Science and Ecological Knowledge: Insight into conflicting claims concerning cod and hake predation on juvenile lobster

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Summer 2000

Introduction / Statement of issues

It is widely believed that demersal fish such as the Atlantic cod (*Gadus morhua*) and white hake (*Urophicis tenuis*) are a dominant source of natural mortality of the juvenile American lobster (*Homarus americanus*) (Fogarty 1995). Fishermen of the St. George's Bay region are particularly concerned about this phenomenon due to the elevated concentration of cod (Cameron & Mitchell 1999; FRCC 1995) and especially hake (Poirier et al.1999; FRCC 1995) in the bay relative to surrounding areas. If cod and hake are predators of lobster, a significant impact on reproduction and year class recruitment would naturally be a consequence. This would have negative consequences for landings and earnings.

Despite this widely acclaimed belief, there is little in the way of published literature to support the idea of groundfish predation on juvenile lobsters, apart from a few articles that categorically list lobster as a food source of both cod and hake (DeWolfe 1974; Powles 1958). However, in a study that evaluated cod and other potential lobster predators in the southern Gulf of St. Lawrence (including white hake), it was reported that cod could be ruled out as an important predator and that hake ate very few lobsters (Hanson and Lanteigne, 1999).

Ecological knowledge of fish harvesters, in this case, is at odds with the understandings of marine scientists. It is important to understand why this is the situation. There are two possible explanations; on the one hand the study may be flawed, on the other hand fish harvesters knowledge may be imperfect. Here I provide a discussion about fish harvesters ecological knowledge and explain how it may be linked to science in an alternative approach to fisheries management. I will also provide a summary of the background information available concerning the issue as in initial stage of resolving the problem of differing views.

My intention here is not to design or carry out a study. It is simply to provide recommendations on how to proceed in resolving the issue at hand, based on an assessment of the literature related to the subject.

Scientific literature review

Very little is known about natural mortality of lobster before recruitment into the commercial fishery. There are few published reports concerning fish predation on juvenile lobster. Most studies conducted were laboratory analyses, with only very few studies completed on fish predation in the natural habitat.
In a recent study conducted in the southern Gulf of St. Lawrence concerning fish predation on the American juvenile lobster, findings were recorded in a report by John Mark Hanson and Marc Lanteigne (2000). The study focused particularly on Atlantic cod, but also examined other possible fish predators, including white hake. This report ruled out Atlantic cod as an important predator and suggested that white hake eat very few American lobsters. The study, however, contains several difficulties as I will demonstrate in the following analysis of the document.

The report first examined abundance indices to see if there was a relationship between Atlantic cod and American lobster population abundances in the southern Gulf of St. Lawrence, over a number of years. It was concluded that, despite the apparent correspondence of abundance peaks there was no significant relationship for any time lag tested (time lags were tested for 0 to 7 years). This observation, as pointed out by the authors themselves, does not mean that cod do not eat large numbers of lobster. It simply indicates that cod do not control lobster populations (and do not compete with them for food). In addition, “Atlantic cod could respond to increased American lobster abundance and, presumably, increased availability, by consuming American lobster only when they are abundant (i.e., the 90's)” (Hanson and Lanteigne 2000; p17).

The report also examined depth distributions of fish and lobster to examine the potential availability of lobster as prey in all 4 seasons.

In the spring, according to several studies, cod prefer waters cooler than 8-100C, and thus are present in shallow waters of the lobster habitat. They tend to travel to deeper, cooler waters later in the spring, however, when temperatures exceed about 60C. It was therefore suggested that in the summer, “juvenile American lobster were not available as prey to Atlantic cod ... because the distributions did not overlap” (Hanson and Lanteigne 2000; p 18). The problem with this assumption, however, is the fact that summer research surveys did not cover water less than 10m deep where small juvenile lobsters are most commonly found (Lawton and Lavalli, 1995).

The authors justified omitting the inshore waters in their survey claiming that cod do not inhabit shallow waters less than 10 m deep as indicated by bottom trawl surveys conducted in all seasons in 1991-1993 in the Miramichi estuary area and by the fact that none were caught in gill nets that were set in water 7-20 m deep in Chaleur Bay. The authors later go on to say, however, that “...the generality of the pattern should be investigated across the entire geographic range of American lobster” because in Newfoundland waters, for example, Atlantic cod are often found at depths of 1 to 2 meters in the summer, and “...these Atlantic cod, could in principle, feed on very small American lobster” (p 19).

