RESPONSIBLE FISHING

A Strategy For An Improved Industry

Handbook For a Curriculum Supplement
For Use In Intermediate and Senior High Social Studies

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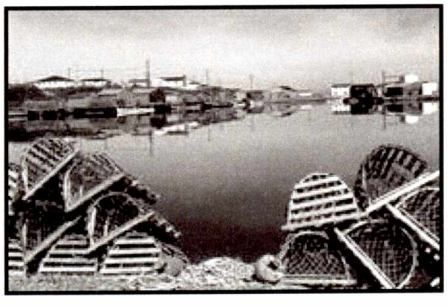


Real, normal, and very rare.

FOREWORD

The fishing industry is a very complex one, involving many different fish species, a wide variety of fishing gears and methods, fleets of vessels in a broad range of types and sizes, and an extraordinarily varied environment, of which different water and weather conditions are only the most obvious. All of these differences have significant implications, potential consequences, for everyone involved in this challenging, sometimes frustrating, always fascinating industry - including scientists, managers, processors, buyers and sellers, and of course fish harvesters; and last but by no means least, educators.

Fisheries issues penetrate deeply and intricately into the broadest, most complex areas of human endeavour and investigation: scientific, social, economic, environmental and cultural. In a place such as Newfoundland and Labrador, where the fishing industry historically has played such a central role in the individual and collective lives of almost the entire population, this is understood, to a greater or lesser degree, by virtually everyone. There is no need here to illustrate such an obvious truth with specific examples.

Not always so obvious, however, are the multitude of questions, and their possible answers, that flow from the seemingly straightforward daily business of finding, catching, processing and marketing fish. Some of the larger questions are becoming clear enough in recent years, thanks largely to our failure to recognize them and seek appropriate answers to them in earlier times. *How much fish can we catch before we begin to kill the goose that lays the golden egg – the resource itself? How do we avoid catching too much fish? What are the environmental impacts of the fishing industry? What are the effects on the fishing industry of the environmental impacts of other industrial activities? How does such a dramatic upheaval as the destruction of the northern cod stock affect our society – not just our individual lives, where the effect is often starkly obvious, but our overall economy, our politics, our demographics, our culture, and so on?*

We are learning – the hard way – to ask and to come to grips with these large and difficult questions that surround and inhabit our defining industry. The answers, however, are anything but obvious, and finding them, like all such great challenges, is an endless, ongoing task. In the process we find ourselves, often adrift, on that boundless ocean wherein the devil is said to dwell – the Details. Though the problems confronting the fishing industry overall are broad and deep, their details are reflected over and over again in the particular problems facing specific sectors and localized segments of the industry throughout the province. The immediate problems facing the Eastport Peninsula Lobster Protection Committee loomed large in the lives of the fish harvesters (and the lives of their families and neighbours) who first determined that a locally organized effort was necessary to deal with particular issues that threatened their livelihood.

This curriculum supplement (including the CD of additional supplementary materials) is an attempt first and foremost to give teachers and students alike a sense of the myriad of details – problems, questions, actions, implications, arguments, mistakes, blind allies, and occasionally answers and solutions – that are encountered daily in the struggle to maintain and enhance an industry so complex, and so vital to our society. It is an attempt not so much to provide answers to questions, as to illuminate the size and complexity of the task, to prompt serious thinking about the issues, and to point a finger tentatively in some directions where answers may be found. More specifically - and very definitely - it points to one of those answers in particular: the idea, the concept, of **Responsible Fishing**.

THE DOCUMENT

The document *Responsible Fishing: A Strategy for an Improved Industry* is designed chiefly as a guide for Grade 9/10 social studies and geography teachers who wish to **introduce to students the idea of fishing responsibly** as a key strategy in our effort to maintain the fishing industry as an important productive and life-enhancing component of our province's socio-economic structure. It offers a definition of the concept of Responsible Fishing, and attempts to show some of the ways in which that concept can be translated into effective action. The document starts with a brief historical overview of the province's fishing industry.

The section on the work of the **Eastport Peninsula Lobster Protection Committee** provides a comprehensive overview of how one group of fish harvesters perceived a set of problems and set about finding solutions to those problems. Their work is far from done – and indeed never will be completed in the usual sense of the word – but the problems they faced and their attempted solutions are an excellent introduction to larger issues and larger solutions within the industry as a whole. It is important to note that their situation, and the way they are dealing with it, illustrates in particular the involvement of the communities they live in – firstly in terms of the impact of fisheries issues and problems (and solutions) on the entire community, and secondly in terms of the need for the whole community to be involved in dealing with those issues and problems.

The sections on the lumpfish and turbot fisheries introduce some of the problems inherent in the use of a particular fishing gear – the gillnet – and suggest some approaches to solving to those problems. As with the work of the Eastport Peninsula lobster fishers, the idea of fishing responsibly is highlighted.

The references section, For Your Information, cites two key documents relating to the most dramatic and disturbing of all the many calamities that have befallen our province's fishing industry over several centuries, the destruction of the northern cod stock. But the great bulk of that section is a list of internet websites which contain a vast world of information on fishing industries and related topics. Most of these references are annotated, to give a quick glimpse of the sort of information one may expect to find on each website.

THE CD

Along with the *Responsible Fishing* teacher's guide, the CD contains a set of documents, in PDF format, produced under the Environmental Awareness and Conservation Harvesting component of the federal/ provincial Fisheries Development Program. These documents are reports and summary reports of fish harvesting experiments and other activities undertaken as attempts to solve specific problems in specific fisheries. They illustrate perfectly the complexities of those problems and the gradual, incremental nature of finding solutions. If it often seems like two steps forward, one step back, that's because it is like that. The work is hard, both mentally and physically. As a rule, the problems are more or less easy to define; solutions are far more difficult to come by.

Readers of this material will note that sometimes a problem is solved, sometimes it is not. Often the results of a project are inconclusive, and further work is recommended. Sometimes what was thought to be a solution is shown to be ineffective. The one thing that can be said about all of this material is that it contributes usefully to our understanding of the industry and how to keep it healthy. Many of the reports deal with other species, other fisheries, other harvesting methods, other problems, etc., than those covered in the *Responsible Fishing* document. This material broadens the teacher's possibilities for illustrating the issues and for assigning work to students. It should also make this curriculum supplement feel more relevant to teachers and students outside the Eastport Peninsula, the chief geographic focus of *Responsible Fishing*.

The CD also contains illustrations of the fish species, fishing gears and fishing vessels common to the Newfoundland and Labrador fishing industry.

CONCLUSION

It is hoped that these materials, all drawn from the very real world, will be an interesting and sufficient source of information for teachers and students to think about, discuss, analyze and draw useful lessons from - and about – some of the realities and perplexities of the Newfoundland and Labrador fishing industry. Also they may provide inspiration, and some guidance, for those who wish to dive deeper, in high school or in post-secondary education, into the intriguing world of the fishing industry and marine studies generally. The possibilities span almost the entire spectrum of education, and are especially broad in the areas of science, environmental studies, resource management and conservation, and socio-economics.

ACKNOWLEDGEMENTS

This document and its supplementary materials - all contained on the accompanying CD - constitute a curriculum supplement designed to be used in the Newfoundland and Labrador Intermediate and Senior High School Social Studies programme.

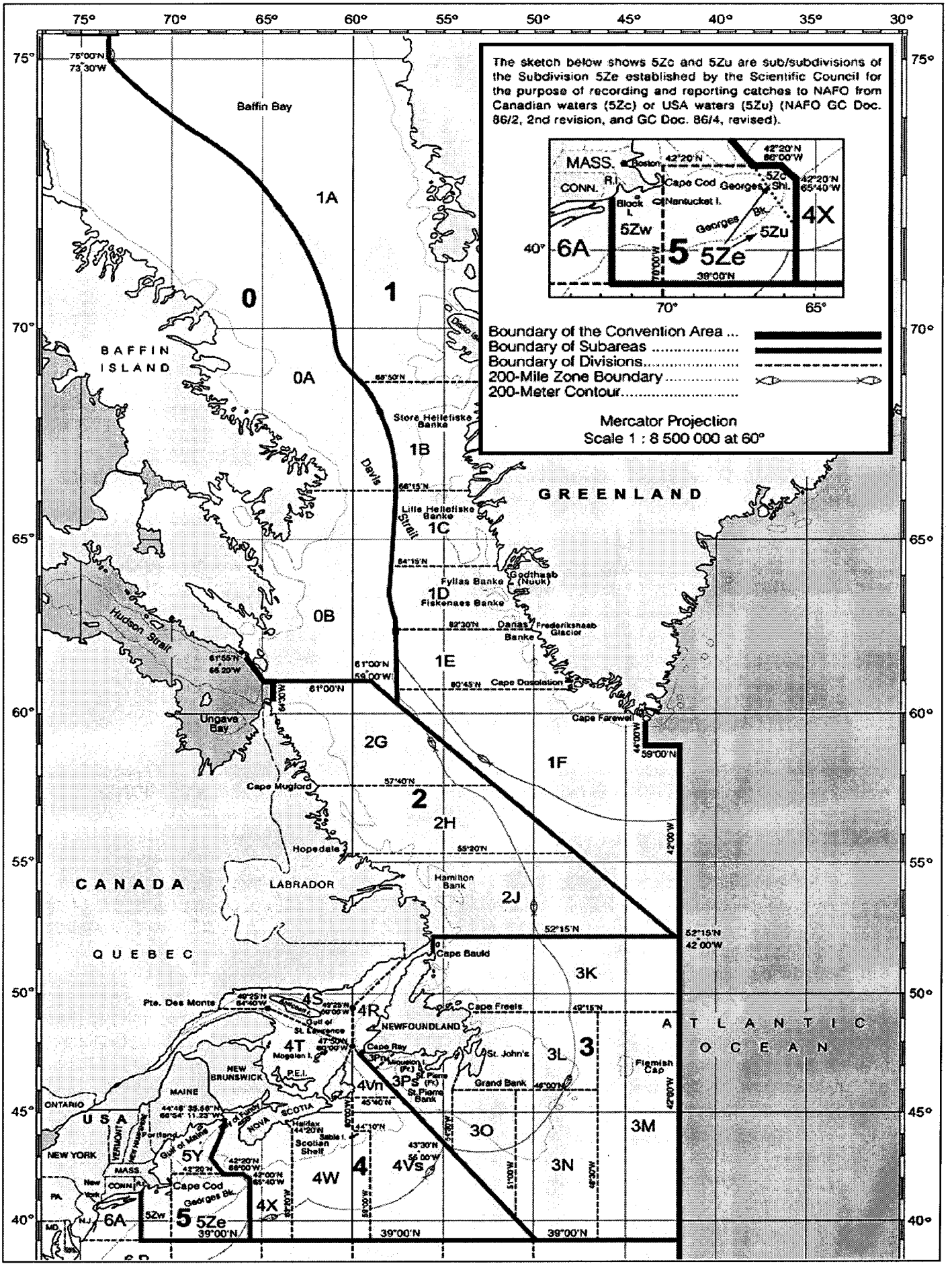
The project began as an idea of the **Eastport Peninsula Lobster Protection Committee**, under the chairmanship of George Feltham of Salvage. The committee felt that one of the best ways to promote best fishing practices in the area, immediately and for the future, was to involve local high school students. Students were taken on annual field trips to the lobster fishing grounds, to see conservation practices in action and to hear a fisheries scientist talk about lobsters and responsible fishing. In 2000, the committee proposed that a curriculum supplement focusing on the concept of Responsible Fishing be developed and introduced into the peninsula's high school studies. This curriculum supplement is the result of that proposal.

Many individuals helped bring the proposal to fruition. The role of George Feltham and the EPLPC, in initiating the project and shepherding it through its various stages of development, has been paramount. The first draft of the core document, *Responsible Fishing: A Strategy for an Improved Industry*, was written, under contract, by Doug Young, a former high school teacher at Holy Cross School, Eastport. Mr. Young also completed, as a voluntary contribution, major revisions to the document after it had been submitted to fisheries scientists, fisheries managers, industry representatives and others, for first review.

Gerry Ennis, lobster scientist with the Science, Oceans and Environment Branch, Department of Fisheries and Oceans - Newfoundland and Labrador Region, provided invaluable information and advice during the writing and review of the lobster sections of *Responsible Fishing*. (Mr. Ennis worked closely with the EPLPC in developing their lobster conservation program, and has provided indispensable assistance ever since.) DFO flatfish scientist Ray Bowering and Resource Sampling Head Dave Kulka corrected and updated the turbot and lumpfish sections. Various individuals from the fishing industry, educational institutions and government contributed suggestions, comments and corrections at various stages of the project.

Anne Manning, Intermediate Program Specialist with the Lewisporte-Gander School District, under the direction of Assistant Director of Programs Charles McCormack, and in consultation with Holy Cross School Principal Robert Hiscock, made sure the document met the pedagogical requirements for its intended use, and secured necessary approvals within the educational system. (It was Ms Manning who, upon reviewing the document, declared it suitable for use in the Grade 10 Canadian Geography 1202 course, as well as the Grade 9 Social Studies programme for which it initially had been developed.)

Most of the funding for the project was provided by the Environmental Awareness and Conservation Technology component of the federal/provincial Fisheries Development Program, under the auspices of the Atlantic Canada Opportunities Agency (ACOA). Andrew Duthie, Chief - Responsible Fishing Operations, at DFO's National Headquarters in Ottawa, enthusiastically supported the project from the beginning, providing early 'seed' funding and good advice. Gerry Brothers, Chief – Conservation Technology with DFO's Newfoundland and Labrador Region, and administrator of the EACT program, regarded this project as one of special significance, and maintained a close personal involvement from its inception to its completion. Bernard Brown, technical writer and communications officer with the EACT program, oversaw the document's three reviews and revisions and its final editing, contributed the Foreword, the To the Teacher section and the references section (For Your Information), added the extra supplementary materials included on the CD, and managed the final production of the document and the CD.



Map of the Northwest Atlantic Fisheries Organization (NAFO) Convention Area.

TO THE TEACHER

RESPONSIBLE FISHING: THE CONCEPT

The concept of Responsible Fishing has arisen from a crisis in fisheries world-wide. This crisis is a result chiefly of overexploitation of fish resources and degradation of fish habitats, in some cases exacerbated in certain regions by relatively sudden and often ill-understood natural changes in the marine environment (eg. the lowering of average ocean water temperatures off eastern Canada). The loss of sustainable yield from fish stocks and the accompanying decline or collapse of historically viable fisheries, together with significant changes in ocean bio-diversity, have led to a global search for ways to harvest, manage, conserve and protect fish resources and marine environments in a more responsible manner. In Canada, the collapse of Newfoundland and Labrador's northern cod fishery and serious declines in many of British Columbia's salmon stocks are prime examples of the problem.

TEACHING STRATEGIES

The Modules

The separate chapters of the *Responsible Fishing* handbook are meant to serve as learning modules. They are designed to provide teachers with sufficient, and sufficiently flexible, material to begin to address a variety of fisheries-related and associated topics of considerable interest, importance and relevance to students who are residents of Newfoundland and Labrador and members of an increasingly interconnected global community.

Learning Opportunities

Students may be engaged in a variety of learning opportunities to develop learning strategies and skills transferable to other topics and situations. Interviews with fish harvesters and other participants in the industry will provide various perspectives on problems and the implications of different approaches to solutions. Interviews with business owners can provide insight into the broader impact of success or failure in the fisheries. Students can research the household economic changes that accompany changes in the fishery, and assess the social impact that these changes bring about. The internet can supply comparisons with other areas and other fisheries. In such a complex field as the fishing industry, there is no limit but the imagination to the variety of active research and learning experiences available.

The case study of the Eastport Peninsula Lobster Protection Committee is an excellent example of a comprehensive look at a complex local situation, where fish harvesters perceived a set of problems and set out to develop their own solutions. The gillnetting, lumpfish and turbot overviews introduce a different harvesting technology with different problems and different possible solutions. Students can use the case study and overviews as models or stepping stones to more independent research into other specific fisheries involving other technologies, other problems and other resolutions.

Given the variety and complexity of the industry and its many unresolved issues - locally, provincially and worldwide - there is every opportunity for group work, with different members of the group tackling a specific topic from these varying perspectives, and collaborating on creating a comparative overview of a given fishery, technology, or issue. Comparative studies of how different regions or countries try to solve similar problems are another fruitful area of study. How different historical, political, cultural or economic backgrounds and conditions impact on people's approach to solving problems in the fishing industry can provide endless possibilities for research by more enterprising students. Environmental issues of one sort or another are almost always present in any perceived set of problems in the fishing industry, and will provide yet another broad area of learning activities.

The modules will provide an introduction to some of these possibilities. The supplementary materials

on the compact disk can be used to explore certain issues somewhat further. The internet can open up a vast world of national and international variations on any number of themes.

TOPICS TO BE COVERED

Using combinations of module texts in the *Responsible Fishing* handbook, information freely available from the many internet websites listed in the handbook, and the supplementary texts, photos and other illustrations contained on the accompanying compact disk, teachers should be able to address a considerable range of specific topics through this curriculum supplement. The topics listed below are suggested. These need not be considered an exclusive or complete or 'best' list; there is ample room in the subject area, and in the materials supplied, for teachers to devise specific topics of their own.

- **Responsible fishing**: An examination of the concept of responsible fishing and its implications – technological, economic, educational, political, environmental, etc. – for fish harvesters, fish processors, communities and the province as a whole.
- **Our fishing heritage**: What have been the demographic, political, cultural, economic, technological and/or environmental impacts of changes and developments in the fishing industry in our province, and on different areas within the province, at different times throughout our history? What is our present heritage as a result of those impacts?
- **The fishery and economics**: An examination of the importance of the fishing industry in Newfoundland and Labrador to personal, community, regional and the provincial economies.
- **Fish and fish habitats**: There are many fish species. While several may inhabit the same general area of the ocean, they will use and relate to - and be affected by changes in - that area in various ways.
- **Fish harvesting methods and technologies**: The different species of fish harvested commercially, and the different ocean environments in which they are harvested, require more or less different (in many cases very different) fishing methods and fishing vessels, gears and other technologies.
- **Conservation and management**: How do we harvest, manage, conserve and protect fish resources and fish habitats? How have we done it in the past? How should we do it in the future?
- **Case study – the Eastport Peninsula Lobster Protection Committee**: A detailed look at a real-life, ongoing effort by a group of fish harvesters to apply the concept of responsible fishing to their industry locally – its origins, the difficulties of getting it right and keeping it going, and its direct and indirect effects on the resource, environment, people and communities concerned.
- **Gillnet fishing**: The gillnet is a very efficient fishing gear, but has also become a very controversial one. Why, and what is to be done about it?
- **Careers**: Although this curriculum supplement does not directly address the subject of careers available in the fishing industry and related fields of endeavour, the materials provided may readily be used to examine the multiplicity of such career choices, and the various educational levels required to pursue them.

GOALS TO SHOOT FOR

The Department of Education's Program of Studies establishes a hierarchy of goals within the K - 12 secondary school system. At the top are the six ESSENTIAL GRADUATION LEARNINGS, the broad, fundamental understandings, skills and attitudes that students should leave high school with. They are: Aesthetic Expression - Citizenship - Communication - Personal Development - Problem Solving - Technological Competence.

These are achieved through a set of GENERAL CURRICULUM OUTCOMES, the fundamental lessons to be learned, during the different stages in the Primary to Senior High School progression, in each of six basic fields of conceptual competence: Citizenship, Power and Governance - Culture and Diversity - Individuals, Societies and Economic Decisions - Interdependence - People, Place and Environment - Time, Continuity and Change.

For each of the four end-stages of secondary school study – Grades 3, 6, 9 and 12 - the General Curriculum Outcomes are expressed as KEY-STAGE CURRICULUM OUTCOMES. These are the still basic but more specific competencies that students should have achieved in each of the six GCO's at the ends of those four stages.

Underlying the entire goals structure are the sets of SPECIFIC LEARNING OUTCOMES expected from specific programs and courses of study.

The fishing industry offers such a complex and wide-ranging field of study, and the concept of responsible fishing so thoroughly encompasses every aspect of the industry, that a particularly enterprising teacher could use the Responsible Fishing curriculum supplement as a starting point to teach lessons - produce learning outcomes - appropriate to almost the entire breadth and depth of this hierarchy of goals. However, the supplement can most readily be directed toward a particular number of those goals. The following, taken from both the Intermediate and Senior High lists, would seem to be most apposite:

- **Essential Graduation Learnings**
  CITIZENSHIP: Graduates will be expected to assess social, cultural, economic and environmental interdependence in a local and global context . . . to
  - demonstrate understandings of sustainable development and its implications for the environment.

- **General Curriculum Outcomes &**
  Key-Stage Curriculum Outcomes
  INTERDEPENDENCE: Students will be expected to demonstrate an understanding of the interdependent relationship among individuals, societies, and the environment – locally, nationally, and globally – and the implications for a sustainable future . . . to
  - explain the complexity that arises from the interdependent nature of relationships among the individuals, nations, human organizations and natural systems.
  - explain how values and perspectives influence interactions among people, technology, and the environment.
  - analyse selected issues to illustrate the interdependence among society, the economy, and the environment.
  - evaluate current technological developments and their potential impact on society and the environment.
  - articulate and justify a personal vision of a sustainable future.

  PEOPLE, PLACE AND ENVIRONMENT: Students will be expected to demonstrate an understanding of the interactions among people, places and the environment . . . to
  - analyse the influences of human and physical systems on the development of distinctive characteristics of place.
  - analyse ways in which social, political, economic, and cultural systems develop in response to the physical environment.
  - evaluate issues concerning the diversity and sustainability of Earth's ecosystems.
  - analyse the interactions within and between regions.
  - analyse the causes and consequences of human modification of the environment on systems within the environment.
  - evaluate the role of perspective, power, and authority in the use of and development of policies to manage Earth's resources.

- **Specific Learning Outcomes**
  GRADE NINE SOCIAL STUDIES:
  1.4 Link human activity to the natural resources of the Atlantic region.

2.3 Demonstrate an understanding of the local and global factors that have shaped the culture(s) of Atlantic Canada.
2.6 Demonstrate an understanding of and appreciation for the link between culture and occupations/lifestyles in Atlantic Canada.
3.1 Examine and explain the role that basic economic principles play in daily life.
3.4 Examine and explain the contribution of the primary, secondary, tertiary, and quartenary sectors of the economy of Atlantic Canada.
4.2 Examine and describe the historical application of technology in the Atlantic region.
4.3 Demonstrate an understanding of how technology has affected employment and the standard of living in Atlantic Canada.
4.6 Analyse the effect of technology on resource industries in Atlantic Canada.
5.3 Assess the individual qualities and attributes Atlantic Canadians need to become contributing members of the global community.
CANADIAN GEOGRAPHY 1202: Students will . . .
1.5 Reflect upon selected human responses to land and water forms.
3.4 Value the need for Canadians to be responsive to the fragile nature of the ecosystem.
5.1 Identify selected features of commercial fish habitats.
5.2 Examine selected activities associated with the harvesting of the fish resource.
5.3 Reflect upon issues related to a sustainable fishery.
5.4 Demonstrate an understanding that the future well-being of Atlantic Canada involves cooperation with the national and global communities.

- **Goals for the Module**

The developers of the Responsible Fisheries curriculum supplement have also identified the following set of goals specific to the supplement itself and to Newfoundland communities where the supplement might be used. Students should learn to . . .

- Appreciate the importance of the fishing industry to the viability of coastal communities and to the overall economy of Newfoundland and Labrador.
- Develop awareness of the issues affecting the viability of the fishing industry, and of the processes available to address those issues.
- Increase their knowledge of procedures and practices being implemented at international, national, provincial and local levels to ensure that fish harvesting is conducted in a manner which maintains the sustainability of fish resources.
- Appreciate the interdependence of people and their activities and the environments in which they live and work, and understand the necessity of a healthy environment to healthy communities and economies.
- Develop awareness of career opportunities within the fishery and related industrial, commercial and academic activities (eg. commercial fish harvester, aquaculturist, fisheries or marine biologist, marine resource manager, enforcement officer, gear technologist, naval architect, shipbuilder).

- **Topic for Discussion**

There is an endless number of topics for discussion where the fishing industry is concerned. One seems especially fruitful, however. There is almost universal condemnation of DFO's decision to close cod fisheries in 2003. Discuss this reaction in light of events in he cod fishery in the past 40 years.

PAST ... PRESENT ... FUTURE

OUR FISHING HERITAGE

"Since John Cabot (known as Giovanni Caboto in Italy) discovered Newfoundland in 1497, fishing peoples from Europe have exploited the rich cod-fishing grounds of Newfoundland and Labrador's frigid waters."

Early Beginnings

Fish brought Europeans to Newfoundland, fish dictated the pattern of their settlement, and the catching, salting, drying and marketing of fish laid down the forms and structures of the society they built. For two hundred years the fishery was carried on mainly as a seasonal enterprise from ports on the other side of the Atlantic, but as conditions of market and competition changed, it became advantageous for Great Britain to have a fishery based in Newfoundland. By the middle of the last century, Newfoundland had a resident population of over 100,000, and an apparently secure position as the world's largest exporter of salt codfish. (Memorial University of Newfoundland and the C. R. B. Foundation, 1997).

In the past 100 years, the Newfoundland and Labrador fishing industry has gone from a predominantly salt cod trade to a fresh and fresh frozen multispecies industry. At the turn of the last century, cod was the primary species harvested. The production of salt cod was largely a role filled by women and children. At the outbreak of World War I, approximately 40,000 fishermen secured a form of livelihood from the fishery. Economic conditions of the 1920's and 1930's gave way to low prices for salt cod. This resulted in economic hardship for much of the population, few alternative employment opportunities and significant outmigration.

The outbreak of World War II and subsequent years restored an element of prosperity to the fishing industry. The period saw the gradual evolution of commercial enterprises dedicated to the large scale salting and drying of fish. Alternative employment opportunities increased throughout the post-war period and employment in the fishery declined to under 20,000.

The entry of Newfoundland and Labrador in 1949 into the mainstream of North America resulted in the application of new technology within the industry, and an opportunity to provide a new type of fish product to a new and much enlarged marketplace. The industry continued to produce salt cod together with fresh and frozen fish products that would eventually dominate all other forms of production.

The Rise of the Modern Offshore Fishery

This appetite for fresh fish also resulted in the introduction of new harvesting technologies in the predominant inshore sector and the creation of large processing facilities dependent on an offshore trawler fleet for its supply of raw material. Foreign offshore trawlers, however, decimated fish stocks with uncontrolled and unregulated fishing on the Continental Shelf. Unknown at the time, this disastrous overexploitation would have a devastating impact on cod and other groundfish stocks from which most have still not fully recovered. (Groundfish are fish that generally feed and dwell at or near the sea bottom. They include cod, haddock, hake, redfish, lumpfish and the various flatfishes - halibut, turbot, witch flounder, yellowtail flounder, winter flounder and American plaice.)

The total **recorded** cod landings by foreign and Canadian vessels, inshore and offshore, in eastern Canadian waters peaked in 1968 at the astounding level of approximately **810,000 metric tonnes (810,000,000 kg, or 1,785,745,000 lbs)**. No one knows how much more was caught and subsequently discarded as small or spoiled, and how much was landed but not recorded. The total catch that year may well have approached a million tonnes.

