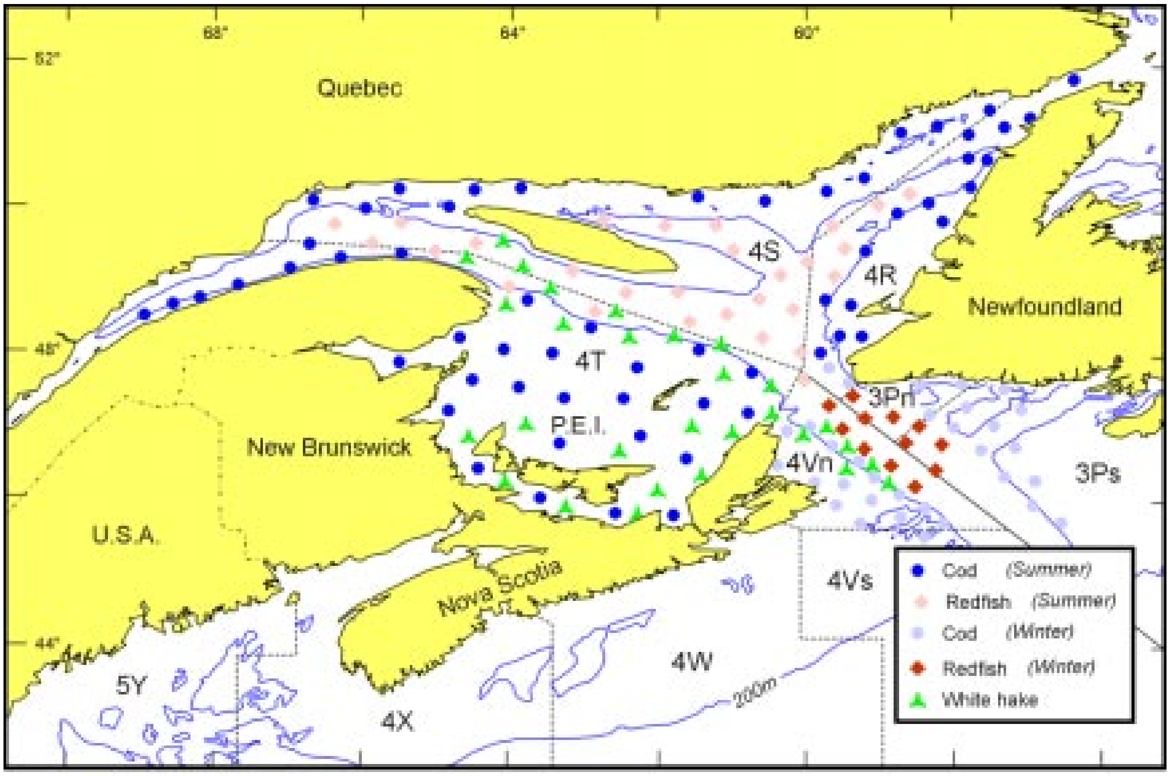


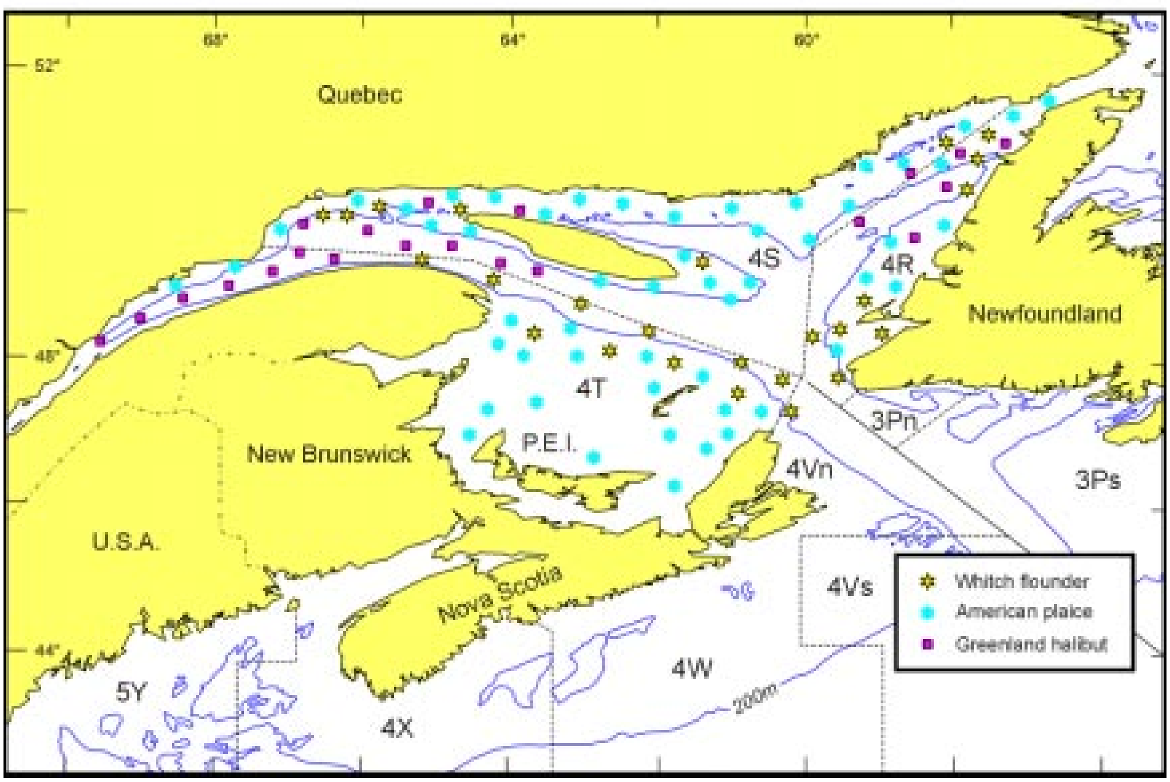
Distribution of groundfish resources on the Grand Banks, as well as off northeastern Newfoundland and Labrador





Distribution of groundfish resources in the Gulf of St. Lawrence, including winter distribution at the entrance of the Gulf



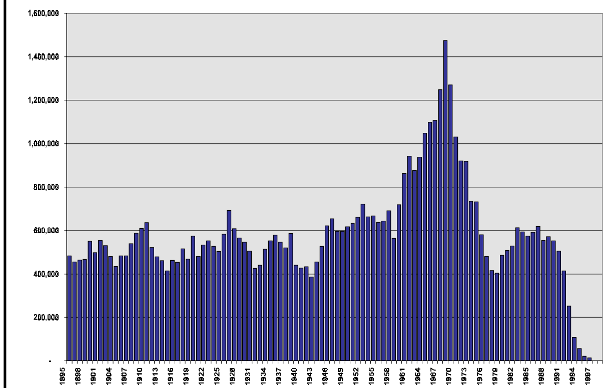


temperatures. However, the southern part of the Scotian Shelf (Gulf of Maine, Bay of Fundy, Georges Bank) have not shown the temperature decline observed in the rest of Canadian waters.

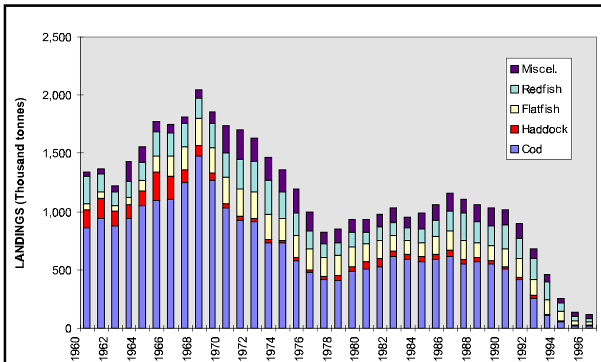
The fish resource

Groundfish populations of the North Western Atlantic consist of a community of species typical of the latitude. Cod is viewed as the representative species, as historically it has been the most abundant species. Besides cod, the community includes other gadoids (haddock, white hake, silver hake) and several flatfish: American plaice, witch flounder, yellowtail flounder, winter flounder, Greenland halibut and Atlantic halibut. Redfish used to be the most abundant species after cod. Other "secondary species", often of more localized or commercial importance, are associated with that community: e.g. skates, monkfish, lumpfish, cusk, wolffish. We can differentiate truly bottom fish, which spend their entire life on, or very close to, the bottom such as the flatfish, skate and lumpfish, and species that come occasionally (essentially to feed) to the bottom, but spend most of their life in the water column, such as the redfish and the adult cod.

The abundance of the groundfish resource has fluctuated greatly in the recent past. Landings provide a rough index of abundance, even if they are limited by fishing regulations such as TACs. The long-term trends of cod landings illustrate the history of the groundfish fishery, despite uncertainties related to data prior to 1950. Until the Second World War, catches fluctuated around 500 000 tonnes. At the end of the forties, and until the early sixties, effort increased tremendously, mainly due to foreign fleet activities, leading to an explosion of cod landings. This increase in landings may also have been favoured by exceptional biological productivity. The landings peaked in 1968 (1 475 000 tonnes) and this was followed by a steep decline (404 000 tonnes in 1978), partially arrested after the implementation of the Exclusive Economic Zone, in 1977. The apparent recovery observed in the mid-eighties (618 000 tonnes in 1986), while Canadian fishing effort replaced foreign fishing effort inside the 200-mile limit, did not last. Again, severe overfishing, associated with poor environmental conditions brought about a quick collapse of most cod stocks in the early nineties. This



Long-term trends in cod landings (metric tons) in the Northwest Atlantic (excluding Greenland). Until the Second World-War, catches fluctuated around 500 000 tonnes. Cod landings increased thereafter, due to increasing effort by foreign fleets. Landings peaked at 1.5 million tonnes in



Trends in groundfish landings in the Northwest Atlantic (foreign fleets included). The decline of cod in the late sixties was partially compensated by the increased landings of other gadoids (370 000 tonnes in 1973) and of redfish (293 000 tonnes in 1973). In 1977, when Canada implemented the Exclusive Economic Zone (EEZ), all stocks were severely depleted, and overall landings reaching a mere 819 000 tonnes. After the implementation of the EEZ, the groundfish stocks partially recovered in the late seventies and the early eighties, overall landings exceeding 1 million tonnes in 1982 and staying over this value between 1986 and 1989. Collapse of several stocks followed. In 1996, most groundfish stocks were at the

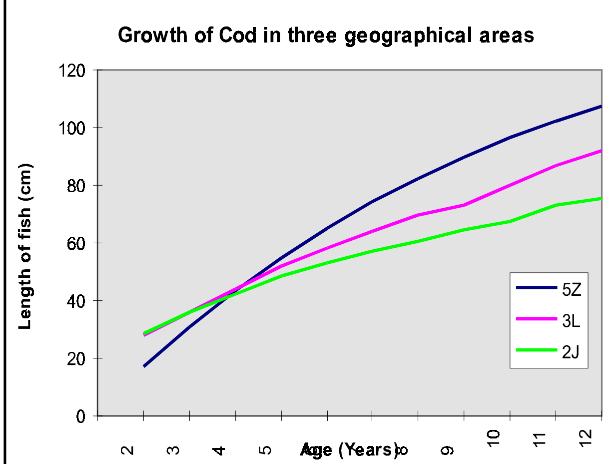
led to fishing closures, the first one being the moratorium on fishing on the Northern Cod stock in 1992. In 1996, cod landings represented only 13 000 tonnes.

The distribution of each species varies in time and space according to species preferences and seasonal migrations. Within a single species, several populations can be differentiated based on spawning sites, migration patterns, growth rate and mean age at maturity. A population is then treated as a single "stock unit" for management and conservation purposes. Numerous biological studies have been carried out to delineate those populations: tagging experiments, description of biological as well as morphological characteristics, and, more recently, biochemical research. As a result, more than fifty groundfish stocks are under management in the Canadian Atlantic, among which are eleven cod stocks. Although established decades ago, major stock delineations seem to remain valid today, at least in their broad lines.

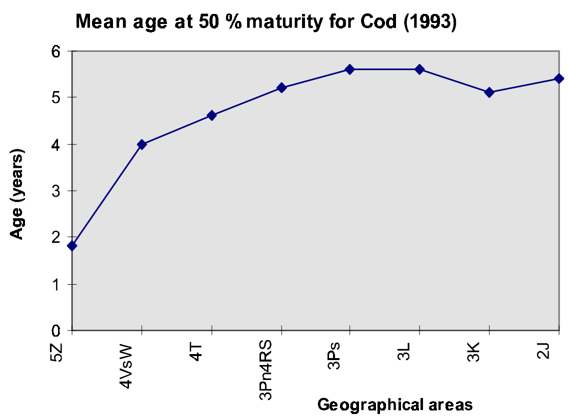
Each stock unit, however, is not a homogeneous entit , as it may include several components ("sub-populations), representing the genetic diversity of that stock un t. Within its geographical range, each component usually has its own spawning site. The disappearance of spawning components (i.e. no fish spawning any more in a particular site), or the shrinking of the spatial distribution of a population (as observed for the northern cod, where fish are now concentrated in the most southern part, "3L" area, and in some bays) may be interpreted as a loss in the genetic diversity of the population.

The delineation of sub-stocks, within a large stock unit, remains a complex issue. The 3Ps cod stock, in Southern Newfoundland, is composed of several sub-units, which can also be augmented by fish coming from the western Gulf (3Pn area) and from eastern Newfoundland (3L area). The whole 2J3KL area is considered as a single stock unit for management purposes but recent studies indicate that this unit may be composed of at least two components, one in the southern area (3L) and one in the north. In the last decade, it has been observed that cod were migrating "earlier, further and deeper" than usually known, resulting in a mixing of stocks that did not occur in the past. For redfish, differentiation between t e Gulf stock ("Unit 1") and the southern Newfoundland stock ("Unit 2") is not clear in winter, when the t o units can mix; the Unit 1 includes two species, whi h complicates the picture. The Greenland halibut fou d in spring and summer in the Gulf presents similari es with the halibut found in winter in the Cabot Strait area. Pollock in southern Newfoundland (area 3Ps), managed as a unit, may be part of a larger population and its abundance results from an unpredictable outflow from more southern populations. Finally, spawning sites are not precisely known or, at least, not scientifically documented, even if many fishers may have gathered this information for their own fishing areas.

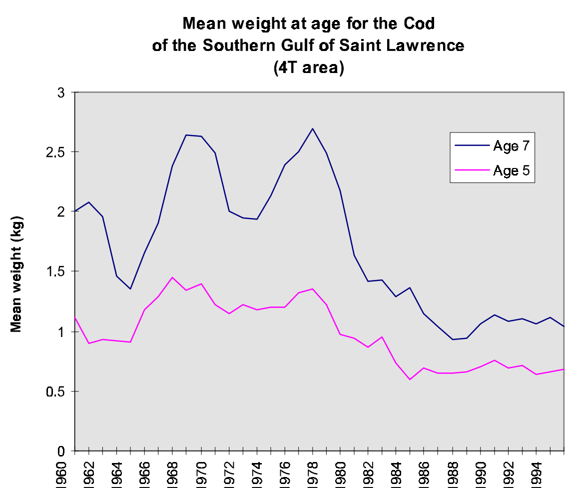
Biological characteristics may be related to environmental conditions: e.g. for cod stocks, growth is faster in southern areas than in northern ones, and the mean age at maturity increases from south to north. Environmental factors can affect directly the biology of fish: cold temperature may modify migration patterns as well as the physiology, inducing a lower growth rate. These factors can also affect the biology in an indirect way, through the overall productivity of the ecosystem, that would provide less food or inadequate food (e.g. different planktonic species). Since the early eighties, a decrease in weight at age has been noticed for several cod stocks. Significant efforts have been made by scientists to document fish condition, through field observations and laboratory experiments. For example, from the late eighties to 1995, cod were found to be in bad



Growth of fish is related to their geographical location. For cod stocks, growth is faster in southern areas (George's Bank, 5Z) than in northern areas (Eastern



Maturity occurs at different ages in different areas. For cod in Atlantic Canada, females mature earlier in the most southern stocks (5Z, George's Bank) and later in northern ones (3Ps, Southern Newfoundland; 3K-3L, Eastern Newfoundland and 2J, Labrador).



Growth rates of fish as illustrated by the average weight of cod in the Southern Gulf of St. Lawrence, from year to year. Since the mid-eighties, the average weight of cod is only 50% of its value at earlier periods.

condition ("slinky" animals), at a stage that induced a high mortality rate in laboratory experiments. At this stage of our knowledge, it is difficult to separate the direct effects from the indirect effects of environmental factors and to really quantify the role of environmental factors in natural mortality.