The article also indicates that about 90% of very small Atlantic cod (<20cm Total Length (TL)), about 40% of small Atlantic cod (20-29cm TL), and less than 5% of large cod (>50cm TL) were caught in water less than 30 m deep, where most of the American lobster population exists and thus lobster are only available to small cod. In several reports on cod diets, however, it was suggested that crustaceans are fed upon more by small cod, while larger cod tend to rely more heavily upon fish (Waiwood and Majowski 1984; Cameron and Mitchell 1999).

Hanson and Lanteigne reported that in the autumn very small Atlantic lobsters living in waters less than 10m deep were "immune to predation by any size of Atlantic cod" because their distributions do not overlap. I think the authors place too much emphasis on co-existence, however, in their assumption that lobster must forage in the same region as cod in order to be potential prey. Clearly, there would be a much higher incidence of predation occurring when the two share the same habitat, but it is also reasonable to assume that cod residing primarily in deeper waters occasionally travel inshore for the purpose of feeding, especially in times of primary prey scarcity.

Diet analysis studies were conducted during the period of 1955 -62 and 1979-82. In six studies from 1955-62, nearly 20,000 stomachs were examined and no American lobsters were found. In the three studies conducted between 1979 and 1982, about 3,000 cod stomachs were analyzed and only one American lobster was found. A possible explanation for the apparent low incidence of predation, as pointed out in the report, is that American lobster abundance was relatively low during this time, and "noticeable predation by Atlantic cod might not be expected if predation was density dependent" (p. 21). Given that cod are opportunistic species, this could very likely be the case. It is rational to assume cod would be more apt to eat lobster when there is a more abundant supply available.

In contrast, in the period of relatively high lobster abundance between 1990-1997 lobster was, again, not found to be an important part of the cod diet. Sampling was done seasonally during this period. No lobster was detected in winter because cod overwinter in deep water of the Laurentian channel (90% of cod stomachs contained no food). No lobster was found in Atlantic cod sampled during the spring (except for one fragment). During summer and autumn, a few lobster remains were detected in stomach contents. None of the fish that had eaten lobster were smaller than 50 cm TL (even though as pointed out earlier in the study, distribution of this size range and lobster did not overlap) and none of the American lobster eaten were large.

The authors suggest that "the low occurrence of American lobster in Atlantic cod stomachs can be partly explained by the low overlap in distribution." The problem with this notion, however, is that we do not know if distributions overlap more in the St. Georges Bay area than surrounding areas as was found to be the situation in Newfoundland. Local fishermen often claim to see cod near shore and also claim to frequently see lobster remains in cod gut contents. Hanson and Lanteigne suggest that another prey species that is common in the study area, Axius serratus, is often misidentified as a small lobster, especially when partially digested (Hanson and Lanteigne- unpublished study proposal).

According to another study in the Irish Sea, Norwegian lobsters are an important source of Atlantic cod diet. This implies that when a preferred food source is not as readily available, cod will replace it with something that is available. Because lobsters are relatively abundant in the St. Georges Bay region, conceivably, in the absence of a principle prey item, cod will select lobster in its place.

A more limited study on white hake diet was also conducted. Very few white hake were found to consume American lobster. The authors admit, however, that they may have underestimated white hake consumption of American lobster, because of the poor method of capture used; "white hake often regurgitated their prey if the fish was alive when brought to the surface", and because no samples were collected from fish caught in waters that were less than 20 m deep. The best sampling method to use for study purposes would be gill nets or handlining (suggested by Tom Hurlbutt- white hake specialist, DFO, Moncton). Shallow water sampling is essential because hake and lobster co-exist in shallow waters; in fact, young hake less than 15cm are found near shore in depths of about 1m (Scott and Scott, 1988). The authors also pointed out that sampling did not include spring and most of the summer months which is a very important time for sampling because lobster are most vulnerable to predation when they are molting (July to mid August). White hake occupy the same shallow waters as lobsters for much of the year also, making them highly available as predators.

Again there is little published literature on white hake diets, but according to one study, hake "prey heavily upon crustaceans as well as fish" (Kenchington, 1980). And it is also reported that fish in different locations exhibit different feeding behaviors (Cameron and Mitchell 1999).

It is clear that further evaluation of hake predation is essential in order to determine what kind of affects they may have on lobster stocks. Similarly, further assessment of cod predation is necessary in the St. Georges Bay region given the many problems that are present in the surveys.