Well over a third of this now unimaginable quantity of codfish came from the 'motherlode' of spawning northern cod on the Hamilton Bank, off eastern Labrador, where the Europeans had learned how to fish amid the winter ice while the cod gathered in their hundreds of millions to reproduce. The Grand Bank and lesser fishing banks from the northeastern US and Nova Scotia to northern Labrador likewise saw huge concentrations of freezer trawlers, as well as more traditional offshore fishing vessels, during those years. Author William Warner, in his book *Distant Water: The Fate of the North Atlantic Fisherman*, describes flying at night over fishing fleets that looked like "small cities".

Soon inshore fishermen began to complain of declining catches, and of having to set more and more gear, and to fish longer seasons, to catch the same amount of fish they had landed in earlier times. Table 1 gives an idea of what was happening (though an inadequate idea, since this is Newfoundland landings only, and includes offshore as well as inshore).

The 200 Mile Limit (and Its Failure?)

In 1977, a 200 mile economic zone was established off Canada's shores, encompassing almost all of the country's most productive fishing banks. Over the next few years the huge foreign fleets largely disappeared from Canadian waters, only to be replaced by a much smaller but much more efficient Canadian offshore fleet. The result in Newfoundland and Labrador was a period of unprecedented expansion in the fishery.

Optimistic estimates of resource availability pushed expansion in both the processing and harvesting sectors. After the frighteningly low catches experienced in the early and mid-1970's, cod and other groundfish landings gradually improved following the introduction of the 200-mile limit. Cod landings in Newfoundland and Labrador climbed to as high as 150,000 tonnes in 1982 (Table 1), and it was thought that the cod stocks, in particular the famous northern cod stock, were recovering. Fisheries scientists eventually concluded that indeed there had been a slight increase in the stocks from the devastation of the 1960's and 70's

After 1982, however, landings started to decline again, slowly but surely. A brief increase in the late 1980's may have given false hope to some. That hope was soon dashed. The decline resumed and deepened, until in 1992 the inevitable was recognized and a fishing moratorium was announced on the once great Northern cod stock. Moratoria on other groundfish stocks were quick to follow. Some groundfish stocks have since recovered (eg. yellowtail flounder on the southern Grand Banks), but others are still struggling, and the great cornerstone resource – the cod – shows little or no sign of coming back. On May 2, 2002, the northern cod was officially declared an endangered species, by the Committee on the Status of Endangered Wildlife in Canada.

Since 1992, the industry has become tremendously dependent on shellfish. Shellfish landings have increased enormously, giving rise to questions as to whether current rates of exploitation can be sustained. Snow crab currently accounts for about half the total landed value of the fishing industry of Newfoundland and Labrador. (Table 4) Shrimp, another high-value species, has become even more important than crab in some areas of the province, though it is second in total value in the industry overall. Lobster, while it is fished in much smaller quantities, is found throughout most areas of the province, and ranks number one in terms of value per tonne of landed product. (On the other hand, lobster provides relatively little value in terms of secondary processing, since by far most of it is sold live to fish brokers, retail outlets and individuals.

FISHING AND THE ECONOMY

Dramatic Change

The province's fishing industry experienced a dramatic transformation over the past decade. Although the groundfish stocks had collapsed, the shellfish industry expanded, and because shellfish are so much more valuable, pound for pound, by the mid-1990's the overall value of the Newfoundland and Labrador fishing industry was higher than ever. What groundfish was still being caught had also increased considerably in price, as the market responded to a scarcity of product.

At the beginning of the groundfish moratorium strenuous efforts were made to reduce the numbers of fish harvesters. The cry was that "there are too many fishermen chasing too few fish." People with part-time fishing licences – people who made most of their living from other jobs – were all but eliminated from the industry. Many fishermen were persuaded to sell back their licences to the government, and their boats and gear to others in the industry. The category of 'Core' fisherman was created. This was a person who could own a multi-species licence, and operate as the head of a 'fishing enterprise'.

Table 1: Cod landings (in metric tonnes) and landed values in Newfoundland and Labrador, 1969-1992

Year	Landings (tonnes)	Value (M $)	Value/t ($)
1969	89,600	11.462	128
1970	76,600	11.427	149
1971	69,900	23.555	337
1972	58,000	13.023	224
1973	79,600	15.351	193
1974	41,700	15.032	361
1975	38,800	14.821	382
1976	59,800	25.515	410
1977	71,000	34.502	486
1978	86,400	47.472	550
1979	108,200	63.846	590
1980	125,000	80.813	646
1981	122,700	83.496	681
1982	150,800	101.156	671
1983	147,500	100.310	680
1984	137,900	93.975	682
1985	135,300	91.666	677
1986	141,300	107.200	759
1987	140,200	169.486	1,209
1988	148,200	136.371	920
1989	131,000	119.943	915
1990	122,800	134.600	1,096
1991	89,700	111.192	1,240
1992	37,500	50.472	1,346

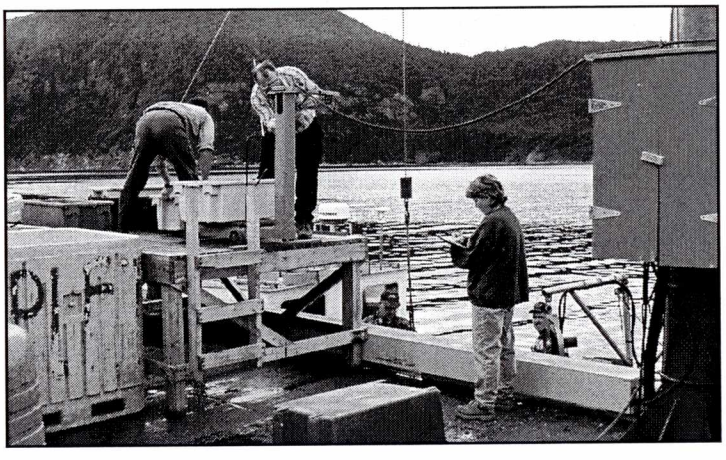
(Landings figures rounded to '00.) Look what happened to the per-tonne value of cod as the marketplace responded to the declining supply.)

However, a Core fisherman needs a crew to operate his vessels and gear. The number of fulltime fish harvesters has not significantly declined, and there are still many small-boat one and two-person enterprises operating on a few single-species licences such as lobster and snow crab.

The pressure from fishermen to maintain a livelihood in their traditional industry – and, perhaps more importantly, to preserve the communities their families have lived in for generations – has led to fierce resistance to the cutting of quotas (eg. crab in 2002, cod in 2003) and equally fierce pressure for the granting of more and more licences in the lucrative snow crab fishery. In 2003 a large number of small-boat fishermen who had fished crab for years on annually renewable 'permits' succeeded in finally having DFO turn those permits into permanent fishing licences.

It is in these sorts of pressures, and their implications for the sustainability of fisheries and fish stocks, that we most clearly see the conflicts that arise between individuals (and their communities) and the government agencies whose responsibility it is to exercise overall control over fishing efforts. It is in this context that the concept of responsible fishing becomes vital to the long-term survival of the industry – and at the same time faces some of its greatest challenges.

Tables 1 to 5 supply some basic statistical information about the province's fishing industry today and in the recent past.



Dockside monitor recording snow crab landings.

Table 2: Total landings, total landed values, and value per tonne, in the Newfoundland and Labrador fishing industry, 1988-2000.

Year	Landings (tonnes)	Value (M $)	Value/t ($)
1988	561,200	292.046	520
1989	522,000	266.359	510
1990	545,400	279.474	512
1991	424,800	261.973	616
1992	285,600	199.177	697
1993	247,600	209.112	844
1994	138,200	225.340	1,630
1995	138,600	345.818	2,494
1996	195,300	289.759	1,483
1997	220,300	325.530	1,477
1998	262,100	377.261	1,439
1999	276,500	533.044	1,928
2000	273,200	581.348	2,127

Note the steep decline in landings during 1988-95, as cod and then other groundfish fisheries were shut down, than a gradual increase as shellfish landings grew. Value per tonne grew steadily (with a huge bump from other market forces in 1994-95).

Table 3: Landings and landed values - groundfish, pelagics, molluscs, crustaceans – Newfoundland and Labrador, 2000-2002.

Species	2000	2001	2002
Groundfish			
Landings (t)	68,850	67,233	16,272
Value (M $)	74.548	68.233	15.565
Pelagics			
Landings (t)	11,106	45,506	3,465
Value (M $)	11.934	9.898	0.557
G + P (t)	*79,956*	*112,739*	*19,737*
G + P (M $)	*86.841*	*78.131*	*16.122*
Molluscs			
Landings (t)	20,531	16,075	6,876
Value (M $)	18.714	14.927	5.479
Crustaceans			
Landings (t)	142,563	136,233	64,660
Value (M $)	472.234	417.557	182.758
M + C (t)	*163,094*	*152,308*	*71,536*
M + C (M $)	*490.948*	*432.484*	*188,237*
TOTAL (t)	243,050	265,047	91,273
TOTAL (M $)	577.789	510.615	204.359

2002 was not a good year for the Newfoundland and Labrador fishing industry. Find out which individual species suffered huge drops in landings

The Processing Sector

The provincial Department of Fisheries and Aquaculture is responsible for issuing fish processing licences. There are four main types of licences:

1. **Primary processing lincence**: These plants produce fish products classified as being filletted, split, salted, whole or fresh. There are two sub-categories of primary plant, Core and non-Core.
   - Core plant – a multi-species processing operation permitted to handle all species except for snow crab and shrimp (unless there was previous approval for these species). Core plants have the flexibility to diversify their production strategies to encompass different developing or under-utilized species. Besides being issued a licence directly, a company can acquire Core status through licence transfers from other firms until it reaches a production capacity threshold of 1,000 tonnes.
   - Non-Core plant – a processing operation which retains whatever species licences it had prior to the implementation of the new licensing policy establishing the two categories of primary plant. A non-Core licence-holder cannot add new species, and can only acquire additional species licences by purchasing other processing facilities and requesting licence transfers.

2. **Secondary processing licence**: Allows processors to add value to fish by transforming its taste and/or texture by adding ingredients (other than salt and water), and by applying a treatment, such as smoking.

3. **Aquaculture processing licence**: Allows licence-holder to process and/or market fish sourced only from aquaculture sites licensed under the Aquaculture Act.

4. **In-province retail licence**: Allows the licence-holder to market fresh fish products to local consumers within the province, either directly or through retail establishments such as restaurants or supermarkets.

5. **Buyers licence**: A licence to purchase fish directly from fishermen (usually for re-sale to fish processors).

Table 4: Fish processing licences by type, Newfoundland and Labrador, for selected years from 1988 to 2002.

Licence type	1988	1992	1996	1999	2000	2002
Primary	214	193	197	126	125	122
- Core	---	---	---	62	64	65
- Non-Core	---	---	---	65	60	57
- Groundfish[1]	177	174	144	---	---	---
- Crab[2]	18	19	22	19	18	40
- Shrimp	---	2	---	10	11	15
Secondary	11	11	25	10	9	13
Retail	---	15	15	16	14	18
Buyer's licence	---	400	135	59	58	48
Aquaculture	---	---	6	6	5	6

[1] *The category of Groundfish licence was discontinued when the province restructured the processing sector after the collapse of groundfish stocks so drastically reduced the supply of raw material.*
[2] *Only certain primary plants are licensed to process snow crab and/or shrimp. These may be crab-only or shrimp-only, or they may combine the crab and/or shrimp with other species. There is a certain amount of overlap, therefore, in these numbers. Among the 40 crab plants licensed in 2002 were 5 licensed to turn out value-added product.*

Note the disappearance of groundfish-only licences after 1996. What happened? What policies are at work here? What happened to all the buyers during 1992-96? (Not much. Buyers licences used to be issued to all processors. In a move to streamline the licensing system, the province decided that a licence to process was also a licence to buy, and a host of buyers licences just dropped off the books.) Where are those fish plants located? How many people do they employ, and for what lengths of time? This is another table that can generate a great deal of interesting research for students.

In 1999, the total value of fish landings was over $500 million. The production/market value was a record one billion dollars. Peak employment in the processing sector before the groundfish collapse was around 25,000 people (the great bulk of whom were seasonal workers.) In 1996, peak employment was around 16,700. On a per-unit basis the industry has had a much higher average value in recent years than in the past, reflecting market forces (especially rising prices in reaction to growing scarcity of product) and product mix.

As Table 5 indicates, the processing sector has been dramatically restructured since the collapse of groundfish stocks, in an attempt to maintain viable plants in strategic locations throughout the province. Groundfish-only processing licences have been discontinued, and the number of primary licences has been almost cut in half as small plants were forced to close for want of raw material. The number of plants licensed to process snow crab only was held more or less constant (in spite of increased landings) until 2000, then suddenly doubled There was also a rapid increase in plants processing shrimp, as that fishery suddenly took off in the late 1990's. Secondary licences peaked in 1996, then dropped to former levels as smaller plants were forced to close or were absorbed by larger firms.

The Government of Newfoundland and Labrador, through its processor licensing policies, exercises considerable control over the structure of the province's fish processing industry. The so-called 'free market' does not have a completely free hand in this area here. This might be a particularly interesting area for research, discussion and debate. What are the economic, social, demographic and political motivations and implications that underlie and flow from the province's fish plant licensing policies?

Table 5: Landings and landed values by individual species, Newfoundland and Labrador, 2000.

Species (ranked by landed value)	Landed value $ (to '000)	rank	Landings tonnes	rank	Value/t $	rank
Molluscs & crustaceans						
Snow crab	262,585,000	1	55,400	2	4,740	2
Northern shrimp	168,000,000	2	76,600	1	2,193	3
Lobster	18,640,000	3	1,780	5	10,471	1
Softshell clams	13,849,000	4	14,660	3	945	7
Icelandic scallops	4,251,000	5	2,660	4	1,598	4
Quahogs	1,421,000	6	1,780	5	798	9
Sea Urchin	1,242,000	7	800	7	1,553	5
Other crabs	686,000	8	830	6	827	8
Squid	311,000	9	800	7	389	12
Whelks	271,000	10	470	8	577	11
Sea scallops	33,000	11	29	9	1,320	6
Other	2,000	12	3	10	667	10
All	471,292,000		155,808		3,025	
Pelagics & groundfish						
Cod	51,049,000	1	31,000	1	1,647	3
Turbot	23,346,000	2	14,570	2	160	13
Flounders	9,689,000	3	12,800	3	757	6
Lumpfish (roe)	3,936,000	4	1,590	5	2,475	2
Redfish	3,727,000	5	6,060	4	615	7
Halibut	1,598,000	6	265	10	6,030	1
Pollock	527,000	7	960	7	549	8
Skate	436,000	8	1,510	6	289	11
Hake	258,000	9	560	9	461	9
Monkfish	195,000	10	140	13	1,395	4
Haddock	165,000	11	180	12	917	5
Other	161,000	12	590	8	273	12
Grenadier	99,000	13	220	11	450	10
All	95,187,000		70,445		1,351	

This is a fascinating set of numbers, starting with total shellfish landings more than double the groundfish, a situation that would have seemed laughable 15 years ago. Look at how the rankings change between landed values, landings and value per tonne. Among the shellfish, only two species are worth more per tonne than the average of $3,025, thanks to the huge per-tonne value of the mighty lobster. No wonder the fishermen of the Eastport Peninsula are so concerned about their lobster resource. (It would be interesting, however, to get figures on the value of different species to the overall economy of the province. Some species produce large earnings through processing, others do not - and lobster is one of those that do not.) Note that the top five groundfish in landed values are also the top five in landings, but turbot maintains its number 2 position only by being so large in quantity; its value per tonne is lowest of all. Explore this table for other interesting comparisons. Do rankings of all the species combined. Seek out information on value generated by processing operations, and see how the different species rank against one another then. Who ever thought the lowly sea urchin would one day be more valuable (both overall and per tonne) than the sea scallop? How long can the sea urchin resource sustain those landings? This one table can generate enough research questions to keep a class going for a full year.

Aquaculture

The aquaculture industry traces its roots back to the late 1800's with the establishment of cod and lobster hatcheries around the province. In the 1980s there was a rebirth of aquaculture with the development of blue mussel, rainbow/steelhead trout and Atlantic salmon farming. A slightly different form of aquaculture that has developed in Newfoundland is the capture of cod, to be held in 'grow-out' pens and fed until they are ready for market.

Mussels, salmonids and cod are the commercial side of aquaculture in the province. There is also a significant ongoing research effort in various aspects of aquaculture involving a much wider range of species, including halibut, sea urchins, eels, scallops, arctic charr, soft shell clams, the American oyster, yellowtail flounder and wolffish.

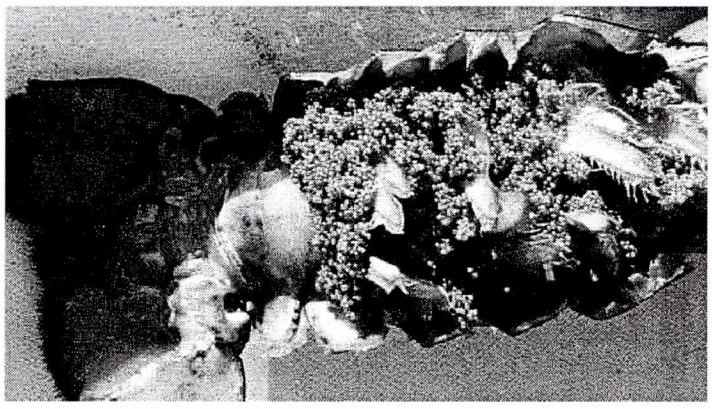
The Newfoundland Aquaculture Industry Association (NAIA) website provides an overview of the species being farmed in Newfoundland, including information on reproduction, life cycles, feeding habits, growing techniques, farming areas and related research.

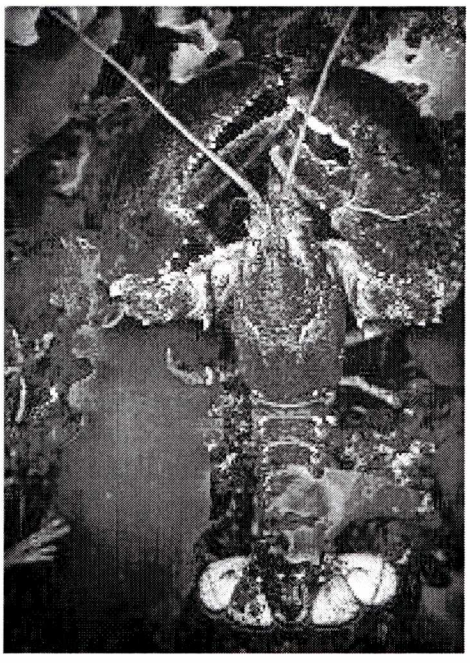
There are 25 mussel farmers in the province, five significantly larger than the others, nearly all operating at several growing sites. There are five salmon and steelhead (seagoing rainbow) trout farms; most of these also operate a number of different growing sites. The cod grow-out business seems to have received a serious blow with the recent closure of all cod fishing along the northeast and west coasts. These operations depended on being able to catch wild cod, chiefly smaller ones, to hold in their pens for fattening. They can now no longer do this, and it appears that cod farming will be limited to the five or six operations currently found in Placentia Bay, unless new ones start up on the south coast.

There are no true cod aquaculture operations – that is, sites where the cod are actually grown from the eggs, as with mussel and salmonid farming. However, that situation may change this year or next (2003-04). A firm called North Atlantic Seafarms is planning to open full-scale cod farming operation in the Bay Roberts area within the next 12 months

Harvesting cultured blue mussels in Green Bay.

Life Cycle of a Lobster





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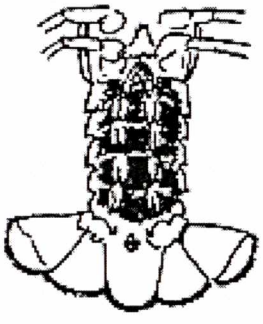
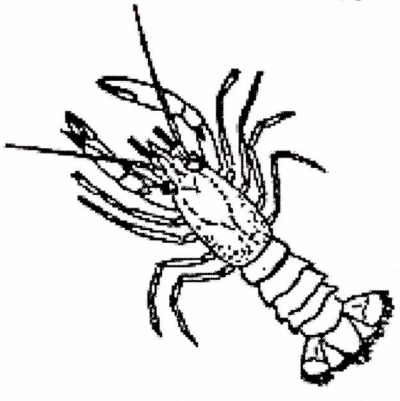


1. Eggs on female abdomen
2. Embryo
3. &
4. Newly hatched larva
5. Stage I (8 mm at 10 days)
6. Stage II (9 mm at 11 days)
7. Stage III (11 mm at 15 days)
8. Stage IV (14.6 mm at 32 days)
9. Juvenile
10. Adult

10

9



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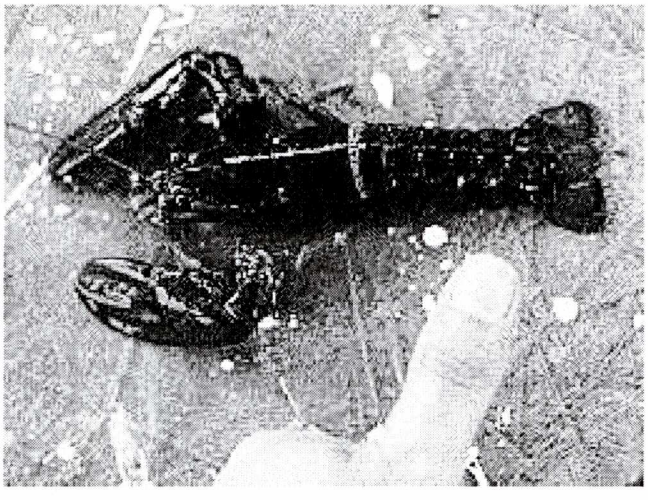

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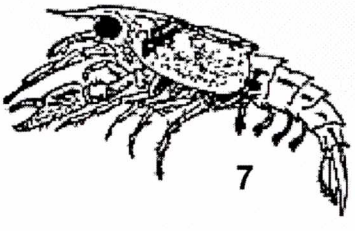

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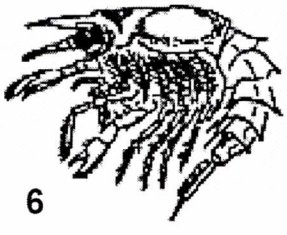

6

RESPONSIBLE FISHING

MANAGING RESOURCES

What are Resources?

Resources are things used by people to meet their social and economic needs and wants. In industrial terms, people themselves are a resource (labour). A resource such as fish is the raw material for fillets, tinned fish, oils and other products processed from the whole fish. A critical characteristic is whether or not it is renewable. If the resource that is being exploited is not likely to be replenished in the foreseeable future, it is considered to be a *non-renewable resource*. Some examples of non-renewable resources include minerals and oil. The circumstances which created these resources are not likely to be duplicated in anyone's lifetime, so once they have been consumed they are no longer available. New sources have to be discovered, or the supply will no longer exist. If a resource can be replenished, it is called a *renewable resource*. Trees and fish are examples of renewable resources. However, whether the renewal or replenishment of any such resources actually occurs and is sustained over time, depends largely on two things – the method and rate of exploitation, and the success of any active attempts at protection, conservation and renewal.

Managing Resources for the Future

In order for a renewable resource to be replenished, it must be properly managed. Measures must be taken to ensure that the supply of that resource will be available for future harvesting. In the case of forestry, that means planting new trees so that nature gets a helping hand to ensure that there will be a new supply of trees to meet the needs of future generations. It also means that a cutting plan is created that does not result in all the trees being cut in a short period of time, which could lead to long periods of inactivity in the industry while new trees are growing. (It should also be noted that the improper or careless harvesting of one resource can have serious consequences for other resources. For example, poor management of cutting and transportation of trees can lead to severe soil erosion, flooding, and serious damage to rivers, streams and lakes – and to the fish stocks which inhabit them - through silting, loss of shade cover and extreme seasonal variation in water levels.

It is much more difficult to replenish or re-create damaged or destroyed fish stocks, ***even if we stop commercial exploitation altogether***. Once the fine ecological balance has been seriously altered, especially the ocean's extremely complex predator-prey relationships – the food chain – there is no guarantee that the part that has been weakened or removed will ever come back to its former position or numbers within the system. In 1992, a moratorium on commercial cod fishing was announced. Both the scientific evidence and rapidly falling catch rates indicated that the biomass of cod was so depleted that commercial fishing efforts could no longer be sustained without totally destroying the resource. More than a decade later there is little sign that the cod stocks are recovering. Indeed, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has officially listed the northern cod as "endangered" (Friday, May 2, 2003). The designation is defined by the Committee as "a species facing imminent extirpation or extinction"; it is the last listing before outright disappearance. (COSEWIC is a scientific committee to which Canada has given the responsibility of determining how healthy are Canada's various populations of wildlife: animals, birds and fish.)

THE NATURE OF RESPONSIBLE FISHING

Responsible fishing can be described as:

The conduct of fish harvesting – using fishing gear and fishing methods, and quantitative catch limits – such that the fish stock(s) being harvested will be conserved and the fishery sustained indefinitely, and other fish stocks, other marine life, fish habitats and the marine environment generally will not be unduly damaged.

This requires of fishermen an attitude of respect for resources and the environment, and an awareness that responsible fishing techniques have significant benefits for fish stocks and the marine environment – and therefore significant benefits as well for individuals, the fishing industry, communities and the economy as a whole.

This definition touches on a number of significant attitudes, behaviours and ideas that are examined in this curriculum supplement. As the description suggests, these include:

- Fishing gears, fishing methods and fishing practices
- Behaviours of individuals
- Vulnerability of fish stocks
- Complexity of the marine environment
- Responsibility and self-discipline in the fishing industry
- Cooperation within and among communities
- Interdependence of economic and social activities
- The role of government in resource management.

The material in the *Responsible Fishing* handbook and the supplementary materials on the accompanying CD should allow teachers and students to examine all of these more or less closely, to assess their importance in our lives, and to examine our individual and collective success in managing both their positive and their negative implications.

The principles applied to responsible fishing are an example of *stewardship*. According to the Merriam-Webster Online Dictionary (**http://www.m_w.com/cgi_bin/dictionary**) stewardship is defined as:

the conducting, supervising, or managing of something; especially: the careful and responsible management of something entrusted to one's care – eg. stewardship of our natural resources.

THE IMPORTANCE OF RESPONSIBLE FISHING

Conservation and Management

The concept of Responsible Fishing in Canada arose as one of the most important responses to serious resource problems within Canada's fishing industry. The decline of the groundfish stocks in Atlantic Canada and the critical problems affecting conservation and sustainability in the Pacific salmon fisheries are serious issues for all Canadians. Concerns about stocks go beyond our national borders, extending into all the world's fisheries. The Food and Agriculture Organization (FAO) of the United Nations stated in their 1995 report that "about 70 per cent of the world's marine fish stocks are full to heavily exploited, over-exploited, depleted or slowly recovering." There is a critical need for effective conservation and management measures to rebuild stocks.

