SPECIAL REPORT 262

A Process for Setting, Managing, and Monitoring Environmental Windows for Dredging Projects

Committee for Environmental Windows for Dredging Projects

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Division on Earth and Life Studies

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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Committee for Environmental Windows for Dredging Projects

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Preface

Environmental windows are those periods of the year when dredging and disposal activities may be carried out because regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds during these periods. Environmental windows, therefore, are used as a management tool for reducing the potentially harmful impacts of dredging activities on aquatic resources. The first environmental windows were established more than 30 years ago and, according to the U.S. Army Corps of Engineers (USACE), are applied today to more than 80 percent of all federal dredging projects. Given the cumulative restrictions on dredging operations resulting from the application of environmental windows, USACE requested that the National Research Council's Transportation Research Board (TRB)–Marine Board conduct a workshop to explore the decision-making process used to establish environmental windows, as well as the consistency of the windows-setting process. The statement of task for the workshop is included in Chapter 1.

The National Research Council established the Committee for the Workshop on Environmental Windows for Dredging Projects to design, oversee, and interpret the results of the workshop. Formed in June 2000, the committee comprised 12 members representing ports, dredging contractors, benthic and wetland ecologists, commercial fisheries experts, sedimentologists, ichthyologists, environmentalists, and state and federal regulatory agencies. During the course of a 1-year period, the committee met three times—the first to plan the workshop, the second to review the workshop results, and the third to prepare the committee's findings and recommendations presented in this report. Members of the committee also participated in the Sea Grant Conference on Dredged Material Management: Options and Environmental Considerations and organized and participated in a half-day session at the 2001 National Dredging Team Conference.

The committee used information obtained through case studies and outreach efforts conducted in preparation for the workshop to develop a draft template for a process for setting, managing, and monitoring environmental windows. This draft template was presented during the workshop, held March 19–20, 2001. Participants at the workshop represented a cross-section of stakeholders involved in the windows-setting process, including federal and state government officials, port officials, representatives from environmental interest groups, dredging contractors, and academic experts from a variety of relevant fields. A listing of the workshop participants is provided in Appendix C. The draft template was reviewed and refined throughout the course of the workshop, and a summary of the workshop proceedings including the refined template was distributed to participants expressing a willingness to review and comment on its accuracy.

The committee wishes to acknowledge the contributions of many individuals and organizations to the development of this report. Kris A. Hoellen managed the study and drafted the report under the guidance of the committee and the supervision of Stephen R. Godwin, Director of TRB's Studies and Information Services Division. Susan Roberts provided liaison support from the Ocean Studies Board, Thomas Bigford served as liaison from the National Oceanic and Atmospheric Administration (NOAA), and Douglas Clarke served as liaison and project sponsor from USACE; all three provided background materials and valuable insights to the committee.

The committee also wishes to thank the organizers of the National Dredging Team Conference and the Sea Grant Conference on Dredged Material Management: Options and Environmental Considerations for allocating space and time for the committee's outreach efforts. In addition, the committee would like to acknowledge personnel from USACE and NOAA who developed case studies that documented their experiences with environmental windows.

The workshop benefited greatly from the contributions of a reaction panel whose members provided much-needed advice and guidance during critical points in the proceedings. Panel members were Suzanne Schwartz (U.S. Environmental Protection Agency), Thomas Bigford (NOAA), Joseph Wilson (USACE), and Robert Van Dolah (South Carolina Department of Natural Resources). Finally, the committee is indebted to all those who participated in the workshop for both their time and continued interest.

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 the 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.

The committee thanks the following individuals for their review of this report: Steven Goldbeck, San Francisco Bay Conservation and Development Commission; H. Thomas Kornegay, Port of Houston Authority; Charles A. Simenstad, University of Washington; and Ancil Taylor, Bean Stuyvesant LLC. Although these reviewers provided many constructive comments and suggestions, they were not asked to endorse the findings and conclusions, nor did they see the final draft before its release.

The review of this report was overseen by Lester A. Hoel, University of Virginia. 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.

Suzanne Schneider, Assistant Executive Director of TRB, managed the report review process. The report was edited and prepared for publication under the supervision of Nancy Ackerman, Director of Reports and Editorial Services. Rona Briere edited the report. Special thanks go to Frances Holland for assistance with meeting arrangements and to Alisa Decatur for production of the final report.

Contents

Executive Summary

Environmental windows are periods in which regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds, and dredging is therefore permitted. Conversely, seasonal restrictions are applied—dredging and disposal activities are prohibited—when the perceived increase in potential harm to aquatic resources is above critical thresholds. Since passage of the National Environmental Policy Act in 1969, resource agencies have requested environmental restrictions on dredging and disposal activities with increasing frequency. More than 80 percent of the federal contract dredging program is now subject to some type of restriction.

Windows are an intuitively simple means of reducing risk to biological resources from stressors generated during dredging and disposal activities, including entrainment of fish eggs and larvae, resuspension of buried contaminated sediments, habitat loss, and collisions with marine mammals. The use of windows as a management tool, however, can have significant cost implications for both the U.S. Army Corps of Engineers (USACE) and the local sponsors of dredging projects. For example, windows can prolong completion of dredging projects, delay project deadlines, and increase risk to dredging personnel by shifting dredging to periods of potentially inclement weather and sea states. Because both recommendations to impose environmental windows and the cumulative economic impact of their application are increasing, USACE requested that the National Research Council's Transportation Research Board–Marine Board form a committee of experts to conduct a workshop to explore the decision-making process for establishing environmental windows and provide suggestions for improving the process.

A committee with expertise in port operations, dredging, benthic and wetland ecology, commercial fishing, sedimentology, ichthyology, environmental protection, and federal and state environmental regulation was formed to conduct the project. The committee gathered information from other experts, conducted case studies, and planned and carried out the workshop. The workshop was designed to solicit the views of the different parties involved in and affected by the process of setting windows. Participants represented ports, federal and state environmental regulatory agencies, environmental interest groups, dredging operations, and relevant academic fields. Breakout sessions were devoted to such topics as how to evaluate trade-offs between environmental benefits and operational costs, the strengths and weaknesses of current decision-making processes, the scientific and technical justifications used in establishing windows, and dredging technologies designed to minimize environmental impact.

Through examination of case studies and discussions with workshop participants, the committee found that the scientific evidence used in setting windows varies greatly. Some decisions appear to be based on outdated data and information, others on the authority of the resource agency, and only a few on scientific observation. Economic and project considerations appear to have been given minimal consideration in the majority of the cases reviewed. The overall impression that emerged from the case studies examined was a discernible lack of consistency in the current windows-setting process.

Proposed Process for Setting, Managing, and Monitoring Environmental Windows

Prior to the workshop, the committee developed a draft template for a systematic process for achieving greater consistency, predictability, and reliability in decision making related to setting, managing, and monitoring environmental windows. The draft template was then refined to reflect input obtained during the workshop (see Box ES-1). The template embodies an ongoing process that involves all stakeholders and is based on principles of adaptive management. The adaptive nature of the process should make it possible to achieve the consistency, predictability, and reliability lacking today without sacrificing needed flexibility.

The proposed methodology is not dependent on the conduct of new scientific or technical research in the first instance, and can be incorporated into other, ongoing stakeholder processes. Although it is capable of standing on its own, its implementation would be most useful if the process were piloted in a few districts; the pilot program would include training sessions and workshops

BOX ES-1

Template for a Process for Setting, Managing, and Monitoring Environmental Windows

Step 1

All stakeholders are identified, and commitments to the integrity and completion of the process are secured from all agencies with advisory and decision-making roles.

Step 2

The stakeholders are convened. The following tasks should be completed during the first meeting or shortly thereafter:

Step 2A. Agree on the time period for the evaluation.

Step 2B. Define the specific geographic area(s) of interest or concern within a region.

Step 2C. Identify and rank the resources of concern.

Step 2D. Conduct a systematic evaluation of proposed dredging projects, as well as existing and proposed window applications, and rank the projects in terms of such factors as economic importance and sensitivity to timing.

Step 2E. Form a Science Team whose expertise will make it possible to identify and evaluate the threats to the resources of concern. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

Step 2F. Form an Engineering Team, including contractors and USACE personnel whose expertise will allow them to identify the most appropriate technological options (i.e., equipment, management controls, or operational procedures) for conducting dredging and disposal activities to meet the resource goals specified by the Science Team and to assess the costs associated with the options identified. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

continued

BOX ES-1 (*continued*)
Template for a Process for Setting, Managing, and Monitoring Environmental Windows

Step 3

The Science and Engineering Teams conduct biological and engineering evaluations of the proposed dredging projects. All potential adverse impacts, along with the biological resources of concern, should be identified. Close coordination between the two teams should be sought, and overlap should be created by having the chairperson of each team serve as an adviser to the other team.

Step 3A. The Science Team identifies biological resources predicted to be adversely affected by each dredging project and provides this information to the Engineering Team.

Step 3B. The Science Team documents the temporal variability of the species and the vulnerable habitats. The Science Team also identifies the acceptable levels of impact (e.g., "takes") and the specific stressors responsible for the impacts and provides this information to the Engineering Team.

Step 3C. The Engineering Team, using information from the Science Team on the stressors involved, recommends strategies for reducing the stressors to acceptable levels (e.g., technology, contracting, operational methods, equipment selection). The Engineering Team provides cost estimates for these strategies. The results of the Engineering Team review are provided to the Science Team.

Step 3D. The Science Team reviews the information developed by the Engineering Team and notes any resulting changes in the expected impacts.

Step 3E. The Science Team recommends acceptable dredging periods, that is, environmental windows.

Step 3F. A formal consultation under Section 7 of the Endangered Species Act is conducted if listed species may be adversely affected.

Step 3G. The Science Team prioritizes the recommendations for windows and provides this information to the Stakeholder Group in areas where multiple windows for varying species are recommended.

continued

Step 4
The Stakeholder Group reviews the alternative strategies—including windows—identified by the Science and Engineering Teams and endorses a plan of action.

Step 5
The recommended plan is implemented.

Step 6
The Stakeholder Group reviews the season's dredging activities to evaluate monitoring data and to identify changes that can be incorporated to refine future dredging and disposal activities.

demonstrating how the proposed methodology could be integrated into existing processes.

The key to successful implementation of the proposed process is twofold. First, each stakeholder must commit to the integrity and completion of the process (see Step 1). Without a commitment from each government agency involved (both advisory and decision making) to dedicate the necessary financial and staff resources to the process, the methodology will not succeed and should not be attempted. It should also be noted that this process was designed to be implemented in cases in which dredging projects have been congressionally mandated or approved. The starting point for the process is not whether to dredge but how and when to dredge.

Second, a factor that distinguishes this from other windows-setting processes is the interaction between the Science and Engineering Teams specified in Steps 2 and 3. In many instances, experts in dredging technology are working in a vacuum—attempting to develop technologies for reducing the biological impacts of dredging activities without the benefit of clearly specified goals. Interaction among biologists, environmental scientists, dredging technology experts, and those responsible for safe ship operations is critical to the proposed process. Specifically, the methodology calls for the formation of a Science Team charged with identifying those biological resources most likely to be adversely impacted by dredging activities. In addition, the Science Team is to identify the acceptable levels of impact for those species identified as most vulnerable. On the basis of the information provided by the Science Team, the Engineering Team will recommend strategies (e.g., technology, contracting, operational methods, equipment selection) for meeting the target levels of acceptable stress. Using the strategy recommended by the engineers, the scientists will reassess potential biological impacts and recommend windows accordingly. The committee is confident that by integrating the knowledge provided by both scientists and engineers, the proposed process will lead to the establishment of windows that are predicated on a higher degree of scientific certainty than is presently the case.

Key Findings and Recommendations

The committee's key findings and recommendations are presented below.

Broad-Based Management Strategies

Dredging and disposal operations are only one of a number of human activities that affect the nation's waterways. They need to be evaluated not only in the absolute sense so that management strategies for reducing environmental impacts to acceptable levels can be developed but also in the context of other activities that affect the uses and value of water bodies important to society.

> *Recommendation 1.* **The decision-making process for managing dredging and disposal operations to achieve sustainable waterways and to protect natural resources, both living and nonliving, should be broadly based.**

Management Tools

Environmental windows are one of a number of management and technological tools that can—when properly selected and applied—not only reduce the environmental impacts of dredging and disposal operations but also increase the efficiency and effectiveness of those operations.

> *Recommendation 2.* **All tools, including windows, should be considered in designing a management plan for carrying out dredging and disposal operations.**

Proposed Process for Setting, Managing, and Monitoring Environmental Windows

Existing processes for setting, managing, and monitoring environmental windows vary widely from region to region. The variations reflect differences among natural environments and their living resources; sociopolitical contexts; and experience with involving stakeholders in resolving complex, multidimensional issues. It is only through testing and refinement of the proposed process in a variety of settings that the methodology can be refined, endorsed, and incorporated into existing decision-making processes to provide greater consistency.

> ***Recommendation 3.* The proposed process for assessing the need for windows and for managing and monitoring windows when selected should be pilot tested in a small number of districts.**

Scientific Data and Information

A series of technical syntheses encompassing field and laboratory studies of environmental stressors, biological resources, and specific life-history stages affected by dredging and disposal operations needs to be undertaken and regularly updated. These syntheses should focus on integrating and interpreting local and regional data and information and placing them in a larger context. Through this process, gaps in scientific information will become apparent and can serve as the focus of future research. These syntheses should be undertaken as an integral part of the recommended pilot studies.

> ***Recommendation 4.* All existing scientific data and information should be exploited in evaluating and setting windows as part of an overall management strategy for dredging and disposal operations.**

Opportunities for Cross-Training

The current divide between those responsible for engineering dredging projects and those responsible for protecting biological resources needs to be narrowed. Each discipline must become better educated about and sensitive to the pressures faced by the other if management tools that satisfy the needs of both parties are to be developed.

