Final Comments on the Science Plan for the North Pacific Research Board

Committee on a Science Plan for the North Pacific Research Board, National Research Council

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for the North Pacific Research Board
Ocean Studies Board
Polar Research Board

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Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by **Donald Siniff**, University of Minnesota. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Introduction to the North Pacific Research Board and the Purpose of this Report

The North Pacific Research Board (NPRB) was established by Congress in 1997 to recommend marine research activities to the Secretary of Commerce, using funds generated by interest earned from the Environmental Improvement and Restoration Fund. The enabling legislation requires the funds to be used to conduct research on or relating to the fisheries or marine ecosystem in the North Pacific Ocean, Bering Sea, Arctic Ocean, and related bodies of water. The NPRB has undertaken a careful process to identify its missions and goals (see Box 1).

One part of the NPRB's planning was to enlist the help of the National Research Council (NRC) to develop a comprehensive long range science plan. The assistance has been provided in two phases. In phase one, beginning in early 2003, the NRC established a committee of independent experts who worked to understand the purpose of the NPRB, gather information to help identify research needs, and provide advice on the components of a sound science plan (see Statement of Task in Appendix A). The committee's phase one activities are contained in a report released in early 2004, *Elements of a Science Plan for the North Pacific Research Board* (NRC 2004). The executive summary of the report is provided in Appendix B.

With this guidance as a tool, the NPRB staff, Science Panel, and Advisory Panel worked together to write a draft science plan that they hope will steer the program in the coming decade. Now, in a second phase of activity, the same ad hoc NRC committee has looked carefully at the NPRB's draft science plan and is providing final feedback to the NPRB. This report is the committee's reaction to the NRPB's draft science plan dated October 14, 2004. It is a focused review, generally following the organization of the NPRB document. This report is intended primarily as a direct communication from the committee to those planning the North Pacific Research Board's programs, to help them improve the science plan and ensure successful implementation. Readers seeking greater detail are encouraged to look at the committee's first, more comprehensive report (NRC, 2004), which is (available online at http://books.nap.edu/catalog/10896.html).

BOX 1
North Pacific Research Board Mission and Goals

The mission of the NPRB is to develop a comprehensive science program of the highest caliber that will provide a better understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems and their fisheries. It has identified five supporting goals to carry out this mission:

1. Improve understanding of North Pacific marine ecosystem dynamics and use of the resources;
2. Improve ability to manage and protect the healthy, sustainable fish and wildlife populations that comprise the ecologically diverse marine ecosystems of the North Pacific, and provide long-term, sustained benefits to local communities and the nation;
3. Improve ability to forecast and respond to effects of changes, through integration of various research activities, including long-term monitoring;
4. Foster cooperation with other entities conducting research and management in the North Pacific, and work toward common goals for North Pacific marine ecosystems; and
5. Support high quality projects that promise long-term results as well as those with more immediate applicability.

General Committee Comments on the NPRB Draft Science Plan

The Committee recognizes that the development of a multi-decadal science plan for the NPRB represents both a great opportunity and a great challenge. It is an opportunity to improve our understanding of the way marine ecosystems function and thereby provide better advice on sustainable resource use. It is a challenge because marine ecosystems are complex and dynamic and are therefore difficult and expensive to study, and yet this understanding is fundamental to wise management of the fisheries (NRC, 1998; NRC 1999). The committee thinks that the NPRB has done a good job overall in drafting a science plan that is consistent with the Mission Statement of the NPRB. The hard work of some dedicated individuals is evident. The committee is especially pleased with the overarching philosophy of the program, including the focus on Integrated Ecosystem Research Programs (IERPs)[1]; plans for incorporating Local and Traditional Knowledge (LTK) in programs and outreach activities; management changes already put into place; and planning for data management and proposal evaluation. The committee supports the idea of using planned workshops to help synthesize knowledge and produce action plans for the implementation of the Science Plan. In total, the NPRB program is off to a good start. But all draft documents benefit from constructive criticism, and thus our committee is conveying this final summary of advice. This report begins with some overarching observations and recommendations and then presents specific comments and recommendations tied to the chapters of the NPRB draft Science Plan.

First, the committee assumes that the authors of the NPRB draft science plan delayed preparing an executive summary until the plan is closer to its final form. An executive summary presenting the key ideas of the plan will be valuable. The summary should include a concise description of the NPRB mission, goals, and priorities. This is

[1] The NPRB Draft Science Plan (October 14, 2004) recognizes that the type of work required to meet their goals will require interdisciplinary research teams, well-integrated regional and large-scale investigations, and support of fundamental science to study the structure and function of ecosystems in order to understand the populations they support. Thus it is going to use some of its longer-term funding to establish Integrated Ecosystem Research Programs (IERPs) that cut across scientific disciplines and begin to address critical questions regarding ecosystem structure and function, how they are influenced by natural variability and human use of resources, and how all that might be affected by change in climate. This approach will discourage single-factor hypotheses and encourage consideration of entire ecosystems, as well as interactions of the spatially and temporally heterogeneous components.

an effective way to communicate the program's activities to a wide audience. It will also help NPRB management identify and articulate its focus.

Second, the concept of the IERPs is critical. The committee believes this integrated approach is the heart of the Science Plan, providing the glue that holds it together. Therefore, the commitment to develop IERPs should be brought forward to a more prominent position in the Science Plan. The introduction to the IERPs, provided in section 3.9 is good as are the examples of existing programs that could be considered IERPs and examples of opportunities for new ones. The use of the term is sometimes confusing, however, and the committee provides some specific guidance to clarify the role and scope of the IERPs in our comments on Chapter 3. A related issue is that, given its limited resources, the NPRB should focus its research activities within one or at most two particular geographic regions for a period of time (perhaps 5–10 years). Without these thematic (IERPs) and geographic foci, the NPRB will at best be a collection of loosely related projects, not a well-integrated program. These issues are discussed in more detail in the chapter comments.

As a point of clarification, the committee noticed that in the draft Science Plan, the terms "IERPs" and "geographical regions" appear to have the same meaning. The committee views them to be separate, albeit related, concepts, as explained in our comments on Chapter 3. Indeed, it is possible that more than one IERP could take place within a given geographic region.

When moving from the draft to the final plan, the committee suggests that the NPRB consider including references to recently published material such as reports from the Pew Oceans Commission (2003), the U.S. Commission on Ocean Policy (2004), the Arctic Climate Impact Assessment program (Arctic Climate Impact Assessment, 2004), the Global Earth Observation efforts, the Ecosystem Studies of Sub-Arctic Seas (ESSAS) program (a regional chapter for GLOBEC), the Gulf Ecosystem Monitoring Program (GEM) and Ocean Research Interactive Observatory Networks (ORION). These reports provide supportive background information and justification for some of the NPRB program elements. Representatives of these programs could be invited to participate in the NPRB workshops to provide information on program objectives, recent findings and future outlooks and to ensure that collaborative relationships are established.

