9 Ecosystem bill of rights

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Introduction

New information about the factors that affect the dynamics of fish populations and new policies that expand the responsibilities of managers beyond single species are changing our attitudes of how we should be stewards of ecosystems. For example, there is accumulating evidence that climate, climate change and the ocean environment affect the abundance trends of commercially important fishes[1] in a manner that we previously believed was exclusive to fishing impacts. This new information indicates that fish populations are affected by atmospheric impacts as well as by human interventions into their ocean habitats.

We also are learning that there are natural trends in abundance of fish that persist for periods, then may shift to new states.[2] Some investigators suspect that the frequency and extent of these shifts will change as the impacts of greenhouse gas accumulations are realized.[3] Thus, there is a new appreciation of the relevance of the impacts of the ocean habitat of a species when assessing the levels of catch that safely ensure that a population is not prevented from replenishing itself. In Canada, it is not only an appreciation, it is policy, entrenched in new legislation.

In Canada, the *Oceans Act*[4] and the *Species at Risk Act* (SARA)[5] are new policies that identify a requirement to consider ecosystem-based management approaches and provide protection for any species that is at a critically low abundance. It is clear from the *Oceans Act* that Canada intends to move beyond a single-species-based management approach (Table 9.1). It is true that developing an ecosystem-based management approach is difficult because fisheries are often regulated at the single species level. It is also true that it is difficult for science to determine fishing quotas using multi-species assessments because the required models are poorly developed. Perhaps our own organizations perpetuate a single-species orientation by assigning the management and research of single species to individual investigators rather than creating multi-species task teams. SARA treats all species equally and legislates protection and recovery for any species that is determined to be in need of protection (Table 9.2). In fisheries management there has been a preference for some species because of their taste or charisma and an indifference or even animosity and fear for others. A legislative requirement to protect species and stocks at risk will eventually require that there is an assessment of the impacts of fishing on associated species. It will be in the best interest of the fishing industry to ensure that by-catch, as well as targeted catch, are not overfished. Irradication fisheries, such as existed for spiny dogfish (*Squalus acanthias*) in British Columbia in the late 1950s and early 1960s[6] obviously will no longer be tolerated.

Table 9.1 Highlights from Canada's Ocean Act that relate to ecosystem-based management

1	WHEREAS Canada promotes the understanding of oceans, ocean processes, marine resources and marine ecosystems to foster the sustainable development of the oceans and their resources.
2	WHEREAS Canada holds that conservation, based on an ecosystem approach, is of fundamental importance to maintaining biological diversity and productivity in the marine environment.
3	WHEREAS Canada promotes the wide application of the precautionary approach to the conservation, management and exploitation of marine resources in order to protect these resources and preserve the marine environment.
4	WHEREAS the Minister of Fisheries and Oceans, in collaboration with other ministers, boards and agencies of the Government of Canada, with provincial and territorial governments and with affected aboriginal organizations, coastal communities and other persons and bodies, including those bodies established under land claims agreements, is encouraging the development and implementation of a national strategy for the management of estuarine, coastal and marine ecosystems.

Table 9.2 Highlights from Canada's Species at Risk Act that relate to the legislative requirement to protect species and stocks at risk

1	Create a legislative base for the scientific body that assesses the status of species at risk in Canada.
2	Prohibit the killing of extirpated, endangered or threatened species and the destruction of their residences.
3	Provide authority to prohibit the destruction of the critical habitat of a listed wildlife species anywhere in Canada.
4	Lead to automatic recovery planning and action plans through the listing of species at risk.
5	Provide emergency authority to protect species in imminent danger, including emergency authority to prohibit the destruction of the critical habitat of such species.
6	Wildlife has international value and that providing legal protection for species at risk would in part meet Canada's obligations under the United Nations Convention on Biological Diversity.