In the future, I think a study should be conducted strictly in St. Georges Bay. This study should focus on the weaknesses of the diet study conducted by Hanson and Lanteigne. Sampling should certainly cover water depths under 10 meters close to shore as well as the deeper waters that have been sampled in this study. Timing of the sampling is of crucial importance as well; the study should certainly include spring and summer months when lobsters are molting and are most vulnerable to predation. In addition, the method of capture used should be carefully considered. I would suggest the use of both gill nets and handling techniques in this study.

Social science literature review

In contrast to the limited published scientific literature available concerning groundfish predation on lobsters, there is an overwhelming supply of published material regarding

the issue of ecological knowledge as it pertains to environmental management, particularly in the area of fisheries management.

As suggested by David Symes (1996), fishermen and those concerned with the marine environment “have more reason than most to doubt the ability of policy makers to deliver the concept of sustainable development” (p 146). He goes on to point out that governments have routinely given into social pressures, even against biological logic, by setting TAC's above scientific recommendations. In addition to this flaw in fisheries management, the reliability of stock assessments have been highly questionable as well. Each of these weaknesses in the approach to secure a sustainable resource has in part contributed to the crisis in the fisheries of recent years.

Some social scientists have criticized the exclusion of fishermen from policy-making processes, and have recommended systems of self-governance or co-management as an alternative approach to fisheries management (Jentoft 1989). What is necessary in achieving a system in which environmental management is effective and reflects the interest and values of local people is “involvement of local people in design, implementation, and monitoring of environmental management programs” (Dene Cultural Institute 1991).

Involving local people in management programs involves using the valuable ecological knowledge that they possess. There are several types of ecological knowledge, including local, traditional, and scientific. As pointed out by several academics regarding the subject, it is a very difficult concept to define (http://faculty.msvu.ca/ecoknow, 1999). I will address this issue later in the essay. For now, I will simplify the concept of fish harvester's ecological knowledge as knowledge about the natural resources of the local environment (in this case the marine ecosystem), that these people have accumulated through years of hands-on experience, direct observation, and/or knowledge that has been passed down through generations by word-of-mouth. According to Rejeanne Camirand (1999), “ethnoscience applied to fishery science allows biologists to diversify the source of information related to fisheries and take into account the knowledge of those that have experience of several years on the sea.”

An important issue concerning ecological knowledge is the question of how it can be documented in a way in which it can be implemented in management agendas. “Ethnoscience”, as indicated by Camirand (1999), “provides the methodology necessary to plan, conduct and analyze interviews.” It also functions as a way of gathering historical information about the environment that only fishermen may possess. Similarly, Maria Recchia (1999) suggested that ecological knowledge can be best used to pick out fishery-related issues or problems. Once the concerns are documented (through a series of interviews) and reveal a management problem or contradict an accepted scientific theory, a scientific study should be carried out to test the fishers' views. It is important, however, that fishers also be involved in the research design, because it is these people who are most affected by the outcomes of the studies. Unfortunately, in the past such studies have been frequently conducted without fisher's input.

David Symes (1996) recognizes that there is an imperative need for collaboration and integration of research findings among the social, economic, and biological sciences, from which must result “a more profound understanding of the fisheries crisis as well as a more enlightened approach to fisheries management” (p 151).

Assessment statement

At this point it is important to assess fishers' conceptions about cod and hake predation on juvenile lobsters and decide whether or not their concerns are valid. Based on three factors I think that local fish harvesters do have ample reason to be apprehensive. My first reason for this position sizes from the limited amount of information available and due to the fact that the reliability of this material is questionable. My second rationale pertains to the reported abundance of hake present in the St. Georges Bay relative to surrounding areas. And my third and final reason is linked to the importance of the lobster fishery in the area, both to the economy as well as to tradition in local communities.

As pointed out earlier, there have been few studies conducted in the area focusing on the diets of cod and hake. Those that have been reported on in the southern Gulf of St. Lawrence, have not been conducted thoroughly, and leave many areas of doubt and uncertainty. For this reason, I think that the subject must be further researched until the concerns of fish harvesters are addressed adequately and there no longer exists skepticism.

In 1999, according to the preliminary results from the September groundfish survey in the southern Gulf, white hake mean number per tow increased to the highest level observed since 1992. Much of the increase was due to incoming recruitment. However, the abundance of commercial size fish has increased marginally each year since 1996 as well. The main areas of concentration of white hake in 1999, according to the survey, were St. Georges Bay and the Cape Breton Trough (Poirier et al. 1999).