The committee found the frequent citations of our 2004 report, *Elements of a Science Plan for the North Pacific Research Board* (NRC, 2004b) report helpful as we worked through the draft plan and could see where the authors were being responsive to our input. However, ultimately the NPRB Science Plan should be a stand-alone document. Therefore, the Committee suggests that a single citation to the NRC report in Chapter 1 would suffice.

The NPRB will be a significant source of funding for marine research. Thus, the Committee suggests that to attract the best ideas to advance understanding of marine ecosystems and resource managment, NPRB should consider adding a brief section to the Science Plan on how broad dissemination of Requests for Proposals (RFPs) will be achieved. NPRB might consider using existing scientific society membership lists (e.g., American Society of Limnology and Oceanography and American Geophysical Union, Ecological Society of America, etc.), and programs such as National Association of State Universities and Land Grant Colleges to attract the best proposals. Scientific societies usually maintain electronic mail lists of their members, or have ongoing electronic

newsletters, and are glad to pass along information about opportunities to their members. Copies of the RFP should also be sent to Alaska Native organizations. Incorporating information about how RFPs are to be disseminated into the science plan itself is useful because it ensures that the intention to do broad disseminations is firm, and practices not included in the document may not last. Repeated broad dissemination of program information is an important way to publicize the program and attract high caliber proposals.

Finally, as discussed in more detail below, the committee believes that the NPRB Science Plan would benefit from some re-organization of Chapters 2 and 3 to achieve greater clarity of the plan's objectives.

RECOMMENDATIONS:

- **Add an executive summary to the NPRB science plan.**
- **Highlight the section entitled Integrated Ecosystem Research Programs (IERPs), now located in section 3.9, by moving it to a more prominent position earlier in the plan.**

Throughout its deliberations, this committee asked how best to help the NPRB achieve a scientific legacy in which it can take great pride. In each of the following sections, the committee offers comments and recommendations on the chapters of the NPRB draft Science Plan.

Comments on NPRB Draft Science Plan - Chapter 1

Chapter 1 was generally well done and the committee applauds the effort and commitment that the NPRB is demonstrating toward organizing its Science Plan. In particular, the committee agrees with the NPRB that a useful step toward success will be to support some focused organizational workshops. Workshops can be an effective way for the NPRB to obtain the advice it needs to move from the broad ideas presented in the Science Plan to a more focused Implementation Plan that provides specific guidance on what work will be done and how it will be accomplished. Workshops will use program funds that otherwise would support research, so they should be used judiciously and with clear purposes.

But how the workshops will be used and the relationship to the IERPs is somewhat unclear in the NPRB draft Science Plan. In the committee's view, to provide a basis for resource management, the first step is for the NPRB administration (Executive Director with guidance from the Board and Science Panel) to identify the most pressing management needs and questions; that is, to ask "What are the greatest management issues now and in the foreseeable future for the North Pacific/Bering/Arctic regions." An example of two possible question might be "What limits the abundance and distribution of salmon" or "What determines salmon escapement/survival?" The subject might be groundfish, or it might be bowhead whales. With a need in mind, NPRB can identify an IERP to provide the integrated scientific information required to answer the question. And at the same time, the geographic focus becomes clear, when planners ask "Where do we go to get that information?"

The next step is difficult: the total list of possible management needs and associated IERPs will likely be long, and with its limited resources the NPRB needs to keep focused or its work will be diluted and not useful. It should be the role of the NPRB Executive Director, with guidance from the advisory bodies to make balanced judgments and prioritize the IERPs, selecting a set for attention now (and recognizing that others will need to be set aside for another time). Once the priority IERPs are identified, then NPRB can organize a workshop specific to that question, with the right participants and a clear mandate for the group to define what needs to be measured, where, and what hypotheses to test. In this way, the workshops define the specific science questions and approaches for implementation of the IERPs.

As noted in the following section, the committee believes that NPRB must limit its geographic focus to one or two key areas, for a period of time long enough to build a body of knowledge. Multiple IERPs can be addressed in this region or regions, but care should be taken not to select multiple IERPs in multiple regions, or the program's impact

will be diluted and likely not useful to resource managers. The more focused NPRB activities can be, the more they will accomplish.

Given the key role the IERPs will serve in organizing NPRB science activities, the committee feels strongly that the concept of IERPs should be introduced early in Chapter 1 (with their detailed description still remaining in Chapter 3). In this way, the intent of the workshops, which is to provide targeted information that helps bring the IERPs to fruition, can be made explicitly clear. If this is not clear, the workshops will appear unrelated and fragmented, and in the end they will not be very useful to the Science Panel or support the success of the NPRB overall.

Along with the concept of IERPs, the committee believes that the IERP discussion in Chapter 2 section 3 contains information that actually belongs in Chapter 1, where it would be given more prominent attention. Chapter 1 is where the NPRB's overarching premises, goals, and philosophies are explained and the IERP concept belongs as part of this description of the program's foundation ideas, and not buried at the end of Chapter 2.

RECOMMENDATIONS:

- **Revise the organization by moving Section 2.3 to Chapter 1 and introduce the IERP concept early in Chapter 1.**
- **Planning workshops should be used where additional, focused scientific input is needed, such as to outline the scientific issues, research components, and estimated resource needs for the IERPs.**
- **The NPRB (Executive Direction with guidance from the Board, and Science Panel) should identify pressing management needs and select the priority IERPs for study.**

Comments on NPRB Draft Science Plan - Chapter 2

The purpose of Chapter 2 is to provide an overview of the environmental variables that affect and are involved in the ecosystems of the NPRB region of interest. As such, the discussion is necessarily broad, as it must encompass everything that the NPRB might undertake throughout its lifetime.

Given this broad purpose, the committee believes that the discussion of trophic levels in Chapter 3 (Sections 3.2-3.8) would logically be better placed in Chapter 2, where it can serve as a summary of background material rather than a description of NPRB science themes. Furthermore, the presentation of fragmented trophic levels in these sections reflects more of a "traditional research" approach that is not consistent with contemporary understanding. Any background discussion of trophic levels should include information about the organisms that dominate the biomass: the prokaryotes (bacteria and archaea) and the unicellular eukaryotes. Even with such additional information, the trophic discussion should be shortened significantly. This change will also reduce some repetition between the two chapters. The recommended restructuring is outlined below in the recommendation, with Sections 3.2-3.8 being incorporated into Sections 2.3-2.5.

Because resources are limited, NPRB activities will have to be focused geographically in one or two regions for a given period of time (e.g., at least 5 and possibly as long as 10 years) as discussed earlier. A limitation of this focusing is that some important study areas and issues will have to be delayed. Its overriding benefit, however, is that geographically focused research will provide a more comprehensive understanding of the selected region, and yield results that are transferable to research undertaken in regions studied later.

