FISHERS' AND SCIENTISTS' SOCIAL-ECOLOGICAL KNOWLEDGE AND NEWFOUNDLAND'S CAPELIN FISHERIES

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FISHERS' AND SCIENTISTS' SOCIAL-ECOLOGICAL KNOWLEDGE AND NEWFOUNDLAND'S CAPELIN FISHERIES

by

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Abstract

Using a case study of the Newfoundland capelin fisheries, this thesis explores the potential benefits of a social-ecological approach to gathering fishers' knowledge, analyzing both fishers' and scientists' knowledge, and attempting to integrate insights from both knowledge forms. In doing so, the thesis employs data from two types of personal interviews with fishers, as well as findings from scientific studies, to highlight points of both agreement and disagreement between fishers and scientists on four major issues that were forefront in the Newfoundland capelin fishery in the 1990s. Using a social-ecological approach to knowledge, possible reasons are posed to understand why scientists and fishers disagree with each other and why some fishers disagree with others.

The thesis demonstrates that this approach to understanding fishers' and scientists' knowledge is essential for projects that aim to critically assess and effectively integrate insights from these different sources. The thesis also sheds light on areas of scientific research that may require further research and analysis and proposes a series of policy recommendations that may strengthen future collaborative efforts that aim to integrate fishers' and fisheries scientists' knowledge.

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TEK-Traditional Ecological Knowledge

LEK-Local Ecological Knowledge

CIDA-Canadian International Development Agency

CARC-Canadian Arctic Resource Committee

IDRC-International Development Research Centre

DFO-Department of Fisheries and Oceans

TAC-Total Allowable Catch

FRCC-Fisheries Resource Conservation Council

FAO-Food and Agriculture Organization

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Chapter 1 Introduction

Fishers' and fisheries scientists' knowledge are products of their social-ecological environments. For fishers, this implies that their observations and interpretations are conditioned by their relationships with other fishers, fishing technologies, fishing strategies, and management initiatives (Neis and Morris, 2002; Felt, 1994; Neis, 1992). The locations where they fish, timing of their fisheries, and features of the local environments that are the focus of their attention also influence their knowledge (Felt, 1994; Neis, 1992). Similarly, the ecological knowledge of fisheries scientists is mediated by their training and the division of labour within science and between science and management. The relationships that scientists have with each other as well as the bureaucratic structures in which they work serve to influence the knowledge that is developed within that environment (Hipwell, 1998; Mackinson and Nottestad, 1998; Hutchings et al., 1997; Finlayson, 1994). Fisheries science is also influenced by the paradigms scientists operate within including the models they use, research methods including the sampling tools they use, and the spatial and temporal dimensions of their sampling. This understanding about fishers' and scientists' knowledge is essential for projects that aim to critically assess these different types of knowledge and seek ways to effectively integrate insights from these different sources. Failing to account for and understand the social-ecological character of both fishers' and scientists' knowledge can lead to the improper use of insights from these types of knowledge and to a tendency to dismiss one or the other type of knowledge.

Using a case study of the Newfoundland capelin fisheries, this thesis employs data from two types of personal interviews with fishers, as well as findings from scientific studies to explore the potential benefits of a social-ecological approach to gathering fishers' knowledge, analysing both fishers' and scientists' knowledge, and attempting to integrate insights from both knowledge forms. A central aim of the thesis is to identify possible areas where fishers' knowledge of capelin might contribute to fisheries science through identifying points of convergence and divergence between fishers' and scientists' knowledge on four major issues that were forefront in the Newfoundland capelin fishery in the 1990s. These issues include capelin stock structure, capelin abundance, cod bycatch in the capelin trap fishery, and dumping in the capelin fishery. Areas of agreement and disagreement are highlighted and efforts are made to explain differences through analyzing social-ecological factors that may mediate both fishers' and scientists' knowledge. It is hoped that such an approach will enlighten and challenge current scientific initiatives, such as logbook programs and telephone surveys, that sometimes uncritically rely on fishers' knowledge as a basis for informing fisheries science. It is also hoped that this research will shed light on areas of scientific research that may require further research and analysis. At a broader level, the aim of the research is to strengthen future collaborative efforts that aim to integrate fishers' and fisheries scientists' knowledge and use them as the basis for fisheries management.

This thesis draws upon important research on the fishery, fisheries science and local ecological knowledge (LEK) (Neis and Morris, 2002; Hutchings and Ferguson, 2000; Neis and Felt, 2000; Neis and Morris, 2000; Berkes, 1999; Neis et al., 1999a; Mackinson and Nottestad, 1998; Dewalt, 1994; Felt, 1994; Finlayson, 1994; Berkes, 1993; Mailhot, 1993; Neis, 1992; Nakashima, 1990). In particular, it builds upon themes addressed in research on local ecological knowledge and science by exploring some of the challenges associated with comparing and integrating these knowledge forms. It starts from the assumption that all forms of knowledge are produced within and mediated by social, ecological, political, economic, and cultural contexts but focuses on the immediate social-ecological contexts rather than the wider contexts that might influence knowledge production. Awareness of the relationship between these contexts and reported observations and interpretations is critical if we are to learn from different knowledge forms such as that of fishers and scientists.

1.1 Statement of the Problem

The world's fish resources are in trouble. Since the 1970s, there have been recorded problems with overfishing, fishing down the marine ecosystem, threats to ocean bio-diversity and unrecorded catches due to high-grading (FAO, 1997). Just recently, data published in Nature by Myers and Worm (2003) revealed a dramatic decline in the numbers of large predatory fish such as tuna, marlin, and swordfish since the beginning of industrialized fishing. These scientists argue that most of these fish have been caught or destroyed as a result of fish harvesting. In the 2002, State of the World Fisheries and Aquaculture Report, the Food and Agriculture Organization (FAO) of the United Nations states:

> About 47% of the main stocks or species groups are fully exploited and are therefore producing catches that have reached, or are very close to, their maximum sustainable limits. Another 18% of stocks or species groups are reported as overexploited [while another] 10% of stocks have become significantly depleted, or are recovering from depletion and are far less productive than they used to be (p. 23).

According to the Canadian International Development Agency (CIDA), many stocks of fish have been pushed close to, and in some cases past, their natural limits (1998). Furthermore, some stocks have reached the point of collapse while others have collapsed. One example is Newfoundland's Northern cod stocks (Finlayson and McCay, 1998).

In response to many of these problems, researchers, scientists, managers and fishers suggest the need for meaningful collaborative efforts in the management of fisheries. A particular focus has been placed on the need to integrate insights from fishers' knowledge with that of scientists. To illustrate, in a report produced by Bill Hipwell (1998) for the Marine Ecosystems Conservation Branch, Department of Fisheries and Oceans (DFO), it is argued, "It is becoming increasingly clear that because of their differing yet complimentary areas of competence, the synthesis of conventional science and traditional ecological knowledge (TEK) would be a boon to resource management" (p.13). The Fisheries Resource Conservation Council (FRCC) made several recommendations to improve the relationship between fishers and scientists that relate to areas of knowledge development and exchange. These recommendations include systematically collecting and using information from fishers in the stock assessment process and forging real partnerships with fishers to improve data quality and general science (Kearney et al., 1998).

There are several reasons why these collaborative efforts are important for fisheries policy. Improved communication between fishers and scientists and the greater use of fishers' and their knowledge in scientific research and the development of management policies could improve cooperation between fishers, scientists and managers and reduce the risk of overfishing and mismanagement (Mackinson and Nottestad, 1998; Pinkerton and Weinstein, 1995). Fishers, in particular, could improve current understandings about fisheries and fish ecology as well as offer perspectives that have not been present in the past (Neis et al., 1999a; CCPFH, 1998; Mackinson and Nottestad, 1998; Pinkerton and Weinstein, 1995). This is particularly important when considering that much of fisheries science is relatively young with limited temporal frames. Fishers are also well adapted to a particular marine environment and have acquired considerable insight about the particular ecosystem, including fish (Neis and Morris, 2002; Hutchings and Ferguson, 2000; Neis and Felt, 2000; Neis and Morris, 2000; Neis et al, 1999a and b; Hutchings, 1996; Neis 1992). Fishers' knowledge could also provide a means to improve and complement scientific knowledge and possibly increase the legitimacy of resource management institutions in the eyes of resource harvesters and processors. Furthermore, fishers' knowledge could provide an important check on scientific knowledge.

Several initiatives have been developed that integrate the knowledge of fishers with that of scientists. The extent of the role that fishers have played in these projects has differed from project to project. For the most part, however, those involved in the fisheries management and science process have controlled these projects. The most common role that fishers have performed in these projects is that of data gatherers performing the duties of research assistants or technicians (Wilson, 1999). Such projects include sentinel fisheries, test fisheries, logbook programs, and tagging studies. Fishers involved in past sentinel fisheries, for example, have been responsible for gathering biological, behavioural, and stock assessment data on cod. They have also provided physical oceanographic and environmental monitoring information from inshore waters, areas that have been historically difficult to survey during research vessel ground fish surveys (Neis and Felt, 1995). After a six-week science training program, fishers surveyed their own fishing grounds using their gear but used more traditional scientific methods to survey and sample. In the Northern cod sentinel fishery, resulting data are expected to play an important role in the assessment of the cod stocks and help determine the viability of future fisheries (FRCC, 2003).

The logbook program is another data gathering initiative that was designed in the early 1980s by scientists who sought to gather fishers' knowledge by giving them the opportunity to record their daily fishing activities (Nakashima, 1984). Depending on the fishery, information gathered for logbooks might include catch records, gear changes, and knowledge concerning fish ecology and behaviour. Other initiatives have included collection projects such as the Community Based Coastal Inventory Project. These projects have been carried out in all Atlantic Provinces with the main objective being to gather information from fishers on the fishery and fish stocks in coastal areas (O'Brien et al., 1998: 12). Other collection projects include phone surveys such as that carried out by capelin scientists in Newfoundland in which a sample of fishers are interviewed annually regarding issues of abundance, migration, dumping and bycatch (Nakashima, 1996a).

These projects aimed to integrate fishers' knowledge with that of scientists are a step in the right direction. However, there are a number of limitations with many such programs. First, where scientists have tried to use fishers' knowledge, fishers have generally played the role of fishery technicians rather than participating fully in the design, implementation and assessment of these programs. For example, logbook programs, hailed as a great success in bridging the gap between scientists and fishers, recruit commercial fishers to provide data for use in abundance indices and science methods to meet survey and sampling objectives. In some cases, participation in these programs is mandatory. Second, fishers are rarely encouraged to offer knowledge on fishery issues and marine ecology outside areas explored in DFO programs. With the Community Based Coastal Inventory Project, fishers are encouraged to contribute their knowledge to develop a database of information on various fish stocks. However, their opportunities for offering knowledge are reduced to a set of questions proposed by researchers. Fishers are not encouraged to explore areas of interest to them, nor are they given opportunities to present reasons for their observations. This type of information would be useful if groups of fishers disagreed with each other or with existing science.

Due to the characteristics and challenges associated with integrating fishers' knowledge into fisheries science and policy some initiatives that have sought to integrate this knowledge with science have failed to meet their objectives. This is because the knowledge collected from fishers can be hard to organize, quantify, and match to scientific data and often the differences between fishers' and scientists' observations are too hard to explain. More importantly, these projects have failed to approach knowledge as a social-ecological product. Instead of trying to understand why fishers disagree with each other or with scientists through looking at the contexts that mediate these knowledge forms, these projects have all but abandoned knowledge that does not correspond with the approach that science has taken. Phone surveys are one example of this. Little tends to be done with the data collected other than showing the variability in fishers' observations. Limited effort is devoted to trying to understand why fishers disagree with each other or with scientists on issues related to the fishery and fish species.

Past projects that have sought to integrate fishers' and scientists' knowledge have taught us some valuable lessons, particularly that it is critical to explore both fishers' and scientists' knowledge, its limitations, strengths and, more importantly, the contexts within which such knowledge is produced, as well as how these contexts may affect the outcome of how this knowledge is used. This approach is particularly important when considering that a fishery involves many different players including fishers, scientists, managers and processors, all of whom have different roles in the fishery, different goals and different perspectives. Consider, for example, where fishing for the same species of fish using different gear in different areas of the grounds and adjusting to different management initiatives may contribute to a situation where fishers disagree with each other. These disagreements can be used as a reason for summarily dismissing such knowledge as bad or uncritically embracing knowledge from a particular group of fishers as accurate and representative of a larger social-ecological reality rather than interpreting it as an indication of the social-ecological basis of fishers' knowledge, an understanding of which is essential to the interpretation of that knowledge (Felt, 1994). Another situation could be fishers who completely disagree with the scientific position on the state of the fishery or the resource. How can divergences of this kind be explained? What do these divergences in knowledge mean for the science and management of fishery resources or initiatives already underway to integrate the knowledge of fishers and scientists? Inconsistencies between these knowledge forms may be a reason to dismiss what fishers have to say because it does not fit with the standards of scientific knowledge, rather than a cue to explore both knowledge systems in more depth (Neis et al., 1999a; Hipwell, 1998).

To date, much of the research on fishers' and scientists' knowledge has demonstrated that both knowledge forms are mediated by varying social or political contexts (Palmer and Sinclair, 1996; Felt, 1994; Finlayson, 1994; Neis, 1992). However, little research to date has systematically explored these knowledge forms as social-ecological products, which implies a relationship between the ecological and social environments that fishers and scientists work within and their observations and interpretations. For example, social science research by Felt (1994) argued that fishers' knowledge is socially constructed while Finlayson's research (1994) on science used a theory of social-context to show how scientists' knowledge is socially constructed. These researchers did not pay explicit attention to the way fishers' and scientists' knowledge is mediated by ecology. Natural scientists, on the other hand, are much more sensitive to the effects of ecology (e.g. depth sensors and forms of gear design) on knowledge but tend to ignore social contexts. In this thesis, it is argued that the successful integration of fishers' and scientists' knowledge lies in first understanding that their interpretations and observations are conditioned by social and ecological contexts. In cutting across this divide between social and ecological contexts, the thesis uses a case study of the Newfoundland capelin fishery to demonstrate how fishers' and scientists' knowledge is mediated by the temporal pattern of their observations, the location of fisheries and research, the gear they use, sampling methodologies, management initiatives, and other contexts.

1.2 The Case Study

The Newfoundland coastal fisheries for roe-bearing capelin provide an excellent opportunity to examine issues related to the importance of treating fishers' and scientists' knowledge as social-ecological products. Unlike scientists working on or studying other fisheries such as the Northern cod fishery, Newfoundland's capelin scientists have been collecting information from fishers through a logbook program since the early 1980s and phone surveys since 1994. Newfoundland's capelin scientists were among the first scientists in Newfoundland to integrate local knowledge from inshore fishers with fisheries assessment science. In the 1980s, they developed biomass abundance estimates based on offshore acoustic surveys and validated these estimates using an index based on catch rates in the commercial capelin trap and seine fisheries derived from a voluntary fisher logbook program (Carscadden et al., 1994). In 1994, they added a random sample telephone survey of capelin fishers to their data sources. In addition to incorporating fishers into capelin stock assessment science, scientists also adopted a conservative approach to capelin management that recognized the importance of capelin in the marine food web. Despite these efforts scientists have been unable to generate reliable estimates of capelin abundance since the early 1990s when inshore and offshore estimates of capelin abundance diverged (DFO, 1997). As a consequence, the offshore fishery was closed and inshore fisheries were closed in some areas and greatly reduced in others.

This Newfoundland coastal capelin fishery also makes a good case study because information collected from fishers by the Department of Fisheries and Oceans (DFO) and analyzed by scientists is easily accessible. Hence, the methods of collection have been clearly outlined and it is easy to understand how scientists have collected and used information and what this suggests about their underlying assumptions about fishers' knowledge. In addition to the vast amount of information available from capelin science, one-on-one in-depth interviews with fishers from the Bonavista and Trinity Bay area were carried out by a team of interdisciplinary researchers involved with the Traditional Ecological Knowledge (TEK) component of the Eco-Research Project. These interviews, which were conducted in 1994 and 1995, contained a vast amount of information about the capelin species and fishery. Follow-up interviews were conducted in 1998 with a sub-group of capelin fishers for this thesis in order to supplement the data gathered through the initial interviews.[1] The information collected indicated areas of disagreement between fishers and scientists in the 1990s, many of which scientists are aware of but have not been able to explain.

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[1] The initial TEK interviews were carried out by researchers involved with the Eco-Research project. The follow-up interviews were carried out by the author.

1.3 Theoretical Approach

At the most general level, the theoretical framework that informs this thesis draws on insights from critical realist thinking within sociology. Unlike other theories of knowledge, Critical Realism argues that analysis of knowledge claims must give due explanatory weight to mediating contexts. Not accounting for contexts in the analysis of knowledge severely limit one's capacity to accept, much less explain, the knowledge or provide well-informed critiques of its restrictive influence (Reed, 1997). Critical realists argue that the work of both social scientists and natural scientists should aim to identify and understand underlying mechanisms that produce knowledge and divergence in knowledge within and between groups of people. Influences such as race, age, gender, and, arguably, location all mediate knowledge and observations (Reed, 1997). This process is called retroduction, which means moving beyond knowledge to understanding what mediating factors may be influencing it (Lawson, 1996). For this thesis, a critical realist perspective allows analysis of knowledge to progress beyond a mere description of 'expert' claims and differences between such claims to a project that has the potential for offering a new approach to gathering fishers' knowledge and integrating it with science, and a more collaborative approach to the development of fisheries policy.

Unlike other social theories that explore knowledge production such as Postmodernism and the Sociology of Knowledge, Critical Realism allows social scientists not only the opportunity to critically analyze knowledge development but also the possibility of posing alternative knowledges (Bielawski, 1992). In contrast, some postmodernists agree that all knowledge is relative. In other words knowledge is socially produced and therefore no objective standards of truth and no way of validating knowledge exist. As such, all knowledge is considered equal and applauded as expressions of local autonomy. Critics of this approach to knowledge have argued that caution should be taken with this view of knowledge because it leaves no room to be critical of these forms of knowledge or ideas (Hacking, 1999; New, 1995, Bielawski, 1992). Social constructionists also argue that all knowledge is socially constructed. However, they offer no guidance when demonstrating the importance of that approach for integrating fishers' knowledge with that of scientists. Furthermore, both theories fail to provide the necessary theoretical standpoint needed to properly develop and guide this thesis, that is, the process by which social scientists can analyze and understand what fishers and scientists say and why they think that way. It is important to note, however, that though Critical Realism offers a stronger theoretical backbone for this thesis, critical realists tend to focus only on the social contexts that mediate knowledge whereas this thesis supports a social-ecological approach to understanding fishers' and scientists' knowledge which emphasizes the relationship that exists between the environment that fishers and scientists work within and the knowledge they generate.

1.4 Roadmap of the Thesis

The thesis is organized into nine chapters. Chapter Two reviews the literature on LEK with a particular focus on the juxtaposition of fishers' and scientists' knowledge. Chapter Three reviews the various data collected and used in this thesis, including the framework for data analysis. Chapter Four introduces Newfoundland's commercial roe-bearing capelin fishery and the state of the fishery in 1980s and the 1990s. It also introduces capelin science and provides a detailed overview of the position of capelin science and management during the 1980s and 1990s. Chapters Five through Eight review fishers' knowledge of the capelin fishery and capelin ecology and compare it to fisheries assessment science including data from programs carried out in the 1990s such as logbooks and telephone surveys. Each data chapter concludes with an analysis and discussion of the importance of treating fishers' and scientists' knowledge as a social-ecological product and discusses the implications of such an approach to understanding and integrating insights from these knowledge forms. The concluding chapter summarizes and explains the findings, outlines the contribution of the research to the larger body of knowledge on fishers' knowledge and LEK, discusses the implications of these findings for policy and practice as well as critical research avenues for the future.

1.5 Conclusion

This thesis demonstrates that any attempt to integrate insights from fishers' and scientists' ecological knowledge must include the understanding that both knowledge forms are social-ecological products. Lacking this, attempts to integrate insights from these knowledge forms can lead to misunderstandings about fishers' knowledge and ultimately its dismissal by scientists and the dismissal of scientific knowledge by fishers. Essentially, the integration of both scientists' and fishers' knowledge needs to build on more than just the understanding that science, as it presently stands, is inadequate to guide future fisheries. Further, it requires more than just the belief that fishers' knowledge, by virtue of its existence, provides an instant answer to successful future fisheries policy. The successful integration of these two knowledge forms requires a proper understanding and evaluation of knowledge that includes an understanding of the social-ecological characteristics of both forms. With this understanding and appreciation knowledge integration will be more successful than without it. Hence, projects that aim to gather fishers' knowledge require more than an opportunity for fishers to have their say but an understanding that both fishers' and scientists' knowledge are influenced by the location and timing of their fisheries and research, gear location, sampling methodologies used, and management initiatives, all of which, will likely contribute to disagreements among fishers and between fishers and scientists.

Chapter 2 Literature Review

2.1 Introduction

This chapter explores themes addressed in previous research on local ecological knowledge (LEK) and science. It focuses on understanding some of the challenges associated with comparing information from different sources and attempts to integrate insights from different forms of knowledge. The chapter highlights some of the lessons from the LEK and science literature including the lesson that all types of knowledge are produced within and mediated by the social-ecological and social-political contexts within which they are developed. Awareness of the relationship between these contexts and reported observations and interpretations of information is critical if we are to maximize the potential for learning from different knowledge forms and, where possible and appropriate, integrate information taken from different historical periods, social groups and different geographical areas. A related observation explored in this chapter is that the social-ecological and social-political contexts shaping LEK and the development and interpretation of scientific knowledge are diverse, resulting, not surprisingly, in points of disagreement within, as well as between, LEK and science. Often the disagreements within groups are as great as the disagreements between groups.

2.2 What is Local Ecological Knowledge?

The study of LEK developed out of the earlier research on Traditional Ecological Knowledge or TEK. For the most part, the research on TEK has focused on indigenous peoples who have a vast amount of information about the environment around them and are often deeply rooted in centuries of association with a particular area. In some cases, technological advances, western industrial societies, and changes to the environment have only recently influenced the knowledge indigenous peoples possess about their environments.

Defining TEK is difficult, as one definition is not universally accepted (Neis and Felt, 2000; Berkes, 1999). Jose Mailhot (1993) defines TEK as, "the sum of the data and ideas acquired by a human group on its environment as a result of the group's use and occupation of a region over many generations" (p.11). Berkes (1999) expands the definition of TEK as proposed by Mailhot (1993) to include the element of practice and belief that is adaptive and handed down through generations. He defines TEK as, "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations, by cultural transmission, about the relationships of living beings with one another and with their environment" (p. 8). Traditional ecological knowledge has also been referred to as "indigenous knowledge" (Berkes, 1999).

Many researchers have argued that there are definitional problems with labelling the knowledge of other resource users, such as that of fishers and farmers, as "traditional" or 'indigenous'. Johnson (1992) argues that indigenous knowledge refers to indigenous people, when in fact, such knowledge "is also found among non-indigenous peoples such as fishermen and farmers who also acquired their knowledge and skills through hands on experience living in close contact with the environment" (p. 4). According to Dewalt (1994), "The term indigenous knowledge carries the connotation of native people's ideas and beliefs" (p.125). Berkes (1993) and Palsson (1995) argue that the term "traditional" is ambiguous and raises questions about "the cultural dynamics of such knowledge systems" (Palsson, 1995; Berkes, 1993).

> In the dictionary sense, traditional usually refers to cultural continuity transmitted in the form of social attitudes, beliefs, principles and conceptions of behaviour and practice derived from historical experience. However, societies change through time, constantly adopting new practices and technologies and making it difficult to define just how much and what kind of change would affect the labelling of a practice as traditional (Berkes, 1993, p. 3).

Howes and Chambers (1980) point out that the term "traditional" is problematic because it ignores the dynamic processes associated with knowledge production.

Neis and Felt (1995) suggest that differences exist between the traditional ecological knowledge of indigenous peoples and the ecological knowledge of non-indigenous peoples such as those who work as commercial fishers. They argue that western scientific and management techniques affect fishery workers' activities, relationships with the environment and, by extension, their knowledge. Contemporary fishery workers are also more mobile and tend to experience periods where they have migrated to other work locations, or undertaken formal training. Their local knowledge is also reflective of the changing environmental, economic, technological and social contexts that shape fisheries.

To distinguish between the knowledge of resource users such as fishers and farmers and the traditional ecological knowledge of indigenous peoples, many researchers use the term local ecological knowledge or LEK. Local knowledge is defined as a form of vernacular knowledge or knowledge derived from the "direct experience of a labour process and shaped by the distinctive characteristics of a particular place within a unique social and physical environment" (Kloppenburg, 1992, p. 528). Local knowledge is also cumulative and dynamic, building upon the experience of earlier generations and adapting to new technologies and socio-economic changes of the present (Johnson, 1992, p. 4).

This thesis uses the term LEK as defined above. That is, it emphasizes the social and cultural contexts within which fishers' knowledge is developed; the technology, ecology, and management changes that mediate how knowledge is produced and disseminated; and, the temporal and spatial scales in which fishers' knowledge is formed. The emphasis on the contextual component of fishers' knowledge is important as the main focus of the thesis is to explore how fishers' knowledge is influenced by social-ecological contexts and how these contexts can help understand points of agreement and disagreement between scientists and fishers, and among fishers.

2.3 What are the Benefits of LEK and Why is LEK Important?

Recently, researchers have begun to discuss LEK in terms of its importance and usefulness in the policy formation process and in scientific realms. In those discussions, organizations such as the Canadian International Development Agency (CIDA), the Canadian Arctic Resource Committee (CARC), and International Development Research Centre (IDRC) have been working with local resource users to help bring their knowledge to the table when decisions are being made. These organizations argue that local knowledge could prove useful if combined with science and management. In the report from World Commission on Environment and Development titled Our Common Future, it is stated:

> Tribal and indigenous peoples' . . . lifestyles can offer modern societies many lessons in the management of resources in complex forest, mountain and dry land ecosystems. These communities are the repositories of vast accumulations of traditional knowledge and experience that link humanity with its ancient origins. Their disappearance is a loss for the larger society, which could learn a great deal from their traditional skills in sustainably managing very complex ecological systems (1987, p. 114-115).

Berkes (1999; 1993) argues that LEK could be used as a source of biological and ecological information in resource management and for development planning to provide more accurate and realistic evaluations of the environment, natural resources and production systems. He suggests that people who are more dependent upon and aware of a particular environment can potentially assess the costs and benefits of development much better than outsiders. According to Dewalt (1994), resource users have a lot to contribute to the science and management process (p. 125). He claims that perhaps the greatest benefit that local knowledge can offer is that it is local in nature. The advantage of this is that those who have acquired it are able to understand their local environment and have gathered a lot of experience during their survival and existence. Also, they have an understanding of the interconnectedness of nature, such as the links between plants, animals and soils (1994, p. 125). The Canadian Arctic Resource Committee argues that the inclusion of LEK in land and resource use planning will help to implement principles of sustainable development (Fenge, 1997). Huntington and Mymrin (1999) of the Inuit Circumpolar Conference deliver the same message:

> TEK is an important source of information and understanding for anyone who is interested in the natural world and the place of people in the environment. Many scientists recognize the value of working with people who live in an area and who have great insight into the natural processes at work in that area. While the scientific perspective is often different from the traditional perspective, both have a great deal to offer one another. Working together is the best way of helping us achieve a better common understanding of nature (p. 1).

In his research on Inuit knowledge of eider ducks, Nakashima (1990) found that Inuit hunters are particularly well placed to make a significant contribution towards the protection of the environment. He argues that though the TEK of Inuit hunters does not provide immediate solutions to ecological problems or answers to all questions related to Eider Ducks, the Inuit can offer a familiarity with ecological relationships that they have monitored over a long period of time, particularly information about the spatial and temporal distribution of wildlife. He concludes, "[T] heir knowledge of where and when animals occur, a direct product of their hunting lifestyle, provides an essential element for assessing the potential impacts of an oil spill" (p. 3).

Neis and Felt (2000) argue that stock collapses in the Newfoundland fisheries have highlighted the limited knowledge that exists about the oceans, fish species and fishing practices (p. 2). They also point out that the collapse of certain fisheries has drawn attention to the governing systems that manage these fisheries. These collapses indicate that the knowledge and understanding of marine ecosystems and of fishery dynamics must improve and propose that one way to improve this knowledge involves integrating fishers and their knowledge into the science and management process. They support increasing fishers' involvement in the management process through co-management programs.

Numerous projects have been conducted in Canada and elsewhere, demonstrating why fishers' knowledge is so important. Neis et al. (1999a) used oral history interviews to explore the usefulness of fishers' local knowledge about resources. They maintain that Newfoundland fishers could contribute knowledge that can be effectively combined with scientific data in five main areas: stock structure, ecology and behaviour, trends in catchability, trends and patterns in bycatch, and inter-fishery interactions. Hutchings and Ferguson (2000) argue in their research on temporal changes in catch rates and fishing effort in the inshore Northern cod fishery, that fishers could contribute information concerning temporal changes in catch rates and fishing effort in the inshore cod fishery. They think that efforts should be made to integrate fishers' local knowledge with science, particularly stock assessment and fisheries management. Three main areas where fishers' knowledge could be applied to elements of fisheries science are identified: seasonal movements and migrations of fish, stock identification, and changes in catch rates, fishing effort and efficiency (p. 33).

2.4 What are the Disadvantages of Using LEK

The arguments against the use of LEK are numerous. Many scientists and managers argue that too much emphasis is being placed on local knowledge at a time when such knowledge is influenced by technology and economic needs. Molnar et al. (1992) claim, "An individual farmer is less concerned about global effects of technological change than about effects that change will have on the profitability of his or her farm" (p. 87). They argue that resource users are more aware of their surrounding environment and conditions than most scientists but their success is often based upon an adaptation to local conditions.

> While some farmers are inventors with superior insights . . . we should not blindly promote them as a category to a superior status as knowledge producers without first giving consideration to the fundamental difference in perspective between the bench scientist and the ordinary farmer. The objective of the bench scientist is to search for generalizable solutions . . . by testing hypotheses under controlled and replicable conditions. By contrast, the farmer's objective is to maximize profit in the context of a myriad of changing variables, many of which are specific to that one particular farm (p. 86).

Trupp (1989) points out that not all local systems are in harmony with the environment because some indigenous peoples degrade their environments for various social and economic reasons.

> Not all resource people have valuable indigenous knowledge . . . and some people have relied on beliefs that are ineffective for the peoples' own interests . . . Sometimes knowledge that was once well-adapted and effective for securing the peoples' livelihoods . . . becomes inappropriate when confronted by rapid socio-economic changes and interventions (p. 15).

Other critics fear that local knowledge will not be rigorously tested and criticized, and instead, accepted at face value based on its supposed immediate and intimate relationship with local environments and ecological systems. Molnar et al. (1992) claim that this leads to an over-emphasis of the value of local knowledge, thus elevating it to the "status of freestanding and complete when in fact it may be nothing more than capacities called forth by the needs of the moment" (p. 86). Richards argues that assigning virtue to local knowledge would only lead to misplaced abstraction and eventually "obscure important cases of innovative local knowledge" (quoted in Murdoch and Clarke, 1994, p. 118). Simply put, romanticization could mean that structure, dynamics and the empirical basis of local knowledge will become mysterious and the process by which skills are acquired and adapted will become unclear.