> ***Recommendation 5.* Cross-training opportunities should be created for resource managers and dredging operators. For example, resource managers should be encouraged to observe the operations of a wide array of dredges in various weather and sea states. Opportunities should also be created for dredge owners and operators to observe, and perhaps even take part in, the public participation processes undertaken by resource managers and to learn about the biological constraints, natural history, habitat types, and issues related to dredging and its consequences for the natural environment.**

Structured Decision-Making Tools

Although the process outlined above for setting, managing, and monitoring environmental windows is intuitively simple, its implementation will be challenging because it calls for a balancing of priorities. The most difficult step is Step 4, the balancing of scientific conclusions against economic and societal considerations. Structured decision-making tools can be helpful in addressing these issues.

> *Recommendation 6.* **A special effort should be made to identify existing tools for structured decision making in complex socio-political situations and to evaluate their applicability to the process of setting, managing, and monitoring environmental windows for dredging. One or two of the most promising tools should be selected for additional testing, research, and refinement aimed at enhancing their acceptability and use in the windows-setting process.**

Funding

If resource agency staff are expected to fulfill their mandates under the law and participate in the windows-setting process in a timely manner, the agencies will need additional funding.

> *Recommendation 7.* **Additional funding should be allocated to resource agencies to ensure full, thorough, and active participation in the windows-setting process.**

Adaptive Management

The justification for windows needs to be reviewed periodically. All windows ought to be viewed as subject to change on the basis of new data and information that should be incorporated routinely into the windows-setting process.

> *Recommendation 8.* **The windows-setting process should reflect the principle of adaptive management. That is, as new data and information are acquired and experience is gained, they should be fed back into the process.**

1

Introduction

Environmental windows are those periods of the year when dredging and disposal activities may be carried out because regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds at these times. Conversely, seasonal restrictions are applied during periods of the year when dredging and disposal activities are prohibited because of the increased potential for harm to aquatic resources. Environmental windows are one of a number of management and technological tools that can be used individually or in combination to reduce the environmental impacts of dredging and disposal operations on living resources, aesthetics, and recreation and tourism. This report presents the findings and recommendations of a committee of experts formed to examine the decision-making process for establishing environmental windows and provide recommendations for improving the process. These recommendations are based largely on the results of a workshop held to (*a*) explore the decision-making process for establishing environmental windows and (*b*) examine options for introducing greater consistency, reliability, and predictability into the process.

Background

Environmental windows are most frequently designed to provide an opportunity for dredging while protecting against the following primary stressors generated during dredging and disposal operations:

- Entrainment of fish eggs and larvae, juvenile fishes, sea turtles, and other threatened or endangered species;
- Suspended sediments and turbidity, which may affect fish and shellfish spawning, disrupt anadromous fish migrations, reduce water quality, and cause aesthetic degradation;
- Resuspension of buried contaminated sediments, which may release toxins and nutrients that can have acute and chronic effects on living resources;
- Sedimentation (burial of plants and animals and economic resources);
- Habitat loss by burial, removal, or degradation; and
- Collisions with marine mammals (e.g., whales).

For each dredging project, the goal of resource agencies and the U.S. Army Corps of Engineers (USACE) is to achieve cost-effective dredging and disposal while maintaining and protecting aquatic resources—living resources, aesthetic resources, and recreational and tourism activities. Accomplishing this goal is frequently a challenging balancing act. In conducting dredging projects, USACE must be cognizant not only of the need to protect natural resources but also of project timelines, the availability of equipment, and the safety risks posed to dredging personnel by operating in potentially inclement weather and sea states. Ports must also weigh the risks to ships and their crews and the economic losses associated with project delays. Resource managers, on the other hand, must consider potential damage to the life histories of multiple species (particularly those that are threatened or endangered) that reside in or migrate through dredging and disposal areas, along with critical habitat concerns, when making recommendations for restricted periods and environmental windows. Yet biologists and regulatory agencies are frequently hampered in their mission to protect critical resources by a lack of definitive scientific information on either the susceptibility of the resources to dredging stressors or the actual biological impacts. In these cases, the agencies that are charged with protecting public resources have historically adopted a conservative or risk-averse approach, resulting in recommendations for narrow dredging windows. The establishment of environmental windows also frequently involves multiple state and federal agencies that may follow different procedures in recommending windows.[1]

Since the passage of the National Environmental Policy Act in 1969, resource agencies have requested environmental restrictions with increasing frequency.

[1] The committee acknowledges that both the resource agencies and USACE are bound by several governing laws and considerations when recommending windows (e.g., the National Environmental Policy Act; Clean Water Act; Marine Protection, Research, and Sanctuaries Act; Fish and Wildlife Coordination Act of 1958; Marine Mammal Protection Act; Endangered Species Act; and Magnuson–Stevens Fishery Conservation and Management Act). However, the overall process for factoring the various considerations into the windows-setting process and the level of documentation for the windows provided to USACE vary from agency to agency.

According to USACE, environmental windows today are applied to more than 80 percent of all federal dredging projects. Because of the frequency of recommendations to impose environmental windows and the cumulative economic impact of their application for more than 30 years,[2] USACE recently challenged the efficacy of the windows-setting process. Moreover, USACE questioned the scientific validity of establishing windows in the absence of definitive scientific information, and called for greater consistency, predictability, and reliability in the process.

Purpose

Given the above concerns, USACE asked the National Research Council's Transportation Research Board–Marine Board to undertake an examination of the application of environmental dredging windows in federal navigation projects; this effort was conducted in collaboration with the Ocean Studies Board. USACE requested a workshop to explore the decision-making process for establishing environmental windows and to solicit suggestions for improving the process. The statement of task for the project is shown in Box 1-1.

To carry out this charge, a committee was appointed with expertise in port operations, dredging, benthic and wetland ecology, commercial fishing, sedimentology, ichthyology, environmental protection, and federal and state regulation. The committee chose to place particular emphasis on the last portion of its statement of task—the development of a pilot process for setting, managing, and monitoring environmental windows. The workshop was designed to solicit the views of a wide range of experts and interested parties involved in and affected by the establishment of environmental windows. The workshop discussions on the regulatory, scientific, and economic issues associated with windows and participants' reactions to a proposed pilot process presented at the workshop assisted the committee in developing a pilot process that could be used to improve the technical and scientific bases used for establishing windows.

Organization of This Report

Chapter 2 details the research and outreach efforts conducted in preparation for the workshop, the workshop structure and rationale, and the major points made during the proceedings. Chapter 3 presents a template for a proposed

[2] Cumulatively, windows can create very tight requirements for contracting, mobilization, and conduct of dredging projects, with little flexibility for unanticipated shutdowns for repairs or severe weather conditions.

BOX 1-1

Statement of Task

This workshop will be used to identify issues and discuss options that could lead to greater consistency in the procedures used by the U.S. Army Corps of Engineers in setting environmental windows. It is anticipated that the workshop will have several panels covering topics such as: the wide range of laws and regulations establishing bases for various protection measures; knowns and unknowns about the biological consequences of alternate dredging methodologies; new developments in dredging techniques; better (and worse) examples of decision making for windows in different regions; models of collaborative decision making in other environmental and transportation areas; and tools (processes, analytical models, etc.) for improving decision making.

Workshop participants will be invited to represent a cross-section of groups involved in setting windows, including federal and state resource agency staff, experts in dredging, port officials, environmental groups, and academic experts from the variety of relevant fields. The workshop will be designed to ensure opportunities for dialogue and information exchange. The summary will provide an identification of the issues raised and the opinions expressed both pro and con on these issues. The project committee will also provide ideas and suggestions for appropriate follow-up activities, such as additional research, workshops, or a pilot process for setting, managing, and monitoring environmental windows.

process for setting, managing, and monitoring environmental windows, developed in draft form by the committee prior to the workshop and refined in accordance with the workshop discussions. Chapter 4 provides recommendations formulated by the committee, largely on the basis of information that emerged from the workshop. Appendix A contains summaries of the workshop sessions, Appendix B is a glossary of terms relevant to this report, Appendix C provides the workshop agenda and a listing of the participants, and Appendixes D and E contain copies of the forms used to solicit information and feedback from various stakeholders. A final section presents biographical information on the committee members.

2

Workshop Preparations, Design, and Major Points of Discussion

Workshop Preparations

During its first meeting, the committee was briefed by representatives of the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE) on the current status of the windows-setting process. On the basis of these briefings, the committee decided to conduct case studies of dredging projects to expand its knowledge base. Additional outreach and information-gathering opportunities were also identified. All of these activities were completed prior to the workshop and provided important input to its design and execution, as well as to the draft template described in Chapter 3. These preparatory activities are described below.

Case Studies

Information for each case study was solicited from both USACE and NOAA. The committee developed forms to be used for providing the requested information (see Appendix D). These forms were sent to USACE Headquarters and subsequently distributed to all USACE districts. NOAA was asked to provide information on the case studies submitted by the USACE districts.

The following USACE districts responded to the original request: Mobile, Galveston, Norfolk, Baltimore, Detroit, New England, New York, San Francisco, New Orleans, and Rock Island. The districts provided basic information on project specifics, involvement of state resource agencies, resources of concern, perceived impact, habitat type, life-history stages, technical evidence, and procedures used in setting environmental windows. In some cases, examples of the resource agencies' decisions were included, and for some studies, committee members obtained additional information through discussions with USACE personnel, state resource agencies, and others familiar with particular projects. In one case, a committee member participated in an actual windows-setting meeting involving the state and federal resource agencies and USACE. The case studies also formed a basis for discussion at the National Dredging Team Conference held in Jacksonville, Florida, in January 2001.

The overall findings from the case studies supported USACE's original assertions to the committee regarding the efficacy of the windows-setting process. Districts reported substantial variation in the number of projects that have windows, the effort spent in developing the windows, the extent of interagency coordination and cooperation, the level of regulatory restrictions, and other factors. Although some districts have better-developed processes than others, one of the impressions resulting from this exercise was the lack of consistency in the windows-setting process.

The case studies also revealed large differences in the scientific evidence used for setting windows. In some instances, no such evidence was provided. Some decisions were based on outdated data and information; some were based on the authority or opinion of the resource agency; while a few were based on specific scientific observations. The proposed windows were generally accepted by USACE as unavoidable restrictions on the projects. As a result, formal objections were rarely raised, as there appeared to be no reliable process for dispute resolution. Economic considerations were generally not factored into the windows-setting process. Disputes appeared to be more common among agencies in the interpretation of existing data, and there was apparently little attempt to include a broad range of stakeholders in the process.

Although some windows were set on the basis of environmental conditions (e.g., temperature) that could be monitored, relatively little monitoring was generally done to verify biological impacts, although in some cases the resource concerns (and the windows) changed over time, indicating that the conditions were actively reviewed as the project progressed. The lack of participation by certain resource agencies in the windows-setting process was cited as a shortcoming, which is a problem that all parties recognize. Some of these agencies did not send representatives to attend meetings or entered the process fairly late, causing significant delays and disruptions. Many resource agency representatives have commented that they do not have readily available the staff or the fiscal resources to participate fully in the process, especially on a project-by-project basis. Other shortcomings in coordination and communication among agencies were also noted.

Outreach Efforts

The committee sought opinions and comments from a wide range of key stakeholders as input to the workshop. The committee was fortunate to have the opportunity to participate in the Sea Grant Conference on Dredged Material Management: Options and Environmental Considerations, held in December 2000 at the Massachusetts Institute of Technology, and to plan and host a full-day session at the National Dredging Team Conference, held in January 2001 in Jacksonville, Florida. During both meetings, the committee members apprised the audience of the upcoming environmental windows workshop; invited their participation; and actively solicited feedback, particularly on the information provided in the case studies. A copy of the questionnaires distributed by the committee for this purpose at the meetings is contained in Appendix E.

Workshop Design

The workshop was structured to enable the committee to produce three primary outputs:

- An analysis of environmental dredging windows as a management tool, with an emphasis on (*a*) their effectiveness in protecting natural resources; (*b*) the processes by which they are developed, applied, and managed; and (*c*) other management and technological tools available that could be used in conjunction with or instead of environmental windows to provide the appropriate level of protection of aquatic resources.
- A set of recommendations for improving the process by which environmental windows are developed, enhancing the efficacy of windows as one of a number of tools available to protect natural resources, and promoting greater consistency in their development and application across regions.
- A process template outlining specific steps designed to ensure the involvement of all stakeholders and effectively integrate scientific and engineering data. The goal of this template is to introduce greater consistency, reliability, and predictability into the windows-setting process and to establish a firm scientific foundation for windows-setting decisions.

The committee designed the workshop to facilitate information exchange; maximize dialogue and participation by attendees; identify the major categories of unresolved research questions; and produce the raw materials needed to develop a process for setting, managing, and monitoring environmental windows for federal dredging projects. After reviewing the case studies and consulting with a number of agencies, the committee prepared a draft process template before the workshop to stimulate discussion. This draft template was presented during the opening plenary session of the workshop. Participants were challenged to focus on reviewing, revising, and refining the draft template, or developing an entirely different alternative by the end of the workshop.

Throughout the workshop, results of each session were summarized and incorporated into the draft template. As the template was revised and refined during the course of the workshop, it was presented periodically to the participants and to a commentary panel comprising senior-level executives from USACE, NOAA, the Environmental Protection Agency, and a state resource agency. After each presentation, the committee met and revised the template, as appropriate.

