

12. A FRAMEWORK FOR INTEGRATED ASSESSMENT

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12.1 Introduction

The preceding chapters identified the major pathways by which changes in the global climate, coupled with other global changes, may affect people in the north and the role of the north in the world economy. Most of the links between global change and human impacts involve large cumulative uncertainties. We are doing well if we can confidently predict the direction of probable change.

The proposed approach to integrated assessment framework reflects the large uncertainties associated with the causes of ecosystem change and the intense concerns of Native peoples in the region that the Bering Sea ecosystem will continue to sustain their cultures. We can combine research, local knowledge and an adaptive approach to policy development to improve the chances that the Bering Sea ecosystem will continue to sustain Native peoples in the region and serve as an important contributor to the economies of Alaska and the nation as a whole. This chapter presents a draft framework for an approach to integrated assessment of ecosystem changes in the Bering Sea. The elements shown in the framework are discussed in some detail in the preceding chapters. The intent here is to show how the human impacts of global change are likely to result from a combination of environmental changes and human responses

The proposed approach of integrated assessment is based on the premise that we are more likely to develop sound public policies if we can distinguish between true uncertainties and the uncertainty that arises from difficulties in simultaneously taking into account multiple sources and pathways of change. An example of true uncertainty may be, for example, that we do not understand enough about ecosystem processes to relate pollock harvests to steller sea lion population changes. An example of uncertainty due multiple sources and pathways of change is how aggregate subsistence harvests of all resources will change over the next 20 years. If we can pool our understanding of the processes that we think may be affecting each type of subsistence resource, we will be better able to assess the likelihood of simultaneous decreases in multiple subsistence species.

Finally, the proposed approach reflects the limited funding currently available to support research and the application of indigenous knowledge in the Bering Sea region. We can more effectively use these dollars if we develop a common understanding of the full range of environmental changes and their potential implications for human well-being.

12.2 Major Pathways of Ecosystem Change

Dramatic declines in Steller sea lion, harbor seal, spectacled eider, and Kittiwake populations have caused Native people in the region along with scientists, environmental organizations, and wildlife managers to worry that the Bering Sea ecosystem as a whole has become unstable. The coincident growth in pollock stocks has led some people to link large pollock harvests with ecosystem changes. People are also concerned that concentration of contaminants in marine mammals may have affected their health.

During the same period that the pollock stocks expanded, however, air temperatures increased over the eastern Bering Sea, reducing the extent of sea ice. This change may have decreased the surge in primary production associated with the retreat of sea ice. We do not know the relative contributions of climate change, harvests of resources, and even the possible role of contaminants in the observed changes in the Bering Sea ecosystem. We also do not know the relative contributions of climate change and forest management practices on tree mortality due to insect outbreaks.

The costs of taking the wrong actions, or not taking the right actions, are potentially enormous. The culture, social relationships, and livelihood of Native residents in the region are inextricably bound to the region's biological. If commercial fish harvests in the region are mainly responsible for declines in marine mammal populations, for example, then failure to reduce commercial harvests may mean an end of subsistence harvest activities that form the core of Native culture and a primary basis of valued social relationships.

At the same time, commercial fishing industries annually harvest thousands of tons of pollock, salmon, herring, cod, and flounder. If declines in marine mammal populations are mainly the result of climate induced ecosystem changes, then actions to reduce commercial harvests may mean the unwarranted loss of millions of dollars to the fishing industry and to the communities which are closely tied to that industry.

Ecosystem changes in the Bering Sea region are not limited to the ocean. Large areas of ice-rich, discontinuous permafrost are subject to thawing (e.g. south side of the Seward Peninsula, see Osterkamp paper). The resulting landscape would likely be poor habitat for reindeer and caribou, both of which are important to the mixed subsistence-cash economy of the region. Reindeer and caribou populations could also be affected by a potential increase in the frequency of storms that produce icing and snow crusting conditions.

Communities themselves are subject to the effects of coastal erosion and inundation resulting from storms in the region. Understanding how changes in the frequency of such storms may change is of concern to residents, insurance companies, and agencies charged with the responsibility for maintaining the public infrastructure.

A substantial decrease in the extent of sea ice could also make marine transportation a viable option in the Arctic. The transport of petroleum products through Arctic waters introduces new opportunities and risks.

The forests of the Bering Sea region constitute another environmental change of concern. Coastal and Boreal forests are important as habitat for subsistence resources and themselves constitute commercial resources.