Other criticisms worth noting include the notion that LEK cannot be verified. According to Howard and Widdowson (1997):

> The integration of [local] knowledge hinders rather than enhances the ability of governments to more fully understand ecological processes since there are no mechanisms, or will, by which spiritually based knowledge claims can be challenged or verified. In fact, pressure from aboriginal groups and their consultants has made local knowledge a sacred cow for which only uncritical support is appropriate. Local knowledge is thus granted a sanctity, which could lead to the acceptance of incorrect conclusions (quoted in Fenge, 1997, p. 2).

The concerns of critics are justified and deserve attention by researchers aiming to integrate LEK and the knowledge of scientists. However, claims that local knowledge is anecdotal and cannot be systematically tested tend to lead to the too rapid dismissal of local knowledge without first understanding its potential. Nakashima (1990) argues that the current scientific paradigms based on "ideals of truth" could result in the rejection of local knowledge based on the perception that it is anecdotal and non-quantitative. He said that the aim of local knowledge research is to provide a source of information not available in current scientific understanding, an understanding that should not be lost in arguments over "methodology, quantification and statistical significance" (p. 23).

Dewalt (1994) maintains that the character of local knowledge and the extent of its use within natural resource policy have to be addressed by policy makers who are considering the incorporation of alternative knowledge in sustainable development policies. However, he suggests that researchers should not be too over-optimistic, presenting local knowledge as "viable ways of knowing" while blaming scientists for the "ecological and inequality problems that exist" and implying that all we need to do is "learn the local knowledge systems of farmers and we will have many of the answers to development ills" (p. 123). He argues that a framework has to be developed that recognizes both the advantages and disadvantages of all belief systems, to develop effective and creative interactions between science and LEK. The desired goal involves taking advantage of the "creativity and innovativeness of both groups" while keeping in mind that it is important to see "both systems as complementary sources of wisdom" (p. 127).

Some researchers suggest, that taken together, both scientific knowledge and LEK may prove useful in providing a much clearer and more holistic picture. In agriculture, Jack Kloppenburg (1992) argues that an alternative and truly sustainable agriculture would encompass a transformed science that articulates multiple ways of knowing the environment and the world. Murdoch and Clarke (1994) suggest that a new world should "recognize the heterogeneous quality of knowledge forms" (p. 129). They remind us that local forms of knowledge should not be portrayed as superior to science or more ecologically friendly and that the key to sustainable development is an approach that reflects a mixture of knowledge that can "lead to an enrichment and diversification of the natural and social worlds in which we live"(p. 130).

Researchers also argue that the notion that TEK is a product of its social, ecological and political environment is not a reason to avoid this knowledge, but a reason to be much more critical of the knowledge production process in general, including treating all knowledge forms as contextual products, influenced by various social-ecological contexts as well as political and economic contexts. In the case of fisheries, for example, Felt (1994) argues that the more fishers' knowledge "is characterized by user group conflict, competition, and significant state regulations, the more critical the knowledge process becomes" (p. 253). However, fishers' knowledge should not be overlooked because of this. Similar arguments have been made about Northern cod science (Finlayson, 1994).

2.5 LEK as a Social-Ecological Product

No form of knowledge is entirely immune to organizational, technological, political and social-ecological processes (Berkes and Folke, 1998; Felt, 1994). In the fishery, these processes will vary between groups of fishers, and are different from those associated with other knowledge systems such as fisheries science (Felt, 1994). For example, factors such as the gear that fishers use, or their proximity to certain fishing grounds, may play a big role in shaping their perceptions of the resource. Fisheries are dynamic, characterized by technological change, shifting fishing locations and changes in fishing strategies and fishery duration. These changes can affect individual fishers' observations and perceptions about fisheries resources over time. This is a message that researchers, scientists and managers must not forget. But, of course, science is also dynamic and changing in response to changes in commercial fisheries, paradigm shifts, budget cuts, and other factors.

Felt (1994) argues in his work on salmon fishers that fishers' local knowledge is a social product, influenced by social processes and context.[2] In an assessment of

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[2]Felt argues that social-ecological conditions influence fishers' knowledge. However he does not theorize

differences between two groups of fishers on the health of the salmon stocks, Felt found that those fishers who were supported by the union, affected by management initiatives that reduced quotas, and also had restricted access to salmon stocks tended to agree that the salmon stocks were fine. Those who supported the claim that stocks were declining had interacted with the resource longer, lived closer to salmon rivers, and harvested a higher percentage of a smaller population of fish.

Researchers also suggest that the technology that fishers employ and the location of their fishery mediate fishers' perceptions of their environment (Neis, 1992; Johannes, 1981; Forman, 1970). Forman (1970) and Johannes (1981) both claim that fishers' knowledge tends to reflect the strategies that fishers employ. Forman (1970), in his research on Brazilian fishers, found that these fishers depend upon their ecological knowledge for survival. He claims that the knowledge that these fishers possess about the marine environment is linked to the types of strategies that they employ, whether it is fishing for species on gill net grounds or using landmarks to distinguish good fishing berths (p. 68).

Palmer and Sinclair's (1996) study on the dragger fishery on the Great Northern Peninsula focuses on the socio-political factors that influence fishers' knowledge about fish resources. Designed to examine how skippers perceived the extent of the resource crisis, its causes and future possibilities, the study revealed discrepancies in the opinions of fishers. Palmer and Sinclair (1996) link these different opinions to the fact that

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this argument in his work.

different groups of fishers have different material interests. Based on these results, they conclude that despite the belief that all fishers share the same opinions and possess the same knowledge no single knowledge set was shared among these fishers. They maintain, though do not address fully in their study, that knowledge is context based and may vary according to the socio-political environment in which fishers work. Thus, socio-political contexts can influence claims about the state of the resource. The nature and extent of these influences can be expected to vary depending upon the context within which information is provided and the nature of the information available to harvesters about fish and fisheries.

Equally important but not discussed by Palmer and Sinclair is recognizing that fishers' knowledge is an ecological product. In her study of the Petty Harbour coastal cod fishery, Neis (1992) suggested that the cod trap and hand line fishery promoted a unique environment where fishers could develop in-depth ecological knowledge including knowledge about migration patterns and fish behaviour in their area. The fishery used fixed gear, had been generally carried out in the same location for centuries, and had not undergone serious technological change. The ecological and social contexts that shaped their knowledge were different from those that informed Northern cod science (Neis, 1992) and the ecological knowledge of the dragger skippers studied by Palmer and Sinclair (1996).

The argument that LEK and science are social-ecological products has been made elsewhere. However, little work to date has taken this important observation to the next level which includes explicitly stating, addressing and demonstrating the importance of treating knowledge as a social-ecological product for projects that aim to integrate insights from LEK and science. This message is important when considering the fact that projects are underway by scientists and managers to integrate both LEK and scientific knowledge forms.

2.6 Science as a Social-Ecological Product

Modern science has enjoyed a privileged position among the possible ways of establishing knowledge (Kloppenburg, 1992). For many centuries, society has viewed it as the only source of knowledge that guarantees objectivity, truth and rationality. As such, the contributions of science to society have been enormous. The premise behind science is that it offers a privileged view of nature that is independent of social context and is universal (Johnson, 1992). There are three fundamental principles of science, which are often used to distinguish it from alternative knowledge forms. Reductionism is the first principle and involves breaking nature down into small parts, analyzing the parts and then making predictions based on the analysis of these parts (Berkes, 1999; Johnson, 1992). The second principle of science is objectivism, which is the belief that scientists must separate themselves from nature and from society in order to obtain true and reliable facts. Lastly, science is positivist, meaning that what is real is measurable. Stories and anecdotes, which are often associated with LEK, have been downplayed by scientists because of the notion that they cannot be measured or analyzed (Hipwell, 1998).

Despite its general contributions to society, the application of modern science in resource management systems has resulted in numerous problems over the last few decades. Hipwell (1998) argues that these are due in large part to the fact that science is entwined with the political process and, as such, is mediated by ecological, social, political, and economic contexts. Within the fisheries policy formation process, several different paradigms are operating which influence how scientific knowledge is developed. In the bureaucracy of management, managers and policy makers have different and often conflicting opinions about the state of the fishery, which may conflict with how scientists view the fishery. Scientists are also influenced by social contexts such as funding policies, which may limit or eliminate research programs, policies that control the publication of research, the timing and location of research, and access to appropriate research instruments and tools (Hutchings et al., 1997; Finlayson, 1994).

Sociologists of scientific knowledge have been leaders in the critical analysis of fisheries science. Social constructionists, in particular, argue that scientific knowledge is subject to social influences, as are other ways knowing (Kloppenburg, 1991). Social constructionists perceive scientific knowledge as a social product, consisting of social artifacts and accomplishments, rather than objective descriptions of external natural reality. Trevor Pinch (1986), a social constructionist, claims that this perspective is premised on the belief that if society and culture are social constructs then our knowledge, including scientific knowledge, is also socially constructed.

Finlayson (1994), a follower of the social constructionist school of thought, treats scientific knowledge as socially produced, and challenges the traditional view of science as a privileged kind of knowledge immune to social context. For Northern cod science, Finlayson shows that science was in part a product of negotiation, shaped not only by relations between scientists but also by bureaucratic decision-making structures, by the culture of science at DFO in St. John's, and by assumptions about the inshore versus offshore fisheries in that culture. He argues that the 1990s Northern cod crisis was a product of social forces and processes that came to play important roles in the production and practice of this science.

> [The fisheries] crisis can be most usefully understood as a product of multi-leveled and interactive social forces and processes. This perspective diverges quite sharply from the traditional view. "Tradition" holds that the "success" and/or "failure" of stock assessment science is attributed solely to the ability of scientists to objectively and accurately understand, describe, and predict the dynamics of external natural reality (p. 10).

Hipwell (1998) supports Finlayson's argument by arguing that when scientific research is translated into policy, political considerations sometimes take priority over scientific research. Scientists are often discouraged by their managers from pursuing certain avenues of research and often face threats of dismissal that can discourage them from reporting certain facts. Hipwell also notes that because science is embedded in the policy and political framework, the funding and personnel do not exist to support the scientific approach, as it should operate. As such, scientists can only hypothesize about the status of fish populations and make suggestions about future fishing effort.

Hutchings, Walters and Haedrich (1997) provide support for Hipwell's argument. In their review of the Atlantic cod and Pacific salmon crises, they argue that non-scientific influences impede the "dissemination" of scientific information and the science process in DFO (p. 1198). Their findings related to Northern cod science suggest several areas where the scientific process was influenced by the bureaucratic structure in which it existed. Foremost, they argue that the government's denunciation of independent scientific research was one example of how bureaucracy mediated the science process.

The authors argue that research questioning the validity and reliability of scientific processes for measuring cod abundance was largely ignored. They point to DFO's interference in scientific conclusions, disciplining of scientists who communicated independent results publicly, and the misrepresentation of scientific reports and statements (Hutchings et al., 1997) as other examples of how bureaucracy influenced the science process within DFO.

In addition to the political and bureaucratic structures which can mediate the scientific process, dominant scientific paradigms, like the "numbers based approach" to science associated with quota-based management will also affect where research is carried out, the scientific tools that are used and the types of questions that are asked. Further, high levels of uncertainty in the face of stock decline leave plenty of room for interpretation and the possibility that social contexts will influence scientific interpretations. Finlayson (1994) makes this argument in reference to the scientific models used to measure cod abundance prior to the closure of the Northern cod fishery. At that time cod scientists were using a Virtual Population Assessment[3] (VPA) model to measure cod abundance. Several indices fed into this model including research vessel catch rates (RV) and catch per unit of effort data (CPUE). Finlayson (1994) argues that there were several biases associated with these individual indices that were not accounted for in the overall abundance model, particularly the biases associated with offshore

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[3] Virtual Population Assessment involves tracking and estimating the annual mortality of each year class of fish.

landings data and the unreported discarding of smaller fish. Finlayson (1994) admits that inaccurate or misrepresented landings data may not have been a problem in the 1990s due to 100% observer coverage on these boats. However, prior to 1990s, the presence of observers was inconsistent at best. These biases in abundance indices were also discussed in the Hutchings et al. (1997) article on the interplay of politics, policy and science in DFO. Neis et al. (1999a) also discuss some of the social-ecological factors that may have biased the CPUE data that were an element in the overall cod abundance model. They argue that changes in vessel capacity, fishing technology and changes in gear utilized by inshore cod fishers throughout their careers may have influenced catch rates and masked stock decline.

> Most trap fishermen changed the design of their traps from traditional to modified, Japanese or long range in the 1970s and the 1980s. They also introduced power blocks. These changes, often associated with reductions in mesh size outside of the drying twine are believed to have increased their catches by retaining smaller fish and allowing them to fish more traps efficiently by increasing the retention of fish. Power blocks also made it easier to move traps more frequently in search of fish (p. 1954).

Arguably, room has been created for fishers' knowledge in fisheries science primarily because of recent problems with the way that science and bureaucratic management regimes have managed fisheries. Inconsistent and misinformed decisions made by scientists and managers have led to many problems and depleted stocks. Problems can partly be attributed to the fact that scientists hardly ever see their knowledge as mediated by social, ecological, cultural, and political contexts in which the scientific process is embedded. This inability to accept the contextual nature of scientists' knowledge has led to strong resistance and a lack of understanding on the part of some scientists when integrating fishers' knowledge with that of their own.

2.7 Capelin Science as a Social-Ecological Product

The knowledge of capelin scientists is also a social-ecological product influenced by the paradigms in which they operate, including the models they use, by the research methods, including the sampling tools they use, and by the spatial and temporal dimensions of their sampling. For example, capelin scientists use a variety of abundance indices to estimate stock biomass. However, these indices are all based on research carried out at specific times of the year and only within certain areas. Some of these indices, such as catch rates, are influenced by a number of different factors including changes in gear, fishing efficiency, and management initiatives, which control the gear that is used, and the timing and duration of the fishery. Further, these management initiatives have changed over time, which has caused scientists and other researchers to question the validity of trends in catch rate data. Other indices such as aerial and egg deposition surveys are only carried out in certain areas and at certain times of the year. These results are then analyzed to reflect the whole stock area. Further, environmental conditions have affected the timing of some scientific studies. Bureaucratic influences such as limited funding have also influenced the production of capelin scientists' knowledge. For example, aerial surveys that were once carried out in several locations have been reduced in frequency while other surveys have been eliminated. *Chapter 4* contains a detailed description of these scientific studies including when they started, how they have changed over time, and how scientists have adjusted to these changes in their assessments of the capelin stocks.

The factors that influence the knowledge of capelin scientists are somewhat different from those that influence the knowledge of fishers. For example, the development of these two knowledge forms is temporally and spatially different. Fishers' knowledge is developed at a local level. That is, fishers are knowledgeable about what is happening in their area but can often only speculate about what may be happening on a larger scale. Scientists, on the other hand, work at a macro level and use their findings to predict stock status and capelin behaviour at the micro level. Fishers also have a limited amount of time each year to interact with the resource, and depending on the gear they use and the management initiatives in place, the opportunity to gather knowledge about capelin may not allow for the same opportunities to observe as they might have in the past. Fishers and scientists interact with the resource at different times throughout the capelin life cycle. Fishers' observations are largely confined to coastal areas and to the period associated with capelin spawning migrations. Some scientific studies are conducted offshore in early spring or fall, while other studies are conducted during capelin migration inshore. Scientists are also faced with changes to their scientific program, which may hinder comparisons with previous years or with fishers' knowledge. It is also worth noting that, depending on the age of fishers, some may possess general observations of capelin abundance extending back twenty or more years, while younger fishers, who joined the fishery at a time when capelin abundance was in decline, might have a different sense of the trends in resource abundance. Likewise, capelin science is young with much of it having been initiated in the early 1980s. The different spatial, temporal and ecological dimensions of capelin fishers' observations and those of scientists and different sampling tools will contribute to disagreements between fishers' and scientists' observations. This can make it difficult to integrate insights from these knowledge forms but does not remove the importance of understanding the contexts that shape them and using both to improve our understanding of the relationship between capelin fisheries and capelin stocks.

2.8 Conclusion

Integrating fishers' knowledge into the fisheries policy formation process, including gathering it, interpreting it, and integrating it with that of scientists and managers is challenging. Scientists, managers and fisheries researchers are well aware that issues of validity, reliability, generalizability, temporality, disagreements and contradictions plague any project aiming to integrate fishers' knowledge with science. These challenges derive in part from the fact that fishers' and scientists' knowledge differ significantly. The contexts in which both knowledge systems are developed, the tools they use to shape their knowledge and the methods they employ to gather and record that knowledge all contribute to significant gaps between fishers' and scientists' knowledge (Neis and Felt, 2000) and to plenty of disagreements among fishers and among scientists.

This chapter has reviewed some of the literature on LEK and scientists' knowledge. It has argued that both knowledge forms are social-ecological products. Little research has focused on why this approach to understanding knowledge is so important and how it might explain differences between fishers' and scientists' knowledge. Little research has also discussed how this approach to understanding knowledge can be helpful to projects that aim to integrate knowledge from both fishers and scientists.

Chapter 3 Research Methods

3.1 Overall Approach

For the purposes of this study, capelin and capelin-fishery related observations were collected from forty-seven one-on-one career-history and taxonomy interviews.[4] The taxonomy interviews were generally carried out with older, retired fishers living in the area while the career-history interviews were conducted with inshore (< 35 foot) and nearshore (> 35 foot) longliner fishers from the communities between Plate Cove, Bonavista Bay and Dildo, Trinity Bay. All of these interviews took place between the fall of 1994 and the fall of 1995. To supplement the secondary data on capelin from these interviews, follow-up telephone interviews were carried out in the summer of 1998 with seventeen of twenty-six fishers who fished capelin commercially.[5] The third component of the methodology for this thesis included an analysis of numerous DFO management and scientific documents. Two interviews were also conducted with capelin scientists (Brian Nakashima and Bruce Payne).

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[4] Sixty-five original interviews were conducted. Forty-seven interviews contained information related to the capelin fishery.
[5] These interviews were conducted by the author. Nine commercial capelin fishers from the original sample could not be reached, had moved or refused to be interviewed.

3.2 The Interviews

3.2.1 The Study Area

The interviews upon which this thesis is based were carried out with fishers who resided in the Bonavista and Trinity Bay region on the northeast coast of Newfoundland. The career-history and taxonomy interviews were carried by a team of interdisciplinary researchers involved with the TEK component of the Eco-Research Project. This project was developed to study the sustainability of cold-ocean coastal communities (Ommer, 2000).[6] The sample area, including the communities between Plate Cove, Bonavista Bay and Dildo, Trinity Bay, was chosen to capture a range of fishing locations, from inner bays to outer headland areas (see Figure 3.1 for a visual of this area). The fisheries in this area also included a range of fishing sectors from inshore coastal fisheries to nearshore longliner and offshore trawler fisheries. The follow-up interviews were conducted by the author and involved a sub-group of fishers who harvested capelin commercially in the Bonavista and Trinity Bay area.

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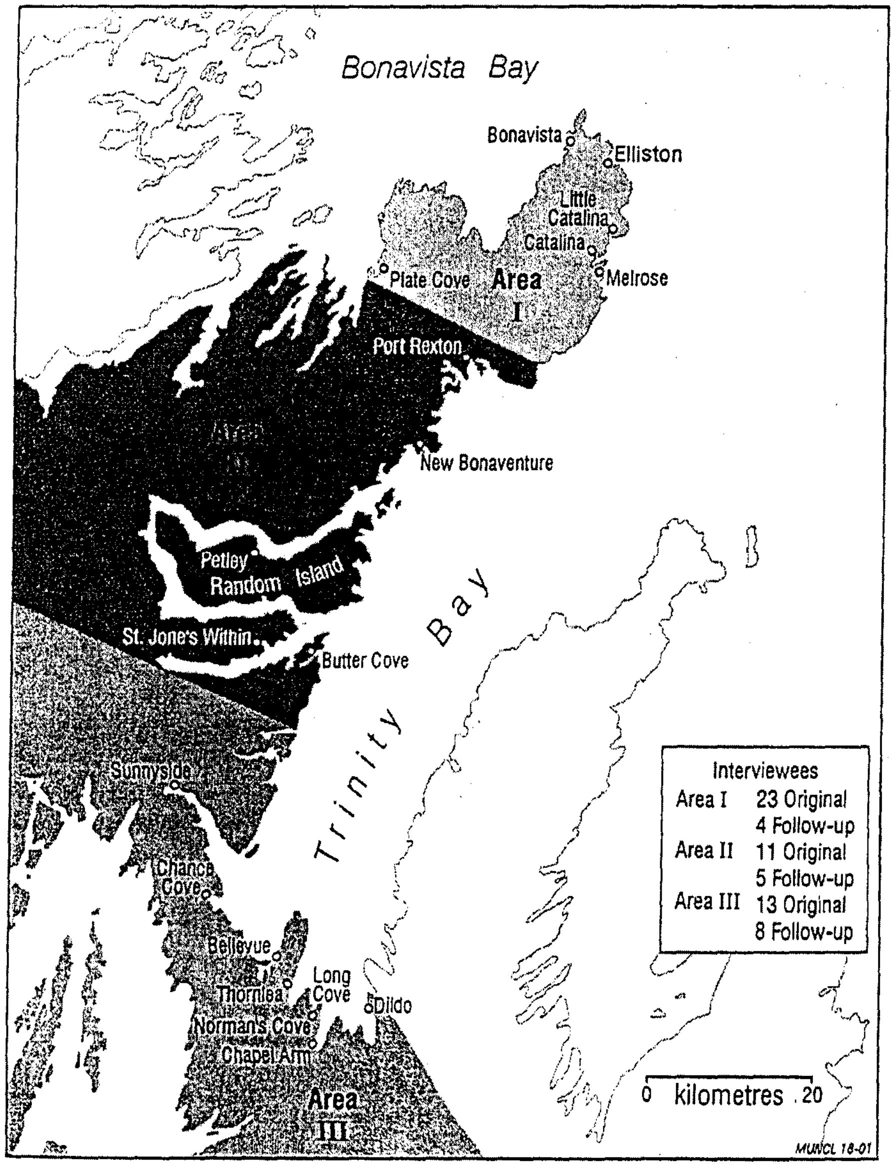
[6] This research was approved by the Interdisciplinary Committee for Ethics in Human Research (ICEHR) at Memorial University.

Figure 3.1: Sample Area and Distribution of Original (1995) and Follow-up Interviews (1998)



3.2.2 The Sample

Interviewees who participated in the initial interviews were drawn from a union list of fishers provided by The Fish Food and Allied Workers' Union. A list of Trinity

Bay fishers was not available. To supplement the Bonavista list of fishers and identify possible interviewees for the Trinity Bay area, a technique called snowball sampling was employed. Snowball sampling is designed to identify fishers deemed locally to be 'experts'. Snowball sampling generates an ever-increasing set of interviews through a referral process in which interviewees are asked to provide additional names for interviewing. This sampling methodology is commonly accepted when a sampling frame is not available or when there are high rates of non-participation (Babbie, 1989). Based on the hypothesis that fishers' knowledge is a social-ecological product, the sample of interviews was distributed across gear sectors, age groups of fishers, and included fishers whose grounds were located at the Bonavista Headland as well as some who fished down through the inner reaches of Trinity Bay. It should be noted, however, that commercial capelin fishers were more heavily concentrated in the area inside of Trinity Bay between Sunnyside and Dildo. Fishers who had not fished capelin commercially were concentrated in the Bonavista area.

3.2.3 The Interview Process

Sixty-five interviews were conducted by the team of interdisciplinary researchers involved with the TEK component of the Eco-Research Project (Ommer, 2000). Ten of these interviews were taxonomic interviews conducted with older, retired fishers for the purpose of familiarizing the researchers with the local names of places and species so that they would be better able to communicate when interviewing fishers from different locations. These interviews were taped and a list of key terms and issues were generated for other team members. Career-history interviews were then carried out with fifty-five fishermen. These interviews, designed to gather the ecological knowledge of fishers, were semi-structured. An interview schedule was used to keep the interviews on track and a shorter questionnaire was administered to gather more logistical information (Neis et al., 1999a). The interviews lasted between 1.5 and 4 hours. Before the interviews started, respondents were asked to sign a consent form agreeing that the information collected could be used for research purposes and that transcripts could be placed in the Memorial University Folklore Archive for use by future researchers. Respondents were also asked if the interviews could be taped. Most of the interviews were taped and transcribed and any spatial information collected was recorded on nautical charts with Mylar overlays and subsequently digitized.

Of the original sixty-five interviews conducted, forty-seven transcripts contained information on capelin and the capelin fisheries. To supplement the information on capelin from these interviews, follow-up telephone interviews were carried out with seventeen of twenty-six fishers who fished capelin commercially. Each fisher was contacted initially to determine whether they would like to participate in a follow-up interview. If the fisher agreed to participate, a scheduled call-up was arranged. These interviews were conducted between July 6 and August 3, 1998. Each interview lasted approximately forty-five minutes to one hour.

3.2.4 The Interview Schedule

All of the original career-history and taxonomic interviews followed a semi-structured format beginning with background information about the interviewee, including age and training. Subsequent questions related to information on licenses held, vessel, engines, gear, and equipment used throughout the fishers' careers. The interviewees were also asked to describe fishing seasons at different points in their careers including species pursued, fishing grounds, catch, gear used, and timing. Fishers were also asked to identify important points of change during their careers and describe the fishery after these changes had occurred as well as at the end of their careers or the time of the interview. Information was also collected related to migration patterns, spawning, diet, and colour of major commercial species, particularly cod (Neis et al., 1999a).

The interview schedule for the follow-up interviews was divided into five sections (see Appendix 1 for a sample of interview schedule). Fishers were encouraged to discuss changes in capelin spawning behavior and seasonal variations in capelin spawning throughout their careers. Fishers were then asked to discuss all the vessels, gear, and fishing technology that they had used in the capelin fishery. They were also asked to discuss their landings, gear locations, and bycatch. Two general questions were asked about the fishery in order to ascertain their opinions and concerns about the state of the capelin stocks and the future of the capelin fishery. It was found that organizing fishers' careers around the succession of boats they had owned, helped fishers reconstruct their fishing careers and the timing of particular events, observations, and changes during those careers. However, there were some problems with temporal imprecision in the interview data.

3.2.5 Data Analysis

In the interest of privacy, interview numbers were assigned to the fishers.

Transcript data from the original interviews were analyzed by excerpting capelin-related quotes, sorting them according to themes, and coding responses, where reasonable to quantify. This approach to the data is called secondary data analysis. Secondary data analysis is the analysis of interviews used to investigate questions for which they were not necessarily produced (Goldenburg, 1992). The data collected from the follow-up interviews was used to help clarify information provided in the initial interviews.

3.3 Profile of Study Participants

As mentioned in the previous section this study developed out of the research conducted by an interdisciplinary team of researchers involved with the TEK component of the Eco-Research Project between the fall of 1994 and the fall of 1995. Of the original sixty-five interviews conducted for that project, forty-seven interviews contained information on capelin. The fishers who participated in these interviews are profiled in the sections below.

3.3.1 Area of Residence

Fishers who participated in this study resided in three areas of the Bonavista Bay and lower Trinity Bay area. As Figure 3.1 shows, twenty-three fishers were from the Bonavista headland area, comprising the communities between Plate Cove and Melrose. Eleven fishers were from the New Bonaventure region, comprising the communities between Port Rexton and Butter Cove. Thirteen fishers resided in lower Trinity Bay, comprising the communities between Sunnyside and Dildo.

3.3.2 Commercial Status

Twenty-six of the forty-seven fishers interviewed had harvested capelin commercially at some point throughout their careers; twenty-one fishers had not. This is a small sample relative to the population of commercial fishers in the study area. According to DFO, in 1995, 249 fishers from Trinity Bay were licensed for capelin traps and 36 fishers were licensed for purse seines (DFO Statistical Data, 1999). Those fishers most intensively engaged in the commercial capelin fishery were concentrated in the area inside Trinity Bay, particularly across the bottom, from Chance Cove to Dildo. Most fishers interviewed in the Bonavista Headland area were not directly involved in harvesting capelin for a living although many had fished capelin for bait or picked them on the beaches (sorted out the female) in the early years of the commercial roe-bearing fishery.

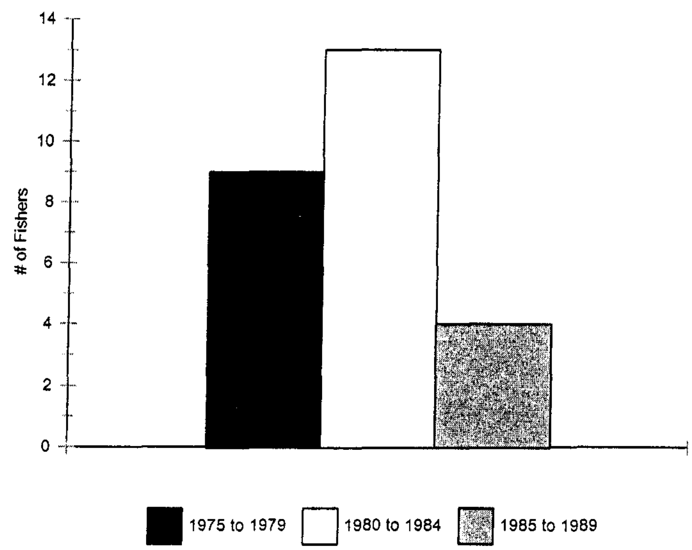
3.3.3 Gear Type

Of the twenty-six fishers who had fished commercially, most employed the capelin trap as the gear of choice throughout most of their career. However, two fishers used the purse/ring seine throughout their careers. Most fishers had used the beach seine early in their careers and then adopted the capelin trap later in their careers.

3.3.4 Tenure in the Commercial Capelin Fishery

All of the twenty-six commercial fishers interviewed had extensive experience in the capelin fisheries. Figure 3.2 illustrates that nine of the twenty-six fishers began fishing capelin between 1975 and 1979, thirteen between 1980 and 1984 and four between 1985 and 1989. Overall, most commercial capelin fishers interviewed had ten years or more experience in this fishery.[7] Of the twenty-six fishers who fished commercially, all had fished capelin continuously from their entry into the fishery except during those years when the fishery was closed or there was no market.

Figure 3.2: Year Entered Capelin Fishery



Source: TEK Interviews

3.3.5 Age

The average age of a fisher in this study was forty-nine years of age. Most fishers were over forty years old.

[7] By 1988, twenty-six fishers were harvesting capelin commercially. Two fishers retired from the commercial capelin fishery in 1989, five fishers retired between the years 1990 and 1992 and fourteen fishers were still actively engaged in the fishery in 1993.

3.4 Additional Data Analysis

The other component of the methodology included an analysis of numerous DFO management and scientific documents. All of the official 3L Capelin Fisheries Assessment Documents from the years 1985 onward were reviewed, including the Capelin Management Plans from the years between 1982 through to 1997. In addition, information was taken from the Fisheries Marketing Board, non-governmental papers and various DFO documents.

3.5 Limitations of the Study

This study provides useful information to support the research purpose and objectives. Despite this, the study has some limitations and biases that should be considered when reviewing the findings. The research is qualitative, based primarily on semi-structured interviews. By its very nature, qualitative research provides neither precise measures nor quantifiable results. Moreover, the results may not necessarily reflect the opinions of the population of interest since the approach to respondent recruiting was not based on principles of probability sampling. On the other hand, qualitative research provides useful direction and guidance not readily obtained using quantitative methods of data collection. The insight and in-depth understanding gained through qualitative research was well suited to this research study.