Ecosystem rights

We suggest that a logical next step is to agree that ecosystems have rights. A statement of rights is recognition that our own health and quality of life is related to the other species that share our habitat. Most humans expect that our marine ecosystem will continue to function in a manner that will sustain our fisheries and will not threaten our own well-being. All species compete for space and humans are no exception to this generalization. A statement of the rights of ecosystems does not inhibit our intervention into the habitat of other species, but it does make a commitment that we will attempt to understand the consequences of our interventions and be responsible stewards of the species that share our ecosystem. In Canada, we place great value on our Charter of Rights and Freedoms. We believe that people in other countries deserve similar rights. Canadians and others have defended these rights, sometimes with horrific consequences. An ecosystem bill of rights would be an extension of the values we hold for ourselves and a reminder that we cannot remain indifferent to the health of our environment.

We illustrate the need for responsible changes in the stewardship of marine ecosystems using two areas off Canada's west coast. One area is Bowie Seamount, located 180 kilometers west of the Queen Charlotte Islands and the other is the Strait of Georgia. Approximately 74 percent of the population of British Columbia lives close to the shores of the Strait of Georgia.[7] The Strait of Georgia is the most important rearing area for juvenile Pacific salmon and habitat for a variety of other species of commercial and charismatic importance.

Bowie Seamount is one of the shallowest seamounts in the Northeast Pacific. It rises from 3,100 meters to 25 meters below the surface where the area above 1,000 meters is approximately 120 km^2 (Figure 9.1). It is a discrete ecosystem that has a fish fauna similar to coastal ecosystems but simpler. Surprisingly, the top trophic levels are well represented, and the mid-trophic levels, such as small pelagics, appear to be reduced in diversity. Pacific halibut (*Hippoglossus stenolipis*), sablefish (*Anoplopoma fimbria*) and rougheye rockfish (*Sebastes aleutiaus*) appear to be abundant. There are 19 other species of rockfish and 29 other species of fish.[8] Fishing is permitted on the seamount, but there are no stock assessments made for any of these species.[9] There have not been any evaluations about the impacts of the permitted fishing activity on the species being fished or on any of the associated species. There is no understanding of recruitment processes for the species that are fished that extends beyond some creative speculations. There are no restrictions on halibut fishing. Any licensed fisherman can fish on the seamount and theoretically remove halibut down to the last fish. Licensed sablefish fishermen give themselves one trip per year to the seamount. There is no apparent limit to this catch, and the catch is not counted either in the individual's quota or the total annual quota. Apparently, it is believed that these sablefish are surplus to the population that is being managed. There