Major Points of Discussion

The majority of time at the workshop was devoted to working group sessions focused on such issues as the current state of the science concerning the biological-ecological impacts of alternative dredging technologies, new developments in dredging techniques and technologies, analytical methods for assessing costs and benefits, and the administrative process currently followed for establishing windows in various districts. In addition, participants in breakout sessions were challenged to focus the discussion of each issue on environmental windows and to make specific recommendations for improving the draft template. Major points of discussion that emerged from the sessions included the following:

- Although there have been some examples of effective and successful environmental windows for dredging projects, many participants noted that it is impossible to demonstrate direct causation between a specific dredging and disposal operation and the long-term health of a particular species or natural system.
- Participants also noted that environmental windows have been used historically as a tool for protecting juvenile fish, shellfish, and other marine life, as well as critical habitats for spawning, nursery, and foraging—particularly during the early life stages. Windows are used as well in certain circumstances (e.g., threatened or endangered species) to protect species at the individual level. Additionally, there are species that, while not formally listed, may warrant special consideration because of population status. Therefore, it becomes exceedingly difficult to

separate spatial and temporal considerations within an estuary when setting environmental windows for dredging projects. In general, the scale of threat to a species should be the key consideration when selecting the most appropriate management tool. Environmental windows should be targeted toward the most sensitive life stages of selected species of concern. Participants also observed that in the absence of complete scientific information regarding the potential impact of a dredging project on a given species, resource managers should adopt a precautionary, risk-averse approach when interpreting existing regulations.

- Although there has been significant research and experience regarding the risks of dredging to species at the individual level, little work has been done on the risks of dredging at the population level. Population-level effects are therefore poorly understood, and in the context of windows have been used inconsistently to protect resources at this level. Nevertheless, participants stated that individual-, population-, and ecosystem-level effects should be important management considerations for any given dredging project.
- Many participants noted that appropriate monitoring—before, during, and after dredging operations—should be designed specifically to measure the effectiveness of windows in protecting species of concern. A feedback mechanism should be established to incorporate the best information on existing tools, lessons learned, and related research to ensure that the process is managed adaptively in the future as new information is generated. If targets are defined properly, monitoring can be used to set or refine windows.
- Additional factors were identified that should be considered when establishing environmental windows. These factors include the following: human health and safety, cumulative impacts of dredging, and availability of agency staff and resources.
- In setting operational or physical controls, the target must first be defined (e.g., total suspended solids level, plume extent). For this step to succeed, the potential impacts must be identified specifically and quantitatively.
- Several participants suggested that problems involving the impacts of well-designed and -executed dredging and disposal operations often are mainly a matter of public perception. Windows should be accompanied by clear and explicit identification of what is being protected and how. Then the various aspects should be prioritized. The goal should be to strike a balance between the costs of resource protection and the costs of delay, and even of the no-dredging scenario.
- Finally, several participants commented that USACE and an independent group of engineering and industry (contractor) experts, with input from scientists, should recommend the most appropriate technologies for effectively managing the environmental impacts of dredging projects. For greatest efficiency, this should be done on a regional or local basis rather than on a project-specific basis.

Complete summaries of the workshop sessions are contained in Appendix A; the workshop agenda is provided in Appendix C.

Throughout much of the workshop, the committee heard engineers express the desire for a clearly articulated target level of acceptable impact. Resource professionals also articulated a strong desire to interact with and provide input to the dredging engineers in an effort to foster a greater understanding of the biological resources potentially at risk. This expressed desire for cross-communication served as an impetus for the committee's decision to recommend the process template contained in this report. The committee is confident that by integrating the knowledge provided by both scientists and engineers, the proposed process will lead to the establishment of windows that are predicated on a higher degree of scientific certainty than is currently the case.

3

Process for Setting, Managing, and Monitoring Environmental Windows

The template for a process for setting, managing, and monitoring environmental windows shown in Box 3-1 was developed through focused discussions that occurred before, during, and after the workshop (see Figure 3-1 for a graphical depiction of the process). The process itself is simple, but its successful execution is more difficult, demanding sustained commitment by all parties concerned. Although any decision to dredge should be based on clearly established need, the proposed process is designed to pertain only to those federal projects that have been preapproved and for which funds have been appropriated. The starting point for this process is not whether to dredge but how and when to dredge.

The proposed methodology works most effectively if it is recognized by all participants as an iterative process allowing for the resolution of environmental windows and related issues that require decisions based on the best available scientific and technological information. It is not the aim of the proposed process to modify the legal basis by which the various agencies (both lead and trustee) participate in shaping dredging projects. Nor does the committee intend to force all projects into a "one-size-fits-all" approach. For example, when threatened and endangered species are involved, the process may need to be applied to a larger area than is typically associated with a single dredging project to avoid cumulative impacts. The committee also believes the proposed process can be applied (after being appropriately adapted to local circumstances) to all major federal dredging projects. Details on each step in the process are provided below. The committee recommends that all

BOX 3-1

Template for a Process for Setting, Managing, and Monitoring Environmental Windows

Step 1

All stakeholders are identified, and commitments to the integrity and completion of the process are secured from all agencies with advisory and decision-making roles.

Step 2

The stakeholders are convened. The following tasks should be completed during the first meeting or shortly thereafter:

Step 2A. Agree on the time period for the evaluation.

Step 2B. Define the specific geographic area(s) of interest or concern within a region.

Step 2C. Identify and rank the resources of concern.

Step 2D. Conduct a systematic evaluation of proposed dredging projects, as well as existing and proposed window applications, and rank the projects in terms of such factors as economic importance and sensitivity to timing.

Step 2E. Form a Science Team whose expertise will make it possible to identify and evaluate the threats to the resources of concern. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

Step 2F. Form an Engineering Team, including contractors and USACE personnel whose expertise will allow them to identify the most appropriate technological options (i.e., equipment, management controls, or operational procedures) for conducting dredging and disposal activities to meet the resource goals specified by the Science Team and to assess the costs associated with the options identified. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

continued

Step 3

The Science and Engineering Teams conduct biological and engineering evaluations of the proposed dredging projects. All potential adverse impacts, along with the biological resources of concern, should be identified. Close coordination between the two teams should be sought, and overlap should be created by having the chairperson of each team serve as an adviser to the other team.

Step 3A. The Science Team identifies biological resources predicted to be adversely affected by each dredging project and provides this information to the Engineering Team.

Step 3B. The Science Team documents the temporal variability of the species in the area or the vulnerable habitats. The Science Team also identifies the acceptable levels of impact (e.g., "takes") and the specific stressors responsible for the impacts and provides this information to the Engineering Team.

Step 3C. The Engineering Team, using information from the Science Team on the stressors involved, recommends strategies for reducing the stressors to acceptable levels (e.g., technology, contracting, operational methods, equipment selection). The Engineering Team provides cost estimates for these strategies. The results of the Engineering Team review are provided to the Science Team.

Step 3D. The Science Team reviews the information developed by the Engineering Team and notes any resulting changes in the expected impacts.

Step 3E. The Science Team recommends acceptable dredging periods, that is, environmental windows.

Step 3F. A formal consultation under Section 7 of the Endangered Species Act is conducted if listed species may be adversely affected.

Step 3G. The Science Team prioritizes the recommendations for windows and provides this information to the Stakeholder Group in areas where multiple windows for varying species are recommended.

continued

BOX 3-1 (*continued*)
Template for a Process for Setting, Managing, and Monitoring Environmental Windows

Step 4
The Stakeholder Group reviews the alternative strategies—including windows—identified by the Science and Engineering Teams and endorses a plan of action.

Step 5
The recommended plan is implemented.

Step 6
The Stakeholder Group reviews the season's dredging activities to evaluate monitoring data and to identify changes that can be incorporated to refine future dredging and disposal activities.

meetings of the Stakeholder Group, Science Team, and Engineering Team be professionally facilitated.

Step 1
All stakeholders are identified, and commitments to the integrity and completion of the process are secured from all agencies with advisory and decision-making roles.

The purpose of this step is to identify all concerned and relevant stakeholders and to obtain a commitment to the process from each such individual and agency. In the absence of an existing stakeholder group, USACE should be charged with initiating the process by convening a small group of appropriate stakeholders who will subsequently identify appropriate additional members. All permitting and advisory agencies must be included in the discussions held during this step. Designated agency representatives should be empowered to speak on behalf of their respective agencies. Each member should be asked to ratify a charter stipulating decision-making processes to be used by the Stakeholder Group, time periods for completing work, and the like.

The term "regional" was used in the workshop to signify the proper spatial area within which to select members of the Stakeholder Group. The term could denote different geographic scales in different areas of the country; the notion

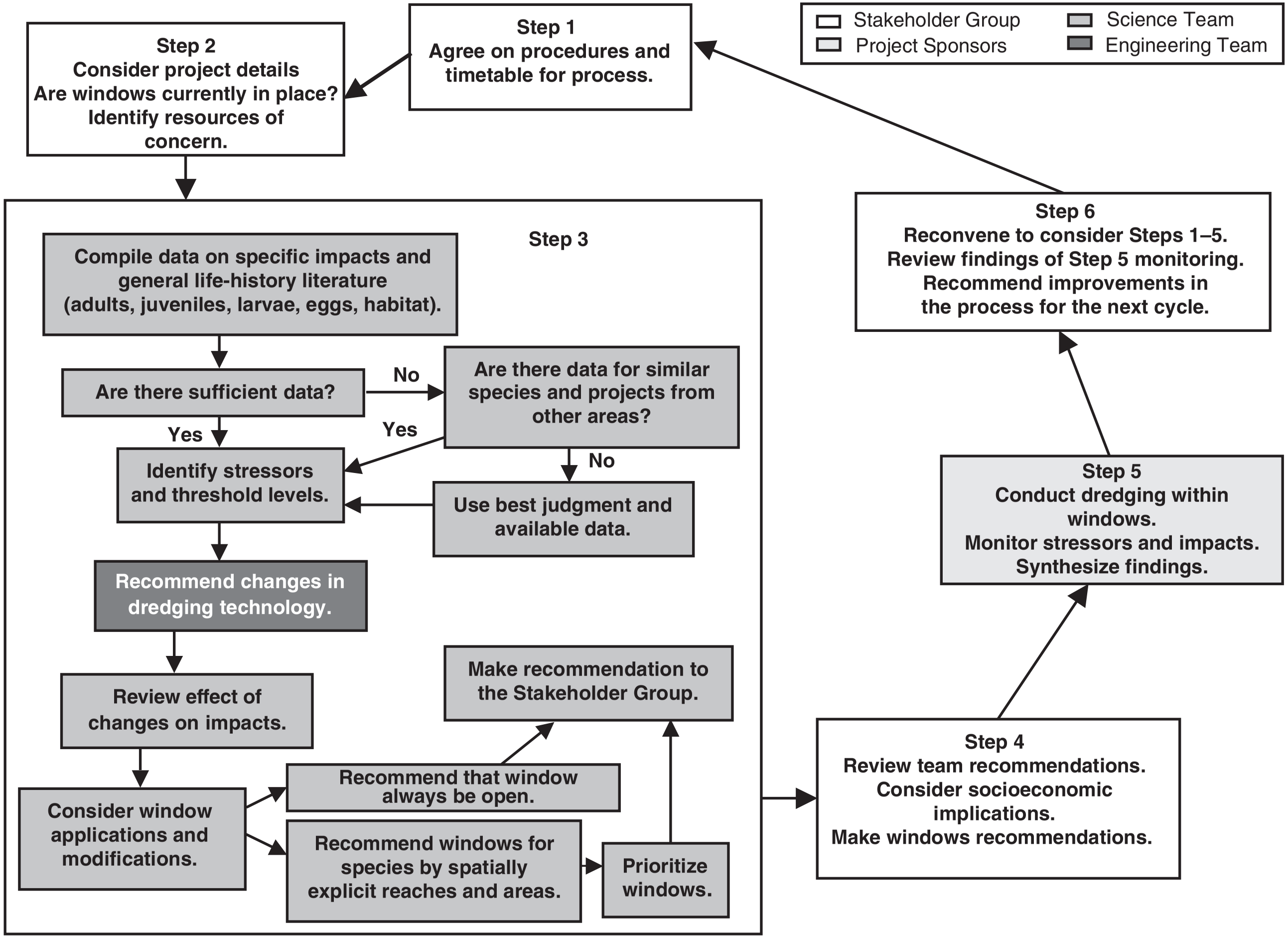

FIGURE 3-1 Process for setting, managing, and monitoring environmental windows. Steps 1–6 can be completed in one annual cycle. In the following years, all steps incorporate information from prior cycles.

of delineating a "region" must be based on locally acceptable definitions. For example, many areas have existing groups that actively assess environmental issues, such as groups addressing watershed issues, participating on regional dredging teams, or working on a particular estuary's comprehensive conservation and management plan. These existing groups should help define "regional" and facilitate the rapid identification of regional stakeholder participants. They should be encouraged to evaluate their current membership in selecting the team of core stakeholders and to expand the team as necessary to encompass all relevant groups and individuals and areas of expertise.

Once the Stakeholder Group has been identified, the first action needed is to secure the commitment of all parties to the windows-setting process, including a declaration to provide staff and monetary support as necessary to complete the process on an agreed-on schedule. Senior representatives of each agency or organization must make this commitment. A public statement of policy and support from senior officials will drive the process forward; thereafter, a person with decision-making authority should be obligated to abide by this commitment. It should be noted that participation in the process by government agencies does not imply an abrogation of responsibilities or legal rights under governing laws or regulations.

Step 2
The stakeholders are convened. The following tasks should be completed during the first meeting or shortly thereafter.

USACE and the local project sponsor should convene the stakeholders identified in Step 1 to accomplish the tasks described below. USACE and the resource agencies should assemble pertinent background material for the stakeholders' review prior to the first meeting.

Step 2A
Agree on the time period for the evaluation.

A commitment to a set time period for the systematic review and resolution of salient issues is necessary. Once the Stakeholder Group has selected a specific time period, the process that follows will be based on the best available information that can be assembled and considered within that time frame.

Step 2B
Define the specific geographic area(s) of interest or concern within a region.

The specific geographic area or areas of interest or concern within a region should be identified and agreed on. All anticipated federal dredging projects within the region should be enumerated. Ultimately, the areas of interest or concern should be defined by the interests of the Stakeholder Group.