Random sampling from a "sample frame" of harvesters within this area was not possible because of the absence of an accurate, full list of licensed fishers for the region. The rate of non-participation was also high among fishers who were asked to participate.

As noted above, a probabilistic sample was not produced and therefore statistical inference to a wider population of fishers in the study area is not possible. To deal with the lack of a sample frame, snowball sampling was adopted and as such, the sample will be biased towards particular groups. This sample is heavily concentrated on lower Trinity Bay and capelin trap fishers. The sample is also small and mixed. For example, there are commercial fishers mixed with retired fishers and fishers pursuing other fisheries rather than capelin.

Lastly, there are disadvantages to secondary data analysis that are important to mention. The original interviews were not carried out specifically for a project on capelin and the commercial capelin fishery. As such, some transcripts did not always contain full and consistent data on these topics. A preliminary analysis of the transcript data from the career-history interviews revealed a number of important themes, but significant gaps in the data were identified relating to the actual timing of observed changes in capelin abundance, details about changes in fishing gear and the timing of those changes, and precise information on local spawning times and bycatch. Follow-up interviews were conducted in order to alleviate some of these problems.

3.6 Conclusion

This chapter has addressed the research methodologies employed for this thesis. Three different methodologies have been employed: secondary research using data excerpted from the taxonomic and career-history interviews with fishers from the Bonavista and Trinity Bay region; follow-up interviews with a sub-set of commercial fishers who participated in these interviews; and analysis of various DFO documents.

The chapter discussed the sampling procedures involved with interviewing fishers, the interview process and details the interview schedule or guide used to administer the interviews. Further, the chapter also included a section on the profile of research participants including findings on age, tenure in the fishery, and gear used. Lastly, the chapter identified the weaknesses of using these types of methodologies and some of the methods used to minimize these weaknesses.

Chapter 4 Capelin and the Capelin Fishery

4.1 Capelin

Capelin, *Mallotus villosus*, is a short lived, small, pelagic fish found in the cold oceanic waters of the Northern Hemisphere (DFO, 1991; Jangarrd, 1974). In the North Atlantic they are common around Russia, Norway and Greenland. In Canadian waters they spawn from Hudson Bay to south of Nova Scotia. In the Pacific, spawning occurs along the coasts of Alaska, British Columbia and Japan (DFO, 1991). Capelin generally spawn on beaches. However, some capelin do spawn in deeper waters, such as on the Grand Banks. Once the eggs are hatched, capelin migrate to sea, feed and grow for three or four years, return to spawning areas, spawn and most then die (DFO, 1991). In Newfoundland and Labrador, it is also believed that capelin spend most of their lives away from coastal areas, moving inshore only to spawn on beaches and on the bottom in adjacent water. However, it is also believed that some stocks of capelin are local to certain bays (Carscadden and Nakashima, 1997; Dodson et al., 1991). Five major spawning stocks have been identified off the coast of Newfoundland and Labrador: Labrador-Northeast Newfoundland stock; Northern Grand Banks-Avalon stock; Gulf of St. Lawrence stock; South Grand Banks stock; and St. Pierre-Green Bank stock (Carscadden et al., 2001; DFO, 1991). The South Grand Banks stock of capelin is the only known stock to spawn offshore. The spawning offshore is believed to occur at the same time as spawning on the beaches (DFO, 1991)

Capelin are a vital link in the food web of the cold ocean environment of the

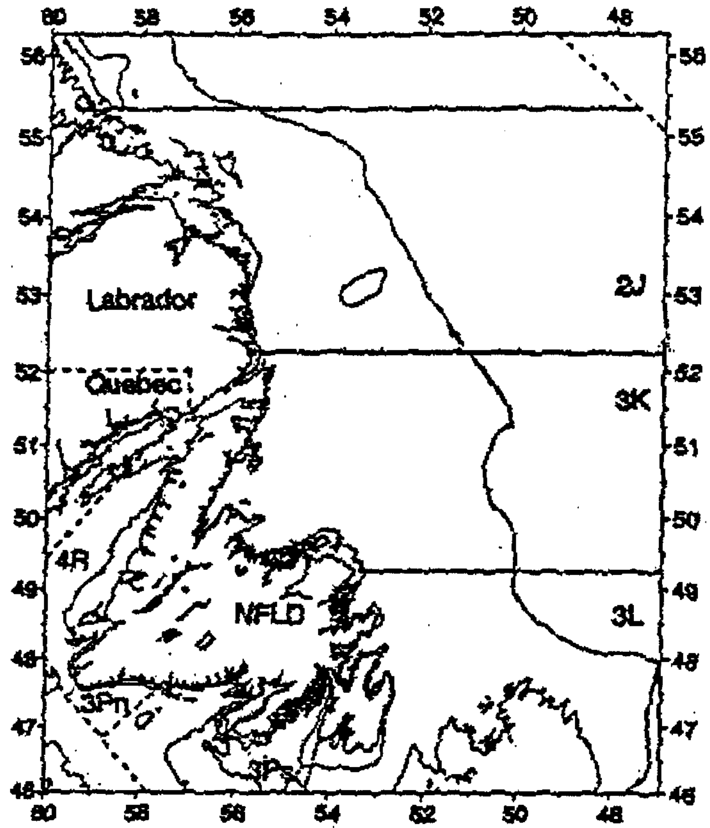
North Atlantic. They constitute the most important forage species for ground fish such as cod, Greenland halibut and marine mammals such as seals and whales (DFO, 1991). The greatest predator of capelin is the cod, with capelin constituting almost 98% of their diet, although in recent years it is unknown how much capelin cod are consuming. Greenland halibut are also known to feed extensively on capelin, as well as American plaice and salmon. Seals and seabirds consume large amounts of capelin (Massaro et al., 2000).

4.2 The Capelin Fishery

Canada's commercial capelin fisheries are confined to Atlantic Canada and heavily concentrated in Newfoundland and Labrador. In Newfoundland, the capelin fishery was as important as the Northern cod fishery to many small boat fishers living in outport communities, especially on the northeast coast of Newfoundland and Labrador. Before the development of a commercial capelin fishery in the 1970's, the arrival of capelin to spawn on the beaches heralded the arrival of the economically vital cod fishery, and the abundance of capelin rolling on the beaches ensured that there would be bait for the cod fishery, food for dogs, fresh fish to eat and an important fertilizer for potato patches. It has been estimated that in the past, 25,000 to 50,000 tonnes of capelin were used for bait, human consumption, fertilizer and dog food (DFO, 1991). In the early 1970s an offshore commercial capelin fishery developed with reported catches of about 70,000 tonnes per year. In 1974, the International Commission for Northwest Atlantic Fisheries (ICNAF) took over management of this fishery. They set an initial total allowable catch (TAC) of 250,000 tonnes and increased this to 500,000 tonnes for the period between 1975 and 1978 for the Northeast coast Newfoundland fishery. Offshore catches in this foreign fishery are reported to have peaked at 246,000 tonnes in 1976, then declined until this fishery was closed in southern areas (3L), and was given much reduced quotas in northern areas (2J3K) in 1979 (see Figure 4.1 for a visual of this area). The offshore fishery was closed completely in 1992 after abundance estimates derived from offshore acoustic surveys collapsed from 7 million tonnes to 100,000 tonnes between 1990 and 1991 and concentrations of capelin disappeared from area 2J off Labrador and from the adjacent northern 3K area off northeast Newfoundland (Carscadden and Nakashima, 1997; Carscadden et al., 1994).

An inshore fishery for roe-bearing capelin developed in the mid to late 1970s and expanded to become the major commercial capelin fishery in the region in the 1980s. This fishery was based initially on bar seines and handpicking female capelin on the beaches. The fishery shifted to purse seines and capelin traps in the early 1980s. Inshore catches increased during the 1980s, peaking in area 2J3KL at between 79 and 83,000 tonnes in 1988-1990, and within Newfoundland as a whole at 126,000 tonnes in 1990 (Carscadden and Nakashima, 1997).

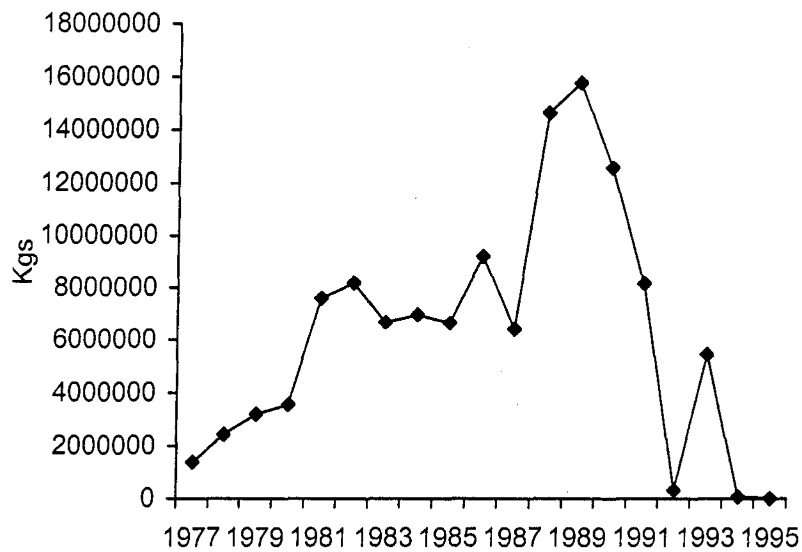
Figure 4.1: DFO Statistical Divisions



Source: DFO, 1998b: 2

Starting in the 1990s, the inshore fishery began to experience serious problems. Figure 4.2 illustrates that landings in the study area declined dramatically in the early 1990s with some year's landings lower than those in the late 1970s and early 1980s. Due to the small size of females and low abundance estimates in 1994 and 1995, there was no commercial capelin fishery in the study area and only a limited fishery in 1992 and 1993. Inshore catches still remain low today. For example, in 2000, landings in 3KL represented only 46% of the 35,580 tonne quota (DFO, 2000). In 2003, DFO announced a 40% reduction in the total allowable catch of capelin in Divisions 2J3KL indicating deepening problems with capelin stock abundance.

Figure 4.2: Capelin Landings: Bonavista Bay and Trinity Bay, 1977-1995

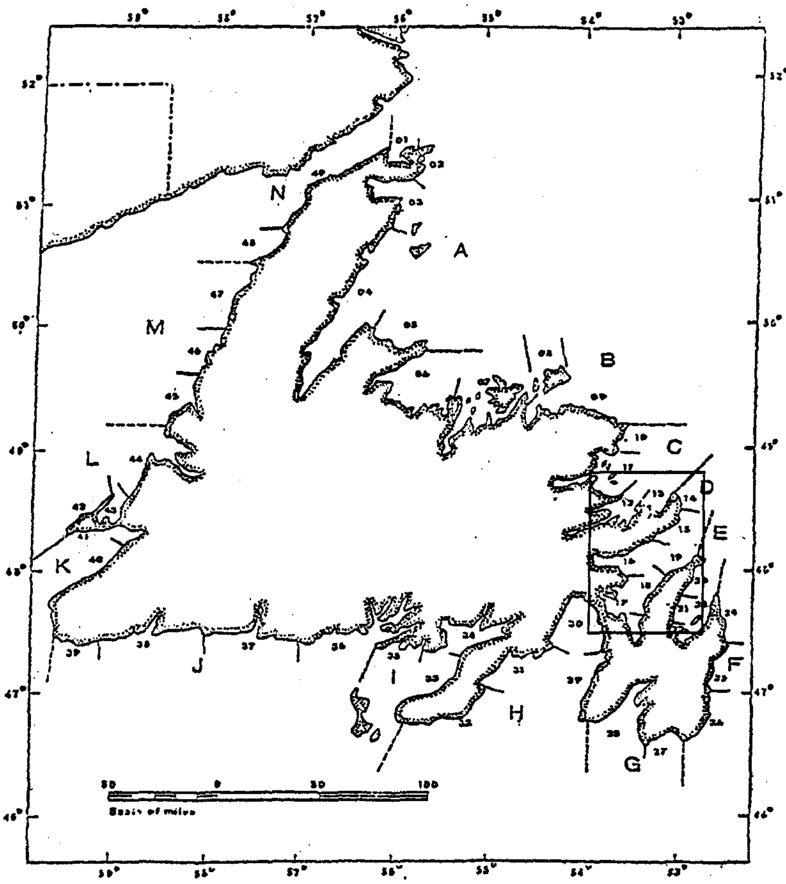


Source: DFO Purchase Slip Data 1977-1995

4.3 Capelin Landings and Value

There are two major sectors within the inshore roe-bearing capelin fishery: the fixed gear or capelin trap/bar seine sector and the more mobile purse seine sector. Quotas are allocated on the basis of these sectors and, from 1987 onwards, by area. Boats with purse seine licenses have the right to fish for capelin across multiple areas, whereas fixed gear fishers are largely confined to the bay or area where they have traditionally fished. On a regional basis, during the 1980s, capelin allocations for Trinity and Conception Bays were, on average, the highest within Divisions 2J3KL. Within the Bonavista-Trinity Bay region, the study area for this thesis, fishers living in lower Trinity Bay (area 17) landed a growing proportion of capelin in the 1980s and 1990s relative to other parts of the region (areas 13-16) (see Figure 4.3 for a visual representation of these areas).

Figure 4.3: DFO Statistical Areas for Newfoundland[8]



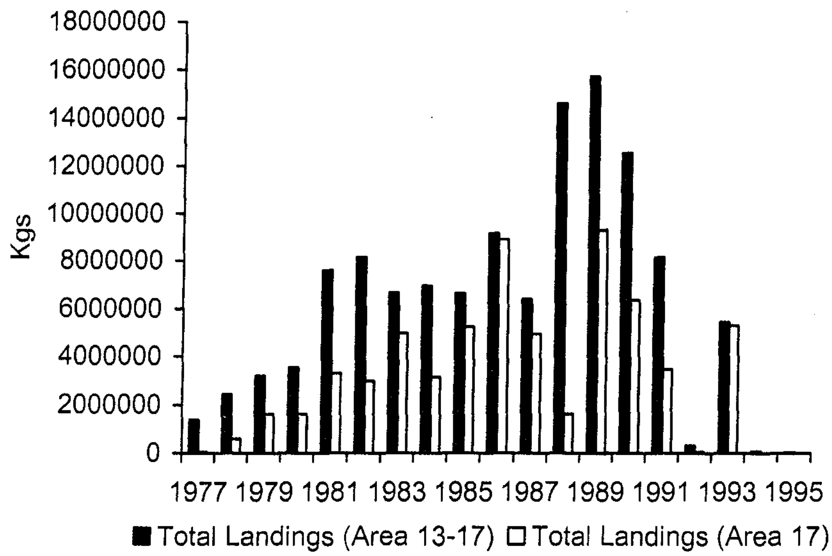
Source: DFO, 1997

Figure 4.4 illustrates that for the years 1985, 1986 and 1987 fishers from lower Trinity Bay, including the communities between Butter Cove and Dildo (statistical area 17) landed 78%, 97% and 76% of the total landings for statistical areas 13-17 which includes the communities between Plate Cove, Bonavista Bay and Dildo, Trinity Bay. This intra-regional concentration of landings appears to have been the result of the early arrival and slower decline in the abundance of capelin in this area, greater access to

[8] Statistical areas (A= White Bay, B=Notre Dame Bay, C=Bonavista Bay, D=Trinity Bay, E=Conception Bay, F=Southern Shore, and G=St. Mary's Bay.

processing facilities, and a management system that allocated capelin quotas based on areas rather than at finer spatial scales.

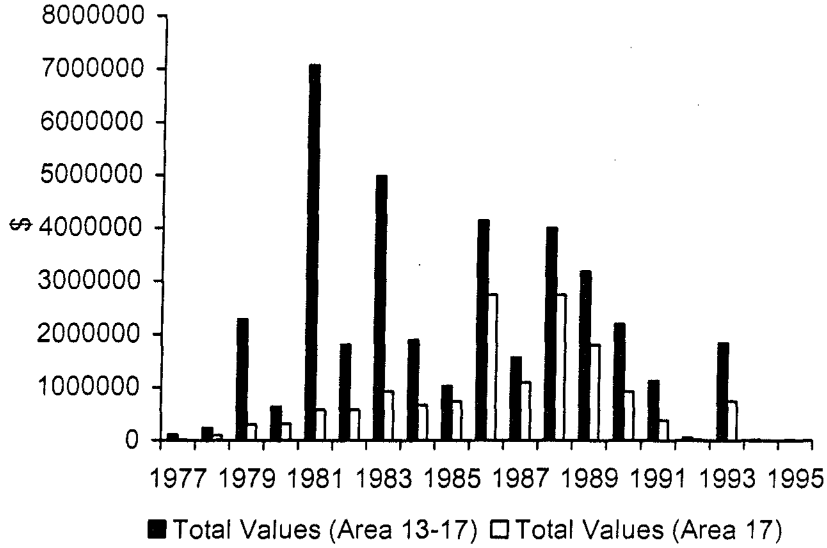
Figure 4.4: Capelin Landings: Bonavista Bay and Trinity Bay, 1977-1995



Source: DFO Purchase Slip Data 1977-1995

DFO purchase slip data and interviews with fishers indicate that income derived from the fishery varied significantly intra-regionally as well. Fishers from lower Trinity Bay benefited more than fishers from the Bonavista Headlands and Bonavista Bay. Figure 4.5 illustrates that for the years 1985 through to 1987, fishers from lower Trinity Bay (area 17) benefited from 72%, 66% and 71% of the total value for capelin in those years. The remaining wealth was distributed among fishers from the communities in the areas 13-16 (Plate Cove, Bonavista Bay to St. Jone's Within, Trinity Bay).

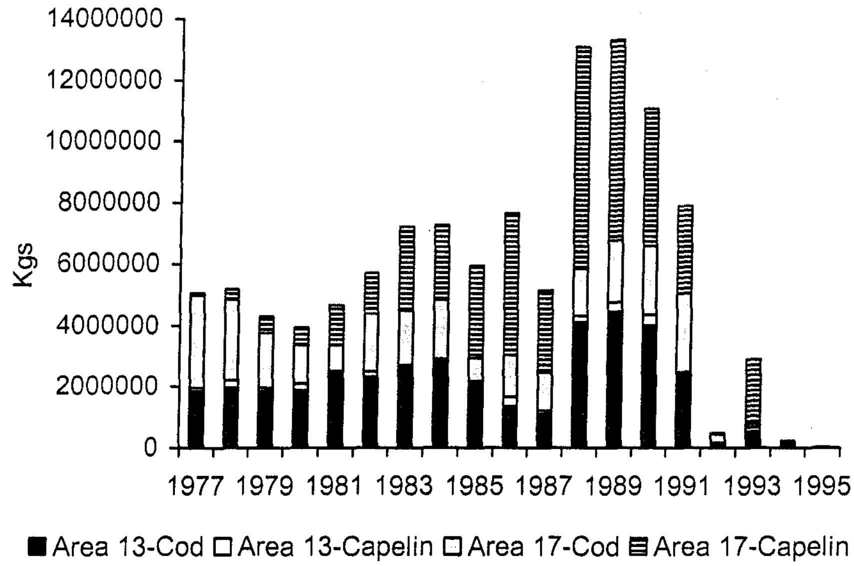
Figure 4.5: Total Landed Values: Bonavista Bay and Trinity Bay, 1977-1995



Source: DFO Purchase Slip Data 1977-1995

This intra-regional concentration of wealth could be linked to a number of different factors including the buyers' preferences for capelin from lower Trinity Bay. A comparison of landings of catch compositions in these different areas based on DFO purchase slip data reveals that groundfish predominated in landings from the Bonavista area between 1970s and the 1990s, whereas pelagic and squid landings made up a larger proportion of landings within the inner reaches of Trinity Bay. Figure 4.6 demonstrates this.

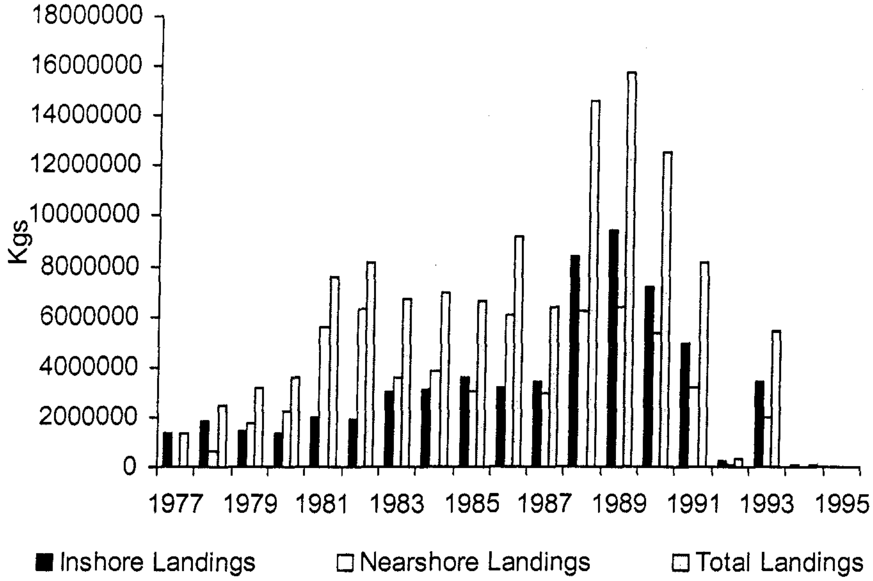
Figure 4.6: Cod and Capelin Landings: Bonavista Bay (Area 13) and Lower Trinity Bay (Area 17), 1977-1995



Source: DFO Purchase Slip Data 1977-1995

Nearshore capelin landings exceeded those recorded for the inshore between 1977 and 1984. After this period, inshore landings exceeded those in purse seines on the larger boats. For example, Figure 4.7 shows that for the years 1981 and 1982 the nearshore landings for areas 13-17 represented 74% and 77% of the total capelin landings, while in 1990 and 1991 the inshore landings represented 57% and 61% of the total landings.

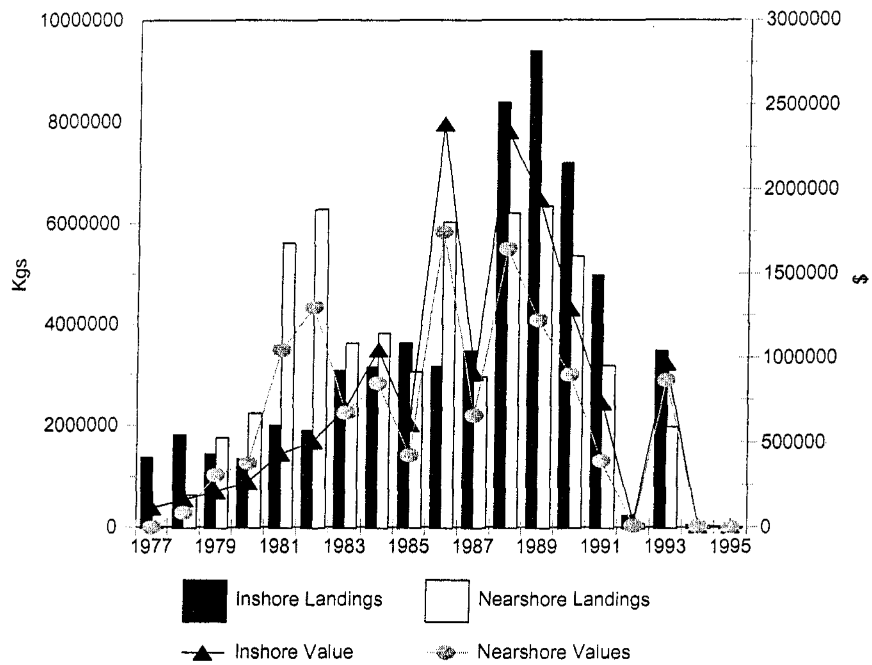
Figure 4.7: Capelin Landings: Inshore and Nearshore, 1977-1995 (Areas 13-17)



Source: DFO Purchase Slip Data 1977-1995

It is also important to note that even though nearshore fishers landed more capelin before 1984, the value of their harvests was somewhat lower than those of capelin trap fishers who fished much less. Figure 4.8 shows that, in 1983, trap fishers harvested 3,062,601 kilograms of capelin worth 695,840 dollars while seine fishers harvested 3,606,915 kilograms of capelin worth 677,074 dollars. Nearshore fishers received an average of eighteen cents a kilogram and inshore fishers received an average of twenty-three cents a kilogram. This difference in value may indicate that buyers preferred capelin harvested in traps because of the quality and higher percentage of female capelin in harvests taken close to shore.

Figure 4.8: Capelin Landings and Values: Inshore and Nearshore, 1977-1995 (Areas 13-17)



Source: DFO Purchase Slip Data 1977-1995

In summary, DFO purchase slip data on landings and the value of landings indicate that at the peak of the fishery (1988-1991) inshore fishers were harvesting more of the species and benefiting as well from the higher prices. Fishers harvesting capelin with purse seines landed roughly 7 million kilograms of capelin in 1989 valued at 1.25 million dollars while trap fishers harvested over 9 million kilograms of capelin worth approximately 2 million dollars.

Purchase slip data are one data source on the capelin fishery for the study area upon which this thesis is based. These data are also a form of social-ecological information in that they are shaped by the distribution of processing plants that record such information, the relationships between capelin harvesters and these purchasers, price of capelin, trucking costs and other factors. As is well recognized, these data probably provide a poor indication of trends in capelin abundance because harvester efficiency can ensure that landings will stay high until abundance is substantially reduced. They can also be affected by market and management mechanisms in that, as discussed further in the thesis, market preferences can contribute to discarding, dumping and under-reporting of catches, particularly in the context of quota-based fisheries.

4.4 The Science of Capelin

4.4.1 The Science of Capelin Abundance

Like other major commercial fisheries in the Northwest Atlantic, since the 1970s, capelin scientists have used a "numbers-based" approach based on a mathematical model to develop an estimate of capelin abundance. Varying indices of abundance feed into this model including results gathered from acoustic surveys, trap and seine catch rates, and aerial surveys. From the results of this model, relative estimates of abundance are determined (Winters, 1996). From this estimate of capelin abundance, total allowable catches (TACs) have been recommended and area quotas implemented.

Several different indices have been used to measure capelin abundance for the Division 2J3KL of which the study area for this thesis is a part (see Figure 4.1). In the 1980s and early 1990s, biomass estimates came from two offshore acoustic surveys carried out in Division 2J3KL, one in the spring and one in the fall. These results were validated using logbook catch rates and data from an inshore aerial survey (Carscadden et al., 1994). The aerial survey was used to estimate the surface area of capelin schools in coastal areas during spawning. The aerial survey was carried out in lower Trinity Bay and Conception Bay but did not include beaches along Bonavista Bay and the headland area around Bonavista. The assumption was made that the trends observed in lower Trinity Bay and Conception Bay were indicative of what was happening with the whole stock in Divisions 2J3KL (Nakashima, 1998).

The logbook program, which started in the early 1980s, was partly developed because of the absence of a Canadian offshore capelin fishery for use in stock assessments. Data from these logbooks provided the basis for the development of a fisheries-dependent relative abundance index based on capelin catch rates, length, sex, and maturity of capelin caught. The logbook program also provided a means to monitor fishers' estimates of bycatch and discards, which was information that was often lacking but important for accurate stock assessments for other species as well as for capelin. Up until the mid-1990s, both the purse seine and trap catch index were based on catch-per-day. This changed in 1993 when the trap catch rate was based on catch-per-haul (DFO, 1997). The voluntary logbook program, which is still carried out today, involves a group of purse seine and fixed gear licensed fishers in the Division 3KL. Additional offshore indices used to validate the trends from offshore acoustic surveys included the groundfish Division 2J3K fall bottom trawl bycatch index which started in 1980, the groundfish Division 3L bottom trawl bycatch index which started in 1985, and the Russian 2J3K fall commercial catch rate index which started in 1972.

In 1995 the Multiplicative Model was implemented to measure stock abundance and year class strength[9]. The purpose of this model was to provide an objective framework for combining several types of indices into a single standardized index (Nakashima and Winters, 1997). At that time and because there was no way to weight indices, general considerations rather than statistical strength were used to determine whether indices would be included in the overall model (Nakashima and Winters, 1997). That is, if the results from one index did not make sense or did not correspond with other indices it was removed from the model until further research was undertaken to address the inconsistencies (Nakashima and Winters, 1997). Many of the traditional indices as described above were included in this model with each receiving equal weight. An average was produced from the model and relative estimates of abundance and year class strength were provided (DFO, 1997). In 1996 another inshore index was introduced called the egg deposition index, which served as an indirect measure of female spawner escapement. In the early 1990s, when data for this index was starting to be collected, surveys were conducted on six beaches in Conception Bay and Trinity Bay. These surveys were reduced to two beaches in 1996 and one beach in 1998 (DFO, 1997). This index was included in the model with the assumption that the results from these beaches were indicative of beach spawning in Division 3KL (Evans and Nakashima, 2001).

The multiplicative model underwent modifications in 1999. At that time, all available indices were included in the model and each index was weighted according to

[9] Year class estimates are measured up to four years. Capelin are identified as belonging to a specific year class by counting annual growth rings in the ear bones. During the years when temperatures are colder, the rings will be closer making age determination difficult (DFO, 1997).

the level of uncertainty in its contribution to the overall index (DFO, 1999). The theory behind this was that indicators with less predictable strength or high uncertainty would be assigned a smaller weight and would have less of an impact on the overall result (DFO, 1999). Additional recruitment indices were added including larval studies, which were carried out on beaches in Conception Bay and Trinity Bay. It is important to note that these indices were relative and had to be verified using absolute estimates from other indices such as acoustic and aerial surveys. That is, these indices could not be included in the model on their own (Evans and Nakashima, 2001). Other non-traditional offshore indices including the 0-group and age 1 capelin index were also added to the model. In 2000, the Canadian spring and fall acoustic survey was added and the larval studies were removed. The Canadian acoustic survey had been ongoing since the early 1980s. However, in past years it was not included in the model because of its lack of correspondence with other indices (DFO, 2000). Because of continuing unexplained differences between the offshore and inshore indices, scientists agreed at that time that the multiplicative model would not be used to determine abundance (Nakashima, Personal Interview, 2003).

Between 1981 and 1990, inshore indices (catch rates and aerial survey) and offshore acoustic surveys produced trends that tended to correspond and each year DFO scientists were able to predict annual spawning biomass. After 1990, results from the inshore and offshore started to diverge with the offshore acoustic survey indicating low estimates in offshore abundance and inshore abundance indices indicating relatively stable and even increasing stock abundance. To illustrate, scientific abundance indices, inshore and offshore, placed 3L capelin abundance around two to four million tonnes in the early to mid-1970s, declining to under one million in the late 1970s, and then increasing to around seven million tonnes in 1990. In 1990, however, the offshore acoustic survey suggested a collapse in projected biomass to below early 1980 levels (Carscadden and Nakashima, 1997; Frank et al., 1996). As a result of these diverging indices, biomass estimates were not determined between 1991 and 1994. Assessment meetings were carried out to try to understand the divergence between offshore and inshore indices. Year class strength was discussed in terms of what year classes were strong or weak. However, actual estimates were not determined (Nakashima, Personal Interview, 2003). Various offshore indices were also cancelled throughout this time period including the Russian CPUE series that ended in 1991 and the bottom trawl survey that ended in 1994. These cancellations were related to gear changes. Further, the results from the offshore fall and spring acoustic surveys carried out in Division 2J3KL were removed from the abundance model in the mid-1990s after the inconsistencies between this index and inshore indices could not be explained (DFO, 2001) The trap catch rate index was excluded in 1993 because of concerns over its comparability with previous years (DFO, 1998b).