Both industry and government recognize the need for changes in the management and operation of all fisheries, whether for recovering fish stocks, healthy resources or newly developed commercial fisheries, and a shift in attitude and responsibilities is underway.

The evolution of cooperative management and the introduction of responsible fishing activities in Canada address sustainable exploitation of the resource, protection of the habitat and resource, and shared responsibility for management of the resource. Industry leaders, governments, and fishermen from all vessel sectors must be active participants in the development and promotion of responsible fishing.

A commitment to responsible fishing is an active response to immediate and long-term conservation issues in the fishing industry. It rests on the recognition that fish and fish habitats are resources that are able to be

destroyed, and must be protected and managed to ensure that short-term exploitation does not exceed, and therefore does not prevent, long-term sustainable harvests.

(In light of the foregoing, students might wish to discuss the reaction of Newfoundland fishermen in the spring of 2003 to the Government of Canada's decision, based on the advice of its scientists, to close the province's last remaining cod fisheries, including the so-called 'recreational' fishery. What are some of the – often conflicting - historical, political, social and economic factors that underlie that reaction? What are the implications for the concept of Responsible Fishing?)

CONSERVATION OBJECTIVES

The first requirement for achieving sustainable fisheries is to limit catches to sustainable levels by means of effort and quota controls, and to minimize adverse practices such as discarding undesired catches. Optimizing the conservation aspects of harvesting gear and operations, however, is also an important requirement for conserving fisheries resources and protecting the marine environment as a whole.

Increases in harvesting capacity and advances in fishing technology have contributed to the decline of many fish stocks around the world. At the same time, however, technology has also been used to help conserve fisheries stocks. These applications of technology for conservation purposes has resulted in more accurate stock assessments, improved sea and air surveillance of fishing activities, and improved selectivity capabilities in fishing gear.

Although a wide variety of fishing gears and vessels are used in the groundfish, pelagic and shellfish fisheries of Canada, certain conservation characteristics are common to all harvesting methods. These are the characteristics that fisheries managers try to control and that gear designers try to improve. New gear developments are usually focused on improving one or several of the following list of characteristics, but the overall impact of the gear and of conservation devices in general has to be considered.

a. **Size selectivity** – The capacity of a fishing gear to retain a certain size range of fish and to let smaller or larger sizes escape. It is an important part of fisheries management, since the future of any stock is influenced by the size and maturity of the fish that are captured. Size-selective harvesting can be used to maximize the long-term yield from a resource.
b. **Species selectivity** - The capacity of a gear to catch targeted species while minimizing the bycatch of other species. This is especially important in quota management systems. Using gear that is both size- and species-selective reduces the destructive practice of discarding catches of fish that are small, prohibited or otherwise undesirable.
c. **Limiting catches** - Having the ability to control the volume of catches is an important characteristic of fishing gear. This assists fishers to stay within quotas or trip limits, and thereby minimizes the motivation for adverse practices such as discarding or illegal landings. Limiting catches to levels that can be readily handled and stowed onboard also promotes improved product quality and best use of the resource.
d. **Controlling gear losses and unintended fishing** – Every year, significant quantities of fishing gear are lost, for various reasons but especially because of adverse weather and environmental conditions. Besides contributing to the oceans' garbage collection, lost gear will entrap and kill various marine species. The most notorious and possibly the most destructive of 'ghost-fishing' gear is lost gillnets.
e. **Best use of the resource** – Maximizing the quality and the economic value of the fish that is landed. Some adverse quality effects may be due to the intrinsic characteristics of the gear being used. However, a major cause is also how the gear is operated (eg. towing trawls for excessive periods, leaving gillnets in the water too long, etc.).
f. **Protection of marine mammals and birds** – A selectivity issue affecting the overall health of the marine environment, and of great interest to the general public. Many environmental groups and government agencies have targeted specific fisheries and types of fishing gear because of their capacity to catch, deliberately or incidentally, marine mammals and birds. Besides the actual loss of these important

creatures, bird and mammal by-catch has resulted in much adverse publicity and regulatory constraints for some fisheries. The Japanese driftnet fishery for tuna in the Pacific Ocean is notorious for its destruction of certain birds and porpoises.

g. **Impacts on fish habitat and the ocean environment** – The constant use of any equipment in the marine environment will have some impact on that environment. Most fishing gears appear to have little impact. However, great concern has been expressed about, for example, the possible effects of otter trawling on the sea bottom. These effects can be minimized with continuing gear modifications, the use of ancillary equipment such as underwater cameras and other sensors, and conservation-oriented fishing practices.
h. **Impacts on the whole environment** – Some aspects of fishing operations will affect the global environment. For example, improving the fuel efficiency of fishing vessels will help conserve non-renewable oil resources (as well as helping to achieve best economic value for the catch), and reduce air pollution.

No matter what species is being fished and what gear used, the ingenuity of fishermen and the continued advances of technology can often defeat most regulatory attempts to control fishing effort and impacts. Reducing the adverse impacts of fishing gears and practices must start with changed attitudes, and with motivating fishermen to assume more personal responsibility for the proper operation of harvesting gear. For example, if there is an abundance of small or immature fish, or fish of a non targeted species, in a particular area at a particular time, responsible fishermen will look for ways to avoid catching and killing those fish, either through the use of appropriate fishing gears and practices, or by avoiding any fishing activity in the area until the situation changes.

In Canada, the approach used by both government and the fishing industry to improve the sustainability of harvesting operations has been to:

- Develop and introduce more effective conservation harvesting technology.
- Increase fish harvesters' awareness of the need for conservation-oriented approaches to fishing.
- Improve fishing practices so that new and traditional fishing equipment is utilized in a manner to ensure the conservation of fisheries resources.

The need for such improvements in fishing technology and practices is being driven by:

- The necessity of preventing a recurrence of the resource declines that have occurred in some of our fisheries.
- Budgetary constraints at all levels of government, as well as the reduced profitability of many fisheries sectors.
- Changing industry attitudes toward long-term resource conservation, and away from simply catching the most fish in the least time.
- The need to demonstrate a responsible approach to harvesting in Canada, offsetting the adverse publicity that has been directed at certain fishing sectors and practices.

PROJECTS TO IMPROVE RESPONSIBLE FISHING

The Canadian fishing industry is changing. One of the most important engines of that change is the promoting, by the Department of Fisheries and Oceans, of a broad range of responsible fishing initiatives which are conducted in partnership with the Canadian fishing industry. Responsible fishing is promoted through four basic initiatives:

- Conservation harvesting technologies and practices
- Professionalization of fish harvesters, and industrial training in responsible fishing
- Implementation of a Code of Conduct for Responsible Fishing

Conservation Harvesting Technologies and Practices

In recent years the fishing industry across Canada, supported by Fisheries and Oceans and other stakeholders, has undertaken many conservation harvesting initiatives, including more than 100 fishing gear selectivity projects. Many of these initiatives are industry-proposed and industry-driven, and nearly all projects are carried out under commercial fishing conditions and using DFO's methodology manual, Measurement of Fishing Gear Selectivity. Initiatives to improve fishing gear selectivity have concentrated mainly on the following:

- Mesh size - in trawls, seines, gillnets and fish traps
- Hook size - in longlines
- Square mesh - in trawls and Scottish seines
- Rigid grids - in trawls and purse seines
- Trawl and Scottish seine designs - to improve species selectivity
- Escape panels - in shellfish traps and trawls
- Electronic devices - to reduce mammal entanglements and lost gillnets
- Live capture gear - to allow the live release of non-targeted species.

The conservation objectives of each of these projects address:

- fish size selectivity
- species selectivity; limiting catches
- survival of escaping fish
- protection of marine mammals and birds
- the best use of the resource (maximizing quality, minimizing waste)
- protection of the marine environment (especially through reducing 'ghost-fishing')
- protection of the whole environment (fuel efficiency and air pollution).

Other initiatives have focused on:

- energy-efficient fishing methods in pair-trawl fishing to harvest species such as mackerel, squid and shrimp
- twin trawling for shrimp to reduce fuel costs
- the establishment of databases on energy-consumption and efficiency in fish harvesting
- the development flume tank testing protocols and standards for fishing gears
- the development of a vessel/harvesting monitoring system using satellite-based technology.

Responsible Fishing Initiatives: Gillnet Gear

- electronic locating devices to reduce the number of lost nets
- mesh size for groundfish size selectivity
- deepwater turbot nets for size and species selectivity
- tooth nets for Pacific salmon species selectivity
- large-mesh monkfish/lumpfish nets to minimize bycatch of non-targeted species
- purse seine grid system to reduce harbour porpoise mortality.

Responsible Fishing Initiatives: Shellfish Traps

- selectivity of snow crab traps to reduce catch of small and soft-shell crabs
- an escapement device in snow crab traps to allow crabs to escape from lost traps
- an escapement device in lobster traps for size selectivity
- modifications to rock crab pots to prevent the capture of lobsters and to allow small crabs to escape.

Professionalization and Training

The development of a Code of Conduct for Responsible Fishing goes hand-in-hand with efforts to promote the professionalization of fish harvesters which was begun in the early 1990's by fisheries organizations in the Atlantic region. Professionalization is based on the idea that full-time fish harvesters should be formally recognized as experienced professionals – in both a business and 'technical' sense - with the specialized knowledge and skills to manage their enterprises and their operations. The current focus of this initiative is on developing standards for knowledge, skills and experience.

The movement toward responsible fishing and cooperative fisheries management is clearly related to the idea and process of professionalization. A profession is generally a self-regulating body, and the regulation of most professional organizations is based on an explicit Code of Conduct. Formal training and practical experience are key requirements of such organizations, since their members must fully understand those requirements and conduct their affairs in accordance with the objectives and standards of their profession.

A fisheries industrial training program has been developed in Canada and is evolving to meet the needs of both new and practicing fishermen at the secondary and post-secondary school levels. A Fishing Technology Network, centered at the Memorial University's Fisheries and Marine Institute, will provide its members with a pool of technical expertise from industry, governments and independent research agencies across Canada. Canada's program of professionalization for fish harvesters is also being adapted for use by other countries.

The Canadian Code of Conduct for Responsible Fishing Operations

Canada is the first country to adopt a national responsible fishing code. Canada's code builds on the International Code of Conduct for Responsible Fishing, developed by the United Nations Food and Agricultural Organization (the FAO) and adopted in 1995 by 80 countries. Because it is so crucial to the maintenance of a sound, sustainable fishing industry, we will wind up this chapter with a note on this landmark development.

ADOPTING A RESPONSIBLE FISHING ATTITUDE

Overexploitation of fish resources and negative impacts to the aquatic environment have resulted in a loss of biodiversity, sustainable biological yield and economically viable fisheries. The crisis extends beyond Canada's borders, reaching all the world's fisheries. According to the Food and Agriculture Organization (FAO) of the United Nations, 13 of the 17 major fisheries of the world are in serious trouble. Increases in harvesting capacity and advances in fishing technology have contributed to the decline of many fish stocks around the globe. The dramatic decline of the groundfish stocks in Atlantic Canada and the serious concerns in the Pacific salmon fisheries are examples of this global problem. A fundamental change in the approach to fisheries is essential - change that includes improvements in the management and operation of all fisheries, whether for recovering fish stocks, healthy fisheries or newly developed fisheries.

Fishers and industry leaders alike, recognize that real change requires a fundamental shift in attitudes and responsibilities. This shift in attitudes and responsibilities must be adopted by all participants in the fishing industry - from small boat operators to major corporations. There is a real need for more efficient and competitive fishing operations that are economically viable, yet do not increase fishing capacity. In other words, a need for the same amount of fish to be harvested with less effort and expense. If this can be effectively achieved, there will be less wastage of resources, especially of undersized fish, and improved profitability for participants in the commercial fishery.

One Fisherman's Views

One small vessel operator summarized his vision of responsible fishing. He indicated that responsible fishing was a combination of improved gear technology and responsible attitude and behavior on the part of those operating the gear. By this he meant that the improved gear design could help to reduce or eliminate

unnecessary bycatches or the capture of undersized fish. Or, as he put it, "the gear is neither good nor bad when it comes to responsible fishing; it's how the gear is used that determines whether it demonstrates responsible fishing practices."

A responsible attitude towards fishing would require that a fisherman would not set more nets or traps than can be checked within a reasonable period of time. This means that the quality of fish caught will be high, and will fetch the best price for the fisherman. Nets or traps that can't be checked in a reasonable period of time may result in fish that are of poor quality and thus will receive a lower price, or it could result in fish that have to be dumped because they have decayed. In this case, time and money will have been wasted, since there are expenses in getting out to the fishing ground, and there is no income from a catch that is spoiled. Not only is there a direct financial implication for the fisherman; there are long-term implications for the health of the fish stocks. If young fish are dumped because they are undersized or if adult fish are dumped because they have decayed, then these fish won't be around to reproduce in the future. By not adopting responsible fishing practices, a fisherman could be reducing his access to future sources of income. Using larger mesh, checking nets frequently, and avoiding situations requiring the dumping of fish would constitute responsible fishing practices.

Another interesting observation made by this spokesperson for responsible fishing had to do with the price of fish. He noted that when the supply of fish is scarce, prices are usually high. As the availability of fish increases, prices fall. "Perhaps it would be better for fishermen and the fish stocks if the supply of fish was limited," he suggested. He went on to explain, using the example of lumpfish roe: "If, at the beginning of the season, a particular grade of lumpfish roe gets a price of $1.75 per pound, a fisherman would make $3,500 for 2000 pounds of roe. If there is a large supply of roe, the price might drop to $1.25 per pound. At this price, 2800 pounds of roe would be needed to make $3,500. It may take another week or two of fishing in order to make up the additional 800 pounds. This means additional expenses for the fisherman, and additional lumpfish resources taken, in order to make the same income."

THE CANADIAN CODE OF CONDUCT FOR RESPONSIBLE FISHING OPERATIONS

The creation of a code of conduct for Canadian fish harvesters was first proposed at a meeting of DFO and fishing industry representatives in 1994. An Industry Steering Group was formed to oversee development of the code, and a DFO secretariat was set up to provide support.

Fish harvesters throughout the country were consulted as the code was being developed. In January, 1998, more than 60 representatives of fish harvesters' organizations endorsed the code text and agreed to a ratification process. A Canadian Responsible Fishing Board was established and given a mandate to see ratification of the code by fish harvesters across the country. The code has since been ratified by organizations representing about 90% of Canadian commercial fish harvesters. There are currently (2003) 15 projects underway across Canada to bring the fishing practices of members of various organizations into line with Code guidelines.

The heart of the code is a set of nine basic principles. From these flow 36 operational guidelines aimed at achieving the code's main objective, which is to:

"Achieve sustainability in marine and freshwater fisheries for present and future generations of Canadians by directly contributing to the conservation of stocks and the protection of the aquatic environment."

In other words, the fundamental job of the Responsible Fishing Board, guided by the principles and operational guidelines of the code, is to ensure – through education, consultation and cooperation – that all fishing gears are used responsibly by fish harvesters everywhere in Canada.

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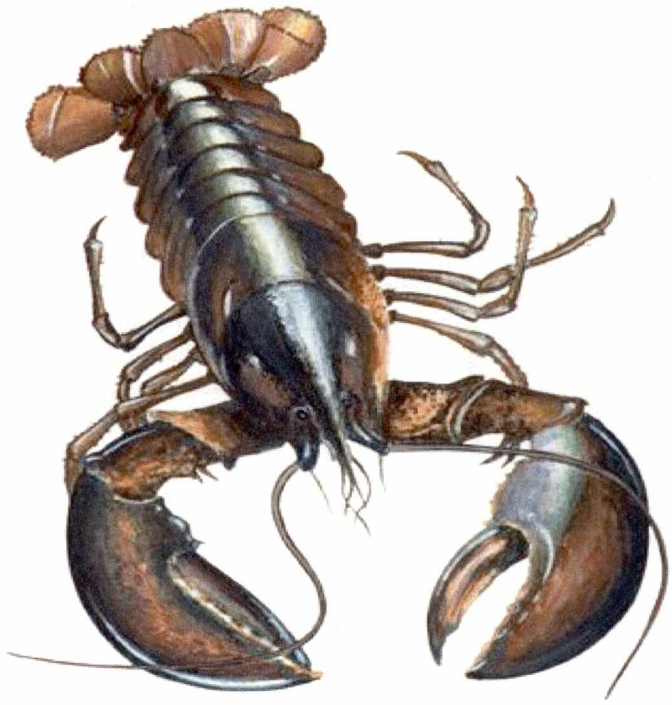


HOMARUS AMERICANUS

A Brief Biology

Description

That most coveted of crustaceans, the American lobster (*Homarus americanus* is its scientific handle), is an invertebrate crustacean. It has no immediate relatives in Canada. It does have, however, one European brother - *Homarus gammarus* . Also related is the Norway lobster, or scampi. The lobster belongs to the decapod or 10-legged family of crustaceans, which includes shrimps, prawns, crabs and crayfish.

Homarus americanus is the most common type of lobster caught in Atlantic Canada. Widely acclaimed for its delicious meat, it is the king of Canadian shellfish. At one time, before lobster stocks were depleted and before the advent of high-speed, refrigerated transportation, surplus catches of lobster were used as fertilizer. Fishermen considered them a nuisance when they became entangled in their nets. There was a relatively small lobster fishery supplying a modest canning industry. Lobster canning in Newfoundland was concentrated mainly on the west coast. However, once it became possible to ship fresh product to worldwide markets on a regular basis, the lobster became a highly sought after creature, prized by gourmets the world over. Now they are trapped unremittingly, and their populations in certain areas may be threatened.

Scientists are concerned, and are calling for stiffer controls. Fishermen and producers, on the other hand, say the industry is already over-regulated. In any event, there is a need to re-examine a management code which has evolved over the past 90 years. Skillful management must weigh potential short-term losses against long-term gains. Ultimately, all concerns are contingent upon the protection of the species.

Anatomy

The lobster's shell-armoured body is divided into two main sections, the combined head and thorax, and the 'tail'. There are two pairs of antennae, a complicated set of mouth parts, and two black eyes mounted on short movable stalks set on either side of a stout, spiny horn. The lobster has a jointed external shell, or exoskeleton, which protects and supports the body parts, while still permitting movement. Its body is formed mainly by the cephalothorax, or head and chest area, and the six-jointed abdomen, the part commonly known

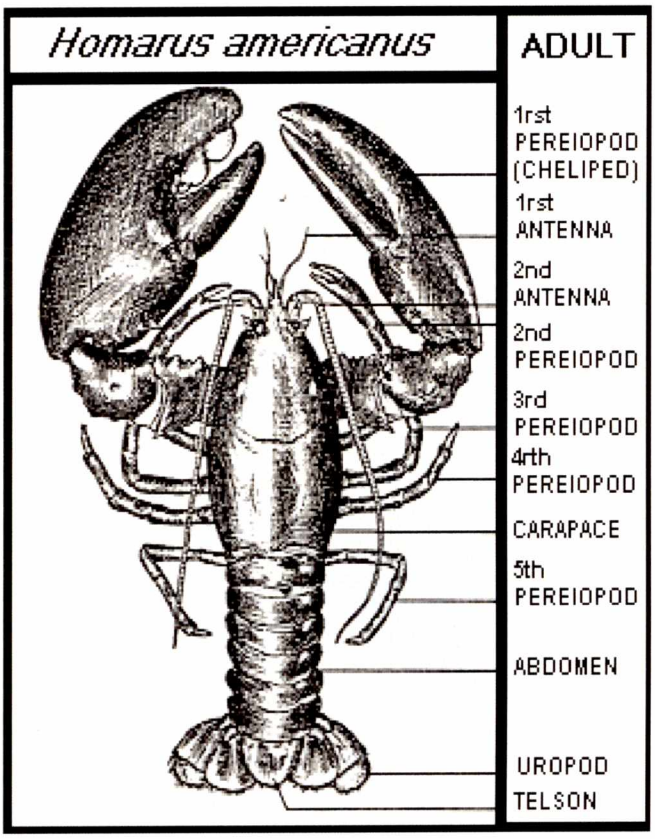


Figure 1: Adult Homarus americanus. Dorsal view. Length of specimen, 18.5 inches - weight, 11.75 lbs - age probably about 16 years. (Drawn from life by Phillip B. Hadley, 1906.)

as its tail. It has no spinal column, hence it is an 'invertebrate'. The body rests on four pairs of spindly, jointed walking legs, the first two pairs of which have small claws. Two much larger front legs provide the lobster with formidable tools for capturing food. They are well-armed with strong claws generously equipped with teeth and sharp spines. Usually, one claw is considerably heavier and is known as the 'crusher', in contrast to the other, more slender 'pincer'. There is a series of small 'paddles' or swimmerets on the underside of the abdomen; in the female, these are used to carry eggs. The abdomen ends in a wide, five-section tail fan.

In their natural habitat, lobsters tend to take on colour schemes, usually in greenish and brownish shades, that will afford them some camouflage protection on the sea bottom. The shell is often speckled with darker spots, and the overall effect varies with the area of habitat. Out of the water, lobsters start to lose their varied colouring and turn a common dull red. The familiar brilliant orange-red hue that gives rise to the standard "red as a lobster" is a product of the boiling-pot.

Lobsters live chiefly on fish (dead or alive) and immobile or slow-moving invertebrates such as mussels, sea urchins, crabs and worms which inhabit the sea bottom. They will readily eat dead fish, and are great scavengers.

Adult lobsters vary greatly in size among localities, depending upon the age and local growth rate, as well as the intensity of the fishery. In areas where the exploitation rate is high, the local stock of lobsters is maintained at a young average age. The average size is consequently smaller than it would be if there were less fishing pressure. The intensively fished Gulf of St. Lawrence stocks have an average size of less than 400 g. Some lobsters can grow to a size of more than 20 kg if they survive the fishery and natural mortality.

Behavior

Small lobsters lead a very secretive existence, and most of their time is spent hiding in burrows. Throughout their lives, they prey upon correspondingly small individuals of high food quality, such as crabs, mussels, clams, sea urchins and starfish. There is no evidence of cannibalism among lobsters in the wild.

As the growing lobster becomes too big for its shell, it sheds it for a larger one. Between moults, the flesh becomes progressively more densely packed inside the shell. Meanwhile, a new soft shell develops inside the old one. Calcium salts are absorbed from the old shell and stored in the stomach wall. When the time comes to shed the old shell, the lobster arches its body into a "V" form, folded at the junction of carapace and abdomen. It stretches, then splits, the large, flexible old membrane joining its body and tail sections. Then the lobster lies on its side and wriggles out of the two old shell sections. Once free, the lobster uprights itself again and proceeds to suck in water and to puff itself up to about 10 to 15 per cent larger than its previous size.

At this stage the shell is very tender and the lobster is extremely vulnerable to predation. It begins to eat soon after moulting, concentrating on high-calcium foods to encourage the rapid hardening of its shell. The calcium which had been stored in the stomach walls is also used at this time. Sometimes it may even eat its old shell. For one or two months after a moult the lobster's flesh is watery and does not quite fit the shell. During this period its appetite is enormous and it is readily attracted to the bait in lobster traps.

Life Cycle

The female lobster is sexually receptive only during the few days after moulting, while her shell is still soft and flexible. When lobsters mate, the male deposits sperm in the spermatheca between the female's last two pairs of walking legs. The sperm is then stored for as long as a year, until the eggs are ready. At that time the eggs are released from the openings of the oviduct at the base of the third pair of walking legs. As they pass toward the swimmerets, sperm is released to fertilize them. The eggs are then carried on the swimmerets until the following year. In the past it was assumed that after hatching the eggs, the female would moult and then mate again to recommence a two-year reproductive cycle. However, it seems that very large females are able to conserve enough sperm from a single mating to fertilize two or even three broods of eggs. They may spawn several times without an intervening moult, so the energy that normally is used in increasing body size is directed by these prolific females solely to reproducing. (Another deviation from the normal two-year reproductive cycle is the case of females who moult, mate and extrude eggs all in one season. This phenomenon seems to be limited to individuals reproducing for the first time in warmer water habitats.)

The egg production of female lobsters varies significantly with size. A large 'canner' with a carapace (back shell) length of 78 mm releases about 7,500 eggs at one time. Even if only one per cent of these make it to the bottom, she has produced at least 75 offspring (though most of these will be lost to various predators before they reach adulthood). Typical large breeders in the Bay of Fundy release 30,000 eggs at a time, and the 'jumbos' of more than 125 mm in length have been known to produce more than 40,000 eggs.

The lobster begins its life as an egg, glued to the swimmerets on the underside of the female's abdomen. At this stage, maturation may be accelerated by higher water temperatures. Usually the eggs hatch in the summer and the newly released larvae float to the surface, where they feed upon smaller planktonic organisms and undergo three moults, each time growing larger and more similar to an adult. In three to six weeks, depending on the water temperature, the surviving larvae descend to the sea bottom. At this stage they are about 15 mm (5/8") long. The mortality rate is very high - only about one per cent of the floating larvae will live to settle on the ocean floor.

Growth slows down progressively as the juvenile lobster grows to adulthood. In areas of warmer waters they grow faster and may therefore moult more often. In the Northumberland Strait, for example, between Prince Edward Island and the main land, summer water temperatures may reach 20 C, and a lobster at the current canner minimum of 63.5 mm carapace length can moult twice in one year. Once a lobster has replenished the flesh within its new shell, it will be about 50 per cent heavier than before a moult. So in one year a lobster from the Northumberland Strait can grow from 200 g to 450 g, after two moults, while its counterpart in a cooler habitat will moult only once, reaching a weight of about 300 g.

Temperature is also a factor in the age at which a lobster attains sexual maturity. Female lobsters in the Northumberland Strait may mature at 200 g or three years of age, whereas their counterparts in the Bay of Fundy will not mature sexually until they are 700 g or eight years of age. The size at which the average female is mature and capable of producing eggs to replenish the population is very important in the regulation of lobster harvesting. If females are not given the chance to contribute to the reproduction of the species, the lobster population will obviously suffer a decline. This is the main problem facing the lobster population today.

As with most ocean creatures, the natural mortality rate for lobsters is very high. Firstly, 99 per cent of the larvae perish. Once the survivors reach the sea bottom, the still vulnerable juveniles are so secretive that divers cannot accurately estimate their numbers. The survival rate increases dramatically as the young lobsters become larger and better able to defend themselves. But once they reach commercial fishing size, the rate at which they are harvested by fishermen renders natural mortality figures almost insignificant by comparison. In specific isolated cases, epidemics of gaffkemia, a bacterial disease, have decimated local populations of lobsters, but these have almost always been in holding facilities rather than in the wild. Other than fishermen, there are few predators to which an adult lobster is vulnerable.

Distribution & Migration

Lobsters live along the east coast of North America from North Carolina to Labrador. They are abundant off Maine, southwest Nova Scotia, and the Gulf of St. Lawrence coastline of the Maritimes. Lobsters are distributed nearshore around the island of Newfoundland and along the Strait of Belle Isle portion of the Labrador coast.