If higher levels of hake abundance do exist in the St. Georges Bay area relative to the rest of the Gulf region, clearly the incidence of hake eating lobster would be elevated. This is partially due to the fact that when populations increase there is a greater tendency for competition for food to exist. Based on this hypothesis, lobster in the St. Georges Bay would be more vulnerable to hake predation than would those in other areas.

On account of the importance of the lobster fishery in the St. Georges Bay area, any potential threat to the stocks is a serious matter that should be examined extensively. There are more than 400 licensed lobster fishermen fishing in St. Georges Bay. Lobster ranks number one in terms of landed value (followed by snow crab, cod, Bluefin tuna, and American Plaice). Though landings have declined slightly, landed values of lobster increased steadily in the period between 1990 and 1998. Summed across all ports in the St. Georges Bay study area during this time interval, landed value of lobster were

calculated at $138,600,000, contributing nearly 50% of landed value for the top 10 species landed (http://www.stfx.ca/research/gbayesp/ 1998).

The commercial fishery has been a primary industry of the area, with the lobster fishery acting as the backbone to the sector. The local lobster fishery has a history dating back over 100 years, and has provided a way of life and livelihood for many in the area. The industry has offered employment not only to fishermen, but also to their helpers as well as those working in fish processing plants. The traditional aspect of the lobster fishery as well as its importance to the local economy provides a further source of concern among fishermen for the protection of their stocks.

Because there exists insufficient proof that cod and hake do not eat lobster, and due to the relative abundance of hake in the area, as well as the importance of the lobster fishery, I think it is essential that further study be conducted to ensure questions be more adequately answered.

Fisheries public policy

The recent collapse of the Atlantic groundfish fishery has had major implications on the Maritime economy and the livelihood of several who relied on the resource as a way of life. “For generations fishing has been the economic and social foundation of the east coast” (Government of Canada 1995; preface). The present situation is partly a reflection of poor fisheries management of the past and emphasizes the need for alternative approaches to regulating the industry.

The Northern cod fishery had been the single most important fishery on Canada's East coast. In 1991, a year when landings were at their lowest in a decade, the fishery supported directly and indirectly some 31,000 jobs in the region. Cod at this time accounted for about half of groundfish catches (Government of Canada 1995).

In September of 1993, a moratorium was introduced to cod stocks in the southern Gulf of St. Lawrence, due to the drastic decline in landings and poor incoming recruitment (FRCC 1995). The fishery remained closed until 1999 when it was reopened for limited commercial effort. The stock continues to rebuild slowly, and will likely take several more years before it is restored to historic levels (FRCC 2000). The effects of over fishing may be generally reversible, however, the time required for the population of many marine fishes to recover appears to be considerably longer than previously believed. An important contributor to the slow recovery of the populations of species such as cod and hake, is likely a consequence of the disruption to their ecosystem and community structure as a result of over-exploitation. In addition, the collapse of a groundfish stock rarely results in the cessation of bottom-trawling activities. Consequently, fishing mortality cannot be eliminated because dwindling stocks can continue to be exploited by means of by-catch due to the low species selectivity of the fishing gear used (Hutchings 2000).

Since the moratorium, many fishermen dependent on the fishery as their main or only source of income have been forced to turn to alternative non-traditional species (skate, monkfish, and winter flounder, for example) to compensate for the loss of the important species they depended on in the past such as cod and hake. According to DFO officials, because little is known about the biology of these less traditional species, the department is applying the precautionary principle in management of their stocks, being both cautious and conservative in setting catch limits. Due to the collapse of the groundfish fishery, harvesting of shellfish such as lobster and crab has become much more important as well, consequently placing additional stress on these stocks (Government of Canada 1995).

There are several possible explanations for the drastic decline in cod abundances such as “the cold water theory” as well as other environmental changes that may have caused poor recruitment. The most widely believed explanation, however, has to do with the heavy exploitation of stocks, especially by offshore trawlers using sophisticated technology and fishing gear. This argument is especially common among inshore fishermen, who often criticize the Federal Department of Fisheries and Oceans for continually ignoring their concerns about declining stocks and smaller length classes during the 1980's and early '90s (Government of Canada 1995).

In addition to ignoring fishermen's concerns, the Department also dismissed the advice of its own scientists with respect to northern cod stocks. Stock assessments were severely flawed, significantly underestimating abundance levels for a variety of reasons. Firstly, the models used by scientists to predict supplies of stocks were quite imperfect, in that they did not account for the improvements in landings due to the improved efficiency in landing fish, made possible by use of modern vessels and equipment. Another possible explanation for the unreliability of estimations were caused by inaccurate reports by the Canadian fleet. “The fleet is believed to have harvested substantially higher volumes of fish than were reported to the Department of Fisheries and Oceans” (Government of Canada 1995; p.6).

