Scientific Review of the Draft Environmental Impact Statement: Drakes Bay Oyster Company Special Use Permit

ISBN
978-0-309-26166-1

70 pages
8 1/2 x 11
PAPERBACK (2012)

Committee on the Evaluation of the Drakes Bay Oyster Company Special Use Permit DEIS and Peer Review; Ocean Studies Board; Divison on Earth and Life Studies; National Research Council

PREPUBLICATION

SCIENTIFIC REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT
DRAKES BAY OYSTER COMPANY SPECIAL USE PERMIT

Committee on the Evaluation of the Drakes Bay Oyster Company Special Use Permit DEIS and Peer Review

Ocean Studies Board

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

PREPUBLICATION

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This study was supported by Contract/Grant No. 10000991 between the National Academy of Sciences and the Department of the Interior, National Park Service. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

Cover art courtesy of NASA, NAP.

Library of Congress Cataloging-in-Publication Data
or
International Standard Book Number 0-309-0XXXX-X
Library of Congress Catalog Card Number 97-XXXXX

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, N.W., Lockbox 285, Washington, DC 20055; (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area); Internet, http://www.nap.edu

Printed in the United States of America

PREPUBLICATION

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

www.national-academies.org

PREPUBLICATION

COMMITTEE ON THE EVALUATION OF THE DRAKES BAY OYSTER COMPANY SPECIAL USE PERMIT DEIS AND PEER REVIEW

DR. THOMAS C. MALONE, *(CHAIR)*, University of Maryland
DR. JOAO FERREIRA, New University of Lisbon, Portugal
DR. W. MICHAEL HANEMANN, Arizona State University
DR. EVAMARIA KOCH, University of Maryland
DR. JENNIFER MIKSIS-OLDS, Penn State University
DR. BRYAN PIJANOWSKI, Purdue University
DR. JENNIFER RUESINK, University of Washington
DR. CHARLES SIMENSTAD, University of Washington
MS. LUCINDA LOW SWARTZ, ESQ., Environmental Consultant, Washington, DC
DR. PAUL THOMPSON, University of Aberdeen, UK

PREPUBLICATION

OCEAN STUDIES BOARD

PREPUBLICATION

Acknowledgments

This report was greatly enhanced by public input in advance and during the committee's meeting. The committee would like to thanks those who were available to answer questions during the public meeting and prepare public comments. The written submissions and the public comments helped set the stage for fruitful discussions in the closed sessions that followed.

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 NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in their review of this report:

Dr. Ann Bowles, Hubbs-SeaWorld Research Institute
Dr. Keith R. Criddle, University of Alaska Fairbanks, Juneau
Dr. James W. Fourqurean, Florida International University
Dr. Eileen Hoffman, Old Dominion University
Dr. Joel A. Mintz, Nova Southeastern University Shepard Broad Law Center
Dr. Francis O'Beirn, Marine Institute, Galway, Ireland
Dr. Robert T. Paine (NAS), University of Washington
Dr. Kenneth A. Rose, Louisiana State University
Dr. Peter L. Tyack, University of St Andrews, Scotland
Dr. Alan Washburn (NAE), U.S. Naval Postgraduate School

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by **Dr. Paul Risser**, University of Oklahoma, appointed by the Division on Earth and Life Studies, and **Dr. Bonnie McCay (NAS)**, Rutgers University, appointed by the Report Review Committee, who were 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.

PREPUBLICATION

Scientific Review of the Draft Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit

Table of Contents

PREPUBLICATION

SUMMARY

In May 2012, the National Park Service (NPS) asked the National Research Council to conduct a scientific review of a Draft Environmental Impact Statement (DEIS) prepared to "evaluate the effects of issuing a Special Use Permit for the commercial shellfish operation" in Drakes Estero for a 10-year period.[1] Drakes Bay Oyster Company (DBOC) currently operates the shellfish farm in Drakes Estero, part of Point Reyes National Seashore, under a reservation of use and occupancy that will expire on November 30, 2012 if a new Special Use Permit is not issued. Because the commercial shellfish operation is the single, nonconforming use in this congressionally-designated potential wilderness, closure and removal of the shellfish farm would prompt the conversion of Drakes Estero to full wilderness status. Congress granted the Secretary of the Interior the discretionary authority to issue a new 10-year Special Use Permit in 2009 (Public Law 111-88, Section 124); hence, the Secretary now has the option to proceed with or delay the conversion of Drakes Estero to wilderness. To inform this decision, the NPS drafted an Environmental Impact Statement (EIS) for the DBOC Special Use Permit. Under the National Environmental Policy Act (NEPA), an EIS is prepared to inform the public and agency decision-makers regarding the potential environmental impacts of a proposed federal action and reasonable alternatives. The Department of the Interior commissioned a peer review of the DEIS (Atkins Peer Review) that was released in March 2012.

This report reviews the scientific information presented in the DEIS that is used to determine the potential environmental impacts of a 10-year extension of DBOC operations. In particular, this report responds to the following tasks given to the committee: assess the scientific information, analysis, and conclusions presented in the DEIS for Drakes Bay Oyster Company Special Use Permit, and; evaluate whether the peer review of the DEIS conducted by Atkins, North America for the U.S. Department of the Interior is fundamentally sound and materially sufficient. The committee did not perform an independent evaluation of the environmental impacts of the proposed alternatives, but restricts its findings to the strength of the scientific conclusions reached in the DEIS and to the identification of concerns, if any, not covered in the Atkins peer review.[2] The report focuses on eight of twelve resource categories considered in the DEIS: wetlands, eelgrass, wildlife and wildlife habitat, special-status species, coastal flood zones, soundscapes, water quality, and socioeconomic resources.

Ecological Setting

Drakes Estero is a coastal lagoon located approximately 25 miles northwest of San Francisco, California that extends northward into the Point Reyes peninsula from Drakes Bay. The ecosystem consists of five branching bays (Barries, Creamery, Schooner, Home and Estero de Limantour) with an area of ~2,500 acres and a narrow mouth allowing tidal exchange with coastal ocean waters. Major habitats include intertidal mudflats, sandbars, and subtidal eelgrass beds that support wildlife including native shellfish, finfish, shorebirds, and harbor seals. After trial plantings of the nonnative Pacific oyster (*Crassostrea gigas*) in 1932, farming of this species in Drakes Estero has continued as a commercial enterprise under various owners up through the DBOC which assumed ownership in 2005.

Alternatives Assessed in the DEIS

The DEIS assesses impacts of four alternatives on twelve resource categories, and classifies intensities of impact as beneficial or minor, moderate, or major adverse. The four alternatives (described in more detail in Chapter 1 of the DEIS) are briefly characterized below.

[1] Congress requested the NRC review in the December 2011 conference report.
[2] Study statement of task is provided in Appendix B.

PREPUBLICATION

No Action Alternative – Special Use Permit under which DBOC operates expires on November 30, 2012 and is not renewed:

> **Alternative A**: mariculture activities cease and equipment is removed; Drakes Estero potential wilderness is converted to full wilderness.

Action Alternatives – Special Use Permit for shellfish culture is reissued for an additional 10 years under the conditions specified in three alternatives:

> **Alternative B**: Level of use consistent with conditions and operations present in fall 2010; Shellfish production limited to 600,000 lbs/yr.
> **Alternative C**: Level of use consistent with conditions and operations at the time the current Special Use Permit was signed in April, 2008; Shellfish production limited to 500,000 lbs/yr.
> **Alternative D**: Considers an expansion of operations and new or modified onshore facilities as requested by DBOC as part of the EIS process; Shellfish production limited to 850,000 lbs/yr;

Major Conclusions

For the eight resource categories, the committee evaluated conclusions in the DEIS concerning levels of impact of each alternative and the information and interpretations that led to them. The committee also commented on whether alternate, scientifically sound conclusions could be reached based on the available information (in the DEIS and the scientific literature) and the level of uncertainty associated with the conclusions. As noted in the previous NRC report on Drakes Estero (NRC, 2009), there is not an extensive scientific literature on Drakes Estero and research on the potential impacts of shellfish mariculture on the Drakes Estero ecosystem is even sparser. Therefore, the NPS had little primary data on which to base the DEIS and had to rely to a large extent on inference from research conducted in other areas. Although this was the only approach that could be used under the circumstances, it not only made it difficult to differentiate impacts of alternatives B, C and D, it resulted in a moderate to high level of uncertainty associated with conclusions concerning levels of impact for most of the resource categories reviewed by the committee (Table S.1).