Lobsters prefer a habitat where they can find shelter. In deep water canyons off the coast of the US, lobsters have been observed lodged individually in small burrows dug into the face of clay cliffs. Inshore lobster populations are found on rocky bottoms, where a large number of individuals can obtain appropriate shelter. On sand or mud, lobsters may be found hiding under rocks of about their own size.

In many areas lobsters tend to be larger in deeper water, but there are exceptions. For example, large egg-bearing females are found in shallow waters in the Bay of Fundy where they reproduce and moult during the summer months.

Considerable care must be taken in trying to count lobsters, to estimate their population in a given area. Just as the emergence of droves of office workers on a sunny day in spring does not necessarily indicate that the number of office workers is on the rise - so it is with lobsters. They become more active when the water begins to warm up. Thus the catch increases and it appears that there are more. In fact, they are only more active. So water temperatures, if not taken into account, can play havoc with demographic surveys.

THE LOBSTER FISHERY

Licensed Canadian fisherman harvest inshore lobsters during the open season in their area, usually in the warm months of the year, although the open season in certain regions of New Brunswick and Nova Scotia is from November to June or July. They use small boats to fish with baited, wooden or wire traps or pots which are weighted and lowered to the sea bottom. The traps are hauled by ropes attached to wood or plastic buoys which mark their location.

There is also a small fleet of offshore lobster vessels. They use oversize traps because of the larger lobsters, and are not permitted to fish closer than 80 km from shore. The principle of lobster trap fishing is to attract lobsters into traps using bait. Once in the trap, the lobster is unable to escape.

Inshore Lobster Fishing

Lobster traps, also referred to as lobster pots, vary in design and size from region to region. Older styles consist of a round-topped, flat-bottomed box constructed from wood laths on a wood frame. Plastic-coated metal wire mesh is becoming more common in pot construction. Each trap is equipped with one or two funnel-shaped openings or 'doors' made from cotton or synthetic twine, which allows the lobster to enter the trap, but prevents it from escaping. The common design of traps used today in the Maritime provinces consists of a rectangular metal frame covered with wire mesh. Entrances are located on each side of the trap. Newfoundland and Labrador fishermen still use mainly the traditional style wooden traps.

In the setting operation, traps are baited and then positioned at the rail of the vessel. Traps may be set in 'fleets' or individually. In setting a fleet, one end of a 'mainline' is weighted and sent to the bottom. The traps are affixed one by one to the mainline with a shorter line and dropped into the water along with an attached buoy line and buoy. The mainline is payed out, with traps connected at intervals along the line, until the whole 'fleet' has been set. In other areas, fishermen usually set their traps individually, each with a buoy line but with no mainline connecting them. This is the common practise in Newfoundland.

Traps are set in waters of varying depths, but usually on or near a rocky bottom, which lobsters prefer. In recent years, fishermen have begun to make greater use of electronic equipment to determine water depth and bottom type. Traps are ballasted with flat stones or concrete slabs to sink them and reduce their movement on the ocean floor. Marked buoys allow the gear to be easily located and identified.

Lobsters are attracted to the bait, which may consist of squid, herring, mackerel or flounder. They enter the funnel-shaped entrance and drop into the trap. The narrow inside end of the funnel is located near the top of the trap, preventing escape.

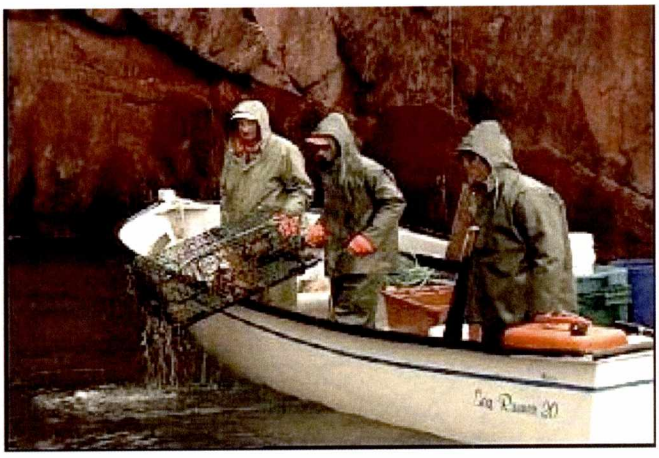


Figure 2: Hauling a traditional wooden lobster pot (top), and a modern wire trap.

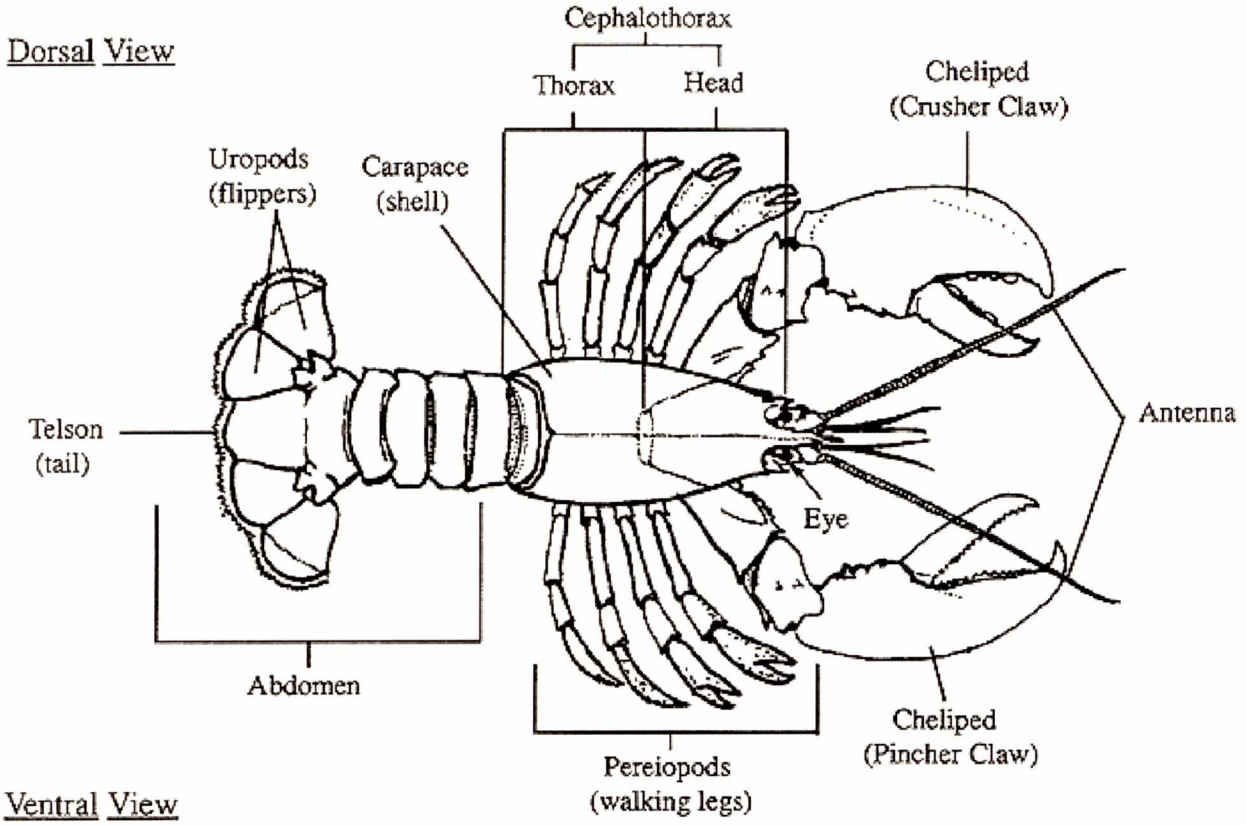
When hauling a fleet of lobster traps, the buoy at one end of the mainline is taken on board and the mainline is connected to the hauling winch. Traps are brought up to the side of the vessel and lowered on deck. The catch is removed and the traps are stored for the next deployment. Individually set traps are hauled one at a time, usually by hand.

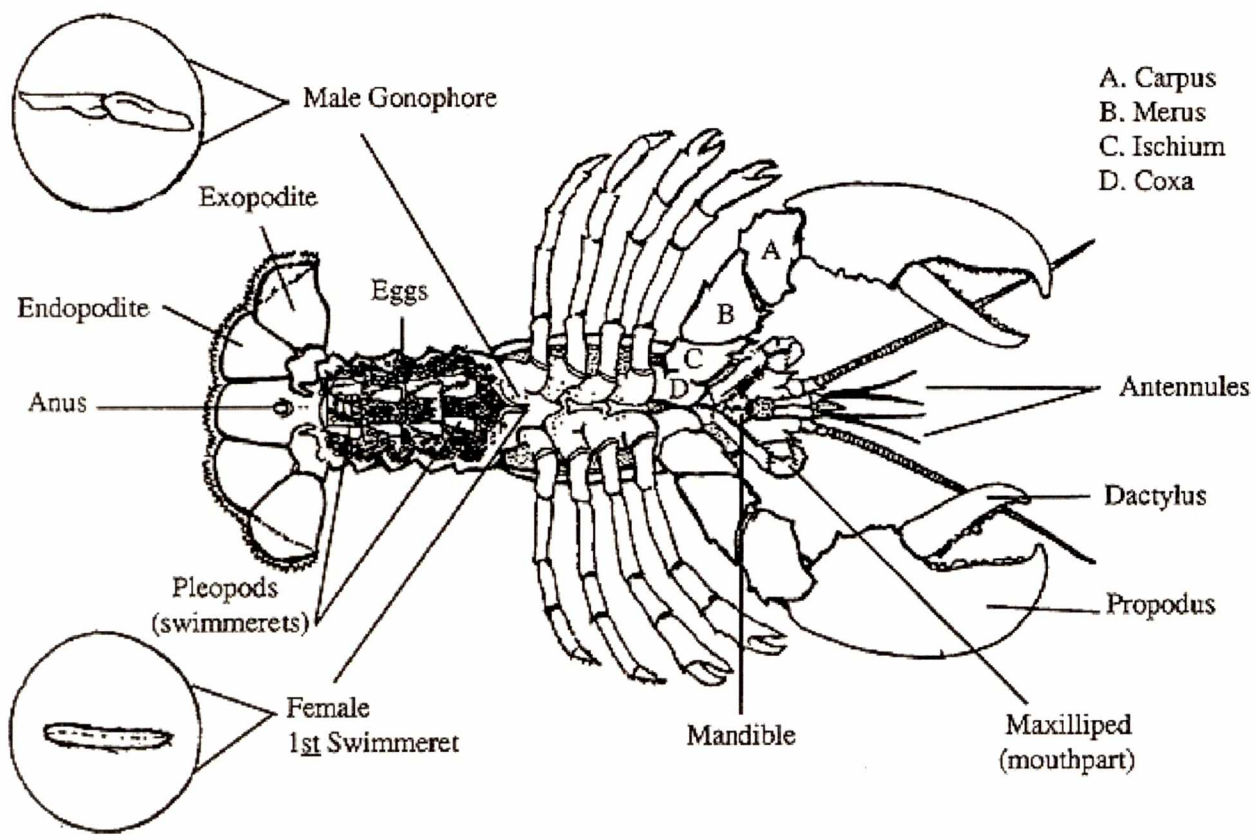
In most lobster fishing areas in Atlantic Canada, traps are equipped with narrow openings that allow undersized lobsters to escape. These are mandatory in most areas.

Offshore Lobster Fishing

Offshore lobster traps are constructed of a metal or heavy wooden frame covered with wire mesh, and are considerably larger and sturdier than inshore traps. Lobsters caught offshore are usually bigger than those landed in inshore areas, averaging from 1.36 to 2.26 kilograms, with a few reaching over 9 kilograms. Offshore lobster vessels measure between 18 and 34 metres in length and most are based in southwestern Nova Scotia. These vessels are not permitted to harvest lobsters closer than 80 kilometres from shore.

External Anatomy of a Lobster





LOBSTER CONSERVATION ON THE EASTPORT PENINSULA

LOCAL ECONOMIC IMPORTANCE OF LOBSTER

On the Eastport Peninsula, before the 1992 moratorium, the lobster fishery was pursued for only three or four weeks a year, before the start of the cod fishery. About 48 fishers had both cod and lobster licences.

After the moratorium was announced, the lobster fishery assumed a greater importance for these fishers, since their other source of fishing income was no longer available. During the time of the moratorium, lobster accounted for 50 per cent of the income from small-boat fishing. Approximately a half million dollars came into the area from the lobster fishery. Ten years prior to the moratorium, most licenced lobster fishermen would only fish four to five weeks of an 11-week season, and they often did not fish their full allotment of lobster traps. With the advent of the moratorium, many of the conditions changed significantly. This is referred to as "re-direction of effort".

This is important to the local economy since fishers and their families still had to purchase things for everyday living - food, gasoline, clothing, vehicles, appliances and so on. The fishers also had to purchase fishing gear, bait and other goods and services needed to pursue the lobster fishery. Without this money going into the local economy, businesses which employ other people would be adversely affected. Local employment would be reduced, and the drop in total spending money available would have spin-off effects further afield. Vehicle dealerships and department stores from Gander to St. John's stand to gain or lose from changes to the fishing economy of the Eastport Peninsula.

When jobs are no longer available, people may have little choice but to move away. This affects the amount of money available to towns in the form of taxes. Lower levels of income to towns from taxes means reduced services such as snow clearing, road paving, clean-ups, etc., which also employ people. Every dollar that is made by fishers has a potential impact on many others living in the region.

Table 1: Eastport Peninsula community populations and reported family incomes,

Community	No. of families	Total pop.	Male	Female	Average age	% change	Average income
Burnside	75	235	125	110	41.1	-10.4%	NA
Eastport	145	555	275	280	44.6	-7.3%	$14,779
Happy Adventure	85	285	135	150	42.0	-11.8%	$11,865
Salvage	70	240	120	120	38.0	-2.4%	NA
Sandringham	75	295	155	140	35.7	-5.5%	$13,260
Sandy Cove	50	160	80	80	44.3	-8%	NA
St. Chad's	75	230	125	105	41.1	-10.4%	NA
Totals/averages	575	2000	1015	985	40.97	-7.97	$13,301.33

LOBSTER WARNING SIGNS

In July 1992, people in the fishing industry were advised that there was a moratorium on the fishing of cod in the province. For many fishers, cod was an important source of income, but not necessarily the only species that they caught. Other species now became more important to them than ever. On the Eastport Peninsula, the lobster had long been an important fishery species along with the cod. During the 1990's, the lobster fishery became extremely important for these fishermen.

Long before the 1990's, inshore fishers throughout Newfoundland and Labrador were aware of signs of trouble in the fishing industry, especially in the cod fishery. Many of them were predicting a collapse of the

cod fishery well before scientists and politicians had arrived at their conclusions in 1992. Fishers on the Eastport Peninsula absorbed the hard-earned lessons of the cod fishery and recognized that they had to make sure the same thing didn't happen with their lobster stocks. During the first half of the 1990's they had made a number of significant observations which led them to action. These observations included:

- Egg-bearing females represented the future stocks of lobster.
- Small lobsters would create more revenue if they were allowed to grow to maturity.
- A number of observed activities, if allowed to continue, would be very detrimental to lobster fishing in the area. These activities included:
  - setting extra traps, beyond the legal limit
  - harvesting undersized and egg-bearing lobsters
  - fishing out of season.

THE EASTPORT PENINSULA LOBSTER PROTECTION COMMITTEE

"We are professional fish harvesters. We believe in the future of the fishery. The Committee and fish harvesters have demonstrated that this fishery can be conserved and enhanced to provide greater benefits to themselves and their communities. These activities have been a success."

Concerned about declines in their lobster harvest, in 1955 fishers on the Eastport Peninsula of northeastern Newfoundland formed the ***Eastport Peninsula Lobster Protection Committee (EPLPC.)***

The Strategy Behind the Initiative

The organizers of the EPLPC faced a difficult task. They recognized that some harmful fishing activities had a long history in the area, and that it would be hard to change the practices of some people. They decided that they would have to get the support of fishers and the community in order not only to prevent a major decline in the lobster stocks, but to assist the stock in growing to a level which would sustain a profitable fishery for many years to come.

Once a significant number of fishers were convinced that something had to be done to protect and improve their lobster fishery, they decided to seek the involvement of fisheries scientists from the Department of Fisheries and Oceans. The fishers knew what they wanted to achieve, but they needed advice on how they could achieve it.

They were fortunate to get the support and involvement of a fisheries scientist who recognized their determination to do things better. Once he heard what they hoped to accomplish, Dr. Gerry Ennis was able to suggest strategies the fishermen could undertake to accomplish their goals. Furthermore, Dr. Ennis agreed that scientific research would be conducted in conjunction with the committee's efforts. This was extremely important, because lobster fishers were being asked to return some of their catch to the water. That meant voluntarily giving up some income in the short term in the expectation of better income over the long term. They needed evidence that such measures would have a positive impact on future landings. It was recognized from the beginning that the scientific data from the research component of the committee's work could benefit not just local fishers but also fishers elsewhere in the province and throughout the Atlantic region, by demonstrating the benefits of their proposed lobster protection measures.

CONSERVATION-PROTECTION ACTIVITIES

Initially the EPLPC reduced illegal lobster harvesting activities, including the harvest of undersized and egg-bearing lobsters, the setting of extra traps beyond the legal limit, out-of-season fishing by licensed fishers and poaching by other members of the local community. This was accomplished by a program of community awareness and fishers-watching-fishers - a self-policing initiative.

V-Notching

In 1996, the EPLPC implemented a voluntary v-notching program to mark egg-bearing females. This involved sorting female egg-bearing lobsters out from the rest of the catch, cutting a v-notch in their tail-ends, and releasing these breeding females back into the water. By making the possession of these lobsters illegal, the EPLPC sought to enhance egg production, as recommended by the Fisheries Resource Conservation Council (FRCC). From 1996 to 2000, more than 4000 lobsters were notched and released.

Log Books

Fishers voluntarily keep detailed log books which record information about the number of egg-bearing females, v-notched females and undersized lobsters which are captured and released. The data also includes details about the location where the lobsters were captured. Information is also gathered from tagged lobsters to meet both the legal requirements mandated by DFO, and the additional requirements voluntarily adopted by fishers participating in the Eastport Peninsula Lobster Protection initiative. This information gives scientists and fishers important information about the migratory patterns of lobsters.

Lobster Management Area and Closed Areas

Following these successes, the EPLPC entered into a Memorandum of Agreement with the Department of Fisheries and Oceans to establish a special lobster management area. This area consisted of two zones: an inner zone where only fishers from the Eastport Peninsula were allowed to fish, and an overlap zone where both fishers from the Eastport Peninsula and fishers from other areas who traditionally fished in these zones would share the lobster resource. Fishers from the peninsula were not permitted to fish beyond the overlap zone, and fishers from elsewhere were not permitted to fish the inner zone. In addition, the EPLPC and DFO established within the inner zone two Closed Areas, with the objective of enhancing egg production by totally protecting the lobster resource in these locations. Figures 1, 2 and 4 show the Duck Islands and Round Island closed areas and the overlap zone. Field studies conducted in these two areas have provided baseline data to assess future changes in population size and age and gender structure.

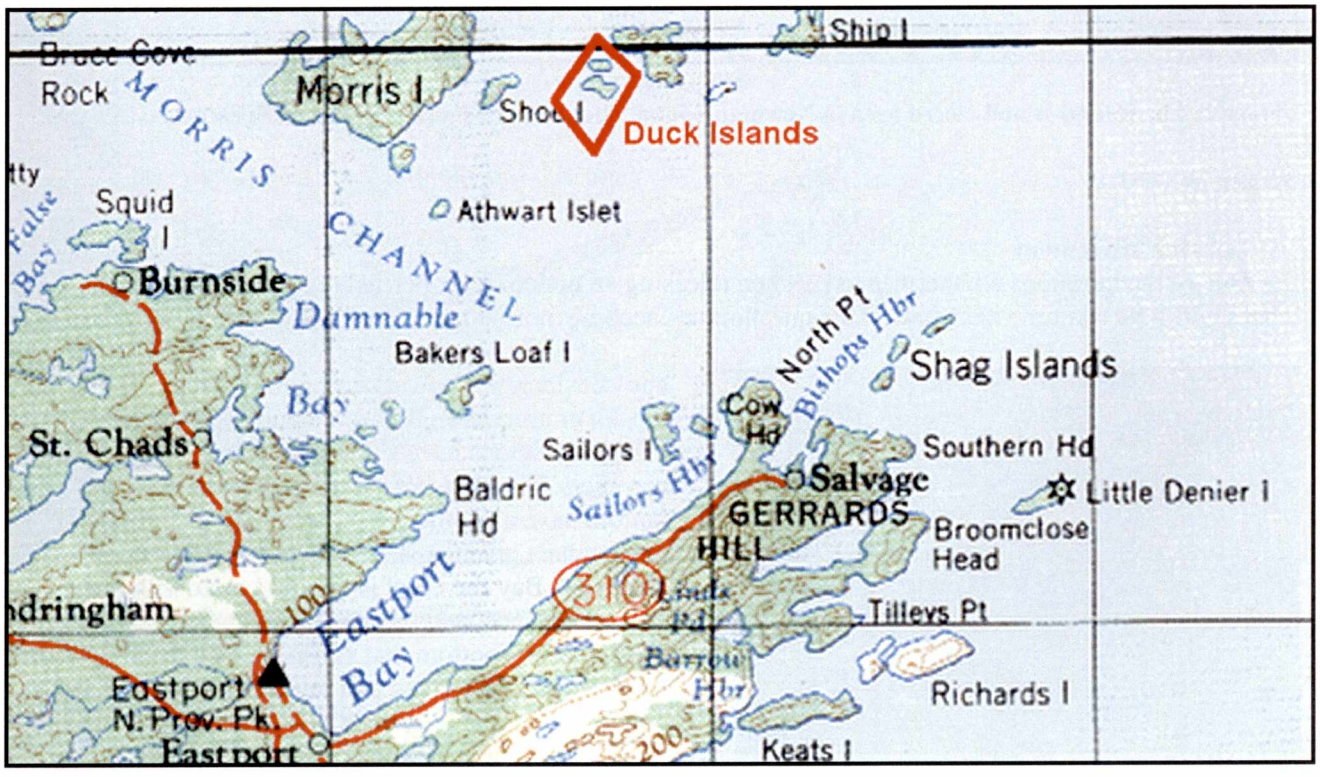


Figure 1: Approximate boundaries of the Duck Islands closed area, just off Burnside.

The data already show an increase in the proportion of berried females in the closed areas. These studies will determine the capacity of closed areas to increase egg production and juvenile survival, and to serve as sources of new lobsters for nearby fished areas through natural emigration. Data from detailed fisher log books and the field program were compiled and analyzed by students at the high school in Eastport, and by DFO, Parks Canada and Memorial University.

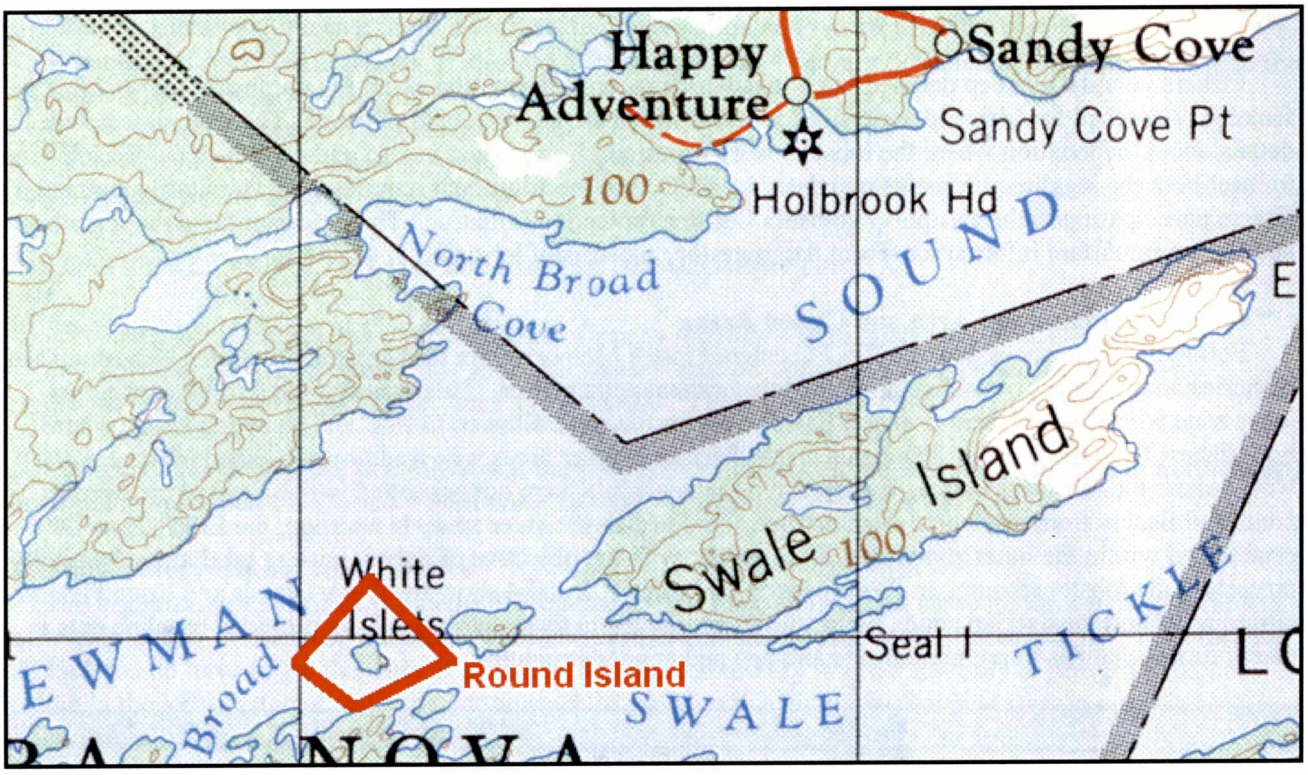


Figure 2: The Round Island closed area in Newman Sound, about 10 km south of Happy Adventure.

More Science

Lobster Movement

One of the questions a fisherman asks when releasing an undersize or berried (egg-bearing) lobster is: where will it be this time next year? This question has become more important recently, with much discussion and consideration of various options for addressing lobster conservation issues. Tagging studies done at various locations have shown that lobsters are not great travellers. The shape of the coastline and adjacent bottom have a significant effect on the movement of lobsters in a given area. In the St. Chad's area of Bonavista Bay the coast is very irregular with many steep headlands, and the lobster grounds are a narrow band of rocky bottom that slopes steeply from the shore. Lobsters caught, tagged and released in the St. Chad's area, and recaptured about a year later, on average had moved only 400 metres from the location where they were originally caught and released.

Figure 3: A tagged lobster.

More than 50 per cent were caught in the immediate vicinity of their original capture location, and about 45 per cent had gone no further than one kilometre. The most adventuresome of the tagged lobsters had traveled only 2.8 km from where it had been caught, tagged and released.

Figure 4: Approximate boundaries of Eastport Peninsula lobster conservation areas, including Duck Islands and Round Island closed areas.