What has resulted from DFO's inability to provide accurate assessments is a lack of trust between fish harvesters and government scientists as well as a lack of faith in DFO's ability to regulate the resource effectively.

Had the Department responded to the many warnings issued by fishermen, the severe socio-economic affects that resulted could have been avoided and the fishery could be in a much healthier state today. Quite possibly, the government felt pressured by the large, powerful corporations operating in the offshore fishery, and thus little was done to protect the stocks. Nevertheless, the current crisis stresses the need for fishermen to be more involved in decision-making, by working with scientists in assessing stocks as well as being involved in other fisheries research.

Ecological knowledge

The concept of ecological knowledge is one that has been debated over extensively in recent years. There is a growing trend toward sustainable development in which local and traditional knowledge of community members play a fundamental role in environmental management (Dene Cultural Institute 1991).
In 1995, subsequent to the collapse of the Atlantic groundfish fishery, the Standing Senate Committee on Fisheries issued a report which included several recommendations in response to the crisis. One recommendation stated as follows,

> The committee recommends that the Department of Fisheries and oceans further promote the participation of fishermen in fish stock assessments and in carrying out various fisheries research activities. In the future, the Department should recognize the value of the anecdotal knowledge of coastal fishermen (Government of Canada 1995; p.39).

Another recommendation suggested that fishermen play a greater role in decision-making through a genuine and effective system of co-management and partnership with government.

Ecological knowledge, as illustrated earlier, can be defined as knowledge of the natural resources within a local environment that has been developed over generations of careful observation and experience (Dene Cultural Institute 1991). Many critics, however, question the usefulness of such knowledge. Several questions must be addressed when dealing with this issue. It is important to understand where the so-called knowledge originated, how to identify those fishers who are most knowledgeable (on what basis are they distinguished?), and how much value fishers' knowledge may have with respect to understanding marine ecosystems as well as its contribution to achieving sustainable management.

Western science differs from ecological knowledge in that it seeks to obtain quantifiable data that test and document ideas, where ecological knowledge is generally based on accumulation of qualitative data that is not 'tested' per se. Traditional ecological knowledge is often collected through years of direct observation and is built upon experience of earlier generations and adapted to the new technological and socio-economic changes of the present (Dene Cultural Institute 1991). The qualitative data that ecological knowledge holders tend to possess involve awareness of ecological processes, species behavioral patterns, as well as spatial distribution of organisms.

Anthropologist Greg Guest (1999), examined factors that promote knowledge about local ecosystems in a study conducted in Palestina, Ecuador, involving Ecuadorian shrimp farmers. In the study, a random sample of Palestinian residents were surveyed. The survey consisted of a number of questions related to shrimp life-cycles, predator-prey relationships, species / climatic dynamics, and abiotic interactions. The resulting data was analyzed and competency scores were attached to each.

The results indicated that engagement with the natural world is a better predictor of ethno-ecological knowledge than other demographic variables tested such as age, sex, length of residence, and formal education. All factors that have been implicated in other studies as related to acquisition of and social distribution of ecological knowledge.

The research also supports the notion that engagement in the global market economy does not necessarily instigate the destruction of local knowledge in subsistence communities, as Guest suggested is generally depicted by anthropologists. On the contrary, he advises, in some cases the involvement may actually provide incentive to learn about the natural world, and as a result stimulate accumulation of ethno-ecological knowledge (Guest 1999).

“While some progress has been made toward the recognition of the value of traditional ecological knowledge among western scientists, there has been scant progress toward its effective application to environmental assessment and management” (Dene Cultural Institute 1991). There are a number of problems associated with traditional ecological knowledge that make its integration with western science difficult.

One problem is that knowledge passed down by word-of-mouth often is not properly documented consequently generating questions about its reliability. Another problem is that scientists tend to believe that traditional Ecological Knowledge lacks credibility as a source of information for environmental resource management due to its qualitative nature. Another important problem is the issue of how to arrange the best means of integrating the two systems in an effective approach to resource management. Finally, a problem with application of traditional ecological knowledge is the failure of managers to understand that this knowledge is the “property” of those who possess it and that these people are best able to apply it effectively (Dene Cultural Institute 1991).

All of these problems must be overcome before ecological knowledge systems can be combined with modern science in an alternative approach to fisheries management.