RECOMMENDATIONS:

- **Reorganize Chapter 2 within the following outline:**
  - **2.1 Introduction**
  - **2.2 Large Marine Ecosystems: Physical Environment**
  - **2.3 Large Marine Ecosystems: Biological Environment (edited from Chapter 3, Sections 3.2-3.8)**
  - **2.4 Ecosystem Dynamics**
  - **2.5 Human Dimensions**
- **The NPRB Implementation Plan should identify one or at most two geographical regions to focus their activities so NPRB activities in total build a comprehensive understanding.**

Comments on NPRB Draft Science Plan – Chapter 3

The intent of Chapter 3 is to provide a blueprint outlining the types of research the NPRB will fund. It is critical that a clear directive be provided and highlighted early and often. As noted in the Science Plan and in the NRC's *Elements* report, the intent of the NPRB is to fund ecosystem-oriented research, that is, research that crosses disciplines and emphasizes interactions and fluxes. Section 3.9 (Integrated Ecosystem Research Programs) clearly outlines this approach to research. Given its importance, its placement at the end of this chapter is puzzling. Sections 3.2 through 3.8 present a trophic level view of ecosystems and when presented in this manner tend to further encourage isolated approaches to research along single-discipline lines. For this reason, the committee recommends a major reorganization of Chapter 3 (see the recommendations below for details). The trophic level summaries are best positioned in Chapter 2 along with the background material on atmospheric and oceanographic features of large marine ecosystems.

The NPRB should consider communicating and coordinating with the Long Term Ecological Research Network (LTER) (http://lternet.edu/). The LTER network was established in 1980 to support research on long-term ecological phenomena in the United States. There are 26 sites representing diverse ecosystems and research thrusts, and the network strives to promote synthesis and comparative research, and thus should be an important information source to the NPRB as it matures. They may be willing to share information on data management, archiving, and program coordination. The North Pacific logically organizes into three LTER-like regions: the Bering Sea/Aleutians, Gulf of Alaska and Arctic Ocean.

To maximize the return on its investment, the NPRB will need to establish a geographic focus for its research activities in any given period of time, and commit a majority of its annual funding to research in that region. This kind of commitment of significant time and funds is needed to build a body of knowledge. The Science Plan itself does not need to specify geographic focus areas (beyond those broadly defined in the Mission Statement) because they are likely to change over the life of the plan.

The committee recommends that the NPRB divide its annual research funds (i.e., funds remaining after program administration, data management, and outreach) into three categories:

1. Category 1 includes a relatively stable annual amount that funds one or more long-term monitoring projects.
2. Category 2 includes funding for Integrated Ecosystem Research Projects conducted in the identified geographic focus research areas.
3. Category 3 includes support for small-scale, short-term process studies and/or specific research projects on individual questions of interest.

An important question is how funds will be allocated among these three categories. The committee understands that the NPRB needs flexibility to set its own direction and meet changing needs, so we do not recommend set percentages. However, the committee does believe that category three – which is where most studies funded during the first three years of NPRB operation fall – is likely to be reduced over time as the IERPs develop and the Science Plan begins to have greater effect in setting research directions. Indeed, proportionately more funding will shift to category 2 projects, so that NPRB becomes an integrated approach to address interdisciplinary issues in a particular large marine ecosystem, from basic research on the regional environment, through ecosystem dynamics, to guidance relevant to overall ecosystem management and fisheries management in particular. Given the limited resources, the committee recommends that high priority be given to the development and use of biophysical/ecosystem models of increasing complexity to focus research efforts and to synthesize observations from long term monitoring projects and from other historical data when it is developed. One of the ultimate goals of an Integrated Ecosystem Research Project should be the prediction of future ecosystem states in response to natural variability and human activities. Another important goal would be the determination of the limits of ecosystem predictability, which would be useful to resource managers and decision makers. This approach will allow comprehensive understanding of the ecosystem as a whole and its response to natural and human-induced changes, which can then be used to improve management.

The committee suggests that the NPRB verify the information regarding walleye pollock on page 94, line 33 of the draft because the committee believes the statement is incorrect (see Shuntov et al. 1993; Bakkala et al. 1986; Wolotira et al. 1977). The committee commends the NPRB's intent to use retrospective data to extend time lines backward, and suggest that data in other languages may be useful to the NPRB's goals. The Committee was satisfied with the section relating to economic and social research (Human Dimensions, Section 3.7) and feels that these studies have been appropriately weighted.

RECOMMENDATIONS:

- **Reorganize Chapter 3 within the following outline:**
  - **3.1 Introduction**
  - **3.2 Integrated Ecosystem Research Programs**
  - **3.3 Long Term Monitoring Programs**
  - **3.4 Short-term Process Studies**
  - **3.5 Research Tools**
    - **3.5.1 Modeling**
    - **3.5.2 Short-term Process Studies**

3.5.3 Retrospective Studies
3.5.4 Ecosystem Indicators

- **At the end of Introduction (3.1), define and discuss the benefits of three categories of research (i.e., integrated ecological research programs, long-term studies, and short-term focused studies).**
- **Consider communicating and coordinating with the Long Term Ecological Research Network and to learn from its experience.**
- **Edit line 21 on page 53 as follows: "…based on interdisciplinary cooperation, as a means of addressing pressing fisheries management needs …"**

Comments on NPRB Draft Science Plan – Chapter 4

Chapter 4 discusses planned NPRB partnerships including but not limited to the strategy that will be developed to gather and utilize Local and Traditional Knowledge (LTK).[1] These important outreach programs will provide opportunities to enhance the NPRB mission and to broaden its support base. The proposed partnerships with the fishery industry and plans to involve teachers and students with NPRB research were exemplary. The committee also suggests that final reports of the NPRB-funded studies include lay as well as technical summaries. This will simplify the task of communicating results to the lay public. Overall, the committee felt that this chapter was thoughtful and well prepared.

The committee commends the Board for their planned use of LTK, but also reminds them of the potential challenges. In this regard it is imperative to engage the target Alaska native communities from the start to foster trust and meaningful collaborations. The NPRB project must be a "two-way" street, or it will not succeed. The plan articulated in Chapter 4 is a very good start.

As mentioned previously, the NPRB will be a stronger program if it builds relationships with other entities and programs, as discussed in the draft Science Plan in section 4.2. Two particularly timely activities are the recently released *Arctic Climate Impact Assessment* (2004) and planning for the International Polar Year 2007-2008 (NRC, 2004a). Both share the goal of increasing understanding of biological, physical, and social processes in polar regions.

Education and outreach are key components of most science programs and in this regard NPRB is no exception. However it is one thing to acknowledge this and another to actually carry out these important missions. The committee believes that the NPRB should establish explicit performance goals that can be compared to actual achievement in these areas. In this regard, the Committee urges the NPRB to consider contracting with a professional education research and development organization to provide formative and summative evaluation services, at the program's inception and at five-year intervals thereafter. The external organization could provide guidance on all aspects of the NPRB's success from basic and applied research to education and outreach.