Impacts of the Alternatives

Alternative A can be readily distinguished from alternatives B, C, and D because mariculture activities would cease and all DBOC infrastructure would be removed. However, alternatives B, C, and D are differentiated primarily in terms of production limits for offshore activities (600,000 lbs, 500,000 lbs and 850,000 lbs for B, C, and D, respectively), which do not provide a clear basis for comparison. An overview of the DEIS impact findings shows that the expected impact intensities are the same for each action alternative regardless of resource category (Table S.1). Production limits dictate the maximum level of harvest, but do not directly scale with level of activities or spatial extent of mariculture operations. Additionally, harvest may vary as a function of environmental conditions, shellfish diseases, harmful algal blooms, predation, and market conditions, and therefore does not represent a reliable indicator of potential impact.

Adverse impacts are defined in the DEIS as minor, moderate or major in order to describe impacts based on their intensity or magnitude. It is noteworthy that only one category of beneficial impact is used, eliminating the possibility of distinguishing between effects that may range from minor to major beneficial in parallel with the definitions used for adverse impacts. Also, the definitions do not include a negligible impact, a useful category that is included in NPS NEPA guidance documents (Director's Order 12[3]). For most of the eight resource categories that the committee was asked to review, the committee concluded that the DEIS does not define impact intensity levels that can be clearly related to the magnitude of the effect (spatial or temporal; direct or indirect). This makes it difficult to determine both the comparative impact of the different alternatives and the relative levels of impact across resource

[3] Available at: www.nature.nps.gov/protectingrestoring/do12site/pdf/tab12_imp.pdf.

categories. For example, both the moderate and major intensity definitions for wildlife and wildlife habitat include the mention of impacts on "individuals." Such a definition implies that the mortality of an individual organism associated with flipping of oyster bags could be interpreted as a moderate impact on the resource, which would be incompatible with the level of ecological impact.

Level of Uncertainty and Alternate Conclusions

An estimate of uncertainty, which reflects the strength of the available scientific information, gives decision makers a better understanding of the range of potential impacts for a given action alternative. Therefore, the committee assessed the data and analysis for each resource category in terms of the level of uncertainty associated with the impact assessment given in the DEIS.[4] Of the eight resource categories, the committee judged that the projected impact levels for seven had moderate to high levels of uncertainty and, for many of these an equally reasonable alternate conclusion of a lower impact intensity could be reached based on the available data and information (see Table S-1). To provide an accurate analysis for the decision maker, it is important for the EIS to include estimates of level of uncertainty as part of the assessment of environmental consequences.

Baselines

The DEIS employs two different baselines in assessing the impacts of the no action and action alternatives. In a typical EIS, the "no action" alternative is considered the current baseline environmental condition against which the impacts of the action alternatives are compared. However, for the DBOC Special Use Permit EIS, the no action alternative (alternative A) refers to a change from the current condition (the Special Use Permit would expire and DBOC would cease operation) and shifts to a new, future condition that is unknown. Impacts associated with action alternatives B, C, and D (10 year extension of the permit for the mariculture operation) are then compared to this projected future "baseline" (alternative A), while impacts of alternative A are compared to the better known existing conditions (i.e., with DBOC facilities and operations as described for alternative B) as the baseline. This introduces an extra level of uncertainty to the evaluation of the action alternatives and creates asymmetry in the assessments conducted for the action alternatives relative to the no action alternative. By invoking two baselines, the DEIS essentially contains two separate impact assessments, one for the no action alternative and another for the action alternatives, such that there is not a common basis for comparing the potential impacts of the no action alternative (A) with the potential impacts of the action alternatives (B, C, and D).