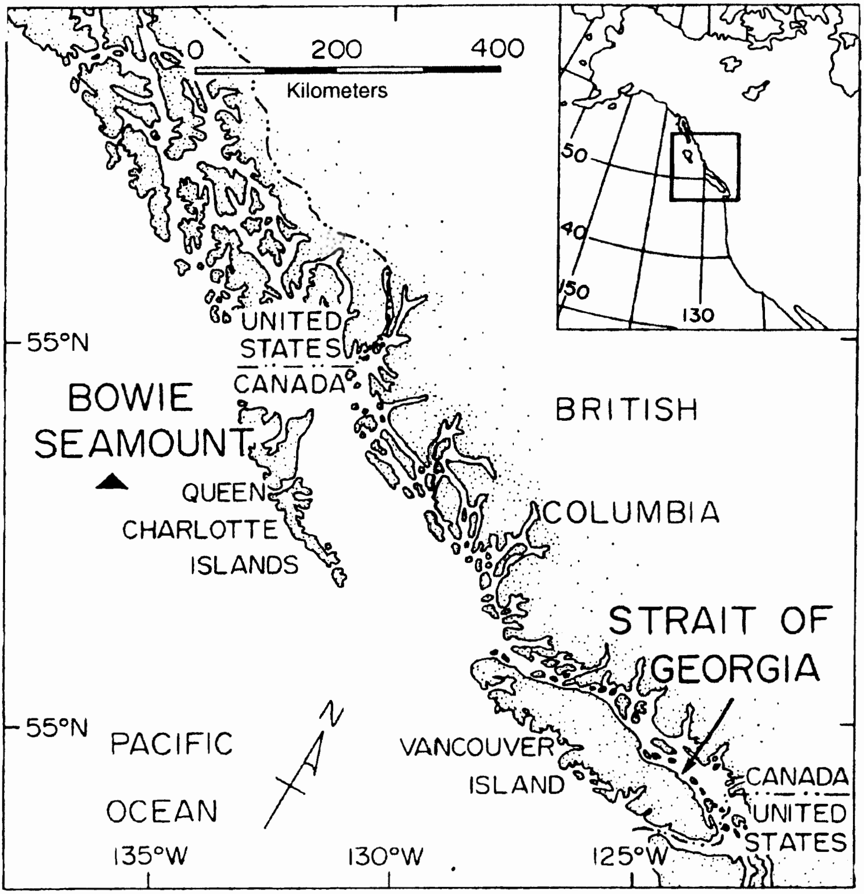

Figure 9.1 The west coast of Canada showing the location of Bowie Seamount (180 km southwest of the Queen Charlotte Islands) and the Strait of Georgia (between Vancouver Island and the mainland).

has been some research on sablefish from Bowie Seamount and it indicates that there is some continuing movement of individuals between the coastal population and the Bowie Seamount population[10] indicating that the fish on the Seamount are part of the coastal population.

Rockfish catch on Bowie Seamount is also additional to annual quotas determined for the commercial fishery. There has been some research on the rockfish stocks on the Seamount, although there are no separate assessments and the impact of the fishing on the other species has not been assessed. Fishing was regulated by special permit, sometimes referred to as an "experimental" permit. In some years the catch was large relative to the annual quota. In 1999, the catch of rougheye rockfish was about 21 percent of the total allowable catch.[11] Since 2000, rockfish have only been allowed to be caught incidentally in other fisheries.

We suggest that management of fish stocks on Bowie Seamount is an example of single species management taken to the extreme. Clearly, the aggregate of fish have been considered to be outside of the structure of the "coastal" population that must be managed in a responsible manner. Fish on the seamount have been treated as some fortuitous discovery of wealth. It has only been the economic cost of acquiring and transporting the fish that has slowed the exploitation. The individual species all live in an area less than 13 percent of the size of the city of Vancouver, but the agencies associated with the management of the particular species have never considered the impact of their decisions on the dynamics of the other species, and only recently on the ecosystem in general. The reason goes beyond the "out of sight, out of mind" nature of human behavior. Rather, the current management structure has never needed to consider Bowie Seamount as a whole ecosystem. There was no policy, no directive and apparently no interest in the impacts of the removal of animals from the top of the food chain in this small and discrete ecosystem.

Beamish and Neville (2002) constructed a model of the Bowie Seamount ecosystem using the trophic accounting model Ecopath.[12] The relationships (Figure 9.2) are based on relatively poor information and thus speculative as there has been limited study of the relationships among species. The biomass estimates and diets for key functional groups can only be considered

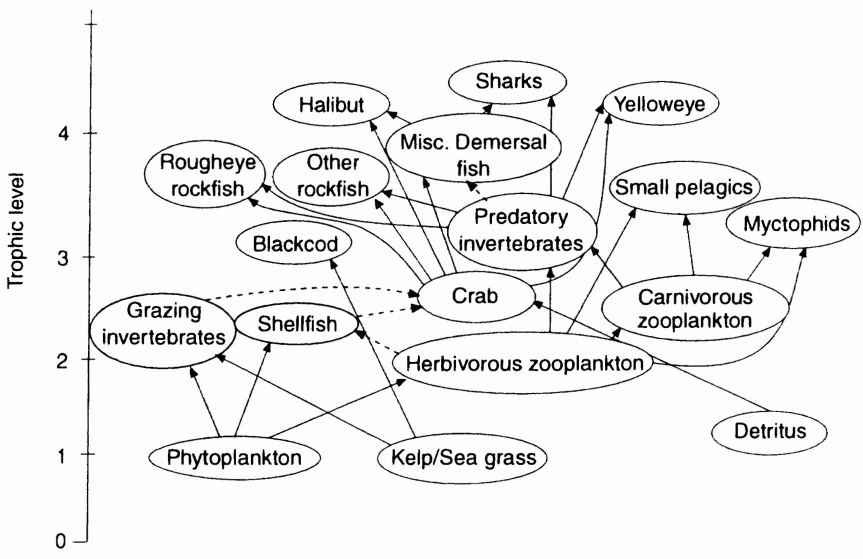

Figure 9.2 Ecopath model of major functional groups at Bowie Seamount (Beamish and Neville 2002).