Throughout the 1990s, low estimates of capelin offshore continued while inshore indices of abundance indicated relatively stable, high abundances of capelin during the same period (Carscadden and Nakashima, 1997; Frank et al., 1996). Scientific research has linked this divergence to changes in capelin and capelin behaviour including size reductions, later spawning, and large scale shifts in the location of capelin (Neis and

Morris, 2002). The scientific consensus is that environmental conditions produced changes in capelin biology and behaviour, affecting the accuracy of offshore acoustic estimates and resulting in an underestimation of true offshore capelin abundance (Carscadden et al., 2001; DFO, 2001; Carscadden and Nakashima, 1997; Carscadden et al., 1997; Nakashima, 1996b; Carscadden et al., 1994). Data collected from telephone surveys conducted with fishers in the mid-1990s have not supported DFO's inshore estimates. The consensus has been that abundances levels were below those that existed when they first started fishing. Many fishers also expressed the opinion that the capelin fishery should be closed because of low abundance (DFO, 2001; Nakashima, 1996a). Carscadden et al. (2001) concluded that there is no scientific evidence to indicate that "over-exploitation of capelin has ever occurred any point in the histories of fisheries in SA2 + Division 3KL where most of the fishery has occurred" (p. 4).

Due to the inconsistencies between the inshore and offshore indices, abundance has not been estimated since the early 1990s (DFO, 1998b; DFO, 1996,). In addition, estimations of year class strength have been much more difficult to achieve. Difficulties assessing abundance and year class strength have also been heightened by delayed spawning and by changes in research methodologies and the elimination of some research programs. By 2001, only a few indices were available to estimate year classes including two beach sampling surveys conducted on the same beach. It was determined at that time that the use of the model with only two indices was not scientifically defensible (DFO, 2001). As a result a relative estimate of year class strength was not produced and has not been produced since 2000.

Since the mid-1990s, scientists have raised concerns about the uncertainties related to the model used to assess stock abundance and year class strength. They have been particularly concerned with catch rates and whether this information was an accurate indicator of stock abundance. Scientists claim that these rates are affected by changes in fishing effort due in part to monitoring for quality and fishing only when a market exists (DFO, 1998b). Scientists also expressed concerns with the egg deposition index and the aerial survey, both of which were scaled back as a result of funding cuts (DFO, 1998b). In particular, several concerns have been raised over the results of the aerial survey. In the late 1990s it had been scaled back to just one area of Trinity Bay and the concern was that the results of the survey might not have adequately reflected the whole stock in Division 2J3KL (DFO, 1998b). Furthermore, there were indications from fishers that abundance might have been changing at different rates within the bays versus around the headlands, which had scientists wondering whether the aerial survey adequately reflected what had been happening with the stock in the area (DFO, 1998b). All of these factors combined have produced a state of great uncertainty with regard to the capelin and the fishery.

4.4.2 The Science of Stock Structure

Prior to 1992, capelin in the study area were managed as two distinct stocks[10]

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[10] A group of fish is regarded as a stock if it keeps to itself enough so that it can be harvested without having too much of an impact on other stocks of the same species. DFO defines stock as a population of individuals of one species found in a particular area. It is used as a unit for fisheries management (DFO, 1991).

which included the Northeast Newfoundland stock in Division 2JK and the Northern Grand Bank and Avalon stock in Division 3L. It was believed that capelin from the Northeast Newfoundland stock migrated as far south as Conception Bay and mixed with the Northern Grand Bank stock before migrating north to spawn in Notre Dame and White Bays. However, after examining tagging data from the period between 1983 and 1988 to determine inshore migration patterns, DFO scientists decided in 1992 that capelin in these areas could be considered one stock complex[11] (DFO, 1998a and b). The results showed that capelin tagged during the fishery were caught in the same bay and capelin tagged prior to the fishery were caught north of the release sites indicating a northward movement (Nakashima, 1998). For example, capelin tagged in St. Mary's Bay were caught on the Southern Shore and Conception Bay, while those in Conception Bay were found in Trinity Bay and even in Notre Dame Bay. Similarly those tagged in Trinity Bay were caught in Bonavista Bay, Notre Dame Bay and White Bay. The data showed that capelin from two stock areas including the Northeast Newfoundland and Labrador stocks and the Northern Grand Bank stock intermingled during their inshore migration (Nakashima, 1998). This meant that although there may be more than one stock of capelin in Division 3KL, due to the fact that the fishery is targeting mixed populations, a management system based on a particular stock is not feasible. Therefore, quotas are now extended based on the abundance of capelin within the stock complex. Scientific studies

[11] A stock complex is a group of heterogeneous sub-stocks located within a management unit (Frank and Brickman, 2000). The number of stocks within a stock complex may never be known with any confidence.

conducted in the area are considered to be reflective of what is happening in the whole area. What scientists do know is that there are two types of capelin caught in the Bays before spawning: capelin waiting in the Bays to spawn in that area and capelin that are intercepted during their migration to spawn on beaches further north (Nakashima, 1992).

The tagging study did not address the possibility of a bay stock of capelin in Trinity Bay and what consequences the stock complex management approach would have for any existing bay stocks. Some scientific research has reviewed the possibility that one or more Trinity Bay stocks of capelin may exist (Winters, 1970). However, the current scientific regime makes no reference to the idea that within stock complexes, sub-stocks or bay stocks of capelin could also be spawning on community beaches. According to one capelin scientist "the question of bay stocks has always been around [but] we have not come up with any viable means to answer the question scientifically" (Nakashima, Personal Interview, 1998).

As demonstrated above, the science of capelin abundance and stock structure is a form of social-ecological knowledge influenced by the scientific models that are used, research methods including the sampling tools used, and by the temporal and spatial dimensions of the sampling. For example, a variety of abundance indices are used to estimate stock biomass. However, these indices are all based on research carried out at specific times of the year and only within certain areas. Further, some of these indices are influenced by a number of different factors including changes in gear, fishing efficiency, and management initiatives, which control the gear that is used, and the timing and duration of the fishery. Bureaucratic influences such as limited funding have also limited or eliminated some studies.

4.5 The Management of Capelin Fisheries

Managers set total allowable catches (TACs) partly in response to scientific advice on abundance and market need. Managers also respect the 10% rule when setting TACs. Under this rule, the recommended exploitation rate for capelin is less than 10% of the projected spawning biomass in the next year (Carscadden et al., 2001). The rationale for this low exploitation rate includes widespread recognition of the importance of capelin as a forage fish and associated concerns about the potential negative effects of a commercial capelin fishery on other commercial fisheries, as well as the ecosystem as a whole. Since the early 1990s and in the absence of reliable scientific data, TAC's have reflected market demand (DFO, 1998b)

4.6 Fishers' Involvement in the Science and Management of the Capelin Fishery

Data from logbooks completed by fishers have provided a basis for discussion and dialogue between capelin scientists and capelin fishers something that was absent in Northern cod science. In the latter case, early disagreements between inshore fishers and scientists and the shortage of scientific information on inshore fish populations and inshore fisheries appear to have contributed to delayed recognition of problems with the Northern cod stock assessments (Hutchings and Myers, 1994). After offshore acoustic and inshore abundances diverged in 1991 and dramatic changes were observed in capelin size and spawning times, DFO scientists introduced a telephone survey with fishers in

1994. The purpose of the survey is to collect information from fishers about their observations and interpretations of changes happening with capelin and the capelin fishery. This information contributes to the evaluation of quantitative biological and fishery-related information on the fishery with a long-term goal of developing and verifying an index of abundance (Nakashima, 1995; 1996c). The information collected from the surveys is also used to supplement the information collected by the logbook and inshore acoustic surveys. The logbook program and telephone survey are still included in the capelin science program.

4.7 Conclusion

Capelin play an important role in the marine ecosystem, acting as a source of food for many other fish species such as cod and halibut. Capelin have been harvested commercially in Iceland, Greenland and along Canada's east coast. Over the past five decades, within Atlantic Canada, Newfoundland's Northeast coast capelin fisheries have been the most extensively fished and economically viable. Capelin harvesters from the Trinity and Conception Bay areas, prospered most from this fishery with fishers from lower Trinity Bay benefiting more than others in the study area.

In the last ten to fifteen years, the inshore capelin fishery along Newfoundland's Northeast coast has declined dramatically. Capelin scientists maintain that capelin biomass was relatively healthy up to the early 1990s. At that point, offshore data suggested a decline in capelin biomass closer to levels prior to 1980 while inshore data suggested that capelin biomass was healthy. In contrast to scientists, fishers have reported since the late 1980s that the capelin stocks have been declining. In response to fishers' observations and offshore estimates, the scientific position has been that environmental conditions produced changes in capelin biology and behaviour, which affected offshore survey data resulting in the underestimation of capelin abundance from that index.

Scientists' knowledge used to assess the health of capelin stocks as well as the purchase data that are used to monitor quotas and determine overall landings are all forms of social-ecological knowledge. The social and ecological contexts that mediate stock assessment science have changed significantly over time. For scientists' knowledge, the spatial and temporal dimensions of scientific knowledge as well as the paradigms informing the research that is done and interpretation of that research have all been subject to change. Factors such as management initiatives and the changing duration of the fishery will also affect elements of scientists' knowledge.

Chapter 5 Capelin Migration Patterns and the Bay Stock Theory

5.1 Introduction

This chapter discusses fishers' and scientists' understandings about capelin stock structure in Trinity Bay and Bonavista Bay. Data collected for this thesis in the mid to late 1990s show that fishers and scientists generally agreed on issues of capelin migration into Trinity Bay and Bonavista Bay. However, scientific thinking at that time diverged somewhat from fishers' perceptions regarding capelin stock structure, particularly around issues concerning the presence of a bay stock of capelin in Trinity Bay. Fishers who think there is a Trinity Bay stock of capelin use their observations that there are two runs of capelin, observed differences in sex composition, differences in the timing of the two runs, and indications of overwintering capelin in Trinity Bay to support their perceptions. Scientists have reviewed the possibility of a bay stock of capelin but have been unable to come up with a way of managing capelin on the basis of sub-stocks. The chapter concludes by discussing the social-ecological factors that appear to mediate fishers' and scientists' knowledge contributing to some differences related to capelin stock structure.

5.2 Scientists' Knowledge of Capelin Migration Patterns

A proper understanding of the migration patterns of capelin is important in order to manage this resource effectively. Migration patterns are one indication of stock structure. Poor understanding of stock structure can result in inadvertent overfishing on particular stocks of fish. If scientists are unable to tell how many stocks of capelin exist then management decisions around quotas and licensing are difficult to make (DFO, 1991).

As explained in *Chapter 4*, the stock assessment regime assumes that 3L capelin overwinter in a nursery area on the Grand Bank and the Northeast Newfoundland shelf. Juvenile capelin start to mature offshore in the late winter-early spring and then, at maturity, schools of adult capelin migrate inshore in late June, early July. These capelin are thought to arrive first in St. Mary's Bay and then to migrate north through various bays (DFO, 1998a and b). Results from a tagging study carried out between the years 1983 and 1989 showed that capelin tagged along coastal areas of southeastern and eastern Newfoundland in May and June remain in the same area to spawn or migrate further north and west (Nakashima, 1992). Tagging studies conducted in the 1990s also showed that some capelin recaptures were found down stream of the Labrador Current (Nakashima, 1992).

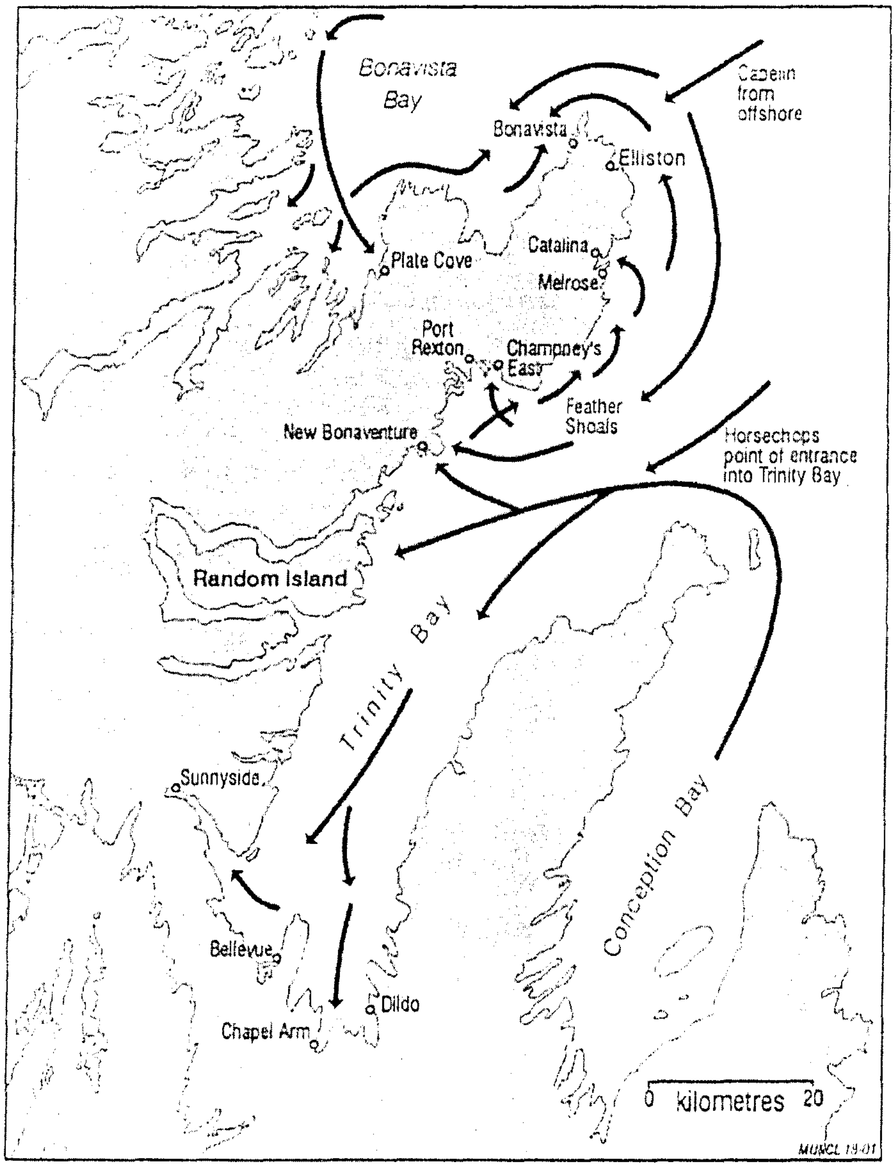
5.3 Fishers' Knowledge of Capelin Migration Patterns

Fishers' observations of capelin migration patterns are mediated by the location of their fishing grounds, most of which are along the coast. Inshore fishers' observations generally capture what happens locally in their area. Precise origins of migrating capelin, their movement in and out of the Bays prior to approaching the coast, and the ultimate spawning locations of aggregations that do not spawn locally are not well understood by individual fishermen, particularly those relying on fixed gear like beach seines and, more recently, capelin traps. However, fishers often supplement their own observations with information received from other fishers and capelin science. This can produce a larger picture of capelin activity throughout the area. LEK research can aggregate local observations by individual fishers to give a larger scale picture if interviews are spread throughout a larger area.

In the original interviews carried out by the Eco-Research team, fishers were asked to describe their observations of capelin movement in and out of the bay and the timing associated with those movements. Fishers were also asked to describe any observed changes in timing and migration over the course of their fishing careers. Twenty-one fishers discussed migration patterns of capelin in the study area. Eight fishers were from Bonavista Bay, five were from the New Bonaventure area, and eight were from lower Trinity Bay. A majority of these fishers harvested capelin commercially and had been fishing for capelin an average of eighteen years at the time of this study. These fishers varied in age between forty and eighty-four, with the average fisher being forty-four years of age.

Overall, fishers' observations concerning the direction of pre-spawning migrations were consistent with scientific tagging data (Nakashima, 1992). Nineteen of twenty-one fishers who offered information on capelin migration patterns agreed with the prevailing scientific perception that capelin migrate into Trinity Bay and Bonavista Bay from the south, and move north along the coast, separating out to spawn at different locations. Within Bays, fishers suggested that capelin migrate along deeper water channels and then spread out into shallow water areas (See Figure 5.1).

Figure 5.1: Capelin Migration Patterns Described by Fishers



Among fishers from lower Trinity Bay, eight said that capelin strike in lower Trinity Bay first, particularly Chapel Arm or Chance Cove and then work their way north. Another early point of arrival was Bonaventure Head, on the west side of Trinity Bay. This pattern is consistent with tagging data. Some fishers claimed that capelin landed in Smith Sound and then worked their way along the coast towards Bonavista Bay

(Nakashima, 1992). The migration pattern most commonly emphasized by those near the Bonavista Headland area described the migration of capelin into Trinity Bay from the south, striking along the coast between Random Island and English Harbour and then migrating along the coast, around the Bonavista Headland and down into Bonavista Bay. Fisher 1 of Melrose stated, "They (people from Port Rexton, Champneys) would have the capelin a week up there before we would get them." Six of eight fishers from the Bonavista Bay area said that capelin entered the bay from the south along the east side of the Headland (Bonavista Bay) striking places such as Port Rexton and Melrose first and then moving around the Headland into Bonavista Bay. Fisher 26 of Bonavista said, "[Capelin] are coming in probably from the southward, spawning in places such as Red Cove, Long Beach, and Bailey's Cove [Bonavista Bay]." Fisher 29 of Bonavista said, "You get them up around Random Island and these places, and then you get them down in Spillars Cove (on the east side of the Headland) and then they'll come on up around the shore that way."

Fishers from Bonavista Bay observed other movements consistent with findings from tagging studies in the 1990s which showed migrating capelin from area 3L in the north, mixing with those from area 3K (Nakashima, 1992). Four fishers claimed that capelin sometimes entered first on the north side of Bonavista Bay, while other times capelin entered directly onto the Headland rather than migrating out of Trinity Bay, along the east side of the Headland. Fisher 4 of Elliston claimed, "Some summers you would get the capelin coming from the north." Plate Cove, Salvage Cove and Dunville, communities situated along the west side of the Bonavista Peninsula, were all described as places where capelin landed prior to arriving in Bonavista. Fisher 26 of Bonavista said, "The understanding that I am getting [is that] the capelin used to come on the north side of the Bay first, and go to Greenspond area." Fisher 22 of Plate Cove claimed, "Most times the capelin in Bonavista Bay always lands [in] Greenspond. Now you will get a little sign of capelin before it, but the main body of capelin usually lands in Greenspond first. The next spot you usually get them is Salvage [Cove] area." One fisher also mentioned that capelin migrated into Bonavista from northeast of Cape Bonavista. He stated that longliner fishers off the Cape Bonavista would see the capelin first.

5.4 Discussion

Overall, the data suggest that at a large spatial scale fishers and scientists agree on the capelin migration patterns for Trinity and Bonavista Bays. Though fishers from particular parts of Trinity Bay can, in many cases, only account for what happens in their immediate environment, it is clear that, when aggregated, fishers' local knowledge points to migration patterns that are similar to those derived from tagging studies. A different picture would have emerged if only fishers from a certain area of Trinity Bay or Bonavista Bay were interviewed, an indication of the social and ecological factors that can influence LEK. In that case, the picture of migration patterns would have differed somewhat from those in the tagging data.

5.5 Is There a Trinity Bay Stock of Capelin?

The science of capelin stock structure provides essential information for determining quotas and licensing decisions. If scientists know that distinct stocks of capelin exist then, ideally, management initiatives should be put into place to ensure that these distinct stocks are not overfished. This is difficult to achieve when dealing with mixed stock fisheries and in contexts where it is difficult to separate capelin caught in commercial fisheries on the basis of their stock of origin. As explained in *Chapter 4*, scientists divide capelin in Newfoundland waters into five general stocks. Prior to 1992, capelin in the study area were managed as two distinct stocks which included the Northeast Newfoundland stock in Division 2JK and the Northern Grand Bank and Avalon stock in Division 3L. In 1992, DFO scientists decided that capelin in these areas could be considered one stock complex (DFO, 1998a and b). Scientists believe that capelin intermingle during their migration to spawn on beaches further north (Nakashima, 1992). However, a quota-based management system based on quotas for a particular stock would be impossible because the fishery is targeting mixed populations. As a result, quotas are based on the abundance of capelin within the stock complex. Scientific research has not addressed the possibility of a bay stock of capelin in Trinity Bay and what consequences the stock complex management approach would have for any existing bay stocks. Research over the next few years is expected to address the issue of bay stocks (Nakashima, Personal Interview, 2003).

5.6 Fishers' Knowledge and a Trinity Bay Stock of Capelin

In the interviews carried out by the Eco-Research team, fishers were asked to describe their observations of capelin stock structure, changes in the size of capelin and observations of overwintering capelin. Some fishers who participated in this study believed that a bay stock of capelin existed at the time of the study, or had existed in

Trinity Bay in the past. Fishers who presented this argument used their perceptions of two runs of capelin in their area, links they had observed between the size of capelin and timing of capelin runs, and indications of overwintering capelin to support their arguments. Fourteen fishers discussed the possibility of a bay stock of capelin in Trinity Bay. All of these fishers resided in communities in lower Trinity Bay. Further, all of these fishers had fished capelin commercially and had been involved in the fishery for an average of nineteen years at the time of interviews. Fishers varied in age between thirty-two and fifty-eight, with the average fisher being forty-eight years of age.

Eight fishers, all from lower Trinity Bay, supported the idea that a stock of capelin exists or existed in Trinity Bay. Some of the characteristics they associated with the Trinity Bay stock included early arrival, larger size, and different sex composition in the landings. First, fishers who supported the Trinity Bay stock theory referred to the bay stock capelin as a bigger size of capelin compared to the smaller offshore "run" that appeared some weeks later in the season. Fisher 39 of New Bonaventure stated, "I think there is a bay stock of capelin, but that's a different capelin from out there. It's bigger capelin. The bay stock is bigger than the outside." Fisher 40 of Random Island claimed, "[They] always had two stocks of them . . . used to have what you call the big capelin. They used to spawn here. But we'd always run into this stock we are getting now. By the last day or two of the capelin, we'd always get those small ones in our traps." Fisher 44 of Thornlea stated, "There always was a big capelin and a small capelin, and they came in June. And then you'd have three or four weeks at the capelin, and then you would get a week or two at the small ones." Fisher 46 of Chapel Arm stated, "We always found two runs of capelin. What was traditional-father would tell you the same thing-the first run would always be the big capelin, coming and landing early June, middle of June. But then in July you get what they call the second run, and this is the stock of capelin you hear talk of. You hear talk of it off Conception Bay and all of a sudden it disperses in the Bay."

Secondly, fishers described the bay stock as always comprising more males than females. In contrast, in the later run of capelin there were more females than males.

Fisher 54 of Old Shop claimed:

> The first run was largely made up of big capelin while the second run was smaller. The first run was the bay stock and the second run came from offshore. Well the first ones that we fished were always big capelin like this. The females were really big . . . but there wouldn't be a high percentage of females in them. The female content would be down in the 30s and 40s like that[12] . . . The female always got higher during the second run... they be all females. You would hardly see any males at all.

Fisher 55 of Chance Cove observed, "From the years that we were getting good capelin, first when they come they were big capelin. But they wouldn't be so good a percentage. There would be more males than females. But when the smaller capelin come there would be a lot more females than males. You know it seemed like that run of capelin would be smaller capelin."

This first run of capelin, sometimes known as *June capelin* or the capelin

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[12] This fisher is referring to the percentage of females in the landings. DFO management set both size and composition criteria as a conservation measure to minimize the exploitation of small capelin and excessive dumping of male capelin, In 1995, the requirement was for a maximum of 50 females per kilogram and a minimum of 30% female content in the total landings. Fishers were told to meet this criterion before they landed their catches.

associated with the capelin scull, arrived during the first three weeks of June, depending on the location. In a follow-up interview Fisher 46 of Chapel Arm stated:

> The amount of capelin can be ranged in two ways-no big banks of capelin . . . there was capelin in June and then capelin in July . . . different stocks of capelin. The first run was called the bay stock . . . after it spawned it went out in deeper waters . . . then that capelin would move out and then the second run would move in . . . smaller run and much the same as the capelin as we got today . . . the big capelin was early.

Of the eight fishers who supported the idea a bay stock of capelin, six thought that the first run of capelin was a stock of capelin that lived in Trinity Bay all year long. Fisher 41 of Chance Cove said, "I certainly think there was a bay stock of capelin in this bay, I think that's the early one we were catching." Half of the fishers who said that capelin overwintered in Trinity Bay described observing *whitefish*, small capelin caught during the winter. Fisher 52 of Dildo stated, "They [capelin] definitely overwintered in the bay, well if you like, killing Turrs and sea birds in the bay in the winter had capelin . . . And there's always capelin, always during sometime in the winter that you hear people picking up capelin on the beach somewhere."

Not all fishers agreed with the possibility of a bay stock. Six fishers, all from Trinity Bay, said that the presence of two distinct stocks of capelin was a possibility. Fisher 48 of Bellevue agreed that there were two runs of capelin but he was not sure if the bigger run was a different stock or just more mature than capelin in the second run. He stated, "It seems there was big capelin at one point, that was what we fished. The small ones always came after them."

Previous scientific research conducted by Winters (1970) documented overwintering juvenile and older capelin in Trinity Bay. He found that local people referred to these capelin as *whitefish*.[13] He also found that these capelin began segregating by sex in May and spawning ridges would start to appear on the males around mid-May. During the overwintering period, they were concentrated in large, mixed sex, inactive schools in cold water.

5.7 Discussion

Some fishers in this study believed that a bay stock of capelin exists or existed in lower Trinity Bay. Other fishers were unsure about the possibility of a bay stock arguing that there had been an early first run of larger capelin but these may have been part of the same stock. Using both their perceptions of two runs of capelin and observed differences in the size and timing of runs, some fishers who thought the bay stock existed also argued that this stock of capelin may have been overfished in the 1980's and that management initiatives should be put into place to protect it. Some scientific research has reviewed the possibility of a bay stock of capelin but it has proven difficult to confirm its existence and to manage on a stock-by-stock basis.

5.7.1 Disagreement Between Fishers and Scientists

The observational basis for scientists' and fishers' knowledge of stock structure differs. Scientists base their theories about capelin stock structure mostly on results from

[13] The Dictionary of Newfoundland English says the term whitefish refers to spent (post spawning capelin) and, in some cases, to immature capelin that "stayed in the Bay during the winter are sometimes washed ashore after being killed by cold water and can be found in the stomachs of turrs, puffins or seals" (Storey et al., 1990: 611). See also Templeman 1948; Winter, 1970).

the capelin-tagging program. Harvesters' views come from observations about the apparent timing of arrival, direction of movement and composition of different "runs" in their area. If tagging has been targeted in particular areas or particular periods during the fishery and there is a Trinity Bay stock that is harvested at a different time and only in Trinity Bay, tagging data may not be capturing information about this stock. On the other hand, if capelin from the same stock tend to come to the shore at different times and if these "runs" tend to differ in their sex composition, then the runs observed by fishers could be from the same stock.

Scientists have not fully explored the idea that a bay stock exists in Trinity Bay. Fishers are aware of the environment they fish in and it is a necessity for them to understand the fish they are harvesting. If a sub-stock of Trinity Bay capelin exists and if they comprise or comprised an important part of fishers' landings failure to manage this stock effectively could threaten their fishery. Research indicates that there are major concerns with management systems based on the one stock complex. Failure to properly understand stock structure increases the risk that particular stocks may be overfished despite relatively low fishing mortalities at the level of the stock complex as a whole (Wilson and Kornfield, 1998). If there is a local stock of capelin in Trinity Bay, intense fishing effort concentrated on particular "runs" of capelin might have produced a pattern of delayed spawning, smaller sized capelin and reduced abundance. The reduced abundance would not necessarily be evident at the level of the stock complex as a whole but would be detrimental to these sub-stocks or "runs" of capelin.

5.7.2 Disagreement Among Fishers

There were some disagreements among fishers in Trinity Bay over the issue of a Trinity Bay stock of capelin. Unfortunately, with the data that are available it is impossible to know all of the social-ecological factors that might be contributing to these disagreements. However, age may be a factor. To explain, changes in the capelin fishery took place as early as the 1980s. Since that time, fishers have been observing a gradual but steady change in migration patterns, timing, and capelin size. It is possible that some of the fishers who were less inclined to agree with the bay stock theory were younger and did not have the baseline knowledge that older fishers possessed. It is also possible that a bay stock of capelin existed unique to the bay in the past prior to when some of the younger fishers joined the fishery. The data available on age indicates that those less likely to agree with the bay stock theory were younger fishers averaging forty-three years of age. Fishers who agreed with the bay stock theory were older fishers averaging fifty-one.

Location is another social-ecological factor that could explain disagreements between fishers from different parts of Trinity Bay. To clarify, fishers from the Bonavista area described only one "run" or "stock" of spawning capelin. This was the June capelin that traditionally arrived in that area between the twentieth and twenty-fifth of June. Those in lower Trinity Bay distinguished between two runs or stocks that differed not only in the timing of their spawning, but also in size and sex composition. Fishers from Bonavista Bay were only familiar with their surrounding environment and were less inclined than those in Trinity Bay to speculate about capelin migration patterns outside their immediate area. In addition, fishers from the Bonavista area were generally not commercial capelin fishers and may not have paid as much attention to size, timing and composition of capelin as those from lower Trinity Bay. In other words, they might have observed less and had a less sophisticated and focused understanding of these issues than fishers in Trinity Bay.

The data presented here limit any analysis of purse seine fishers' knowledge of the bay stock theory. Only two of the fishers who discussed the bay stock theory used purse seines. One fisher agreed that a bay stock of capelin existed. It is important to note, however, that purse seine fishers may have a somewhat different perception of stock structure than trap fishers, as a result of the gear they use. Purse seine fishers generally pursue capelin rather than wait for capelin to arrive inshore like trap fishers. Further, seine fishers are less likely to pick over their capelin but generally sell all their landings to the plant. Given this, purse seine fishers might have more knowledge about migration (because they can follow capelin) but less about local "runs" and their composition. Any future study of capelin fishers' observations on capelin stock structure should take this in consideration.

5.8 Conclusion

This chapter discussed the findings related to fishers and scientists' understanding of capelin stock structure, including migration patterns and other observations and beliefs related to stock structure. For the most part, fishers and scientists agreed on issues related to migration patterns and how capelin move in and out of Trinity and Bonavista Bay. An analysis of fishers' and scientists' knowledge as social-ecological products suggests some reasons for the differences that exist between fishers and scientists and among fishers on issues related to the bay stock theory. Differences in perception may be related to the timing of tagging studies versus the timing of the capelin trap fishery. Social-ecological factors such as age, location and possibly gear type should be used as assessment variables in future studies aimed to gather and integrate fishers' knowledge on capelin stock structure. Given the potential risk to local capelin stock structure, such as the possible Trinity Bay stock, from managing stock complexes as one unit, more scientific research is needed in this area.