The "typical" life cycle of groundfish species (e.g. cod, flatfish) follows successive stages. The population is composed of males and females, between which we can observe differences in growth rate and size. Reproduction takes place at specific locations and times for each population component. Eggs and sperm are released in the water column where the fertilization takes place. For those fish, fecundity is very high: a female cod can release from some hundred thousand to millions of eggs, depending on body size. Recent scientific studies show that large females also tend to produce eggs of better quality, with a greater chance of survival, than small females; older females also release eggs over a longer period, which could lead to a greater probability of survival for some of the offspring. The latter results suggest that the "spawning biomass", as an absolute value, is not a sufficient indicator of the reproductive potential of a stock and that the age structure should be taken into account.

Eggs and first larval stages float in the in water and are subject to environmental conditions (salinity, temperature, drifting due to water movements) and to heavy predation; larvae also need to feed on plankton. The survival rate is dependent on those various factors and fluctuates from year to year, inducing fluctuation of the recruitment rate ("bad" or "good" year-classes). As a result, less than 0.1% of eggs produced will survive and become adults. Even if knowledge remains limited, we are beginning to understand the relationships between the environmental factors and larval survival, as several studies are underway.

Young immature fish (the "juveniles") often live in a particular environment and location that suit their needs ("nursery" areas), sometimes different from the adult geographical distribution: e.g. in the Southern Gulf, the largest concentrations of cod under 3 years of age are found regularly in the western part (the Shediac Valley). We have to recognize that the location of the nurseries is not precisely known for most stocks. As is the case for spawning areas, compiling the traditional knowledge of fishers would certainly help to solve this issue.

Some species display a different behaviour. For redfish, males and females mate and the females release young larvae, instead of eggs. Skates also mate and the females release large floating eggs. In both cases, the fecundity is very low, compared to cod, for instance; practically, this means, that those populations may be sensitive to heavy exploitation. Lumpfish reproduce on the bottom, in nests built in sand and gravel; it seems that individuals tend to come back to the same location year after year which means that the genetic diversity will be affected if lumpfish disappear from one site.

When reaching a certain size, fish can be harvested: they are then "recruited" to the fishery. Recruitment is the process by which fish enter the fishable stock. It depends on biological characteristics, such as growth and maturity rates, harvesting techniques, such as gear type and selectivity, and regulations, such as the minimum legal size. Recruitment occurs at different ages for different fisheries and stocks. The level of recruitment is related to number of adults that reproduce and to the survival of young fish in their environment. The level of potential future harvesting is tied to the level of recruitment, i.e. the number of young fish that will reach the fishery in the following years. For most groundfish stocks, the slow process of rebuilding during the moratorium period is due to continuous poor recruitment in the recent past.

A fish population is not alone in the sea: fish eat and they are eaten. Population abundance may be affected by fluctuations of the abundance of prey species (e.g. capelin or sand-lance, which several species are feeding on) and of the abundance of predators (e.g. seals), due to natural causes or to harvesting activities. The system is complex, however: a recognized predator of one valuable species may also feed on other predators of the that species; letting the abundance of a prey species grow does not necessarily mean that a larger amount of food will be available for the targeted species, as other predators are also present. We have begun to understand some food links in the Canadian Atlantic, but we are a long way from having a precise picture of those links.

Even if our basic knowledge of the resource has tremendously increased in the recent past, several issues still remain to be addressed.

- ***Recruitment.*** We do not understand why recruitment was very poor in the past ten years and what the factors are that influence recruitment. These requirements are key for the forecasting of the resource.
- ***Knowledge of the biology of the resource.*** Natural mortality, assumed constant for years, appears to have changed in the recent past. The reproductive capacity of the stock also appears not to be properly measured by the absolute volume of spawning biomass, as generally assumed.
- ***The number of components of a stock unit, spawning periods and areas, as well as nursery areas,*** are poorly known. This information appears necessary to implement a comprehensive conservation scheme, including preserving genetic diversity, and to implement measures such as protected areas and seasons.
- ***The functioning of the ecosystem*** (role of hydro-physical factors, predator-prey relationships, etc.) is not precisely known. While moving from a single species conservation approach to a more systemic approach, this knowledge will become more and more crucial. Environmental indicators have also to be defined and a monitoring system for those indicators put in place. We will have to account for the effect of the environment to understand the effect of fishing activities.

2.2 The harvesting

Harvesting, the process of catching fish and bringing them ashore, involves physical equipment:

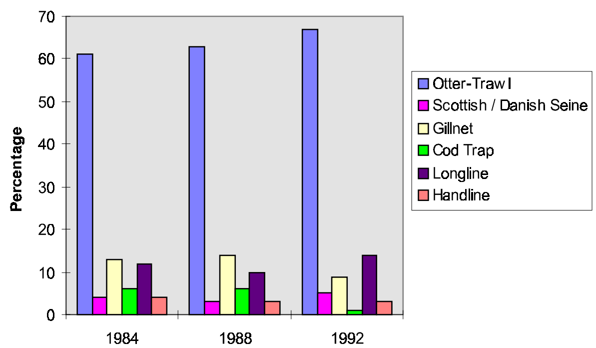
- gear (number, type, size, mesh-size, hook size, etc.);
- vessels (number, size, engine power, etc.);
- electronic equipment;

as well as a major role for human skill and experience.

The sum of physical equipment and human characteristics is called the “fishing (or harvesting) capacity”. Overcapacity occurs when the capacity is too high compared to the resource level, unable to sustain a viable economic activity. The present fishery is characterized by overcapacity: increasing amounts of gear, increasingly more efficient gear and vessels, and increasing ability to find and catch fish.

The gear

It is common to divide the gear types in two broad categories: mobile gear (Otter Trawl, Danish Seine), that are dragged on the bottom or in "mid-water", and fixed gear (Cod Traps, Gillnets and Longlines and Hand-lines), that are put in place for a certain period of time. The contribution by the different gear types to the overall harvest has varied over the years, but catches by otter trawlers have dominated the total groundfish catches from the Northwest Atlantic (around 60% of the total catches) since the arrival of the distant water fleets in the 1960s, and have been the major component of Canadian groundfish landings for almost as long.



Proportion of groundfish catches prosecuted by various gear types in Atlantic Canada

The otter-trawl has the ability to catch large volumes of fish in a short period of time and to fish in very unfavourable conditions and at any time of the year. In recent years, there have been significant changes made to this gear through the introduction of square mesh, large diamond mesh, lastridge ropes, and sorting grates. It has been demonstrated that this gear could have an impact on bottom habitat. Many people are concerned as well that its high catching power makes it dangerous from a conservation perspective.

Danish (Scottish) seining originated as its name implies in Denmark and was subsequently adapted to its present form in Scotland. It is a very common groundfish gear and is considered to be very efficient in catching slow-swimming, bottom-dwelling species such as flatfish. While this gear is classified with otter-trawl as a mobile gear, the two gears are very different in their manner of fishing and the extent of their use. In recent years, there have been significant changes made to this gear through the introduction of square mesh, large diamond mesh, lastridge ropes, and sorting grates.

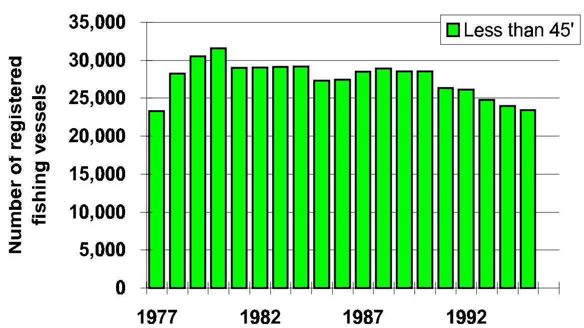
The gillnet is efficient in catching fish and is widely hailed as being very size-selective. It is capable of being fished in depths of water as great as 1600 meters, for almost all types of groundfish. While it can be very size selective, generally speaking, its ability to select for species is poor, and there are concerns about the loss of fish to ghost fishing, incidental catches in some areas of threatened species such as porpoises and salmon, and waste due to quality deterioration if nets are left in the water too long. Many people are concerned that gillnet fisheries have resulted in rapid depletion of some stocks, through increases in the number of nets, and reductions in mesh size as the numbers of larger fish decline and only smaller fish are available.

Baited hook and longline fisheries are often viewed as one of the most conservation friendly of all the gear types used in the Eastern Canadian fishery. The ability to ghost fish is lost quickly and bottom disruption is limited. There are some problems associated with the catch of non-target species. This gear has also been subject to considerable technological improvements, not only to the lines and hooks, but also in handling techniques, boat design, electronic fish finding and positioning equipment, artificial bait and chemical attractants.

The cod trap has been used extensively throughout most of Newfoundland and Labrador, and to some extent on the Quebec Lower North Shore, since it was developed in the late eighteen hundreds. It is a very efficient method of catching fish, capable of catching large volumes of fish in short periods of time when they are available to the gear, and this efficiency has increased over time, particularly with the introduction of the Japanese trap in the 1960s. It is used exclusively near shore. The most significant problem with the cod trap is its capacity to catch large quantities of small cod.

The fleets

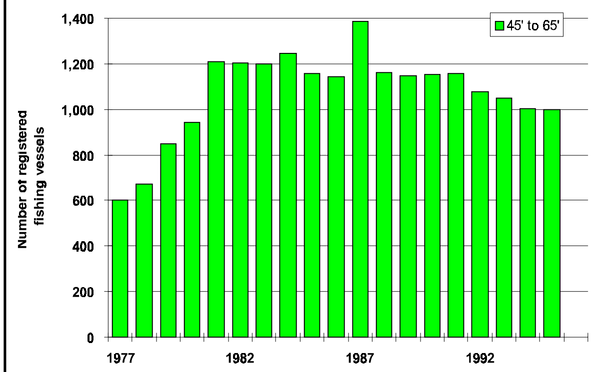
The groundfish fishery in the Northwest Atlantic has been described by the Task Force on Income and Adjustment in the Atlantic Fishery as being composed of three major components: an inshore component using vessels smaller than 45', a midshore component using vessels between 45' and 65', and an offshore component which includes domestic and foreign vessels larger than 65'. In the sixties and seventies, vessels from the inshore component had only limited capability and could only fish close to their home port. During the eighties, the distinction between the midshore and offshore components became less obvious, as technological improvements were brought in to give smaller vessels higher mobility and more efficiency. As a result, many vessels smaller than 65', and some smaller than 45', now are capable of offshore operations.



Trends in the number of vessels less than 45'. The capacity of this fleet increased with the introduction of faster boats, electronic navigation aids, and a larger amount of gear.

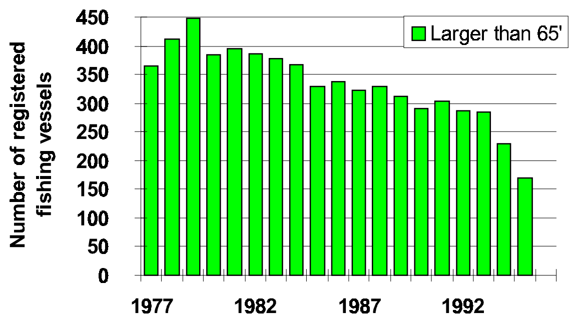
Although the number of groundfish licenses has been somewhat constant between 1983 and 1992, the capacity of the fleet to find and to catch fish has substantially increased because of technological innovation. In 1989, the Haché Task Force concluded that due to these changes, the vessel replacement rules had not been effective in limiting fishing capacity.

Vessels smaller than 45'. These vessels use mainly fixed gear such as gillnets, handlines, longlines, and cod traps (but some also use mobile gears such as bottom trawls or Danish seines). Fishing by this component could vary greatly between seasons as fishing success is greatly affected by fish movements or migrations (e.g. the Newfoundland inshore cod trap fishery is associated with the inshore migration of cod in the spring). While this sector has often been described as exerting limited and somewhat constant fishing pressure, recent studies suggest that this component also became more efficient in catching fish and that their effective effort may have increased significantly throughout the eighties. As in other fleet sectors, better navigation equipment was introduced and resulted in higher accuracy in returning to fishing grounds. This component is managed through overall allocations, and gear restrictions.



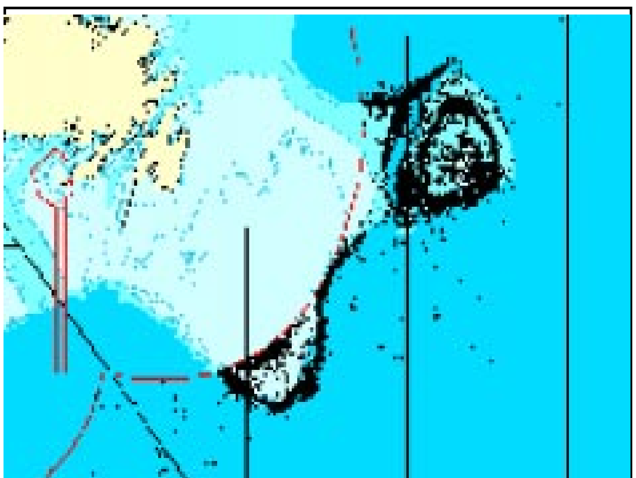
Trends in the number of vessels between 45' and 65'. The capacity of this fleet component increased with the increasing volume of boats and the introduction of more efficient equipment.

Vessels from 45' to 65'. The number of vessels in this size category increased tremendously in the late seventies. These vessels, which traditionally specialized in fishing for cod, use fixed gear (e.g. longlines) or mobile gear (e.g. bottom trawls). Some of this fleet has been brought under the system of Individual Quotas (IQs) or Individual Transferable Quotas (ITQs) in an effort to rationalize its operations. These systems appear to have had success in reducing the fishing capacity and served to either reduce effort or to prevent effort from increasing further. Prior to the introduction of moratoria, this component used poor fishing practices leading to a waste of the resource: use of liners in trawls, discard of small fish, highgrading, misreporting, etc. While improvements have been made in fishing practices, there still remain some problems (e.g. highgrading).



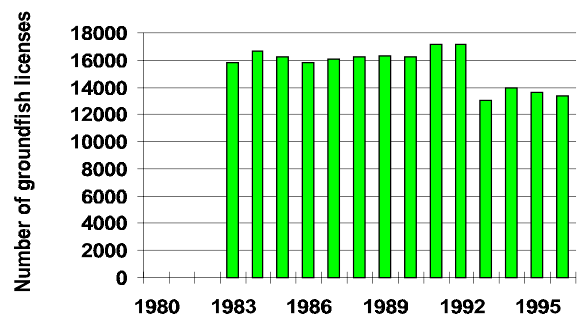
Trends in the number of vessels greater than 65' (offshore vessels) in Atlantic Canada. The decline in number was offset by a greater fishing ability due to important technological improvements.

Canadian offshore vessels larger than 65'. This fleet of larger vessels developed as foreign vessels were replaced by domestic interests, after the declaration of extended fisheries jurisdiction, the 200 mile limit, in 1977. These large vessels could fish year round and proved to be very efficient in catching groundfish in offshore areas. A management system based on Enterprise Allocations was introduced in the early 1980s for offshore vessels larger than 100' to reduce the "race for the fish" and allow large companies to rationalize their operations. Even though the fleet has never accounted for a large number of vessels, and despite the introduction of new fisheries management measures, this fleet exerted a very high pressure on the resource given its harvesting capacity: before moratoria, the offshore fleet's harvest represented around 50% of the total groundfish landings in Atlantic Canada.



Sightings of foreign vessels fishing beyond the Canadian 200-mile zone in 1993.

Foreign offshore vessels. Since many groundfish stocks extend beyond the 200-mile limit, uncontrolled fishing and abusive fishing practices by large foreign vessels have put additional pressure on the resource. Cod, American plaice, yellowtail flounder, Greenland halibut and redfish are fished under reduced quotas, but these quotas are commonly over-run. In the absence of effective surveillance and sanctions, the use of small mesh sizes, and the catching of large amounts of juvenile fish were also common. Foreign vessels have exerted, and still exert, a significant amount of fishing pressure in the waters immediately adjacent to the Canadian 200-mile zone, as illustrated on the map of sightings by Canadian patrol vessels.



Trends in the number of groundfish licenses in Atlantic Canada

Between 1988 and 1995, Canadian catches for the major groundfish stocks throughout the Atlantic decreased by about 90%. During the same period, the number of groundfish licenses declined by about 16%, most of this reduction occurring after the introduction of moratoria on many of the groundfish stocks. The potential to exert high fishing pressure when the groundfish moratoria are lifted is real and, for that reason, reopening of closed fisheries requires careful planning and close monitoring.

Technological improvement

Over the past fifty years, tremendous changes have taken place in the fishery off Eastern Canada. The development of new technologies, both on the boat and in the water, coupled with better vessel design and construction, and the development of new materials and designs of fishing gear, has dramatically changed and increased our ability to catch fish. We now have at our disposal the capacity and technology to fish at any time and almost anywhere. In virtually all fleet/gear sectors, the ability to fish has increased through use of new fishing materials and electronic or hydraulic equipment. These improvements are noticed from the small-scale cod-trap fisheries to the big offshore stern-trawlers. In all cases, electronic equipment, particularly high-powered sounders (hydro-acoustics) ensure that the fish have nowhere to hide.