Step 2C
Identify and rank the resources of concern.

The specific resources of concern should be identified, categorized (e.g., listed species), and prioritized according to the consensus of the Stakeholder Group. The prioritization will be subjective and dependent on the collective judgment of the stakeholders.

Step 2D
Conduct a systematic evaluation of proposed dredging projects, as well as existing and potential window applications, and rank the projects in terms of such factors as economic importance and sensitivity to timing.

The Stakeholder Group should conduct a systematic evaluation of projects, existing windows, and potential window applications. The group should categorize the projects in terms of whether significant environmental issues are involved, for example, whether endangered species are migrating through the area or there is a heightened level of uncertainty associated with the project. Factors other than environmental considerations should also be evaluated and prioritized; examples include the economic importance of the project, contractor constraints, the frequency of vessel operations, and navigational safety. This step is important because not all projects will require the group's attention; a simple sorting of the projects at the beginning of the process will help focus the group's time and energy. It should be noted that the ranking and prioritization process conducted in this step refers to the application of environmental windows. The process should not be used to prioritize or rank dredging projects. As noted earlier, the template is designed for federal projects that have been preapproved and for which funds have been appropriated.

Step 2E
Form a Science Team whose expertise will make it possible to identify and evaluate the threats to the resources of concern. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

The scientists selected for the Science Team should represent the salient federal and state agencies, the relevant port authority, nongovernmental organizations, and academic institutions. Scientific expertise and reputation should be the essential criteria for selection to maintain the confidence of the stakeholders and the integrity of the process. The chair of the Engineering Team should serve as a liaison and adviser to the Science Team.

Step 2F

Form an Engineering Team, including contractors and USACE personnel whose expertise will allow them to identify the most appropriate technological options (i.e., equipment, management controls, or operational procedures) for conducting dredging and disposal activities to meet the resource goals specified by the Science Team and to assess the costs associated with the options identified. Select or elect a chairperson. Prepare a charge to the team outlining its assignment, deliverables, and timetable.

The engineers selected for the Engineering Team should represent the salient federal and state agencies, academic institutions, and dredging contractors, as appropriate. Engineering expertise and reputation should be the essential criteria for selection to maintain the confidence of the stakeholders and the integrity of the process. The chair of the Science Team should serve as a liaison and adviser to the Engineering Team.

Step 3

The Science and Engineering Teams conduct biological and engineering evaluations of the proposed dredging projects. All potential adverse impacts, along with the biological resources of concern, should be identified. Close coordination between the two teams should be sought, and overlap should be created by having the chairperson of each team serve as an adviser to the other team.

Step 3A

The Science Team identifies biological resources predicted to be adversely affected by each dredging project and provides this information to the Engineering Team.

The Science Team will receive the Stakeholder Group's recommendations and translate them into scientific questions. The team should first conduct an initial screening to determine the specific life-history stages or habitat areas of concern relative to the expected dredging operations. A general assessment of the species' vulnerability to various dredging stressors, along with the cumulative impacts, should be calculated. A matrix approach might be used to summarize this initial screening and to focus subsequent efforts. This information should be provided to the Engineering Team.

Step 3B

The Science Team documents the temporal variability of the species in the area and the vulnerable habitats. The Science Team also identifies the acceptable levels of impact (e.g., "takes") and the specific stressors responsible for the impacts and provides this information to the Engineering Team.

The Science Team should identify all relevant studies and data that can assist in evaluating temporal variations in the vulnerability of particular species and habitat attributes to different stressors, and use this information to identify the specific stressors of concern. This information should be provided to the Engineering Team. Stressors should be defined by type [e.g., total suspended solids (TSS), noise], zone in the water column (e.g., lower water column, surface), magnitude (e.g., critical levels of TSS above which species are affected), and temporal and spatial extents of concern (e.g., how long TSS above the critical level can be tolerated, or how close the resource is to the source of stress). To the degree possible, this evaluation should take into account the cumulative effects of dredging-related stressors and other factors—including fishing, cooling-water intakes, and other dredging projects that can affect the same population—on the resources of concern.[1] Input from the chair of the Engineering Team will be important for ascertaining the current state of knowledge about particular parameters, such as actual levels of TSS around different types of equipment or anticipated noise levels. If time and resources are available within the context of the process, new investigations or summaries might be initiated to fill and identify data gaps. It is also expected that as new information is gleaned (e.g., from monitoring activities), it will be incorporated routinely into the existing body of knowledge.

[1] Human activities in the coastal zone often result in the cropping of organisms, and in the alteration of their habitats. The capacity of populations to sustain themselves in the face of such losses, or reductions of carrying capacity in the ecosystem in which they reside is a cross-cutting issue in environmental impact assessment. Whether losses of individuals or alteration of their primary habitats constitutes an adverse impact has been addressed in relation to a plethora of human activities: mineral extraction, dredging, beach nourishment, water withdrawal for industry and power generation, shoreline alteration (e.g., armoring), development, commercial and recreational fishing, and military activities, to name a few. The setting of windows for proposed dredging projects should benefit from the analytical techniques and decision trees developed during the past 30 years for aquatic impact assessment, especially when an activity is judged to be time sensitive to the presence of aquatic species.

Step 3C

The Engineering Team, using information from the Science Team on the stressors involved, recommends strategies for reducing the stressors to acceptable levels (e.g., technology, contracting, operational methods, equipment selection). The Engineering Team provides cost estimates for these strategies. The results of the Engineering Team review are provided to the Science Team.

The Engineering Team, with the assistance of the Science Team chair, should review the information on dredging stressors and environmental impacts provided by the Science Team, and recommend the most appropriate mitigating technologies and operational controls for dredging and placement.

For this step to succeed, the potential stressors must be specified and the levels of concern quantified by the Science Team. Technological control methods should then be recommended for achieving the stated objectives relative to zone (e.g., water column, pelagic, benthos) and type of stressor (e.g., suspended solids, entrainment). It must be recognized that the range of feasible technologies may be limited and that technological solutions will probably be only partial ones. The objective is to achieve the most effective dredging operation while meeting the environmental criteria provided by the Science Team. The success of the template will depend on the interaction of the Science and Engineering Teams. The process might work as follows:

- Scientists define the target levels for stressors (e.g., levels of take by entrainment, maximum TSS).
- Engineers choose appropriate technology to meet the targets using a matrix approach.[2] Key components of the matrix include impact media, impact character, and equipment control methods.
- Monitoring is used to refine the matrix, as needed.

Step 3D

The Science Team reviews the information developed by the Engineering Team and notes any resulting changes in the expected impacts.

The Engineering Team should provide to the Science Team information regarding improvements or changes in operational approaches to the dredging

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[2] One key technology implementation issue is whether there is enough commitment to fully utilizing the flexibility in the USACE Federal Acquisition Regulations to specify certain dredging equipment for a particular project. Depending on the recommended technology (or technologies), one or more options for setting windows may evolve, resulting in a range of potential windows-setting strategies for a given project.

project that could reduce the stressors involved below critical levels, as well as any impact these changes might have on the duration of the dredging and disposal activities. The Science Team should consider these modifications in relation to (*a*) the degree of certainty relative to the threshold levels for each stressor, (*b*) the extent to which the suggested changes reduce the spatial and temporal extent of the dredging impacts, and (*c*) whether the changes in approach introduce any new stressors or are likely to result in any indirect effects on the resource that were not considered in the evaluation in *b*. For instance, a particular technological approach may reduce the level of TSS below that believed to cause acute stress to the species and habitat of concern, and as a result the project may take longer to complete. This may in turn increase the time period when the TSS level exceeds that for chronic impacts as compared with the impact of the original project, or only reduce suspended sediment concentrations (SSCs) below the upper limit of the range of TSS expected to harm the resource. The technique used to minimize SSCs might also involve physical measures (e.g., silt screens) that may be thought to cause some other stress to the resource by, for instance, further limiting access of migrating species through a constrained channel.

Such considerations should be used by the Science Team to weigh the potential advantages of the recommended technological changes against the risk to the resource posed by the project with and without the changes. The Science Team should provide a clear evaluation of the potential risk to the resource of concern under both of the latter scenarios.

Step 3E

The Science Team recommends acceptable dredging periods, that is, environmental windows.

On the basis of its findings in earlier stages of the process, the Science Team should determine the temporal constraints that need to be imposed on dredging activities to protect resources of concern from likely substantial adverse impacts. The environmental windows thus identified will be those periods when dredging and disposal operations can take place without unacceptable impacts on species and habitats and other resources of concern. These windows should be assessed for both technological scenarios considered in the previous step (i.e., with and without technological changes in approach) to identify clearly the changes in window length and timing associated with the implementation of different technological approaches.

In addition, the Science Team should specify the criteria to be used to set the windows. In some cases, windows will be delimited by specific dates (e.g., to avoid cropping of anadromous fish eggs and larvae). In other instances, a window may be closed (e.g., based on a documented take of a threatened and endangered species) or triggered (opened, extended, or closed) by physical environmental variables such as water temperature or determination of species activity (e.g., the presence or absence of a species of concern at certain levels of abundance). In cases in which real-time environmental or resource observations are to be used to open or close windows, the Science Team will have to specify the monitoring protocols and data standards to be used to support the decision to open or close a window.

If temporal constraints on dredging activities are not considered necessary to protect the species or habitats of concern, the Science Team should provide a clear recommendation for the window to remain open year round. The Science Team may provide a justification for this recommendation in the same manner used to justify recommendations for specific windows.

Should sufficient information for assessing the effect of dredging activities on local populations or habitats be unavailable, the Science Team should use available studies and information for other systems, together with data concerning the physical environment of the local system, to assess the potential impact of dredging activities on species and habitats of concern (Step B). Because of the uncertainties associated with such inferences, it is unlikely that the Science Team will be able to specify potential conditions and stressors in sufficient detail for review by the Engineering Team. In these cases, the Science Team should recommend windows on the basis of the information for other systems, considering any differences in local conditions that may limit the utility of this information, and state explicitly where the greatest areas of uncertainty lie. The rationale for such recommendations should be summarized and explained to the Stakeholder Group.

Step 3F

A formal consultation under Section 7 of the Endangered Species Act is conducted if listed species may be adversely affected.

A dredging project that has the potential to affect species listed as threatened or endangered under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) may be the subject of an informal consultation during the earliest stages of planning and scientific review. During this phase of the project, the goal of the informal consultation is to identify whether listed or proposed species and critical habitats are in the project area and if so, to eliminate or mitigate the potential impact by modifying the timing, method, or scope of the project in such a manner as to avoid the need for a formal consultation. During this informal process, input from all sources (e.g., existing data and literature, observers) can be used to positively confirm species in the area, ensure that there is a complete understanding of the potential impacts to these species, and identify the best tools for eliminating or reducing impacts to the maximum extent possible. Once it has been determined that unavoidable adverse effects are likely, a formal consultation is required to determine whether the proposed action is likely to jeopardize the continued existence of the species of concern or result in destruction or adverse modification of critical habitats. During this formal consultation, the information resulting from the informal consultation is useful in developing the Biological Assessment (required for major construction activities) and the Biological Opinion. The *Endangered Species Consultation Handbook* (published jointly by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service) may be useful to participants not fully familiar with the consultation process.

Step 3G

The Science Team prioritizes the recommendations for windows and provides this information to the Stakeholder Group in areas where multiple windows for varying species are recommended.

It is likely that more than one species' life-history stage or habitat will be considered by the Science and Engineering Teams using the above process for any given project reach. The result may be restrictions on dredging or technological approaches that effectively limit the sponsor's capability to complete the project in a cost-effective manner. Thus when the Science Team recommends for multiple resources individual windows that are not concurrent, it should provide an assessment of the relative importance of implementing those restrictions based on the suite of affected resources within the project reach. The Science Team should consider (*a*) the vulnerability of the population to the expected impact; (*b*) the degree of protection provided by restricting dredging and disposal activities to the window; (*c*) the level of uncertainty associated with both of these factors; (*d*) the cumulative effect of dredging and disposal activities in this reach and other factors affecting the resource of concern, including fishing, cooling-water intakes, and other dredging projects that affect the same population; and (*e*) the diversity of resources protected by any given window. The team should base its assessment on available data concerning the resource in the particular reach, information from other areas, and its members' best professional judgment in the absence of data. The Science Team should provide the Stakeholder Group with a prioritized list of windows, along with a supporting rationale that reflects the relative utility of the various windows in protecting resources of interest to local communities, regions, and the nation.

Step 4
The Stakeholder Group reviews the alternative strategies—including windows—identified by the Science and Engineering Teams and endorses a plan of action.

This is the most difficult step in the process; it is also the most critical. The conclusions of the scientific and technical experts must be explained to the stakeholders and affirmed or supported by the decision makers. Briefing the Stakeholder Group will be the last formal action of the Science and Engineering Teams. Stakeholders will then have an opportunity to discuss the scientific conclusions presented, as well as economic and societal considerations, such as the consequences of choosing a particular environmental window for the recreational use of the area or the overall economics of the dredging project. The final product from the Stakeholder Group should be a consensus recommendation for the implementation of environmental windows. During Step 1 of the process, the Stakeholder Group should have selected two or three structured decision-making tools to evaluate; the most appropriate of these tools should be selected.

Actual implementation of the consensus recommendations will occur through applicable regulatory and interagency review processes (e.g., National Environmental Policy Act, Coastal Zone Management Act, 401 certification, Essential Fish Habitat consultation). Agencies involved in these processes should integrate the work of the scientists and stakeholders into their assessment of proposed projects. There should be no surprises; if there are, it may mean a key player was not at the table, or his or her participation in the process was compromised in some manner.

A final task of the Stakeholder Group is to determine how each member should be informed of unexpected developments that may result should a departure from the agreed-on recommendations occur. Again, there should be no surprises or post-consensus side agreements, as these would erode the trust and open communication needed to make the process successful on a sustained basis. An ad hoc committee may be useful for resolving disputes and revising the recommendations.