"best guesses." However, there is a requirement within the ecosystem model to ensure that there is a balance between the food produced or entering the system and the consumption or export from the system. Therefore, the model provides a good starting point to examine the species relationships within the Bowie Seamount ecosystem.

It is interesting that there is an apparent lack of small pelagics in the Bowie Seamount community.[13] Beamish and Neville (2002) also identified the possible impacts of large removals of the top predators (i.e. Pacific halibut, sablefish, rougheye rockfish) in the ecosystem. Major reductions of these species, and the reduced diversity of the small pelagic community, put increased pressure on the lower trophic levels and caused imbalances in the system that could potentially last for decades due to the long life span of these predators.

It is apparent that additional studies at Bowie Seamount are essential. The most critical information includes basic diet information, biomass estimates of key species and estimates of age of the populations resident at the seamount. As this information becomes available, the ecosystem model can be modified and the understanding of the dynamics of the ecosystem at Bowie Seamount will improve.[14]

Our second marine ecosystem example is virtually the opposite of Bowie Seamount. The Strait of Georgia is located between the British Columbia mainland and Vancouver Island (Figure 9.1). It is a semi-enclosed sea[15] that supports a diverse fish fauna, including a large number of juvenile Pacific salmon during their early marine residence. Two of the major fish predators in the Strait of Georgia are lingcod (*Ophiodon elongatus*) and spiny dogfish (*Squalus acanthius*). Lingcod are overfished.[16] Oral reports of their historic abundance would indicate that they were the dominant large predator, growing to sizes of 14 kilograms in about 15 years.[17] We propose that the large reduction in lingcod abundance could have resulted in an increase in the abundance of fish in the small pelagic community. It is only speculation, but the current large abundance of seals (*Phoca vitulina*)[18] may result from the abundant prey at the small pelagic level. The seals and sea lions also feed on the resident Pacific salmon, which annoys those trying to increase their abundance through management and those trying to land a sport-caught salmon before it is eaten by a seal. There have been recent unpublished proposals by scientists and fishers to correct a perceived "trophic imbalance" by eradicating seals. We suggest that a better-managed lingcod fishery may have restricted the growth rate of the seal population by limiting prey, thus avoiding the current issue that agonizes managers, fishers and the admirers of small marine mammals. Spiny dogfish, however, have few admirers. In the late 1950s they were identified as being a nuisance.[19] Apparently this meant that they would eat the bait designed to catch more charismatic species. People were paid to kill spiny dogfish, and 11 separate eradication programs were supported by government agencies who did not know better and scientists who should have known better.

We explored the possible impact of a much larger population of lingcod on the abundance of associated species using an ecosystem model for the Strait of Georgia in 1998.[20] There are obvious difficulties with this approach, but our intent was to show that lingcod were a major predator and a major influence in the abundance of prey species.

The largest recorded commercial catch of lingcod in the Strait of Georgia occurred in 1944.[21] This catch was approximately 130 times larger than commercial hook and line catch in 1996–98.[22] This increase does not directly measure biomass, however it does indicate a large-scale change in abundance. We estimated that the biomass of lingcod in the 1940s might be at least 100 times the current biomass in our 1998 ecosystem model (Figure 9.3). We increased the biomass of lingcod 100 times and examined the impact on other species. The impacts are not dynamic as the resulting trophic level changes were not modeled. However, it is possible to show that the prey of lingcod would be dramatically affected. Obviously, the other species that consume these prey would also be affected. In the Strait of Georgia, the current dominant fish biomasses are Pacific herring, Pacific hake and aggregates of species in the small pelagic and miscellaneous demersal fishes categories. The modeled increased abundance of lingcod resulted in a significant imbalance of the model as there was no longer enough annual production from these major categories for the various predators including lingcod (Figure 9.4). This impact illustrates the important associations between lingcod and the abundance of Pacific hake and other small pelagic species. Thus, it is possible that the collapse of the lingcod population was linked to the increase in the Pacific hake population. In fact, the