[1] The NPRB uses the term Local and Traditional Knowledge to connote the experimental knowledge of all local residents, including Alaska Natives and others with experience-gained knowledge such as commercial fishers. This is a slightly different concept than the more common seen term "Traditional and Ecological Knowledge" (TEK).

RECOMMENDATIONS:

- **The final reports for NPRB-funded research should include both a technical and a lay summary. The latter will be invaluable as a means of public information about NPRB's mission.**
- **Performance measures for outreach and education should be established, and a non-profit education organization should be contracted to provide a periodic formal review of the NPRB's success in education and outreach.**

Comments on NPRB Draft Science Plan – Chapter 5

The reputation of any granting body depends on the extent to which the procedures used to evaluate proposals and award funding are judged to be transparent and fair. Overall, the committee believes that the NPRB has done a good job in this regard. The committee also commends NPRB board members on the extent to which they have taken the advice of the Science Panel. Listening to those advisors will protect the integrity and the reputation of NPRB programs.

On the whole, the NPRB has adopted protocols that reflect high standards in the scientific community, but the committee is concerned with how recusal will be practiced. The NPRB and their advisors should be subject to the same rules of recusal that are used by the National Science Foundation, to avoid conflicts of interest or the appearance of such conflicts in the selection of funded proposals. That is, a conflict exists if the proposal has an effect on their own or their organization's financial interests or if any of the other criteria for conflicts apply. The committee feels strongly that when members of the Board or the Science Panel have a conflict of interest, they should recuse themselves by leaving the room during discussion and voting. Even the presence of members who have recused themselves from participating in the discussions, but who have remained in the room can influence decisions or be perceived to do so, thus compromising the integrity of the process. The practice of remaining in the room must be avoided both to build and maintain NPRB's good reputation in the scientific community. The extent to which the NPRB is respected by the scientific community will play a large role in attracting the best applicants and the best reviewers, both of which are critical to the successful implementation of the Science Plan.

The committee suggests that the Science Plan be more specific about the role that the Science Panel plays in the selection of proposal reviewers. It is common practice elsewhere for members of such panels to select reviewers and thus the committee suggests this practice be adopted by the NPRB. Given the need to protect the confidentiality of the reviewers, reviewer comments should not be discussed during public sessions.

Although NPRB has set up many procedural safeguards to protect the integrity of its activities, NPRB management may find that they need to combat the perception that funding is somehow biased in favor of certain individuals, such as those with past NPRB experience or who have participated in program planning. Negative perceptions can be avoided or overcome by open communication of the mission and opportunities and by carefully following all procedures and policies (NRC, 2003).

The committee is also concerned about the plan to require all researchers to have their final reports externally reviewed. This step places an unnecessary burden on the reviewing community. If the intent is to ensure quality of the NPRB supported work before allowing additional funds to be allocated, then a better approach would be to require investigators to submit a summary of prior NPRB supported research in any future proposals upon submission. This summary (including reference to peer-reviewed publications arising from the work) would enable NPRB to evaluate the value of previously supported research before granting new funds but requires only one set of reviewers, not two.

The committee was also pleased that NPRB is planning regular external program reviews. However, the committee is concerned that decadal reviews will not be frequent enough given the pace at which new methodologies can be introduced and promising areas of research are identified.

The committee agrees that archiving tissue samples and voucher specimens is complex, difficult and potentially expensive. However, we reiterate that archiving is essential to document diversity. The committee commends the NPRB's intent to seek archiving partnerships.

RECOMMENDATIONS:

- **Members of the NPRB and their advisors should recuse themselves by leaving the room during discussion and voting if the proposal has an effect on their or their organization's financial interest or if any of the other criteria for conflicts apply.**
- **Reviewer comments on research proposals should not be discussed during public sessions to protect reviewer confidentiality.**
- **Do not require that researcher's regular final reports undergo external review; a more practical approach is to require a summary of prior NPRB supported research in subsequent proposals.**
- **Once an implementation plan has been developed, program reviews should be at five-year rather than ten-year intervals.**

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Appendixes

A

Committee on a Science Plan for the North Pacific Research Board Statement of Task

The NRC study committee will assist the NPRB in developing a science plan that (1) is comprehensive and long range (10-20 years), (2) identifies major research themes, with emphasis on marine resource management issues, (3) is flexible, dynamic, and able to adapt to new research and monitoring findings, (4) is responsive to the vision, mission and goals of the NPRB and addresses the elements of a science plan identified as important by the NPRB, (5) builds on past and ongoing research programs of the Federal government, the State of Alaska, universities, and other relevant entities, (6) has a high probability of furthering the goals and objectives of the NPRB and maintaining awareness of the need to sustain a variety of marine resources and (7) is consistent with NPRB enabling legislation.

In addition, the committee should consider questions such as the appropriate balance between process studies and time-series studies, the role of modeling, the availability and usefulness of proxy and historical data, coordination with other activities (including international activities), and any other issues related to assuring the program has a strong strategic vision and sound management and oversight.

To guide the NPRB as it develops its science plan, the committee will:

- Identify broad research themes in the North Pacific, Bering Sea, and Arctic Ocean region, through discussions and a workshop.
- Conduct a series of site visits in Alaska to gather further input on the research themes.
- Provide supporting information and recommendations for achieving the desired attributes of the plan.
- Prepare an interim report that outlines the components of a successful long-term science plan and provides guidance to NPRB as it develops its plan, drawing on insights gained from past reviews of similar science plans to help the NPRB avoid known difficulties and pitfalls.
- Subsequently review the science plan drafted by the NPRB in light of the identified research themes and overall guidance provided in the interim report, making any necessary suggestions for improvement.

B

Elements of a Science Plan for the North Pacific Research Board: Interim Report Executive Summary

In 1979, the U.S. government filed a complaint with the U.S. Supreme Court against the State of Alaska regarding ownership of submerged lands along Alaska's North Slope. Royalties from oil and gas sales of these submerged lands were held in escrow during the ensuing court proceedings. Nearly 20 years later, the Supreme Court ruled in favor of the U.S. government, signing over the lands and nearly $1.6 billion in proceeds. Congress later created the Environmental Improvement and Restoration Fund and the North Pacific Research Board (NPRB) with the settlement money. Each year, 20 percent of the interest from the account is given to the NPRB for funding marine research activities in the Arctic Ocean, the Bering Sea, and the North Pacific Ocean.

The NPRB began operating in 1997, and it approved funding for about $2.2 million in 2002 and $7 million in 2003 (Appendix B). The NPRB also began developing an administrative structure and advisory mechanisms similar to other research programs. Concurrently, the NPRB recognized the need to develop a high-caliber, long-range science plan that provides a comprehensive understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems and their fisheries. To ensure that its Science Plan is of the highest quality, the NPRB asked the National Academies to provide advice on the components of a sound science plan (Box ES-1). The National Academies established the Committee on a Science Plan for the North Pacific Research Board for this purpose (Appendix C). To gather information for this report, the committee held three committee meetings and a science workshop (conducted in Anchorage). The workshop agenda and list of participants can be found in Appendix E. In addition, members of the committee made site visits to various communities in Alaska (Kodiak, Barrow, Fairbanks, Juneau, Kotzebue, Dillingham, Anchorage, and Bethel) and in the State of Washington (Seattle) to receive input on the marine research needs of each community. This input is summarized in Appendix D. Information received from the workshop and site visits was considered in the committee's deliberations.