Beyond the use of advanced electronics, acoustics and hydraulics, today's fishing vessels have considerably greater distance/weather capabilities than their predecessors of comparable size. What would have been regarded previously as inshore/nearshore vessels, today fish to the full reaches of Canada's continental shelf, including those areas which extend beyond 200 miles. Vessel design improvements, new construction materials and technologies as well as technological advances in anti-roll tanks and stabilizers, all contribute to the construction of larger capacity vessels even when regulatory restrictions limit the overall length of the vessels.

All these elements mean that measuring the amount of fishing effort has become very complex. It is not correct to equate a day's fishing effort of 10 years ago with a day's effort by the same sized vessel at the present time.

Overcapacity

Overcapacity remains a major issue in the groundfish sector:

- ***in some instances, capacity is two to three times larger than needed;***
- ***effort remains high due to technological improvements or activation of latent effort;***

Overall, overcapacity remains a major issue in the groundfish sector. In some instances, capacity is known to be two or three times larger than needed. There has been a noticeable reduction in the number of registered vessels in recent years, particularly for the Canadian offshore fleet. However, there is a tendency for effective effort to remain high simply due to technological improvements in the fleet or to the sudden activation of latent effort in the various sectors (licenses for mixed fisheries, inactive licenses). The Task Force on Incomes and Adjustment in the Atlantic Fishery (1993) concluded that "Too many harvesters use too many boats with too much gear trying to supply too many processing plants by finding and catching too few fish". The Task Force added that "A first step is to bring harvesting and processing capacity into balance with the sustainable limits of the resource." Finally, because of the multispecies nature of fishing licenses, effort can be shifted rapidly between species, creating a potential for sudden increases in effort targeted at the species of high economic value.

Achieving a significant capacity reduction in the groundfish fleets (up to 50%) was one of the primary objectives of The Atlantic Groundfish Strategy (TAGS). It appears that the reduction achieved under TAGS and by the Harvesting Adjustment Board (HAB) process is far less than predicted. Although there has been some progress, the overall reduction in capacity is disappointingly small. The capacity of the remaining fleet has likely been maintained as a result of expansion of, and re-direction into other lucrative fisheries, notably snow crab, lobster and scallop. As a result, the potential fishing power in most groundfish fisheries may be effectively unchanged, or even greater given the advances in technology.

Conservation issues

While conservation changes with respect to fishing practices did not prevent the decline in the groundfish resource, the changes in fishing gear (e.g. square mesh), the introduction of conservation measures for the protection of small fish and other improvements in management measures since the beginning of this decade have to be recognized. For instance, the minimum mesh size for trawls was increased and small fish protocols (whereby fishing grounds are closed to a sector when the abundance of small fish in the catch reaches a predetermined threshold) were introduced in an attempt to reduce the capture of small fish. All mobile gear vessels under the Enterprise Allocation (EA) or ITQ systems are now under 100% dockside monitoring in an attempt to get a better appreciation of the quantities being landed. Dockside monitoring has also been introduced for other components of the fishery. There are also provisions in some areas for protection of spawners (e.g. closure of some spawning grounds). With the Conservation Harvesting Plans introduced in recent years, greater emphasis has been placed on conservation.

There remains a number of issues that need to be addressed, among them:

- ***bycatch of untargeted species;***
- ***redeployment of vessels to non-traditional species with unproven productivity;***
- ***with increasing technology, a loss of refuges for fish;***
- ***potential effect of gears on stocks and on the environment, which has been downplayed in the past.***

From a conservation standpoint, there remains a number of issues that need to be addressed. Continued effort is needed to reduce the bycatch of untargeted species and to control vessel redeployment to non-traditional species with unproven productivity. In hindsight, it appears that poor practices, such as highgrading and misreporting, were common and have contributed to overfishing. Fishing capacity and the ability of fishing fleets to move between inshore, midshore and offshore grounds are such that fish have no chance to escape the fishing pressure. The potential effect of gear on fish stocks and on the environment have typically been downplayed in the day-to-day management of groundfish resources. Decisions concerning gear change or changes to fishing practices, were driven by the desire to improve fishing performance so as to get better catch rates and better economic performance. While these are valuable objectives, the problem is that these were sought at the detriment of longer term goals such as sustainability of the resource. Many people now realize that the fishery of the future should be a smaller, more conservation-oriented, fishery. Failure to achieve this will undoubtedly mean that failures of the past will be repeated.

2.3 The Science

Through their research and assessment work, scientists are expected to provide basic information for the conservation of groundfish stocks. In that context, they are expected to monitor fish abundance and fish condition, and to forecast future abundance or harvest levels under various scenarios. The framework for groundfish assessments is based upon our general understanding of fish distribution, their life cycle, and their environment. Because fish stocks can change rapidly as a result of fishing levels and of changes in growth or recruitment, they need to be monitored on a regular basis. The work of scientists must cover routinely over fifty stocks of about 15 species which are spread from Georges Bank in the south to Davis Strait in the north.

The underlying fundamental research

Fishery scientists have undertaken over time a number of special studies aimed at developing an understanding of fish distribution, of fish movements or migrations, and of their biological characteristics (growth, reproduction, etc.). Such studies have been instrumental in the adoption of the current system of “management units” based on separate stock entities. These studies continue to be important as they provide the material needed to refine our knowledge of stock boundaries and to evaluate when adjustments to management units are needed. For instance, the recent changes in the management units for redfish and the impact of fish migration on the management of groundfish stocks at the entrance of the Gulf illustrate the importance of research on these topics.

Basic research is also needed on fish maturity, fecundity and growth, as well as on the distribution of juveniles and spawners. The results of such studies have been instrumental in evaluating alternate management measures based, for instance, on fish size, gear restrictions (mesh size), area closures, etc. Finally, research on the role of each species in the food web and on changes in the oceanic environment (physical and chemical) has provided valuable information on the complex nature of the groundfish ecosystem.

Information on commercial fisheries

The monitoring of commercial fisheries provides information on landings, fishery performance (e.g. catch per unit effort), and the biological characteristics of fish being caught. Fishery-based data include the following elements:

> *Catch statistics:* The amount of fish caught is obtained from the various reporting systems which serve as a basis for quota monitoring, including Dock Side Monitoring Programs, Hail Reports, Sale Slips and Surveillance Reports. In some cases, landings have to be estimated from surveillance operations (e.g. catches by some vessels operating beyond 200 miles are not reported to NAFO).
>
> C*ommercial catch sampling information:* Port and at-sea samplers are used to obtain information on the size of fish caught in the various fisheries, as well as to obtain biological samples necessary to determine the age and growth profile of fish in the catch.
>
> *Logbook information:* The information collected by logbooks kept by fishers often serves as a basis for a measure of fishing performance or an estimation of effort in various fisheries. While the catch rates derived from logbooks provide information on fishing performance, they are often poor indicators of fish abundance as they tend to be affected by changes in fleet characteristics, in fishery regulations (e.g. changes in mesh size), and in fishing practices. A key issue with logbooks has been that they are often available only for a small portion of the fleet or available only for the larger vessels fishing offshore.
>
> *Observer data:* The information collected by observers aboard fishing vessels has many of the characteristics of the information obtained through logbooks and commercial catch sampling programs. Because it is collected in a systematic manner using trained personnel, the observer data are more amenable to detailed analyses and have proven an important source of information on distribution of fish by size, catch rates, fish growth and movement, etc.

Overall, the reliability of commercial data (in particular statistics on catches and landings) has been a concern, considering that the most direct indicator of the results of the fishery is the catch. Highgrading practices, as well as under- and mis-reporting have had an impact on the quality or completeness of the data collected from commercial fisheries. In addition, commercial data, and commercial catch rates in particular, have been affected by changes in technology, in regulations or in fishing practices. Enhancements in the quality and the timeliness of fish catch information would contribute significantly to improving overall information about exploited stocks.

Where, when and how the fish is caught, is usually basic information that should be routinely registered, as it provides important insights into changes in stock distribution and abundance. It appears, however, that this information was generally not properly considered in the stock assessment process. Technological change, in particular, was not accurately incorporated in the measurement of the fishing effort.

Monitoring of fish stocks

A number of programs have been put in place to provide direct monitoring of fish stocks and thereby complement the information collected in commercial fisheries. Such programs include field work to monitor fish populations, laboratory work on the samples collected (e.g. to determine the age of fish taken), research surveys carried out with scientific protocols, the use of index fishermen to monitor certain areas, and sentinel surveys for fish stocks under moratorium. In particular:

> *Research surveys* are used for estimation of abundance, monitoring of abundance trends, and forecasting of recruitment prospects. These surveys also provide information on groundfish distribution, changes in growth, and changes in the environment. The standardization of surveys (gear, vessel, sampling design), over years, avoids the bias induced by technological changes in commercial fisheries. Groundfish surveys have mainly been conducted with bottom trawls but

other techniques, such as acoustic sounders, have also been used. The costs of fisheries research surveys have been a limiting factor and, for that reason, these have been conducted only once per year, with the exception of a few stocks for which seasonal surveys have been conducted. Research surveys have often been criticized by fishers for poor precision, incomplete coverage (e.g. no coverage in inshore areas, inability to adjust to rapid changes in fish distribution) and rigid standardized scientific protocols that put fishing sets where there is no fish. A key advantage of the groundfish surveys is that they have provided the scientists with long time series of results taken in a consistent manner over time. For that reason, they have played a key role in the determination of stock status.

Index fishermen programs. These programs are relatively new for groundfish, having been phased in since the mid- to late-1980s. While these programs provide information on fish growth, size, condition etc., their main purpose is to develop independent indices of abundance to be used in stock assessments. They have been of limited importance until recently in the determination of abundance for groundfish stocks because the time series of observations were typically too short to be used in stock analyses. However, the information collected by index fishermen is expected to play an increasing role in the determination of stock status as more years are added to the time series.

Sentinel surveys were introduced recently on cod stocks under moratorium and originated from the general concern that, in the absence of a commercial fishery, information on these stocks would be based solely on research surveys which are limited in time and scope. Sentinel surveys have provided abundance indices, as well as information on fish distribution, fish growth, fish condition and a detailed profile of sizes and ages in the stocks.

The assessments

The main purpose of assessments carried out in the context of Atlantic groundfish fisheries is to integrate all sources of information to develop an understanding of population trends (typically expressed in terms of total abundance, abundance of spawners, number of recruits), to quantify the impact of fishing on the resource, to document changes in biological characteristics (e.g. fish growth and condition) and to develop an understanding of the resource in its environment.

Several methods have been used to integrate the information coming from the various sources (catch statistics, commercial catch sampling, surveys). The existence of long and consistent series of data is critical to the successful reconstruction of population trends. Typically, DFO scientists use various techniques to reconstruct population trends from commercial catch data and from all indices of abundance available (e.g. research abundance estimates, recruitment indices, observer catch rates, etc.). The advantage of this approach is that it provides a detailed description of the population in terms of recruitment levels, stock abundance, and abundance of spawners, as well as an estimation of fishing mortality rates. Also, the approach allows scientists to forecast abundance and anticipated catches under various scenarios.

When only limited information is available for the assessment of a given stock, scientists have to revert to less sophisticated techniques for determining stock status. While the approach taken will depend upon the information available, the end result is rarely amenable to a forecast of stock abundance or catches and, in these cases, recommendations on Total Allowable Catches have to be based on precautionary levels. Unfortunately, it is currently possible to use complete models describing stock trends only for a limited number of stocks. This is due to the fact that these models were designed to operate properly when there is a sizable commercial fishery but work poorly in the absence of a significant catch. Because many of the groundfish stocks have been under moratorium for a number of years, the ability to perform detailed analyses to estimate trends in abundance and biomass has been reduced significantly in recent years. However, when it is not possible to apply the more sophisticated models, scientists can use the abundance indices and other techniques to provide insight into relative trends in abundance, in biomass, in recruitment, in fish growth and fish condition.

In any case, the reliability of mathematical tools depends on the validity of input data. Catch and effort data are especially critical. Dumping, discardings and misreporting lead to inaccurate calculations and to false estimation of abundance. Fishing effort is generally considered only in gross terms, using a reference fleet (usually trawlers). The actual effort of the various fleets involved, and the related catch rates, are generally not properly documented. As well, technological improvements are not factored in. Inaccurate estimation of effort, in space and time, leads to misinterpretations of the fisheries trends. Finally, mathematical tools use basic assumptions, such as constant natural mortality rates. Those assumptions should be revisited, in a context of changing environments.

There is a general tendency, from managers and the industry at large, to consider that an assessment is only of use if it can fully determine a number for the abundance or biomass. This is so because the management system needs an absolute calculation of the Total Allowable Catch (TAC) to work out the allocations or quotas that would be assigned to the various user groups. In many cases, the message has been that "only the TAC matters", to the point that many concerns about stock status, abundance of spawners, or loss of yield expressed in the stock status reports have been downplayed or ignored. The repeated warnings about the effects of discards of small American plaice in the southern Gulf of St. Lawrence are a good example of this. It must be recognized that, even in the absence of an absolute calculation of abundance, an assessment still provides valuable information on trends in biomass and abundance, fish condition, fish growth, expected recruitment, and more. In many cases, the high dependence of a fishery on recruits and the poor range of ages in the population are sufficient indicators of high exploitation and the need for action. In others, the declining trends in indices of abundance and the observation that survey estimates have been the "lowest ever observed" must be sufficient cause for concern.

Fishermen have often questioned assessment results because of their reliance on research surveys. They have also questioned the validity of the basic assumptions (e.g., definition of stock boundaries, constant natural mortality in the presence of an increase in predators). An effort has been made in recent years to demystify stock assessments by involving fishers, managers and external scientists in various aspects of the assessment process. For instance, the information collected by fishers through sentinel surveys is compiled and summarized by the actual participants. As a means to improve the information collected from research surveys, scientists have invited, in recent years, many fishermen to participate in the design of surveys and in their realization. The Fishermen and Scientists Research Society is another example of how fishermen and scientists can get together to address questions of mutual interest.

In most cases, the sampling intensity we can afford for the surveys does not provide the level of accuracy needed for risk-free decision making. Presenting the results of assessments in terms of the risks of various options has served to remove some of the concerns. The difficulties of arriving at a consistent interpretation of stock status when abundance indices are moving in opposite directions have also been recognized. While changes in the catchability of survey gears and problems with catch statistics are known to have led to systematic biases in assessment results (often referred to as retrospective errors), the corrective measures needed to remove these biases remain unclear.

We cannot continue to rely on a single source of information or single indices of stock abundance; we need to develop multiple indices of abundance for each stock. This will take time. Efforts in developing sentinel surveys and index fishermen programs are steps in the right direction but these efforts need to be continued over time if they are to be of value as indices of stock trends.

There is a need to account for uncertainties in assessment such as those related to systematic biases, or related to the precision of estimates. A retrospective error in assessment has led to a systematic overestimation of stocks, and of the derived TACs; the

causes of this error have to be investigated. The use of risk analyses, as has been done for some of the groundfish stocks in recent assessments, must continue and be encouraged for other stocks.

There is a need to document fishing effort levels in a more systematic manner; technological improvements, especially, need special attention. In the past, information on effort has not been routinely processed.

There is a need to develop assessment models that take into consideration environmental factors. We have to extract the effect of environmental factors to understand the effect of fishing.

The timeliness of assessments needs to be improved and the calendar of advice adjusted so as to provide advice that takes into consideration the results of the most recent surveys.

Cooperation between various laboratories must be improved so as to foster an approach to research and assessments that is consistent.
We must continue to improve the relationship between scientists and fishers.

2.4 Groundfish management

In the sixties and the early seventies, management controls aimed primarily at limiting the capture of small fish by regulating the characteristics of the commercial fishing gears (e.g. mesh size regulations for trawls and gillnets). These gear limitations proved insufficient to protect the resource in the face of the massive increase in fishing pressure that occurred in the 1960's. The search for a solution led to the concept that separate quotas for each stock would allow better control of the quantity of fish being taken. In the international arena prevailing at the time, quotas had a certain advantage in that they could be allocated separately to each country. Until 1977, management of North-West Atlantic fisheries was under the jurisdiction of the International Commission of North Atlantic Fisheries (ICNAF), which was the precursor of the Northwest Atlantic Fisheries Organization (NAFO). NAFO was implemented in 1978 to consider fisheries outside the 200 mile limit and transboundary stocks. In 1970, ICNAF started to implement the concept of Total Allowable Catch (TAC) for certain stocks. By 1974, fisheries on most Atlantic groundfish stocks were controlled by TACs.