Step 5
The recommended plan is implemented.

Dredging projects are now performed. The work should include monitoring intended to (*a*) test the assumptions on which the windows were based, (*b*) test the expected performance of the dredging option selected, and (*c*) provide basic information for better discussions in the future.

Step 6
The Stakeholder Group reviews the season's dredging activities to evaluate monitoring data and to identify changes that can be incorporated to refine future dredging and disposal activities.

It is imperative for the efficacy of the process that follow-up reviews of both the implementation of the recommendations and the specific environmental windows be conducted. The validity of key assumptions and expectations will have a bearing on how they feed into the next iteration of the process. The final step should be scheduling of the next iteration, which is essential to maintain continuity.

Role of Adaptive Management

The process that has been presented in this chapter is based on adaptive management. In other words, as new information is acquired and experience is gained, it is fed back into the process. Each project should be viewed as a tool for improving the process. Successful stakeholder processes place responsibility on the participants for demonstrating leadership in effecting such improvements.

4

Key Findings and Recommendations

The committee's key findings and recommendations are presented below.

Broad-Based Management Strategies

Dredging and disposal operations are only one of a number of human activities that affect the nation's waterways. They need to be evaluated not only in the absolute sense so that management strategies for reducing environmental impacts to acceptable levels can be developed but also in the context of other activities that affect the uses and value of water bodies important to society.

> *Recommendation 1.* **The decision-making process for managing dredging and disposal operations to achieve sustainable waterways and to protect natural resources, both living and nonliving, should be broadly based.**

Management Tools

Environmental windows are one of a number of management and technological tools that can—when properly selected and applied—not only reduce the environment impacts of dredging and disposal operations but also increase the efficiency and effectiveness of those operations.

Recommendation 2. **All tools, including windows, should be considered in designing a management plan for carrying out dredging and disposal operations.**

Proposed Process for Setting, Managing, and Monitoring Environmental Windows

Existing processes for setting, managing, and monitoring environmental windows vary widely from region to region. The variations reflect differences among natural environments and their living resources; sociopolitical contexts; and experience with involving stakeholders in resolving complex, multidimensional issues. It is only through testing and refinement of the proposed process in a variety of settings that the methodology can be refined, endorsed, and incorporated into existing decision-making processes to provide greater consistency.

Recommendation 3. **The proposed process for assessing the need for windows and for managing and monitoring windows when selected should be pilot tested in a small number of districts.**

Scientific Data and Information

A series of technical syntheses encompassing field and laboratory studies of environmental stressors, biological resources, and specific life-history stages affected by dredging and disposal operations needs to be undertaken and regularly updated. These syntheses should focus on integrating and interpreting local and regional data and information and placing them in a larger context. Through this process, gaps in scientific information will become apparent and can serve as the focus of future research. These syntheses should be undertaken as an integral part of the recommended pilot studies.

Recommendation 4. **All existing scientific data and information should be exploited in evaluating and setting windows as part of an overall management strategy for dredging and disposal operations.**

Opportunities for Cross-Training

The current divide between those responsible for engineering dredging projects and those responsible for protecting biological resources needs to be narrowed. Each discipline must become better educated about and sensitive to the pressures faced by the other if management tools that satisfy the needs of both parties are to be developed.

Recommendation 5. **Cross-training opportunities should be created for resource managers and dredging operators. For example, resource managers should be encouraged to observe the operations of a wide array of dredges in various weather and sea states. Opportunities should also be created for dredge owners and operators to observe, and perhaps even take part in, the public participation processes undertaken by resource managers and to learn about the biological constraints, natural history, habitat types, and issues related to dredging and its consequences for the natural environment.**

Structured Decision-Making Tools

Although the process outlined above for setting, managing, and monitoring environmental windows is intuitively simple, its implementation will be challenging because it calls for a balancing of priorities. The most difficult step is Step 4, the balancing of scientific conclusions against economic and societal considerations. Structured decision-making tools can be helpful in addressing these issues.

Recommendation 6. **A special effort should be made to identify existing tools for structured decision making in complex sociopolitical situations and to evaluate their applicability to the process of setting, managing, and monitoring environmental windows for dredging. One or two of the most promising tools should be selected for additional testing, research, and refinement aimed at enhancing their acceptability and use in the windows-setting process.**

Funding

If resource agency staff are expected to fulfill their mandates under the law and participate in the windows-setting process in a timely manner, the agencies will need additional funding.

Recommendation 7. **Additional funding should be allocated to resource agencies to ensure full, thorough, and active participation in the windows-setting process.**

Adaptive Management

The justification for windows needs to be reviewed periodically. All windows ought to be viewed as subject to change on the basis of new data and information that should be incorporated routinely into the windows-setting process.

> ***Recommendation 8.*** **The windows-setting process should reflect the principle of adaptive management. That is, as new data and information are acquired and experience is gained, they should be fed back into the process.**

APPENDIX

A

Summary of Workshop Sessions

A summary capturing highlights and key points was prepared for each of the working group sessions. Workshop participants were given an opportunity to review and comment on the accuracy of these summaries, the final versions of which are presented below.

Economic and Operational Trade-Offs Session

This session addressed the question, "How should we evaluate the environmental benefits versus the operational costs of implementing windows?" During the last several decades, there has been little or no consideration of the cost to project sponsors or the public for the application of environmental windows. The environmental benefits have been assumed to justify the windows set, in part through application of the precautionary principle,[1] and have generally overshadowed consideration of economic concerns. As the numbers of dredging restrictions have increased, the economic consequences of multiple windows have grown. Today, dredging projects and the direct economic benefits they provide may be foregone in favor of the establishment of environmental regulations

[1] The precautionary principle, as stated in Principle 15 of the 1992 Rio Declaration on Environment and Development, is as follows: "[T]o protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

to protect natural resources. Typically, the explicit trade-off between the economic benefits of dredging and the benefits of environmental protection is not considered in a formal manner. This situation prompted the question posed for consideration during this session.

The session began with presentations of three papers describing processes or techniques that might be used to analyze and evaluate the establishment of environmental windows and the decision-making process involved in their application. The presenters suggested how each process or technique might be relevant in assessing the above trade-offs between economic and environmental interests.

The first paper, presented by Thomas Gulbransen, Regional Manager, Battelle ("Proposed Framework for Evaluating Beneficial Uses of Dredged Material in the NY/NJ Harbor," by N. Bonnevie, T. Gulbransen, J. Diamantides, and J. Lodge), describes a proposed framework for evaluating and comparing various beneficial-use options for dredged material. A key point made during the presentation of this paper was the need to identify specific measurement outcomes (e.g., job creation, operating costs, economic value) at the outset of the evaluation process. Gulbransen discussed the systematic development of such outcomes and described a multiparameter equation for quantifying the evaluation. This equation uses a combination of assessment categories (e.g., economic effects, environmental effects, resource management) and subcategories of the identified outcomes. The evaluation process depends on the application of relative importance factors or weights to the outcomes. The importance factors are generated through stakeholder input. Combining these factors makes it possible to integrate varied and conflicting information and perspectives to help guide decisions on use options.

The second paper ("Tradeoff Analysis for Assessing Coastal Management Actions," by K. Wellman and R. Gregory), presented by Katherine Wellman, Battelle Seattle Research Center, describes a structured decision approach that can be used to provide improved public involvement in and input to the decision-making process on environmental windows. This approach goes beyond the goals of conventional public participation and economic analysis processes, focusing on providing insights to decision makers about the proportions of community members that would support or oppose specific actions. Because of the broad array of stakeholders in windows-setting decisions, the decisions made are often controversial, involving the need—real and perceived—to make trade-offs between environmental integrity and economic impacts. Wellman outlined several steps in the structured decision approach, designed to present and clarify alternative strategies and consequences by defining the problem, clarifying the objectives, developing trade-off analyses, acknowledging uncertainty, and linking the decisions made.

The Tillamook Bay Comprehensive Conservation and Management Plan was presented as an example of how the approach works. Through the increased public involvement that characterized the development of this plan, the participants gained greater sensitivity to the issues involved. Moreover, the process improved the insights available to decision makers.

The third paper ("Economic Analysis of Dredging Windows: Framework, Model, and Examples," by T. Grigalunas, M. Luo, and J. Opaluch) proposes a framework and model for analyzing the economic aspects of a dredging project's material placement alternatives and the impacts of establishing environmental windows. According to the presenter, Thomas Grigalunas, Department of Environmental and Natural Resources, University of Rhode Island, Kingston, the use of windows raises several issues. Windows extend the overall length of a dredging project or increase the number of dredges. Dredging equipment must be remobilized to the site once the critical period has passed, and delays in a project's completion also delay its anticipated benefits. These economic consequences are quantifiable and sometimes significant. An evaluation of the environmental benefits in similar terms is needed to make it possible to assess the trade-offs involved and compare project alternatives. Grigalunas described a cohort model designed to assess the impact of windows on affected populations and to calculate associated changes in recreational and commercial catch. The focus is on the incremental economic values associated with changes in catch due to environmental windows. The presentation included an example of a dredging project proposed for the Port of Providence with disposal in either Narragansett Bay or Rhode Island Sound. Grigalunas noted that there are both positive and negative impacts of applying windows, but that much uncertainty exists regarding their quantification.

Following the presentations, Tom O'Connor, session comoderator, made some additional observations. He suggested that dredging can be compared to fishing in that both impose resource losses. Unlike fishing, dredging generally has its effects during early life stages; at the population level, however, eggs never spawn because of this loss at early life stages. Dredging is also episodic, posing less of a population-level effect than chronic activities such as fishing. If the proportion of the total population at early life stages threatened by dredging were known, population models could incorporate dredging mortality and be used to estimate the equivalent fishing mortality. O'Connor suggested that this would allow comparisons with other activities for which the economics are known and would enable assessment of the overall importance of losses associated with dredging projects.

The presentations and observations summarized above served as the foundation for a subsequent group discussion about how the windows-setting process in many cases has been driven by resource protection demands, particularly requirements for endangered species. Some participants believe decisions about the establishment of windows should involve a quantified assessment of benefits and costs. They suggested that a decision-making process requiring some analysis of the trade-offs among resource protection, project schedule, operational impacts, and safety needs to be developed. Unfortunately, there has to date been no broadly accepted methodology for conducting an analysis of this nature. Research is therefore needed to develop methodologies acceptable to resource managers, dredging project sponsors, and stakeholder groups that would help guide regulatory decision makers. Successful application of such methodologies generally depends on good input information. This requirement raises several questions, such as who pays to collect the biological data, who has the burden of proof, and who pays for the development of new technologies. It was suggested that these responsibilities should be shared between the dredging community and resource managers.

The session culminated in a recommendation to apply a systematic approach (e.g., a structured decision analysis or trade-off analysis) in seeking to answer the question that served as the theme for the session. Thus, if the results obtained are to be meaningful, this approach should be developed with the buy-in of stakeholders and their input should be incorporated into the analyses.

Administrative Process Session

The purpose of this session was to focus on the various tools used for coordinating agency involvement in the environmental windows-setting process. The session began with a review of the steering committee's draft template and of the questions provided to the session presenters regarding their experience of the windows-setting process:

- What are the strengths of the process? Its weaknesses? How could it be improved?
- In what circumstances does the process work best? Worst?
- At what point are federal and state natural resource agencies involved? Are all agencies or parts of the same agency involved at the same time in the process or at different times? Is this effective or inefficient?
- Does the process result in multiple agency recommendations that are coordinated? Duplicative? Divergent? Contradicting?
- If divergent or contradicting, how is the difference resolved?
- How much supporting information and rationale for the recommended windows is provided?

• How are disputes about scientific information or interpretation resolved?
• How does the process prioritize projects to deal with staff shortages?
• Does the process encourage consideration of cumulative effects, or does "piecemealing" tend to occur?

Each presenter was asked, based on his or her experience, to provide insights into the process used in setting windows, placing an emphasis on both the strong and weak points.

The first presenter, Michael Street, Chief, Habitat Protection Section, North Carolina Division of Marine Fisheries, described the windows set by the state of North Carolina in the 1980s, based on state and federal sampling data. The goal of the state was to use spatial and temporal windows to minimize impacts; cumulative effects were not addressed under the process. As the state's geographic information system was developed, areas were designated for special protection, such as primary nursery areas, anadromous fish-spawning areas, seagrass beds, and critical habitats for threatened and endangered species. In 1994 an interagency group chaired by the U.S. Army Corps of Engineers (USACE) was organized to conduct an update and review of the existing windows. However, the review was not completed because of a change in personnel and an overall lack of commitment on the part of the agencies. Therefore, the original windows remain in effect, and in fact have been adopted by the state as regulations.

The second presenter, Frank Hamons, Manager, Harbors Department, Maryland Port Authority, described a case in the state of Maryland in which the windows-setting process failed in terms of involving all the pertinent parties in the process. In this case, preexisting windows for anadromous fishes that had been set on the basis of water temperature and had originally been recommended by the Maryland Department of Natural Resources were narrowed last year without the involvement of the local sponsor. In fact, the local sponsor was never consulted. The Port Authority contends that if a monitoring program for temperature had been undertaken, the window might have been lengthened instead of narrowed.

The third presenter, Edward O'Donnell, USACE, New England District, described the windows-setting process currently used in the five-state New England area. Windows were originally set 30 to 40 years ago and tended to be generic, partly because of limited staff and a lack of scientific information. Interagency coordination on windows occurred through the National Environmental Policy Act process, the permit coordination process, Coastal Zone Management Act consistency determinations, and water quality certification under Section 401 of the Clean Water Act. More recently, USACE initiated annual interagency meetings at which projects are discussed 2–3 years before dredging is scheduled. Stakeholder groups help prioritize projects.