Chapter 6 Capelin Abundance

6.1 Introduction

This chapter presents the findings from the analysis of fishers' and scientists' knowledge about capelin abundance. In reviewing both the scientists' and fishers' knowledge on stock abundance, it is clear that in contrast to scientific indices of abundance which showed capelin stocks increasing between the early and late 1980s, fishers were almost unanimous in the view that a substantial decline had occurred in capelin abundance in their areas during this same time. A comparison of fishers' observations also suggests that fishers from the Bonavista area described indications of stock decline much earlier than fishers from lower Trinity Bay.

The chapter concludes with an analysis and discussion section, which presents social-ecological factors that may explain the apparent disagreements between fishers and scientists and among fishers. It also presents one of the strongest examples of the consequences of projects that integrate fishers' knowledge with that of scientists while failing to understand the social-ecological character of fishers' and scientists' knowledge.

6.2 Scientists' Knowledge and Trends in Capelin Abundance

Capelin play an important role in the food web of the cold ocean environment of the North Atlantic. Cod, halibut, and many marine animals such as seals and whales consume major amounts of capelin and, for many more species, the capelin constitute the most important food source. Capelin have also been harvested extensively in Greenland, Iceland and on the east coast of Canada. In some fishing communities in Newfoundland the capelin were as important to small boat fishers as the Northern cod stocks. Areas along Newfoundland's Northeast coast benefited the most from the capelin fishery. As a result of its important role in both the fisheries ecosystem and as harvestable fish species, capelin science and management are extremely important to the health of these ecosystems and potential economic viability of small-scale harvesters.

As explained in *Chapter 4*, prior to 1990, scientists thought that the capelin stocks were in good health. After 1991, however, results from inshore indices and offshore acoustic abundance surveys started to differ, with offshore estimates suggesting a collapse in projected biomass to below early 1980s levels (Carscadden and Nakashima, 1997; Frank et al., 1996) and inshore indices of abundance indicating relatively stable, high abundances of capelin in the 1990s (Carscadden and Nakashima, 1997; Frank et al., 1996). In subsequent years, offshore estimates continued to suggest stock collapse while inshore estimates suggested stable, relatively increasing biomass (DFO, 2001). Due to this diverging data, scientists have not been able to produce a reliable estimate of capelin abundance for use in management of the capelin fishery since the early 1990s. Difficulties assessing abundance have been heightened by delayed spawning and by changes in research methodologies, as well as the elimination of some research programs from the stock assessment process (DFO, 1998b).

Some scientific research has linked the divergence between offshore and inshore abundance indices to changes in capelin growth rates and capelin behaviour including later spawning and reductions in the spatial scale of beach spawning. The current scientific consensus is that environmental conditions produced changes in capelin biology and behaviour, affecting the accuracy of offshore estimates and resulting in an underestimation of true offshore capelin abundance (Carscadden et al., 2001; DFO, 2001; Carscadden and Nakashima, 1997; Carscadden et al., 1997; Nakashima, 1996b; Carscadden et al., 1994). In contrast, most inshore commercial capelin fishers who participated in DFO's telephone surveys in the 1990s suggested that capelin abundance levels were below those that existed when they first started fishing, attributing most of the decline to overfishing (Nakashima, 1996a). Scientists argue that there is no scientific evidence to indicate that overfishing has taken place in Division 2J3KL (Carscadden et al., 2001).

6.3 Fishers' Knowledge and Trends in Capelin Abundance

Fishers' and scientists' views on capelin stock abundance in the 1990s differ. In a telephone survey conducted by DFO for the capelin stock assessment, in the years 1994 through 1997, fishers clearly suggested that capelin abundance had declined since the early 1980s. For example, in 1996, DFO conducted a telephone survey of 212 fixed gear fishers who were licensed to fish in the areas 3PS and 3KL. Ninety percent of fishers interviewed said that abundance in 1996 was much lower than when they had first started to fish capelin. DFO did not establish how much capelin fishers had experienced in previous years, the basis for fishers' estimates of abundance, or develop a time line to document when abundance started to decline from the fishers' point of view. Factors such as location of observations were not used to stratify the results.

In the interviews conducted for this study, fishers were asked to discuss their observations of capelin abundance over their fishing career. In particular, fishers were asked to discuss capelin landings, if applicable, and the amount of capelin they had observed spawning on beaches throughout their lifetime. Those who voiced concerns about capelin stock decline were asked when they thought the decline had occurred, how they knew that capelin abundance was declining and possible reasons for the decline. Overall, thirty-six fishers discussed capelin abundance. Of these, seventeen were from the Bonavista area, seven were from the communities around Pork Rexton and New Bonaventure, and twelve were from lower Trinity Bay. A majority of these fishers harvested capelin commercially and had been involved in the fishery for an average of eighteen years at the time of the interview. Of the thirty-six fishers, thirty-three were over forty years of age.

A majority of interviewed fishers said that stock abundance was much lower in recent years than when they first started fishing or before. Specifically, thirty-one fishers argued that capelin abundance started to decline gradually in the 1970s and early 1980s and had reached low levels by the late 1980s and early 1990s. In particular, fishers argued that a gradual decline in capelin abundance occurred in earlier years around the beginning of the capelin roe-bearing fishery. Fisher 3 of Bonavista said he noticed the change at the beginning of the roe-bearing fishery. Fisher 7 of Bonavista stated, "When they started to pick out the female capelin and leave the rest on the beach, you know. I think that was the first start of the [end] of the capelin." Fisher 51 of Norman's Cove said, "They were getting scarce year after year, ever since they started catching them and selling them, and destroying it. In 1983, I gave it up. I'd say five or six years before that it began to get scarce." Several fishers referred to their declining landings to support their perceptions of stock decline. Fisher 52 stated, "The capelin got scarcer and scarcer and scarcer, like in the 1980s there were millions of them and they just seemed like they just went down hill like that. Every year they got worse. In fact, you had to have four traps by the end of the day for you to get a load in, lots of times." Fisher 53 of Long Cove said, "The landings was probably 300,000 pounds in the early 1980's. Then they dropped. 1986 was a good year. Then it went down to the last year, in 1991, I think, it was less than 100,000 pounds. Less than one-quarter of the fishers who provided information on stock abundance said they did not notice changes in capelin abundance until the 1990s. Two fishers said that they did not notice any changes in capelin abundance at all. However, one of these two fishers said that they noticed that the capelin were migrating much later in the 1990s.

Fishers used several types of observations to illustrate that abundance had declined. These included: observed reductions in the depth and texture of capelin spawn on local beaches; reductions in the density and size of capelin schools in their area; changes in the depth of capelin on beaches; range of spawning on beaches; and shorter spawning seasons. Fisher 40 of Random Island stated:

> Definitely a lot of spawn them days . . . In capelin scull weather, the more rain the more capelin that would land on the beaches . . . Where you used to see masses of capelin, now there's little wads. I'm thinking of buckets of spawn rather than tonnes . . . If the capelin is gone . . . I would say they're down to 2% right now. If you go by the spawning places, I'll say 10%" . . . There was a half a mile of spawn and off as far as the eye could see.

In a follow-up interview Fisher 11 of Bonavista said, "On Long beach, I remember walking on it, it was just like a sponge.... Certain beaches had a lot of spawn . . . by 1997 there was four to five beaches left that capelin spawned on." Fisher 42 of Random Island described "thousands of capelin. In every beach and cove, every single year . . . You be on the beach with your rubber boots, half up your rubber boots. Piles of it...In 1996 the capelin were slight on the beach, no mass, little spots, eight feet by ten feet long . . . The last capelin that we took, on a scale of one to ten, it was a two." Fisher 4 of Elliston said:

> Before they started taking the capelin, all the cove everywhere, every gulch would be right full of capelin. Spillar's cove, right to Catalina. Everything was right full, nothing only capelin. Every year. I minds we used to go to the trap in the morning, start the engine up, and time we get to the trap we'd have a job to get through it, where the fish had the capelin drove afloat. It was like that, every year like that, until after so many years they'd start taking the capelin.

Fisher 28 of Bonavista stated:

> The first thing you would have to get was the capelin for the potato garden. And they would be rolling in the beach, and you would walk around with your thigh rubbers on and you would be half up your legs, in capelin. I haven't seen that this twenty years. If you want capelin now, this last few years, to do any gardens worthwhile like you used to do one time, you want a purse seine to get them.

Fishers also mentioned experiencing a decrease in the density and size of local capelin schools throughout the 1970s and 1980s. Fisher 4 of Elliston revealed that in past years the capelin were numerous, so much that they would "have a job to get through it, where the fish had the capelin drove afloat." Fisher 23 of Little Catalina stated, "When I was young and with my Dad fishing for cod, (before 1983) I remember looking at the front of the boat and seeing capelin right black from the shore to the trap...Yes, it's been a long time. The capelin just didn't disappear all of a sudden. The capelin started dwindling away years ago, around 1979. Less and less capelin." In a follow-up interview Fisher 11 of Bonavista said, "The capelin were not as plentiful when I started in 1985 as when I was younger. I started fishing when I was 16 years old and I remember I had a 16-foot punt, 91/2 horsepower. I honestly thought that the punt would ground on capelin there was so much . . . The motor was cutting them up with the blades. This was in 1966."

Fishers also discussed the decreased length of the spawning season as years went by. Fisher 28 of Bonavista stated, "Seems like it's only a week or so and then they're gone...it used to be here a couple of weeks, three weeks." Fisher 12 of Bonavista noted, "The [capelin] used to be rolling on the beach for three weeks before they go off...there was none on the beaches last summer. They got a few down here I believe for a couple of hours up on Long Beach. And a few down in Spillar's cove. I think they got down there for a day or two, little ones about four inches long."

This analysis of capelin stock abundance also shows that fishers from the Bonavista area appear to have experienced stock decline much earlier than fishers from lower Trinity Bay who reported that they did not experience stock decline until the late 1980s and early 1990s. To illustrate, eleven fishers from the Bonavista area who discussed capelin abundance said that changes started to occur during the 1970s. Twelve fishers said a change occurred during the 1970s and into the late 1970s and sixteen said changes occurred throughout the 1970s and into the early 1980s. Only six fishers from the Bonavista area said that they started noticing changes in capelin abundance during the late 1980s and early 1990s. Of those individuals who described a change during the late 1980s and early 1990s, all said that they experienced other changes in their indices of abundance in earlier years. For example, Fisher 38 of Melrose stated that he noticed a change in capelin spawn on beaches early in his career. This fisher did not notice a decline in the number of spawning beaches until later years.

Observations documented by fishers from the Port Rexton area revealed a different trend in capelin abundance from that observed by fishers from the Bonavista area. Two of the seven fishers from this area said that changes occurred in the 1970s, while four fishers described changes during the late 1970s and early 1980s. However, five fishers from the Port Rexton area said that most changes in abundance occurred during the late 1980s and early 1990s. In a follow-up interview, Fisher 31 of Port Rexton stated, "[In 1991] she was dropping, dropped then, certain beaches wasn't getting capelin. [Also] there was a decline in capelin biomass off the beach compared to when I first started." Of those five fishers who experienced decline in the late 1980s, two said that they had experienced other changes in earlier years.

Unlike fishers from the Bonavista area, most fishers interviewed from the Trinity Bay area said they did not experience noticeable stock decline until the late 1980s and early 1990s. One fisher said that changes occurred in abundance during the 1970s. Three fishers said that the decline occurred during the late 1970s and early 1980s. This suggests that possible capelin decline occurred first in the Bonavista area and then next in the Trinity Bay area. Fisher 52 of Dildo said, "They used to be black here. They fill up over there and everything here would fill up with capelin, the whole harbour and every place in the bottom would fill with capelin, right black, banks. Just a solid mass. I don't know if we seen that since we had that boat, not that good since 1989 and 1990." Fisher 43 of Sunnyside stated:

> In 1987 there was no capelin and they started to get small. We buddied up with a fellow and he had his trap out down there. We went down one morning and hauled, and I'd say there was a good 30-40,000 pounds of capelin, and just about all female capelin. And neither one of them met the measure. 5 ¼, that's what they had to be. And they were all about 4½ inches.

6.4 Discussion

The data presented suggest that fishers and scientists disagree on the extent and timing of capelin stock decline during the period between 1970 and 1990. Scientists argue that capelin stock decline did not start until the 1990s with the advent of severe environmental changes. Collectively, fishers argue that stock decline started much earlier. However, depending on fishers' locations throughout Trinity Bay, stock decline may have occurred as early as the 1970s or as late as the mid-to late 1980s.

6.4.1 Disagreement Between Fishers and Scientists

Across the whole Bonavista and Trinity Bay region, it is clear that most fishers did not agree with scientists' perceptions of the timing of declining stock abundance when these interviews were carried out. The analysis presented here suggests that there are a number of different social-ecological factors that may support these differences concerning the timing of declining abundance. First, the time series that form the basis of scientists' and fishers' observations differ. The majority of fishers who discussed capelin abundance were able to draw on their experiences from the 1970s and earlier, whereas scientific inshore abundance indices were not developed until the early 1980s. Thus, these fishers' perceptions of stock abundance in the 1990s were based on comparisons with abundance in a time period that does not exist in DFO's inshore time series.[14] If abundance was higher in the 1970s than the early 1980s, this would affect fishers' perceptions of abundance trends in the 1980s, and for older fishers, their point of comparison with the 1990s.

It is also worth noting that the observational base for scientists' and fishers' estimates of abundance differs in other ways as well. As noted earlier, most fishers use their observations of the intensity and the spatial and temporal scale of capelin rolling on beaches to support their perceptions of declining abundance. As discussed in Neis and Morris (2002) beach spawning was not monitored scientifically in the past. Scientists suggest that environmental change may affect the distribution of beach spawning giving fishers the impression that capelin abundance has declined (Carscadden, et al., 1994). Nonetheless, given the fact that beach spawning was not monitored scientifically in the past, the relationship between reduced beach spawning intensity and overall capelin abundance should be given some consideration. Scientists are currently conducting studies on beach sampling and gathering opinions from fixed gear fishers (DFO, 2000).

As noted above, fishers' observations have indicated abundance trends that are not evident in DFO's indices of abundance either because the indices were not designed to capture the same type of information or they were put into place at a time after some fishers' observations. In other cases, indices of abundance were designed to capture only particular types of information and largely ignored other information that may have

[14] Some offshore acoustic survey data is available for this earlier period.

explained possible abundance decline. This has possibly biased index results, leading scientists to believe that abundance levels were fine until problems occurred in the early to mid 1990s. One example of this is trap catch rates. Analysis of fishers' knowledge as a social-ecological product provides some insight into how this index of abundance has been mediated by various efficiency and non-efficiency changes including increases in trap size, trap modifications, and changes in vessel size.

Interview data from fishers who participated in this study suggest that unacknowledged changes in efficiency within this fishery may have positively biased capelin trap catch rates. The capelin trap catch rate series was based on fisher logbooks and, prior to 1993, catch per day was the abundance index derived from the logbooks. According to catch rate data, daily catches increased from an average of 3.6 tonnes between 1981 and 1986 to 7.1 tonnes between 1987-1992 and 8.93 in 1993, 1996, and 1997 (Neis and Morris, 2002). At first glance, this would lead to the impression that the capelin stocks were in good health. However, trends in daily catch rates have been clearly affected by the number of hauls that fishers were making per day. A DFO analysis of logbook data in 1993 showed that hauls per day increased from 1.5 in 1982, to over 2 per day in the early 1990s (Winters, 1994). This increase in hauls per day produced concerns about the comparability of capelin trap rates in the 1980s and the 1990s and led to the decision to exclude inshore capelin catch rates from abundance estimates (DFO, 1998)

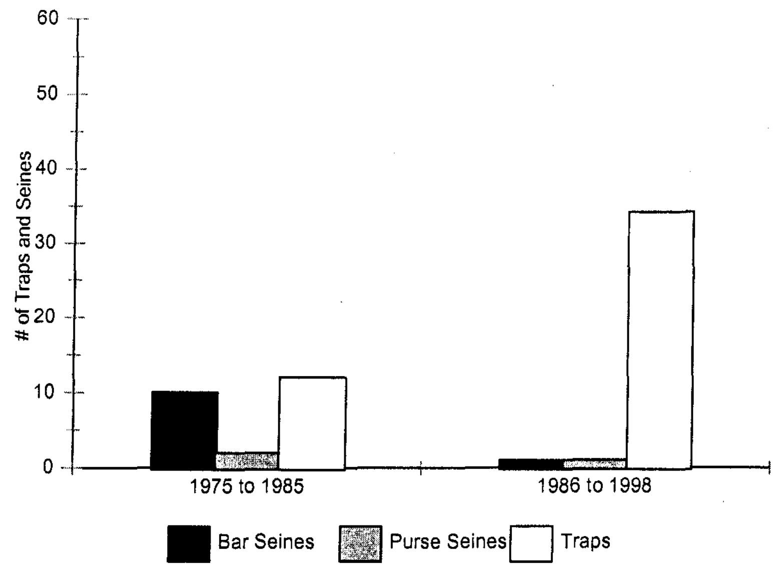
In 1994, Winters argued that catch-per-haul would provide a better index of abundance. Logbook data indicate that catch-per-haul increased from an average of 1.29

tonnes between 1981-1986 to 1.82 tonnes between 1987-1992 and 2.35 tonnes in 1993, 1996 and 1997. However, catch-per-haul is vulnerable to changes in efficiency caused by modifications of fishing gear and fishing practices. Adjustments in mesh size and changes in season length and ecological conditions associated with season openings can affect catch per haul. For logbook trap fishers in 3KL, average fishing days decreased from 22.71 to 5.67 days per season between 1981 and 1997 (Nakashima and Slaney, 1998).

Any attempt to use catch rates without first exploring effort and efficiency trends may lead to an overestimation of stock size (Neis et al., 1999a). For example, changes in vessel capacity, fishing technology and changes in gear utilized by fishers throughout their careers can influence catch rates and mask stock decline. This was evident in the data presented by Neis et al. (1999a) about the cod fishery. Neis et al. concluded that in addition to other factors, fisheries innovation could be explained by lower resource abundance. Fishers reported that the pressure to change gear structure was linked to the presence of smaller fish (Neis et al., 1999a). The capelin fishery is no exception to this trend.

The interviews with fishers for this study suggested changes in efficiency that would have affected catch rates, perhaps positively biasing them. These fishers changed their fishing technology and increased their capelin fishing effort during the 1980s. As Figure 6.1 illustrates, between 1975 and 1985, there were just as many seines owned by fishers in the sample, as there were traps. However, this changed dramatically as years went on.

Figure 6.1: Change in Effort-Traps and Seines, 1975-1998



Between 1986 and 1998, fishers in the sample were using two seines and thirty-four traps. On average, enterprises included in this analysis used 1.4 traps at the start of their careers. This increased to 1.75 traps at the end of their careers (or at the time the interview was conducted). This trend is also supported by data reported by fishers who participated in the logbook program. On average, fishers reported using 1.17 traps in 1981 and 1.57 traps in 1990 (Nakashima and Slaney, 1998). Most acquired traps because the capelin were getting harder to chase, they could not catch them in shallow water, the counts were low, or the percentages of female capelin were not appropriate for the purpose of the Japanese purchasers. The traps were more efficient, secured a much higher catch rate and better percentage of females than the seines. Fisher 39 of New Bonaventure started his career in the early 1970s with a bar seine. In 1982 he stopped seining because the plant did not like the quality of the capelin, and because the sand coming in with the load ruined their equipment. Fisher 53 of Long Cove reported that he stopped using the beach seine early in his career "because the Japanese did not like the capelin when already spawned." Fisher 42 of Petley stated:

> When we started, we started with three and four fathom seines, and then we started going to six, eight and ten fathom seines. Then we had to go to the capelin trap. So we could see the change over the years.... For some reason capelin just wouldn't come to the beach anymore...So you had to go deeper and deeper, and then you had to stop bar seining altogether.

Fisher 54 of Old Shop said that when he first started he was using the bar seine to catch capelin but then shifted to traps because "the bar seine wasn't very productive and [he] couldn't find any capelin to seine." Interestingly, fishers revealed that they noticed the decline in capelin stocks as more fishers introduced the capelin trap into their fishing strategy. Fisher 53 of Long Cove said:

> Probably every fisherman had one seine. Some had one seine and some had one trap. And the amount of capelin that we brought in was unbelievable, out of just one trap and one seine. So next year, the year after, every fisherman had two traps, some had two bar seines. Then it was getting into the third trap, because it was so good and so plentiful. If there was 75 cod traps, there was practically 75 capelin traps. Until the government put a ban on the amount of gear you could have. Two traps and one bar seine was the extent of your license.

In addition to adding traps to their enterprises, fishers also created larger traps or modified traps to be larger than those introduced at the start of the fishery. For example, Fisher 39 of New Bonaventure started using a capelin trap in 1982. In 1985 he made modifications to the trap and increased the size from thirty-five fathom round to fifty-two fathom round and 8 fathom deep. Before 1985 the trap could hold seventy thousand pounds and after 1985 it could hold one hundred thousand pounds. Overall, the average size of twelve capelin traps introduced between 1979 and 1983 was 936 cubic fathoms while the average size of thirteen traps introduced after 1983 was 1,251 cubic fathoms.

Trap design also changed throughout the early years of the fishery. Early capelin traps were often adapted from herring or other gear and tended to have larger mesh. By the mid-1980s almost all traps had been converted to small mesh in the body of the trap (this varies in size between 5/8" and 1" with most using 3/5"). Fishers argued that, as capelin became less plentiful, traps with large mesh had to be converted to save capelin. For example, Fisher 54 of Old Shop changed his trap to all capelin twine "because it was losing the capelin." He stated, "I did not mind it before because they always had too much capelin in the trap and they had to let it go. When it got scarcer I had to change the mesh so I could make a go of it." Likewise, Fisher 53 of Long Cove acquired two traps by 1983. He converted the first trap in 1987 and the second in 1989 to all capelin twine because he was losing capelin. In the earlier years he did not mind losing capelin out of the trap because there was so much and he always had to let some go. But "as capelin got scarcer and it got harder to fill up a load we had to make modifications to keep the capelin in." He stated, "It went along well for two or three years, and then, all of a sudden, the capelin began to get smaller. [We] had capelin in the 20's, 20 per kilo, 28, 29 per kilo...After three or four years, it went down to 35 per kilo, still big compared—look at it now.... in 1990, it was in the 60's per kilo." Fisher 41 of Chance Cove started his career with one trap converted from an old herring trap. He used smaller twine until 1983 when he had to make changes. He stated, "The trap was no good because the mesh size was too big and the capelin were escaping. Others converted to all capelin twine because of "redfeed."[15] Fisher 39 of New Bonaventure made changes to his trap in 1985 because "the last ten years, capelin have been scarce and the redfeed was bad." Fisher 43 of Sunnyside said that he was told that by "changing to all capelin twine it would reduce the amount of redfeed." To reduce the redfeed I had to pin [the trap] up and tie it over night, which helped to eliminate the redfeed. I had to reduce the mesh size so I would not lose the capelin over night."

Some fishers argued that this change in mesh size also increased trap capacity. For example, Fisher 53 of Sunnyside converted two traps to capelin twine but did not increase the volume of his trap. He argued that the trap capacity increased from twenty thousand to seventy thousand pounds as a result of this conversion. Fisher 41 of Chance Cove described an increase in trap capacity from twenty thousand to fifty-five thousand pounds with mesh conversion. Some fishers converted their traps to small capelin mesh throughout the entire trap so that they would hold the capelin better.

Fishing efficiency is also affected by non-gear-related changes, which may have positively biased catch rates and catch per haul in the logbook data. As Figure 6.2 illustrates, average vessel capacity almost doubled between the years 1983 and 1990 and average engine horsepower went from thirty-six to eighty. This allowed fishers to make fewer, larger trips, a major asset when the competition for capelin increased and the capelin season got shorter.

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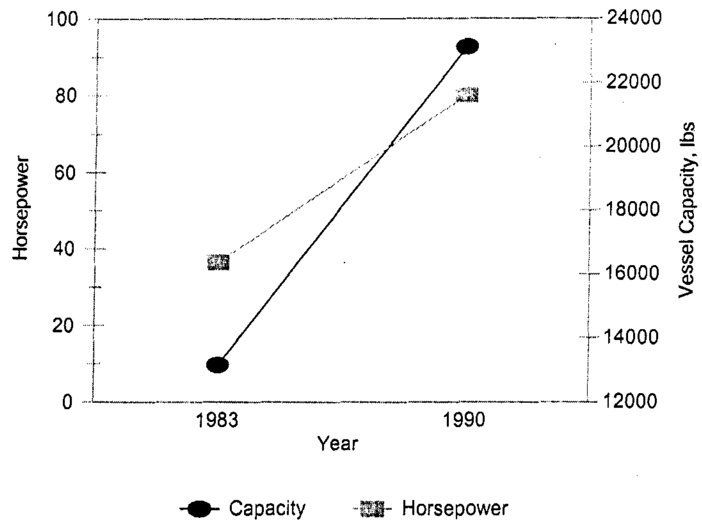
[15] Redfeed is a small organism that capelin feed heavily upon (Jangaard, 1974). The level of redfeed in an area will determine whether the fishery is opened or not.

Figure 6.2: Average Vessel and Engine Horsepower, 1983-1990



When the government limited the number of capelin traps per license, crews began to cooperate with each other, increasing their likelihood of bringing in full boatloads from each trap. Three fishers mentioned that they teamed up with other enterprises. Fisher 55 of Chance Cove stated, "We could take two boat loads out of either one of our four traps. Fifty-thousand pounds out of two traps..." Another benefit of cooperation was that it allowed fishers to reduce discarding. When capelin had redfeed in them, they could hold the capelin in the trap for a day until the redfeed cleared their system. Crews also kept an extra trap so that they could replace torn traps and avoid losing time in the fishery.

In response to the decrease in abundance and size of capelin, fishers in this study increased the number of hauls per day. Fisher 52 of Dildo stated, "The capelin got scarcer and scarcer. Like in the 1970s there were millions of them and they just seemed like they just went downhill like that. Every year they got worse. In fact, you had to have four traps by the end of the day to get a load in." Fisher 42 of Petley acquired a trap in 1982. In 1986-87 he landed less than eighty thousand pounds a day and often had to haul two to three times to make a load.

The changes in efficiency described above may have helped sustain or even increase catch rates at a time when capelin abundance was declining in the 1980s and 1990s. As illustrated above, these changes were well noted by fishers but were not monitored by DFO in the logbook data collected from fishers. Unlike scientists and resource managers, fishers may have been taking these changes into account when describing trends in capelin abundance throughout their lifetime.

Fishers' observations of reduced density and volume in capelin schools are also inconsistent with results from another inshore abundance index, inshore aerial surveys introduced in 1982. DFO's aerial surveys, tasked with measuring capelin density, have been interpreted as indicating expanding capelin biomass in the 1980s and relatively stable levels in the 1990s (Carscadden et al., 1994). However, based on the data collected from fishers, it is possible that these surveys may have been positively biased. Capelin, as with other schooling species of fish (MacCall, 1990) may be density dependent. This means that as capelin density declines, high-density aggregations (lower Trinity Bay) may recruit from surrounding lower and medium aggregations (Bonavista Bay and the Headlands), thus allowing the former to persist, despite an overall reduction in capelin abundance.[16]

Fishers' observations suggest that capelin arrive in deepwater areas first, such as

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[16] See Hutchings 1996 for a similar analysis of the relationship between distribution and abundance in cod.

lower Trinity Bay, and then spread out to shallow water areas, such as Bonavista (see Figure 5.1). The areas sampled by the aerial survey in Trinity Bay include the deeper water area where capelin tended to arrive first but does not include shallower areas like the Bonavista Headland (Carscadden and Nakashima, 1997). The findings in this chapter indicate that a majority of fishers from the Bonavista area dated decline from the 1970s while a majority of lower Trinity Bay fishers dated decline from the late 1980s. This suggests that if capelin abundance was in decline in 1980s, the decline may have started in the Bonavista area first in the 1970s and early 1980s, and occurred later in lower Trinity Bay. This change in capelin abundance in the Bonavista Headland area would not have been documented in DFO's inshore aerial surveys of capelin abundance because these surveys did not include that area, thus positively biasing this index of abundance (Neis and Morris, 2002).

As noted above, fishers generally perceived different long-term trends in capelin abundance from those documented in stock assessment science and the various inshore indices of abundance. An analysis of their knowledge as a social-ecological product suggests that fishers' observations may also be influenced by their observations of excessive dumping in the capelin fishery (see *Chapter 8* for a detailed discussion on dumping). The amount of capelin caught and dumped may not have been considered a major problem for DFO management and science given that the capelin stocks could have withstood a higher harvest rate than permitted under the management regime. According to the Fisheries Development Division of the Fisheries and Habitat Management Branch total allowable catches set by the Department of Fisheries and

Oceans were considerably lower than they could have been (DFO, 1989). For example, in 1987, estimated capelin biomass was eleven times higher than the recommended TAC for that year in the area 3L (DFO Statistical Data, 1987).

Nine fishers attributed the decline in capelin stocks to excessive dumping as a result of inadequate sex composition, redfeed, and buyers' preferences. Fisher 22 of Plate Cove said, "A group of people said we should never touch the capelin. I got a different view of the capelin. The amount of capelin that we sold never hurt the stocks. It was the amount of capelin we dumped...." In their interviews, fishers' estimates of the ratio of dumped to landed capelin varied a lot. High estimates were of ten thousand pounds dumped for every one thousand pounds sold and low estimates were one thousand pounds dumped for every one thousand pounds caught. Even the lowest estimates exceeded those recorded in DFO logbook data which varied between a low of 13.1% discards in 1993, and a high of 74.5% in 1997 (DFO, 1997). Other fishers attributed the decline in capelin abundance to the continuous discarding of males in a fishery that was targeting roe-bearing females. Fisher 40 of Random Island stated, "Right off, even the next year, there was some places that never had come populated no more. The capelin, there's no question the capelin was ruined by dumping all them males."

6.4.2 Disagreement Among Fishers

An analysis of fishers' knowledge as a social-ecological product provides insight into the disagreements between fishers from lower Trinity Bay and those from the Bonavista area. Fishers from the Bonavista were more inclined to agree that capelin abundance started to decline in the early 1980s. To support their observations, these fishers used their perceptions of declining stock abundance, reduced density in schools of capelin, reduced depths of spawn on beaches and the decreases in the lack of intensity related to beach spawning. Fishers from Trinity Bay did not notice stock decline until much later and associated decline with a relatively sudden decrease in abundance and a decrease in landings. The profile of fishers from these areas shows that fishers from the Bonavista area were less likely to have fished capelin commercially while those from Trinity Bay were likely to be commercial fishers. To illustrate, of the seventeen fishers from the Bonavista area who said that a change occurred in capelin abundance during the 1970s and early 1980s, only four had fished commercially for capelin. Of the five fishers from the Port Rexton area who noticed changes in abundance during the late 1980s and early 1990s, four had fished commercially for capelin. Similarly, of ten fishers from lower Trinity Bay, who said that changes in abundance occurred in late 1980s and early 1990s, all had fished commercially for capelin. It is possible that those from Trinity Bay did not notice longer-term stock decline such as the intensity of beach spawning or the depth of spawn on beaches because the opportunities were not available to them to observe such trends. It is also likely that their ability to maintain catch levels also affected their perceptions of stock decline.