In contrast, the coast in the Bellburns area of the northern peninsula is nearly straight and the lobster grounds are a wide band of rocky bottom that slopes gently from the shore. Here, tagged lobsters had traveled an average of 2.5 km from their original point of capture. Even here, however, 39 per cent were recaptured in the immediate vicinity and another 10 per cent had moved no more than two km. The longest journey recorded was a marathon of 26.4 km.

In the Bellburns area, lobsters are generally more mobile than at St. Chad's, where headlands form physical barriers that tend to restrict their movements. Even at Bellburns, lobster movements are generally localized, and among those that moved, approximately equal numbers moved north and south along the coast, indicating that those lobsters that move out of an area would likely be replaced by others from nearby areas.

Biological Perspective on a Size Increase in Lobsters

The minimum size for keeping lobsters in Newfoundland and Labrador has been increased from 81 mm to 82.5 mm carapace (back shell) length. When people were discussing the issue of whether to increase the legal size limit for lobsters, the question was asked: What would happen to the 81 mm and 82 mm lobsters that would have to be thrown back when caught? Scientific statistical tools have been developed that can answer this question. Biological models have been developed to determine yield-per-recruit and egg production-per-recruit for Newfoundland lobsters. ("Recruit" here means a lobster that has reached the legal minimum size limit for the commercial fishery, and has been 'recruited' into the commercial stock.) The yield and egg production numbers were generated, using the biological models, from the recorded biological relationships of lobsters at Arnold's Cove, Placentia Bay. While the results using similar records from other areas would be somewhat different, the numbers from Arnold's Cove can be taken as generally representative of Newfoundland lobster populations.

The yield-per-recruit model was run with a starting population of 1,000 males and 1,000 females. Half of them (500 from each gender group) measured 81 mm CL, and half were 82 mm. The analytical model also assumed a minimum legal catch size of 83 mm, and an exploitation rate of 85 per cent of available lobsters. The analysis showed that the 2000 lobsters, if caught at 81 and 82 mm CL, would weigh a total of 867 kg (1,911 lbs). However, if they were returned to the water to grow, 1,700 (85 %) would be harvested over the next several years, at a total weight of 1,150 kg (2,530 lbs). This would mean a 12 per cent reduction in numbers caught, due to natural mortality rate, but a 32 per cent increase in the total weight harvested.

The egg production-per-recruit model was run with a starting population of 1000 females (500 each at 81 and 82 mm CL). If harvested at those sizes an 85 per cent exploitation rate, they would produce about 1,000,000 eggs before being removed from the total stock. However, if the size limit were increased to 83 mm, the same 1000 females would be able to produce more than 7,000,000 eggs before being harvested. Clearly, the smallest of the commercial lobsters being harvested today have potentially much greater value than is currently being realized.

The Economics of Allowing An Undersized Lobster to Grow

DFO shellfish scientists in Newfoundland have studied, among other things, how much an individual lobster grows when it moults. Through the use of a tag designed to remain attached to the lobster after it moults, the carapace length moult increment (i.e. how much longer the new backshell is than the previous one) has been accurately recorded for many individual lobsters at six different sites around Newfoundland. The relationship between carapace length and the weight of the lobster has also been determined from biological sampling at these sites. This relationship provides a basis for estimating weight gain after moulting.

Moult increment varies between individual lobsters, between males and females, and to some extent between areas. Results from the Arnold's Cove study illustrate the growth per moult of lobsters that are just smaller than 81 mm carapace length. At this size, male lobsters, on average, weigh 435 grams (454 grams = 1 lb). They grow 13 mm in carapace length when they molt, and weigh 680 grams (1.5 lbs) at the larger size. This represents a 56 per cent weight increase in a single moult. Female lobsters at just under 81 mm CL weigh an average of 410 grams, add 10 mm to their carapace length when they moult, and weigh 560 grams at the larger size, for an average weight increase of 37 per cent. The average weight gain on moulting for male and female lobsters together is 47 per cent. Among those lobsters just below 81 mm present in the population during the fishing season, about half the non-berried females will spawn during the summer. More than 90 per cent of the remaining females, and 90 per cent of all the males, will moult.

Table 2: Size, weight and value of male and female lobster before and after a single moult.

	Before	After	Increase:
Male	81 mm CL	94 mm CL	16 %
	435 grams	680 grams	56 %
	$5.27	$8.24	$2.97 (45 %)
Female	81 mm CL	91 mm CL	12 %
	410 grams	560 grams	37 %
	$4.97	$6.78	$1.82 (36 %)

(Based on year 2000 lobster prices.)

Size frequencies obtained from sampling commercial catches quite often indicate a large reduction in the abundance of lobsters around 90 mm CL compared to the smaller commercial sizes. This suggests that many lobsters just under the legal size limit were harvested during the previous fishing season. Given the increase in weight that these would achieve if left in the water for just one more summer, this poaching represents a tremendous waste of the resource.

MEASURING SUCCESS

It is easier in some industries than in others to measure the resource. In forestry, for example, it is relatively easy to determine the supply of trees that are available in any given area. It is not quite as simple when you are dealing with species that live in the ocean. Therefore, data that is collected and analyzed over a number of years is important in determining whether conservation measures are having a positive effect. Scientific research data from scientists and observations by fishers seem to support the conclusion that the measures taken by the Eastport Peninsula lobster fishers are having a positive impact. This is very reassuring to fishers who have maintained and strengthened their commitment to the conservation practices they adopted.

There appears already to be an increase in total landed weight due to the practice of returning undersized lobsters to the water. The released lobsters stay in the local area, grow, and are caught again, if not by the fishers who caught them first, then by other fishers in the region. In the long term, all fishers benefit.

The positive impacts of v-notching and the closed areas may take longer to become obvious. It takes up to 10 years for a small lobster to reach legal harvest size. Since the v-notching part of the initiative was only started in 1996, it may be 2004 or later before fishers are able to reap the benefits of these actions. The results of protecting some areas from all fishing, and allowing those to 'seed' surrounding areas, may likewise take several more years to show up in the area's fishery.

Table 3: Total and average lobster catches, 1989-1996, for three Eastport Peninsula fishing enterprises.

YEAR	1989	1990	1991	1992	1993	1994	1995	1996
Weeks fished	8	10	8	8	9	9	7	7
Total pots fished	750	750	750	750	750	600	600	600
Total Landings (lbs)	3370	5088	6053	6475	4481	5939	5559	6185
Av. catch/pot (lbs)	4.49	6.65	8.07	8.50	5.98	9.90	9.26	10.31
Av. per pot/week	0.56	0.67	1.07	1.06	0.75	1.10	1.32	1.47

Note the sudden decline in all catch figures in 1993, and then a steady recovery during the next three years.

RAISING AWARENESS

The Eastport Peninsula Lobster Protection Committee needed to raise the level of awareness about the importance of their conservation efforts with a number of different groups, including:

- Fishers in the Eastport Peninsula region
- Other fishers in other regions
- Community residents

Fishers in the Eastport Peninsula Region

Through involvement in the lobster conservation initiative, most of the licenced fishers in the area became aware of the importance of the principles of good stewardship. With the help of scientific data and their own catch results over several seasons, and through their own personal discussions over time, it became clear that the initiative was having the intended effect. The fishers saw that the predicted benefits of releasing undersized lobster were happening within one or two fishing seasons. With the scientific research that was being conducted and the sharing of the data with the members involved in the initiative, fishers then became more confident that v-notching egg-bearing females would also have a positive affect on lobster stocks. They accepted the proposition that once the eggs hatched from the released females, and started to produce additional harvestable lobsters, their strategy would be paying off. These results were shared amongst the fishers in the region, and very quickly the benefits to the entire group of licenced lobster fishers on the Eastport Peninsula became an accepted reality.

Other Fishers in Other Regions

Through fisheries meetings, these positive results were shared with fishers in other regions. They wanted to know about the improved landings, and they also wanted to know how these results could be achieved in their region. More publicity was achieved when a popular CBC television program, *Land and Sea,* featured the success of the Eastport Peninsula Lobster Protection Committee.

The success of the Eastport Peninsula initiative was acknowledged when the Canadian Centre for Fisheries Innovation presented the 1999 award for Fisheries Innovation to the project. On April 28, 2000, the Committee's efforts were further recognized when chairman George Feltham accepted the prestigious Roméo LeBlanc Award for Responsible Fishing on behalf of his fellow fishers at an official ceremony at Rideau Hall in Ottawa.

Student Involvement in the Eastport Initiative

These developments raised the community's awareness of the importance of lobster conservation. The fishers were particularly interested in involving students in the initiative. They felt that the next generation should be made aware of what was involved in creating a sustainable lobster fishery and at the same time protecting the ecology of the region. There is a delicate balance between the fishing effort - which is an important source of income for fishers and their families - and protecting the long-term viability of the lobster stock for future generations of fishers. Some of the students may become fish harvesters. The development of responsible fishing attitudes would help to ensure that the lessons of the past would not be forgotten and that there would never be a time when the health of the stock and the viability of the fishery would be in question.

The fishers also realized that some of the problems with the lobster stocks were not their fault. Poaching by non-fishers had also been a problem. They realized that both fishers and the general public must adopt responsible fishing attitudes, and that this is important to all species, not just lobster. The Committee members saw the involvement of students in the project was an important element in achieving necessary attitude changes.

Grade seven students at the local school serving the communities of the Eastport Peninsula were directly involved in aspects of the scientific research. Each year, they studied aspects of lobster conservation as part of an optional research project in their science program. They also participated in a field trip with a fisheries scientist to learn more about the lobster conservation measures. They learn about the biology of lobsters, including their habitat, migratory patterns and life cycle, and the methods used to catch them.

Students investigate the environmental aspects of the lobster fishery. Part of this involves an examination of the fishers' log books, which record catch rates, the level of catch effort, and environmental conditions such as water temperature. This enables them to explore and discuss concepts such as the impact of environmental factors on fish stock growth and catch rates in the fishery.

Students have entered logbook data on spreadsheets, then analyzed it and created data charts using the computerized spreadsheet program. They created a web site to share information from the project with others around the globe. One of their hopes is that this initiative will foster community participation in fisheries conservation and good management elsewhere in the world. Through these and other activities, the students have become more aware of the importance not only of good lobster management, but also the importance of learning and self-discipline on the part of fishers.

Involving students also helps to raise the level of awareness with adults in the communities involved. Students talk to their parents, and often influence their parents' attitudes on various matters quite significantly.

It was also important that the need for the initiative was recognized by the fishers themselves. These weren't rules that were imposed on them by DFO. Rather they were rules that they themselves helped to create so as to secure the supply of lobsters for themselves and for their descendants who will want to pursue this fishery.

SUMMARY

The fishers involved with the Eastport Peninsula Lobster Protection Committee are convinced about the benefits of fishing responsibly. They have made their own observations as they pursue their livelihood in the fishery, and these observations have been confirmed by scientific data that was conducted over a number of years in the waters off the Eastport Peninsula. The results have given them a great deal of confidence in the future of the lobster fishery, and have convinced them to apply the principles of responsible fishing to other species and fishing methods. Because of their responsible fishing attitude, they have improved the income from this fishery, which has benefited their families and the local economy.

Expand Your Knowledge

1. Prepare some questions that you can use to interview a fisherman about the benefits of conservation. Conduct the interview and record his/her answers.

2. Prepare some questions that you can use to interview a fisherman about the methods he/she uses to catch lobsters. Some things to ask might include: How do you know where to set traps? What do you use for bait? What conditions might suggest that there will be lobster in the traps?

3. Why is it to the advantage of fishers and the lobster stock for undersized lobsters to be thrown back?

4. Why is it a good practice for an egg-bearing female to be returned? How does v-notching help in the practice of responsible fishing?

5. Trust is an important part of the responsible fishing methods used in the Eastport Lobster Protection Initiative. Discuss.

6. It makes good economic sense to allow a lobster to moult. Explain.

A Lobster Field Trip for Eastport Peninsula Students

Students go lobstering.

Scientist on the grounds.

Hauling a lobster pot.

Class is about to start.

Dr. Gerry Ennis.

Egg-bearing female lobster.

Two more lobsters.

Measuring a lobster

Fast rescue craft, in case.

This is what it's all about – cooked lobster, one of the world's great culinary dishes.

The Roméo LeBlanc Medal and Awards for Responsible Fishing

The Roméo LeBlanc Medal and Awards for Responsible Fishing were created in 1999 by the Canadian Responsible Fisheries Board, the governing body for the Canadian Code of Conduct for Responsible Fishing Operations. As patron of these awards, the Right Honourable Roméo LeBlanc, former Governor General of Canada, expressed his support of the Canadian Responsible Fisheries Board and lent his name to the Medal and Awards.

The Roméo LeBlanc Medal and Awards for Responsible Fishing are presented annually in recognition of the outstanding contribution by Canadian commercial fishermen to the development and practice of responsible fishing principles as expressed in the Canadian Code of Conduct for Responsible Fishing Operations.

Four fishermen, one from each of the Atlantic, Pacific, Arctic and freshwater commercial fisheries are selected for the Awards. From these four laureates, the Medal is awarded to the one individual who has demonstrated exceptional contribution to responsible fishing in the spirit of the Code. The Code is a significant step by Canada's fishing industry towards achievement in sustainability in marine and freshwater fisheries. It contributes directly to the conservation of fish stocks and the protection of the aquatic environment for present and future generations of Canadians.

The nominees for the Awards must be active, practising Canadian commercial fishermen. They must be nominated by their peers, associations or others related to the commercial fishing industry. The Canadian Responsible Fisheries Board Awards Committee assesses the nominations according to the established criteria and selects the laureates.

Year 2000 was the first year of the annual Roméo LeBlanc Medal and Awards for Responsible Fishing. The laureates represent the national commitment being made by Canadian fishermen to the sustainability and conservation of our ocean resources.

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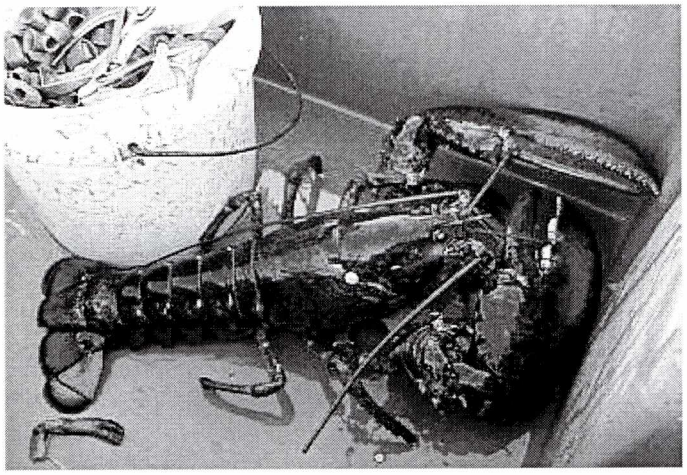
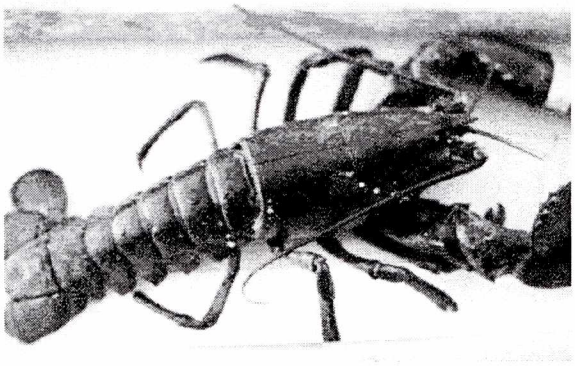
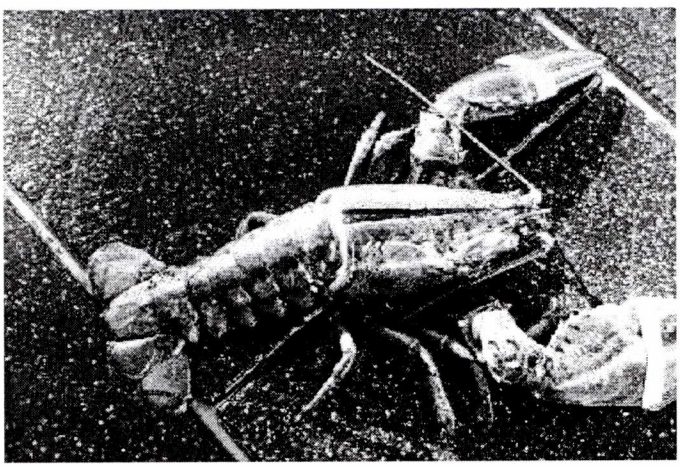
The Moulting Process



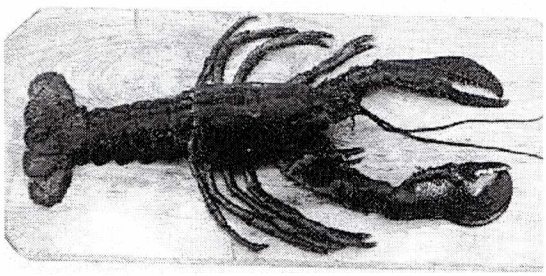
A freshly caught lobster, in full hard shell.



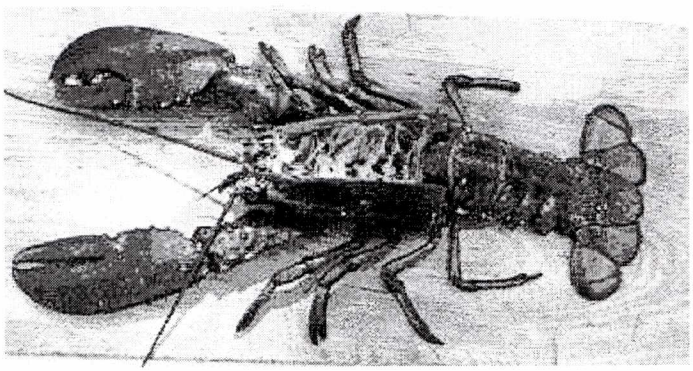
Another lobster. This one is just starting the moulting process - you can see a sharp, straight line where its body shell (carapace) is starting to split along the center.



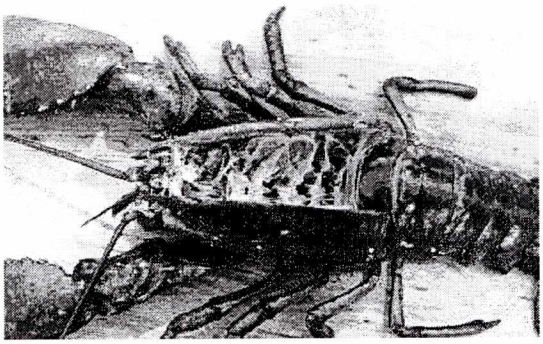
The lobster is arching its body, between thorax and abdomen, and the back shell is opening up wider. It will continue to bend and force open the shell until it is able to wriggle out of it altogether.



The lobster has completed the moult, and lies limp and exhausted. The new shell is paper thin and soft, and of no great protection should he encounter an enemy. If he were in the ocean now, he would begin sucking in water to puff himself up and fill out the new shell. He will now develop a fierce appetite, eating both to grow into his new suit and to harden it into his new protective armour.



The abandoned shell of a moulted lobster.



A closer look at the same shell.

GILLNETTING

THE NATURE OF GILLNETS

In Canada, gillnets are used to harvest many species of finfish, including herring, Pacific salmon (in British Columbia), Arctic charr (in Labrador and the Arctic), smelt and Gaspereau (in the Maritime provinces), and most groundfish species in Atlantic Canada.

A groundfish gill net is 91 metres (50 fathoms – 300 ft) long and 25 meshes deep. These measurements remain the same for most nets, regardless of mesh size. Mesh size in gillnets varies considerably, according to the species a net is designed to fish. Mesh size is measured from the inside corner of one mesh to the diagonally opposite corner. When determining the mesh size of a particular net, at least 20 meshes should be measured, to give a fair representation of the mesh throughout.

The nets are constructed principally of monofilament netting (groundfish) or nylon netting (pelagics) and may be either secured to the bottom of the sea with the use of weights, or left to drift. Individual gillnets are usually connected together end-to-end in a 'fleet'. According to their design, and with the use of different combinations of weights, buoys and mooring lines, gillnets may be used to fish on the surface, in mid water or on the bottom.

Fish are caught as they attempt to swim through the webbing. Groundfish species commonly fished with gillnets include cod, haddock, pollock, lumpfish, hake, winter flounder, monkfish, skate, and turbot. The pelagic species most commonly harvested with gillnets are herring and mackerel. (Salmon was also caught with gillnets before the commercial salmon fishery was shut down.)

HOW GILLNETS WORK

A fish caught in a gillnet is usually either hooked by the gills in a single mesh of the netting, or its body becomes firmly stuck in a mesh as it tries to force its way through. Sometimes the fish simply becomes tangled up in the net. Gillnets are said to be 'selective' in terms of mesh size – i.e. the larger the mesh, the larger the average size of fish retained; smaller fish pass through without being caught.

The configuration of gillnets varies with the species being sought. Directing for groundfish requires the gear be arranged to fish near the bottom. Directing for pelagic species requires the gear to be suspended up in the water column. The gillnet is kept upright in the water by a series of small plastic floats attached to a 'headrope' running the length of the net's upper side or edge. The bottom of the net rests on the sea floor (in the case of a groundfish net), held there by a leadrope (a hollow-core, lead-filled rope) attached to the 'footrope'. (Often the leadrope also serves as the footrope.)

When a fleet of groundfish nets is set, the lower corner at each end is anchored to the bottom with a heavy weight (often a tube of rubber or canvas filled with sand), and the top corners are attached, via a long buoy line, to a marker buoy at the surface. The buoy should be large enough to remain afloat even if the nets are somehow dragged off the fishing ground into water deeper than its mooring line. Large flotation buoys help prevent nets from becoming lost. For the same reason, the buoy line should be at least 1.5 times the depth of the water where the net is set. The buoy line is usually a floating polypropylene, and should have several feet of leadrope spliced into it several fathoms down to sink it straight down from the buoy. This will prevent passing vessels from becoming entangled in the line.

Usually a second buoy will be attached to the first with several fathoms of line. This second line will have attached to it a five- or six-foot buoyed pole, weighted at bottom to keep it upright in the water, and having a

small flag or metal radar reflector at the top. This is the 'high-flyer', designed to help fishermen locate their nets when visibility is poor. Flotation buoys and high-flyers should be attached to both ends of the fleet of nets. It will provide a lot of extra security at little extra cost. The buoys are marked with the owner's fishing vessel licence number. The buoys, with the high-flyer and buoyline, thus perform several vital functions. They let fishermen find their nets in all kinds of weather; they enable location and recovery of nets that have been moved by storm tides or other causes, and; of course, the buoyline is the means by which the fisherman starts hauling his net when fishing.

Fishermen are also required to attach a plastic tag (supplied by DFO) with a unique identification number on it to each fleet of nets, at one end of the headrope.

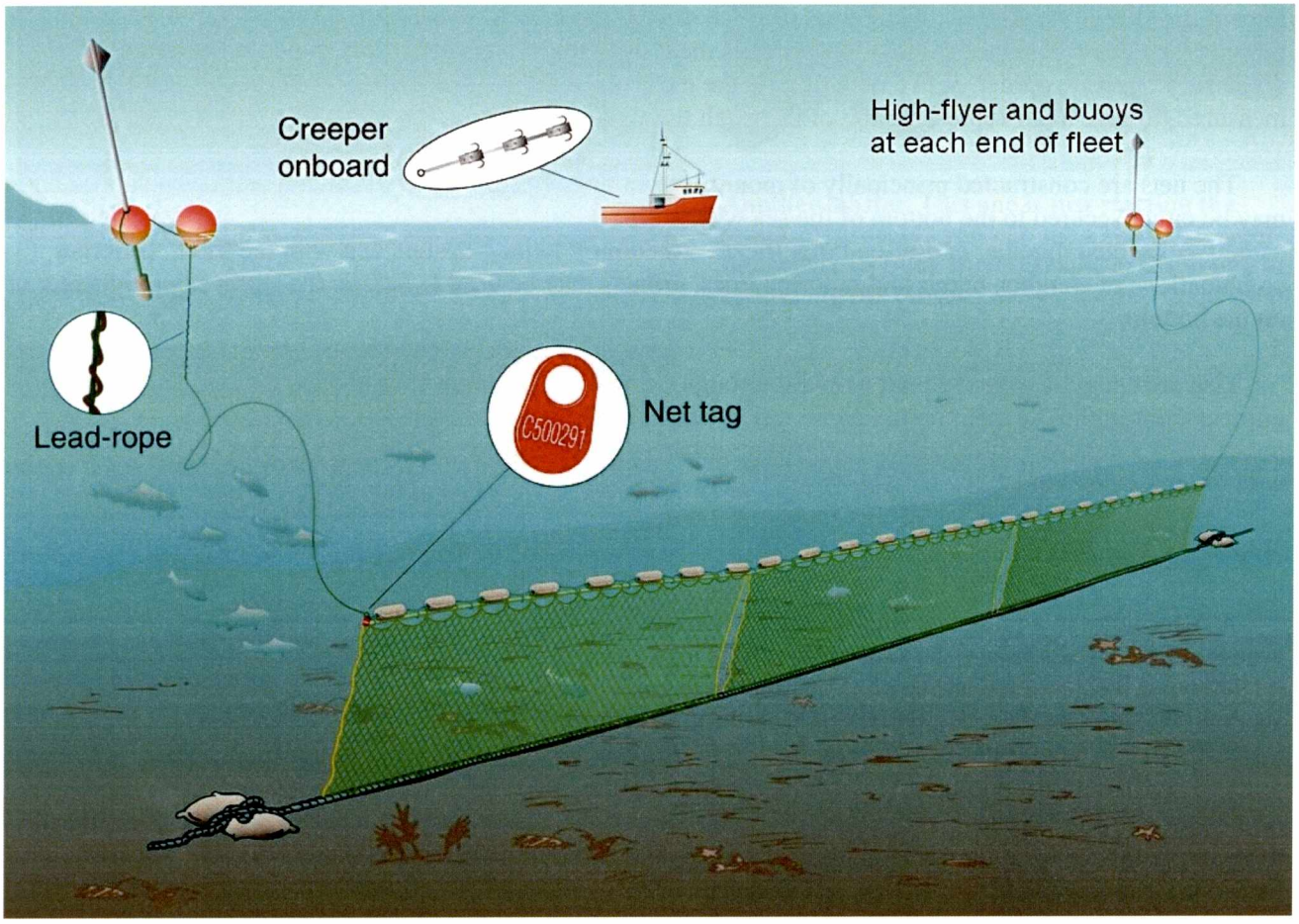


Figure 1: A fleet of three gillnets, illustrating some of the 'best practices' followed by responsible gillnet fishermen, including long buoylines sunk with leadropes, high-flyers and buoys at each end of the fleet, and a 'creeper' onboard for recovering lost nets

GILLNETS AND CONSERVATION ISSUES

Gillnetting is an ancient fishing technology, efficient and cost-effective across a wide range of species. However, while a gillnet of a particular mesh size is very selective in the size of fish it retains, it is not nearly as selective in species. So a gillnet set for cod, for example, may also catch crab, turbot, redfish, American plaice, etc. In recent years, for reasons of conservation and the quality of fish landed, gillnets have come under serious criticism in certain areas and certain fisheries. Their use in groundfish fisheries has been more and more closely scrutinized, and brought under growing restraints and restrictions.