This interim report presents the National Research Council's (NRC's) initial advice for the development of the NPRB Science Plan. The report is the first step in an advice-giving process that will continue through 2004. It is not meant to be an extensive literature review of work done in the NPRB region; instead, the goal of this report is to

summarize broad research themes and the key components of a successful science plan. These themes are based mainly on the experience and expertise of the NRC committee, input from the science workshop, site visits, and discussions with stakeholders. The report is meant to guide the NPRB in developing a science plan that meets the objectives of the enabling legislation and is consistent with the NPRB's mission and goals (Box ES-2). Since the NRC was not charged with writing the NPRB Science Plan, recommendations for specific research topics have not been made. The NRC will review the final draft of the NPRB Science Plan once it has been developed, taking into consideration the broad research themes and guidance provided by this report.

Chapter 1 provides background information and Chapter 2 discusses criteria necessary for a successful NPRB Science Plan. Chapters 3-4 discuss specific elements of the plan in more detail. Chapter 5 provides the committee's findings and recommendations. Below are brief descriptions of the major sections of the report followed by key recommendations. For a more complete discussion of a specific section or a listing of all recommendations, please refer to the respective chapter or to the findings and recommendations in Chapter 5.

BOX ES-1
Statement of Task

The NRC study committee will assist the NPRB in developing a science plan that (1) is comprehensive and long range (10-20 years), (2) identifies major research themes, with emphasis on marine resource management issues, (3) is flexible, dynamic, and able to adapt to new research and monitoring findings, (4) is responsive to the vision, mission and goals of the NPRB and addresses the elements of a science plan identified as important by the NPRB, (5) builds on past and ongoing research programs of the Federal government, the State of Alaska, universities, and other relevant entities, (6) has a high probability of furthering the goals and objectives of the NPRB and maintaining awareness of the need to sustain a variety of marine resources and (7) is consistent with NPRB enabling legislation.

In addition, the committee should consider questions such as the appropriate balance between process studies and time-series studies, the role of modeling, the availability and usefulness of proxy and historical data, coordination with other activities (including international activities), and any other issues related to assuring the program has a strong strategic vision and sound management and oversight.

To guide the NPRB as it develops its science plan, the committee will:

- Identify broad research themes in the North Pacific, Bering Sea, and Arctic Ocean region, through discussions and a workshop.
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- Provide supporting information and recommendations for achieving the desired attributes of the plan.
- Prepare an interim report that outlines the components of a successful long-term science plan and provides guidance to NPRB as it develops its plan, drawing on insights gained from past reviews of similar science plans to help the NPRB avoid known difficulties and pitfalls.

- Subsequently review the science plan drafted by the NPRB in light of the identified research themes and overall guidance provided in the interim report, making any necessary suggestions for improvement.

Box ES-2
NPRB Mission and Goals

The NPRB's overall mission is to develop a comprehensive, high-caliber science program that provides better understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems and their fisheries. Its work will be conducted through science planning, prioritization of pressing fishery management and ecosystem information needs, coordination and cooperation among research programs, competitive selection of research projects, enhanced information availability, and public involvement.

To carry out this mission, the NPRB will emphasize coordination and cooperation in supporting high-quality research projects with the goal of improving:

- the understanding of the dynamics of the North Pacific marine ecosystem and use of the resources;
- the ability to manage and protect the healthy, sustainable fish and wildlife populations that comprise the ecologically diverse marine ecosystems of the North Pacific and provide long-term, sustained benefits to local communities and the nation; and
- the ability to forecast and respond to effects of changes, through integration of various research activities, including long-term monitoring.

CRITERIA FOR A SCIENCE PLAN

The NPRB Science Plan will be the underpinning of the entire science program and will determine the legacy of the NPRB. Many studies have examined the elements that contribute to making a successful science plan (Weisberg et al., 2000; NRC, 2002, 2003a); in general, it operates under the aegis of an overriding goal or conceptual foundation that provides rationale for the program and a signature that will identify the program. It also contains clearly defined scientific goals and program management policies; has a clearly defined geographic focus; has an effective data management and dissemination strategy; coordinates actively with other funding programs; develops applications that are useful to decision makers and stakeholders; and recognizes the importance of public interaction and community involvement. In order to be successful the following elements should be included in the NPRB Science Plan.

- In developing a science plan, the NPRB must include policies and procedures that provide for the development and articulation of the overriding goal or conceptual foundation.

- Since emerging issues cannot be predicted, the NPRB has to include mechanisms that will allow the conceptual foundation to evolve over time through periodic review.
- The Science Plan should limit studies in the North Pacific and Arctic Ocean to geographically proscribed areas where comprehensive studies can be undertaken. For example, the Arctic could be limited to the East Siberian, Chukchi, and Beaufort Seas, and the North Pacific to its subarctic gyre, except for studies that naturally extend outside these boundaries. These regions, together with the Bering Sea, comprise an interacting series of ecosystems that may be studied comprehensively through research funded by the NPRB.
- During periods of funding constraints, all long-term monitoring should be protected and short-term process studies should focus on core scientific questions. If necessary financially, it would be better to support research in a limited geographic area than to scatter research over a larger area.

RESEARCH THEMES

Populations of marine organisms are managed based on a solid understanding of the entire ecosystem to which they belong (NRC, 1999a). This demands a comprehensive understanding of the mean state and variability of key habitats and their inhabitants on all relevant scales.

Ecosystem States and Variability

Research teams addressing interdisciplinary issues are an excellent strategy for advancing understanding of the marine ecosystems in the region. This approach will allow the NPRB to fulfill its primary mission to address marine ecosystem and fishery management information needs, while developing a predictive capability for the region.

Process studies should be well integrated with modeling studies and should be designed to provide data for model testing. To encourage strong linkages between biological and physical studies, and between empirical and modeling studies, interdisciplinary approaches should be encouraged through priority funding. Research is needed that will elucidate community compositions; the structure, functioning, and transfer efficiencies of food webs; and predator as well as non-predator interactions such as competition among species and symbiotic association. Research integrating biological data within the framework of the physics and chemistry of the ecosystem is also needed.

The development of ocean models is essential because they provide a means of interpolation among scattered and scarce data sources, thereby providing a more complete physical setting for the region. They are also essential for identifying the basic processes that determine the region's ocean circulation, sea-ice formation and decay, and biogeochemistry.