In response to the questions provided before the session, O'Donnell stated that sometimes state and federal agencies do provide differing recommendations, and that disputes are resolved at the staff level whenever possible, but can involve a governor or congressman. He also noted that the windows-setting process is piecemeal but suggested that a cumulative approach might not result in better windows. O'Donnell believes participants in the process need to appreciate financial and time constraints. He concluded by suggesting that the best tool for success is early discussions with the full involvement of all stakeholders.

The fourth presenter, Therese Conant, Fishery Biologist, National Marine Fisheries Service, Office of Protected Resources, described the process of developing windows to protect threatened and endangered sea turtles in the southeastern United States. The major tool used was a regional biological opinion developed through both informal and formal consultation under the Endangered Species Act. The resulting window, which is based primarily on water temperature, is keyed to monitoring of the number of turtles harmed by dredging. Dredging may continue as long as a certain level of take is not exceeded. The major advantages of this regional approach are that it reduces paperwork and can provide flexibility. Among the disadvantages are that emerging needs cannot be anticipated, and that take tends to be underestimated. In response to a question about interagency coordination, Conant explained that an Endangered Species Act consultation involves the "action agency" and the responsible federal agency (Fish and Wildlife Service or National Marine Fisheries Service) but that the involvement of other agencies may occur at the discretion of the action agency.

Following the presentations, a process used successfully in the Seattle USACE district was discussed. Essentially, the Seattle district has adopted a two-step meeting process for setting windows. The first meeting is held early in the year; all appropriate agencies and tribes and interested members of the public are invited to review the proposed dredging projects for the year. If necessary, work groups may be formed to focus on areas in which additional follow-up effort may be needed to resolve issues in dispute. The second meeting is held near the end of the dredging season (federal fiscal year) for the purpose of reviewing and recapping lessons learned and preparing for the next dredging season. This process is now 3 years old. It started with only a few participants accepting invitations, and now includes more than 50 people representing state and federal agencies, tribes, and other groups.

In the subsequent discussion, it was noted that many good administrative processes exist for coordinating windows, but that some of these processes are missing important steps related to communicating information in a timely manner. One of the most common shortcomings mentioned was the lack of a process for revising windows to incorporate new information. Participants also identified competition between windows for one species (salmon) and another (clapper rail) as a major challenge that will become increasingly common as more species become imperiled. Scientific information will be needed to support prioritization of natural resource concerns when such competing interests are involved. In addition, citizen involvement was identified as a necessary but unpredictable element of the administrative process for setting windows. Many participants expressed frustration at the perceived use of windows as a surrogate for antidredging sentiment by citizen groups.

Participants also discussed project-specific windows as opposed to statute-driven or statewide windows. Although some participants expressed a preference for the former, others believe that a programmatic approach is the only way to make effective use of limited agency staff and other resources. Concern was also expressed about having consistent regulatory policies for both USACE-funded and privately funded dredging projects.

Finally, the group discussion focused on the draft template prepared by the steering committee. Participants offered the following suggestions for improving this draft:

- There should be early buy-in to the process up front by all relevant agencies and stakeholders (especially the federal and state permitting agencies). This buy-in should include a commitment of the personnel and fiscal resources necessary to accomplish the task from senior-level agency decision makers.
- There should be some overlap between the biological and engineering expert teams to ensure communication and cross-fertilization.
- A feedback loop should be added to the process, for use in assessing its success and identifying needed improvements.

Biological Sessions

Two of the workshop sessions were devoted to biological issues. Both sessions explored the scientific and technical justifications for environmental windows and examined aspects of the potential impacts of dredging operations on biological resources. As these two sessions were interrelated, they are treated here in a single summary. The sessions were designed to address the following questions:

- What are the potential effects of dredging operations on biologically sensitive resources at the individual species, population, and ecosystem levels?
- To what degree of certainty can existing science predict these effects?
- How can the benefits of environmental windows as an effective management tool be maximized?

Michael Weinstein, President of the New Jersey Marine Sciences Consortium, opened the morning session with an overview of the issues to be addressed. He then discussed the concept of "compensatory reserve" in ecology—the notion that impacts to individual members of a species below a certain threshold can be sustained by a population. A species' ability to sustain the impacts of dredging depends on the total population's ability to recover and repopulate the impacted area, and on the number of other stressors being experienced at the time, such as fishing pressure, exotic species as competition or predator, food scarcity, and oxygen stress. Weinstein described the application of scientific modeling and consideration of compensatory reserve as a management tool. He then introduced the panelists.

Panelist William Kirby Smith, Associate Professor of the Practice of Marine Ecology, Duke University Marine Laboratory, presented on the impacts of dredging operations on shellfish. He described the life cycle of various types of mollusks and gastropods and the potential for impacts on these species at their various life stages. In general, he noted that shellfish resources tend to be hardy and resilient, and can recover quickly from short-term or acute water quality impacts. During spawning and other early life stages, however, other species (bay scallops, gastropods) can be susceptible to adverse impacts.

Charles Epifanio, College of Marine Studies, University of Delaware, discussed the biology and ecology of blue crabs in the Delaware Bay estuary. He reviewed their complex life cycle and spatial and temporal distribution and migration patterns throughout the year. He noted the potential for impacts from dredging projects to interfere with the critical life stages of blue crabs. In the winter, adult crabs bury themselves in the sediments of the lower estuary and may be subject to physical impacts from dredging. In the summer, it is the disposal of dredged sediment in structured shallow areas of the upper estuary that poses the greatest threat to juveniles and their habitat.

Edward Houde, Center of Environmental Science, University of Maryland, described the potential impacts of dredging operations on the spawning and nursery of anadromous fish in the Chesapeake Bay estuary. He described the concept of the "estuarine turbidity maximum," a zone of the upper estuary that serves to retain planktonic organisms and sediment. This is a biologically important zone, as trophic interactions and biological productivity are enhanced; the recruitment of larvae and juveniles is strongly linked to these processes. Houde explained that the physical, chemical, and biological components of habitat can be altered by dredged sediment disposal. For example, he noted that deepwater thermal refugia are important in winter for fish and that disposal activities can raise the bottom, resulting in the disappearance of thermal refugia. Houde concluded by noting the difficulties and uncertainties involved in linking these impacts to the health of fish populations in the future and in the year the dredging occurs.

James Cowan, Dauphin Island Sea Laboratory, spoke in more detail about the concept of compensatory reserve in ecosystems and how it can be modeled and quantified. He cautioned that the concept is controversial among ecologists and noted that without sufficient data, a risk-averse approach should be taken. He also described density-dependent larval survivorship estimates as a tool in fisheries management, explaining the risks and benefits of this type of analysis and discussing its various applications.

Charles Simenstad, University of Washington Wetland Ecosystem Team, described the use of environmental windows as a management tool to reduce the impacts of dredging on anadromous salmonids in the Pacific Northwest. He outlined the life cycles of various species of salmon and discussed their complex life stages. Since salmon are present in the rivers of this area throughout the year, they present unique challenges to the setting and administration of windows. Further complicating these issues is the fact that some of these species are protected under the Endangered Species Act, making the killing of any salmon a violation. Simenstad noted that salmon are directly vulnerable to turbidity plumes from dredging projects. He discussed methods for improving the application of windows for salmon, including the use of real-time monitoring, system-specific data, and direct observation. Other issues that must be considered include the potential for release of contaminants, blockage of migration, water quality degradation, and ecosystem changes (estuarine circulation, salinity distribution, habitat decline, and changes in the food web).

Major points made in the ensuing open floor discussion are summarized below:

- Although participants believe there have been some examples of effective and successful environmental windows for dredging projects, many observed that it is impossible to demonstrate direct causation between a specific dredging and disposal operation and the long-term health of a particular species or natural system.
- Many species of shellfish, such as the Chesapeake Bay oyster, are in severe population declines. The declines are due to various stressors, including disease, overfishing, and pollution. Sediments or other environmental changes due to dredging activities could hinder recovery of the population or contribute to its decline. These issues should be considered when evaluating the potential impacts on shellfish or any other species. Impact assessments should also consider the extended project duration caused by the implementation of windows.

- Economic valuations should consider lost natural resource values as part of the project cost.
- The questions of how agencies resolve scientific issues and develop technical justifications related to windows and of how the determination is ultimately made were discussed and debated.
- Statutory and scientific obligations to consider the multispecies cumulative impacts of various projects within an ecosystem (in both time and spatial scales) were discussed. There is a wealth of literature on the range of impacts of dredging and sediment disposal, and statutory requirements necessitate a risk-averse approach in data-limited situations. The concept of regional and resource-specific management approaches was endorsed by many in the group.

During the afternoon session, rather than using a panel of presenters, session chair Robert Diaz, Professor of Marine Science, College of William and Mary, began with an overview and summarized meta-analysis of the scientific literature on windows. He discussed models that can be used as tools for evaluating various impacts of dredging projects, including such models as FISHFATE, SSFATE, and STFATE, which can be used to estimate the impacts of suspended sediments from dredging projects on fish populations. The Newcombe–Jenssen model for predicting effects of suspended sediments on fish was also discussed.

Diaz reviewed the range of potential impacts that prompt agencies to request environmental windows[2]:

- Interference with spawning and nursery habitat of living marine resources,
- Interference with migration,
- Habitat loss,
- Burial and turbidity,
- Dissolved oxygen impacts,
- Noise,
- Entrainment in dredges,
- Harassment of animals,
- Disturbance of overwintering animals,
- Contamination of sediments,
- Interference with recreation,
- Interference with feeding, and
- Direct mortality.

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[2] As outlined by LaSalle, M. W., D. G. Clarke, J. Homziak, J. D. Lunz, and T. J. Fredette. 1991. *A Framework for Assessing the Need for Seasonal Restrictions on Dredging and Disposal Operations.* Technical Report D-91-1. USACE, Waterways Experiment Station, Vicksburg, Miss.

A point noted by many participants was that the literature on the biological impacts of dredging is broad and frequently encompasses a number of fields and related disciplines. Therefore, studies documenting biological impacts and issues associated with, for example, coastal zone management, fisheries research and management, and power plant impacts are often relevant to scientists assessing the value of environmental windows and should be consulted more frequently.

Participants also noted that environmental windows have been used historically as a tool for protecting juvenile fish, shellfish, and other marine life as well as critical habitats for spawning, nursery, and foraging—particularly during the early life stages. Windows are used as well in certain circumstances (e.g., threatened or endangered species) to protect species at the individual level. Additionally, there are species that, while not formally listed, may warrant special consideration because of population status. Therefore, it becomes exceedingly difficult to separate spatial and temporal considerations within an estuary when setting environmental windows for dredging projects. In general, the scale of threat to a species should be the key consideration when selecting the most appropriate management tool. Environmental windows should be targeted toward the most sensitive life stages of selected species of concern. Participants also noted that in the absence of complete scientific information regarding the potential impact of a dredging project on a given species, resource managers should adopt a precautionary, risk-averse approach when interpreting existing regulations.

Another point made in the discussion was that although there has been significant research and experience regarding the risks of dredging to species at the individual level, little work has been done on the risks of dredging at the population level. Population-level effects are therefore poorly understood, and in the context of windows have been used inconsistently to protect resources at this level. Nevertheless, participants believe that individual-, population-, and ecosystem-level effects should be important management considerations for any given dredging project.

It was also suggested that representative species—those deemed to be most at risk or having special ecological value, sensitivity, or socioeconomic importance—be used as the target for setting environmental windows. Selection of a representative species may result as well in protecting other species within the system. Moreover, resource agencies may be able to select the most appropriate windows more efficiently.

Participants stated that appropriate monitoring—before, during, and after dredging operations—should be designed specifically to measure the effectiveness of windows in protecting species of concern. A feedback mechanism should be established to incorporate the best information on existing tools, lessons learned, and related research to ensure that the process is managed adaptively in the future as new information is generated.

Finally, additional factors were identified that should be considered when establishing environmental windows. These factors include the following: human health and safety, cumulative impacts of dredging, and availability of agency staff and resources.

Dredging Technology Breakout Session

This breakout session addressed the question, “How can we dredge our waterways and berths more effectively using advances in technology and controls, while minimizing impacts on living resources and thereby maximizing the duration of environmental windows?” The goal was to find ways of improving existing dredging techniques and technologies to result in fewer and smaller impacts on the marine environment and its living resources. Several dredge manufacturers (both in the United States and abroad) have invented new or modified existing technologies to make dredging more environmentally acceptable. This session focused on identifying technology advances that could be used in navigational dredging projects, as well as associated research needs.

Specific questions addressed in this session included the following: (*a*) What expected environmental impacts of dredging are associated with different technologies? (*b*) What physical controls can make dredging more effective and practical? (*c*) What existing operational controls are cost-effective and reduce environmental impacts? and (*d*) How can environmental effects of dredged material placement be minimized?

There was a strong sentiment expressed that technology developments (i.e., in dredging equipment, management controls, and operational procedures) can and should be one of the tools used in setting environmental windows. It was acknowledged that technology can provide only partial solutions and cannot completely eliminate the impacts of concern, but that selection of appropriate technologies and best management practices can make an important contribution.

The first panelist, Donald Hayes, Associate Professor, University of Utah, stated that operational and physical controls used in dredging may be effective to a certain degree but have associated costs. For example, for a cutterhead dredge, controls include lower swing and rotation speeds and smaller cut depths. Mechanical dredging controls include lower bucket fall speeds, although this is difficult to monitor and control. A better mechanical dredging control for sediment losses is to use flocculants in barges or to minimize or even eliminate the barge overflow. Physical barriers (such as silt screens and curtains) are effective only in quiescent waters.