Suggestions for DEIS Revisions[5]

The committee provides the following high priority suggestions for revising the final EIS: (1) use definitions of impact intensities that demonstrably scale with their magnitude (e.g., minor, moderate, major), and fully reflect the range of both adverse and beneficial impacts including a category for

---

4 Low uncertainty is assigned when the committee finds that substantial scientific evidence exists to support the conclusions reached, i.e., the evidence demonstrates a strong cause-effect relationship between Drakes Bay Oyster Company (DBOC) actions associated with an alternative and a measurable effect.

Moderate uncertainty is assigned when the committee concludes that, while there is insufficient data and information for Drakes Estero, observations from other comparable ecosystems and current scientific understanding allow logical deductions concerning a possible cause-effect relationship between DBOC actions and a measureable effect.

High uncertainty is assigned when the committee concludes that there is insufficient data and information for Drakes Estero; observations from other comparable ecosystems are not available; and scientific understanding is insufficient or controversial such that conclusions regarding a possible cause-effect between DBOC actions and a measurable effect can be made only by inference.

5 These suggestions are based on the committee's review of the scientific foundation of the DEIS and should not be interpreted as a conclusion that the DEIS does not meet NEPA requirements.

negligible impacts; (2) provide a discussion of the levels of uncertainty for the impact intensities (e.g., Table S.1); (3) specify all assumptions used in assessing impact and in scaling the intensity of impact; (4) describe potential alternate conclusions as appropriate (e.g., Table S.1); (5) segregate impact assessments for alternative A from alternatives B, C, and D and indicate that the assessments are not comparable due to use of different baselines; (6) use all relevant and available information, especially for soundscapes and water quality (from research in Drakes Estero and in other comparable systems) and; (7) include additional mitigation options as possible permit conditions for the action alternatives to reduce impacts, e.g., an option to discontinue the culture of Manila clams would address some concerns about the establishment of that nonindigenous species in Drakes Estero; impacts of many DBOC practices (i.e., boat use, culture techniques, marine debris, soundscape disturbance) could potentially be reduced by the implementation of appropriate mitigation measures.

Table S.1. Summary of impact intensities from the DEIS and the committee's assessment of the analyses and conclusions reached in the DEIS for each resource category. Level of uncertainty for each resource category, as estimated by the committee, is indicated by a white dot (low uncertainty), gray dot (moderate uncertainty) or black dot (high uncertainty). For additional details see Chapter 3.

PREPUBLICATION

Resource Category[1]		DEIS Impact Levels: Beneficial	DEIS Impact Levels: Adverse Level: Minor	DEIS Impact Levels: Adverse Level: Moderate	DEIS Impact Levels: Adverse Level: Major	Committee's Comments on DEIS Analysis & Conclusions: Comments	Uncertainty (Low / Mod. / High)	Possible Alternate Conclusion
Wetlands		A		B,C,D		• Lacks assessment of tidal freshwater wetlands • Benthic disturbance from bag & rack cultures not well differentiated	Mod.	Impacts could be minor or moderate adverse depending on level of sediment disturbance
Eelgrass		A		B,C,D		• Data not available on turbidity for evaluating impacts of DBOC operations (sediment resuspension & oyster filtration) • Analysis of aerial photographs could be used more extensively to assess changes in extent & fragmentation	Mod.	Impact may be minor at the population level given the local scale of the DBOC footprint
Wildlife	Benthic fauna	A		B,C,D		• Impacts may differ between analyses of non-indigenous species and analyses of DBOC impacts on native species • Too little differentiation among the individual/population/community impact definitions	Mod.	Impacts may be minor given rapid recovery of benthic fauna & local scale of the DBOC footprint
Wildlife	Fish	A	B,C,D			• Possibility of indirect effects on prey resources (i.e. benthic infauna)	Mod.	Impact may be negligible given the small overall footprint of the mariculture activities
Wildlife	Harbor Seals	A		B,C,D		• Insufficient consideration of cumulative impacts under alternative A • Impact definitions not linked to biologically significant criteria	High	Seals may tolerate or habituate to DBOC activities resulting in minor impacts
Wildlife	Birds	A		B,C,D		• Additional data available from species list & survey data that could indicate population trends	Mod.	Impact may be minor given high abundance & species richness
Special Status	Butterfly	A	B,C,D			• Description of species preferred habitat would inform the impact assessment	Low	
Special Status	Frog	A	B,C,D			• Map of potential breeding grounds needed to assess impact of DBOC onshore operations	Low	
Special Status	Plover	A	B,C,D			• Need more detailed description of breeding & overwintering grounds	Mod.	
Special Status	Tern	A	B,C,D			• Time-series of abundance from Christmas birds counts & other publically available surveys could be included	Low	
Special Status	Coho	A	B,C,D			• Include critical juvenile habitat (freshwater tidal wetlands) in the project area	Mod.	
Special Status	Steelhead	A	B,C,D			• Could consider prey resource habitats in the impact assessment	Mod.	
Coastal Flood Zone		A		B,C,D		• Lacks quantitative assessment of floodplain displacement volume under different alternatives • Effects of sea level rise were not included in assessment	High	Given the small upland footprint of the DBOC operation, impacts may be minor
Water Quality		A	B,C,D			• Lacks data on water quality parameters needed to assess the impacts of DBOC operations • Underestimates the potential of biological processes within DE on water quality	High	Impacts of alternatives B, C, and D may be negligible or beneficial if shellfish filtration provides a beneficial ecosystem service
Soundscape		A			B,C,D	• No data available on underwater soundscape • Additional data available (not used) to assess temporal & spatial variability • Sound levels presented in dBA makes it more difficult to assess impacts on wildlife • Lack of direct measurements of sound levels related to DBOC operations in DE	High	Based on the data presented in the DEIS, impacts could be moderate to minor
Socio-economics		B,C,D	A			Lacks assessment of change: • in producer's plus consumer's surplus for commercial shellfish[2] • in consumer's surplus for recreation • in non-use value	High	