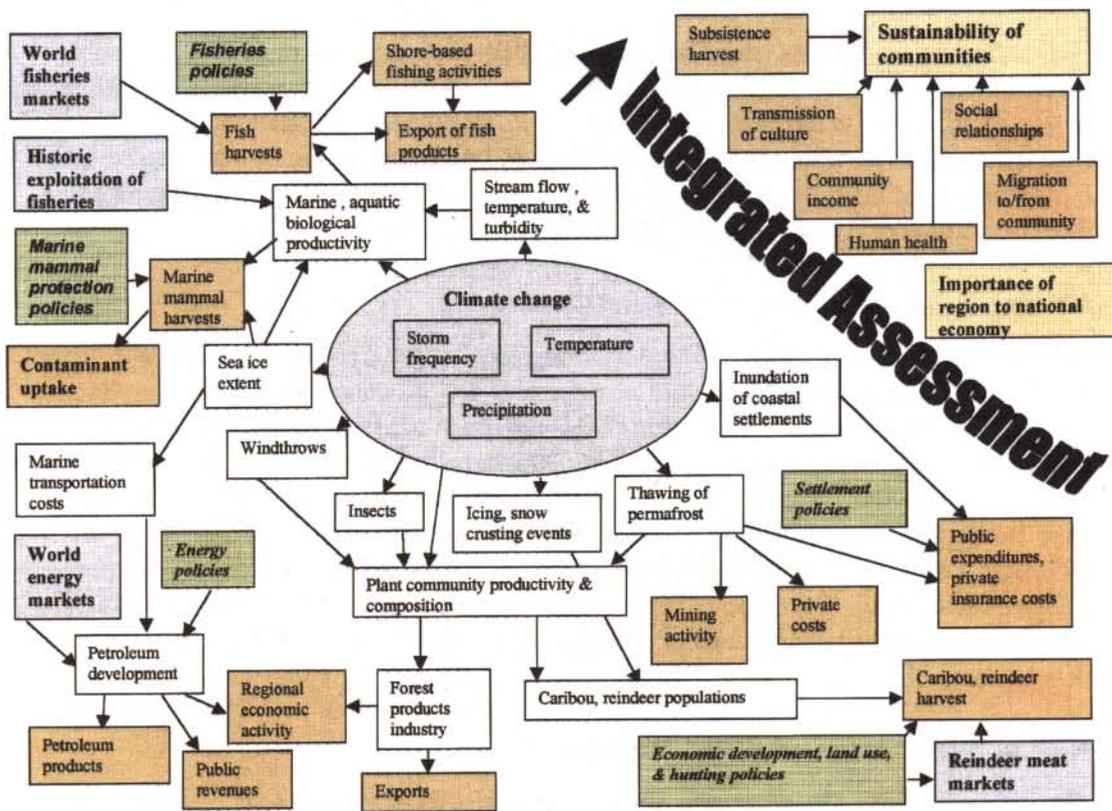
12.3 Uncertainties

We know too little about the Bering Sea ecosystem to be able to explain, much less predict, ecosystem changes. The observed changes in the ecosystem, however, are too alarming to ignore. We therefore need to devise an approach to action which both recognizes the large uncertainties and which simultaneously builds and applies knowledge of the ecosystem.

The approach suggested here distinguishes between uncertainty about a specific pathway by which ecosystem change may occur, and the cumulative uncertainty stemming from the large number of such pathways we need to take into account at the same time. We can reduce cumulative uncertainty by clearly describing each causal pathway. In particular, we need to identify how each causal pathway is related to an outcome of direct importance to people.

12.4 Integrated Assessment Framework

Figure 1 is an attempt to illustrate the pathways of major interest to an integrated assessment of ecosystem changes in the Bering Sea region. My intent is to provoke discussion. I expect, and indeed hope, that Figure 1 will substantially change as a product of discussions. I have attempted to incorporate major pathways identified by other workshop authors.



The sustainability of communities in the region and the importance of the Bering Sea region to the state and national economies are my suggestions for the two principal *targets for assessment*. I am not suggesting that all Bering Sea Impact Studies research include a human dimensions component. Rather, I am suggesting that all research have a logical connection to either the sustainability of communities in the region or to the economic importance of the region to the state and the nation (or to regional economies in the Russian Far East).

The ***drivers of ecosystem change*** (shown in bold letters) include climate, world fisheries markets, historic exploitation of fisheries, world energy markets, and reindeer meat markets. While there are additional drivers of change, my intent here is to identify the drivers most likely to interact with climate change to produce human consequences.

Policies which may affect outcomes of the ecosystem drivers are shown in Figure 1 in bold italics. Relevant policy areas include: fisheries, marine mammal protection, energy, land use, hunting, settlement, and economic development.

The ***human implications*** of ecosystem change appear as gray boxes in Figure 1. Note that nine of these human implications are directly associated with physical and natural processes: fish harvests, shore-based fishing activities, marine mammal harvests, caribou and reindeer harvests, regional petroleum economic activity, petroleum products, public revenues from petroleum production, mining activity, both public expenditures and private insurance costs as well as direct private expenditures associated with damage to human structures.

I have shown five ***dimensions of human well-being*** with gray boxes in Figure 1: subsistence harvest, transmission of culture, community income, human health, social relationships, and migration to and from the community. These six concepts are not intended to be comprehensive with respect to human well-being. I do intend them, however, to be broadly representative of the different dimensions of human well-being relevant to an integrated assessment of ecosystem changes in the Bering Sea region.