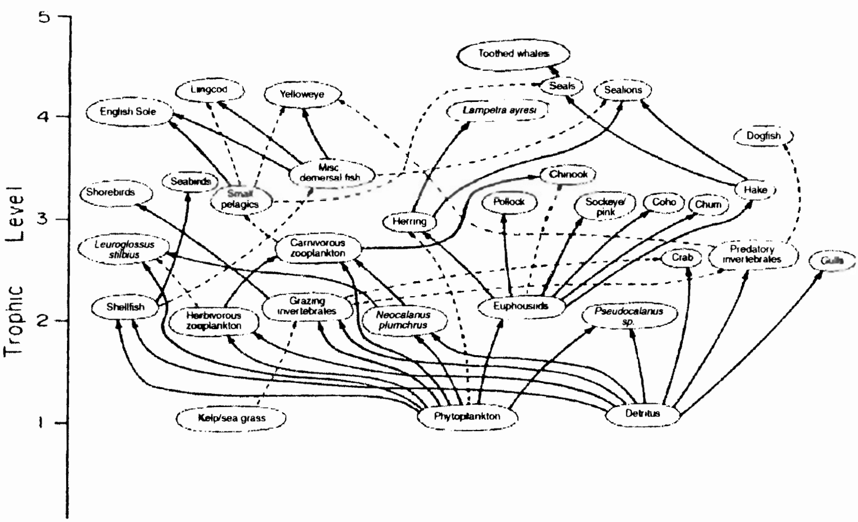

Figure 9.3 Ecopath model of major functional groups in the Strait of Georgia (Beamish *et al.* 2001).

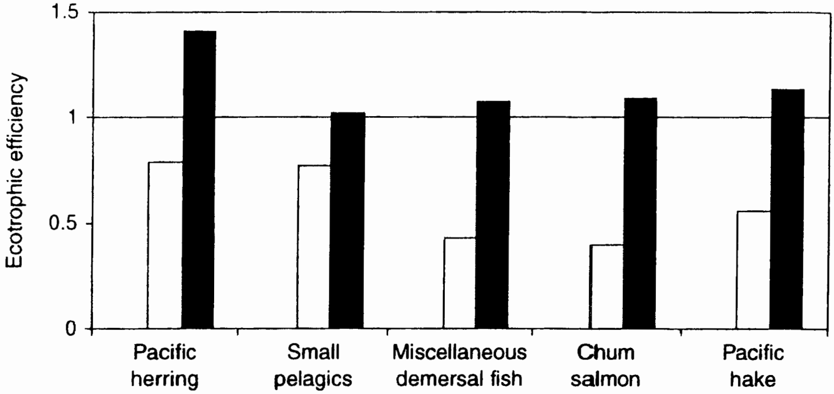

Figure 9.4 Changes in the ecotrophic efficiency of the major species or groups of species in the Strait of Georgia when lingcod abundance is increased 100 times. Ecotrophic efficiency is the proportion of annual production that is consumed or exported from the ecosystem. A value of 1 means that all of the production is lost. Values greater than 1 are theoretically not possible in the model, but for our hypothetical exercise, values greater than 1 would indicate that the population would decline.

large abundance of Pacific hake was first detected in the early 1970s, possibly indicating that abundance in the 1940s was low. Our point is that an ecosystem-based management approach would not have allowed the severe overfishing of lingcod, which increased the abundance of small pelagic fishes. According to this logic, we created the "seal problem" when we overfished lingcod.

These are only two examples of interventions into the Strait of Georgia ecosystem that were undertaken without a commitment to understand the consequences to the whole ecosystem. There are many more. Our point is that the Strait of Georgia is in the center of the human community in British Columbia. Fortunately this community values the health of their environment. However, it is difficult for people to assess the health of the Strait of Georgia ecosystem, as there are few standard procedures that can be used as evaluation criteria that are meaningful to most British Columbians. We have measures of our own health that are useful indicators of the proper relationship among the cells and systems that keep our human ecosystem functioning. Proper care of our own systems usually allows us to live out a natural life span. Identifying the criteria that promote a healthy Strait of Georgia ecosystem or a Bowie Seamount ecosystem will begin the development of ecosystem-based thinking in the general population. The requirement to do this is no longer "a nice thing to do," it is legislated. We actually have no choice but to change. Having established the *Oceans Act* and SARA, it is no longer possible to ignore the changes in the fish community that result from fishing, or other interventions into our marine ecosystems.