The second panelist, Daniel Averett, Chief, Environmental Engineering Branch, Environmental Laboratory, USACE Research and Development Center, noted that there have been several improvements in dredging equipment. Examples include modified buckets (e.g., enclosed bucket, cable arm), cutterhead shrouds, improved dredge designs (e.g., horizontal auger, matchbox, deflectors), higher solids dredging (e.g., Eddy pump), and improved instrumentation for positioning and monitoring. Newer dredges have been used on a small scale for highly contaminated (Superfund) sediment projects in the United States and abroad. However, issues remain concerning their performance as compared with traditional equipment on large-scale projects, as well as their availability in this country.

The third panelist, Robert Randall, Professor and Director, Center for Dredging Studies, Texas A&M University, suggested that environmental impacts of placement can be minimized by proper choice of site (e.g., subaqueous pits, underwater berms), better control of placement using instrumentation (e.g., differential Global Positioning System), improved placement techniques (e.g., thin layer placement, underwater pipes), and better site management (dewatering, segregation, improved aesthetics).

The following major points were made in the open floor discussion:

- Technologies for managing impacts should be defined clearly. The following aspects should be considered: equipment selection, management controls, and operational procedures.
- Innovative dredging technologies often are applied on small-scale pilot remediation projects in the United States and abroad. Such equipment does not usually see high production and can be expensive to deploy. It was suggested that there are not enough data on full-scale, side-by-side field comparisons of promising innovative and standard technologies to assess their relative advantages.
- Operational controls are generally expensive to implement. One way to implement such controls would be to require that dredgers self-monitor and report to USACE, and that standards of operation be verified through periodic unannounced inspections by USACE personnel.
- In setting operational or physical controls, the target must first be defined [e.g., totally suspended solids (TSS) level, plume extent]. For this step to succeed, the potential impacts must be identified specifically and quantitatively.
- Both the scope and goals of monitoring should be clearly defined. Otherwise, the monitoring performed may be complicated, expensive, and of little value. It

was suggested that the technological limits on monitoring should be acknowledged (e.g., level of accuracy in measuring TSS).

- If targets are defined properly, monitoring can be used to set and refine windows.
- It is difficult to measure the specific environmental advantages of a given technology. In Europe, there is cooperation between industry and regulators in generating quantitative data from actual dredging projects for such applications.
- Technology cannot prevent impacts; it only can aid in minimizing or mitigating them.
- Problems involving the impacts of well-designed and -executed dredging and disposal operations often are mainly a matter of public perception. It was suggested that windows should be accompanied by clear and explicit identification of what is being protected and how. Then the various aspects should be prioritized. The goal should be to strike a balance between the costs of resource protection and the costs of delay, and even of the no-dredging scenario.
- Many believe that USACE and an independent group of engineering and industry (contractor) experts, with input from scientists, should recommend the most appropriate technologies for effectively managing the environmental impacts of dredging projects. For greatest efficiency, this could be done on a regional or local basis, rather than on a project-specific basis.

The technology selection process needs specific input on impacts of concern from scientists. Scientists should first define the targets of concern (e.g., solids concentration, TSS, entrainment). Engineers can then recommend the appropriate technology to meet those targets. A matrix-based analysis may be best for evaluating the effects of different dredging technologies and strategies. The matrix should include the affected media, the character of the impacts, and equipment control methods. Future monitoring would then be used to refine the matrix, as needed.

The key technology implementation question is whether there is enough commitment to fully utilize the flexibility in the USACE Federal Acquisition Regulations to specify certain dredging equipment for a particular project. Depending on the recommended technology or technologies, one or more alternative sets of environmental windows may evolve, offering a range of potential strategies useful to port and resource managers.

APPENDIX

B

Glossary

401 certification Section 401 of the Clean Water Act requires that an applicant for a federal license or permit provide a certification that any discharges from the facility will comply with the act, including water quality standard requirements. The law gives the Environmental Protection Agency (EPA) the authority to set effluent standards on an industry basis (technology based) and continues the requirement to set water quality standards for all contaminants in surface waters. The act makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit [National Pollutant Discharge Elimination System (NPDES)] is obtained under the act.

Clean Water Act 33 U.S.C. s/s 1251 et seq., 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. See *401 certification.*

Consensus General or widespread agreement among all the members of a group.

Consistency Conformance with applicable federal guidelines or regulations.

Consultation (Endangered Species Act context) Sec. 7(2): "Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an 'agency action') is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species, which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. In fulfilling the requirements of this paragraph, each agency shall use the best scientific and commercial data available."

Critical habitat Under the Endangered Species Act, "critical habitat" for a threatened or endangered species means "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species."

Cumulative effects The sum total of accumulated impacts.

Cutterhead dredge A suction dredge that uses a rotating "cage" of cutter bars to facilitate the removal of consolidated sediments.

Decision analysis A structured way of evaluating how an action taken in a particular process would lead to a specific result.

Dredge A mechanical device used to remove or relocate sediments and other unwanted materials from the bottom of water bodies.

Dredging placement The subsequent placing of sediments removed during dredging activities.

Endangered species Under the Endangered Species Act of 1973, "any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man."

Endangered Species Act According to the act, its purposes are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section."

Entrainment Aquatic organisms carried by water currents beyond their capability to influence the direction or speed of passage.

Environmental window Time periods in which regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds, and dredging is therefore permitted.

Essential fish habitat As defined in the Magnuson–Stevens Fishery Conservation and Management Act (Public Law 94-265), those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

Hopper dredge A self-contained and self-propelled suction dredge that, once filled with dredged materials, travels to the area where the materials are to be deposited and drops them through trapdoors in the bottom of the hull.

Impacted population A geographically distinct segment of a species that is affected by a particular activity.

Indicator species A species used as an indicator of the effects of an activity or of the ecological health of a particular area.

Keystone species See *indicator species.*

Listed species A species included on the list of "threatened or endangered species" established by the Endangered Species Act.

Maintenance dredging Dredging performed periodically to maintain the usability of navigation channels, docks, and port areas.

Marine Mammal Protection Act A 1972 act (16 U.S.C. 1361–1407) that prevents the "taking" of marine mammals in U.S. waters by any person under U.S. jurisdiction on the high seas.

Mechanical dredge A dredge that moves sediment by lifting it with a bucket-like mechanism.

Monitoring The process of observing particular biological, physical, and/or chemical parameters during and after dredging activities.

National Environmental Policy Act Federal law (42 U.S.C. 4321–4347) designed to help public officials make decisions based on an understanding of environmental consequences and take actions that protect, restore, and enhance the environment through two primary mechanisms: (*a*) establishing the Council for Environmental Quality to advise agencies on the environmental decision-making process and to oversee and coordinate the development of federal environmental policy and (*b*) requiring that federal agencies include an environmental review process early in the planning for proposed actions.

NOAA National Oceanographic and Atmospheric Administration in the U.S. Department of Commerce

Population A group of individuals of the same species inhabiting the same area.

Region A geographically defined administrative area used by the U.S. Army Corps of Engineers, the Environmental Protection Agency, and others.

Risk analysis An approach and set of tools for systematically comparing the social, economic, human health, and other environmental costs and benefits of decision options.

Risk averse Given outcomes of unknown probability, an approach that involves taking an action with a minimum chance of having negative impacts.

Species (Endangered Species Act context) Defined as “any species, any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature.”

Spoil displacement Removing dredged materials to another location.

Spoil disposal Removing dredged materials to another location.

Spoils Sediments and other materials displaced during dredging.

Stakeholder A group or individual with an interest in the outcome of a (generally governmental) process.

Stressor An action that has a deleterious consequence for an organism, an ecosystem, or a population.

Superfund Refers to the federal Comprehensive Environmental Response, Compensation and Liability Act.

Take According to the Marine Mammal Protection Act, to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." The 1994 amendments to the act define "harass" as "any act of pursuit, torment, or annoyance that has the potential to: Injure a marine mammal or marine mammal stock in the wild (Level A); or Disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns (for example, migration, breathing, nursing, breeding, feeding, or sheltering) (Level B)."

Total suspended solids (TSS) The total amount of solid matter in a representative water sample retained on a membrane filter. It includes all sediment and other constituents that are fluid suspended.

Turbidity The degree to which light is blocked because of materials suspended or dissolved in water.

USACE U.S. Army Corps of Engineers

APPENDIX

C

Environmental Windows for Dredging Projects Workshop

March 19–20, 2001
National Academy of Sciences
Washington, D.C.

Agenda

Monday, March 19

0800–0915 **Opening Plenary Session**

0800–0830 Introductions, Purpose of Workshop, Origin of the Project
Jerry Schubel

0830–0900 Overview of the Issues Surrounding Environmental Windows
Denise J. Reed

0900–0915 Strategy for the Workshop and Charge to the Participants
Jerry Schubel

0915–0930 Break

0930–1200 **Concurrent Sessions**

Session 1: Dredging Equipment and Technology
The goal of this session was to identify methods for improving existing dredging techniques and technology to result in lesser impacts to the marine environment, thereby reducing the need for seasonal restrictions. During the course of years, several dredge manufacturers (both in the United States and abroad)

have invented new or modified existing techniques to make dredging more environmentally sensitive. This session focused on the engineering aspects of dredging and explored alternatives and complements to windows as the tool for protecting resources.
Facilitator: Ram K. Mohan

Session 2: Biological Drivers for Windows
This session was designed to explore the impacts from dredging on communities and populations of species, focusing on the variability of resources. Issues such as life histories, key assumptions, end points, and parameters for variability were discussed.
Facilitator: Michael P. Weinstein

1200–1300 Lunch

1300–1400 **Plenary Session**
Reports were presented from the two morning breakouts. Following the reports, a panel comprised of representatives from USACE, EPA, NOAA and a state environmental agency were asked to comment on the results.

1400–1630 **Concurrent Sessions**

Session 1: Tools for a Successful Administrative Process
This session focused on tools for coordinating agency involvement in the process of establishing environmental windows. Panelists from the National Marine Fisheries Service, USACE, North Carolina Department of Environment and Natural Resources, and the ports presented tools that have been used to coordinate agency involvement in setting dredging windows. All participants were asked to critique the tools and provide recommendations for improving the process. Discussion topics included timing of agency input, use of programmatic approaches, and means of resolving disputes over science or interpretation.
Facilitators: Peter F. Bontadelli, Jr., and Susan-Marie Stedman

Session 2: Biological Impacts (State of the Science)
The goal of this session was to achieve a clear expression of confidence level with regard to the certainty and uncertainty of impacts on living resources resulting from dredging. The focus was on both the species and essential habitat that supports the

species. Data and research needed for evaluating dredging windows were also considered.
Facilitator: Robert J. Diaz

Session 3: Economic and Operational Trade-Offs
How should we evaluate the environmental benefits versus the operational costs of implementing windows? The session began with three technical presentations addressing uniquely different aspects of this question. These papers provided the foundation for a subsequent group search for methodologies than can be used to judge the merits of windows and their cost impacts versus other strategies for protecting resources. The session culminated in recommendations for a systematic approach (an equation or series of steps) to answer the theme question.
Facilitators: Thomas H. Wakeman and Thomas P. O'Connor

1630–1730 **Plenary Session**
Reports and committee comments. Reports were presented from the three previous afternoon breakouts. Following the reports, a panel comprised of representatives from USACE, EPA, NOAA, and a state environmental agency were asked to comment on the results.

Tuesday, March 20

0800–0900 **Plenary Session**
A strawman model framework for setting environmental windows was presented.
Jerry Schubel and Henry J. Bokuniewicz

0900–1100 **Concurrent Sessions**
The model framework was reviewed and discussed. Participants examined the draft template for establishing windows.
Facilitator: Henry J. Bokuniewicz

1100–1200 **Closing Plenary Session**
Comments and recommendations for refining the model framework were heard. Following the reports, a panel comprised of representatives from USACE, EPA, NOAA, and a state environmental agency were asked to comment on the results.

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APPENDIX

D

Environmental Windows Workshop Dredging Project Case Study Data Form

Dredging Project District Office

Name of District Office:

____

Name of Contact Person(s) & Telephone #/Email Address:

____

Dredging Project Description

Name & Location of Project:

____

Project Authorization Date:

____

Project Construction Dates:

____

Project Volume:

____

Project Questions

1. *Agencies:*
   What state or federal agencies and organizations participated in the determination of need and development of the project's environmental windows? Under what law or regulation was the action taken?

   ____

   ____

   ____

2. *Resources:*
   What biological resources (common name and genus species) were identified as the primary concerns in requesting windows as protective measures?

   ____

   ____

   ____

3. *Threat:*
   What was the nature of the detrimental effect (turbidity, burial, entrainment, chemistry, habitat loss, other)?

   ____

   ____

   ____

4. What was the anticipated damage (avoidance, habitat loss, behavior, mortality, other)

   ____

   ____

   ____

5. If habitat, what type (i.e., spawning, nursery, cover, critical)?

   ____

   ____

   ____

6. If organism, what life stage (egg/larva, juvenile, adult), listing status (endangered, threatened, not listed), and commercial/recreational?

____

____

____

7. What information was used to judge that dredging activities would adversely affect the resource (i.e., unpublished, published, agency recommendation, other)?

____

____

____

8. How were the beginning and end dates of the window set (expert opinion, literature review)?

____

____

____

Please attach copies of any interagency coordination letters containing comments relevant to the request for windows on selected projects.

PLEASE SUBMIT INFORMATION BY WEDNESDAY, FEBRUARY 21, 2001 TO:

Kris Hoellen
Senior Program Officer
Transportation Research Board (GR-346I)
2101 Constitution Avenue, NW
Washington, DC 20418

APPENDIX

E

Environmental Windows: Forms Used to Solicit Suggestions for Improvements

National Dredging Team Conference

Jacksonville, Florida, January 23–25, 2001

The National Research Council's Transportation Research Board and the Ocean Studies Board have been asked to organize and conduct a workshop to review the process used to set, administer, and monitor environmental windows as one option for managing impacts of federal dredging and disposal projects; and to make recommendations on how to improve that process. We seek your advice.