The early TACs were set on the concept of using a fishing mortality that would provide the Maximum Sustainable Yield (MSY). This means that the catch is calculated to be equal to the maximum possible production of the biomass (as a result, the biomass should be maintained at a level that would provide the highest possible catches). However, many stocks had already been fished too hard and the TACs based on this concept did not prevent further stock declines. Incomplete catch statistics, poor adherence to the TACs, and the inability to enforce the established regulatory measures were contributing factors in that decline. By 1975, it became clear that TACs should be based on a more conservative criterion than the Maximum Sustainable Yield. The negotiations that followed led ICNAF to adopt, in 1977, the concept of $F_{0.1}$, which refers to the fishing mortality applied to a stock (i.e. in practical terms, the percentage of the biomass taken every year). The idea was to reduce fishing mortality below the MSY level, to allow a larger biomass and a larger part of the natural production untouched, as safeguards in the face of unexpected events. For most stocks, $F_{0.1}$ corresponds to an annual harvest rate of 16 to 22%, depending on the characteristics of the stock (growth rate, etc.).

Following the decision to extend fisheries jurisdiction to 200 miles on January 1, 1977, the principal objective of fisheries management was to rebuild the fish stocks so as to improve the catches and catch rates for the benefit of the Canadian fishing industry. Canada formally adopted $F_{0.1}$ as the reference fishing mortality level for the stocks under its jurisdiction.

Expected Characteristics of fish stocks managed at $F_{0.1}$

In general terms, $F_{0.1}$ corresponds to a fishing mortality beyond which increases in yield relative to increases in fishing effort are marginal. $F_{0.1}$ has a number of advantages over strategies that are based upon higher fishing mortality rates (e.g. MSY). In particular, $F_{0.1}$ should lead to:

- a larger total biomass which should translate into higher catch rates;
- larger fish in the catches, allowing higher value products, and lower processing costs;
- more stable catches and stocks from year to year, as more year classes contribute to the exploited stocks and catches;
- more year classes in the spawning biomass to improve the chances of better recruitment;
- less effort (about one third to one half) than at the catch maximizing yield, which means a lower total yield (about 10% lower in the long term).

In addition, $F_{0.1}$ provides a higher "safety margin", in the sense that the higher stock levels associated with low fishing mortalities provide longer lead times to identify the effects of uncertainties in stock assessments and take corrective measures.

However, $F_{0.1}$ presents some limitations. As with any management system based on TACs, such a strategy needs a precise annual assessment of the stock size, which is often difficult to realize. In the past decade, the systematic overestimation of the biomass has led to the setting of excessive catch levels. The calculation of catches also implies some simplifications, such as constant natural mortality and growth rates. The risk analyses calculated recently for some cod stocks indicate that fishing at $F_{0.1}$ can produce a high probability of stock decline. Despite the high expectations raised by this concept in the past, it appears now that $F_{0.1}$ does not represent an absolute guarantee for the future of the stocks. At the same time, we have to acknowledge that the strict application of the $F_{0.1}$ concept was actually never achieved.

Was $F_{0.1}$ really given a chance?

In the mid 1980s, the Canadian Government, industry and politicians observed that a strict application of the $F_{0.1}$ concept could lead to drastic changes in TAC levels between successive years. In order to minimize the negative socio-economic impact of such drastic reductions in TACs between years, a rule was established by which catches at $F_{0.1}$ would be phased in over time. This rule, often referred to as "the 50% rule", stipulated that the fishing mortality in the coming year of the plan would be set at a value half way between the current fishing mortality and $F_{0.1}$. This was adopted in recognition that some lead time was required to adjust to the new reality when stocks are declining and the fact that annual adjustments in stock assessments could, in part, be related to the variability in annual data.

The 50% rule was invoked frequently in the mid- to late-1980s, not only because of the declining trend in the abundance of groundfish, but also because of inherent uncertainties in calculated fishing mortality levels. The end result is that the allowed fishing mortalities used in setting TACs have, by design, been higher than $F_{0.1}$.

Other factors led to fishing mortalities higher than $F_{0.1}$. For instance, the actual fishing pressure exerted on many straddling stocks outside the 200-mile zone has often been significantly higher than $F_{0.1}$, either because of inconsistent approaches to conservation, or because of a lack of control on fishing activities. Misreporting, discarding practices and enforcement difficulties have also led to catches in excess of the TACs on some stocks entirely under Canadian control.

In the late-seventies to the mid-eighties, exploitation rates were reduced substantially in comparison to the levels of the early 1970s. Overall, the biomass of the groundfish resource recovered and was, by the mid-1980s, substantially higher than before extended jurisdiction. However, in most cases, the $F_{0.1}$ target levels were far from being achieved. In hindsight, the $F_{0.1}$ level was usually exceeded simply because of the constraints or limitations inherent in the fishery management system.

Finally, the $F_{0.1}$ strategy was implemented when a significant reduction in the productivity of the groundfish resources took place, as evidenced by changes in recruitment and changes in growth. As a consequence of this, some of the conservation benefits that $F_{0.1}$ would have provided to the stocks, were obscured by the lower productivity.

Management in transition

Fisheries management in the seventies and eighties has been characterized by "micro-management" whereby government regulations controlled virtually every aspect of the fisheries harvesting operation. That style of management led to an interactive web of consultations, as well as numerous confrontations between industry groups and with government agencies. The groundfish fisheries crisis demonstrates the failure of that heavy centralized decision-making process, that was unable to protect the resource and related economic activities.

It is clear that this process must change due principally to three significant developments. First, government down-sizing has led to reduced budgets which simply do not provide the personnel and operating funds to run these intricate, complicated and resource-hungry programs. Secondly, the fishing industry is resisting this type of government interference in the operation of their affairs. The fishing industry is shifting to greater participation in co–management with government. Thirdly, the Canadian industry must now compete, more than ever, internationally for its traditional market share. Governments in Canada must ensure that the industry is equipped to meet these challenges.

A new operational framework

In recent years, DFO has initiated a move to a regime where the focus is on establishing the available harvest, conditions of access, appropriate monitoring of compliance, and a reliable information base.

Integrated Fisheries Management Plans have been introduced to comply with standards developed jointly by DFO and users prior to the opening of the fishing season. The aim is to develop plans that will avoid entering into detailed specific management measures, that are simpler, risk averse, affordable and within well defined conservation objectives. Enforcement elements are articulated as an integral part of these plans.

Fishers are now responsible for the development and implementation of **Conservation Harvesting Plans (CHPs)** which must comply with the conservation standards identified in the Integrated Fisheries Management Plans. The CHPs have been introduced progressively since 1993 for most of the groundfish stocks. Through them, the industry is expected to establish reliable approaches on catch reporting, dumping and discarding, by-catches, as well as promoting responsible harvesting practices in line with conservation.

These efforts constitute only part of the new framework and other initiatives need to be completed to achieve an efficient management system. In particular:

- New institutional arrangements are needed to permit intra-sector allocations and licensing policies to be established by industry themselves. Responsibility for inter-sector allocations would be shared with the Department of Fisheries and Oceans.
- The new relationship between the fishing industry and DFO as partners must continue to evolve. For fishers, partnering will mean a formalized role in decision making, sharing of financial responsibility, and greater security of access.

In this emerging framework, DFO's core business would be on managing conservation "risks" (the level of risk to the sustainability of the resource). The industry would be responsible for devising approaches that are consistent with the conservation of the resource.

The Fisheries Resource Conservation Council (FRCC)

The Council was created as an integral part of the new process, with the aim of addressing conservation issues. The Council was established as a partnership between government, the scientific community and the direct stakeholders in the fishery. Its membership reflects a balance between science and industry. The Council seeks advice and views from the stakeholders, including fishers, scientists and managers. As a means to make its decisions transparent, the Council carries out a series of public consultations before making its recommendations on quota levels for fish stocks and on other conservation issues. The information from the different sources is weighed and incorporated in the decision making process. Above all, the Council has served to promote a "Conservation First" attitude for the management of Atlantic groundfish.

Conservation first: A case for a precautionary approach

In its first reports on groundfish conservation, the FRCC focused on the need to halt the declines and to begin the rebuilding process. In particular, the Council pointed to the need to give maximum protection to small fish, the source of future spawners. The protection of small fish was particularly important as juvenile fish were the principal component of what was remaining in many of these stocks. In some cases, the biomass was so low as to give no alternative but to recommend complete closure. In other cases, reduced TACs or special management measures to give protection to small fish were recommended.

While it appears that declines have been halted in some stocks and that rebuilding has begun in some areas, the principle of protecting small fish remains relevant. In addition, recent research on cod fecundity and egg survival has indicated that it is important to have a spawning biomass that is composed of a wide range of sizes, as large individuals that have spawned more than once appear to contribute proportionately more to the spawning success or spawning potential.

In that context, the Council has sought in recent years to promote conservation by paying more attention to conservation measures that could supplement TACs. This was made clear in the report of the Council on 1994 conservation requirements (FRCC.93.R.2): "At present, the TAC approach combined with the limitation of entry is well-established within the Atlantic groundfish fishery. However, the FRCC recognizes that stock conservation involves more than just catch quotas. Other measures may complement the setting of TACs, in providing protection for fish resources". This point is reinforced in Council's 1996 discussion paper "Quota controls and Effort controls: Conservation considerations " (FRCC.96.TD.3).

In making recommendations on conservation measures for groundfish, the Council has generally sought to "err on the side of caution". A precautionary approach must be taken in deciding on exploitation levels to minimize the risk of harm to the resource. The conservation of Atlantic groundfish must continue to be governed by the precautionary approach.

Groundfish conservation: need for a coordinated approach

Groundfish conservation has been guided by objectives and principles for many years. In the period following the extension of fisheries jurisdiction, the main objective was to limit the fishing mortality rate to $F_{0.1}$. The prevailing theory held that this would lead to stable abundant stocks with stable high catches. Additional objectives were to prevent the increase in harvesting capacity and to avoid catching small fish, through mesh size regulations or gear limitations. These objectives are similar to those we are now considering and were spelled out in the preamble to each year's groundfish management plan. The policy and regulatory framework included limited entry licensing, a vessel replacement policy, quota management with fleet sector allocations and, latterly, enterprise allocations and ITQs, and restrictions on fishing gear such as minimum mesh size.

In addition to policies and regulations directly aimed at conservation, other policies and regulations affected conservation. A minimum fish size was introduced in the late 1980s to prevent landing cod too small for profitable processing. The minimum fish size was incompatible with the minimum mesh size and led to widespread discarding. Trip limits were introduced in some fisheries to spread catches over a longer period and over more vessels. Trip limits exacerbated difficulties in balancing quotas in multispecies fisheries. The introduction of EAs and ITQs led to increased dumping and highgrading. Government programs, subsidy and loan programs, encouraged increases in harvesting and processing capacity and encouraged fishers to remain in the fishery.

The regulatory and policy regime was supported by scientific programs to monitor stocks and estimate appropriate catch levels, by management, licensing, and enforcement programs, and by financial support programs. These programs were only partially successful at providing accurate information and ensuring compliance with regulations and policy direction. The vessel replacement policy controlled vessel length which proved to be only one factor in fishing power. Thus, the licensing policy allowed capacity to grow. In many cases, abundance was overestimated, so that quotas exceeded levels corresponding to the reference level. Catches were sometimes underreported or misreported, so that actual catches were higher than reported catches. These issues have been well documented in previous reports of the Council and in the report of Task Force on Incomes and Adjustment in the Atlantic Fishery (November 1993).

Fisheries sustainability: The need for an improved decision making process

A key aspect of the decision making process must be an assurance that conservation, rather than other interests, truly takes top priority. In recommending TACs and conservation measures, the FRCC process aims to accomplish this. Conservation must also be clearly seen as the driving force for management decision making, in resource allocation, licensing, etc. All components of the fisheries must be driven by a long-term vision of conservation. For example, there must not be a repetition of past decisions that allowed increases in fishing capacity, and consequent pressure for higher quotas, well beyond the natural capacity of the resource. Indeed, the will must be found to properly address the issue of capacity reduction.

The conservation regime of the 1980’s failed to maintain groundfish stocks at productive levels. This failure was not because of a lack of suitable goals and principles but, rather, a failure in execution, in a context of difficult environmental conditions. If conservation is to be achieved, all components of the “system” must work together effectively: goals and principles must be appropriate, policies and regulations must be adapted to achieve the goals, government programs must be effective and the practice of fishers must be consistent with the conservation regime. All these elements must be present and adequate for the conservation regime to be effective.

3. A CONSERVATION STRATEGY

3.1. Conservation Goals and Principles

Goals

In any endeavour, it is necessary to set goals to guide planning, and as a means to judge progress. There are four basic, interrelated goals for the conservation of groundfish resources:

- Rebuilding of depleted stocks
- Sustainable utilization
- Conservationist practices
- Optimization of benefits

Rebuilding of depleted stocks

At present, groundfish stocks of the Canadian Atlantic are at low levels; many are at the lowest levels ever observed. Abundance of others is far below historical highs. Thus, the first goal of a groundfish conservation strategy is to rebuild stocks to "healthy" levels of abundance. The goal of rebuilding groundfish stocks requires that reasonable targets for each stock be developed and that conservation management plans be formulated which achieve these. Targets should be based on historical levels of abundance, taking into account natural fluctuations within fish populations and stock conditions, such as recruitment potential. Agreeing on such targets will require discussion between scientists, managers, harvesters and other interested stakeholders, and thoughtful decisions.

Once targets have been set, a rebuilding strategy can be formulated. By limiting all fishing, stocks might rebound relatively quickly; allowing some fishing will typically mean stocks take longer to achieve target status. For depleted stocks, a restoration strategy will typically mean that any harvesting levels which are allowed will be more conservative than those permitted on healthy populations.

The success of any rebuilding strategy will have to be examined frequently to ensure that objectives are achieved for each stock. Because of natural fluctuations in fish populations, and incomplete and uncertain information, checking all available information on a stock will be an on-going process.

An important lesson may have been learned from the collapse of groundfish stocks and the recent fishery crisis. In spite of complete closures and stringent regulations on incidental catches some stocks under moratoria have shown only limited recovery over the past several years. Recovery of severely depleted stocks is difficult and takes time. It is far better to manage fish stocks to prevent depletions than to endure the long period they require to recover. The primary goal of fishery conservation is to protect the resource.

Sustainable utilization

A widely accepted definition of sustainable development is that publicized in 1987 by the United Nations' World Commission on Environment and Development: "sustainable development meets the needs of the present without compromising the ability of future generation to meet their own needs." This definition readily applies to the sustainable exploitation of a natural resource, like a modern fishery.

To achieve sustainability, a framework of appropriate conservation measures must be formulated and effectively implemented. In the case of a modern fishery, sustainability must be achieved in an environment of ever developing, improving technology, and an industry controlled by social and economic factors which create pressure for maximum yields. Further, there is considerable natural variability in fish populations, which remain poorly understood and beyond management intervention. Sustainability is thus vulnerable to environmental as well as to social-economic influences.

Conservationist practices

Conservation is the practice of managing natural resources such that exploitation does not deplete the resource. If sustainability is the objective, conservation is the means to reaching it. Conservation leads to sustainability through a hierarchy of basic principles, strategic directions and practical rules. The terms of reference of the FRCC provide a general definition of fisheries conservation and identify several specific conservation objectives:

"Fisheries conservation is that aspect of the management of the fisheries resource which ensures that its use is sustainable and which safeguards ecological processes and genetic diversity for the maintenance of the resource. Fisheries conservation ensures that the fullest sustainable advantage is derived from the resource and that the resource base is maintained."

"Conservation objectives include rebuilding stocks to their 'optimum' levels and thereafter maintaining them at or near these levels, subject to natural fluctuations, and with "sufficient" spawning biomass to allow a continuing strong production of young fish; and, managing the pattern of fishing over the sizes and ages present in fish stocks and catching fish of 'optimal' sizes."

What a "sufficient" spawning biomass might be, or what is meant by "optimum" stock level or "optimal" fish size, depends on particular stock conditions.

Optimum benefits

Sustainability and conservation are not meant to imply non-economic levels of exploitation of a resource, or even, no exploitation at all. What they imply is a management regime which gives primacy to careful husbanding of the resource, so that it continuously renews itself and remains available to future generations of harvesters.

Practical groundfish conservation means the management of stocks such that humans gain maximum sustainable advantage and the resource base is maintained. Benefits include employment and economic well-being for individuals, companies and communities.

Optimum benefits can also be derived from the resource by minimizing waste, through catching fish large enough to be utilized, and proper handling practices that would maintain, or increase, the income for less fish being killed.

Conservation principles

Achieving groundfish conservation goals requires a comprehensive program of management actions. Such a program must be guided by clear principles which embody the fundamental rules of conservation. The following principles are necessary in a groundfish conservation strategy.

Understanding the resource

The fundamental principle for achieving sustainable utilization of the resource is adequate information on the resource and the consequences of harvesting both on it directly and indirectly via the ecosystem and habitat. Without adequate understanding of the resource, our management and harvesting activities will be ineffective and often inappropriate.