The quality of fish landed becomes an issue when gillnets are not frequently hauled. Fish trapped in the nets for a number of days can deteriorate significantly, especially during periods of warm weather. Predators such as sea lice, hagfish and snow crab can also reduce the quality of fish left in the nets too long.

More troubling is the problem of 'ghost-fishing'. This occurs when lost or abandoned nets continue to fish untended, for months or even years. There is wide variation in the estimates of the numbers of 'ghost-nets', how long they fish and how much fish they catch, and therefore much debate about the seriousness of the problem. However, virtually everyone agrees that in some gillnet fisheries, 'ghost-fishing' is a significant problem, and that measures must be taken to reduce it.

There have been suggestions, even official recommendations, that gillnets should be banned altogether from certain fisheries and certain areas. However, there are problems of one sort or another with all gear types. For example, longlines frequently catch smaller less mature fish than gillnets, thereby putting added pressure on depleted stocks. Otter trawls damage the ocean bottom and bottom-dwelling species such as snow crab.

Some fishing gears have selectivity problems, catching various species other than those the fishermen are directing for. People who defend the use of gillnets, say the answer to their perceived problems - as well as the problems with other fishing gears - is more responsible use of the gear.

Responsible fishing is at the centre of efforts by the fishing industry, in partnership with Fisheries and Oceans Canada, to make gillnets more quality- and environment-friendly. The **Canadian Code of Conduct for Responsible Fishing** is an excellent example of the results of this partnership.

GILLNETS IN NEWFOUNDLAND AND LABRADOR

Monofilament gillnetting was introduced into the Newfoundland and Labrador fisheries in the 1960's, and over the next decade became important throughout much of the province, especially in the inshore cod fishery. The principal species fished with groundfish gillnets today are cod, turbot, lumpfish, skate, blackback (winter flounder), American plaice and white hake.

It is difficult to determine exactly how many groundfish gillnets are set in the province's waters in any given year. Approximately 4,700 Newfoundland and Labrador fishermen are eligible to fish groundfish with gillnets. These fishermen are licensed to fish other gears as well. Gillnet use will vary from species to species, area to area, season to season. It is safe to say, however, that there are tens of thousands in the water annually for varying periods of time.

Areas of concern

There is a wide variety of concerns with fishing gears and fishing practises in general. Perhaps only one, the notorious 'ghost-fishing', is associated almost solely with gillnetting. Some, such as size and species selectivity and best use of the resource, are also important issues in the gillnet fishery. Others are more or less common through the entire fishing industry. Fisheries managers, gear technologists, fishing companies and individual fishermen are all constantly searching for ways, frequently in close co-operation with one another, to deal with negative aspects of the industry.

1. **Size selectivity** - One of the most important features of any type of gear is the way in which it retains certain sizes of fish and allows others to escape. In particular, this is an important part of fisheries management, since the future of any stock is influenced by the size and maturity of the fish that are captured, and those that are left in the water. Size-selective harvesting can maximize the long-term yield from a resource.

2. **Species selectivity** - The ability to catch only targeted species, minimizing by-catches of other species, is another conservation requirement of harvesting operations. This is especially true with quota

management systems. Having both size- and species-selective gear reduces the incentive to discard unwanted catches overboard.

3. **Limiting catches** - Having the ability to control the volume of catches is an important characteristic of fishing gear. This assists fishers to stay within quotas or trip limits, minimizing the motivation for discarding and illegal landings. Limiting catches to levels that can be readily handled and stowed onboard also promotes improved fish quality and best use of the resource.

4. **Controlling gear losses and unintended fishing** - Every year, significant quantities of fishing gear are lost, for various reasons but especially because of adverse weather and environmental conditions. Besides contributing to the oceans' garbage collection, lost gear will entrap and kill various marine species. The most notorious and possibly the most destructive of 'ghost fishing' gear is lost gillnets.

5. **Best use of the resource** - The key is to maximize the quality of the fish that is landed. Some adverse quality effects may be due to certain characteristics of the gear being used. However, how the gear is operated (e.g., leaving gillnets too long in the water) is often a major cause of poor quality landings.

6. **Protection of marine mammals and birds** - This is a selectivity issue of great concern to the general public as well as to the fishing industry. Many environmental groups and government agencies have targeted specific fisheries and types of fishing gear because of incidental catches and mortality of marine mammals and birds that have occurred. Besides the actual loss of these important creatures, this has resulted in much adverse publicity and regulatory action for some fisheries.

7. **Impacts on the ocean environment** - Probably the most commonly expressed concerns about the effects of fishing gear on the marine environment, are sea bottom damage by deepwater trawls and "ghost-fishing" by lost or abandoned gillnets. Both impacts can be reduced with modern gear technology and responsible fishing practices.

8. **Impacts on the whole environment** - Probably more than any other issue, this one is common to all fishing operations, and for that matter to many other industrial operations as well. Improving vessel engine fuel efficiency and bringing garbage and other unwanted materials back to port rather than dumping them overboard are just two ways of reducing adverse impacts on the whole environment.

Lost Gear - Recovery Efforts

Since the first moratorium on cod fishing was announced in July, 1992, the number of gillnets in use throughout Newfoundland and Labrador has declined dramatically. Every year, however, some gillnets are lost. Some are swept away by storms, ice or heavy tides. Others are lost through conflicts with other gears, or have their buoy lines cut by passing vessels. In some cases, nets have been cut adrift by rival fisherman, and sometimes nets have been abandoned at season's end or after quotas have been caught.

No one knows for sure how many gillnets are lost in the run of a year. No regular or widespread studies of the problem have been carried out, and figures presented over the years by various parties have not always been supported by strong research.

In 1975, Fishing News International reported that approximately 5,000 gillnets were lost in Newfoundland waters during the previous year. In 1992, a discussion paper prepared by a St. John's company stated that approximately 80,000 gillnets were lost throughout Atlantic Canadian waters in during the period 1982-92, two-thirds of them in deep water.

During the 1999-2000 winter cod fishery in Placentia Bay, many cod gillnets were lost when a large influx of fishermen from throughout NAFO sub-division 3Ps resulted in an unprecedented number of nets in the bay.

Fishers reported the loss of more than 180 nets. Because some fishermen are negligent in reporting gear losses, it is almost certain that the total number lost was higher, though how much higher is impossible to say.

The most exact figures on the problem come from the few efforts made to recover lost gillnets over the years - though it is recognized that such efforts do not come close to a full recovery of nets lost. In a 20-sea-day period in November-December, 1975, a total of 148 gillnets were retrieved off Trinity Bay and Bonavista Bay. In October-November, 1976, a total of 176 nets were recovered from the Notre Dame Bay area. Most of the gear recovered in these two operations was in good condition and was estimated to have been lost sometime during the previous four years.

In February, 1984, the local Fishermen's Committee at St. Joseph's, St. Mary's Bay, with DFO funding, undertook a 15-day recovery effort around Cape Pine. Only 16 nets were recovered. In November of that year, the St. Brides, Placentia Bay, Fishermen's Committee failed to find any nets in a five-day recovery effort, despite reports of gear having been lost. Both of these areas had very rough bottom conditions, and damage to retrieval gear was frequent.

From May, 1999, to April, 2000, Fishery Officers recovered approximately 60 lost or abandoned cod gillnets in Placentia Bay. Many of these were taken up in a major retrieval effort after the fishery closed in March, 2000. The department was reacting partly to reports that some of the nets lost had been deliberately abandoned, or cut adrift by rival fishermen. The retrieval effort was part of an extensive investigation aimed at enforcing the requirement to report lost gear and to remove nets from the water before season close time.

'Ghost-fishing'

There is no doubt that lost and abandoned gillnets continue to catch and kill fish of various species. However, the question of how much fish is destroyed is debated even more than the numbers of nets lost. Some people speculate that gillnets lost in shallow water - under 50 fathoms - tend to be rolled up and put out of fishing order by the first storm that occurs after they are lost. However, gillnets lost in deeper water have been retrieved after several years with live as well as dead fish in them. In general, the length of time a lost net continues to fish is significantly affected by a number of factors, including water depth, bottom conditions and current, wave and tidal actions. During recovery efforts, it was found that marine growth was present on nets lost for more than one year, and the amount of fish in those nets was less than in nets lost for a shorter period of time. Nets found in water depths of less than 50 fathoms were often rolled up tightly enough that they caught few fish. Some lost or abandoned nets are put out of fishing order in a matter of months; others will remain in more or less good fishing order for as long as three or four years or more.

Table 1. Condition of fish in nets recovered.

Species	Weight (lbs)	% alive	% dead
Cod	2,169	61	309
Turbot	12,476	49	26
Am. plaice	240	55	27
Catfish	1,953	80	15
Skate	414	53	21
Crab	8,935	96	4
Witch flounder	13	0	75
Wolfish	317	96	4
Lumpfish	4	0	100
Redfish	2	0	100
Sculpins	20	100	0
Seals	150	0	100
TOTAL	26,693		

In 1975-76, DFO undertook two major net-recovery projects off Newfoundland's northeast coast. A total of 148 nets recovered in Trinity Bay and Bonavista Bay in 1975 contained a total of 10,087 lbs of fish, including 4,355 lbs of turbot and 3,220 lbs of snow crab. The 176 nets recovered the following year off Notre Dame Bay contained 16,327 lbs of fish, again mainly turbot and crab. The snow crab by-catch is especially troubling. Snow crab currently comprise approximately half the total value of the province's fishing industry. (The landed value is the price of the fish as paid directly to fish harvesters.) The species has also assumed an extremely important role in terms of

employment, as well. The rapid expansion of total crab quotas, and the issuing of crab fishing licences in recent years to large numbers of fishermen who had not fished crab before has enabled many people to stay in the fishery after the decline of cod and other groundfish fisheries. (For several years, these permits were issued on an annually renewable basis. After continuous lobbying by fishermen, they were turned into 'permanent' licences in 2003.)

The lost-gillnet problem may have been worse in the 1970's than at any other period. It is said by many fishermen today that a government-funded gear-replacement program during the period led fishermen to be less concerned than they might otherwise have been about lost nets. These fishermen believe that government should make greater efforts to anticipate such unintended consequences of any assistance or other programs.

GILLNET RESEARCH PROJECTS

Size Selectivity

In recent years, both industry and government have increased their efforts to develop fishing gear and fishing practices that will reduce the retention of smaller fish. In some areas, fisheries had to be closed because the retention of fish under 43 cm (17") exceeded the limits established by DFO protocols limiting the catch of such small fish to 15 per cent of the total catch. Enabling individual fishermen to reduce their catches of small fish is an obvious remedy to the problem. The positive effect would be two-fold: a contribution to stock conservation and to the rebuilding of depleted stocks, and the provision of enhanced economic return to fishermen, who would be landing larger, more valuable fish.

Various fishing trials have been carried out to determine the relationship between gillnet mesh sizes and the quantity, size and species of fish harvested. For example, as a result of much experimental work off Newfoundland in the early 1980's, DFO increased the regulatory minimum mesh size for groundfish gillnets from 5" (130 mm) to 5 ½" (140 mm). Subsequent tests designed to review the effectiveness of these mesh sizes reconfirmed that using nets with larger mesh size does tend to catch fish of larger average size, and that reducing the catch of smaller fish did not reduce fishermen's income.

In 1997, gillnet size-selectivity experiments were conducted, comparing groundfish catches of cod with gillnets of 5 ½", 6" and 6 ½" mesh. Twenty-two fishing enterprises in Western Newfoundland and Southern Labrador participated in the study. Twenty vessels under 35' fished a maximum of 18 nets each (6 of each size) and two vessels over 35' fished a maximum of 45 nets each (15 of each size) The catch from each mesh size was measured and kept separate. All vessels recorded the total weights and number of fish caught per mesh size on a daily basis.

When catch levels permitted, a total of 250 fish from each mesh size were measured each day (The two larger vessels were required, to the degree possible, to record these measurements for catches from each individual fleet of nets.) The results from the project show that as the mesh size is increased the average size of fish retained also increases in regular intervals. (Table 2)

Table 2 also shows that these mesh sizes will be better able to meet the requirements of DFO small-fish protocol, keeping the catch of small fish (under 43 cm.) below 15 per cent of the total overall catch in a particular fishery or area. The average weights of fish caught varied from enterprise to enterprise. This may have been related to the size of fish the nets were exposed to. However, when all samples were included there was a significant difference in the average weight of fish caught by each mesh size. With each ½" increase in mesh size the average length of fish retained increased by approximately 3 cm. The average weight increased by more than ¾ lb. (Average weight figures are based on data from 15 of the 22 enterprises.) Because of the large number of biological and economic variables involved, the experiment did not provide sufficiently clear information to enable researchers or fisheries managers to conclude whether a particular mesh size would be

Table 2: Average size of cod caught using various mesh sizes in a gillnet selectivity experiment in NAFO Division 4R (western Newfoundland).

Mesh Size	Average length	Average weight	43 cm or less
5.5"	60.5 cm	4.58 lb	3.22 %
6.0"	63.5 cm	5.47 lb	3.79 %
6.5"	66.5 cm	6.26 lb	3.57 %

the most appropriate one to use in groundfish gillnet fisheries. To make that decision, researchers and managers need additional information - on biology, on prices and on costs and effort associated with targeting particular sizes of fish within a given fish stock.

Selectivity of Deepwater Turbot Gillnets

Several studies of deepwater turbot catches by gillnet vessels operating off the east coast of Newfoundland and Labrador have been conducted to measure catch rates, by-catches of other species and the relationships between mesh sizes and the size of fish caught.

In one of these studies, gillnets with mesh sizes ranging from 6" to 8" (140 to 203 mm) were evaluated off Newfoundland in water depths ranging from 450 to 750 fathoms (820 to 1,370 m). Results indicated that the size of turbot caught did increase with mesh size. Maximum catch rates were achieved with 7 ½" mesh (191 mm) whereas the nets with the smallest (6" - 152 mm) mesh size resulted in the lowest catch rates. By-catches of snow crab, skate and roughead grenadier were also reduced with the larger-mesh nets. A subsequent survey indicated that it was not necessary to fish 600 to 700 nets at one time, since fishing only 300 to 400 nets provided good catches.

Further fishing trials in deep waters off the coast of Labrador again confirmed that the best catch rates were attained with large-mesh nets and with 'soak times' (length of time nets are in the water) not exceeding six days. Fishermen are encouraged to use large-mesh gillnets (i.e. greater than 7") in these turbot fisheries since they simultaneously provide the lowest by-catches and the highest catch rates of large turbot, which are in greatest market demand.

Since it has also been demonstrated that it is possible to achieve good catches with approximately half of the gear traditionally used in this fishery, there are significant savings as a result of lower fuel costs, less time required to catch a particular amount of fish and lower gear costs"

Large-Mesh Gillnets for Lumpfish

The Newfoundland lumpfish fishery is conducted with gillnets having a minimum mesh size of 10 ½" (266 mm), compared to minimum mesh sizes of 5 ½" to 6 ½" (140 - 165 mm) in the gillnet fisheries for other groundfish species. For this reason, bycatches of non-targeted species such as cod are limited in the lumpfish fishery.

Reducing Porpoise Mortality from Gillnets

Harbour porpoises are captured incidentally by commercial fixed-gear fisheries, primarily in the Gulf of Maine and the Bay of Fundy. The groundfish gillnet fishery accounts for most of the incidental catches, while the remainder is caused by herring weirs. Unfortunately, most of these porpoise interactions with fishing gear are fatal. Beginning in 1991, a number of technical and management measures were evaluated to minimize porpoise bycatches in this Canadian gillnet fishery. These included:

- Attaching acoustic deterrents ('pingers') to the gillnets.
- Time and area closures, since most porpoise bycatches occurred in several small areas, and at certain times of the year.
- Limiting the time that nets are allowed in the water.
- Restricting fishing to nighttime, when porpoises may be less active.

- Restricting the depths at which nearshore gillnets are set, since it was found that porpoises will dive as deep as 60 fathoms.

Testing of 'pingers' as a possible measure of reducing porpoise by-catches in high-risk areas began in 1995. Results indicate that porpoise by-catch rates can be reduced by up to 90 per cent in nets with such acoustic alarms, as compared to nets without. In 1995, with pingers in use, Canadian gillnetters had a by-catch of only 87 harbour porpoises, compared to an estimated of 424 in 1993. Closing the gillnet fishery from July 21 to August 31, has also helped reduce porpoise by-catch.

Electronic Devices for Locating Gillnets

Experiments have been conducted off Nova Scotia to determine if side scan sonar technology could be used to detect lost gillnets on the sea bottom. Results showed that on sandy bottoms, side scan sonar detected gillnets on 82% of the passes. On gravel sediments, however, the results were poor. Since many gillnets are lost on rough bottoms, it was therefore concluded that this technology was not a practical method for detecting lost nets.

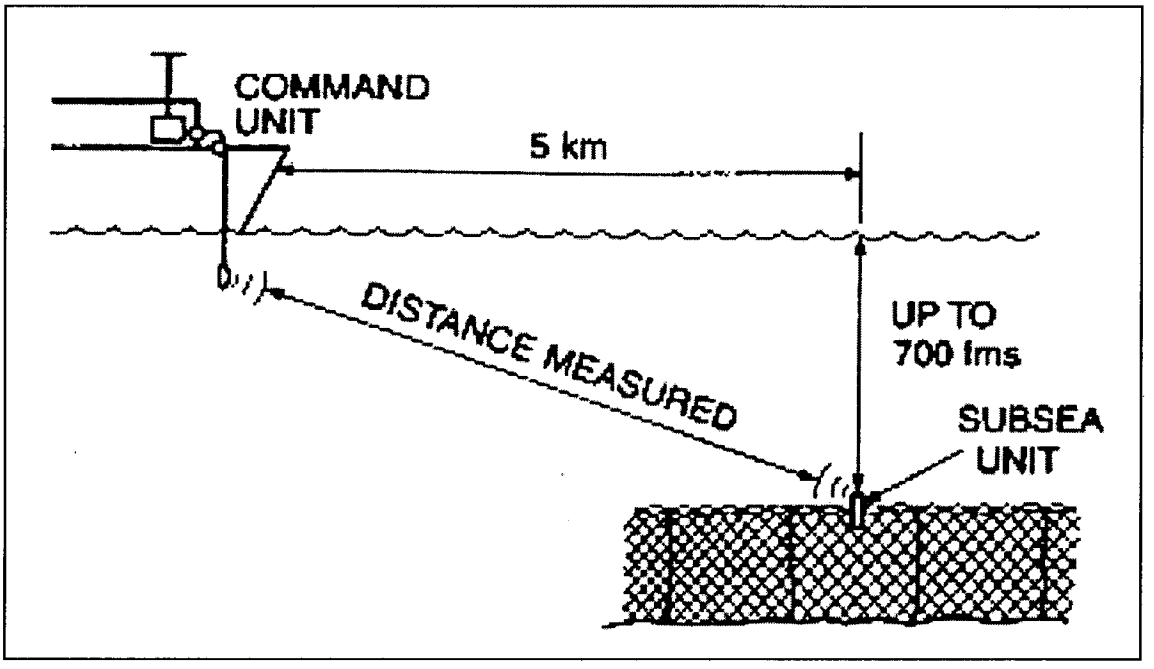


Figure 2: Researchers in 2002 were testing an underwater electronic signaling device for locating lost gillnets.

Another approach to this ghost fishing problem has been the development of devices for locating lost gillnets. A company in Newfoundland has recently developed such an electronic locator system, which is not as yet in widespread use. When this system is activated by an acoustical signal in the water, an electronic device attached to the net begins transmitting a signal that enables the fishing vessel to determine its precise location.

As in most things, prevention is the best cure, since the retrieval of ghost nets from the ocean bottom is extremely difficult and expensive. DFO measures to reduce this gillnet problems include:

- Regulatory limits on the number of nets that can be set
- Requirements on how they must be operated (i.e., tended)
- The compulsory use of biodegradable components to disable their catching capabilities
- Gear marking systems.

How DFO and Fishermen Are Dealing With the Issues

The Department of Fisheries and Oceans has attacked the problem of lost and abandoned gillnets from different angles, including fisheries management measures, the development of a set of 'best practises' for gillnet use, and actions to inform and advise fishermen on the proper, responsible use of gillnets.

A video entitled **The Gillnet Debate** was produced in March, 2001. It discusses the pros and cons of gillnet use, and sets out various practises by which responsible fishermen can make effective, non-damaging use of this potentially destructive gear. The video is available for borrowing, by fishermen and other interested persons, from video libraries established in 23 DFO and DFA (provincial Department of Fisheries and Aquaculture) offices throughout the province. (See For Your Information – Videos section for locations of these video libraries.)

DFO also produced in 2001 a brochure entitled *The Gillnet: A controversial gear requires responsible fishermen*, and a complementary poster, to supplement and reinforce the basic message of the video, which is that gillnets must be used responsibly if they are to continue to have an important place in our fisheries.

The message that gillnets can be used responsibly - and are being used responsibly by many fishermen - is clearly expressed in a second video – **Gillnets: The Responsible Way** - funded by the Fisheries Diversification Program and produced by Memorial University's School of Continuing Education. The primary aim of this video is to illustrate the practices and procedures followed by responsible gillnet fishermen. Several fishermen are interviewed and filmed, onshore and while fishing. This video too is available through the DFO/DFA video libraries throughout the province.

DFO Management Measures

The department has put in place, as conditions of receiving a fishing licence, certain management measures that fishermen must follow when engaged in certain gillnet fisheries.

- Limits have been put on the number of gillnets that can be set in certain fisheries in particular areas.
- Nets in certain fisheries were required to be tagged in 2001. This measure was extended to all gillnet fisheries in all areas in 2002.
- Fishermen must report the loss of any gillnets.
- Minimum mesh sizes are regulated in the various gillnet fisheries, to reduce the catch of small fish and to reduce by-catch of other species.
- In specified areas, inshore nets must be tended within 48 hours, and offshore nets must be tended within 72 hours.
- In many areas, gillnets must be removed from the water by October 31.

Best practices in fishing gillnets

DFO has also defined certain fishing practices as 'best practises' for fishing gillnets responsibly. These practises will minimize the impact of gillnets on fish stocks, fish habitat and the marine environment generally, and will help ensure good quality and high-value landings. They are aimed mainly at preventing gear loss. Most people consider such practices 'common sense', and many fishermen have long been accustomed to following most if not all of them.

- Don't set more gear than can be handled regularly and efficiently under most conditions. One of the main causes of lost gear is the setting of too many nets. Perhaps the gear can all be tended in a timely fashion as long as weather and other conditions are excellent, but as soon as something occurs to slow things down, gear is left untended for extended periods of time, and the chance of nets coming unmoored or being dragged off the grounds is greatly increased.

- Always use radar reflectors to mark gear. Place them at both ends of a fleet of nets. Radar reflectors don't just help fishermen find their gear under difficult weather conditions. More importantly, they warn other fishermen, and other marine traffic, that fishing gear is nearby and they should proceed with caution. Many gillnets are lost when passing vessels cut or tear away buoy lines, and marker buoys are lost.

- Use inflatable buoys, large enough to stay afloat even if the gear is dragged into water deeper than the buoy line. When tide or ice drags gear off the grounds into deeper water, small buoys, especially wooden buoys, will be dragged under the water by the weight of the nets, and will be no help in locating the displaced gear.

- Use buoy lines at least one and one half times the depth of the water where the gear is set. This serves a similar purpose to using large, inflatable buoys. If gear is dragged into deeper water, the buoys will still remain fully afloat if the buoy lines are long enough.

- Place buoyed lines at each end of a fleet of nets. It will double the protective features of visibility and flotation.

- Use lead-ropes to sink the buoy lines. The lead-rope should be placed well down the buoy line, to ensure that none of the buoy line floats at or near the surface. This will make sure that buoy lines are not cut or torn away by passing vessels.

- Pay attention to weather patterns and the forecast at all times and don't set gear when high winds are expected. When the weather is too rough for tending gear, the quality of the catch suffers from being in the nets too long, and there is a greater chance that nets will be lost. On the other hand, fishermen who attempt to hauls nets in high winds and rough seas are operating under unnecessarily dangerous conditions. There is also a greater likelihood of damaging nets, and of losing fish out of the nets, while hauling gear under such conditions.

- Don't set gear across other people's gear, whether it be gillnets or anything else. Sometimes gillnets are lost because the buoy lines are deliberately cut. This may be done for one of a number of reasons, but probably the most frequent cause is setting gear where it may interfere with other gear or with the tending of it. Fishers should set their gear parallel to any other gear in the immediate area where they are fishing.

- Don't set fishing gear in high traffic lanes. Setting gear in specific areas constantly used by vessel traffic multiplies the chances of lines being cut or nets dragged off the grounds.

- Carry some sort of gillnet retrieval gear onboard. If buoy lines have been lost, the gear may be hard to locate precisely. It may even be dragged off the location where it was set. Every vessel should have onboard a device (often called a 'creeper') that can be used to drag the bottom for displaced or lost nets. There are various designs, some home-made, some available commercially.

- Start searching right away for displaced or lost nets. Delaying the search only increases the likelihood that the gear will not be found, and that it will stay in the water fishing for weeks, months, even years, into the future. Drag the creeper in the area where the lost gillnets were set, on a line perpendicular to the set. If the search is started soon after the loss of the gear was discovered, the lost nets will probably be recovered.