Study Objective

Now that the issues have been defined and analyzed, it is important to establish how to proceed in dealing with the fishermen's concerns about juvenile lobster mortality caused by groundfish predation. A fundamental step in this type of social research is proper documentation of fishers' ecological knowledge claims. Here, I will attempt to illustrate how this may be done effectively.

Social science can drive biological fisheries research, as discussed in the Ecological Knowledge working seminars (www.stfx.ca/research/ecoknow 1999). One of the most important ways in which this operates is that detailed ethnographic research can identify important local understandings about fish and fish behaviour that can then be tested by fisheries biologists.

Following a thorough collection of background information dealing with the issue, the next process is to begin to gather ecological knowledge of fishermen. The first step here may be to identify local experts by surveying a random sample of fishermen and asking them to identify those who they consider to be particularly knowledgeable. This method was employed in the St. Georges Bay Ecosystem project (1998). In this case telephone interviews were conducted in which lobster fishermen were asked questions about fishing histories, practices, and local knowledge about the fishing grounds, in addition to identification of local experts.

After the first survey is completed, those names mentioned most frequently may be selected for interviews. These interviews may be conducted individually or in focus groups (three or four fishermen at once, for example). In these sessions, the key is to inquire about where and when sampling should be done. Following these interviews it may be a good idea to conduct individual, more in depth interviews to in which more specific questions may be asked, to find out how often they detect lobster in the stomachs of fish, if there is a particular time of year or a particular location in which they observe the presence of lobster in gut contents more often than others. It is also essential to question them about exactly what they observe in the stomachs that lead them to identify it unmistakably as lobster as opposed to any other organism. Ask them to describe in as much detail as possible what they see (are different life stages observed, etc.?). I would recommend using charts and pictures as aids in conducting these interviews. Such items would act as useful guides, so that all parties involved have a common reference with which to refer to.

Next, it is essential to have the data properly documented for analysis. First “the information may be classified according to different subjects, then a computerized data management system could be developed to handle both the anecdotal and the summarized information” (Dene Cultural Institute 1991).

In this type of study, it is imperative to keep interviewees informed about the purpose of the research, and to ensure confidentiality where it is requested.

A quantitative study may now be designed using fishermen's knowledge. Such a study would involve collection of gut samples of groundfish to be analyzed for the presence of lobster. The key is to determine when and where sampling should take place. This information may be obtained from fishermen through the interview process.

Based on the input from fishermen as well as the background information collected, a proposal must be developed and presented to the Department of Fisheries and Oceans, in support of a request for a test permit to conduct the study. This proposal should focus on the shortcomings in the study that was conducted in the southern Gulf of St. Lawrence (Hanson and Lanteigne 2000). There is a much better chance that the request will be accepted if there is sufficient, well-documented and researched information to support the proposal.

It is essential to inform interviewed fishermen and anyone involved in the project of developments in the research, any findings that may be significant, as well as any

problems that may arise. It is also important to determine what fishers expect to gain from the research. For example, if some anticipate a reopening of the fishery as a result of the research, they may be disappointed. Even if it is proved that groundfish are a significant cause of mortality of the juvenile lobster, it may not be enough to trigger the re-opening of a fishery, especially given the cautious way in which fisheries managers operate today, i.e., with regard to the precautionary principle. It is, therefore, important to ensure false expectations are kept to a minimum while at the same time ensuring them that the time and knowledge extracted from those involved is worthwhile and is intended to benefit them in the long run.

Conclusion

To resolve the present issue of conflicting claims between resource users and resource managers, it is important to combine the knowledge of both parties in order to gain clarification efficiently and effectively. The fishermen of the St. Georges Bay, especially those with several years of experience, hold considerable knowledge about the ecosystem with which they work. It is important that these people have an extensive understanding of the local grounds, trends in species behaviors as well as interactions between species, in order for them to be successful at what they do. For this reason, these fishermen should be involved in fishery related research and their ecological knowledge should be utilized as an effective approach to fisheries management.

The steps recommended for this study are as follows:

- Select fishermen to be interviewed (those whose names were mentioned most frequently in the tier one survey).
- Focus interviews on verifying the details of fishermen's observations regarding stomach contents of cod and hake, as well as determining where and when is best to sample.
- Based on fishermen's input a study may be designed that compensates for the weaknesses pointed out in the diet analysis study by Hanson and Lantaigne.
    - sample shallow as well as deeper water
    - sample spring and summer months (molting period)
    - method of capture: handling, gill netting or both
- Present study proposal to the Department of Fisheries and Oceans in support of obtaining a test permit.
- Carry out study and document findings.

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