Long time-series measurements are imperative for understanding natural processes that exhibit slow or irregular change and rapid event-driven variations that cannot be documented from a single field expedition. The unique funding structure of the NPRB provides a rare opportunity for establishment and maintenance of long-term

continuous monitoring sites. Because of the long-term funding commitment, monitoring sites must be carefully considered.

Oceanography and marine biology have often been limited by technology more than by intellectual vision, and they have progressed rapidly with the advent of each new technological development. Nowhere is this more evident than at high latitudes where the harsh environment presents unique challenges to scientific investigation. The NPRB may find that progress is blocked by the lack of appropriate technology, and funding for the adaptation of existing technologies, along with the development of new technologies, could be a valuable NPRB contribution if such technology is necessary to answer an important scientific question.

Additionally, the NPRB is working in a region with many stakeholders, and it must develop an ongoing mechanism to facilitate communication between scientists and stakeholders. In particular, the incorporation of traditional knowledge into the NPRB program provides a special challenge. A great deal of marine ecosystem knowledge lies in the domain of those who are dependent upon it to survive. Yet the integration of this knowledge with information produced by modern scientific methods has seldom been done well. In order to better understand ecosystem mean states and variability, the NPRB should consider the following elements in its Science Plan:

- The NPRB should support fundamental science to study the structure and function of ecosystems in order to understand the populations they support.
- The NPRB should encourage formation of interdisciplinary research teams by priority funding of well-integrated research groups.
- NPRB funding should support a well-integrated mix of long-term, process, and modeling studies, accompanied by the development of appropriate technology if that technology is necessary to answer an important scientific question.
- The NPRB should fund a balanced mixture of regional and large-scale investigations. Those regional and large-scale studies should be well integrated.
- The NPRB should encourage proposals that include data on the roles and trends of important noncommercial species, such as potential prey species, indicator species, keystone species, and others. Although there are data for commercial species, information regarding noncommercial species is particularly lacking.
- Long-term monitoring sites should be established and observations should be continued uninterrupted. Once a long-term monitoring plan is established, it should be changed only for compelling reasons and only in such a way that the continuity of the long-term record is preserved.
- The NPRB should facilitate communication between scientists and stakeholders in its study area. Several groups, such as the Alaska Native Science Commission, have expertise in this process, and the NPRB should work with appropriate stakeholder representatives to develop strategies for accomplishing scientist-stakeholder interaction.
- The NPRB should consider funding the collection of traditional knowledge relevant to its goals and encourage the incorporation of traditional knowledge into research planning and hypothesis development.

Human-Induced Impacts

Human activities, such as fishing, hunting, coastal and shelf development, shipping, contamination, and to a lesser extent invasive species and tourism, all impact the marine environment. Effects of fishing may be direct (e.g., removal of targeted and nontargeted species) or indirect (e.g., a trophic cascade). Large gaps exist in our understanding of the indirect effects of fishing, as well as the effects of development, shipping, and introduction of contaminants from all sources. Although the NPRB program should focus on integrated ecosystem-based research, it should include research related to the effects of human activities. Therefore, the following is recommended:

- The NPRB should fund studies that have a high potential to determine whether specific human activities have an effect on marine ecosystems, what the scales of such impacts are likely to be, and what kinds of mitigation are possible. Such studies could include impacts of proposed or actual industrial or municipal development, fishing and hunting, shipping, and contamination.

Economic, Social, and Management Research

All important commercial fisheries in the Northeast Pacific are now regulated and much research has been devoted to supporting management of these fisheries. There is a need for economic and social research to assess how well existing management regimes are functioning, how they could be improved, and what regimes would be appropriate for the fisheries when the management regime is at a formative stage. These data should be recognized as a long-term data set, subject to the same procedures for establishing objectives, and so forth, as the ecological data.

The subsistence economy poses special challenges. Many pressures, including decreasing resources and increasing populations, challenge the long-term viability of this way of life. The subsistence economy also is increasingly dependent on vehicles, fuel, and gear that are bought with cash. The following are recommended:

- Economic and social data should be gathered on an ongoing basis to evaluate the changes that new management regimes have brought or are likely to bring.
- Economic and social research is needed to ascertain the long-term viability of the subsistence economy and the social changes spurred by decreasing resources and increasing populations. Researchers should be encouraged to work with rural communities and tribes and with tribal or native organizations on these types of research projects.

Forecasting and Responding to Change

For northern regions, large-scale ecological models are even less developed than physical models. Most of the progress to date has been in simulating the dynamics of phytoplankton and, to a lesser extent, zooplankton. More complex trophic couplings are

not known well enough to simulate statistically or numerically. Interdisciplinary process studies are required to fill in the current data gaps so that these systems can be described more fully and their response to environmental change can be predicted better:

- The NPRB should fund research that leads to the improvement of predictive models. This research includes the acquisition of long-term data records and the undertaking of short-term process studies that reveal underlying processes.

MANAGEMENT ISSUES

NPRB Members, Staff, and Panels

The purpose of the NPRB management structure is to facilitate its science activities, ensuring that they advance the NPRB's mission, goals, and themes. Currently, the NPRB management consists of NPRB members, an executive director, the Science Panel, and an Advisory Panel. NPRB members include individuals knowledgeable by education, training, or experience in fisheries or marine ecosystems in the North Pacific Ocean, Bering Sea, or Arctic Ocean. The NPRB enabling legislation dictates that some NPRB members are representatives or designees from various state and federal agencies. The executive director is the chief NPRB administrator and has overall responsibility for all aspects of its operation, which is a large task that requires administrative support. The executive director and the NPRB are advised by the Science Panel, which ensures that research of the highest possible quality is conducted under NPRB support. An Advisory Panel, with representatives from user groups and other interested parties from the various regions within the NPRB's purview, advises the board to ensure the relevance of the science to the mission and goals of the NPRB. After requesting research proposals, the Science Panel sends recommendations to the NPRB members, who select proposals for funding. Finally, research funding decisions of the NPRB must be approved by the secretary of commerce, who currently is also a member of the NPRB, or an appointed representative.

One of the next tasks for the NPRB is to write a science plan. In general, science plans should be written by scientists with knowledge relevant to the agency mission. The science plan should include mechanisms for both internal and external review. The following recommendations will help to ensure that the management structure is suited to meeting the NPRB's mission:

- The NPRB should provide adequate administrative staff to support its executive director, although care must be taken to minimize the level of funding going to administration.
- The NPRB Science Panel or other scientists with appropriate expertise in regional scientific issues, who can place the regional science within the larger framework, should write the NPRB Science Plan.

The Proposal Process

The process by which proposals are considered, evaluated, selected, and funded has to be clearly specified in the science plan. As the NPRB matures and begins organized implementation of its science plan, it will have to develop and adhere to sound peer review policies. Two guiding principles of proposal review are peer review by qualified, unbiased reviewers and reviewer anonymity. Any potential for conflict of interest, real or perceived, should be eliminated. All proposal reviewers should be respected scientists with expertise in the areas designated in that year's research funding proposals. Reviewers should not be members of the NPRB, nor should they have proposals pending that year or receive any potential or perceived financial gain from the proposal selection process.