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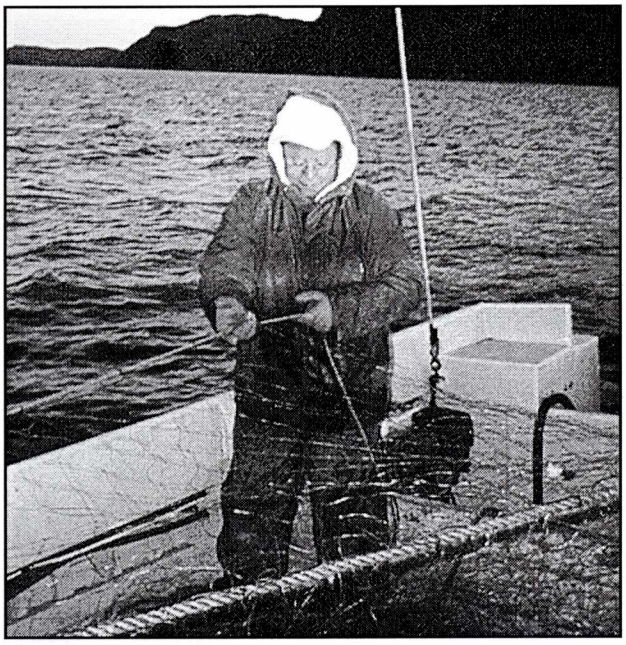
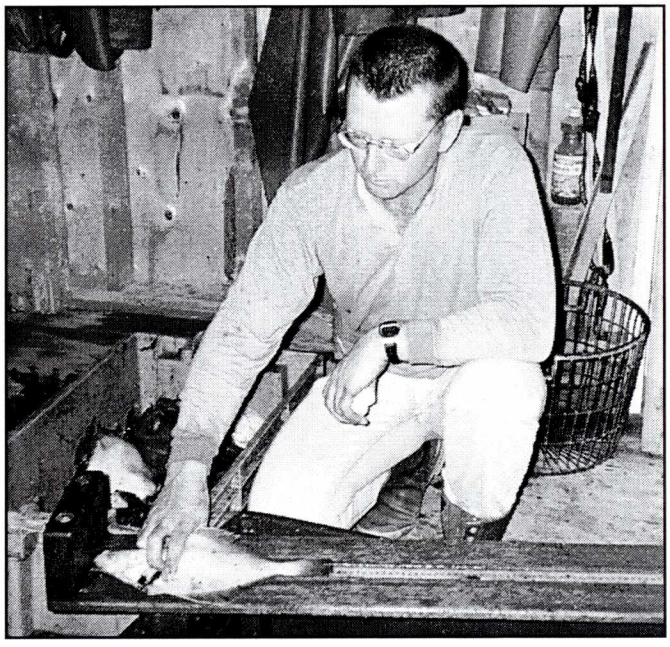
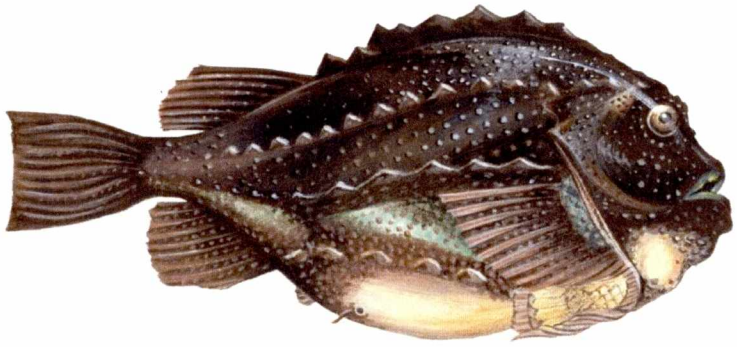




Left: Hauling a turbot gillnet. Right: Measuring American plaice from a gillnet selectivity project.

Gillnetting for American plaice as part of a conservation harvesting research project in western Newfoundland.



LUMPFISH

A Brief Biology

Description

Lumpfish (*Cyclopterus rumpus*) are unattractive creatures, acquiring their name due to their short stout body, which is covered by hard wart-like protrusions called tubercles. In Europe, lumpfish are commonly called lumpsucker. Other common names include henfish, seasnail, lump, paddle-cock, and poule de mer.

Life Cycle

The preferred spawning grounds are rocky shores with abundant sea-weed growth. It appears that lumpfish have a homing tendency, returning to areas where they have previously spawned. Spawning occurs immediately following the shoreward migration of adults, at about age five and older, in April and May. After the sponge-like egg masses are deposited the females retire to the offshore area, leaving the now reddish coloured males to guard them. The males remain near the eggs and promote their development by aerating them with movements of the snout and fins. As guards, the males drive away intruders by darting out at them from their hiding places. Having completed their role as guards, the males also retreat to the offshore and their red hue fades somewhat.

Newly-hatched larvae, 4 - 5 mm long, appear in the early summer months. At first they grow rather quickly, doubling in length within a month. By one year of age they are between 50 and 75 mm long. The growth rate of lumpfish older than one year is not very well defined because the age determination of specimens is difficult due to the small size and shape of the otolith (ear bones). Some results are available which suggest that female lumpfish continue to grow fast until age five, at which point they can average about 30 cm. Beyond age five growth slows down considerably. Female specimens up to 60 cm long, weighing almost 10 kg, have been recorded.

Anatomy

The colour of lumpfish is variable, ranging from blue and bluish-gray, to greenish-brown. The belly is pale yellowish except for breeding males, which have red bellies. The average weight of adult lumpfish is about three kilograms, though individuals up to 10 kg have been reported. Males are generally smaller than females.

The lumpfish is a near relative of the sculpin, which it resembles. Its pelvic fins are modified and united by a circular flap of skin, thus forming a sucking disc and enabling lumpfish to adhere to the bottom or to floating objects. The form and structure of the lumpfish suggest a creature of sluggish habit.

Distribution & Migration

Lumpfish are found in the north Atlantic coastal waters of both North America and Europe. In North America, lumpfish are present from Hudson's Bay and the Labrador coast, south to New Jersey. In offshore areas, major concentrations have been found on the St. Pierre Bank off the south coast of Newfoundland.

Lumpfish are groundfish, bottom dwelling fish, inhabiting rocky and stony bottom areas, but they have also been frequently observed hiding under floating masses of seaweed at the surface of the ocean. Their localized distribution changes seasonally, as they migrate shoreward in April and May and seaward in late autumn. In general, lumpfish favour and seek deeper waters, both inshore and offshore, with lower temperatures.

Behavior

Their small mouth and teeth suggest that lumpfish feed on small, weak animals. Analyses of stomach contents have shown that they eat mainly small shrimp and crustaceans, jelly fish, small fish, and worms. Feeding probably occurs mostly near the surface amongst the seaweeds where these small animals abound.

THE LUMPFISH FISHERY

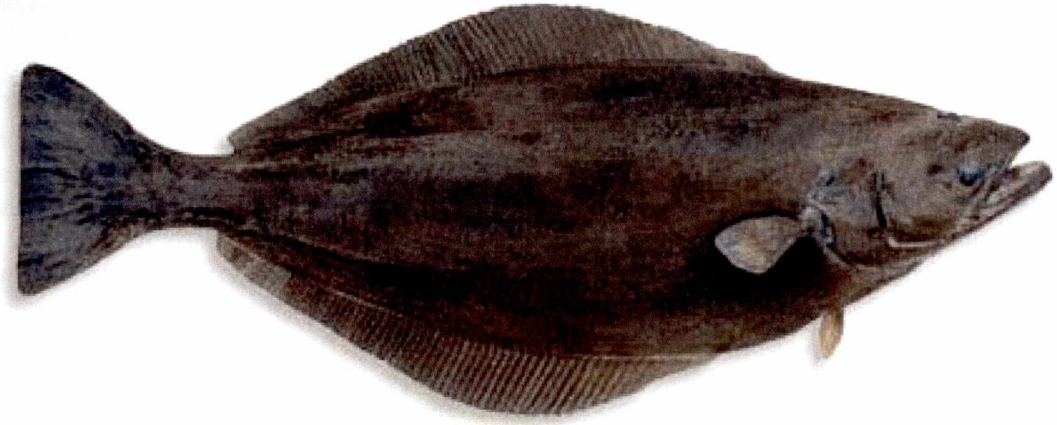
The lumpfish fishery is prosecuted not for the fish themselves, but for the eggs of the mature females, which are far more valuable in the world caviar market. Small quantities of male fish are taken for processing. Lumpfish are harvested mainly in inshore areas by gillnet from small boats during the shoreward spawning migration. Gillnets are a suitable gear for harvesting this resource since, for a given mesh size, only a narrow size range of fish will be retained. For example, in Newfoundland, the 280 mm mesh used in lumpfish gillnets effectively select fish between 37 and 50 cm in length.

Icelanders have fished lumpfish commercially for decades. In North America, concentrations of lumpfish abundant enough to support a fishery have been identified on the northeast and south coasts of Newfoundland. The Newfoundland lumpfish fishery began in the late 1960's. In the early years most of the landings were from the northeast coast, but have since been surpassed by south coast landings. About 60 per cent of the 1,700 t of roe harvested annually in the 1990's was from the south coast.

The flesh of lumpfish has been consumed locally to some extent in both North America and Europe. In Newfoundland the smaller reddish males are preferred. Some smoked products have been marketed in Europe. Roe is by far the most important commercial product, however.

The roe is removed from the fish by cutting open the body wall. The eggs account for approximately 20 to 30 per cent of the female's total body weight during the harvesting period. An average sized female, 45 cm, can produce up to 140,000 eggs or about 1 kg. The roe is best harvested when it is mature but not over-ripe. The eggs at this stage are purple or red in colour. After the eggs are washed and sieved, they are salted and cured. The finished product is considered a delicacy in the European and North American markets.

Obviously, killing the female lumpfish to get her eggs puts a final end to her reproductive cycle. Research has been ongoing for some time on 'stripping' the eggs from the fish and then releasing the fish alive. The success of this procedure depends on several things, including careful handling, and whether or not the eggs are at just the right stage of development. (See the Newfoundland Aquaculture Industry Association website: **www.naia.nf.net/** .)



TURBOT (GREENLAND HALIBUT)

A Brief Biology

Description

The *Reinhardtius hippoglossoides* belong to an order of flat, bilaterally symmetrical fish, the *Pleuronectiformes*, comprising some seven families and 117 species. The members of this order undergo an amazing transformation during the larval stage. They begin life swimming with the dorsal fin upwards, like 'normal' finfish. Gradually, however, one eye migrates across the top of the larva's skull to position itself close to the eye on the other side of the head. There are corresponding modifications to the skull bones, nerves and muscles. The eyeless side becomes flat while the other side rounds out somewhat. The fins which 'normally would be on its back or underside, now extend out from the flattened fish's edges.

The turbot, as it is commonly called by Newfoundland fishers, is a deepwater flatfish with many names. To Americans it's the Greenland halibut and to eastern Canadians it's the Greenland turbot or Newfoundland turbot. English fishermen call it the blue halibut and Germans call it black halibut.

The turbot resembles the common or Atlantic halibut, except that it is much smaller, reaching a maximum size of about 120 centimetres and a weight of about 25 kilograms. Its upper side is darker than the halibut's, hence names such as black halibut, blue halibut, lesser halibut and mock halibut.

Before the establishment of the 200-mile fishing zone in 1977, Canadian fishermen had to compete with many foreign fleets fishing turbot in the northwestern Atlantic. Since 1977, the foreign effort has been phased out in many areas, and the Canadian harvest of this species has vastly improved.

Life Cycle

Turbot from the Greenland, Labrador and Newfoundland areas migrate annually to the deep waters of the Davis Strait, between Baffin Island and Greenland, to reproduce. Spawning takes place in the early spring at depths of 650 to 1,000 metres. To the south of a deep ridge running between Baffin Island and Greenland, turbot spawn in water temperatures between 3° C and 4° C, at around 650 metres. North of the ridge, spawning occurs in much deeper water with temperatures of 0° C or less.

The eggs, as many as 160,000 from a single fish, drift in the middle depths for some weeks, later rising as larvae into the surface waters, where they are carried by northerly currents along the west coast of Greenland and into the northern part of Davis Strait. There, the current turns southward, and some larvae are taken as far

as the continental banks off Baffin Island. The vast, shallow areas to the northwest, west and southwest of Disko Bay are important nursery grounds, where larvae develop at depths down to 250 metres. From here, the young fish drift with the current southward to the continental shelf and slopes of Labrador and Newfoundland.

The numbers of male and female turbot are roughly equal, as is their growth rate, until they reach a length of about 45 centimetres at the age of six to seven years. After that, the abundance of males decreases, and those remaining grow much more slowly than the females. Fish larger than 90 cm in length are all female. This is because in the males much of the energy previously used for body growth during early maturity is subsequently diverted to the formation of products needed for egg fertilization. Females also tend to live longer, with specimens as old as 20 years being recorded, while males seldom live longer than 12 years.

Anatomy

A few features distinguish the turbot from other flatfish. Normally, the eyes of flatfish are located on the top, coloured side of the body, and the blind side is white. Most such fish in the north Atlantic are 'right-sided'. That means that individuals of the species lie on the left side as the eye migrates from the left to the right during larval development. In the turbot, however, the left eye has not completely migrated to the right side, but is located on the upper edge of the 'forehead'. This affords the turbot a wider field of vision than most flatfish have. Moreover, the blind side is not white, but dark grey, while the other side is nearly black. Furthermore, the fish is not perfectly symmetrical, so that some members of the species, those smaller fish that tend to swim in the middle levels of the ocean rather than along the seabed, have been known to swim with the dorsal fin upwards just like 'normal' fish. For a flatfish, the turbot is unusually mobile.

Distribution & Migration

Turbot thrive in the cold, northern waters of both the Pacific and the Atlantic oceans, and is most plentiful wherever there are rich stocks of sea prawn. In the northwest Atlantic, they are especially abundant in the deep waters found in the coastal bays and fjords of West Greenland, off the continental shelf of Baffin Island and in the Ungava Bay area of Hudson Strait. They are also found along the deep continental slope of Labrador and in the deepwater bays of northeastern Newfoundland.

Though the abundance of these fish diminishes south of the northern slopes of Newfoundland's Grand Banks, turbot have also become relatively plentiful in the Gulf of St. Lawrence in recent years. A pre-spawning winter concentration occurs in the Laurentian Channel to the southwest of Newfoundland's Bay St. George, and summer feeding concentrations are found at the mouth of the St. Lawrence River to the north of Anticosti Island. The southeastern tip of the Scotian Shelf appears to mark the southern edge of turbot distribution. As the fish begin to reach maturity, there appears to be a general migration northward into the Davis Strait.

Behavior

The turbot is a voracious feeder. Researchers have found in the stomachs of turbot, whole fish only slightly smaller than the turbot themselves.

Small turbot (under 20 centimetres in length) feed on plankton and shrimp-like crustaceans, while larger fish (up to 80 centimetres) in the southern Labrador and Newfoundland areas, eat mainly capelin. Those that swim in the deep channels of northern Labrador and West Greenland live mainly on shrimp. Very large turbot feed heavily on larger fish such as squid, cod, redfish and even other turbot.

Although turbot can be found in small numbers at depths of less than 100 metres, most of them are caught near the sea bottom at depths of 200 to 600 metres. In the southern part of the range, however, they go as deep as 1,500 metres.

Optimum water temperature for turbot ranges from 1° C to 3° C. Ordinarily, they can tolerate a wide range of temperatures, but this is less true during the reproductive phase. Except during spawning, they are able to range from ocean surface to seabed. Small turbot around 20 centimetres long and under are frequently taken as a by-catch by the shrimp trawlers working bottom depths of 200 to 400 m. Larger fish tend to be taken from deeper areas by longliners and deep-sea trawlers, in depths of over 1,000 m.

THE TURBOT FISHERY

For management purposes, turbot are treated as three stocks in the Northwest Atlantic.

Baffin Island-West Greenland Stock

The northern turbot harvest was an important fishery for Greenlanders from the mid-1800's to the 1920's. Then milder climatic conditions brought a large influx of cod into the area. By 1935, the turbot fishery had completely failed because of predation and competition by the numerous cod. Less than two decades later, however, landings had improved enough to support a growing fishery in Greenland, and more energetic marketing in Europe and the United States.

During the past decade, landings have fluctuated widely, with over 25,000 metric tonnes (t) taken in 1975, for example, while 1979 catches totaled only 12,000 t. The renewed fishery was prosecuted mainly by the (then) Soviet Union and Denmark. Soviet fishermen harvested the turbot from large offshore bottom trawlers, while the Danes preferred longlines and gillnets. In more recent years, the Greenlanders have been the main participants.

Labrador-East Newfoundland Stock

Fish sales records indicate that this stock has been fished commercially since at least 1857. Until 1964, Newfoundlanders played an important part, along with Greenland Danes, in a traditional baited-line fishery. The products, mainly in salted form, were exported to eastern Canadian markets, the United States and British West Indies. However, after the introduction of highly efficient synthetic-twine gillnets in the mid-1960's the use of longlines decreased, and by 1967 had been practically eliminated from the turbot fishery. By then, too, Polish and Soviet deep sea trawlers began to fish turbot in the deep waters of the continental slope off northern Labrador. Newfoundland landings dropped sharply as a result, stabilizing during 1970-1977 at around 30,000 t annually.

With the introduction of the 200-mile limit in 1977, the foreign effort began to be phased out. By 1980, the turbot fishery in this area belonged once again to Newfoundland fishermen. The turbot gillnet fishery has proved more lucrative in recent times, with 1980 landings of about 27,000 t, three times the 1967 harvest of 9,000 t.

However, like every new development in the fishing industry the growth in the turbot fishery has added a few more entries to the industry's long list of complaints and worries. Probably the most worrying of these is the snow crab by-catch in turbot gillnets, already referred to in the Gillnetting chapter. There are also conservation concerns for the turbot stocks. One is the capture of juvenile turbot in shrimp trawls. A number of experiments with gear modifications have been conducted to try and alleviate this problem, but so far the most obvious solution seems to be to stop fishing shrimp at times and places where juvenile turbot are likely to be found (though this may not necessarily seem a happy solution to shrimp harvesters).

Another, larger concern is the heavy fishing of turbot by non-Canadian vessels in deep offshore waters, outside the 200 mile limit, mainly off Labrador. Some fishermen fear it is only a matter of time before reduction of these large turbot stocks will start to show up as declining inshore and near-shore stocks as well. (They've seen this movie before, starring the Northern Cod.)

The Gulf of St. Lawrence Stock

The turbot fishery in the Gulf of St. Lawrence is much more recent than in northeastern Newfoundland and Labrador waters. Up to 1980, annual landings varied tremendously, from as low as 600 t to as high as 10,000 t (1979). Until 1979, most of the landings came as by-catch in the summer shrimp fishery by Quebec fishermen off the north shore of Anticosti Island. Also, some turbot were taken by Newfoundland trawlers southwest of Bay St. George in the Laurentian Channel, where turbot form a pre-spawning concentration during the winter. Since 1979, however, the turbot fishery in the Gulf of St. Lawrence has been almost exclusively directed by Quebec gillnet fishermen operating off the southwest shore of Anticosti Island and near the mouth of the St. Lawrence River.

Quota Regulation

Since 1974, turbot harvesting quotas for the Baffin Island/West Greenland turbot management unit and the Labrador/East Newfoundland unit have been set - with the Total Allowable Catch (TAC) being based on current scientific advice - by the International Commission for Northwest Atlantic Fisheries (ICNAF) and its successor, the Northwest Atlantic Fisheries Organization (NAFO). The TAC for 1981 for all countries was 25,000 t for the Baffin Island/West Greenland stock, and 55,000 t for the Labrador/East Newfoundland stock.

No catch quotas were set for the Gulf of St. Lawrence stock prior to 1982. That year, DFO set a TAC of 7,500 t, based on scientific advice from the Canadian Atlantic Scientific Advisory Committee (CAFSAC).

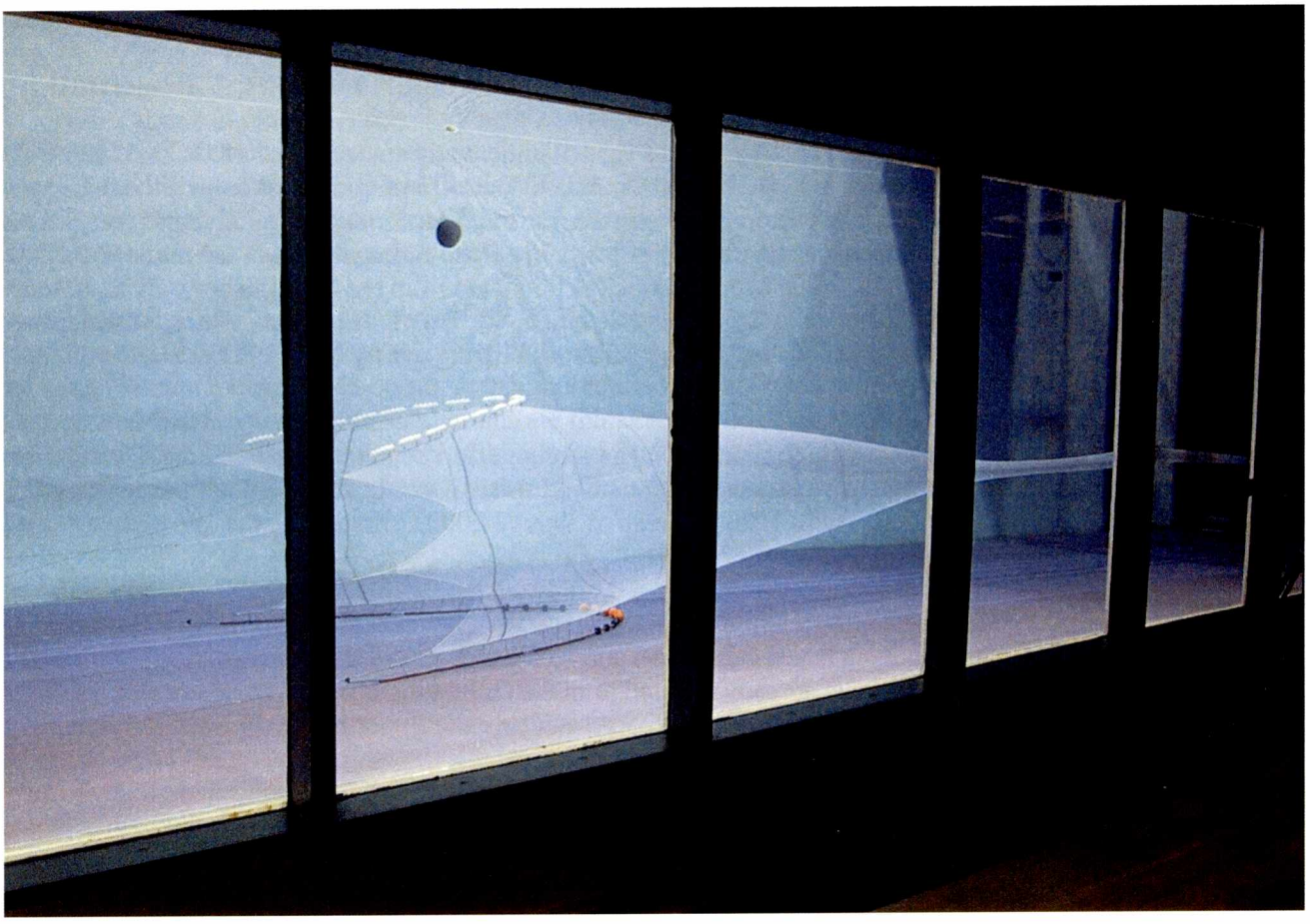


Figure 1: This is a model of an otter trawl being tested in the Marine Institute's flume tank. Otter trawls, in slightly differing versions, are used to fish many species, from shrimp to turbot. Off Canada's east coast, most otter trawl fishing for turbot is conducted by foreign fleets operating in very deep water outside the 200 mile limit.

FOR YOUR INFORMATION

WEBSITES

As with any subject, there are a host of internet websites dealing with various aspects of the fishing industry, fisheries organizations, government fisheries departments, etc. Some useful ones are listed below. Students should also be aware that vast amounts of information about these subjects, organizations, and so on, are not contained in 'official' or dedicated websites, but can best be found by plugging an appropriate name, acronym, word or phrase into an internet search engine, and looking through the first few pages of 'hits' that turn up. The Canadian and international websites listed here are representative of what is available. (Often, the home page of a website will have a link called 'Site Map" – always check it out – it will list all the separate subsites contained in the main website.)

CANADA

AAFC (Agriculture and Agri-food Canada) Fact Sheets: http://atn-riae.agr.ca/seafood/factsheet-e.htm
This website, entitled Fish & Seafood Online, contains useful fact sheets on about 30 seafood species, including lobster. The information is presented in bite-sized chunks under a wide range of headings, including Distribution and Season, Management, Nutritional Profile, Product Forms, and Markets. The lobster fact sheet includes a map showing Lobster Fishing Areas in Atlantic Canada.

Atlantic Fishery Regulations: http://laws.justice.gc.ca/en/F-14/SOR-86-21/
This website contains the Regulations Respecting the Management and Allocation of Fishery Resources on the Atlantic Coast of Canada (short title, Atlantic Fishery Regulations, 1985), the legal regulations governing Canada's east coast fisheries. The information is presented through a long series of internal links covering various fisheries and topics (eg., shellfish, size limits, licensing, etc.) – scroll down to find what you're looking for. The same information is presented, in the same organizational format but a more visually friendly manner on the website of the Canadian Legal Information Institute (CanLII): **www.canlii.org/ca/regu/sor86-21/**

Canadian Code of Conduct for Responsible Fishing Operations:
www.dfo-mpo.gc.ca/communic/fish_man/ code/cccrfo-cccppr_e.htm
A set of industry and government-generated guidelines for fish harvesters, designed to promote fishing practices that protect and conserve fish stocks and fish habitats. (This address is a sub-site of the Fisheries and Oceans Canada – DFO – website.)

Canadian Heritage: www.civilization.ca/orch/www04k_e.html#econ

All kinds of neat historical sites, including fisheries, from the Canadian Museum of Civilization.

CCFI - Canadian Centre for Fisheries Innovation: www.mi.mun.ca/ccfi/noframes/
CCFI is a non-profit organization owned by Memorial University and funded by the Atlantic Innovations Fund of ACOA. The Centre offers the fishing industry expert assistance in aquaculture, harvesting, and processing. CCFI's activities include resource conservation research, equipment development and marine biotechnology.

Change Islands Stages and Stores: www.stagesandstores.com/home.htm
Take a look at one Newfoundland community's excellent approach to preserving and bringing alive its history and its traditional arts and crafts.

CSAS - Canadian Science Advisory Secretariat: www.dfo-mpo.gc.ca/csas/Csas/English/Index_e.htm
CSAS coordinates the peer review of scientific issues for the Department of Fisheries and Oceans. CSAS also coordinates communication of the results of the scientific review and advisory processes. Reports on the status of fish, invertebrate and marine mammal stocks, environmental and ecosystem overviews, research documents featuring detailed scientific information, as well as proceedings of peer review meetings, are available from CSAS or, in many cases, can be downloaded from this web site.

DFA - Department of Fisheries and Aquaculture: www.gov.nf.ca/fishaq/
Home page for the province's fisheries department. Of particular interest is the site's fisheries 'Overview' pages and its 'Publications' section. The publications include, among others, many reports and summary reports of fisheries development and fisheries conservation projects carried out under the Fisheries Diversification Program component (and the FDP's Environmental Awareness and Conservation Technology sector) of the Canada/Newfoundland Fisheries Adjustment and Restructuring Initiative.

DFO - Fisheries and Oceans Canada: www.dfo-mpo.gc.ca/home-accueil_e.htm
Home page for Canada's federal fisheries department. Among statistics and fisheries management policies and measures and other things, you will find here useful links to Canada's provincial and territorial fisheries departments, and links to DFO's six administrative/fisheries management Regions across Canada (of which the Newfoundland and Labrador Region is one). The site contains many DFO science and fisheries management publications, including stock status reports, fisheries management policies, Acts and Regulations, responsible fishing documents and publications on fish habitat.

DFO (Newfoundland and Labrador Region): www.nfl.dfo-mpo.gc.ca/
Home page for DFO's Newfoundland and Labrador Region. Be aware that this site is designed specifically for the 640 x 480 pixel resolution commonly set for 14" computer monitors. If you view the page on a larger monitor with a higher resolution setting, you will find the text small, and difficult or even impossible to read. To correct the situation, go into Start/Settings/Control Panel/ Display/Settings, and change the viewing resolution of your monitor to a higher setting. Fish quota reports and fish landings and landed values reports can be found at this site.