In the future, scientists will continue to lead in developing information about stocks. However, because more information is needed, and resources for such work are in short supply, scientists will depend more and more on harvesters to help in gaining knowledge of fishery resources.

Scientific research on stock structure and on the reproductive capacity of stocks leads to a better understanding of the resource.

Joint science/industry programs are positive initiatives.

- ***the Fishermen and Scientists Research Society, in Nova Scotia, and the Sentinel Fisheries Program are good examples of fishers and scientists acting together to collect and interpret biological data.***

Protect resource renewability

All activities including management decisions, the conduct of fisheries, enforcement, scientific studies and information gathering must be concerned with ensuring continuity of fish stocks. Relevant elements for such continuity include the maintenance of adequate spawning potential, ecosystem balance and function, and habitat.

Small fish protocols and minimum legal sizes are examples of regulations that intend to protect resource renewability.

Limiting fishing activities in areas such as the Shediac Valley (in the Gulf of St. Lawrence), where young cod congregate, and forbidding fishing in the "Haddock Box", (a fishing area closure in Eastern Nova Scotia), also serve to support this principle.

The precautionary approach

The FRCC urges fisheries conservation approaches that are "prudent" and holds that it should not be necessary to await final scientific analysis before taking conservation measures. It should be enough that, on the balance of evidence, it makes sense to take action; that is the precautionary approach.

Closing fisheries when stock status indicators fall below critical levels reflects a precautionary approach. Even if it is possible to calculate a quota, it is important not to "chase quotas down to the last fish".

A systems approach

A systems approach to fisheries has to be built into decision making. This requires understanding of the interaction between the resource, natural environment, fishing activities, technology (including the impact of fishing gear on species and habitats), human behaviour and social and economic factors.

In a systems approach, integrated management principles should be used. This means decision-making that brings all affected interests and players together in the management process. Scientists of different disciplines should work together to solve fishery problems. Science should work closely with gear technologists, fishery statisticians and fishers. Managers must work closely with harvesters and scientists. Fishing activities must be understood as well as the fish resource. Studying fishing effort and how it changes over time is important in a systems approach.

Interregional research programs, such as those established for Cod and Redfish, involving several laboratories and several disciplines are steps toward a systems approach.

Consistency

This implies that all fishing activities should abide by the same principles, which should be consistent between areas and species. Conservation actions should be consistent over the entire range of a particular stock (including transboundary stocks) and should be implemented with fairness and equity. No particular sector should bear alone the cost of, or benefit alone from, the measures.

The best current example of consistency is the introduction and use of Conservation Harvesting Plans for all fleet sectors. These plans set out measures such as small fish protocols, observer coverage, test fishing protocols, seasons, gear restrictions, etc. The plans apply to all fish sectors and deal comprehensively with conservation concerns.

Accountability

All involved in fisheries -- fishers, fish buyers, association representatives, scientists, managers, policy makers -- must recognize how their role and actions contribute to an effective conservation program and must accept the consequences of their activities. It has to be kept in mind that conservation is compulsory, not optional.

An example of accountability is the development of a code of responsible harvesting practices. This code sets out a protocol for harvesters that places the onus for responsible fishing practices on each and every harvester.

The implementation of the Regional Advisory Process also corresponds to the accountability principle. Scientists, managers, and the fishing industry meet together to discuss and interpret scientific advice and harvesting patterns of the previous year.

Implementation of a Regional Sanction Board could also be an example of accountability.

One element of accountability is that all involved must provide the information needed to develop the knowledge necessary in an accurate, comprehensive and timely manner.

Flexibility and responsiveness

Management response to conservation concerns must be flexible and innovative. Management systems must be able to modify measures as new information becomes available, whether this be from real time monitoring of changes in the resource and its environment or from the development of greater understanding of different biological factors.

Key stock indicators must be identified, measured and summarized in a timely manner and used to guide corrections in harvesting practices. Successful conservation requires that actions be assessed regularly, problems recognized and appropriate actions taken at the level the problems occur.

Temporary closures of fishing areas when by-catches of small fish exceed a certain level ("small fish protocol") are examples of responsiveness to changing conditions.

3.2. CONSERVATION MEASURES

In this section, a "checklist" is presented of seven tasks that must be achieved if the conservation principles for the groundfish fishery, described in the previous section, are to be achieved:

- Establish conservationist harvest rates
- Maintain adequate spawning potential
- Establish a diverse age structure in the stocks
- Protect genetic diversity within fish populations
- Protect the ecosystem
- Protect critical habitat
- Minimize resource waste

These requirements are described in turn below. It is important to note here that this checklist reflects a growth in our collective understanding of the groundfishery and its environment over the past two decades. Each of the seven tasks on the conservation checklist is crucial, but in the past, not all received the attention we now realize they deserve. As we come to recognize the importance of the ecosystem in which the fish live, the importance of the biodiversity inherent in fish stocks, the complexities of how fish grow and reproduce, and the need to get as much benefit as possible from each fish we catch, our perspective expands far beyond just "how much fish can we catch". Life becomes more complicated, but that is the reality of an activity that depends on a resource that is very uncertain, very variable and more fragile than we once believed.

Measures to establish conservationist harvest rates

The key to successful fishery management lies in limiting the impact of the fishery on the resource. In managing fisheries around the world, this task traditionally receives the most attention. Direct fishing pressure on the stocks must be controlled, so that our rate of harvesting is in line with the rate at which the stocks grow naturally, the reproductive capability. This is why the conservation focus in groundfish management lies in controlling 'fishing mortality', the rate at which fish are killed. This is often measured by the harvest rate, the percentage of the biomass caught each year (usually around 16-22% in an $F_{0.1}$ strategy).

Measures to ensure conservationist harvest rates

- **a. Applying the Precautionary Approach**
- **b. Setting quotas (TACs)**
- **c. Controlling fishing effort**
- **d. Managing fishing capacity**
- **e. Closing seasons and areas**

In addition to the fundamental need for a Precautionary Approach, there are four major categories of conservation measures aimed at limiting fishing mortality: controls on catches (quota management), controls on fishing effort, controls on fishing capacity, and structural measures such as closed seasons and marine protected areas. These tools are discussed in turn below.

a. Applying the Precautionary Approach

While setting harvest rates, we must consider the uncertainty we face with respect to the resource status and future trends. Application of the precautionary approach for depleted groundfish stocks means that harvest rates are set at levels that assure a fair probability of stock rebuilding. For example, we know now that the $F_{0.1}$ strategy does not provide safeguards against stock declines; it means, in practice, that harvesting must sometimes be set at a lower level than provided by $F_{0.1}$. Application of the approach to non-depleted stocks means that stocks do not decline as a result of management actions. The poorer the information base, the more uncertainty and the greater the caution in establishing harvesting rates.

b. Setting quotas (TACs)

The most established measure for controlling fishing mortality in Atlantic Canada's groundfishery is quota management. In practice, this means limiting the amount of fish killed, through annual Total Allowable Catches (TACs). However, the long-term goal is not to keep the catch at a certain level, but rather to set the TAC so that the same percentage of the biomass is taken each year. In other words, the focus is on controlling the harvest rate; limiting the catch through the TAC is one means to achieve this. This has been a popular 'vehicle' for managers since it provides a way to more easily divide up available catches among the various sectors of the fishery.

While groundfish management remains reliant on quota controls, there have been significant problems:

- Since estimates of the biomass in the sea are typically subject to uncertainty, calculations of the “desirable” TACs have also been subject to the same level of uncertainty;
- although TACs are meant to be limits on total catches, they create incentives for discarding, highgrading, misreporting and non-reporting, and the quotas which were set most often did not account for these.

c. Controlling fishing effort

As noted above, the principal conservation goal in the groundfishery has been not to limit how much fish is taken from the sea, but to limit the "fishing mortality". The most direct means to accomplish this lies in restricting the intensity of fishing activities and the fishing effort, to ensure that the rate of exploitation is in keeping with the reproductive capability of the resource.

Indeed, in fishery science, fishing mortality is measured by multiplying the fishing effort (the number of days of fishing, for example) by a factor that accounts for the technological capability of the fleet. This means that to control the impact of the fishery on the resource, a logical requirement is to limit the amount of fishing (the effort), adjusted for any changes in the technological capability of the fleets.

In practice, effort management must focus on the most important of the many dimensions of fishing activity (since controlling one component of effort creates an incentive for the fisher to look for other ways to increase fishing pressure), and must find the means to compare effort levels across gear types and vessel sizes.

d. Managing fishing capacity

"Fishing capacity" is the ability of the fleets to exert fishing effort, and therefore to kill fish. This depends on the number of boats as well as on the technological capability and debt load of each one. A large vessel contributes more to total capacity than does a small one. A boat sitting at the dock is not exerting effort, but it still contributes to "capacity". If the total of all this capacity is more than is needed to harvest the fish, this is referred to as a case of "over-capacity". This is not in itself a conservation problem, since having too many boats tied to the dock has no direct impact on the fish. However, if fishery management is not effective in limiting effort (or if high debt loads create political pressure to allow fishing), it may be unable to keep the capacity off the water, and conservation problems could result. It is for this reason that reducing fishing capacity can be seen as a conservation issue; the need for reductions in capacity has been noted repeatedly in FRCC documents to date.

e. Closing seasons and areas

Conservation tools such as closed seasons and marine protected areas can be thought of as 'structural' measures, since they affect the way the fishery is structured—when and where the fishery takes place. Such tools form a component of the 'conservation portfolio', the set of measures that can help reduce fishing mortality. They do not necessarily provide direct limits on fishing pressure, since it may be possible for excessive fishing effort to concentrate outside the protected area, or outside the fishing season. What they do provide are the means to selectively limit fishing pressure, on particular components of the stock (e.g. juveniles, spawners or distinct spawning sub-stocks), or on fragile or particularly important parts of the ecosystem.

Measures to maintain adequate spawning potential

One factor in the collapse of Atlantic Canada's groundfish fisheries was a lack of attention to the logical connection between spawning and future recruitment of young fish. While it is obvious that a decrease in the number of spawners to very low levels must have a negative impact on the future production of new young fish, such a connection was not usually incorporated into stock assessments nor into fishery management decision making. This was largely because of the difficulty faced by scientists in "proving" that such links exist, even though they logically must. In the future, such links should be assumed.

Furthermore, recent research highlights the need to focus on the quality as well as the quantity of spawning activity, since older fish have both higher fecundity and more viable egg and larval production than younger fish. Attention must focus on the "spawning potential" of the stock, the sum across all adult age classes of spawner numbers, adjusted by the fecundity and egg viability at each age. A key management objective must be to maintain spawning potential sufficiently high such that future recruitment is not jeopardized (and for depleted stocks, to rebuild as rapidly as possible toward adequate levels).

Measures to maintain adequate spawning potential:

- **a. Apply the Precautionary Approach**
- **b. Limit harvest rates**
- **c. Protect spawning concentrations**
- **d. Implement selective harvesting**

Conservation measures to achieve these requirements include careful application of the Precautionary Approach, limiting harvest rates, protecting spawning grounds, and harvesting selectively.

a. Apply the Precautionary Approach

It is reasonable to assume that depleting the spawning potential (catching too many spawners, particularly older fish) will tend to damage future recruitment, and indeed, that for each stock, there is a certain critical spawning potential below which the chance of stock collapse becomes substantial. We will never know these levels precisely, so a Precautionary Approach suggests that while science and management must understand as much as possible about the spawning process, in any case spawning stocks must be kept well above likely critical levels.

b. Limit harvest rates

A prerequisite for maintaining (or achieving) adequate spawning potential over time is keeping harvest rates suitably low. Clearly, if a large fraction of each year class is harvested before having the chance to mature, it is unlikely that a strong spawning stock can be built up and maintained, and in particular, there will be few old fish (the best spawners) in the population. So controls on fishing mortality (harvest rates), as described earlier, are crucial to long-term sustainability.

c. Protect spawning concentrations

Clearly, there is no point building up a strong spawning stock only to disrupt the spawning activity and reduce the viability of the eggs. Most fishers feel it is appropriate to avoid fishing on spawning concentrations. While the benefits of such actions may not have been 'proven', the prudent policy would be to follow this approach, and let the spawning process take place in as unhindered a manner as possible.

d. Implement selective harvesting

It is accepted that juvenile fish should be protected from harvesting, as they represent the future spawning biomass. Fishing gear must be designed to avoid the catch of these juveniles as much as possible. Protection of large mature fish should be envisaged as those fish produce more eggs with greater chance of survival then young mature fish do.

Measures to establish diverse age structure in the stocks

A sustainable fishery is necessarily one that is not prone to collapse. This means that we should try to avoid "recruitment fisheries", ones that rely for much of the harvest on catching newly-recruited fish. A Precautionary Approach calls for maintaining a broader age structure in both the population and the harvest, to reduce the risk to the future from an accidental over-harvesting of a single year class, or an unexpected environmental effect that harms one year class. This is clearly related to the task of maintaining strong spawning potential. Indeed the two go hand-in-hand—to achieve a suitable population of spawners, we must have a diverse age structure, and vice versa. In ensuring a diverse age structure, it is crucial that harvesting be suitably selective, and that harvest rates be limited so that enough fish can have the chance to mature.

Although one single year class may come naturally to dominate the biomass of a stock from time to time (notably for stocks that produce strong recruitment only occasionally), in general fishery management should pay particular attention to conserving weaker year classes. This can be accomplished through fishing activity that is selective for the proper species and size, so that those age classes most in need of protection are adequately conserved. Also, fish must be protected during critical periods of their life history, for example, through establishment of time and/or area closures for juveniles and spawning concentrations (see discussion above).

Measures to protect genetic diversity within fish populations

Measures to establish a diverse age structure in stocks:

- **a. Implement selective harvesting**
- **b. Limit harvest rates**
- **c. Closing seasons and areas**

sustainability. Protecting genetic diversity in a fish population requires both research—to identify the various spawning components and the behavioral, biological or physical differences between sub-stocks—and management measures. Each spawning component must be conserved as vigilantly as if it were a separate stock, and the geographical distribution of each fish stock must be maintained, in particular by not over-fishing local sub-stocks. A key approach to achieving this lies in implementing Marine Protected Areas.

Measures to protect the ecosystem

We have only a very limited understanding of the complex inter-relationships among species in the ocean, and between a given species and its environment. But we do know enough to realize the importance of ecological processes and of the food chain to all fish species. In protecting the ecosystem, the Precautionary Approach calls for reducing our risks as much as possible. Two key conservation measures in this direction are Marine Protected Areas and Ecosystem-Based Management.

Measures to protect genetic diversity within fish populations:

- **a. Maintain the number of spawning components of fish stocks**
- **b. Maintain the geographical distribution of stocks**
- **c. Implement Marine Protected Areas (see below)**

a. Marine Protected Areas

The Canada Oceans Act states that Marine Protected Areas are ocean areas set aside for one or more of the following purposes:

- conservation and protection of commercial and non-commercial fisheries resources, including marine mammals and their habitats;
- conservation and protection of endangered or threatened marine species, and their habitats,

Measures to protect the ecosystem

- **a. Implement Marine Protected Areas**
- **b. Implement Ecosystem-Based Management**

- conservation and protection of unique habitats,
- conservation and protection of marine areas of high biodiversity or biological productivity,
- conservation and protection of any other marine resource or habitat as is necessary to fulfill the mandate of the Minister of Fisheries and Oceans.

Obviously, the focus of Marine Protected Areas is on conservation—notably of fish resources, habitats, ecosystems and biodiversity. Of the seven items on our conservation checklist, most are directly served by Marine Protected Areas; notably protection of genetic diversity (e.g. by conserving spawning components), protecting eco-systems and protecting critical habitats. In addition, Marine Protected Areas can help with the tasks of building the spawning potential and improving the age structure, by providing strategically-placed refuges for juveniles, spawners and/or older fish.

While Marine Protected Areas can be used for very specialized purposes, such as protecting the spawning grounds of a single fish species, they are particularly important in moving toward a more ecosystem-based approach to management. Protecting habitats and ecological processes may be best accomplished through Marine Protected Areas, since these not only help conserve individual species, they are in fact designed to conserve the ecosystem the fish live in. Marine Protected Areas can also be especially important in protecting the smaller or weaker among a stock's multiple spawning components, even if we do not know the exact nature of these components.

A process must be implemented to ensure full participation of concerned stakeholders in the design and implementation of Marine Protected Areas.

b. Ecosystem-Based Management

While the development of Marine Protected Areas is part of an ecosystem approach to fishery management, the latter involves much more. It emphasizes conservation measures that maintain the resilience of the ocean system, and the integrity of the ocean food chain. Notably, extreme caution must be exercised when considering harvests of species low on the food chain. We must be on guard against shifts in the pattern of harvesting over time, from initially harvesting populations high on the food chain (groundfish) to directing for those species lower (herring) and lower (krill) on the food chain. This is a dangerous sign of overfishing.