It is more likely, however, that differences between fishers from the Bonavista area and those from Trinity Bay have to do with the likelihood that the capelin species is density dependent. That is, as capelin abundance declined overall, it occurred much earlier and more rapidly in shallow areas such as around the Bonavista area while dense schools of capelin persisted for much longer in deeper waters such as in lower Trinity Bay. This would have contributed to the differences in the extent and timing of capelin abundance decline as described by fishers from the Bonavista area and inside Trinity Bay.

6.5 Conclusion

This chapter discussed the findings from the analysis of fishers' and scientists' knowledge of capelin abundance. Fishers' perceive different long-term trends than those documented in stock assessment science. Findings also suggest that fishers from different parts of the study area experienced stock decline at different times. An analysis of fishers' and scientists' knowledge as social-ecological products suggests there may be problems with the indices of abundance developed by DFO to measure stock abundance. The data on efficiency changes documented in this chapter suggest the need for future research based on a larger sample of fishers that takes into account some of the changes documented by fishers in this study. The hypothesis that capelin distribution is density dependent suggests that the inshore aerial survey may be positively biased. At a broader level, this analysis suggests that the level of uncertainty about capelin is greater than previously thought by scientists and managers.

Chapter 7 Cod Bycatch and the Capelin Trap Fishery in Trinity Bay

7.1 Introduction

This chapter presents the findings related to fishers' and scientists' understanding of the extent and impact of cod bycatch in the capelin trap fishery. The majority of fishers profiled in this chapter perceived cod bycatch to be a problem for many years. Fishers linked the problem to small mesh sizes in capelin traps and management initiatives that promoted the destruction of cod. Some fishers were also extremely concerned about the effects that cod bycatch was having on localized cod stocks such as those believed to exist in the deep waters of lower Trinity Bay. An analysis of fishers' knowledge indicates that they differed from scientists in their perception of the extent and ecological significance of juvenile cod bycatch in the capelin trap fishery. Also, fishers' observations were not consistent with DFO logbook data collected from capelin fishers in the 1980s and the 1990s, which suggested that the rate of mortality for cod bycatch was relatively low. Interviewed fishers generally suggested that rates of mortality, particularly for juvenile cod and even for market-sized cod, were high. An analysis of fishers' and scientists' knowledge as social-ecological products has provided possible insight into these differences. For fishers, gear location and type, their choice to employ conservation methods, whether they sold sea-run or picked capelin, are all factors that may mediate their knowledge about cod bycatch. For scientists, the spatial and temporal dimensions of their sampling as well as their approach to analyzing data on cod bycatch may mediate their understanding about the extent and ecological significance of cod bycatch.

7.2 Scientists' Knowledge of Cod Bycatch in the Capelin Trap Fishery

Cod bycatch is a major issue within the commercial capelin trap fishery with potential serious implications for the recovery of localized cod stocks and other stocks of fish that frequent coastal areas in search of capelin. At the extreme, the capelin trap fishery may have seriously affected the recovery of cod stocks in Trinity Bay. A proper understanding of the effects of the trap fishery on cod populations is needed to ensure that further damage will not be done to a stock of fish that may be near the brink of extinction. Despite concerns of fishers voiced for almost two decades, the scientific position in the 1990s was that cod bycatch had not had any major effect on cod stocks. This has not changed.

To address fishers' early concerns about cod bycatch in the capelin trap fishery, DFO conducted a study during the 1981-1983 capelin trap fisheries in Division 3L. The purpose of the study was to assess the impact of capelin trap juvenile cod bycatch on the Division 2J3KL Northern cod stocks. The results suggested that the size of the juvenile cod bycatch was not substantial and did not pose a significant threat to these cod stocks. The study concluded that "although the numbers of young cod caught by capelin traps may be visibly alarming, the estimated quantities of juvenile cod killed annually during each of the study years . . . represent between .1 and .2% of estimated recruitment at age 4" (Stevenson et al., 1984). Based on the results of this study, fishers' perceptions were attributed to observational bias. That is, the scientific position was that fishers' were influenced by what they were experiencing at a micro level rather than considering their experience within the larger picture of cod bycatch and abundance overall. Despite the growth of the capelin fishery in the late 1980s and the closure of the cod fishery in 1992, scientists did not carry out any other study on cod bycatch between 1984 and 1996. There have been no scientific studies on cod bycatch in the capelin trap fishery since 1996.

Scientists agree that with the increasing number of observations of juvenile cod in coastal waters they should be carrying out more studies. DFO scientists do monitor the bycatch[17] problem through data provided by fishers participating in the logbook program. DFO capelin trap fisher logbook data collected between 1981 and 1996 suggests a low but highly variable percentage of cod bycatch relative to capelin landings ranging from a low of .05% in 1981 to a high of 4.61% in 1996 for areas 3KL (Nakashima and Slaney, 1998). DFO logbook data collected from capelin trap fishers also suggest that the rate of mortality of bycatch was relatively low (Nakashima and Slaney, 1998).

7.3 Fishers' Knowledge of Cod Bycatch in the Capelin Trap Fishery

The problem of juvenile bycatch in capelin traps is as old as the capelin trap fishery. Fishers documented the problem of excessive juvenile cod bycatch in capelin traps as early as 1982. A report from the 1982 Regional Capelin Seminar held in Clarenville, Newfoundland, stated:

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[17] In the logbooks no distinction is made between juvenile and adult fish.

> The bycatch of small cod is of particular concern to the inshore cod trap operators who feel that this type of activity will detrimentally affect their future operations. The small mesh size of capelin traps, the coincidence of the capelin and cod seasons, and the increased number of capelin traps in use compound the overall problem.

At that time, fishers argued for better management and gear that would avoid excessive juvenile cod bycatch. Their recommendations included: prohibition on the use of capelin traps; selected areas closed to capelin fishing by traps and other gear types; and, that seasons be imposed on the capelin fishery.

Cod bycatch in capelin traps and perceived high rates of mortality in these bycatches were central concerns for most commercial fishers interviewed in this study, particularly those fishing within Trinity Bay. Many felt that the bycatch problem posed a significant threat to local cod stocks during the 1980s. Fishers said that due to the small mesh size in capelin traps they harvested high bycatches of juvenile cod and, occasionally, juvenile salmon.[18] The interviews also highlighted some major differences between the scientists' and fishers' perceptions of juvenile cod bycatch.

In the interviews carried out by the Eco-Research team, fishers were asked to comment on bycatch in the capelin trap fishery. Fishers who participated in the follow-up interviews were also asked to describe the bycatch, species and amount landed. Fishers were asked to describe what happened to the bycatch they caught and whether any conservation methods were employed to save it. Overall, twenty-three fishers

[18] It is noteworthy that at the time the follow-up interviews were being conducted in 1998, some fishers argued that since the introduction of changes in the mesh size regulations for capelin traps that year that were designed to protect salmon, they had noticed larger bycatches of cod. DFO prohibited the use of capelin trap net leaders with mesh size between 3 5/8 inches and 7 inches (inclusive).

offered information on cod bycatch. All of these fishers were from the Trinity Bay area, which includes the communities between Port Rexton and Norman's Cove. Twenty-two of the twenty-three fishers harvested capelin commercially with their primary gear being the capelin trap. No one in this group of fishers harvested capelin using an alternative gear such as the seine. At the time of the study, these fishers ranged in age between forty and sixty-two, with the average age being fifty-nine years. On average, these fishers had been involved in the capelin fishery for nineteen years.

Seventeen of the twenty-three fishers who discussed cod bycatch said that they considered it to be a serious problem. Fisher 31 of Port Rexton described the amount of bycatch in the 1980s, distinguishing between juvenile cod and cod large enough to make the market. He said that on most occasions there would be "nations of it [juvenile cod]. In the run of a day, we'd be hauling the capelin trap, out of four trips a day, we'd pick out and gut five hundred pounds of cod fish that would be tangled up with the capelin . . . That would be sixteen inch stuff. There [would] be boxes upon boxes of tomcod stuff. Half the length of a pencil." Fishers 45 of Bellevue said, "In 1989 I seen tonnes and tonnes of fish floating around the water, fellows picking out so much fish out of the capelin because they got to be a small percentage on account of the weight. Fellows picking out the fish, and just throwing it overboard. I've seen [cod] down there almost up to your knees deep, floating on the beach." Fisher 54 of Old Shop said that he would throw out two to three thousand pounds of small cod per haul. Fisher 23 of Little Catalina said that his trap was full with small cod every morning while others fishers reported catching three to four hundred pounds of cod bycatch in their traps every day.

Responses to questions on juvenile cod bycatch showed that cod bycatch was an issue for most capelin trap fishers though the amount of bycatch observed seemed to vary depending on when fishers were involved in the capelin trap fishery. Nineteen fishers provided information on the amount of bycatch that they observed in their capelin traps throughout their careers. Eleven fishers documented an increase in cod bycatch over time. Some identified an increase between the early and late 1980s and early 1990s, others suggested that "small cod" bycatches declined in the late 1980s. Harvesters who had fished after 1993 indicated that "large cod" bycatch had become more of a problem since that time. Fisher 39 of New Bonaventure said, "We never had any bycatch problem in the beginning. Since the moratorium I have had a lot of problems with bycatch. In the morning we haul the trap up and have three to four thousand pounds of small cod in the trap." Fisher 42 of Petley said that when he first started he did not have a problem with bycatch. However, in 1996, this fisher had to empty his trap every two hours. Fisher 41 of Chance Cove said that the average amount of bycatch per haul was two to three thousand pounds between 1979 and 1986 but that it dwindled after that. Fisher 43 of Sunnyside said that on average they caught about one thousand pounds of cod per haul and more in the years after 1990.

In addition to discussing the extent of the bycatch problem in the capelin trap fishery, fishers also agreed that bycatch mortality rates were high. For example, Fisher 50 of Norman's Cove stated, "You got this little small mesh, everything goes into it. And that's all destroyed, whatever gets in it." Fisher 43 of Sunnyside stated, "You gets lots of small fish. It's no good for anyone to tell me they don't die. If that's tucked up among thirty to forty thousand pounds and left there for three or four minutes, and when it's turned up and rolled out over the trap, half of it is dead." Fisher 45 of Bellevue stated:

> Once in the trap it all dies, because once you draw it up and start dipping it aboard, the cod float off . . . Once out there we picked out, I think it was three thousand pounds, out of one of our capelin traps with our hands, the big fish. We put a mitt on or a glove and picked them up, grabbed them by the tail, and put them on board. We done that twice one day . . . once you draw them up and start dipping them aboard, they float up anyhow.

Fisher 54 of Old Shop claimed, "When you got a lot of capelin in the trap, there's no way to separate. And then you try to pick some out [cod]. So you're throwing it over and the gulls will get in there, and he's there floating belly up before he gets down, and he won't live." Fisher 31 of Port Rexton stated, "When you're hauling a capelin trap, and you got eight thousand or nine thousand pounds of capelin and you're drawing up that twine, that's extra weight coming on the fish all the time, and eventually when there is no water left for them, the weight of themselves is killing them. They'll die under the pressure."

Thirteen fishers believed that the high bycatches of juvenile and adult cod were affecting localized cod stocks in their areas. In a follow-up interview Fisher 50 of Norman's Cove said, "When I first started [in 1984] I had problems with small fish... fifty thousand pounds of eight inch and smaller cod in a trap . . . this fish was destroyed because it was drawn dry . . . I knew then that the capelin fishery was going to destroy the cod." In a follow-up interview Fisher 53 of Long Cove said, "In the 1980s I saw as much as fifty percent cod in a trap . . . at times a lot of cod . . . maybe the cause of the collapse of the fishery . . . we were scared of it . . . in 1981 you may have had 10% cod in the traps and that does not sound like a lot of cod but it is a lot of cod if it is juvenile cod. Not a lot of cod if it is big cod. So it is the numbers that count not the weight. Fisher 43 of

Sunnyside said, "In later years it was really bad. We had one thousand pounds of cod a load . . . a lot of fish died as the pressure killed them . . . doesn't take much to kill a small cod. As far I am concerned it is the ruination of the cod fishery." Fisher 45 of Bellevue stated, "There shouldn't be no capelin fishery...because they're destroying the cod."

Four fishers extended their argument to include the destruction of the Trinity Bay stock of cod. Fisher 54 of Old Shop stated, "I think [capelin traps] had a big effect on that. Especially if you're talking about a Bay stock." Fisher 44 of Thornlea said, "The fish that we were catching early in the year was Bay stock (cod). The ten or fifteen years with the capelin traps, we cleaned it all up. Because, back then, in the capelin traps, sometimes you get a lot of fish." Fisher 46 also argued that the juvenile fish that was being caught in capelin traps were part of the bay stock. He stated, "The small fish that you were finding in the capelin traps wasn't the small fish from the traditional fish that comes in from the offshore because this fish never spawned here. This stuff moved on out. But when this fish [bay stock] spawned, it would spawn in January or February in deep water and disperse."

Many fishers employed conservation methods, such as rolling the trap to reduce the amount of cod bycatch in the trap.[19] In a follow-up interview Fisher 47 of Butter Cove said that he found that if he pulled the trap the first thing in the morning and "rolled it over the heads the trap would fill again in one half hour to one hour with capelin

[19] Some fishers described that the morning haul of the capelin trap was the worst for cod bycatch. Because the trap was in the water at night, the trap tended to be filled with juvenile cod instead of capelin. To combat this, fishers would roll the trap, set it and then pull it shortly after. Others fishers tied the trap at night to avoid a trap full of cod in the morning.

because cod moved slower, . . . [I] would get mostly capelin after that . . . I would watch the trap very closely to see if the capelin were down deep and if so, haul immediately." In a follow-up interview Fisher 42 of Petley stated that he also rolled the trap to reduce the amount of bycatch. He also tied the trap at night in order to avoid a trap full of bycatch in the morning. He stated, "In the 1990s [I} had to roll the trap out over the heads because the bycatch would be so much . . . rolled the trap every two hours to get the cod out because if not, [I] wouldn't get no capelin. At night we would tie the trap up because it would not be worth the trouble."

Four fishers revealed that despite efforts by fishers to practice conservation methods to protect small cod there was no incentive to do so from the buyers. In many cases the cost (deduction in the price) incurred for bringing in small cod was not worth the effort when considering the time it took to carefully roll the trap. Furthermore, because the capelin fishery tended to only last a couple of days towards the end, fishers were in a hurry to get as much capelin as fast as possible. Thus, employing such conservation measures was considered a hassle and a threat to incomes. Fisher 46 of Chapel Arm said that many times fishers would not take the effort to "roll it out over the heads" because the plant would buy it all. He stated "well most things done here, you bring it to the wharf, you put in the vats, and it's gone to the plants. And a lot of small fish was destroyed." Fisher 50 of Norman's Cove said that the capelin trap was responsible for a lot of small cod bycatch but the buyers were responsible for letting it happen. He said that the "buyers are to blame for making the fishermen throw away the small stuff. The government should have stepped in there and done something with that.

Why throw away-the water used to be white with it." Fisher 52 of Dildo said that the choice to roll the trap was sometimes dictated by the buyers. He revealed that a fisher who was trying to get to the wharf first in the morning there was a tendency not to roll the trap. "The plant did not care as long as they got the capelin." Fisher 53 of Long Cove also expressed that there was no incentive by the government and the plant owners to protect the small cod stocks in the capelin trap. He stated, "The merchants would say there is a lot of cod in your capelin, so we'll take 10% off for cod. Big deal to look back on it now, 10% off for 10% cod." One fisher also mentioned that DFO was under the impression that conservation methods such as rolling the trap were employed frequently thus contributing to their perception that bycatch was not an issue. He stated, "The monitors did not think it to be a problem because it was rolled over the heads . . . but I saw all the dead cod floating in the water."

One fisher noted that buyers were also picky about the type of gear used to harvest capelin, which led to more fishers using the capelin trap, a gear that was considered particularly harmful to juvenile cod. Fisher 53 of Long Cove said that the bar seine did not take small cod because it took capelin when they landed on the beach. He states, "no [the seine does not catch small cod] because it is very close inshore. But the Japanese don't like capelin from the bar seines. Because when the capelin comes that close to shore, the maturity has reached, and they are overripe. And that's where you catch the capelin with the bar seine, is when they come in."

Six fishers said that they did not consider bycatch to be a serious problem. In most cases, however, these fishers employed conservation methods to reduce bycatch, which impacted their perception of the bycatch problem. Fisher 40 of Random Island stated, "In the morning the trap was full. After [we] rolled it out over the heads we had no problem with bycatch all day." Fisher 52 of Dildo said that there was a certain amount, all according to how careful you were. He stated:

> Fishers not careful brought in a lot and [fishers] that were more careful didn't bring in as much. Most everyone used to haul and roll on the mornings but now you would still have some but not like you would. You haul a capelin trap in the morning and there would be three to four thousand pounds of cod in it small cod, so you roll it out so you wouldn't kill it, but then when you hauled it back with fifteen to twenty thousand pounds of capelin in it there might only be a couple hundred pounds in it then [small cod]. You killed a certain amount but you can't get clear of that.

This same fisher also mentioned that there were certain areas in Trinity Bay that were more or less susceptible to cod bycatch. He noted:

> On this shore Spread Eagle Shore. A lot of small cod were caught in here. We used to fish capelin off here [Chapel Arm] and very seldom you'd see small cod in with the capelin right. The bottom of Chapel Arm we wouldn't see any. We could haul traps and never pull any cod aboard but over here on Spread Eagle Shore it was always a problem with small cod.

Seven other fishers also talked about areas within Trinity Bay where cod bycatch tended to be more or less prevalent. Fisher 44 of Thornlea revealed that Bellevue was a particularly good area for small cod. He stated, "It seems like up here in this shoal water, the fish comes up on the bottom here. That's the number one [place] for small cod." Fisher 45 of Bellevue stated, "[In] this area, the small cod is excellent. Especially last year, we had a trap out, the cod was picking up, since they closed it, the moratorium." Fisher 55 of Chance Cove said, "It depended on how close your trap was to the bottom. It seemed like you had a trap in a shoal water place you would get more cod. But if the trap was a long ways from the bottom you'd get less cod. That is what it seemed like."

7.4 Discussion

Fishers differed from scientists in their perceptions of the extent and ecological significance of juvenile cod bycatch in the capelin trap fishery. DFO data suggested a low but highly variable percentage of cod bycatch relative to capelin landings during the late 1980s and 1990s. Fishers' observations were generally not consistent with DFO logbook data collected from capelin fishers, which suggested that the rate of mortality of cod bycatch was relatively low. Fishers interviewed for this study generally maintained that both the bycatch for juvenile cod and their mortality rates were significant, especially when conservation practices, such as rolling the trap, were not employed. Some suggested that rates of mortality, particularly for juvenile cod and even for market-sized cod were high.

7.4.1 Disagreement Between Fishers and Scientists

A number of social-ecological factors provide insight into the disagreement between fishers and scientists concerning cod bycatch in the capelin trap fishery. First, it may be possible that cod bycatches were more prevalent in some areas than others, especially in areas where capelin fisheries were more intensive or where sub-stocks of cod existed. Stevenson's study, carried out in the early 1980s, suggested that estimated levels of young cod caught and killed in capelin traps only represented a minimal percentage of estimated recruitment at age four (Stevenson et al., 1984). However, these percentages were based on recruitment levels for the whole Division 2J3KL cod stock and did not take into account impacts of bycatch on recruitment to cod stocks in areas where capelin fisheries were more intensive. Further, Stevenson's results did not take into account the possibility of sub-stocks of cod and the impact of bycatch at that level.

At the time analysis was undertaken for this thesis (1998), DFO computed cod bycatch as a percentage of capelin landings. Generally, cod bycatch had been considered relatively small compared to overall capelin landings. However, computing cod bycatch as a percentage of capelin landings may have under represented the significance of cod bycatch in certain situations. Specifically, in contexts where capelin catches were high relative to cod catches and where local cod catches came from small, local cod stocks, cod bycatches that appeared small at the level of the fishery as a whole, could have had significant localized effects on cod stocks. This may have been the case in the study area (Neis and Morris, 2002).

Certainly, the fact that fishers and scientists base their perceptions of cod bycatch on different time periods also contributes to disagreements between fishers and scientists. Aside from the data collected from the logbook program, the only scientific study on cod bycatch was carried out in the early 1980s long before the major expansion in the capelin fisheries and the decline in Northern cod abundance in the 1980s.

7.4.2 Disagreement Among Fishers

Social-ecological factors that explain disagreements among fishers include whether fishers harvested capelin in areas where juvenile cod were more prevalent. In this study, some capelin fishers in the sample said that they fished on particular grounds where cod bycatch tended to be much higher or much lower than other fishing grounds. For example, some fishers in the study who avoided prime berths and areas where small cod accumulated generally experienced lower catches of juvenile cod bycatch than other fishers who did not. Thus, fishers who harvested capelin around Lynch's Cove off Bellevue and Spread Eagle Shore were noted as harvesting large amounts of juvenile cod in their capelin traps. In contrast, some fishers from Chapel Arm noted that in their area they saw very little small cod. Certainly the data presented here on areas where juvenile cod may be more prevalent are not conclusive. However, it does suggest the importance of further research in this area.

The choice to use conservation methods such as "rolling the trap over the heads" may also explain varying fishers' perceptions of bycatch in the capelin traps. For example, some fishers were careful in protecting bycatch, particularly small cod, by rolling the trap in the morning. Other fishers were not as careful. Other factors that may explain differing perceptions of juvenile cod bycatch among fishers included their choice to pick their capelin prior to selling it or sell sea-run.[20] Fisher 31 of Pork Rexton explained:

> If you picked your capelin then you would see a lot more juvenile cod. When you sea-run your capelin you were not noticing how much tom cods there was. If it was sea-run then the plant would discard the under 16 inch bycatch. The cod discarded did not live. When they picked capelin they still came ashore to pick through their catch because they didn't have the means to do it on the water. Therefore the cod were not rolled over the heads. They were brought ashore and whatever tomcods (juvenile cod) were discarded.

The majority of fishers in this study who fished commercially picked their capelin.

[20] Fishers who picked their capelin prior to selling it to the buyer would discard any bycatch and male capelin. In order to ensure that that the full amount of capelin was applied to the quota, buyers were required to estimate the discarded catch using a mathematical formula supplied by DFO. Fishers who sold sea-run capelin sold all their catch including the bycatch and the male capelin. Buyers would dock a percentage depending on the amount of bycatch and male capelin.

Though not statistically representative of fishers in this area, this finding does suggest the need for further research on the choice of sale in the capelin fishery.

Gear type, such as traps or purse seines, may also explain differing opinions regarding juvenile cod bycatch. Two fishers said that fishers using the seine did not experience high bycatches of cod. Fisher 46 of Chapel Arm stated:

> The small fish (cod) follow the shoreline and as fish come along, they hit the leader, they move off. And if you got a ring [purse] seine, the seine picks it up, and he comes in and makes a circle around it, the only fish you get is what is in [the] surrounding area, what is around the little bunch. But if you got a trap right here, stuck out on the shoreline, and he's here for thirty hours, all the fish are trimming up along the shore is getting in there.

Fisher 53 of Long Cove said, "The purse seines don't take the cod. They fish them out farther and the seine is on top of the water, more or less, probably in twenty fathoms of water." Though not conclusive this finding does suggest that any future research should take into consideration the impact of gear on fishers' knowledge about cod bycatch.

7.5 Conclusion

This chapter addressed the findings from the analysis of fishers' and scientists' knowledge of the cod bycatch in the capelin trap fishery. The data show that fishers differ from scientists in their perceptions of the extent and significance of juvenile cod bycatch and bycatch of larger market sized cod. Fishers also disagreed with the scientific data suggesting that cod mortality from cod bycatch was relatively low. Fishers stated that the extent of bycatch and the rate of mortality were high and depended often on a number of factors including the location of the fishery and trap berths and the use of conservations methods to save cod bycatch. An analysis of fishers' and scientists' social-ecological knowledge provides some insight into these differences and provides support for future research in this area. At least, Stevenson's study (1984), the only study on bycatch that existed at the time this research was undertaken, needs to be revisited taking into account new scientific research on cod stock structure and abundance. Any new study on cod bycatch should also take into consideration the possibility that cod bycatch is more prevalent in certain areas. This type of analysis may be used to identify juvenile nurseries of cod and identify ways to minimize the mass destruction of juvenile cod. The study should also address fishers concerns about cod bycatch and the negative impact the trap may have on localized cod stocks and possible bay stocks of cod.

Chapter 8 'Dumping' in the Capelin Fishery

8.1 Introduction

This chapter presents the findings from the analysis of fishers' and scientists' knowledge of "dumping" in the commercial capelin fishery. Dumping is referred to as capelin removed from the total biomass without being recorded as landings.[21] Fishers may dump capelin for any number of reasons including redfeed, size, sex composition, bycatch or inability to sell the catch to a buyer. As with the previous three chapters on capelin stock structure, abundance and cod bycatch, dumping represents one of the points of disagreement between fishers and DFO scientists. Specifically, the scientific data suggests that dumping and the rate of mortality for dumped capelin were relatively low. Fishers suggested that dumping was a major problem, especially during the peak of the fishery. They noted that at times dumping was as high as reported landings or higher. Fishers also believed that the rate of mortality for these capelin was high. Many fishers revealed that the main reason for high rates of dumping was insufficient markets and buyers who refused to buy their catches. This chapter, unlike the others, also introduces the DFO management position on dumping, which contrasts with that of fishers reported in this study.

The chapter concludes with a discussion section that presents social-ecological

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[21] The buyer reports all landings to DFO Statistical Division. This includes capelin that are sold sea-run or picked.

factors that may account for the disagreements between fishers' and scientists' and managers' perceptions about dumping in the capelin fishery. Fishers' perceptions of declining capelin stocks and their choice of sale may offer some explanation for why these differences exist. Scientists and managers assumptions about the capelin fishery are also explored as providing support for these disagreements.

8.2 Managers' Knowledge of Dumping in the Capelin Fishery

Dumping in the commercial capelin fishery has both fisheries assessment and management implications. Managers and scientists depend heavily on accurate landings information from plants and fishers to calculate fishing mortality and stock biomass. In the case of managers, landings data are used to decide whether quotas have been filled and fisheries should be closed. If landings data underestimate the amount of capelin that is actually caught then serious implications can come into play, including overfishing of an already scarce resource.

Dumping has been an issue for fisheries managers ever since the beginning of the commercial capelin fishery. To reduce the amount of capelin dumped, DFO management has put several plans in place to help combat this problem and ensure accurate landings data. One plan has been the quota-monitoring program, which was put into place in the early 1980s. The purpose of this program was to provide DFO management with a means of gathering information from fishers and plants on a number of issues related to the capelin fishery, including the practice of dumping in various communities. Information was gathered at both the landing site and at the plant. However, over time, more effort was placed on gathering information from the landing site. The reason for this was that the landing site provided more information on capelin caught and gear type used. Due to lack of manpower and the impossibility of monitoring every community, this program was not considered successful (Mayne, Personal Interview, 1999). Information on landings was supposed to come from the landing sites and the plants, but the monitors could not rely on the information provided by those who trucked capelin from unmonitored landing sites. Despite these concerns, dumping was not considered a problem at that time and was considered not to have impacted the level of fishing (DFO, 1983). In 1984, DFO Management made dumping an offence. The 1984 Capelin Management Plan states that, "any persons found dumping capelin may be prosecuted" (DFO, 1985:4). In 1986, fishers were forbidden to have mechanical sorters on board vessels, thus forcing them to pick through their capelin on shore. The purpose of this measure was to combat dumping on the water and ensure that the processor was able to report all the landings and not just the females (DFO, 1986).

DFO Management also placed observers on vessels to combat the problem of dumping.[22] Because dumping reported by observers on board was low, the value of these observers was considered marginal in the overall enforcement plan (DFO, 1983) and the program was cancelled. DFO Management quickly realized that controlling the dumping problem and ensuring accurate landings data were not easy to achieve. Short of monitoring every landing site, every plant, and every vessel, they could not rectify the

[22] Observers were placed on boats in Conception Bay. DFO documents make reference to observers being placed on purse seine vessels only (DFO, 1984).

problem. Therefore, DFO had to depend on the landings data provided by the processors. The problem with that was that having to dump male capelin constituted a loss of production for the plant. In other words, the processor had to report all landed capelin including the males, which limited the females that the processor could process and hence the profits.[23] Processors stood to benefit substantially by cheating. DFO management recommended that more effort should be placed on plant monitoring rather than landing sites.[24]

At the time of this study, fishers were required to bring all the capelin harvested to the plant for sale. Before 1993, however, fishers were given the opportunity to sell their capelin sea-run or picked depending on the quality and the percentage of females. If fishers chose to sell sea-run, then they would sell their whole catch to the processor. The processor was supposed to report those landings to the Statistical Division stating the amount of purchased capelin and the choice of sale. If the fisher chose to sell picked capelin, they would discard the males and sell the females to the processor. The processor was required to report the quantity of female capelin purchased and the method of sale to the DFO Statistical Division. To estimate the discarded capelin, the Statistical Division used a calculation for determining the whole catch. This formula was 2.3 pounds of capelin to every one pound of roe-bearing capelin. If a fisher sold 500 pounds of roe-bearing capelin to the plant, it was determined that the full harvest had been

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[23]The long-term goal of the capelin processors has been to maintain a minimum market share of 15000 tonne (DFO, 1985).
[24]They also recommended that a market should be developed for both male and female capelin.

roughly 1150 pounds. It is important to note, however, that DFO assumed that most fishers sold capelin sea-run rather than picked. In an interview with Bruce Mayne, a DFO Manager, he stated that fishers who sold their capelin picked were a small minority. He also said that if fishers chose to sell picked then their small trap capacity would have limited the amount of capelin dumped, certainly not enough to make a difference if it did not get counted (Mayne, Personal Interview, 1999).

DFO Management had no measures in place to account for the capelin that fishers brought to shore for sale but did not sell for various reasons. This was not considered a major concern for a number of reasons. First, DFO management thought that given the market, a need existed for all female capelin harvested (DFO, 1989). Second, managers felt that given the capelin that fishers could have harvested if a market had existed, the dumping that occurred because of buyers' preferences would not make much of a difference to the overall abundance of the capelin stocks (Mayne, Personal Interview, 1999). To clarify, the 1985 Capelin Management Plan stated:

> The actual product quality or the buyer's willingness to buy, is often a subject for heated debate on the wharf. Many of the factors influencing this are beyond our control . . . As the resource appears to be sufficient to more than meet the current level of demand, the success of the capelin fishery would appear to lie in the ability of the processors to negotiate a reasonable format for supplying the Japanese marketplace (DFO, 1985, p. 10).

8.3 Scientists' Knowledge of Dumping in the Capelin Fishery

As indicated above, dumping is both a management issue and a science issue. Scientists depend on accurate landings information from both plants and fishers in order to properly assess the size and health of the capelin stocks. To that end, they have been collecting data on dumping practices since the introduction of the logbook program.