An ecosystem bill of rights

We propose that the following five principles, the basis for an ecosystem bill of rights, are statements that honest people can support. Honesty means that people have taken the time to evaluate the benefits and difficulties of committing to managing ecosystems. The principles are statements that recognize that change is needed. The change is in attitude, and this is the first step. We suggest that the second, third and subsequent steps will be much easier.

Principle 1: *Interventions into the dynamics of marine ecosystems occur naturally, intentionally and unintentionally. Ecosystem management must improve our understanding of these interventions and communicate the knowledge to the public.*
This first principle recognizes that ecosystems will change. It is not necessary to know in advance how specific events such as fishing will change ecosystems, but there is a commitment continually to improve our ability to understand how ecosystems respond to changes. This principle ensures that the new information is communicated to the general public. Clients must be kept informed about what we know, what we do not know, and how interpretations differ. In many cases, client information is not typical of daily news, thus innovative methods of communication need to be developed.

Principle 2: *All natural species in an ecosystem are recognized as being important to the health of the ecosystem.*
This principle is similar to the intent of SARA, which treats all species equally. Recognizing the importance of all species would not mean that we must assess the dynamics of all species. However, it would require, for example, that by-catch be managed. It would mean that we would never support eradication programs as was done in the past. Principle 2 would encourage us to begin to assess the impacts of fishing on other species. What happens when top predators such as halibut are fished? We would also want to understand how global warming impacts affect the relationship among species. Principle 2 could be viewed as a minority rights statement. We need to be stewards of spiny dogfish as well as seals and killer whales. Some may view Principle 2 as potentially restricting economic development if the principle is used to block human expansion. However, we consider that Principle 2 is a statement that the impact of our intervention needs to be evaluated; evaluation should not prevent all interventions. There is a reality that humans have babies and expand their habitat. Principle 2 requires that there is an honest evaluation of impacts when we intervene in marine ecosystems.

Principle 3: *Surplus production of some species may be available for human consumption, but estimates of surplus production must include consideration of the impact on associated species.*
This principle reflects basic fishing theory that states that natural populations produce a surplus yield that can be harvested. Some scientists[23] have

proposed that by removing production that is surplus to the production required to replenish the population, it is possible to stimulate more growth in the total population. The concept is best visualized by relating fish production to forest production. Very old trees in a forest do not grow much each year, but the amount of wood in the forest is large. Removing the old trees encourages young trees to grow and the total amount of wood produced each year becomes greater than that produced by the old trees. The removal of the old trees begins a new cycle of succession among plants. Our Principle 3 is a commitment to begin to understand how the ecosystem changes when preferred species are fished and sometimes overfished. For example, using our two marine ecosystems examples, what are the consequences of overfishing lingcod in the Strait of Georgia, or removing large numbers of the very slow-growing and long-lived rougheye rockfish from Bowie Seamount?

Principle 4: *Ecosystems must be able to re-organize naturally which may result in declines of charismatic species.*
There are natural variations in the trends of fish abundance that are large and occur quickly, and may be more important for management than fishing effects in well-managed fisheries. There is a tendency for some to believe that fish abundance will remain constant in a well-managed fishery. The belief is founded on an incorrect interpretation of early scientific theory that reported that the population dynamics of a species could be fitted to an equation that would allow calculations to be made of maximum sustainable catch. This was an exciting idea because it proposed that the correct level of catch could be determined and the stock would become more productive. Fisheries science no longer supports the idea of maximum sustainable yield, although variations of the idea are still in use. Unfortunately, there is still a mythology that good management means that the abundance of preferred species will be high. Levels lower than expectations are sometimes seen as management failures that can be corrected through large commitments of new money. Professionals willing to accept these funds are not hard to find. Principle 4 recognizes that responsible stewardship will let ecosystems change and let key species respond naturally. Principle 4 informs managers and the general public to "let it be."