Measures to protect critical habitat

While fish at early stages in their life histories are especially vulnerable to loss of habitat, fish of all ages require good quality habitat. Accordingly, there is a need to protect the integrity of the most critical habitats for fish of all ages, as well as spawning and nursery grounds in particular. In adopting management measures to protect habitats, certain guidelines are important:

- Both the quantity and quality of habitat must be protected.
- Participatory processes must be used to develop consensus on which habitat needs protection, taking into account both traditional knowledge and scientific evidence.
- Effective processes must be implemented to ensure compliance with habitat protection measures, and to monitor the impacts of habitat protection over long time periods.

Measures to protect critical habitats

a. Limit activities that could be detrimental to habitats

b. Apply technology toward reducing negative impacts of harvesting on fishing grounds and habitats.

c. Implement Marine Protected Areas (see above)

Measures to minimize resource waste

Proper conservation calls not only for re-building stocks and maintaining them at healthy levels, but also for getting the greatest benefits for each fish caught. This means that we must take into account not only how much is caught, but the size and condition of the fish caught, and the timing of the harvest. For example, fish should be caught at such a size (or age) that the benefits obtained are maximized; typically if they are caught too young, substantial growth potential is lost (reflecting lost value to the economy). A basic guideline is that the smallest size of fish caught should be that which can be utilized.

Another option for minimizing resource waste, by minimizing the conservation impact of the available harvest (TAC), may be through incentives, regulations and management measures to induce the shifting of harvesting to conservationist times of the year. This reflects the idea that the fishery must focus not just on the biomass of fish caught but also on the numbers of fish killed. Since the condition of the fish varies over the course of the year, it may be possible to adjust the timing to maintain catch weights while reducing the number of fish killed.

Except in special circumstances, any fishing activity cannot target a single species. However, incidental harvests create unnecessary mortality on commercial and non-commercial species. As a general guideline, incidental harvests should be held at the lowest level possible.

Poor handling practices also induce unnecessary losses, diminish the value of the harvest and create additional pressure on the resource in order to maintain profitability.

Measures to minimize resource waste

- **a. Target the fish at a proper size**
- **b. Target the fish at the proper time**
- **c. Minimize incidental harvests**
- **d. Implement proper handling procedures**

3.3. Building a Conservation Strategy

Developing a conservation plan

A conservation plan provides the practical day-to-day actions designed to achieve conservation goals. The plan ties the various elements together to give the desired results. The accompanying flow-chart describes a general sequence of actions that can be adapted to particular situations.

Step 1

Level of action. Before designing a conservation plan it is necessary to determine the appropriate **level of action** and the scale at which the plan will apply. The problems are not the same if we consider the whole Canadian Atlantic or a single stock: they have to be dealt with at the proper scale. This is determined both by law and policy, for instance:

- at the National level, Government defines broad policies for the fishery, such as capacity reduction, implementation of marine protected areas, etc., in agreement with broader governmental policies;
- at a regional level (for instance, Gulf of St.-Lawrence, Eastern Newfoundland or Southern Nova Scotia), conservation encompasses fishing gear and fleets and may refer more to the ecosystem, habitat protection, interactions between fisheries, sanctioning system, etc.;
- at a stock level, Fishers' Groups and Associations formulate specific Conservation Harvesting Plans.

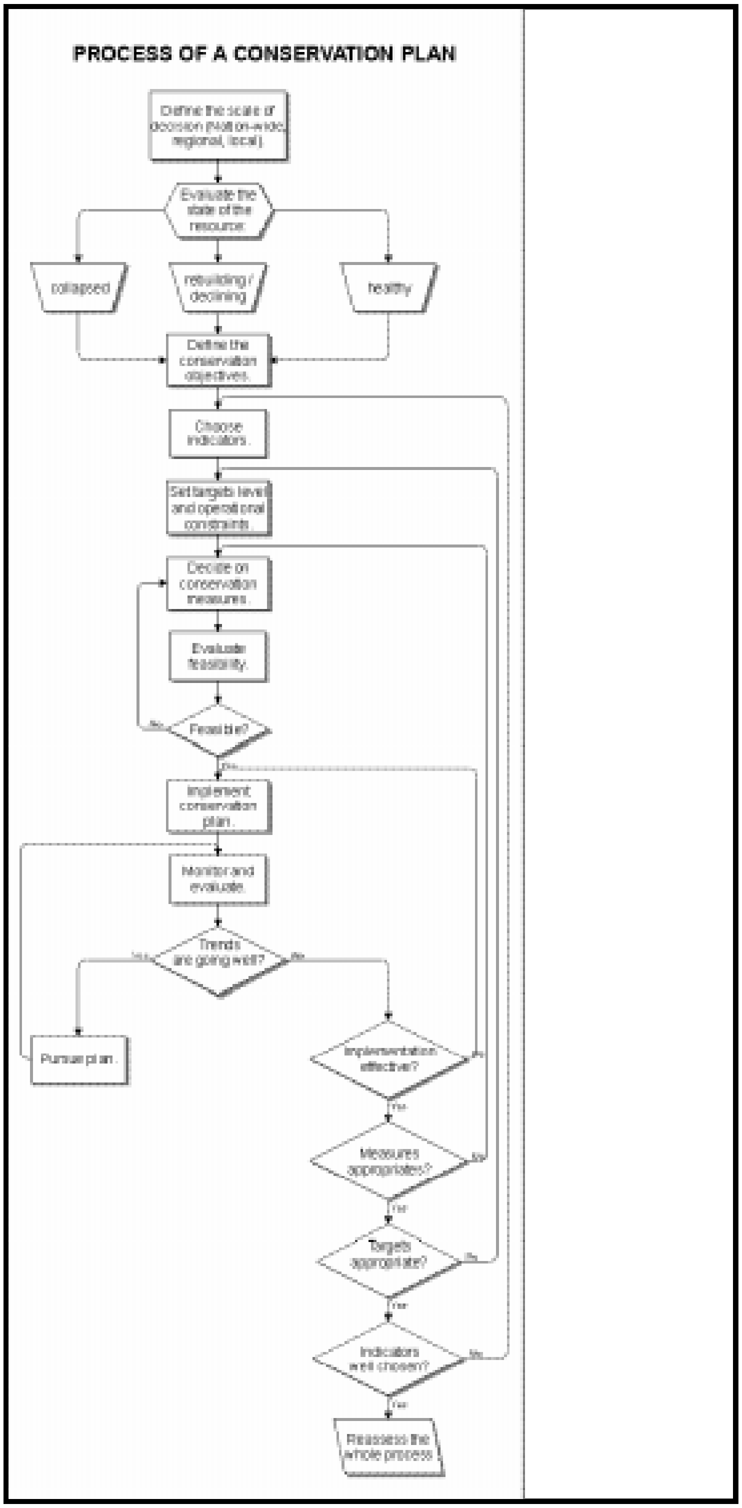
Conservation plans must be consistent from one level to another (e.g. at a local level, CHPs must be consistent with goals defined for the broader area).

Step 2

Objectives have to be identified. Decisions about the objectives to be pursued occur at several levels:

Responsibilities:

- Government identifies the wide national objectives for the fisheries sector;
- Governments, Fishers' groups and other stakeholders, such as Non Governmental Organizations (NGOs), should work together to expand upon objectives at the regional ecosystem level;
- Fishers' groups and managers define objectives at the stock level through the design of Conservation Harvesting Plans.



From general objectives, taken as a start, specific objectives have to be developed, in order to take into account particular or local conditions. Specific objectives depend on the actual status of the resource considered; the following stages can be defined:

- Collapsed stock - The strategy is to avoid any fishing mortality, in order to facilitate the renewal of the resource. The fishery has to be closed and the resource monitored through scientific surveys and sentinel fisheries, under strict scientific supervision.
- Stock at low level (declining or partially rebuilding) - Moderate commercial fishing activity may be allowed, at a low level, below the calculated optimum (i.e. below $F_{0.1}$), in order to facilitate stock rebuilding.
- Healthy stock - A conservation-minded commercial fishery can take place with harvest levels in agreement with the resource renewability.

Note that the stage each stock is in should be determined by scientists, the FRCC and fishers working together. The current Regional Assessment Process leads to that direction. At the ecosystem level, other stakeholders should be involved in the process.

Step 3

Choose indicators. These should be simple, relevant and reliable. Several indicators should be used, where possible, to get a broad picture of the current situation. Information from all sources and the reliability of the information must be considered.

For a single stock, characteristics such as spawning biomass, recruitment levels, age structure and geographical distribution must be considered. Other indicators which may help include: amount of by-catch, condition of the fish, ecosystem characteristics, etc.

Step 4

Set target levels and operational constraints. Targets are the results we expect from conservation measures: e.g. relative to historical levels or unexploited levels. Operational constraints address the undesirable results we want to avoid (small fish protocols to avoid capture of small fish is an example). For instance: to avoid recruitment overfishing, we can set a minimum spawning biomass and target a particular age structure; to maintain genetic diversity, we can set a minimum geographical distribution of a stock; to limit negative impacts on other species, a maximum amount of by-catch can be established. Both targets and operational constraints must be expressed in measurable terms.

When considering the package of indicators, one must then decide what will be an acceptable report card. Which indicators are the most important? Which are the most reliable? Must all indicators reach suitable levels or only some of them? Careful and cautious judgement is required in examining all indicators and in deciding on conservation requirements.

The definition of indicators, target levels and operational constraints should involve scientists, the FRCC and fishers.

Step 5

Decide on conservation measures, in agreement with the objectives and the current status of stocks. In addition to indicators, targets and operational constraints, it should be made explicit when those measures should be amended. Decision points and rules have to be set in advance to specify measures to be taken if deviations from targets or operational constraints are observed. A minimal list of data necessary for the decision making process has to be established. Decision points and rules must allow for reaction at very short notice when deviations are noted (Principle of Responsiveness). A monitoring system of indicators must be designed.

Discussion and consultations with all interested stakeholders, managers and especially fishers, will assist in developing those measures.

Step 6

Evaluate the feasibility and the efficacy of the set of conservation measures. The conservation plan will be accepted after an assessment of its feasibility.

Step 7

Implement the conservation plan. Once the fishery is underway, managers must ensure that conservation harvesting plans are effectively enforced. Compliance by users will be enhanced if it comes from a process which ensures their full participation in the decision making process, and which ensures that their views on the health of fish stocks are considered.

Step 8

Monitor and evaluate the conservation plan. Monitoring and evaluation of on-going fisheries help to ensure that: initial decisions about the fisheries were appropriate, conservation requirements are effectively implemented, and targets set for the stock are being achieved. These assessments will often result in adjustments of conservation measures. In addition to on-going monitoring and evaluation, the status of each stock must be periodically and toughly evaluated.

Managers, scientists and fishers should work together in the implementation, monitoring and assessment of the conservation plan. Fishers must contribute in providing reliable and timely information. Scientists must analyze data in a timely manner and provide the results of these analyzes. The management system must be able to react to emerging situations.

Who does what?

Everyone has a role in conserving fishing resources and insuring conservation plans are effectively made and implemented. It is important to know who does what, as well as one's own responsibility.

Ministers

On behalf of the People of Canada, the Minister of Fisheries and Oceans has the responsibility to protect fisheries resources and the ocean ecosystem on which fisheries depend. The Minister defines the broad policies regarding ocean conservation and makes the final decisions about groundfish conservation.

The Department of Fisheries and Oceans acts within a broader political context where other components affect fisheries conservation. Thus, other federal government departments need to play their roles, as well as Provincial Governments and local authorities. All of these must examine their practices and regulations interfering with groundfish conservation and make necessary adjustments and changes. For example, subsidies from various sources contributed, and still contribute, to excessive of harvesting capacity, and processing capacity, which creates a source of pressure on the resource.

Political decisions rely on management teams which develop and evaluate plans by which fish may be harvested. They also rely on information provided by scientists, who evaluate the state of stocks and ocean ecosystem. Effective implementation of harvesting plans requires enforcement personnel, to ensure the compliance to regulations.

Fisheries Resource Conservation Council (FRCC)

The FRCC's role is to consider information about the status of fish stocks, to consult broadly with interested stakeholders and to make recommendations about conservation requirements for groundfish stocks. These recommendations are communicated publicly to the Minister of Fisheries and Oceans to be considered in establishing groundfish management plans.

The Council is composed of individuals with a wide variety of interests in the fishery. Members are appointed by the Minister and charged with the conservation of fisheries resources.

The mandate of the FRCC tasks it with a variety of activities. The Council:

- is responsible for advising the Minister of Fisheries and Oceans on research and assessment priorities;
- reviews the data provided by DFO and advises on methodologies;
- considers conservation measures, including Total Allowable Catches, that may be required to protect fish stocks;
- reviews stock assessment information and conservation proposals, including through public hearings, where appropriate;
- makes written public recommendations to the Minister on conservation measures.

As conservation problems are identified during contacts with fishers and others during public consultations, or during review of scientific information, the FRCC should initiate immediate contact with appropriate agencies or sectors to communicate these concerns. The FRCC takes the initiative to communicate with all stakeholders about conservation issues in fisheries.

Science sector

The mission of fisheries scientists in the DFO Science sector is to provide timely and reliable scientific information and advice in support of the conservation, protection and sustainable utilization of marine resources.

Scientists work in partnership with the fishing industry to develop new and innovative science programs which make the best use of the abilities and resources of both. Communication between fishery stakeholders and scientists is a primary responsibility.

Management

The Fisheries Management sector of DFO manages programs which deal with resource management, conservation and protection, aboriginal affairs, and program planning and coordination.

Resource Management involves the implementation of plans, policies and programs to protect and enhance fish stocks. Development of Conservation Harvesting Plans is a primary job of management bodies.

The Conservation and Protection branch works to achieve compliance with the management and regulatory framework by providing surveillance and enforcement. They ensure that appropriate consultation precedes regulatory changes.

The Program Planning and Coordination sector acts as the catalyst for elaborating new directions in fisheries management and industry renewal.

Under the *Canada Oceans Act*, management responsibilities may be delegated to other stakeholders, such as Fishers' Associations and communities.

Harvesters

Fishers are responsible for the conservation impact of their activities. They have the personal obligation to ensure minimal conservation impacts of their fishing, notably done through the development of Conservation Harvesting Plans.

Fish harvesters need to be consulted about all aspects of the fishery that affect conservation. They have a major role in participating in the consultations of the FRCC and DFO in providing information, feedback and opinion. Fishers are in the best position to observe first-hand the impact of quotas, regulations and technology. They also are the primary observers of the resource, and need to report their observations to managers and scientists. Fishers should be more and more active in the scientific process through participating in the Regional Advisory Process and joint science/industry initiatives.

Processors

The processing sector must recognize that their actions have an impact on fisheries conservation. They should participate in conservation by refusing to process illegal fish and by providing needed information on the fish they buy. They also should participate in joint science/industry initiatives.

Processors and fish harvesters must work together to develop strategies to enhance the quality and value of market products.

Programs and activities

The current failure of the groundfish fishery system reflects problems in implementing conservation principles. Conservation will just be wishful thinking if not implemented through concrete actions. Conservation should be reflected in daily activities, annual plans and long term policies. The conservation oriented process includes the following elements:

- a proper communication/education system;
- development of knowledge, which is the base for accurate decisions;
- adequate planning and prosecution of fishing activities, which includes every level of the decision making process, from the central decision maker (the Minister of Fisheries and Oceans), to fishers' groups which have to set up Conservation Harvesting Plans.

Stakeholders need to receive on a regular basis and in a simple, easily understandable way, information on :

- **science activities and scientific methods (how they work, what they mean);**
- **findings on fishery status, resource status, biological and ecological data and the marine environment (how we are doing with the resource, how the resource is doing in its environment);**
- **conservation principles and the regulatory system, with explanation of the rationale for regulatory measures (why constraints exist);**
- **the enforcement system and its results**

Transmission of biased or distorted information should not be accepted, whether from managers and science to fishers or from fishers to science and managers.

Communication and Education

Conservation attitudes can be enhanced by an adequate process of education and communication. A good fisheries conservation education/communication initiative should ensure that everyone involved receives all the necessary information regarding the fishery and its environment, in a forum which will allow them to make a judgment on how the fishery and the resource are doing. As well, they should feel fully involved in the conservation process, be able to actively and efficiently participate in the science data gathering and analysis, and participate effectively in the decision making process.

Effective cooperation and conservation attitudes can only be based on mutual trust, which can only be based on clear, transparent processes. Reliable information is a key element of trust building.

The system in place to disseminate stock status reports is a good initiative. Invitations made to stakeholders to participate in the Regional Advisory Process (RAP) sessions appear as a big improvement. This process should be expanded and completed through other programs (e.g. educational videotapes). Regular articles in local newspapers and presentation on electronic media should also be considered, especially during the fishing season.

Fishermen and their organizations should be actively involved in the development, implementation and evaluation of science projects directed at groundfish fisheries.