FANL - Fisheries Association of Newfoundland and Labrador): www.fanl.nf.ca/contact.htm
FANL is an association of Newfoundland and Labrador fish processors. The organization's website contains short descriptions of the member companies, and links to similar provincial, national and international organizations, as well as a several government departments and other agencies with significant interests in the fishing industry.

FFAW - Fish, Food and Allied Workers Union): www.ffaw.nf.ca/frameset.html
Website of the organization we more commonly call 'the fishermen's union'. Contains, among other things, a useful description of DFO's Sentinel Fisheries research program.

Fish landings and values: www.nfl.dfo-mpo.gc.ca/publications/reports_rapports3.asp
Statistical reports found on DFO's Newfoundland and Labrador Region website.

Fisheries history/heritage: www.heritage.nf.ca/society/fishery.html
A Memorial University/CRB (Charles R. Bronfman) Foundation website containing a brief history of the Newfoundland and Labrador fishing industry, with a few links to other sites on the subject.

FRC – Fish Harvesters Resource Centre: www.frc.nf.ca/
Website of the FRC (not to be confused with the FRCC). Contains, among other things, fish price reports, buy and sell ads for fishing vessels, gear, etc., the official map of NAFO fishing areas, a summary report on the non-lethal extraction of lumpfish roe, and some excellent seafood recipes.

FRCC - Fisheries Resource Conservation Council: www.frcc-ccrh.ca/eindex.htm

The Council was created in 1993 by the Minister of Fisheries and Oceans, specifically to advise the minister on important fisheries matters for eastern Canada, in particular fisheries management decisions about openings and closings, catch quotas and scientific research. Council members are drawn from the scientific and academic communities and the fishing industry. This site contains a wealth of information in the form of FRCC reports (and other documents) presented to the Minister of Fisheries and Oceans since the Council was formed. (These documents are in PDF format, and you will need Adobe Acrobat Reader in order to view them.)

Groundfish Atlas: www-orca.nos.noaa.gov/projects/ecnasap/ecnasap.html

An extraordinary collection of maps showing the distribution of groundfish species off eastern Canada and the US, by the ORCA (Office of Ocean Resources Conservation and Assessment) Information Service, an agency of the US National Ocean Service (see USA – National Fisheries and Marine Service, in "The World" list below).

Marine Institute: www.mi.mun.ca/

What used to be the independent College of Fisheries, then the Institute of Fisheries and Marine Technology, is now the Fisheries and Marine Institute of Memorial University. A source of information about fisheries and marine industry careers, as well as research and development in aquaculture, fishing gear technology and fish habitat/marine environment conservation and protection.

MSC - Marine Stewardship Council: http://www.marine.gov.uk/MSC.htm

An international, independent organization working to achieve sustainable fisheries. Among other things, the MSC produces and maintains a fisheries certification standard; operates an accreditation programme for third party, independent certification bodies; provides a logo scheme that demonstrates to the fish consumer that fish and fish products carrying that logo come from a certified sustainable source; carries out an education programme to raise awareness of fisheries issues and the impact of fishing on the wider marine environment.

MUN - Memorial University of Newfoundland and Labrador: www.mun.ca/index.php

Look for links to the university's marine/fisheries research activities and facilities.

MUN – A collection of Newfoundland fisheries web sites: www.mun.ca/library/cns/fisheries.html

Northern Cod – A Guide to Information Sources: http://www.mun.ca/library/cns/cod/cod.html

An excellent guide to a wide range of information sources on the Newfoundland and Labrador cod fishery (now history?), by the Centre for Newfoundland Studies at Memorial University's Queen Elizabeth II Library.

NAIA - Newfoundland Aquaculture Industry Association: www.naia.nf.net/

Website of the organization representing Newfoundland and Labrador's aquaculture producers.

NAFO - Northwest Atlantic Fisheries Organization: www.nafo.ca/

An organization of 17 fishing nations/governments (including Japan, South Korea, Cuba and the European Union) who have more or less extensive fishing operations off Canada's east coast and who negotiate catch quotas and fisheries management measures for various fish stocks in northwestern Atlantic waters. One of the more useful items on this site is a map showing the NAFO fishing areas - the famous 2J, 3K, 3L, etc.

Newfoundland Fishery – A Descriptive Analysis: www.ucs.mun.ca/~noelroy/NfFishery.text.html

This is a lengthy paper prepared in 1997 (and revised in October, of that year) by Dr. Noel Roy of Memorial University's Department of Economics, for presentation at a Symposium on the Efficiency of North American Fisheries, held at Reykjavik, Iceland, Sept. 12 – 13, 1997. It presents a very

comprehensive overview, from mainly an economic perspective, of the Newfoundland and Labrador fishing industry, and contains a great deal of useful information, much of it in the form of easily understood graphs and tables.

Northern cod stock collapse: http://egj.lib.uidaho.edu/egj17/mason1.html
This is a lengthy paper - The Newfoundland Cod Stock Collapse: A Review and Analysis of Social Factors – out of the School of Kinesiology, University of Western Ontario. It describes the collapse of the northern cod stock, looking particularly at social and economic issues that contributed to and resulted from the collapse.

OSC – Ocean Sciences Centre, MUN: www.osc.mun.ca/
Website of Memorial University's Ocean Sciences Centre at Logy Bay. Under Research you will find a list of the centre's senior scientific staff and a brief description of each scientist's particular field of research.

Salt fish heritage/history: http://collections.ic.gc.ca/fisheries/
An Industry Canada-sponsored web site containing a detailed history of the Newfoundland and Labrador saltfish industry, the predominant form of the fishing industry in this province throughout most of its history. This is a link in the Digital Collections sub-site (**http://collections.ic.gc.ca/E/Alphabet.asp#N**) of the Government of Canada website. Digital Collections is a fascinating conglomeration of scores of online verbal/pictorial 'essays' on a huge variety of Canadian subjects.

UBC (University of British Columbia) Fisheries Centre: www.fisheries.ubc.ca/
There is too much on this website to describe here, but particularly interesting are four ongoing projects dealing with marine ecosystems, fish stock restoration, fish habitat rehabilitation, the environmental, social and economic impact of different fisheries management strategies, etc., and related marine science, social and economic research. Back to the Future, Project Seahorse, Coasts Under Stress and (perhaps especially) Sea Around Us, are projects which Newfoundland and Labrador students will find particularly interesting. As its first major study area, the Sea Around Us project looked at the collapse of this province's northern cod stock.

THE WORLD

FAO - Food and Agriculture Organization of the United Nations: www.fao.org
The FAO is probably the best single source for information about fisheries, fish resources and marine conservation on a global basis. On responsible fisheries, look in the FAO site for the international Code of Conduct for Responsible Fisheries, and the FAO Technical Guidelines for Responsible Fisheries.

Governments of the world: www.gksoft.com/govt/en/world.html
This is a site which lists the internet addresses for the most of the world's national governments. When you open the site you will find the alphabet. Click on the appropriate letter for the country you want (eg., C for Canada) and you will get a list of countries. Pick a country and you will get a list of its government's departments, as well as organizations and agencies (eg. research centres) that carry out government-funded activities or have some other more or less close relationship to the national government. Each country's government internet site is in that country's language but some non-English-speaking countries, such as Iceland and Norway, also have English versions. **NOTE**: The national sites listed below are only a tiny sample of what exists on the internet. Enter the name of a country, along with the word 'fisheries', in your internet search engine, and you will get a huge response for all but the smallest of nations. Likewise, enter a term such as 'fisheries development', fisheries research', 'marine ecosystems', 'fish habitat', or the like, and you will be rewarded with a similarly huge number of links world-wide on your chosen subject.

Australia - Fisheries Research Development Corporation: www.frdc.com.au/

Denmark – Danish Institute for Fisheries Research: www.dfu.min.dk/default_uk.htm

European Union – Directorate of Fisheries: http://europa.eu.int/comm/fisheries/policy_en.htm
One of the most useful aspects of this website is its links to other sites, throughout Europe and around the world – look especially under Related Sites for a group of links called Sites of Special Interest.

Great Britain – fisheries: www.defra.gov.uk/fish/fishindx.htm
This is the website of the fisheries sector of the Government of Great Britain's Department for Environment, Food and Rural Affairs.

Iceland – Ministry of fisheries: www.fisheries.is/

ICES - International Council for the Exploration of the Sea: www.ices.dk/
ICES is the organization, headquartered in Denmark, that coordinates and promotes marine research in the North Atlantic. For information particularly interesting and useful to Newfoundland students, look under ICES Work / Working Groups. There you will find research and project-oriented bodies such as the Working Group on Fishing Technology and Fish Behaviour, the GLOBEC Working Group on Cod and Climate Change, the International Bottom Trawl Working Group, and so on.

India – Central Marine Fisheries Research Institute: www.cmfri.com/cmfri_abt.html
This site will not tell you a great deal about the fishing industry of India, but it will give you a sense of the vast scale of fisheries activities and fisheries research in such a populous country.

Ireland – Department of Communications, Marine and Natural Resources: www.marine.gov.ie/

Japan – Ministry of Agriculture, Forestry and Fisheries: www.maff.go.jp/eindex.html

National Sea Grant - USA: www.nsgo.seagrant.org/
A national network of university-housed colleges throughout the US, bringing research, as well as education and community outreach programs to bear on deepwater, coastal and Great Lakes aquatic resources and environments.

Netherlands – Netherlands Institute for Fisheries Research: www.rivo.dlo.nl/

New Zealand – Ministry of Fisheries: www.fish.govt.nz/

Norway – Ministry of fisheries: http://odin.dep.no/fid/engelsk/index-b-n-a.html

Pew Fellows Program in Marine Conservation: www.pewmarine.org/x_Index.html
The PFPMC is a program of the world-renowned Pew Charitable Trusts (**www.pewtrusts.com/**). It is based at the New England Aquarium, Boston, Massachusetts, USA. At their website you will find information on all of their funded researchers (the 'fellows', many of whom are women) and descriptions of their research projects. It is an indispensable site for anyone wanting to know about some of the most important research being conducted today on marine conservation issues.

Scotland – Fisheries Research Services: www.marlab.ac.uk/

Sea Fish Industry Authority - UK: www.seafish.co.uk/
A government-created agency established to promote and enhance the entire UK fish industry, including the catching, processing, retailing and catering sectors.

South Pacific Forum – Forum Fisheries Agency: www.ffa.int/

The South Pacific Forum is the political grouping of independent and self-governing countries in the south Pacific Ocean. Its headquarters is in Suva, the capital of Fiji. Its members are: New Zealand, Australia, the Cook Islands, Fiji, Nauru, Tonga, Western Samoa, Niue, Papua New Guinea, Kiribati, Solomon Islands, Tuvalu, Federated States of Micronesia, the Republic of the Marshall Islands, and Vanuatu.

Taiwan – Taiwan Fisheries Research Institute: www.tfrin.gov.tw/index.html

USA - National Fisheries Marine Service: www.nmfs.noaa.gov/

Website of the national marine fisheries sector of the NOAA – National Oceanic and Atmospheric Administration of the United States. This site contains a huge store of information about US fisheries, various marine fish and mammal species, commercial fisheries, endangered species, and US fisheries and marine biology research centres. Contains a host of mainly economic (fish prices, etc.) reports on the US fishing industry.

USA (Alaska) – Alaska Fishery Research Bulletin:
www.state.ak.us/adfg/geninfo/pubs/afrb/afrbhome.htm

Publication of the Alaska Department of Fish and Game appears twice yearly. Contains reports on developments in the state's fisheries.

USA - Alaskan Oceans, Seas and Fisheries Research Foundation:
www.alaskanoceans.org/welcome.html

THE UNIVERSE

The few sites listed above are presented merely to whet the appetite. The next two sites are where serious students can go on the internet when they really want to find out stuff about the fishing industry and related subjects.

John Maunder's Newfoundland and Labrador Natural Sciences Website:
http://home.thezone.net/~jmaunder/

This is one of those websites that boggle the ordinary mind – a vast compilation of links to other websites – and it is being kept up to date and added to constantly. It's the creation of John E. Maunder, of Pouch Cove. One of its links (called, naturally, Links to Lists of Links) leads to an equally awesome site:

Gadus Associates: http://home.istar.ca/~gadus/index.html

Gadus Associates is a fisheries consulting company owned and operated by Dr. Trevor Kenchington, in Nova Scotia's Musquodoboit Harbour. The Gadus Associates' List of Web Links, their "guide to marine commercial fisheries sites", connects to more than 2,500 websites, all sorted by subject and reachable from an index page.

THE LOBSTER

Atlantic Fishery Regulations: http://www.dfo-mpo.gc.ca/communic/policy/reg/atlf-reg/atlfrege.doc

Regulations Respecting The Management And Allocation Of Fishery Resources On The Atlantic Coast Of Canada (Short title, Atlantic Fishery Regulations, 1985) – all 122 pages of them, with no internal links to take you to any particular part of the whole. They can more conveniently be found at:
www.canlii.org/ca/regu/sor86-21/ , where the regulations are organized as a long list of internal links – to find the lobster regulations, just scroll down to Part VI, Shellfish, and look for Lobster. (This is a subsite of the Canadian Legal Information Institute (CanLII – home page: **www.canlii.org/index_en.html** .)

Community-run Fisheries: http://perc.org/publications/policyseries/community_full.html
This site is not really about lobsters, but it is included here because it focuses on an idea very similar to the philosophy that guides the Eastport Peninsula Lobster Protection Committee. It presents a paper entitled Community-run Fisheries: Avoiding the 'Tragedy of the Commons'. Using examples from around the world, including the recreational salmon fishery on Newfoundland's Exploits River, the paper discusses how local people, working together, can overcome the destructive competition that occurs when a resource is regarded as 'public' and not 'owned' by anyone – the so-called "tragedy of the commons". This is a website of PERC (The Political Economy Research Centre:) and its Centre for Free Market Environmentalism, a 'think tank' focusing on "market solutions to environmental problems", based in Boise, Idaho, USA. (**http://perc.org/index.html**). PERC's website has much to offer in the way of useful and thought provoking information and insight, but the reader should remain always aware of the organization's strong bias toward one particular approach to social, economic and environmental problem-solving.

EPLPC – Eastport Peninsula Lobster Protection Committee: www.k12.nf.ca/hcsc/lobster/purpose.htm
A brief, positive paper - A Successful Co-management Strategy in The Newfoundland Lobster Fishery - on the purpose and activities of the EPLPC.

EPLPS: www.sfu.ca/coastalstudies/capacity/abstracts/EaPe.htm
Another very brief, positive paper - Eastport Peninsula Lobster Conservation: Integrating Harvesters' Local Knowledge and Fisheries Science – about the EPLPC, this one from the Biology Department of Dalhousie University, Halifax, Nova Scotia.

Lobster migration in the Gulf of St. Lawrence: http://fishbull.noaa.gov/1002/03comeau.pdf
A research paper by DFO fisheries scientists at Moncton, N.B., Movement of American Lobster (Homarus americanus) in the Southwestern Gulf of St. Lawrence. Presents the results of a huge and important lobster research program, the tagging of almost 42,500 lobsters, and the re-capture of large numbers of them, between 1980 and 1997, from the lower estuary of the St. Lawrence River to western Cape Breton Island..

LobsterConservation.com: http://www.lobsterconservation.com/door/
A website out of the US state of Rhode Island, funded by the Pew Fellows Program in Marine Conservation. This site concentrates on the eastern US lobster resource and fishery, but contains much that will be interesting and useful to Newfoundland and Labrador students. It also contains links to other excellent sites, including FisheryConservation.com (**www.lobsterconservation.com/fisheryconservationcom/**)

Lobsters: http://octopus.gma.org/lobsters/allaboutlobsters/aalindex.html
This is a website of the Gulf of Maine Aquarium, Portland, Maine, USA. As in Canada's Maritime Provinces, and perhaps to a somewhat lesser extent, Newfoundland and Labrador, the lobster is a cornerstone of the Maine fishing industry. In this excellently organized site you will find a wealth of information - historical, biological, historical, anecdotal, etc. - about the American lobster (Homarus americanus, the same one we fish). Although it focuses on the Maine lobster fishery, there is much information here that will be familiar and useful to Newfoundland and Labrador students.

Stalking the American Lobster: http://www.theatlantic.com/issues/2002/04/corson.htm
A fascinating article on lobster research, from the April, 2002, issue of one of North America's premiere general-interest magazines, Atlantic Monthly.

Status of the American Lobster: www.nefsc.noaa.gov/sos/spsyn/iv/lobster.html
A short but comprehensive paper on the lobster fishery and resource in the US state of Maine, 1966.

Sustaining lobster fisheries: http://imaging.geocomm.com/features/noaa_lobster/
This is not, as you might expect from the title, a comprehensive overview of lobster resource conservation, but rather a description of how scientists and fisheries managers have combined local fishermen's knowledge,

hydrographic science, and satellite-collected data on such things as the migration of larval lobster, to advance the conservation, protection and management of lobster stocks in Penobscot Bay, Maine, USA. The material will be challenging, but not overwhelming, for Grade 9 and 10 students. The site contains many interesting maps, graphs and photographs, including one of a perfect little inch-long lobster sitting in the palm of a researcher's hand.

The Lobster Conservancy: www.lobsters.org/index.html

This is another Maine, USA, website, and the Lobster Conservancy is another wonderful example of how people in Maine work together to preserve and enhance one of their chief resource-based industries. The website contains huge amounts of information about the lobster – lobster physiology, lobster reproduction, lobster migration patterns, how to handle lobsters, "The mystery of lobster vibrations", and much, much more – a fascinating site.

The American Lobster: www.parl.ns.ca/projects/lobster/index.htm

A website produced by Nova Scotia's Pictou-Antigonish Regional Library, with excellent information on Homarus Americanus himself, an overview of the past and present northern Nova Scotia lobster fishery, some good basic lobster market information, and some wonderful lobster recipes.

PUBLICATIONS

Limited press runs, limited accessibility and limited financial capacity are significant problems for teachers looking to acquire printed material. On the other hand, there is ample material readily available on the internet, enough to more than satisfy the needs of teachers and students using the Responsible Fishing supplement. Most of it can be printed. However, there are two publications, not available on the internet, that should be in every school library where people are concerned about responsible fishing. Together these publications tell the story of the destruction of the famed 'Northern Cod', and the decimation of several other groundfish stocks in eastern Canadian waters.

Harris, Dr. Leslie - ***Independent Review of the State of the Northern Cod Stock.*** (Prepared for the Minister of Fisheries and Oceans by the Northern Cod Review Panel) Ottawa: Communications Directorate, Fisheries and Oceans Canada. (1990). This is the now famous 'Harris Report', in which Dr. Harris and a panel of distinguished fisheries scientists, other academics, and fishing industry representatives review and assess the state of the northern cod stock in the late 1980's. The panel also reviewed and assessed the history of both the exploitation and the ongoing scientific assessment of the resource, thereby recording the fundamental causes of the destruction of a resource that generations of people had always considered virtually indestructible.

Warner, William W. - ***Distant Water: The Fate of the North Atlantic Fisherman.*** Toronto: Little, Brown and Company. (1983). William Warner is an American writer with a particular interest in natural history subjects, especially marine life. *Beautiful Swimmers: Watermen, Crabs and the Chesapeake Bay*, became an instant classic when it was first published almost 30 years ago (winning Warner the Pulitzer Prize), and is still in print today. Shortly after completing Beautiful Swimmers, Warner began to pay close attention to another fascinating species of Atlantic marine life, the thousands of European "long-distance" fishermen who spent weeks or months aboard mostly cramped, crowded, generally uncomfortable offshore fishing trawlers on the fishing banks of the north and northwest Atlantic, from northern Russia and Norway to the southern Grand Banks and the fishing grounds off New England. What he found fascinated him. He decided to write about about the extraordinary life these fishermen led, partly because it was intrinsically interesting, but also because he realized that at the rate the fish stocks were being exploited, those fisheries could not last much longer. So while Distant Water focuses mainly on the lives of the offshore fishermen, along the way Warner also draws a superb picture of a collective fishing effort that could only end in the collapse of the resource. Thus he documented, in a way no one else has done, the first and main destruction of the northern cod, occurring in the two decades from 1957 to 1977, from which the stock never managed to recover.

VIDEOS

The Department of Fisheries and Oceans has established in 17 of its field offices, and in five field offices of the Department of Fisheries and Aquaculture, a total of 22 video libraries. These libraries hold more than 60 video tapes containing a total of more than 120 separate videos (some short videos on related subjects are combined on one tape) on a wide variety of fisheries and marine topics. Environmental awareness, conservation and responsible fishing are a particular focus of this material. Following is a list of some of the videos found in the libraries. The numbers beside them are the actual listing numbers of the tapes. Note that some tapes have several videos on them. A pamphlet containing a full list of all the videotapes available may be had from any DFO or DFA field office, or from the DFO Communications Branch, PO Box 5667, St. John's A1C 5X1 - Tel: 709.772.7624.

14. Canadian Program for Responsible Fishing ..... 21 min (1994)

20. Reduction of Fish By-catch in Shrimp Trawls ..... 21 min (1989)

21. People of the Sea ..... 49 min (1999)
Narrated by the province's Wildlife Science Director, Shane Mahoney, this beautiful, award-winning film talks about the importance of the ocean's resources - especially capelin - to the people of Newfoundland and Labrador.

26. Return of A River ..... 52 min (1996)
All about the restoration and preservation of Rennies River, in St. John's, this beautifully filmed video is an excellent portrayal of the importance of maintaining different kinds of natural ecosystems in and around communities.

38. Sustainable Development and the Ecosystem Approach ..... 18 min (1993)
Two short videos: "Sustainable Development" and "Earth's Harmony: An Argument for Changing the Way We Think" .
For the Right Reasons ..... 19 min (1998)
Discusses the concept of Marine Conservation Areas.

41. Mortality in the Shrimp Fishery ..... 16 min (1994)
By-catch Reduction - Northern Shrimp Fishery ..... 10 min (1993)
Mesh Size Selectivity Trials - Northern Shrimp Fishery ..... 16 min (1993)
Shrimp Size Selectivity Project ..... 7 min (1996)
About various conservation concerns, and actions to address them, in the shrimp fishery.

42. The Science and Conservation of Greenland Halibut (Turbot) ..... 44 min (1995)

45. Newfoundland - The Coming of the Capelin ..... 26 min (1990)
Discusses the importance of capelin in the marine food chain, and the drastic effects a collapse of this key species might have.
Capelin Handling and Processing in Newfoundland and Labrador ..... 25 min (1993)

56. Comparing the Newfoundland and Iceland Fisheries ..... 43 min (1994)
Candid discussion of two very different political and economic approaches to the fishery.

60. Salmonid Habitat Improvements - Vol I ..... 47 min (1994)
Salmonid Habitat Improvement - Vol II ..... 31 min (1995)
Two films on freshwater fish habitat improvement techniques.

Pamahec Brook - A Fish Habitat Restoration Success Story ..... 9 min (1992)
About the restoration of a large Grand Falls area brook that had been diverted 20 years ago to accommodate log-driving.

61. **The Atlantic Lobster** ..... 11 min (1987)
Underwater observations of *Homarus americanus.*
Lobsters - Underwater Research in the North Atlantic ..... 59 min (1987)
Sizing Up Southern Gulf Lobster ..... 16 min (1989)
"In Our Own Hands" - Eastport ..... 10 min (. ? .)
"Towing the Line" - Eastport ..... 12 min (. ? .)

63. **Vanishing Point - Fishing Dangerously on the Grand Banks (NTV)** ..... 49 min (1992)
"Taking Stock" (National Film Board) ..... 48 min (1994)
Two historical overviews of the northern cod fishery and its collapse.

65. **Snow Crab: Today's Discards are Tomorrow's Harvest** ..... 20 min (2002)
Discusses the problem of high mortality rates among discarded snow crab; shows how best to handle discards to minimize mortality rates.

66. **The Gillnet Debate** ..... 22 min (2001)
Discusses the pros and cons of using gillnets in the cod fishery, and the need for all fishermen to use gillnets responsibly.

67. **Gill Nets: The Responsible Way** ..... 17 min (2003)
Shows that gillnets can be used responsibly - and are being used responsibly by some fishermen.

Video Library Locations

DFO Area Offices

St. John's	Grand Falls
Corner Brook	-Windsor

DFO Detachment Offices

Bay Roberts	Springdale
Placentia	Stephenville
Clarenville	Rocky Harbour
Marystown	St. Anthony
Twillingate	Happy Valley
Springdale	-Goose Bay

DFO Satellite Offices

Harbour Breton	L'anse au Loup
Port aux Basques	Labrador coast

DFA Offices

St. John's	Gander
Grand Bank	Port Saunders
Happy Valley-Goose Bay	

Modern longliner, rigged for shrimp trawling and crab pot fishing.

LOBSTER RECIPES

In case you didn't know it before, learn it now – if you have a computer, and access to the internet, you own the world's greatest cookbook, and need never buy another. Here's a selection of websites with some great lobster recipes. For other seafoods, just plug in the name of any fish together with the word 'recipes', and you will be amazed at the gastronomic plenitude that lives within your computer.

http://home.maine.rr.com/lobstercoop/lobster_recipe.htm
www.justseafoodrecipes.com/lobster/index.shtml
www.red-lobster-recipe.com/
www.foodtv.com/terms/obsessionlobster/0,4510,,00.html
www.lobster.um.maine.edu/info/cookbook/recipes.html
www.live-lobsters.com/lobster-recipes.html
www.live-lobsters.com/lobster-recipes.html
www.mainelobsterdirect.com/recipes/recipes.html
www.maine-lobster.com/cooking.htm
www.spruceharbor.com/lobster/lobrecip.html
www.recipesource.com/main-dishes/meat/seafood/lobster/00/rec0031.html
www.soupsong.com/rlobste1.html
http://www.mainelobsterpromo.com/recipes.html
http://store.yahoo.com/ronfer343/vendemillobr.html
www.lobsterclambake.com/recipe.html
www.bhg.com/home/Lobster-Recipes.html
www.thelobsternet.com/recipe_menu.htm
www.recipesource.com/main-dishes/seafood/lobster/
http://valentines.spike-jamie.com/L-O-recipes.html
www.lhj.com/home/Lobster-Tail-Recipes.html
http://homecooking.about.com/library/archive/bllobsterindex.htm
www.lobsterz.com/recipes/?rec=recipes
http://dmoz.org/Home/Cooking/Fish_and_Seafood/Shellfish/Lobster/
www.baycooking.com/lobster_recipes.htm
www.simplyseafood.com/Recipes/speciesList.asp

and finally,
these two colossal, mouth-watering collections of seafood recipes from the Open Directory Project, by Netscape Communications Corporation, and the Ohana Seafood Market in Kirkland, Washington, USA.

www.cbel.com/shellfish_recipes/
www.fish2go.com/recipes.htm

Homarus americanus behemoth.

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For further information:

Tel: 709.772.4438
e-mail: brothersg@dfo-mpo.gc.ca

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Salvage, with Cow Head looming over its western side and the islands of Bonavista Bay north beyond.

Happy Adventure, with Eastport just visible in the background.