Principle 5: *Humans are part of the ecosystem and will introduce change, but because of our trophic level we must be stewards of our changes.*
This is an essential principle because it acknowledges that humans compete for space like all animals and plants. However, we credit ourselves with a level of intelligence that obligates us to understand and manage our changes. As our population expands, we will displace other species. Fishing removes species and involves by-catch and possibly habitat damage. Principle 5 recognizes these impacts, but requires that the changes minimize the impact on the ecosystem. Fishing needs to be managed to minimize impact

on both the target species and associated species. Fishing must not restrict the natural ability of a stock to replenish itself. However, it is important to recognize that the term overfishing is difficult to quantify once long-term natural variability is included in the definition. If large, natural fluctuations occur over long periods of time,[24] is it possible to identify a "virgin" biomass that can be used to scale the current impacts of fishing? Implicit in this principle is an understanding that excessive fishing pressures will occur despite the best scientific support. It is logical to assume that when science has not been able to prevent excessive fishing, stewardship should be applied to promote recovery of stocks. This means that traditional knowledge that is wise is an acceptable basis for decision making. Traditional knowledge in this case is wisdom that comes from the old, the young, fishermen, Aboriginal people and local communities.

Conclusion

This ecosystem bill of rights is a first step in changing our thinking. The five principles are public commitments to understand the impacts of our society on the species that occupy our marine ecosystems. Such statements are necessary to draw the attention of humans who do not think about the large majority of fish that are not as charismatic as killer whales or Chinook salmon. The five principles are commitments to change how we think. We need to move away from single species management and we need a new reward system for professionals who learn how to work cooperatively to achieve ecosystem-based management. An essential component of our proposal is public communication, which is not a trivial task. Informing the public is a skill that recognizes that knowledge must be seen to be entertainment as well as education. In Canada, there is new legislation requiring that we begin to change, but perhaps the time has come to modernize Canada's *Fisheries Act*[25] formally to embrace ecosystem principles. This ecosystem bill of rights is a step in changing our attitude about other species in our habitat.

Notes

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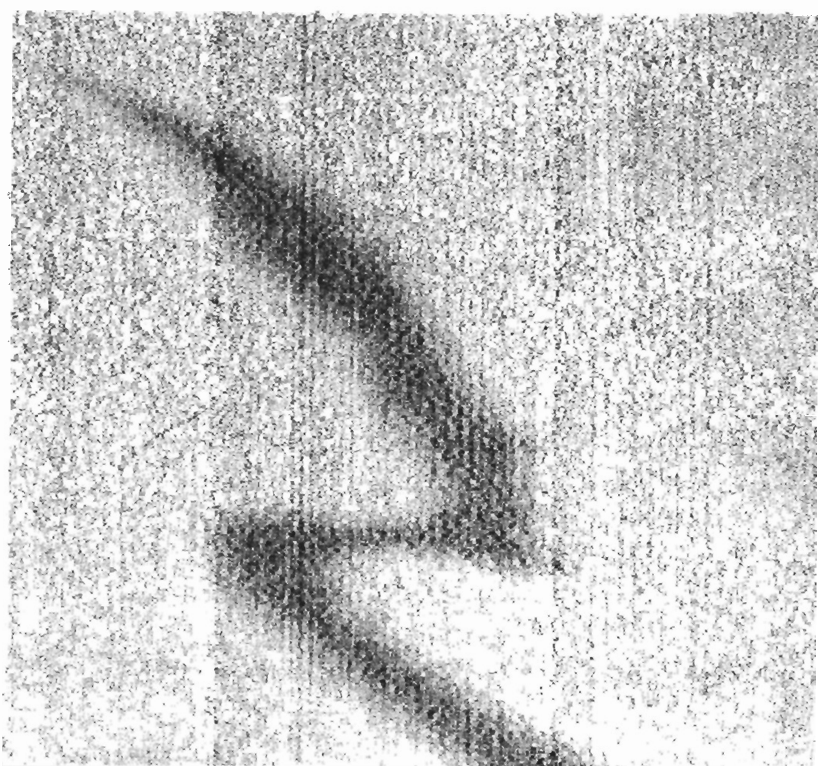

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