Although it is important for the NPRB to identify a geographic focus for research, grant proposals must be evaluated on their merit and not on the geographic location of the proposer. This is necessary not only to ensure that the best proposals are funded, but also to allow for intellectual input from outside the region.

The current NPRB management structure could lead to real or perceived conflict of interest in reviewing and awarding research grants. For example, when proposals are considered for funding, any members having vested interests should recuse themselves when proposals from their agency, industry, or university are considered – something that the NPRB currently does not require. The final recommendations will assist the NPRB in developing an adequate proposal process:

- Final approval of funding decisions should be made directly by the U.S. secretary of commerce or by a representative who is remote from the consequences of funding decisions. The secretary of commerce's representative on the NPRB should not be the same individual who approves funding recommendations on behalf of the secretary.
- NPRB members should recuse themselves, in accordance with standard practice, when proposals from their agency or university are considered for funding.
- The NPRB should establish and publish fair procedures for awarding grants and then follow those procedures without exception. The criteria established by the National Science Foundation are especially respected within the scientific community and might serve as a model.
- The Science Panel should appoint a Proposal Selection Committee to rank research proposals and advise the executive director of its decisions.
- The Advisory Panel and the Science Panel should not be involved in proposal funding decisions because of potential conflicts of interest.
- Since the Proposal Selection Committee will be a panel of experts, the NPRB and the secretary of commerce (or a representative) should respect their proposal rankings. NPRB funding decisions should be documented in writing, including an explanation of any deviations from the rankings of the Proposal Selection Committee.

External Review

During the life of the NPRB program, technology will change, scientific knowledge will accumulate, and public perceptions will shift. All long-lived programs

benefit from periodic external reviews because those who can view a program from a distance often provide insight that cannot come from within. The NPRB will benefit from a regular pattern of reviews in which a panel of outside reviewers is invited to evaluate its Science Plan, long-term programs, and the policies and procedures that govern proposal evaluation and grant administration. Therefore, the following recommendation will provide adequate external review:

- The NPRB should conduct periodic internal and external reviews of the science plan, policies, and long-term programs at five-year intervals. The caution, however, is that the long-term monitoring components of NPRB programs should be protected to the extent financially possible.

Outreach and Education

The NPRB should recognize the importance of public interaction. The science plan must seek public input and respond to this, but it must also acknowledge that the specific problems likely to be identified by the public will probably find their solutions not in direct problem solving, but in a basic understanding of the ecosystem. The NPRB must recognize the need for a broad range of outreach and educational approaches that reflect the rich diversity of the region's communities. The following recommendations will help the NPRB to maintain strong community links:

- The NPRB should encourage outreach and education activity components either by principal investigators as part of their proposals or as independently funded activities. These components should address all levels of education, making sure to include remote communities.
- The NPRB should facilitate communication between scientists and stakeholders in its study area. The board should consider continuing site visits throughout the Northwest United States and Alaska to foster understanding of its efforts and to receive public input on future research directions.

Data Policy and Management

The NPRB's goals require an integrated understanding of ecosystems, which necessitates that user-friendly mechanisms for data storage and sharing be developed and implemented; the NPRB's current management structure does not provide adequate staff for data management. Those conducting NPRB research have an obligation to share the data and metadata they collect with the general community at large. For these reasons, there must to be an explicit NPRB data policy and a centralized data management office. For efficiency, the NPRB should cooperate with an existing archiving program for tissue samples and organisms. Such collections are essential for documenting and understanding biodiversity. Therefore, the following key elements are recommended for the Science Plan:

- The NPRB Science Plan should instruct principal investigators to place all data in the public domain after no more than two years. Within interdisciplinary programs, data should be shared as soon as possible. This will serve to maximize dissemination of knowledge even prior to archival publication.
- The NPRB should establish an administrative staff position responsible for data management and dissemination. This person should create and maintain a web-based archive of data that is easily navigated. Recent successful examples for the NPRB to follow include the Long Term Ecological Research Network, the Ridge Inter-Disciplinary Global Experiment, and the Joint Global Ocean Flux Study.
- The NPRB should join a sample archiving program that provides safe storage and allows for easy retrieval.

Coordination with Other Projects and Programs

The NPRB's mission is ambitious, and it likely cannot fund alone all the empirical and modeling studies that are needed to achieve its goals. However, many other programs are funding research projects in the same geographic area, and many of these have research objectives complementary to those of the NPRB. In addition, many of the projects funded by the NPRB should be related, and the NPRB would be wise to facilitate interactions between principal investigators to further maximize their funds. The NPRB should implement the following recommendations:

- The NPRB should appoint one or more individuals to act as liaisons with other state and federal agencies, universities, environmental groups, industry, and tribes and tribal or native organizations whose missions relate to those of the NPRB. Wherever possible, partnerships should be formed with these other groups to leverage maximum benefit from available funds.
- The NPRB should conduct an annual principal investigator workshop in conjunction with the annual Joint Science Symposium to foster project collaborations and share data.

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C

Committee and Staff Biographies

Lynda Shapiro, chair, is a professor emerita of biology at the University of Oregon's Institute of Marine Biology. Her research interests include the biology of pelagic marine phytoplankton; distributions and abundances of the eukaryotic ultraplankton, incorporation of these minute cells into the microbial food web, and the role of associated bacteria on the nutrition of phytoplankton; harmful algal blooms; and sustainable harvesting of marine macroalgae. Dr. Shapiro has served on several National Research Council (NRC) committees including the Committee on Major U.S. Oceanographic Research Programs, Committee on Fish Stock Assessment Methods, Committee on the Arctic Research Vessel, and Committee to Review Atlantic Bluefin Tuna, and she has served as a member of the Ocean Studies Board (OSB). Dr. Shapiro earned her Ph.D. in marine biology from Duke University in 1974.

Kevin Arrigo is an assistant professor of geophysics at Stanford University. Dr. Arrigo's research interests include understanding the role marine microalgae play in biochemical cycling, with particular emphasis on the scales of temporal and spatial variability of microalgal biomass and productivity; understanding how anthropogenic and atmospheric forcing controls the biogenic flux of CO^2 into the oceans and, ultimately, the sediments; remote sensing; and Antarctic biological oceanography. Dr. Arrigo earned his Ph.D. in biology from the University of Southern California in 1992.

Don Bowen is a research scientist at the Bedford Institute of Oceanography, Department of Fisheries and Oceans, Canada, and an adjunct professor in the Biology Department, Dalhousie University. His research has focused on the life history variation, population dynamics, foraging ecology, and ecological energetics of marine mammals. Since 1999, he has served as editor of *Marine Mammal Science*. He also serves on the Hawaiian Monk Seal Recovery Team and the Special Committee on Seals in the United Kingdom. Dr. Bowen previously served on the NRC's Committee to Review the Gulf of Alaska Ecosystem Monitoring Program and the Committee on Bering Sea Ecosystems, and he currently serves on the North Pacific Research Board's Science Panel. He earned his Ph.D. in zoology from the University of British Columbia in 1978.