[1] Since Drakes Estero does not contain the habitat required for leatherback turtles, this resource category is not included here.

[2] Surplus refers to the net value of the commodity or service. For a producer, this value would be equivalent to profit (sales minus expenses). For a consumer, this represents the difference between the value of the item (e.g. what the consumer would be willing to pay) and the cost of the item.

PREPUBLICATION

CHAPTER 1

Introduction

Drakes Estero

Located 25 miles northwest of San Francisco, California, Drakes Estero is a shallow, tidal, soft sediment coastal lagoon within the Point Reyes National Seashore. The region is characterized by warm, dry summers and cool, wet winters. Major habitats in Drakes Estero are intertidal wetlands (mostly mud and sand flats) and eelgrass beds.[1] The Estero provides important habitat for a diverse assemblage of shorebirds and waterfowl,[2] and about 20% of California's mainland harbor seal population (NRC, 2009).[3] The ecosystem consists of five branching bays (Barries, Creamery, Schooner, Home and Estero de Limantour) with an area of ~2,500 acres[4] and a relatively deep (~26 ft),[5] narrow mouth that opens to the Pacific waters of Drakes Bay. The project area discussed herein (~1,700 acres) does not include Estero de Limantour, but encompasses the four remaining bays and most of the main body of the Estero.[6] Drakes Estero is well mixed vertically with a mean depth of ~6.5 ft and a tidal range of ~6 ft.[7] Tidal pumping is the dominant physical forcing mechanism most of the time, except for events that change coastal water levels such as a storm surge or tsunami.

With the exception of major rainfall events (which occur most frequently during winter) land-based inputs of fresh water and nutrients to Drakes Estero are low (especially during summer); and seasonal variations in temperature, salinity, and nutrients in the Estero reflect those of the adjacent coastal ocean in Drakes Bay (NRC, 2009). Thus, inputs of new nutrients to the Estero are highest during the upwelling season (March – September) and events such as the El Niño-Southern Oscillation and Pacific Decadal Oscillation can influence Drakes Estero water conditions. Phytoplankton blooms in the Estero occur most frequently during summer (Buck et al., 2011; 2012).