Linking Policies to Emerging Understanding

The National Academy Study of the Bering Sea Ecosystem recommended that we, “adopt an adaptive or experimental approach to management actions concerning the Bering Sea ecosystem” (NRC, 1996:4). The intent of this approach is to use actual interventions in the ecosystem on a modest scale to advance our understanding of ecosystem processes and the effects of alternative policies. Study members illustrated this approach by calling for experimentation with no-fishing zones of varying sizes around sea lion rookeries (NRC, 1996:255). Another example mentioned by the committee was to vary fishing pressure among selected areas (NRC, 1996:255). Critical to the success of an adaptive approach to management are the observations of effects of policies and feedback of this information to the development of policy.

Role of Native Knowledge and Expertise

Native hunters have a much longer and extensive history of observing ecosystem changes than do scientists. Native residents are better able to discern subtle changes in the ecosystem on a daily basis. They have ideas on possible relationships between observed changes in the ecosystem. They are in the best position to report changes in their own lives. It therefore makes sense to involve Natives in the design, conduct, and interpretation of research.

The scientists’ ideal is a joint research effort by Native experts, scientists, and managers. Many Native experts, however, would prefer to mount a parallel, but separate effort. Their experience with joint research efforts has commonly been that their expertise is judged by scientific standards to be anecdotal.

Native leaders in the Bering Sea region have formed a coalition to understand changes in the health of the ecosystem and to identify what actions can be taken to improve the health of the ecosystem (Larry Mercurief, personal communication). The Bering Sea Coalition of Native experts offers an opportunity to design separate but interactive efforts. We need an explicit, workable agreement on the process by which research priorities are set; policy alternatives developed; funding is arranged; hypothesis are generated; information is collected, organized, and shared; analyses are performed and interpretations made; results are discussed; and, how further actions are identified.

One of the impediments to interaction between the Native and scientific communities are communication links. Scientists now routinely exchange ideas and data electronically. We need to extend this technology to Native experts. An important component of the research agenda, then, is a jointly developed communications plan which: builds on ongoing communications initiatives; identifies funding to support equipment, software and connection charges; provides technical assistance; establishes a protocol for information sharing; and which identifies clear applications that are appropriate to each phase of the research and policy development process.

12.5 Next Steps in an Integrated Assessment

Native experts, along with natural, physical, and social scientists can initiate an integrated assessment by addressing the following questions:

- ◆ **Human Implications:** What are the most important potential outcomes of direct concern to people?
- ◆ **Notes:** consider both people who live in the region and effects on larger populations at the state and national levels.
- ◆ Specifying human implications does not mean that all research needs to include a human component. Rather, we all need to be clear on how each research effort can ultimately be connected to a human concern.
- ◆ Natural and physical scientists are in the best position to identify the most important direct outcomes of human concern. An example would be a decline in a species known to have commercial or subsistence value. Social scientists are in the best position to trace out the implications of such a change. They may, for example, relate changes in resource harvests to changes in living conditions and to migration decisions.
- ◆ **Drivers of Ecosystem Change:** What are the principal causes of ecosystem change?
- ◆ **Notes:** In your working group's area of interest, a driver of ecosystem change may be considered by another group to be an outcome of ecosystem change. Changes in ocean temperature, for example, may be considered an outcome by one group and may be a driver of ecosystem change by another group.
- ◆ **Pathways:** What are the principal links between each driver of ecosystem change and each human implication?

- ◆ **Notes:** The pathways shown in Figure 1 are no doubt gross simplifications of the pathways that can be drawn by experts in each area. The value of the simplified version of pathways is to establish a comprehensive framework for discussing research priorities and approaches.
- ◆ **Policies:** What current and potential policies are most likely to influence either the drivers of ecosystem change or their effects?
- ◆ **Notes:** Policies affecting the rate of increase of greenhouse gases may be considered beyond our area of expertise, but BESIS is a prime example of a regional study which is capable of illustrating the real world connections between international policies and human well-being.
- ◆ **Time Scales:** For each pathway, estimate whether people are likely to experience a significant impact in years, decades, or centuries.
- ◆ **Uncertainties:** Again for each pathway, highlight the pathway segments that are most uncertain.
- ◆ **Notes:** It would be most helpful if you can differentiate between levels of uncertainty as follows:
 - ◆ unsure that the relationship exists
 - ◆ unsure about the direction of the relationship under varying conditions
 - ◆ unsure about the magnitude of the relationship
- ◆ **Research and Local Knowledge Potential:** Again for each segment, but focusing on those segments with greatest uncertainty, can research and/or local knowledge reduce our uncertainty?
- ◆ **Notes:** If research and/or local knowledge can reduce uncertainty:
 - ◆ Who should be involved in designing the approach to reducing uncertainty?
 - ◆ What are examples of potentially viable approaches?
 - ◆ What, if any, policies might be tested in conjunction with the effort to reduce uncertainty?