Referred to as discarding[25] by DFO scientists, such data are used by scientists to get a sense of how much capelin is caught and discarded, dead or alive, but not landed (recorded as landings by the buyer).[26] Scientists retrieve data on discarding from several sources including the logbook program that was started in the early 1980s.[27] Fishers who completed logbooks reported that they discarded capelin for many reasons, including low percentage of females, redfeed and sorting of male capelin. An analysis of logbook data from 1981 to 1995 suggested that discarding relative to landings ranged from a low of 13.1% in 1993 to a high of 74% in 1997 (see Table 8.1). On average, 41% of capelin landings were discarded each year between 1981 and 1997.[28]

[25]DFO scientists refer to dumping in the fishery as discards.
[26] The landings data that are used by DFO stock assessment scientists is the purchase slip data prepared by the plants.
[27] Scientists also collected discarding information from fishers who participated in the telephone survey. However, due to a lack of data it is impossible to conduct any analysis on these results.
[28] Logbook data does not exist for the years 1994 and 1995.

Table 8.1: Estimated Discarding as Percent of Capelin Landings in DFO Capelin Trap Fishers Logbooks, Division 3KL, 1981-1997

Year	# Fishers	# Traps	Landings (tonnes)	Discards (tonnes)	Discards as % of Landings
1981	35	41	1281.0	417.7	32.6
1982	60	81	4366.5	605.2	13.9
1983	50	71	3051.2	1338	43.9
1984	67	89	4172.5	634.1	15.2
1985	60	80	3011.3	1850.1	61.4
1986	64	91	5056.4	1436.4	28.4
1987	68	93	3150.6	2437.5	77.4
1988	86	125	6792.6	1500.4	22.1
1989	102	154	6275.8	2188.1	34.9
1990	106	167	5538.1	2986.6	53.9
1991	59	76	2793.0	1187.5	42.5
1992	28	34	1225.8	567.1	46.3
1993	59	78	2261.1	297.0	13.1
1996	52	68	1719.4	930.8	54.1
1997	17	22	516.3	384.7	74.5

Source: Nakashima and Delaney, 1998

The survival rate of discarded capelin, as reported by fishers who participated in the logbook program, was high. In 1988, logbook participants from Division 3L reported that 81% of trap discards and 92% of seine discards were released alive (Nakashima and Harnum, 1989). In 1991, fishers from Division 3L, who participated in the logbook program, said that 70% of trap discards and 100% of purse seine discards were released alive (Nakashima, and Harnum, 1992). The mortality rate increased in 1997 when logbook participants from Division 3KL reported a 100% mortality rate for the trap fishery and a 90% mortality rate for the seine fishery (Nakashima and Slaney, 1998).

8.4 Fishers' Knowledge of Dumping in the Capelin Fishery

To date, little formal information exists about dumping other than that which is available from Capelin Management Plans, monitoring reports, log books and the annual capelin phone survey administered each year by DFO scientists. Many questions remain unanswered. For example, how much harvested capelin does not get applied against the quota? Are measures in place to account for the harvests that do not get sold? How accurate are the recorded landings? Do the processors report the actual amount of capelin bought? Although many of these questions remain unanswered, fishers' perceptions of the extent of dumping in the commercial capelin fishery clearly suggest a more serious problem than scientists and managers acknowledge. A quote from Cabot Martin, a journalist with the Evening Telegram in 1998, illustrates this point. He states that, "most fishermen would laugh at DFO's bland assertion about the inshore that, 'most discarding is believed to occur after the fish are landed and since the TAC (Total Allowable Catch) is applied to the landings, these discards are accounted for in the application of the TAC".

Fishers profiled in this chapter were asked a number of questions on dumping, particularly in the follow-up interviews. Though the Eco-Research team did not originally set out to address dumping it arose as one of the main topics of discussion on the capelin fishery. In the follow-up interviews fishers were asked how much capelin was dumped on average per load, where capelin were dumped, the survival rate of dumped capelin and the reasons why dumping took place. Sixteen fishers discussed the dumping in the capelin fishery. Of these fishers, four were from the communities between Plate Cove and Melrose, five were from the communities between Champney's

East and Butter Cove and seven were from lower Trinity Bay. The majority of fishers had fished capelin commercially and all used capelin traps as their primary gear. Six fishers used a seine during an earlier period of their career in the capelin fishery. In contrast to the assumption of management that a majority of fishers sold their capelin sea-run, ten of the sixteen fishers who discussed dumping regularly sold picked capelin at the peak of fishery rather than sea-run. At the time of the study, these fishers ranged in age between forty and eight-four with the average age being fifty-four years of age. The participants were involved in the capelin fishery for an average period of nineteen years.

Of the sixteen fishers who discussed dumping, fifteen identified the practice of dumping as an issue of concern for them. Only one fisher did not consider dumping an issue, though he did acknowledge that a lot of males were dumped. Mainly the information that fishers provided on the extent of dumping contrasted with the data reported in the logbook program. Fishers' estimates of dumped capelin were much higher than that reported by scientists and even their lowest estimates exceeded those recorded in DFO logbook data. Eleven fishers provided information on the amount of capelin they dumped and what they had seen dumped by other fishers. Fisher 22 of Plate Cove said he dumped close to ten times as much as he sold. Fisher 42 of Petley said, "There was more dumped than was actually recorded. And we know what was recorded, seventy thousand metric tonnes or something like that. And guaranteed, so much as that went to the bottom." Fisher 52 of Dildo stated, "I say if there was a hundred thousand tonnes caught, there was another hundred thousand dumped." Fisher 40 of Random Island stated that "we were bringing in here probably ten thousand pounds of capelin and walking off with five hundred pounds of females, dumping all the rest of them over the wharf, all those great big male capelin." Fisher 26 of Bonavista stated, "There's thousands and thousands of pounds of capelin dumped that should never been dumped."

Fishers reported that a lot of capelin was dumped during the capelin fishery and most of it unrecorded. Though there are many reasons why so much dumping took place, much of the dumping was attributed to buyers' preferences. In contrast to DFO's assumption that a market existed for all capelin, fishers argued that this was not the case and many times it was unknown whether they would sell their capelin until it was brought ashore. Fisher 22 of Plate Cove stated:

> We come in from a load of capelin probably get to sell eight or ten thousand pounds of it and dump the rest. I wouldn't even get to sell it but you go out and bring in a load of perfect capelin and if it wasn't to the Jap's liking, dumped it. Nobody wouldn't buy it. They were too picky because the big quota was there the Jap knew you know. "We don't have to buy the stuff, we probably get better stuff the next day, bigger capelin or something like that" and this was destroying the fishery.

Fisher 40 of Random Island stated, "[We were] load after load after load, tied up by the boats, waiting to see if you could make a sale. You wondering if it's big enough." Fisher 52 of Dildo revealed, "The capelin you could never sell and you could catch . . . Be tied on the wharf all day. After you unload, waiting to see if somebody takes a load off you. That's the way it was all the time." Fisher 22 of Plate Cove stated, "The Japs wouldn't buy it [capelin] and it was just dumped and it was never recorded see. Nobody knew you were dumping it. This is where the problem is in the capelin fishery." Fisher 42 of Petley said, "This is probably another place where science fails. And that is, the amount that's dumped that's not recorded." Some fishers noted that sex composition and redfeed were two factors that determined the sale of a load of capelin. Fisher 50 of Norman's Cove stated, "I think the redfeed is an excuse to get the price down. I come in with two boats full one day, and they turned down both, and both came out of two different traps." Fisher 52 of Dildo stated, "I don't know if it's the Japanese or the processors but they were very sticky over the redfeed content in them."

Interestingly, one fisher said he dumped unrecorded capelin on the water because the capacity of his vessel was not big enough to take all of the capelin from his trap. Fisher 48 of Bellevue said, "The dumping that went on . . . even the fishermen didn't realize. You haul your trap, you've got fifty thousand pounds of capelin in your trap and your boat can only take thirty thousand pounds. In a lot of cases the other twenty thousand pounds went over the side."

Fishers also disputed the data reported in logbooks on mortality rates. In contrast to logbook data that implied high rates of survival, fishers argued that the survival rate of dumped capelin was low even in cases where conservation measures were practiced. Fisher 31 of Port Rexton stated that even though fishers took great measures to protect the capelin, in the end the majority of dumped capelin were destroyed. He explained:

> You would haul it up enough, draw it up, get a count on them to see how many spawn is in them. If not enough, you just let the heads of the trap go down and the capelin takes over the trap there, they'll run right to the bottom . . . [However] it's only a matter of five minutes in a capelin trap. You get it just drawn up, and in five minutes, there's neither capelin left alive. They are a very quick fish to die. Getting capelin to go back alive is practically nil, unless you let your trap down and haul him up so they can take over and go out over the heads. And you'll have dead capelin even then, when you get it all dumped out.

It is also worth noting that because fishers were forbidden to pick capelin on their boats, any capelin bought ashore, picked or not, would not have survived.

8.5 Discussion

In contrast to DFO science and management data which suggested that unrecorded dumping and the rate of mortality for dumped capelin was relatively low, fishers interviewed for this study suggested that dumping was a major problem, especially during the peak of the fishery. The majority of fishers also agreed that the volume of dumping was as high as the landings, and in some cases higher. The survival rate for this capelin was considered to be low. Fishers also noted that much of the dumping took place as a result of buyers' preferences, a practice that DFO managers did not consider a problem.

8.5.1 Disagreement Between Fishers, Scientists and Managers

There are a number of social-ecological factors that account for the differences in opinion between fishers, scientists and managers regarding dumping in the commercial capelin fishery. First, DFO scientists and managers made several working assumptions about the nature of the capelin fishery and fishers' practices that do not coincide with the results derived from fishers in this study. These assumptions may have biased data on dumping, leading scientists and managers to believe that it had relatively little impact on capelin abundance. The first assumption that DFO made was that dumping would not result in a major problem because capelin stock abundance was plentiful enough to support the fishery and any minimal rates of dumping (DFO, 1985). In contrast, most fishers in this study believed that dumping was a major concern not only because it occurred at a much higher rate than DFO managers and scientists assumed, but that it occurred while capelin abundance seemed to be declining. As discussed in *Chapter 6* of this thesis, fishers believed that during the 1980s capelin were not as abundant as scientists believed. Research in this thesis demonstrates that fishers and scientists disagreed on the extent and timing of capelin stock decline during the period between 1970 and 1990. Scientists argued that capelin stock decline did not start until the 1990s with the advent of severe environmental changes. Collectively, fishers argued that stock decline started much earlier and, depending on fishers' location throughout the study area, may have started to decline as early as the 1970s or as late as the mid-to late 1980s. As such, fishers unlike managers, who believed that dumping did not warrant any concern because of apparent stock health, operated under the belief that capelin abundance had been declining since the late 1970s and early 1980s, and possibly even earlier.

A second assumption that DFO made was that a market always existed for capelin and because of this all capelin caught were reported in the landings data. In this chapter, evidence is presented that suggests that often buyers would not buy fishers capelin, leaving them with no choice but to dump boatloads of capelin on the wharf, much of it unrecorded. DFO also assumed that dumping was kept to a minimum because most capelin fishers sold sea-run capelin rather than picked. Though not representative of the larger fisher population in this study area, the majority of fishers who discussed dumping in this study said they sold picked capelin at the peak of fishery in the late 1980s and early 1990s rather than sea-run. Fishers said that selling picked or sea-run capelin often depended on the percentage of females in the haul. To illustrate Fisher 31 of Port Rexton stated:

> We would never ship what we call "sea-run". We used to always pick our capelin. So if you come in with two or three boatloads a day, we used to always pick our capelin. A lot of people were running sea-run, they'd come in and whatever they'd get in their trap, they'd just ship it right off. But if we come in with five or six thousand pounds, we might only get a couple of thousand or one thousand pounds of spawn, depending on how much spawn is in it. We've been hours waiting on the trap, lowering down, hauling up and dumping, because there would be no spawn worth bringing in.

Those who sold sea-run did so because the female composition was high in their areas.

DFO also said that even if capelin were picked, trap capacity would limit the amount of capelin that were dumped (assuming a small trap capacity). One fisher said that because his trap was so big it was impossible for him to bring in all the capelin thus leading him to dump some of it. Data on trap size in *Chapter 6* also suggests there was a steady increase in the size of capelin traps in the 1980s.

8.5.2 Disagreement Among Fishers

This chapter has also highlighted differences among fishers who discussed dumping in the interviews for this thesis and those who participated in the logbook program. There are several social-ecological factors that might explain these differences, including the location of gear. Fisher 44 of Thornlea mentioned that there were particular places where the composition of female capelin was higher, thus contributing to less dumping of male capelin. He stated, "There is a few areas you'd probably get more female then male...we find that the capelin traps set close to shore get a higher male count than farther offshore…the female seem to be off a little farther." A couple of fishers also noted particular locations that were favorable for female capelin. They stated that west of Spread Eagle Shore and Chapel Arm were good areas for female capelin and that many times their harvest would be made up of about 90% female. In referring to the area around Chapel Arm, Fisher 53 of Long Cove mentioned "We always had sixty to eighty percent females in that area. Pretty high count."

The use of different gear may also explain differences among fishers. Some fishers mentioned that fishers using the purse or ring seine had fewer problems with dumping. Fisher 22 of Plate Cove mentioned that fishers harvested higher percentages of females in the *purse seine*. He revealed that in a purse seine the percentage of females would go up to eighty percent while in a trap it would be forty to fifty percent. He explained, "There is more males by the shore because that is where you set the traps, in close to shore, So you got more male capelin in around the shore line than you have off clear the shore." Purse seiners catch their capelin off the land. It is also possible that differences can be explained through the practice of conservation measures. However, such a possibility cannot be explored with the data gathered from DFO's studies or the study conducted for this thesis. More research needs to be carried out on dumping practices.

Fishers who participated in this research and those who participated in DFO's logbook program held different views from each other on dumping. There may be social-ecological factors that underlie these differences. However, they cannot be explored fully with the data gathered for this thesis. It is worth mentioning that it is possible that fishers in the DFO survey may not have been truthful about capelin dumped and the survival rate. Dumping of capelin is an illegal activity and punishable by law and fishers may not have been eager to report violations. It is more likely, however, that logbook fishers were reporting information related to the practice of taking a count or 'drawn dry'.[29] For logbook purposes, DFO defines discarding as "capelin caught but not landed by the fishers who caught them and it includes both dead and alive fish." The reason why DFO defines discarding in this way is because capelin are presumed to be landed once they are brought aboard the boat. DFO's assumption is based on the fact that capelin cannot be picked at sea and the belief that a buyer is available to buy the capelin, and that capelin brought aboard the boat would be accounted for in the landings data. If this is the case, then it would explain fishers' inclination to report a 100% survival rate of the discarded capelin. When fishers were asked about dumping in this study a majority referred to capelin dumped on the water after they were brought aboard the boat and capelin dumped at the wharf because of redfeed, buyer's preference or insufficient markets. In most cases this capelin was unrecorded.

[29] Drawn dry means hauling the trap completely out of the water. Given the pressure, capelin usually die when this happens.

8.6 Conclusion

As noted above, fishers' observations indicated dumping practices that are not accounted for in any of the DFO information or data on dumping. This may be the case because DFO management and science made certain assumptions about the fishery that do not correspond with the information provided by fishers in this study. These assumptions may have biased data on dumping, leading scientists and managers to believe that dumping had relatively little impact on the abundance of capelin. Certainly one area that needs to be revisited by DFO is the accuracy of the landings information which is used to set quotas and predict stock size. As noted earlier in this thesis, landings data are also a form of social-ecological information in that they are shaped by the distribution of processing plants that record such information, the relationships between capelin harvesters and these purchasers, price of capelin, trucking costs and other factors. More research should also be carried out that takes into consideration the information presented by fishers in this study and the social-ecological factors that underlie the differences between fishers, scientists and managers. At a broader level, fishers' knowledge suggests that DFO is not in tune with how the capelin fishery has operated. Combined with findings from other chapters it is evident that DFO needs to become more aware of this fishery by developing closer partnerships with fishers and focusing on more of a collaborative approach to understanding the capelin resource and fishery.

Chapter 9 Conclusion

9.1 Current Issues

In response to serious problems with regulated fisheries throughout the world, including the overfishing of many fish resources such as the northern cod, and the scrutiny that science-based centrally controlled systems have been under, fisheries researchers have called for more involvement of fishers and their knowledge in the fisheries management and science process (Neis and Morris, 2002; Hutchings and Ferguson, 2000; Neis and Felt, 2000; Neis and Morris, 2000; Berkes, 1999; Neis et al, 1999a; Pinkerton and Weinstein, 1995). Advocates of this change argue that fishers' knowledge can provide an important check for scientific knowledge. Greater involvement could help contribute to the development of an integrated fisheries knowledge and management system that reflects the knowledge of fishers and scientists and that is more likely to be supported by fishers (Hutchings and Ferguson, 2000; Neis and Felt, 2000).

Some attempts have been made to incorporate fishers into fisheries science. However, these projects have been largely driven by scientists and consist largely of data collection programs such as the logbook program, the sentinel fishery, or telephone surveys (Wilson, 1999). Since these programs have been designed by scientists, the roles that fishers play are restricted, acting more as fishery technicians or data collectors rather than participating fully in the process of assessment and management (Wilson, 1999). Another concern with some of these initiatives is that the design and analysis of these programs pays little attention to the contextual nature of fishers' and scientists' knowledge. This can lead to the underutilization and marginalization of some fishers' knowledge and the complete dismissal of other knowledge that does not coincide with scientific thinking (Neis and Morris, 2002; Mackinson and Nottestad, 1998). Limited effort has been devoted to understanding why fishers disagree with each other or with scientists.

Despite the shortcomings of many of the projects that aim to integrate fishers' knowledge with that of scientists, fishers' knowledge can provide an important source of information for the fisheries policy formation process. However, fishers' knowledge is complex and will likely lead to disagreements if it is not analyzed properly (Mackinson and Nottestad, 1998, Felt, 1994). Fishers' knowledge has a high degree of complexity and requires extra time and effort to understand. It is not standardized making it difficult to assemble and to identify and interpret patterns. In addition, fishers' knowledge is not easily quantifiable and in some cases cannot be quantified at all. It is oral and usually mediated by fishers' quest for better landings (Neis et al, 1999a). As a result, fishers tend to focus on events that influence success including seasonal movements of fish, migration patterns, and feeding habits. Knowledge about other species' behavior may be limited because of time constraints, gear selectivity, or because the need does not exist to know such things. Fishers' knowledge is also mediated by competition, gear, fishing strategies, technology, management initiatives, and location (Felt, 1994; Finlayson, 1994). As such, fishers make changes to their gear or fishing strategies in response to the knowledge they gain about stock decline, fish behaviour and or competition. This means that in times when stocks may be declining catch rates will tend to stay the same, potentially affecting fishers' perceptions of stock abundance. Fishers also appear to draw upon past experiences remembering best particular years that stand out (for particularly good or poor catches) and by telling stories that capture the essence of their observations. Their memories of events and observations can be mediated by many factors and they partially shape their perceptions of changes in the fishery in the present (Neis and Morris, 2002). As noted by many researchers, fishers' knowledge (Neis and Morris, 2002; Felt, 1994) may capture trends better than absolute values. It is also important to distinguish between observations and interpretations of those observations and, as with scientists and managers, to pay attention to the social context within which fishers make knowledge claims.

When disagreements are apparent between fishers and scientists and among fishers, then efforts have to be made to understand why these differences exist (Neis and Morris, 2002). This process starts with the understanding that both fishers' and scientists' knowledge is a social-ecological product. For fishers, this implies that knowledge is influenced by relations with other fishers, technology, gear, and management initiatives that mediate their relationship with their environment. The location of their fishery and local features of the environment also mediate their knowledge. For scientists, the relationships they have with each other as well as their training and the social and political contexts within which they function influence their knowledge production. Ecology can also play a role in scientific knowledge. Choices to survey certain fishing areas, in certain years or seasons, and with certain technologies and methodologies are some examples within scientific knowledge production where ecology can affect their knowledge and outlook on individual fisheries.

To demonstrate the importance of treating fishers' and scientists' knowledge as a social-ecological product, this thesis has focused primarily on issues of debate between capelin fishers and scientists in Newfoundland in the 1990s. The capelin fishery made an interesting case study because unlike other fisheries, scientists have been working for some time with fishers to gather their knowledge through programs such as the telephone survey instituted in 1994, and the logbook program instituted in the early 1980s. Despite these programs, however, fishers and scientists did not see eye-to-eye on certain aspects related to the status of the capelin stocks and the capelin fishery.

Data for this thesis were collected from forty-seven one-on-one career-history and taxonomy interviews carried out with fishers from the communities between Plate Cove, Bonavista Bay and Dildo, Trinity Bay. The interviews were carried out between 1994 and 1995 by a team of researchers involved with the TEK component of the Eco-Research Project. Supplemental data were collected from telephone interviews carried out in 1998 with seventeen fishers from the original sample who harvested capelin commercially. Additional data were also collected from DFO management and scientific research documents and personal interviews conducted with DFO capelin scientists.

The data used for this thesis were analyzed carefully and every attempt was made to capture as closely as possible what fishers said they had observed and their interpretations of those observations. This information was then used to highlight both points of agreement and disagreement between fishers and scientists on issues of capelin migration and stock structure, cod bycatch in the capelin trap fishery, dumping in the capelin trap fishery, and trends in capelin abundance. Focusing primarily on issues of disagreement and using a social-ecological approach to understanding fishers' and scientists' knowledge, possible explanations were then posed to understand why scientists and fishers disagreed with each other and why some fishers disagreed with others. Where applicable, the thesis also identified areas where future research is needed.

9.2 The Research Findings

Fishers and scientists generally agreed on capelin migration patterns into the Trinity and Bonavista Bay areas. Some Trinity Bay fishers, however, expressed greater concern than is commonly found in science about the possibility that the management system may have jeopardized the health of a Trinity Bay capelin stock they believed was the source of the early run of large capelin they targeted in the 1980s. Since the late 1980s, capelin in the Divisions 2J3KL have been managed as a stock complex (DFO, 1998a and b). Relatively little scientific effort had been directed towards determining whether or not separate "bay" stocks of capelin existed. In contrast, many fishers thought that different "stocks" or "runs" of capelin existed in this area and some even argued that a bay stock of capelin existed in Trinity Bay or may have existed in Trinity Bay in prior years. Fishers feared that if this stock was not recognized as distinct then it would be fished to extinction. Given the pressures associated with an extensive capelin fishery in the late 1980s and the early 1990s this may have happened.

Fishers' concerns, along with research in the area of stock structure, indicate that there are major concerns with management systems based on stock complexes. Failure to properly understand stock structure and this approach to management increases the risk that particular stocks may be overfished despite relatively low fishing mortalities at the level of the stock complex as a whole (Wilson and Kornfield, 1998). Intense fishing effort concentrated on particular sub-stocks of capelin might have produced the pattern of delayed spawning, smaller sized capelin and reduced abundance pointed to by most harvesters.

Given these concerns, more research is needed to understand stock structure and the possibility of sub-stocks of capelin unique to Trinity Bay. This research should involve fishers in the process of identifying whether sub-stocks of capelin exist and management initiatives that can be put into place to protect such stocks if they exist. To incorporate fishers' knowledge properly, special attention should be paid to the social-ecological contexts that mediate fishers' knowledge such as age, location and gear. For example, this research found that younger fishers who entered the fishery at a later time were less inclined to support the bay stock theory. This may be due to the fact that they did not have the baseline knowledge that older fishers possessed on stock structure in Trinity Bay or that the Trinity Bay stock may have already been depleted when they began to fish. Fishers from the Bonavista area were also less inclined to agree with the bay stock theory. Many of these fishers had only observed one stock or run of capelin in their fisheries. These fishers were less likely to be commercial capelin fishers thus limiting their ability to observe distinct stocks or runs. Their fisheries may also have depended less on a bay stock, if it existed, than those of fishers at the bottom of Trinity Bay. Another point worth noting is that if future research supports the introduction of micro-quotas for different sub-stocks of capelin, then it is unlikely that seine fishers will support these quotas because they are particularly likely to fish mixed stock aggregations. This could affect the information they are willing to divulge to scientists and managers about capelin movements.

Fishers and scientists disagreed on the extent and timing of capelin stock decline during the period between 1970 and 1990. The scientific position during the 1990s was that capelin abundance increased between the early and late 1980s and remained high in the 1990s, while the observed changes in capelin behavior and the apparent collapse in capelin biomass in the early 1990s were due to environmental changes that affected the distribution, behavior and possibly abundance of capelin offshore (Carscadden and Nakashima, 1997; Frank et al, 1996). Most fishers argued that capelin abundance in the 1990s was well below that when they first started in the 1970s and early 1980s and described the decline as gradual, dating it from the 1970s and early 1980s. Others observed a period of gradual decline between the 1970s and late 1980s, followed by more rapid decline in the early 1990s. A comparison of fishers' observations from the 1990s also suggested that fishers from the Bonavista area experienced decline much earlier than fishers from lower Trinity Bay. Most fishers attributed the decline in abundance to overfishing and not adverse environmental conditions.

The analysis of fishers' and scientists' knowledge provided insight into their differences and also raised some concerns about DFO's indices of abundance. The indices that scientists used to measure abundance were not designed to capture the same information that fishers were incorporating into their assessments and the time frame for scientific observations differed from that of fishers. For example, fishers often referred to the accumulation of capelin spawn on beaches as an indicator of capelin stock abundance. However, scientists did not measure egg deposition at the time of this study. Further, the time series upon which fishers based their observations dated back well before the early 1980s, which is when scientists first started to monitor capelin abundance. Fishers' information on gear and efficiency changes also suggested that there might be problems with DFO abundance indices based on catch rates. Changes in trap size, mesh size, number of hauls per day as well as boat and motor size in the 1980s have been well documented by fishers and may have impacted catch rates leading scientists to believe that catches were the same or increasing at a time when fishers were working much harder to maintain their catches. The DFO aerial survey, based primarily on lower Trinity Bay, may have also been positively biased when taking into consideration that capelin distribution may be density dependent. Certainly, the results from the analysis of fishers' knowledge by area suggest that this may be the case.

More research is needed in the area of capelin stock abundance that takes into account the social-ecological factors that may underline the disagreements between fishers and scientists. Fishers' observations concerning capelin stock abundance appear to be conditioned by the location of their fisheries and by the history and nature of their participation in the fishery. This poses serious issues of consideration for scientists who want to integrate fishers' knowledge into the stock assessment process. If fishers' observations of capelin stock abundance are determined by the location of their fishing effort, a scientific study that focuses only on one area or one community of fishers may be presenting an inaccurate view of what is happening throughout the whole bay. For example, it is quite possible that a study that focused only on lower Trinity Bay fishers could leave scientists with the impression that capelin fishers did not start to observe stock decline until the late 1980s. The fact that fishers from the Bonavista area appear to have observed a decline many years earlier might not become an issue for scientists. Furthermore, a study that focused only on commercial fishers might influence fishers' perceptions of declining stock abundance. In this case observational opportunities may be affected by a fisher's participation or lack of participation in the commercial capelin fishery.

The research on cod by-catch in capelin traps revealed another point of contention between fishers and scientists. Unlike scientists, who reported that cod bycatch was relatively low, fishers agreed that cod bycatch was a major problem exacerbated by small mesh sizes, management initiatives and the promotion of large-scale catches of cod bycatch. Fishers also noted that the rates of mortality were high for juvenile cod and market sized cod. This was not supported by scientific data, which showed mortality rates to be low. Fishers who participated in this research were extremely concerned over cod bycatch and the effects it might have had on localized cod stocks such as those thought to exist in the deeper waters of Trinity Bay.

The research conducted in this thesis suggests there are a number of important factors that underlie fishers' and scientists' disagreements on the cod bycatch issue and should guide any future research in this area. First, DFO's one and only cod bycatch study conducted in 1984 estimated that levels of young cod caught and killed in the capelin traps were low and represented only a small proportion of estimated recruitment.

However, these percentages were based on Divisions 2J3KL cod stocks and did not take into consideration the effect on cod stocks where capelin fisheries were more intensive or where sub-stocks of cod possibly existed. If that research had addressed these considerations then it is likely that the results would not have been as positive. Furthermore, because DFO computes cod bycatch as a percentage of capelin landings this may have under-represented the significance of cod bycatch especially in situations where capelin landings were extremely high and where cod bycatch came from local stocks. Any new research should consider the possibility that cod bycatch is more prevalent in some areas than in others. If fishers are involved in any future research they might be able to identify juvenile cod areas and identify management initiatives that could reduce high-level destruction of juvenile cod in these areas. Additional research should also take into consideration some of the factors that underlie disagreements among fishers related to capelin. For example, gear location and type, and the use of conservation methods will likely play a part in the significance fishers associate with cod bycatch in the capelin trap fishery.

The issue of dumping also represented a point of contention between fishers and scientists. For the most part, fishers interviewed for this study agreed that dumping had been a major problem in the fishery while, based on logbook data from fishers, both scientists and managers felt that the magnitude of dumping and the rate of mortality for dumped capelin were relatively low. Some fishers said that the rate of dumping had been as high as the landings, and in some cases higher. Many also felt that the rates of mortality were extremely high and that, in most cases, dumped capelin was not reported.

The reasons for this point of disagreement between the logbook data and the interview data are not clear.

In reviewing the fishers' and scientists' interpretations of the scale and significance of dumping, this thesis has pointed to some social-ecological factors that might help account for the disagreement. Scientists made a number of assumptions about the capelin fishery that may have biased data on dumping. For example, DFO did not treat dumping as a major problem because it was always assumed that capelin abundance was healthy enough to support the relatively low quotas established for the capelin fishery. DFO also assumed that a market existed for all capelin. Fishers noted that this was not the case and that buyers often refused to buy capelin, which led fishers to dump boatloads of capelin. DFO also assumed that all fishers sold sea-run capelin while many fishers who reported on dumping in this thesis said they sold picked capelin. As a result of these assumptions, scientists held beliefs about the fishery that affected both the management initiatives that were put into place and the science that was conducted and produced. If fishers are right and dumping occurred at a much higher rate than believed by scientists, then it is possible that capelin stocks declined more rapidly than is currently believed and for reasons other than environmentally adverse conditions.

9.3 Recommendations for Future Research in Capelin Science and Fisheries Assessment

This examination of the points of convergence and divergence between fishers and scientists concerning the capelin fishery and capelin stocks of Trinity Bay, Newfoundland suggests that integrating fishers' knowledge with that of scientists involves more than providing fishers a place and means to have their say. It also requires more than recruiting fishers to be technicians for scientists. It requires the recognition that scientists and fishers have different kinds of valid knowledge that is mediated by social-ecological contexts, which differ between the scientific and fishery communities and among fishers. The success of any initiative to integrate all knowledge forms requires that fishery workers and scientists strive to understand each others' knowledge and be willing to scrutinize and look for ways to test observations and interpretations contained in them. Scientists, especially, must understand that any input from fishers without an understanding of what shapes their knowledge could result in poor management and, over time, a return to strict reliance on scientific data. To that end, both groups need to recognize the value of each other's knowledge and its limitations and be willing to work to build a stronger knowledge in the best interests of fish resources and fisheries. Despite important steps in the right direction, this has not yet happened fully in capelin science in Newfoundland.