Rognvaldur Hannesson is a professor of economics at the Norges Handelshoyskole Norwegian School of Economics and Business Administration. Dr. Hannesson's research interests include fisheries management, economics of fish resources, micro and macroeconomics, petroleum economics, natural resources economics, growth theory, and property rights. Dr. Hannesson served on the NRC Committee to Review Individual Fishing Quotas. Dr. Hannesson earned his Ph.D. in fisheries economics from the University of Lund in 1974.

Steven Hare is a quantitative biologist for the International Halibut Commission in Seattle, Washington. Dr. Hare's research interests include climate variability and its impacts on marine populations; fisheries population dynamics modeling and stock assessment; incorporating climate dynamics into fisheries management strategies; factors influencing the processes of growth and recruitment; and the North Pacific ecosystem dynamics and carrying capacity. He serves on the North Pacific Fisheries Management Council's Scientific and Statistical Committee. Dr. Hare earned his Ph.D. in fisheries from the University of Washington in 1996.

David Karl is a professor of oceanography at the University of Hawaii. His research interests include marine microbial ecology, biogeochemistry, long-term time-series studies of climate and ecosystem variability, and the ocean's role in regulating the global concentration of CO^2 in the atmosphere. Dr. Karl is a member of the Polar Research Board. He earned his Ph.D. in oceanography from the Scripps Institution of Oceanography, University of California, San Diego, in 1978.

Brenda Konar is an assistant professor at the School of Fisheries and Ocean Sciences at the University of Alaska, Fairbanks. Dr. Konar's research interests include fish assemblages associated with sea lion haul-outs; utilization of Alaska kelp beds by commercially important fish; freeze tolerance and survival of intertidal invertebrates; Bering Sea benthic amphipod community stability or instability relative to changing oceanographic conditions and increased gray whale predation; comparison of Barents-Bering Sea trajectories of marine ecosystem response to Arctic climate change; subtidal, intertidal, and benthic ecology; phycology; invertebrate biology; research scuba diving; biodiversity; and monitoring programs. Dr. Konar earned her Ph.D. in biology from the University of California, Santa Cruz, in 1998.

Robie Macdonald is a research scientist at the Institute of Ocean Sciences, Fisheries and Oceans, Canada. His research focuses on ocean geochemistry; contaminant processes; stable isotopes; environmental assessment; freshwater budgets, shelf processes, and sea-ice formation; and organic carbon cycling in marine sediments. He has received the University Medal in Chemistry, the Society of Chemical Industry Merit Award, and the Chemical Institute of Canada Prize. Dr. Macdonald is a member of the Polar Research Board. He earned his Ph.D. in oceanography in 1972 from Dalhousie University.

Wieslaw Maslowski is an associate research professor at the Naval Postgraduate School. Dr. Maslowski's research interests include Arctic oceanography; numerical ocean and sea-ice modeling; ocean circulation and climate change; physical and polar

oceanography; dynamical oceanography and numerical modeling; climate variability in the Arctic Ocean; and impacts of mesoscale ocean currents on sea ice in high-resolution Arctic ice and ocean simulations. Dr. Maslowski earned his Ph.D. from the University of Alaska in 1994.

Julian P. McCreary, Jr., is currently the director of the International Pacific Research Center (IPRC) at the School of Ocean and Earth Science and Technology at the University of Hawaii, Honolulu. The IPRC's Mission is "to provide an international, research environment to improve understanding of the nature and predictability of climate variability in the Asia-Pacific sector, including regional aspects of global environmental change." Dr. McCreary's research interests include equatorial ocean dynamics, coastal ocean dynamics, ocean circulation, coupled ocean-atmosphere models of climate dynamics, and ecosystem modeling. Dr. McCreary is a member of the Ocean Studies Board. He received his Ph.D. in oceanography from Scripps Institution of Oceanography, University of California, San Diego, in 1977.

Caleb Pungowiyi is a Yup'ik Eskimo who was born and raised on Savoonga on St. Lawrence Island. He has extensive experience as a spokesperson and advocate for Native concerns and traditional knowledge in regional, national, and international policy matters. Pungowiyi is currently president of the Robert Aqqaluk Newlin, Sr., Memorial Trust in Kotzebue, Alaska. He currently serves as the Marine Mammal Commission's special advisor on native affairs. He is a former president and CEO of the Inuit Circumpolar Conference. He currently serves on the Bering Straits Regional Commission and, the Committee of Scientific Advisors for the Marine Mammal Commission. Pungowiyi also serves on the Bering Sea Impact Study (a subcommittee of the International Arctic Science Committee), the Arctic Research Consortium of the United States, and the Indigenous People's Council for Marine Mammals.

Vladimir Radchenko is the director of the Sakhalin Research Institute of Fisheries and Oceanography in Russia. Dr. Radchenko has more than 15 years of experience in fisheries research in the Bering Sea. His research interests focus on the composition, structure, and dynamics of nekton communities of the Bering Sea epipelagic layer; seasonal spatial distribution dynamics; and historical trends of fisheries and stocks condition of Pacific salmon. He currently serves as member and chair of the PICES Biological Oceanography Committee. Dr. Radchenko earned his Ph.D. in fisheries research from the Pacific Scientific Research Fisheries Center in Vladivostok in 1994.

STAFF

Chris Elfring is director of the Polar Research Board (PRB) and Board on Atmospheric Sciences and Climate (BASC). She is responsible for all aspects of strategic planning, project development and oversight, financial management, and personnel for both units. Since joining the PRB in 1996, Ms. Elfring has overseen or directed studies that produced the following reports: *Frontiers in Polar Biology in the Genomics Era* (2003), *Cumulative Environmental Impacts of Oil and Gas Activities on Alaska's North Slope*

(2003), *A Century of Ecosystem Science: Planning Long-term Research in the Gulf of Alaska* (2002), and *Enhancing NASA's Contributions to Polar Science* (2001). In addition, she is responsible for the Board's activities as the U.S. National Committee to the Scientific Committee on Antarctic Research.

Sheldon Drobot was a program officer at the Polar Research Board and the Board on Atmospheric Sciences and Climate December 2002 until November 2004. He received his Ph.D. in geosciences (climatology specialty) from the University of Nebraska-Lincoln. Dr. Drobot has directed NRC studies on *Climate Data Records from Operational Satellites* and *A Vision for the International Polar Year 2007 – 2008*. His research interests include sea ice-atmosphere interactions, microwave remote sensing, statistics, and long-range climate outlooks. Dr. Drobot is now at the University of Colorado-Boulder. His researching interests include interannual variability and trends in Arctic sea ice conditions and how low-frequency atmospheric circulation affects sea ice distribution; short-range forecasting of Great Lakes ice conditions; and biological implications of sea ice variability.

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