Please complete this brief questionnaire and give it to Jerry Schubel or Kris Hoellen BEFORE leaving the conference. Thanks for your help!

1. Where in the process of setting, applying and administering, and monitoring environmental dredging windows would you recommend that the NRC Study Committee focus its efforts to improve the effectiveness of dredging windows as a management tool? ______________________________

   ____

   ____

2. What are the major unresolved research questions that limit the effectiveness of using "dredging windows" as a management tool to reduce the environmental impacts of dredging and disposal? Please be as specific as possible.

   (a) ______________________________

   (b) ______________________________

   (c) ______________________________

   (d) ______________________________

   (e) ______________________________

3. If you could change two things about the dredging windows process, what would they be?

   (a) ______________________________

   (b) ______________________________

Optional
Name ______________________________

Contact Information ______________________________

____

Dredging Windows as a Management Option: Suggestions for Improvements

If a specific dredging case study is discussed in any breakout session, we invite you to complete this brief questionnaire and return it to Jerry Schubel at the New England Aquarium, Central Wharf, Boston, MA 02110 (fax 617/973-0276), or leave it with your session leader. Thanks for your help!

1. Identification of Project (Case Study): ________________________________

2. Were environmental windows used? ____ Yes ____ No

3. If yes, what were the driving forces? ____ Political ____ Endangered species ____ Aesthetics/Tourism ____ Commercially important species ____ Other.

   If other, please specify ________________________________

4. If biological resources were the driving force, which species?

   ____

5. What was the perceived nature of the dredging threat to living resources (for example, turbidity, burial, blockage of migration, resuspension and release of toxics, etc)? ________________________________

6. If environmental windows were **not** used, were they considered?
   ____ Yes ____ No

7. If considered and rejected, why? ____ Scientific assessment ____ Political

   pressure ____ Other. If other, please specify ________________________________

8. Did the Corps and other federal agencies draw upon and use the appropriate scientific and technological advice in making their decision on windows?
   ____ Yes ____ No

9. In your opinion, was the interagency cooperation in setting, administering, and monitoring environmental windows ___ Poor ___ Fair ___ Good ___ Excellent?

Optional
Name ________________________________

Contact Information ________________________________

____

Conference on Dredged Material Management: Options and Environmental Considerations

MIT, December 4–5, 2000

The National Research Council's Transportation Research Board and the Ocean Studies Board have been asked to organize and conduct a workshop to review the process used to set, administer, and monitor environmental windows as one option for managing impacts of federal dredging and disposal projects; and to make recommendations on how to improve that process. We seek your advice.

Please complete this brief questionnaire and return it to Jerry Schubel at the New England Aquarium, Central Wharf, Boston, MA 02110 (fax 617/973-0276), or leave it in the box at the back of the room. Thanks for your help!

1. Where in the process of setting, applying and administering, and monitoring environmental dredging windows would you recommend that the NRC Study Committee focus its efforts to improve the effectiveness of dredging windows as a management tool? ______________________

   ____

2. What are the major unresolved research questions that limit the effectiveness of using "dredging windows" as a management tool to reduce the environmental impacts of dredging and disposal? Please be as specific as possible.

   (a) ____

   (b) ____

   (c) ____

   (d) ____

   (e) ____

3. If you could change two things about the dredging windows process, what would they be?

   (a) ____

   (b) ____

Optional

Name ____

Contact Information ____

____

Dredging Windows as a Management Option: Suggestions for Improvements

If a specific dredging case study is discussed in any breakout session, we invite you to complete this brief questionnaire and return it to Jerry Schubel at the New England Aquarium, Central Wharf, Boston, MA 02110 (fax 617/973-0276), or leave it with your session leader. Thanks for your help!

1. Identification of Project (Case Study): ______________________________

2. Were environmental windows used? ____ Yes ____ No

3. If yes, what were the driving forces? ____ Political ____ Endangered species ____ Aesthetics/Tourism ____ Commercially important species ____ Other.

   If other, please specify ______________________________

4. If biological resources were the driving force, which species?

   ____

5. What was the perceived nature of the dredging threat to living resources (for example, turbidity, burial, blockage of migration, resuspension and release of toxics, etc)? ______________________________

6. If environmental windows were **not** used, were they considered?
   ____ Yes ____ No

7. If considered and rejected, why? ____ Scientific assessment ____ Political pressure ____ Other. If other, please specify ______________________________

8. Did the Corps and other federal agencies draw upon and use the appropriate scientific and technological advice in making their decision on windows?
   ____ Yes ____ No

9. In your opinion, was the interagency cooperation in setting, administering, and monitoring environmental windows ___ Poor ___ Fair ___ Good ___ Excellent?

Optional
Name ______________________________

Contact Information ______________________________

____

Study Committee Biographical Information

Jerry Schubel (*Chair*) is President and Chief Executive Officer of the New England Aquarium. He received a B.S. in physics and mathematics from Alma College, an M.A.T. from Harvard University, a Ph.D. in oceanography from Johns Hopkins University, and an honorary D.Sc. in 1997 from the Massachusetts Maritime Academy. He served for 20 years as Dean and Director of the State University of New York at Stony Brook's Marine Sciences Research Center. His primary research interests include estuarine and shallow-water sedimentation, suspended sediment transport, interactions of sediment and organisms, and marine geophysics. Dr. Schubel has written numerous articles and papers exploring sedimentation and general marine science issues. He served from 1992 to 1994 as chair of the Marine Board, National Research Council.

Henry J. Bokuniewicz is a Professor at the Marine Sciences Research Center of the State University of New York at Stony Brook. He received a B.A. from the University of Illinois and an M. Phil. and a Ph.D. from Yale University. His current research focuses on the effects of resuspension on containment availability for dredged material, benthic studies associated with containment, prediction of tidal circulation and hydrodynamics, and criteria for the selection of placement sites for dredged material. He has authored or coauthored numerous papers on sediment transport and deposition, sediment mass balance, and effects of storm and tidal energy.

Peter F. Bontadelli, Jr., is founder and President of PFB Associates, an environmental and maritime consulting firm. He graduated from the University of California, Davis, with a B.A. in political science. From November 1987 to January 1992, he was Director of the California Department of Fish and Game, where he was designated as lead for the governor in oil spill prevention and response activities for California's marine waters. Prior to his responsibilities as Director, he served for 22 months as Chief Deputy Director of the Department and was responsible for overall department operations. As a Special Assistant to the Fish and Game Director from June 1984 to January 1986, he was responsible for legislation, coordination of special task forces, and the department's budget. Mr. Bontadelli has also served as a member of the U.S. Coast Guard's Negotiated Rulemaking Committee and a member of the National Research Council panel that conducted an implementation review of the Oil Pollution Act of 1990 (Section 4115). He is currently a member of the Marine Board.

Robert J. Diaz is a Professor of Biological Sciences at the School of Marine Science, Virginia Institute of Marine Science. He received a B.A. in biology and chemistry from La Salle College and an M.S. and a Ph.D. in marine science from the University of Virginia. His areas of expertise include marine benthos, marsh ecology, and salt marsh benthos. Recent research projects have involved a deep-sea assessment of dredged material, a benthic analysis of the Eastern Shore, and a long-term benthic monitoring study conducted on behalf of the Virginia Department of Environmental Quality. Dr. Diaz has coauthored a book titled *In Situ Measurement of Organism-Sediment Interaction: Rates of Burrow Formation/Abandonment and Sediment Oxidation/Reduction*. He has also written numerous articles and papers covering various facets of benthic ecology and has served as an adviser to state agencies and the U.S. Army Corps of Engineers, Waterways Experiment Station, regarding channel dredging and open-water disposal of dredged material.

Marcelo H. Garcia is an Associate Professor in the Department of Civil and Environmental Engineering at the University of Illinois–Champaign and Director of the Ven Te Chow Hydrosystems Laboratory at the University of Illinois. He received a Dipl. Ingeniero in water resources from the Universidad Nacional del Litoral, Argentina, and an M.S. and a Ph.D. in civil engineering from the University of Minnesota. His two primary areas of research are sediment transport (e.g., particle-turbulence interaction, sediment erosion and resuspension by unsteady flows, turbidity currents, particle and pollutant transport and transformation) and environmental hydrodynamics (e.g., turbulence effects on aquatic life, vegetation-flow interaction, density currents, and boundary-layer flows involving turbulence-driven mass transfer at air-water and sediment-water interfaces). Dr. Garcia recently completed a book titled *Hydrodynamics and Sediment Transport* and is the author of numerous articles and papers. He is a frequent lecturer around the world and is an Associate Editor of the *Journal of Water Resources Research* (American Geophysical Union) and the *Journal of Hydraulic Engineering in Mexico* (Mexican Institute of Water Technology).

Ram K. Mohan is Vice President at Blasland, Bouck, & Lee; he was Vice President for Gahagan & Bryant Associates, Inc., when the study commenced. He received a B.S. in naval architecture from the Cochin University of Science and Technology, India; an M.S. in ocean (marine geotechnical) engineering from the University of Rhode Island; a Ph.D. in ocean (coastal and dredging) engineering from Texas A&M University; and a P.E. in civil engineering from the University of Maryland. He has more than 11 years of experience in the areas of dredging systems and dredged material disposal, river and channel hydraulics, sediment transport modeling, and environmental dredging technologies. Dr. Mohan is active in professional societies and serves as Editor-in-Chief of the Western Dredging Association's *Journal of Dredging Engineering,* Editorial Review Board member for the *Journal of Marine Environmental Engineering,* and Editorial Review Board member for the *Journal of Hydraulic Research.* He has authored more than 80 papers in civil, coastal, hydraulic, and dredging engineering. He is also a member of the National Research Council's Ocean Studies Board.

Denise J. Reed is a Professor in the Department of Geology and Geophysics at the University of New Orleans. Her research interests include coastal marsh response to sea-level rise, the contributions of fine sediments and organic material to marsh soil development, and how these are affected by human alterations to marsh hydrology. She has worked on coastal issues in northwest Europe, southern Chile and the Atlantic, and the Pacific and Gulf coasts of the United States; she has published her results in numerous papers and reports. She has been involved in restoration planning in both Louisiana and California and in the scientific evaluation of the results of marsh restoration projects. Dr. Reed serves on the editorial boards of the *Journal of Coastal Research* and *Wetland Ecology and Management.* She has served on numerous boards and panels concerning the effects of human alterations on coastal environments and the role of science in guiding ecosystem restoration. She received her Ph.D. from the University of Cambridge, U.K., and has worked in coastal Louisiana since 1986.

Susan-Marie Stedman has been a Fishery Biologist and Team Leader for the National Marine Fisheries Service, Office of Habitat Conservation, since 1993.

In this capacity, she leads the National Oceanic and Atmospheric Administration's (NOAA) fisheries national habitat conservation efforts; her responsibilities include policy development, outreach, and review and comment on the Army Corps of Engineers' Clean Water Act, Section 404, Program. She received a B.S. in marine science from Southampton College and an M.S. in coastal geology from the University of Delaware. Ms. Stedman assists the Fishery Management Councils in implementing the essential fish habitat (EFH) provisions of the Magnuson–Stevens Act and was the principal author of NOAA's fisheries guidance on conducting EFH consultations. She is currently editing a joint publication with the U.S. Geological Service on the dependence of fish on wetlands and is developing a NOAA fisheries policy on conservation of submerged aquatic vegetation as fish habitat.

Nils E. Stolpe is Director of Communications and an Interim Board Member for the Garden State Seafood Association. He received a B.S. in environmental science from Rutgers University. He is also the publisher of *FishNet USA*, a monthly information sheet addressing fisheries-related topics distributed to more than 1,500 subscribers. From 1995 to 1999 he served as Executive Director of the New Jersey Seafood Harvesters Association and from 1987 to 1993 as Executive Director of the New Jersey Commercial Fisherman's Association.

John B. Torgan is the Narragansett Bay Keeper with Save the Bay in Providence, Rhode Island. He holds a B.S. in environmental studies and biology from Union College. He leads Save the Bay's program to protect the environmental integrity of the bay and its tributaries through sampling, research, and education. He develops outreach activities and other communication programs to bring problems to the attention of the public. He has also performed research on wildlife habitats in the region and has provided testimony on ecological issues. Prior to holding his current position, he conducted ecological research and field studies in New York and Michigan as well as fishery studies in rivers near hydroelectric dams.

Thomas H. Wakeman III is Dredging Program Manager for the Port Authority of New York and New Jersey, where he is responsible for the planning, development, and management of a $20 million annual operating and capital dredging program. He received a B.A. in biology from California Polytechnic State University, San Luis Obispo, and an M.A. in marine biology from San Francisco State University, and he has completed doctoral coursework in engineering at the University of California, Berkeley–Davis. Previously he served as a Special Projects Manager for the U.S. Army Corps of Engineers, San Francisco District. In this position, he was responsible for the project management and coordination of a regional $17 million federal-state plan for dredging and disposal management, an annual $25 million federal maintenance dredging program, and the $130 million John Baldwin navigation channel deepening project. He was recently elected Cochair of the Dredged Material Management Integration Work Group, U.S. Environmental Protection Agency–U.S. Army Corps of Engineers Regional Dredging Team. He is a member of the American Society of Civil Engineers, the International Navigation Association, and the Western Dredging Association and is an individual affiliate of the Transportation Research Board.

Michael P. Weinstein is President–CEO of the New Jersey Marine Sciences Consortium and Director of the New Jersey Sea Grant College Program. He also serves as a Visiting Professor for the Institute of Marine and Coastal Sciences, Rutgers University. He received a B.A. in biology from Hofstra University, an M.S. in zoology from Rutgers University, and a Ph.D. in marine and environmental science from Florida State University. His primary research interests include coastal ecology, early-life history, secondary production, restoration ecology, and ecological engineering. He is the principal author of more than 200 reports and presentations to state and federal agencies and the private sector and has authored or coauthored eight books pertaining to ichthyology.