In contributing to this stronger knowledge base, one of the major goals of this thesis was to identify areas where future research is needed in the capelin fishery. With regard to stock structure, it is clear that any future research should take into consideration the possibility of a bay stock of capelin in Trinity Bay. Brian Nakashima, a capelin scientist, has noted that the bay stock theory will likely be addressed over the next couple of years through research on the genetic biodiversity of capelin (Nakashima, Personal Interview, June 2003). This research sounds promising and is certainly a step forward but it comes after fishing and other factors may have seriously affected the genetic biodiversity of capelin. Scientists may want to consider partnering with fishers to document more systematically than was possible in this thesis their observations relevant to bay stocks. This research should be undertaken with an understanding of how factors such as age, location and gear type can mediate fishers' knowledge.

With regard to capelin abundance, scientists are now questioning the validity of some of the indices of abundance addressed in this thesis. For example, scientists are now exploring whether catch rates can be considered a reliable estimate of abundance given the multitude of changes that have taken place in the capelin fishery since the 1980s. In particular, scientists are concerned about the effects that a shortened fishery season may have had on catch rates and, of course, the opening of the fishery, which is determined solely by market demand. In addition to these factors, this research suggests additional factors that may also be influencing catch rates including changes in gear and efficiency such as increased trap size and changes in trap design. All of these factors should be taken into consideration when examining the validity of catch rates. Scientists are also exploring the results from aerial surveys. Based on information from fishers, which indicate that abundance might have been changing at different rates within the bays versus the headlands, scientists are now trying to determine whether the aerial survey has ever adequately reflected what had been happening with the stock in the area (DFO, 1998b).

It is clear that there is a lack of scientific data related to cod bycatch in the capelin trap and purse seine fisheries. Existing studies are old, and current initiatives such as the logbook data designed to capture the amount of bycatch may not be capturing an accurate picture of the extent and implications of cod bycatch in the capelin fishery. This research should be carried out with fishers because they have particular knowledge about where cod bycatch is more prevalent. In a framework of co-management, fishers could also be responsible for identifying juvenile cod nurseries and implementing management plans protecting these areas from future fishing.

Dumping also appears to be a misunderstood practice in the capelin fishery, which raises serious questions about abundance estimates over the last ten to fifteen years. If unrecorded dumping has occurred at the rates which fishers have implied, then catch rate data and landings data may have seriously underrepresented the amount of capelin removed from the overall biomass. Given that scientists are now reviewing these indices, the impact of dumping has to be explored.

Another area in need of research is cod-capelin interactions, particularly the relationship between capelin and cod in times of stock decline. Though this topic was not discussed in this thesis, fishers discussed this issue quite a bit and expressed concerns over the relationship between cod and capelin. Evidence suggests that capelin play a vital role in the onshore migration of cod (DFO, 1991). However, there have not been many opportunities, except in recent years, to study the effects of capelin on cod in times of stock decline. Unfortunately, science is now met with decreased funding and a related inability to study an important relationship in the fisheries ecosystem.

9.4 Recommendations for Future Fisheries Policy

Given recent problems in the fisheries, researchers have criticized DFO's approach to managing fisheries on a large-scale basis using a numbers based approach

(Neis and Morris, 2002, Pinkerton, 1994). Some researchers have argued for a co-management approach to fisheries management, which operates at the community and regional levels (Neis and Morris, 2002). Community based co-management involves a significant shift of decision-making power from central government to local communities where fishers, processors and the communities in which they live and work, all have a role to play in the management of the resource (Hipwell, 1994). Community based co-management generally requires a clear delegation of power from the federal government to communities, criteria for membership, the institution of a management board at both the community and regional levels, fair and equitable resource sharing, financial resources, and the recognition and incorporation of fishers' knowledge in the assessment process (Neis and Morris, 2002, Hipwell, 1998; Pinkerton, 1994).

The role of fishers' knowledge in community based co-management frameworks will likely depend on the fishery that is being managed and the fish stocks that are being harvested. However, it is unlikely that co-management can exist without some form of integration of fishers' and scientists' knowledge. Equally, it is unlikely that projects that integrate insights from fishers' knowledge in the absence of co-management frameworks will prove successful in the long run. What is needed then is support at the policy level for a community based co-management framework that treats fishers' knowledge as equal to scientists' knowledge in the assessment of fish stocks. Thus being able to exert control over how their knowledge is collected and used in the assessment process will be fundamental to fishers. Projects where fishers are treated only as information gathers, as opposed to being involved in the design of the project, the methodology, the data collection process, analysis, and production of results, should be avoided.

The extent to which fishers are involved in the assessment process should also be addressed at the fisheries policy level. Every effort should be made to include fishers in the process as much as possible. However, this will depend on the species being harvested and the makeup of the fishery. A fishery that harvests different stocks of the same species or employs multiple gears may prove difficult for projects that employ fishers' in the assessment process. Further, the role of scientists in community-based co-management frameworks needs to be explored. For fisheries that harvest stocks that are more local, such as lobster, the role for scientists may not be as extensive as in other fisheries. The capelin fishery is one example where fishers and scientists should work together in the assessment process. With scientists focusing on the assessment process at a much more macro level, fishers could be in charge of assessing stocks at the community level. Certainly, more research would be needed in this area before any co-management structures are put into place.

Future fisheries policy should also address the role of other partners in the assessment process. This research, in particular, has demonstrated the role that social scientists can play in projects that integrate insights from fishers' and scientists' knowledge. Social scientists, unlike natural scientists, are trained to work with the more qualitative form of fishers' knowledge and can ensure that such knowledge is properly understood and analyzed. Social scientists are also more trained to deal with cultural sensitivities associated with fishers' knowledge and can help develop a language which all parties can subscribe to. More importantly, social scientists can develop a methodology, such as that utilized in this thesis, for collecting, analyzing and integrating fishers' and scientists' knowledge.

In the absence of community-based co-management frameworks, fisheries policy has to be developed to support the integration of fishers and their knowledge in the science and management of fisheries. This is essential at a time when scientific research is being cutback and fisheries are dying. Further, fishers and scientists need to be supplied with the tools and funding to initiate these programs and explore the ways in which these knowledge forms can be combined to produce a more collaborative approach to assessing and managing fisheries.

9.5 Epilogue

Several years have passed since the data for this thesis were collected. However, the uncertainty associated with the capelin stocks and fishery during that time has not changed. In fact, it can be argued that there is more uncertainty now than ever before. Since 1998, the fishery has continued but at a much smaller scale. To illustrate, landings data for the Division 2J3KL show that in most years since 1998, fishers have harvested significantly less capelin than the quota allowed for. In 1999, about 52% of the 35000 tonne quota was harvested, while in 2000 only 46% of the 35,580 tonne quota was harvested. During 2000 only 30 fishers out of 142 who sent logbooks to DFO actually fished, suggesting low participation rates (DFO, 2001). In the annual telephone surveys since 1998, fishers have continued to express similar concerns to those noted in this thesis and reiterated the need to close the fishery. This year, there has been a 40% reduction in the capelin fishery on Newfoundland's northeast coast, which has been deemed a conservation measure to help the cod stocks rebuild.

The science of capelin is also in a state of uncertainty. Throughout the late 1990s, low estimates of offshore abundance continued while inshore indices of abundance indicated relatively stable, high abundances of capelin during the same period (Carscadden and Nakashima, 1997; Frank et al., 1996). The scientific consensus is that environmental conditions produced changes in capelin biology and behaviour, affecting the accuracy of offshore acoustic estimates and resulting in an underestimation of true offshore capelin abundance (Carscadden et al., 2001; DFO, 2001; Carscadden and Nakashima, 1997; Carscadden et al., 1997; Nakashima, 1996a; Carscadden et al., 1994). Data collected from fishers during phone interviews throughout this period and into the early 2000's through the telephone survey have not supported DFO's inshore estimates. The consensus has been that abundance levels are below those that existed when they first started fishing, suggesting a need to close the fishery (DFO, 2001; Nakashima, 1996b). Due to the inconsistencies between the inshore and offshore indices, abundance has not been estimated since the early 1990s (DFO, 1998; DFO, 1996,) and year class estimates have not been estimated since 2001. As a result there has been great uncertainty around capelin and the fishery in the last few years.

On a broader scale, the fishing industry in Newfoundland has seen little improvement in the last ten years. In the spring of this year, DFO announced the closure of the cod fishery in the Gulf of St. Lawrence and northeast of Newfoundland and Labrador. Scientific estimates determined that the cod stocks in these areas were at historic lows and showed no signs of recovery despite conservation measures since the cod moratorium in 1992. In response, the government has pledged $50 million to assist individuals and communities affected by the closure as well as expand scientific research into the impact that seals may be having on the decline of the cod stocks. Scientific research will also focus on the relationship between the cod and capelin and whether declining capelin stocks is having any impact on the rejuvenation of cod stocks.

This additional funding to try to understand the interspecies relationship between cod, capelin and seals emphasizes that DFO science shows relatively little understanding of what has been happening with fish stocks in Newfoundland. This certainly comes as no surprise given that fisheries research throughout the world indicates a down turn in the world's fish stocks with relatively little understanding of what is happening. As noted in the introductory chapter of this thesis, the FAO states that 75% of the world's fish resources are nearly or already depleted (FAO, 2002).

Given this rising uncertainty with the world's oceans resources, it is clear that the science based fisheries management process is no longer adequate to address the changes that are currently happening. As such, the current fisheries policy formation process has to allow room for more involvement of fishers in the assessment of fish stocks and in the management of fisheries. Fishers involved in the assessment and management process at the community level can inform the science process and also work within a community based co-management framework to manage fisheries. As partners with scientists, in particular, fishers could inform assessment processes at the local level and contribute to assessment at a more macro level. Given resource cuts, especially in the capelin fishery, at a time of rising uncertainty, fishers' involvement in the assessment process at the local level is essential. It also makes common sense. More importantly, will be the process by which insights from fishers' knowledge is integrated with scientists' knowledge. Any effort to integrate fishers' and scientists knowledge must account for and understand the social-ecological character of both fishers' and scientists' knowledge. Without this understanding any integration can lead to the improper use of insights from these types of knowledge and to a tendency to dismiss one or the other type of knowledge. Given the crisis with the world's fish resources, this is not a mistake that we can afford to make.

References

Babbie, E. 1989. The Practice of Social Research, 5th ed. Belmont, California: Wadsworth.

Berkes, F. 1993. Traditional ecological knowledge in perspective. In J.T. Inglis (eds.), Traditional Ecological Knowledge: Concepts And Cases. Ottawa: The International Program on Ecological Knowledge.

Berkes, F. 1999. Sacred Ecology: Traditional Ecological Knowledge And Resource Management. Philadelphia: Taylor and Francis.

Berkes, F., and C. Folke. 1998. Linking Social And Ecological Systems: Management Practices And Social Mechanisms For Building Resilience. Cambridge: Cambridge University Press.

Bielawski, E. 1992. Indigenous knowledge and science in the arctic. Northern Perspectives 20, 5-8.

Canadian Council of Professional Fish Harvesters. 1998. Creating New Wealth From The Sea: Policy Alternatives For An Economically, Ecologically And Socially Sustainable Fishery. Ottawa: CCPFH.

Carscadden, J., and B. Nakashima. 1997. Abundance and changes in distribution, biology, and behaviour of capelin in response to cooler waters of the 1990s. In Proceedings: Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program. AK-SG-97-0.

Carscadden, J., B. Nakashima, and K.T. Frank. 1997. Effects of fish length and temperature on the timing of peak spawning in capelin (*Mallotus villosus*). Canadian Journal of Fisheries and Aquatic Sciences 54, 781-787.

Carscadden, J., B. Nakashima, and D.S. Miller. 1994. An evaluation of trends in abundance of capelin (*Mallotus villosus*) from acoustics, aerial surveys and catch rates in NAFO Division 3L, 1982-1989. Journal of Northwest Atlantic Fishery Science, 17, 45-57.

Carscadden, J.E., K.T. Frank, and W.C. Leggett. 2001. Ecosystem changes and the effects on capelin (*Mallotus villosus*), a major forage species. Canadian Journal of Fisheries and Aquatic Sciences 58, 73-85.

CIDA. 1998. Strategy for Ocean Management and Development. Ottawa: Government of Canada.

Department of Fisheries and Oceans. 1983. The 1983 Capelin Fishery. St. John's: Resource Management Division of Newfoundland Region.

Department of Fisheries and Oceans. 1984. Report on the 1984 Capelin Fishery. St. John's: Resource Management Division of Newfoundland Region.

Department of Fisheries and Oceans. 1985. Report on the 1985 Capelin Fishery. St. John's: Resource Management Division of Newfoundland Region.

Department of Fisheries and Oceans. 1986. 1986 Capelin Fishing Plan: Newfoundland Region. St. John's: Department of Fisheries and Oceans.

Department of Fisheries and Oceans. 1987-1999. Fisheries and Oceans Statistical Services Landings and International Trade Reports. DFO Website: www.dfo.mpo.gc.ca.

Department of Fisheries and Oceans. 1989. The Potential For Producing Capelin Roe in Newfoundland and Labrador For Sale In World Markets. St. John's: Department of Fisheries and Oceans.

Department of Fisheries and Oceans. 1991. The Science of Capelin: A Variable Resource. St. John's: Department of Fisheries and Oceans.

Department of Fisheries and Oceans. 1996. Capelin in SA2 and Division 3KL. DFO Atlantic Fisheries Document 96/90.

Department of Fisheries and Oceans. 1997. Capelin in SA2 and Division 3KL. DFO Canadian Stock Assessment Secretariat Research Document 97/29.

Department of Fisheries and Oceans. 1998a. Stock Status Report B4-03. St. John's: Department of Fisheries and Oceans.

Department of Fisheries and Oceans. 1998b. Capelin in Subarea 2 and Division 3KL. DFO Canadian Stock Assessment Secretariat Research Document 98/63.

Department of Fisheries and Oceans. 1999. Capelin in SA2 and Division 3KL. DFO Canadian Stock Assessment Secretariat Research Document 99/206.

Department of Fisheries and Oceans. 2000. Stock Status Report B2-02. St. John's: Department of Fisheries and Oceans.

Department of Fisheries and Oceans. 2001. Stock Status Report B2-02. St. John's: Department of Fisheries and Oceans.

Dewalt, Billie R. 1994. Using indigenous knowledge to improve agriculture and natural resource management. Human Organization 53(2), 123-131.

Dodson, Julian J., J.E. Carscadden, L. Bernatchez, and F. Colombani. 1991. Relationship between spawning mode and phylogeographic structure in mitochondrial DNA of North Atlantic capelin *Mallotus villosus*. Marine Ecology Program Series 76, 103-113.

Editorial. Evening Telegram. 8 July 1994.

Evans, G.T., and B.S. Nakashima. 2001. Trends in yearclass strength of capelin (*Mallotus villosus).* Capelin in SA2 and Division 3KL. Canadian Science Advisory Secretariat Research Document 2001/161, 183-199.

FAO Fisheries Department. 1997. Review of the State of World Fishery Resources: Marine Fisheries. FAO Fisheries Circular No. 920 FIRM/C920.

FAO Fisheries Department. 2002. Review of the State of World Fishery Resources: Marine Fisheries. Rome: FAO.

Felt, L. 1994. Two tales of a fish: the social construction of indigenous knowledge among Atlantic Canadian salmon fishers. In Christopher Dyer and James McGoodwin (eds.), Folk Management in the World's Fisheries: Lessons for Modern Fisheries Management. Colorado: University Press of Colorado.

Fenge, T. 1997. Ecological change in Hudson Bay bioregion: A traditional ecological knowledge perspective. Northern Perspectives 25, 1.

Finlayson, C.A. 1994. Fishing for Truth: A Sociological Analysis of Northern Cod Stock Assessments From 1977-1990. St. John's: ISER Books.

Finlayson, C., and B McCay. 1998. Crossing the threshold of ecosystem resilience: the commercial extinction of northern cod. In Fikret Berkes and Carl Folke (eds.), Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge: Cambridge University Press.

Fisheries Resource Conservation Council. 1994. Conservation Aspects of Groundfish Gear Technologies in Eastern Canada. Ottawa: Government of Canada.

Fisheries Resource Conservation Council, 2003. FRCC Website: www.frcc-ccrh.ca.

Forman, S. 1970. The Raft Fishermen: Tradition and Change in the Brazilian Peasant Economy. Bloomington: Indiana University Press.

Frank, K.T., J.E. Carscadden, and J.E. Simon. 1996. Recent excursions of capelin (*Mallotus villosus*) to the Scotian shelf and Flemish cap during anomalous hydrographic conditions. Canadian Journal of Fisheries and Aquatic Sciences 53(7), 1473-1486.

Frank, T.F., and D. Brickman. 2000. Allee effects and compensatory population dynamics within a stock complex. Canadian Journal of Fisheries and Aquatic Sciences 57, 513-517.

Goldenburg, S. 1992. Thinking Methodologically. New York: Harper Collins Publishers Inc.

Hacking, Ian. 1999. The Social Construction of What. Cambridge: Harvard University Press.

Hipwell, B. 1998. Integrating Local and Traditional Ecological Knowledge Into Fisheries Management in Canada. Ottawa: DFO.

Howes, M., and R. Chambers. 1980. Indigenous technical knowledge: analysis, implications, and issues. In David Brokensha, D.M. Warren and Oswald Werner (eds.), Indigenous Knowledge Systems and Development. Washington: University Press of America.

Huntington, H. P., and N. Mymrin. 1999. Traditional Ecological Knowledge of Beluga Whales: An Indigenous Knowledge Pilot Project in the Vchukchi and Northern Bering Seas. Alaska: Inuit Circumpolar Conference.

Hutchings, J.A. 1996. Spatial and temporal variation in the density of northern cod and a review of hypotheses for the stock's collapse. Canadian Journal of Fisheries and Aquatic Sciences 53, 943-962.

Hutchings, J.A., and R. A. Myers. 1994. What can be learned from the collapse of a renewable resource? Atlantic cod, *Gadus morhua*, of Newfoundland and Labrador. Canadian Journal of Fisheries and Aquatics Sciences 51, 2126-2146.

Hutchings, J.A., and M. Ferguson. 2000. Links between fishers' knowledge, fisheries science and management: Newfoundland's inshore fishery for northern Atlantic cod, *Gadus morhua*. In Barbara Neis and Lawrence Felt (eds.), Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management. St. John's: ISER Books

Hutching, J. A., C. Walters, and R. L. Haedrich. 1997. Is scientific inquiry incompatible with government information control? Canadian Journal of Fisheries and Aquatic Sciences 54, 1998-1210.

Jangaard, P.M. 1974. The Capelin (*Mallotus villosus*): Biology, Distribution, Exploitation, Utilization, and Composition. Bulletin 186. Halifax: Department of the Environment Fisheries and Marine Service Atlantic Regional Office (Research).

Johannes, R.E. 1981. Words of the Lagoon: Fishing and Marine More in the Palau District of Micronesia. Berkeley: University of California Press.

Johnson, M. 1992. Lore: Capturing Traditional Environmental Knowledge. NWT: Dene Cultural Institute and International Development Research Centre.

Kearney, J.F., J.D. Neilson, and F. Page. 1994. Cooperative Science as a Critical Component of Co-management: The Role of Fish Harvesters in Fisheries Sciences. Presented at Improving the Link between Fisheries Science and Management: Biological, Social, and Economic Considerations, 82nd Statutory Meeting of the International Council for the Exploration of the Seas, St. John's, Newfoundland, Canada, September 22-30, 1994.

Kloppenburg, J. Jr. 1991. Social theory and the de/reconstruction of agricultural science: local knowledge for an alternative science. Rural Sociology 56 (4), 519-548.

Lawson, T. 1996. Developments in economics realist theory. Review of Social Theory 4 (Winter 1996), 405-422.

Mackinson, S. and L. Nottestad. 1998. Combining local and scientific knowledge. Reviews In Fish Biology and Fisheries 8, 481-490.

Mailhot, José, 1993. Traditional Ecological Knowledge: The Diversity of Knowledge Systems and Their Study. Montreal: The Great Whale Public Review Support Office.

Martin, Cabot, 1998. "Can't Count on Capelin...." Evening Telegram. 2 August 1998.

Massaro, M., J.W., Chardine, I.L. Jones, and G.J. Robertson. 2000. Delayed capelin (Mallotus villosus) availability influences predatory behaviour of large gulls on black-legged kittiwakes (Rissa tridactyla), causing a reduction in kittiwake breeding success. Canadian Journal of Zoology 78, 1588-1596.

Mayne, B. 1999. Personal Interview. February 1999.

Molnar, J. J., P.A. Duffy, K.A. Cummins, and E. Van Santen. 1992. Agricultural science and agricultural counterculture: paradigms in search of a future. Rural Sociology 57:1 (Spring 1992), 83-91.

Murdoch, J., and Judy Clarke. 1994. Sustainable development. Geoforum 25 (2), 115-132.

Myers, R.A., and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. Nature 423, 280-283.

Nakashima, B. 1998. Personal Interview. December 1998.

Nakashima, B. 1998. Relative Multiplicative Trends in Biomass, Cohort Abundance and Recruitment of Capelin (*Mallotus villosus*). Capelin in SA2 and Division 3KL. Canadian Stock Assessment Secretariat Research Document 98/63.

Nakashima, B. 2003. Personal Interview. June 2003.

Nakashima, B.S. 1984. Collection and Interpretation of Catch and Effort Data from the Division 3L Inshore Capelin Fishery. Canadian Atlantic Fisheries Scientific Advisory Committee Research Document 84/24.

Nakashima, B.S. 1992. Patterns in coastal migration and stock structure of capelin (*Mallotus villosus*). Canadian Journal of Fisheries and Aquatics Sciences 49(11), 2423-2429.

Nakashima, B.S. 1995. Results of a Telephone Survey of 1994 Fixed Gear Capelin License Holders. Capelin in SA2 + Div. 3KL. DFO Atlantic Fisheries Research Document 95/70.

Nakashima, B.S. 1996a. Results of a Telephone Survey of 1995 Fixed Gear Capelin License Holders. Capelin in SA2 + Div. 3KL. DFO Atlantic Fisheries Research Document 96/90.

Nakashima, B. S. 1996b. The relationship between oceanographic conditions in the 1990s and changes in spawning behaviour, growth and early life history of capelin (*Mallotus villosus*). NAFO Science Council Studies 24, 55-68.

Nakashima, B.S. 1997. Results of a Telephone Survey of 1996 Fixed Gear Capelin License Holders. Capelin in SA2 and Division 3KL. DFO Canadian Stock Assessment Secretariat Research Document 97/29.

Nakashima, B.S., and B.W. Slaney. 1998. The 1997 Inshore Capelin (*Mallotus villosus*) Fishery in NAFO Div. 3KL. St. Johns: Department of Fisheries and Oceans.

Nakashima, B.S., and G.H. Winters. 1997. Multiplicative Trends of Biomass, Cohort Abundance, and Recruitment of Capelin. Canadian Stock Assessment Secretariat Research Document 97/29.

Nakashima, B.S. and R. Harnum. 1989. The 1988 Inshore Capelin Fishery in Division 3K. Canadian Atlantic Fisheries Scientific Advisory Committee Research Document 89/23.

Nakashima, D. 1990. Application of Native Knowledge in EIA: Inuit, Eiders and Hudson Bay Oil. A Report Prepared for the Canadian Environmental Assessment Research Council.

Neis, B. 1992. Fishers ecological knowledge and stock assessment in Newfoundland. Newfoundland Studies 8(2), 155-178.

Neis, B., and L. Felt. 1995. Fisheries Science and Local Ecological Knowledge in the Northwest Atlantic: Building Bridges. Prepared for the Japan-Canada Conference, St. Francis Xavier University, Antigonish, Nova Scotia.

Neis, B., and L. Felt. 2000. Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management. St. John's: ISER Books.

Neis, B., and M. Morris. 2000. Creative, ecosystem and distributive justice and Newfoundland's capelin fisheries. In Harold Coward, Rosemary Ommer and Tony Pitcher (eds.), Just Fish: Ethics and Canadian Marine Fisheries. St. John's: ISER Books.

Neis, B., and M. Morris. 2002. Fishers' ecological knowledge and fisheries science: capelin (*mallotus villosus*) and capelin fixed gear fisheries in the Bonavista-Trinity region of Newfoundland, 1975-1996. In Rosemary Ommer (eds.), Resilient Outports. St. John's: ISER Books.

Neis, B., D.C. Schneider, L. Felt, R.L. Haedrich, J. Fischer, and J.A. Hutchings. 1999a. Fisheries assessment: what can be learned from interviewing resource users? Canadian Journal of Fisheries and Aquatic Sciences 56, 1949-1963.

Neis, B., L. Felt, R. Haedrich, and D. Schneider. 1999b. An interdisciplinary methodology for collecting and integrating fishers' ecological knowledge into resource management. In Diane Newell and Rosemary Ommer, eds., Fishing Places, Fishing Lives. Toronto: University of Toronto. Press.

New, Caroline. 1995. Sociology and the case for realism. Sociological Review 43(4), 808-827.

O'Brien, J.P., M.D. Bishop, K.S. Regular, F.A. Bowdring, and T.C. Anderson. 1998. Community Based Coastal Resource Inventories in Newfoundland and Labrador: Procedures Manual. St: John's: Fisheries and Oceans.

Ommer, R. 2002. Resilient Outports. St. John's: ISER Books.

Palmer, C.T., and P. R. Sinclair. 1996. Perceptions of a fishery in crisis: dragger skippers on the gulf of St. Lawrence cod moratorium. Society and Natural Resources 9, 267-279.

Palsson, Gisli, 1995. Practical Science and Scientific Practice in the Historical Ecology of Icelandic Fishing. Paper presented at the conference Marine Resources and Human Societies in the North Atlantic Since 1500. October 20-22, 1995, St. John's Newfoundland.

Pinch, T. 1986. Confronting Nature: The Sociology of Solar-Neutrino Detection. Boston: D. Riedel Publishing Company.

Pinkerton, E.W. 1994. Local fisheries co-management: A review of international experiences and their implications for salmon management in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 54, 187-199.

Pinkerton, E. and M. Weinstein. 1995. Fisheries That Work: Sustainability Through Community Based Management. A Report to The David Suzuki Foundation. Vancouver: The David Suzuki Foundation.

Reed, M.I. 1997. Agency and Structure in Organizational Analysis. Organization Studies 18(1), 21-42.

Record of Proceedings. 1982. Regional Capelin Seminar. Clarenville, Newfoundland.

Stevenson, S.C., A.D. Murphy, and R.B. Stead. 1984. Report on the Cod by-catch in the 1981-1983 Newfoundland Capelin Trap Fisheries. Canadian Technical Report of Fisheries and Aquatic Sciences 1310.

Storey, G. M., W.J. Kirwin, and J.D.A.Widdowson. 1990. Dictionary of Newfoundland. 2nd ed. St. John's: Breakwater Books.

Strowbridge, L. 1990. "Hard to Please Buyers...." Sunday Express. 15 July 1990.

Templeman, W. 1948. The Life History of the Capelin (*Mallotus villosus* O.F. Muller) in Newfoundland Waters. St. John's: Bulletin of the Newfoundland Government Laboratory. 17.

Trupp, L.A. 1989. Legitimizing local knowledge: from displacement to empowerment for third world people. Agriculture and Human Values (Summer 1989), 13-24.

Wilson, D. 1999. Fisheries Science Collaborations: The Critical Role of the Community. Paper presented at the Conference on Holistic Management and The Role of Fisheries and Mariculture in the Coastal Community at Tjarno Marine Biological Laboratory, Sweden. November 1999.

Wilson, J.A., and I. Kornfield. 1998. Conference overview. In Hunt von Herbing, I.I. Kornfield, M. Tupper and J. Wilson (eds.), The Implications of Localized Fish Stocks.: Ithaca, N.Y: NRAES, 3-6.

Winters, G.H. 1970. Biological changes in coastal Capelin from the over-wintering to the spawning condition. Journal of Fisheries Research Board of Canada 27, 2215-2224.

Winters, G.H.1996. Further considerations of the age-structured multiplicative abundance model. In Capelin in SA2 and Division 3KL. DFO Atlantic Fisheries Research Documents 96/90.

The World Commission on Environment and Development. 1987. Our Common Future. Oxford: Oxford University Press.

Appendices

Appendix 1: The Interview Schedule

Hi, my name is Melanie Morris. A few years ago a team of researchers from Memorial University interviewed you. You were asked a series of questions on the fishery and your participation. At that time, they also asked you about the capelin fishery and you told us that you are or had been involved in the commercial capelin fishery at one time. I would like the opportunity to follow-up on some of these questions related to the capelin fishery. Would you be willing to participate? The interview will take about ½ an hour. When will be a good time to call. I will be asking questions about the vessels that you used in the capelin fishery, boat capacity, horsepower, length and equipment used; the gear that you used to harvest capelin, gear capacity, amount and changes in the gear you used over the year. Also, I am interested in changes in the local capelin fishery. Do you have a time when I can call back?

INTRODUCTION:

1. What year did you start fishing for capelin?
2. When did you get your license?
3. When was the last year that you fished or are you still actively involved?
4. Did you take off any years in between? If so, when? How many years did you take off?
5. When you first started fishing for capelin, can you discuss where capelin were spawning and the abundance of capelin at that time? How many beaches were capelin spawning on in your area? Can you describe the amount of spawn on the beaches? Were capelin spawning in deeper water? How deep? Was this a regular occurrence?
6. When you first started fishing how did the abundance of capelin compare to when you were younger?

BOAT 1:

1. When you first started fishing for capelin, when did the season start and when did it end?
2. What was the length of your boat when you first started capelin fishing?
3. What was the capacity of that boat? How much capelin could it carry?
4. What was your position on that boat? (Crew member, skipper)

FISHING TECHNOLOGY

1. What was the engine type and horsepower on your first boat?
2. What type of fishing technology did you have on that boat? (GPS, sounder, Loran C)

GEAR

1. What type of capelin gear did you use with your first boat?
    a. If capelin traps, how many traps did you use?
2. What type of traps did you use? Describe the design for each trap? Traditional cod trap design?
3. Were the traps converted from old squid or cod traps? Or were they newly knit?
4. What was the size of each of your traps? Length around?
5. What was the capacity of each of your traps? How much capelin could each trap hold?
6. What was the mesh size in each of your traps? In the leader, body of the trap etc.
7. How did you haul the traps? IE. mechanical hauler or by hand?
8. On average, how many times a day did you haul each trap during the peak

season?

a. <u>If capelin seines</u>, what type of seine? How many seines

b. What was the length of each seine? Beach seine-length and depth, purse seine-diameter? Mesh size?

c. How much capelin could each seine hold? What was the capacity of each seine?

d. On average, how many times a day did you haul each seine during the peak period?

GEAR LOCATION

9. Where did you place your gear? Depth and distance from shore? What area did you fish in? I.e. Trinity Bay and off of what community?

10. How did you decide where to place your gear? Did your community have a trap berth draw or did you place your capelin traps in the same place as your cod traps?

LANDINGS

1. What was your average catch per day at that time? (Or haul but try to remain consistent) Does that amount refer to sea-run or picked capelin?

BYCATCH

2. When you first started fishing for capelin in these areas, can you describe your bycatch? Species and amount?

3. What happened to the bycatch? Sold, dumped, rolled over the heads?

BOAT 2

1. When did you get your second boat? **Repeat Questions from Above**

CONCLUSION

2. Do you have any major concerns over the health of the capelin stocks?'
3. In rank order, what are your concerns?
4. Do you see these problems with the capelin as harmful to the future of the capelin stocks?