Fishermen's organizations have a major role to play in education/ communication activities.

Fishers strongly desire a greater involvement with science in assessing the state of the fisheries. They view this as a way through which they can provide input into the development and implementation of science projects as well as obtain feedback on the results of projects carried out. This two-way communication system already exists in some regions, with regular workshops involving scientists and fishermen. Such workshops are positive and should be a continuing scientific activity to help fishermen provide accurate reliable data but also to help scientists better integrate knowledge gained from years of fishing experience into their own process.

More research is needed on basic biology, to gain better knowledge on the reproductive capacity of stocks;

Stock units and sub-components of stocks have to be scrutinized, in order to set more accurate management measures and to understand the genetic diversity of stocks;

Spawning periods and areas appear to be poorly documented; this needs greater attention in order to be able to define protected areas and seasons, and to avoid fishing on spawning concentrations.

Sensitive habitats such as nursery grounds have to be defined.

We need a better understanding of the functioning of the ecosystem, to understand the relationships between species and their environment and to understand the food chain structure

Education is not only a "top-down" process. Programs implemented through Fishermen's organizations, such as the "Ocean Watch Program" have major value and should be encouraged and expanded.

Information and knowledge

Understanding the resource

Most data on the basic biology of exploited populations are based on work done several years ago (e.g. stocks units and growth rates) while recent research, with up-to-date tools, shows changes (e.g. age-at-maturity, migration patterns) or modifies existing views (e.g. reproductive capacity). It seems that greater effort is needed in this area. In particular, recruitment is a major issue which must be addressed as a priority. Work has to be done to understand the various factors affecting stock renewal.

It has been assumed that environmental factors play a significant role in the decline of groundfish stocks. Several factors have been put forward, such as productivity of the ecosystem, temperature, oxygen concentrations, fresh-water runoffs, and increasing seal populations. Scientific research is bringing conflicting evidence on those topics. We have to consider that harvesting a particular species may have effects on other species (e.g. groundfish-crustaceans relationship), effects that are yet to be fully understood.

Improving stock assessment

Stock assessment cannot rely on a single source of information. We have to improve the data base.

Groundfish surveys were designed several years ago and should be revisited periodically in order to be adjusted to the actual ecological situation. Hydro-acoustic surveys become more and more efficient and appear to provide useful information especially for the near shore environment, where trawling is not feasible, and for detecting spawning concentrations. Ways have to be found to integrate information from traditional surveys and hydro-acoustic surveys.

Gathering and treatment of traditional knowledge must be seen as an important part of the data-gathering process.

Improving cooperation with industry is a necessity:

- **sentinel fisheries and index-fishermen programs must be pursued and enhanced;**
- **further joint science/industry initiatives should be implemented.**

Systematic gathering and treatment of fishing effort data must be implemented.

Ways to routinely gather traditional knowledge and to make this information usable in the assessment process have to be implemented. Social science can provide valuable input in this matter.

Fishers should not be seen only as "data collectors" for science but should be fully involved at every step of the scientific process regarding groundfish stocks. Joint science-industry initiatives have to be encouraged. The Fishermen and Scientists Research Society (Nova Scotia) appears as a good example in this matter. Sentinel fisheries provide valuable information and should be pursued in order to create a long term fully usable data base. Index Fishermen Programs were implemented some years ago and should be expanded. Data from log-books and from at-sea observers should be treated and analyzed on a recurrent basis.

Uncertainty has to be systematically taken into account in the stock assessment process.

The time-lag between information gathering, data treatment and decision making has to be shortened.

Information gathering systems should be flexible and should be able to respond to unexpected events.

Fishing effort is a major issue, as it directly affects fishing mortality. Systematic information-gathering on fishing effort, including technology used, location and time deployment, should be a routine task for scientists.

Even if scientists have known for a long time that uncertainty exists in their assessment process, this uncertainty was generally not fully incorporated in that process. Work on risk analyzes demonstrates that the confidence we placed in absolute values, such as $F_{0.1}$ mortality levels, was not founded. Uncertainty has to be systematically taken into account in the stock assessment process. For fisheries on which we have solid scientific bases, risk analyzes have to be carried out. Other approaches, such as simulation of various scenarios, should be undertaken. For other fisheries, where it is not feasible to collect full-scale information, it should be possible to define an approach based on qualitative, or semi-quantitative, data, that would be accepted by stakeholders. In both cases, the uncertainty that cannot be quantified at the current level of our knowledge (e.g. the role of environmental factors) has to be considered in the assessment process.

A suitable balance has to be found between stock assessment research and more fundamental research.

As many of the problems in fisheries are rooted in human behavior, issues must be addressed in an integrated manner that crosses traditional discipline barriers and includes physical, biological and social sciences.

The time-lag between information gathering, data treatment and decision making has to be shortened. Progress has occurred in this direction but further efforts are recommended. The information gathering system should be flexible in order to respond to unexpected events.

System approach

Fishery problems consist of a complex mixture of social, economic and ecological issues. Solving fishery problems will require an understanding of fish, humans and their environment. In practical terms this means that we will have to deal with fishery problems in an integrated, global manner. We have to move further than the present single-species/single-stock perspective: scientific research should devote energy to "up-stream" ecosystem and biological research as well as to social and economic research; managers should consider the global effects of decisions on the resource, on the ecosystem and on the human communities; fishers must accept that their activity has a detrimental effect on the resource and on the environment and that they have to act so as to limit those negative impacts.

Within the Science sector, cooperation between scientists should be expanded in order to increase the synergetic effect between disciplines and between regions. The Zonal Approach, currently developed by DFO scientists, works in this direction. Finally, a proper balance between “classical” stock assessment research and fundamental research has to be achieved.

Planning and prosecution of fishing activities

Management agencies

Managers have to address issues on a broad scale. They set the basic rules guiding the fishing activity:

- licensing and allocations;
- resource protection;
- control and surveillance of fishing activities, and
- enforcement of regulations.

Management decisions must be driven by a long term vision of fisheries sustainability and not by short term interest.

Fishing capacity remains a major issue and its reduction should be addressed as a priority. Governments, at every level (Federal, Provincial, Local) should ensure that no subsidies are used to increase capacity, directly or indirectly (including the processing sector).

Reducing capacity will take a certain time, in order to avoid socio-economic disruptions. This time can be long, in the absence of political will. In the interim period, capacity should be managed to avoid excessive effort that would compromise conservation objectives.

Resource protection involves many measures, the first ones dealing with how much of the resource can be taken (TACs). TACs remain a major tool of fisheries' management. They must be set at a level compatible with the renewal capacity of the resource. In the case of depleted stocks, TACs should be set at a level which ensures a high probability of stock rebuilding. While we have become accustomed to setting TACs, it is also important to limit fishing effort, which directly affects fishing mortality: in a context of fishing overcapacity, closing fisheries for part of the season should be considered.

Another set of measures addresses resource structure and potential, including new or emerging fisheries. Small fish protocols, protecting the future stock components, should be in place and enforced. Nursery and juveniles areas should be identified and protected. Other measures that would protect the reproductive capacity of stocks have to be implemented, including a proper balance of ages in the population.

Managers must define guidelines on how the fishery should be prosecuted. For example:

- conservation measures must be consistently applied throughout the geographical range of a stock, (including transboundary stocks, inside and outside the 200-mile limit);
- regulations on by-catches must ensure adequate protection of non-target species; for some species, release at sea should be mandatory;
- targeting for species other than what license conditions state must be prohibited;

Managers have the responsibility to survey and control fishing activities to ensure that they abide by the conservation principles and regulations. The first step is to ensure that enforcement is efficient, diligent and consistent across regions and stocks. Non-compliance with the rules must be severely punished (as many fishers say: "get the pirates out of the water"):

- severe sanctions must apply to fishers, and severe penalties to non-fishers, who do not comply with the regulations;
- when a common problem occurs with a particular gear or in a particular fleet sector, corrective measures must be set for that particular gear or sector.

Other stakeholders' activities may have an important impact on the resource, directly or indirectly. Those activities should be monitored and controlled. In that sense:

- food and recreational fisheries should be closely monitored and should abide by strict regulations;
- processors and buyers should keep accurate records of all fish purchased, subject to periodic auditing.

Along with the desire to diversify fishing activities, new fisheries are emerging and others are expanding. The precautionary approach must be used in the development of those fisheries. Managers should ensure that those emerging fisheries do not create a new economic dependency while the resource capacity remains poorly known. New fisheries usually imply new harvesting technology: managers must ensure that new fisheries do not harm habitat or other resources. In the case of resources low in the food-chain (e.g. krill), the TAC should be set at a very cautious level, and after it is proven that those fisheries will not have any damaging effect on the ecosystem. The precautionary approach must also be used for forage species, such as capelin and herring.

Managers:

- **Avoid political interference in the decision making process;**
- **Implement measures to reduce fishing capacity and control fishing effort;**
- **Set Total Allowable Catches in agreement with the renewable capacity of the resource, or with a rebuilding strategy;**
- **Implement measures to protect resource structure and potential;**
- **Regulate how fisheries should be prosecuted;**
- **Survey and control fishing activities efficiently, diligently and consistently;**
- **Use precautionary approach in new and emerging fisheries, especially for species low in the food chain;**
- **Implement a conservation process involving every interested stakeholder.**
- **Ensure a proper consultation process with stakeholders affected by conservation measures.**

A major responsibility of managers is to implement a conservation process leading to conservation plans. They must involve stakeholders in that conservation process through regular consultations. They have to search for and assess innovative conservation approaches.

Fishers and fishers' groups

Increasing management responsibilities are being delegated in the near future to fishers' groups and associations. In some areas, Community Quotas are being implemented. Those factors will lead to a greater involvement of fishers in the planning and design of fishing activities and conservation plans.

Fishers' associations should play a major role in implementing conservation-minded harvesting. Among various actions that could be undertaken, there are:

- developing a code of responsible fishing, to include potential effects of fishing on habitats and on other non-targeted species;
- developing compliance to that code among fishers;
- Increasing conservation awareness through active participation in education and training.

One of the major roles of fishers' associations is now to develop Conservation Harvesting Plans. Those plans should include rules concerning gear use, resource protection and renewal, and data gathering and reporting systems. Included in those basic elements would be:

Rules governing gear use:

- appropriate selectivity, for all gear sectors (catch of small fish should be prohibited, and selectivity should be addressed);
- appropriate technology to minimize impacts of gear and fishing practices on the environment;
- appropriate standards for gears;
- only square mesh when fishing for Gadoid-like species (Cod, Haddock, Hakes, etc.);
- precise rules for dual gear on board;
- reasonable soak-time for gillnets and compulsory locating device for deep water gillnetting;
- use of biodegradable materials for parts of gillnets to prevent ghost fishing when gear is lost.

Rules to promote resource renewal:

- small fish protocols;
- by-catch protocols
- seasonal or permanent area closures;
- protection of spawning and pre-spawning concentrations.

Information gathering systems to report on catches, fishing location and effort, may include:

- log-books;
- dock-side monitoring;
- at-sea observers;
- joint science/industry projects.

A system to assess the impact of emerging new technology on stocks and the environment, including the implementation of test fisheries, is also needed.

Fisher's groups and associations:

- **Improve conservation awareness among harvesters;**
- **Develop Conservation Harvesting Plans, including items below.**
  - **Rules governing gear use, to limit negative impacts of fishing on species and environment.**
  - **Rules to protect resource renewability, including seasonal and area closures.**
  - **Data gathering and reporting systems on fishing activities in coordination with science and management sectors.**

4. CONCLUSION

4.1. Analysis of the Atlantic Groundfish Fisheries

In order to prepare the present Groundfish Conservation Strategy, the FRCC reviewed and analyzed the vast input provided by the fishing industry during the numerous public consultations that the Council has held to date, as well as technical and scientific documentation. This was done in the context of the Canadian Atlantic groundfish crisis. Even though the fisheries have faced several crises during its long history, the present one has no precedent. The mid-eighties are behind us and a much more modest future lies ahead.

Based on its analysis, the FRCC is concerned that the forces that led to the present situation are still in place:

- Tremendous harvesting capacity, created both by the number of vessels and technological improvements, that tends to promote poor harvesting practices;
- An inadequate management system, heavily centralized, still based on a single stock, single species approach, backed by an enforcement system becoming less efficient in a context of shrinking financial resources;
- Poor knowledge of the resource: despite large improvements in scientific tools and intensive scientific work, we are still unable to assess accurately the state of stocks, to take into account their natural fluctuations or to understand properly the functioning of the fishery itself.

If these forces remain in place, the FRCC believes this will lead to a repeat of the past:

- Large uncontrolled capacity racing for a small amount of fish;
- Quota overruns, in pursuit of profitability;
- New severe declines in the resource, along with loss of habitats and stock components.

Considering the current poor state of the resource, a new crisis will be irreversible, with all the disruptions, that it implies: economic, social, biological and ecological.

The FRCC recommends that all players in the groundfish fisheries build, together, a Conservation Capacity, that will balance harvesting capacity, to prepare for sustainable long-lasting fishing activity.

4.2. Building a Conservation Capacity

Just as harvesting capacity is the ability to catch fish, conservation capacity is the ability to achieve conservation, so as to meet the goals stated in section 3.1:

- rebuilding of depleted stocks
- sustainable utilization
- conservationist practices
- optimum benefits

and to follow the seven basic principles, proposed in section 3.1:

- understanding the resource
- protecting resource renewability
- adopting the precautionary approach
- moving to a system approach
- consistency
- accountability
- flexibility and responsiveness

It will accomplish the seven fundamental tasks described in section 3.2:

- establish conservationist harvesting rates
- maintain adequate spawning potential
- establish a diverse age structure in stocks
- protect genetic diversity within fish populations
- safeguard ecological processes
- protect critical habitats

- minimize resource waste

Goals and tasks will be achieved while implementing measures proposed in section 3.4.

> ***"The state of the resource and the conditions of fish stocks must first be the priority of industry stakeholders and DFO (…) The state of the resource and conservation, not government policies, not industry, not market pressures, must dictate the effort and capacity, and determine any management scheme"***
>
> ***Eastern Fishermen's Federation***

Among the numerous tasks and actions described in this Conservation Strategy, this section highlights a set of key elements that appear as prerequisites to the building of the proposed conservation capacity.

Role of Management

As many groundfish resources will remain at a low level for the foreseeable future, the management sector must address as a priority the reduction of fishing capacity. In the absence of general willingness to implement comprehensive actions in that direction, managers must implement measures to strictly control fishing effort. Seasonal closures of fisheries should be considered.

Take immediate actions to facilitate the reduction of fishing capacity, in cooperation with the fishing industry;

Implement immediate measures to monitor and control fishing effort, including seasonal closures;

Avoid the expansion of any technology until we know exactly what will be its impact on both resource and environment; if detrimental effects cannot be mitigated, the technology in question should be banned.

Even if some management responsibilities are delegated to boards, local authorities or fisher groups, the Department of Fisheries and Oceans still has the final responsibility to ensure the long-term conservation of the resource on behalf of the Canadian people.

Implement Marine Protected Areas as soon as possible; if adequate scientific definition of such areas is not yet available, immediately implement seasonal closures on pre-spawning and spawning concentrations;

Identify and protect juveniles and nursery areas for straddling stocks; immediate negotiations should begin with NAFO, to take actions, to protect juvenile components, especially in sub-area 3NO;

Use a cautious approach in setting harvest rates for new or expanding fisheries ; particular attention must be paid to forage species and species low in the food chain.

Ensure that conservation rules are consistent across the full distribution and range of stocks; for transboundary stocks, continue negotiations with NAFO to ensure that the same Conservation Strategy will be followed outside, as well as inside, the 200 mile limit.

Ensure that Conservation Harvesting Plans are conservation-oriented, properly implemented and well-respected;

Implement a diligent, efficient and consistent enforcement system.

Role of Science

The Science sector has the duty to provide relevant and accurate information to guide decisions. Stock assessment remains a crucial step to determining conservationist harvest rates. Single-stock assessment must eventually be replaced by a fuller appreciation of the state of the marine ecosystem.

Stock assessment must be improved;

Considering the levels of uncertainty surrounding resource abundance, alternate ways to determine conservationist harvest rates must be explored; risk analyses should be carried out when feasible.

Effort data must be routinely gathered and treated as a full part of the assessment process.

Identification of critical habitats (i.e. spawning grounds and juvenile areas) must be seen as a scientific priority;

Research must be undertaken to delineate sub-stock components and spawning components;

Research must be pursued to understand the reproductive capacity of stocks;

Effects of fishing activities on the ecological system must be scrutinized;

Multidisciplinary work must be implemented to understand the functioning of the fisheries system, including natural environment and human behaviour.

Information collection must be directed to assist in the protection of the resource, its genetic diversity, and its renewal capacity, and to understand and forecast the effect of both human actions and environmental conditions on the resource. The study of the fisheries ecosystem, as a whole, appears critical.

Scientists should work closely with fishers, who should be involved in the scientific process, through data gathering and interpretation. Traditional knowledge has to be considered as a full part of information gathering systems.

Efforts must be expanded to involve fishers in the scientific process;

Sentinel Fisheries Programs and Index Fishermen Programs must be continued and expanded, even after fisheries re-opening;

Joint science/industry initiatives must be implemented, or expanded;

Work has to be undertaken to gather and analyze fishers' traditional knowledge, in cooperation with fishers' groups or associations and social scientists.

Role of Fishers, fishers' groups and associations

Fishers have a major role to play in the building of a conservation capacity, as their activities have the primary direct impact on resources and the environment. Industry has a responsibility to address the issue of fishing capacity.

Take immediate actions, in cooperation with Management, to facilitate the reduction of harvesting capacity.

The role of fishers becomes even greater with the delegation of management powers, especially through the definition and implementation of Conservation Harvesting Plans (CHPs), which should be in agreement with the overall conservation objectives for the resource. CHPs must include sets of measures related to gear use and gear impact on habitat and environment.

CHPs describe a set of measures to ensure resource protection and respect for conservationist harvest rates. This includes measures to control effort, a size range of fish to be caught, and permanent or seasonal area closures, especially to protect juvenile and spawning grounds as well as pre-spawning and spawning aggregations.

Appropriate selectivity standards must be set for all gear sectors;

Catches of small fish by any gear must be minimized;

Immediate measures must be implemented to prevent gear loss and ghost-fishing;

If a gear type has a significant and potential detrimental effect on a sensitive habitat, the gear type must be excluded from that habitat;

The impact of any new harvesting technology on the environment or on relevant species must be tested; if that technology shows significant and potentially detrimental effects, it must be prohibited.

CHPs must include measures to monitor the fishery, through data gathering and reporting systems. As well, fishers must be involved in the scientific process, while providing data and information and effectively participating in scientific activities.

Implement a system of effort control; if effort cannot be controlled during the fishing season, that season must be shortened;

Implement seasonal and permanent area closures. Move immediately to implement protection of known juvenile and nursery areas;

Implement measures to favour protection of small fish and to favour a proper balance of ages in the population.

Set measures to extensively monitor the fishery, in a timely fashion, through a combination of log-books, observers at sea, dock-side monitoring;

Make provisions for gathering data on fish stocks;

Implement scientific activities in conjunction with the science sector.

Role of conservation attitudes

Resource conservation may be seen as a "joint-venture" in which every stakeholder has a role to play. Those involved in fisheries must accept a moral obligation toward resources and people who depend on the resources. Each person must ensure conservation practices in their own field of activity, taking responsibility for their own behaviour and how it affects the resource. Conservation must be a continuing concern reflected in every fishery. Conservation of resources is not only dependent on regulations; everybody must adhere to conservation principles and act accordingly with those principles. A conservation-minded attitude is a prerequisite to the building of conservation capacity.

Mutual trust among stakeholders is necessary to construct such a conservation-oriented attitude. It means that a common knowledge base has to be built through sharing and discussing information. It also means that stakeholders must understand each other. They also must understand the rationale for decisions and actions, which means that an education process should be implemented. Stakeholders must be confident in the decision making process, which must be transparent and must include full participation of every stakeholder. That process must also be designed to avoid serving short term interests but rather to consider a long term fisheries vision.

"Many things can be done to secure a sustainable fishery for the future, but the most important thing is attitude".
W. Bowles
(Newfoundland)

A decision making process is needed that is transparent and fair and that limits political interference;

A long term vision of a sustainable fishery must be the basis for the decision making process;

Systems to share information between scientists, managers and fishers must be implemented;

An education system, including new information technologies and media, must be designed and implemented cooperatively by managers, scientists and fishers' groups and associations.

Appendix 1: Glossary

APPENDIX 1. GLOSSARY

Assessment: The process of determining what he status of a fishery stock is in relation to exploitation.

Biomass: The total weight of all the fish in a stock or other group, added together. (Spawning biomass - the total weight of sexually mature fish in the stock.)

Bottom fish (ground-fish): Species that are usually caught near the bottom, including cod, haddock, pollock, redfish, halibut, flounder, and many others.

Catch rate: The amount of fish caught by a fixed amount of fishing. For example, this could be pounds of fish per one-hour tow of an otter trawl or pounds of fish per hundred longline hooks hauled.

Conservation Harvesting Plans: These plans describe the sets of conservation measures adopted by a fishing sector or group before the fishing season begins. For example, a plan could spell out the mesh size to be used, protocols to protect small fish, fishing times or periods, gear limitations, etc.

Dockside monitoring: The on-shore surveillance of landings to determine if the total landings exceed acceptable limits and if the by-catch of non-target species or of small fish is excessive.

Enterprise allocation (EA): A catch quota from a particular stock, allocated to a company.

Fishing capacity (or harvesting capacity): This term refers to the global ability of the fishing fleet to catch fish; it includes several elements: the number of vessels, the size of the vessels, the power of the engines, the type, the number and the sizes of the fishing gears, and electronic devices, such as positioning systems, echo-sounding systems.

Fishing effort: The amount of fishing . It is usually recorded in units like “boat days” or “trap hauls”.

Fishing mortality: The death of fish caused by fishing. However, indirect death caused by fishing is generally not included in the estimates of fishing mortality.

Gear (fishing gear): Harvesting technology used in the fishery. The major gear types for groundfish are: otter trawls, Scottish seines, gillnets, cod traps and hook and line.

Highgrading: The discarding of lower-value fish, in order to land more high value fish.

ICNAF: The International Commission for the Northwest Atlantic Fisheries partly replaced by NAFO for stocks which straddle, or are found completely beyond, the 200-mile limit.

Incidental catches (by-catches): The capture of fish other than the intended species.

Index Fishermen Program: Through these programs, a number of commercial fishermen are selected to monitor the performance of their fisheries and to collect biological data so as to provide an index of stock abundance that is independent of scientific surveys.

Individual (transferable) quota: Under an individual quota system, the available catch (TAC for a particular stock)is divided among individual fishermen, fishing units or fishing enterprises before the fishing season. Each individual, unit, or enterprise is assigned a fixed share of the TAC, either as a specific quantity or as a percentage of the TAC. This is done for one year or for a longer period. The quota is ‘transferable’ because it could be leased or traded in perpetuity or for a fixed term. The rationale for an individual quota system is that it would eliminate the incentive to over invest and end the competitive “race for the fish”.

Logbook: Data records kept by fishers while they operate at sea. The logbooks contain information on the location and duration of fishing sets, the quantities caught by species, the fishing gear used, etc.

Model: A simplified description of phenomena allowing a practical analysis. Stock assessment models involve a set of relationships describing fish growth, recruitment processes and the effects of various sources of mortality.

Maximum Sustainable Yield (MSY): The highest yield achievable on a sustained basis for a particular stock. In theory, under a certain set of conditions, this catch will be sustainable year after year. The models implementing this concept, which were prevailing in the 1970s, have been replaced over time by more complex approaches which better describe the dynamics of the fisheries.

NAFO: The Northwest Atlantic Fisheries Organization. It replaced ICNAF in 1979. NAFO sets quotas for some stocks that are outside Canada's 200 mile limit, straddle the line, or are of mainly foreign interest. NAFO could also provide advice on other stocks at the request of a Coastal State.

Nursery (area): Any place in or by which fish are fostered and bred.

Observers program: A program whereby observers on fishing vessels help deter illegal fishing and collect samples for resource assessments. Observers collect certain data, maintain records, report violations, and if necessary call for a boarding inspection and further action by a DFO fishery officer.

Over-Capacity: A state of saturation or an excess of productive capacity. The over-capacity problem in the fishery is directly related to the capacity of the fleet to harvest fish at levels above those that the resource can sustain.

Overfishing: Generally, this means catching so much fish that it reduces the stock's biomass and future catches below desirable levels. The situation when a stock is being exploited beyond its long-term productive capacity; simply put, when the capital is being reduced rather than when the interest is being cropped. Two kinds of overfishing are often considered: growth overfishing, when animals are caught at a size where more growth would provide better production (fishing at too young an age results in yield waste); and, recruitment overfishing, when fishing reduces the stock to a level where subsequent recruitment is lowered.

Population (fish population): A group of fish of the same species that live in the same geographical area and reproduce in a common location; this word has often the same meaning as fish stock.

Productivity (production): The amount of biomass added in a year to a stock through growth and recruitment.

Quota: An amount of catch that one group of fishermen is permitted to take from a stock during a year.

RAP sessions: Refers to the Regional Assessment Process, a program in which scientists and other stakeholders meet to discuss scientific results and analyses on the status of fish stocks and their environment.

Recruitment: When fish survive the egg, larval, and juvenile stages, and grow big enough to be caught in the fishery, they are "recruited" to the fishable stock. "Recruitment" can mean either the process of recruiting or the numbers of fish in a year class that are recruited.

Reproductive (spawning) potential: The capacity of a fish population to regenerate through reproduction; it could be measured in terms of the number of mature fish (spawning biomass) and the physiological condition of those fish.

Retrospective pattern (error): Systematic error (bias) in estimates of abundance. These types of errors have generally led to an overestimation of stock abundance (or biomass).

Season (fishing season): Times in the year when a specific fishery can occur. Seasons vary from one area to another.

Sentinel fishery (survey): A program initiated when moratoria were introduced on the major cod stocks to monitor changes in abundance and obtain biological information.

Spawning component: Part of a given fish population which reproduces in a precise location on a regular basis (e.g. in a particular bay); it is generally similar to a sub-population or sub-stock.

Stakeholders: All those who have an interest (a stake) in a fishery.

Stock (Fish stock): A population of fish of one species found in a particular area, which is used as a basic unit for fisheries management. All of the fish in a stock should have similar growth and migration patterns.

Total Allowable Catch (TAC): The total tonnage of fish allowed to be caught from a particular stock in a particular year.

Year class: All of the fish in a stock that were spawned in a particular year, such as all those born in 1990. Also called “cohort”.

Appendix 2: FRCC Mandate and Membership

APPENDIX 2. FRCC Terms of Reference and Membership

1. Introduction

The Government of Canada is committed to a more comprehensive approach to the conservation and management of our fisheries resource. This approach demands a better understanding of complex fisheries ecosystems - the interaction of fish with other species, predator-prey relationships, and also changes in the marine environment like ocean currents, water temperatures and salinity.

The Government of Canada is also committed to a more effective role in decision-making for those with practical experience and knowledge in the fishery.

The Minister of Fisheries and Oceans has established the Fisheries Resource Conservation Council (FRCC) as a partnership between government, the scientific community and the direct stakeholders in the fishery. Its mission is to contribute to the management of the Atlantic fisheries on a 'sustainable' basis by ensuring that stock assessments are conducted in a multi-disciplined and integrated fashion and that appropriate methodologies and approaches are employed; by reviewing these assessments together with other relevant information and recommending to the Minister total allowable catches (TACs) and other conservation measures, including some idea of the level of risk and uncertainty associated with these recommendations; and by advising on the appropriate priorities for science.

2. Definition of Conservation

Fisheries conservation is that aspect of the management of the fisheries resource which ensures that its use is sustainable and which safeguards its ecological processes and genetic diversity for the maintenance of the resource. Fisheries conservation ensures that the fullest sustainable advantage is derived from the resource and that the resource base is maintained.

3. Council Objectives

3.1 To help the government achieve its conservation, economic and social objectives for the fishery.The conservation objectives include, but are not restricted to:

3.1.1 rebuilding stocks to their 'optimum' levels and thereafter maintaining them at or near these levels, subject to natural fluctuations, and with 'sufficient' spawning biomass to allow a continuing strong production of young fish; and,

3.1.2 managing the pattern of fishing over the sizes and ages present in fish stocks and catching fish of optimal size.

3.2 To develop a more profound understanding of fish-producing ecosystems including the inter-relationships between species and the effects of changes in the marine environment on stocks.

3.3 To review scientific research, resource assessments and conservation proposals, including, where appropriate, through a process of public hearings.

3.4 To ensure that the operational and economic realities of the fishery, in addition to scientific stock assessments, are taken into account in recommending measures to achieve the conservation objectives.

3.5 To better integrate scientific expertise with the knowledge and experience of all sectors of the industry and thus develop a strong working partnership.

3.6 To provide a mechanism for public and industry advice and review of stock assessment information.

3.7 To make public recommendations to the Minister.

4. Mandate and Scope

4.1 The Fisheries Resource Conservation Council will address these objectives by bringing together industry, DFO science and fisheries management, and external scientific and economic expertise in one body.

4.2 The Council will:

4.2.1 advise the Minister on research and assessment priorities;

4.2.2 review DFO data and advise on methodologies;

4.2.3 consider conservation measures that may be required to protect fish stocks;

4.2.4 review stock assessment information and conservation proposals, including through public hearings, where appropriate; and,

4.2.5 make written public recommendations to the Minister on TACs and other conservation measures.

4.3 The Council may recommend any measures considered necessary and appropriate for conservation purposes such as TACs, closure of areas to fishing during specific periods, approaches to avoid catching sub-optimal sized fish or unwanted species, and restrictions on the characteristics or use of fishing gears.

4.4 The Council's scope includes Canadian fish stocks of the Atlantic and Eastern Arctic Oceans. In the first instance, the Council will address groundfish, and then subsequently take on responsibility for pelagic and shellfish species.

4.5 The Council is also responsible for advising the Minister on Canada's position with respect to straddling and transboundary stocks under the jurisdiction of international bodies such as the Northwest Atlantic Fisheries Organization (NAFO).

5. Size, Structure and Make-Up

5.1 The Council will consist of not more than 14 members with an appropriate balance between 'science' and 'industry'.

5.2 Members are chosen on merit and standing in the community, and not as representatives of organizations, areas or interests.

5.3 'Science' members, are drawn from government departments, universities or international posts, and are of an appropriate mix of disciplines, including fisheries management and economics.

5.4 'Industry' members are knowledgeable of fishing and the fishing industry and understand the operational and economic impacts of conservation decisions.

5.5 All members of the Council are appointed by the Minister.

5.6 All members, including the Chairperson, are appointed for a three year term; terms can be renewed.

5.7 Members appointed from DFO serve 'ex officio'.

5.8 Members have to disclose any interest in the Atlantic or Eastern Arctic fishery and take appropriate measures so as to avoid potential or real conflict of interest situations during the term of appointment.

5.9 The four Atlantic Provinces, Quebec and the Northwest Territories may each nominate one delegate to the Council. These delegates have access to the Council's information, and may participate fully in meetings, but will not be asked to officially endorse the formal recommendations to the Minister.

5.10 The Council is supported by a small Secretariat, to be located in Ottawa. The Secretariat will:

5.10.1 provide administrative support for the functioning of the Council;

5.10.2 provide a technical science and fisheries management support;

5.10.3 organize Council meetings;

5.10.4 record decisions of the Council;

5.10.5 undertake a professional communications function for the Council, providing a central point for communications to and from the Council; and

5.10.6 undertake such other matters as from time to time might be appropriate.

5.11 The Chairman may appoint an Executive Committee, consisting of the Chairman, Vice-Chairman, and three other Members.

5.12 In addition, the Chairman may, from time to time, strike an 'ad hoc' committee to deal with a specific issue.

6. Activities:

6.1 Reviews appropriate DFO science research programs and recommends priorities, objectives and resource requirements.

6.2 Considers scientific information - including biology, and physical and chemical oceanography, taking into account fisheries management, fishing practices, economics and enforcement information.

6.3 Conducts public hearings wherein scientific information is presented and/or proposed conservation measures/options are reviewed and discussed.

6.4 Recommends TACs and other conservation measures.

6.5 Prepares a comprehensive, long-term plan and a work plan for the Council which are reviewed annually at a workshop with international scientists and appropriate industry representatives.

6.6 Ensures an open and effective exchange of information with the fishing industry and contributes to a better public understanding of the conservation and management of Canada's fisheries resource.

FRCC MEMBERSHIP:

Members:

Fred Woodman, Chairman
Dr. Jean-Claude Bręthes, Vice-Chair
Michael Belliveau
Bruce Chapman
Dr. Tony Charles
Frank d'Entremont
Sam Elsworth
Sally Goddard
Jean-Claude Grégoire
Tom Hallett
Frank Hennessey
Dr. Paul LeBlond
Dr. Victorin Mallet
Trevor Taylor
Maureen Yeadon

Provincial Delegates:

Bruce Ashley, Northwest Territories
Glen Blackwood, Newfoundland
Yvon Chiasson, New Brunswick
David Gillis, Prince Edward Island
Dario Lemelin, Québec
Clarrie MacKinnon, Nova Scotia

Ex Officio:

Bill Doubleday
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APPENDIX 3:
References and Contributors

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Scientific information and data used in this report come from several sources. The following persons were of particular assistance to the Council in gathering and processing information and data:

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