Shellfish Mariculture 1932 – 2012

Farming of the Pacific oyster (*Crassostrea gigas*, a non-indigenous species) began in 1932, and has been conducted continuously since that time. As of 2005, local oyster operations have been owned and operated by the Drakes Bay Oyster Company (DBOC). Today, shellfish culture (bags and racks) is concentrated in the main body of Drakes Estero and near the mouths of Schooner and Home Bays.[8] Three main species of shellfish have been farmed in Drakes Estero: Pacific oyster, Manila clam (*Venerupis philippinarum*), and purple-hinged rock scallops (*Crassadoma gigantean*; a indigenous species). Annual production of Pacific oysters, the primary species farmed in Drakes Estero, has varied considerably from year to year (e.g., from a maximum of 684,000 lbs of Pacific oysters in 1994 to a minimum of 34,000 lbs in 2000). Since DBOC acquired ownership of operations in December 2004, Pacific oyster harvest has increased from about 139,000 lbs in the first year (2005) to 585,000 lbs (2010).[9]

1 Draft Environmental Impact Statement (DEIS), p. 158, 166, 170; Figures 3-1, 3-2, and 3-3
2 DEIS, p. 181
3 DEIS, p. 179
4 DEIS, p. 8
5 DEIS, p. 159
6 DEIS, p. 166; Figures ES-1 and ES-2
7 DEIS, p. 159
8 DEIS, Figure ES-2
9 DEIS, p. 66

PREPUBLICATION

Policy Context

Drakes Estero (Figure 1.1) is part of the Point Reyes National Seashore (henceforth referred to as "the Seashore") which was established by Congress in 1962 (Point Reyes National Seashore Enabling Act, 16 U.S.C. § 459c–459c-7). In 1972, the mariculture property was sold to the National Park Service (NPS), in exchange for a 40-year Reservation of Use and Occupancy (RUO) and Special Use Permit (SUP) allowing continuation of commercial shellfish operations until expiration. In the Point Reyes Wilderness Act of 1976, Congress designated 25,370 acres of the Seashore as wilderness and 8,003[10] acres as potential wilderness (NRC, 2009). The latter includes approximately 1,363 acres of tidal wetlands and subtidal waters within Drakes Estero utilized by DBOC operations (Point Reyes Wilderness Act, Public Law 95-544).[11] The current RUO and SUP will expire by law on November 30, 2012,[12] thereby terminating DBOC operations in Drakes Estero. The removal of this sole nonconforming activity would result in conversion of Drakes Estero from congressionally designated potential wilderness to congressionally designated wilderness, becoming one of eleven marine wilderness areas in the U.S. and the first on the west coast (NPS, 2007).

At the request of the NPS, the National Research Council conducted a study to help clarify potential impacts of shellfish farming on the ecology and socioeconomics of Drakes Estero (NRC, 2009). After evaluating the limited scientific literature available on Drakes Estero and relevant research on other similar ecosystems, the committee concluded that "there is a lack of strong scientific evidence that shellfish farming has major adverse effects on Drakes Estero" at current (2008-2009) levels of production and operating practices (NRC, 2009).

On October 30, 2009, Congress granted the Secretary of the Department of the Interior (DOI) the discretionary authority to issue a new 10-year SUP (Public Law 111-88, Section 124). This authority allows, but does not require, the Secretary to permit DBOC's continued nonconforming use of the potential wilderness area until November 30, 2022. DBOC submitted a request for the issuance of a new permit upon expiration of the existing authorizations. Thus, the NPS prepared an Environmental Impact Statement pursuant to the National Environmental Policy Act (NEPA) to inform this decision. Through the NEPA process, NPS engaged the public and evaluated the effects of alternatives related to the issuance of a new 10-year SUP for the commercial shellfish operation.

The DEIS, released in September 2011, examines DBOC operations and facilities in and adjacent to Drakes Estero, and offers four alternatives for consideration by the Secretary of the Interior with regard to the permit request (Box 1.1).

10 DEIS, p. 15

11 DEIS, p. 11

12 In 2004, the U.S. Department of the Interior Solicitor determined that, based on the intent of Public Law No. 94-544, Public Law No. 94-567, and NPS wilderness management policies, NPS had no authority to extend the RUO and SUP beyond November 30, 2012. DEIS, p. 2.

PREPUBLICATION

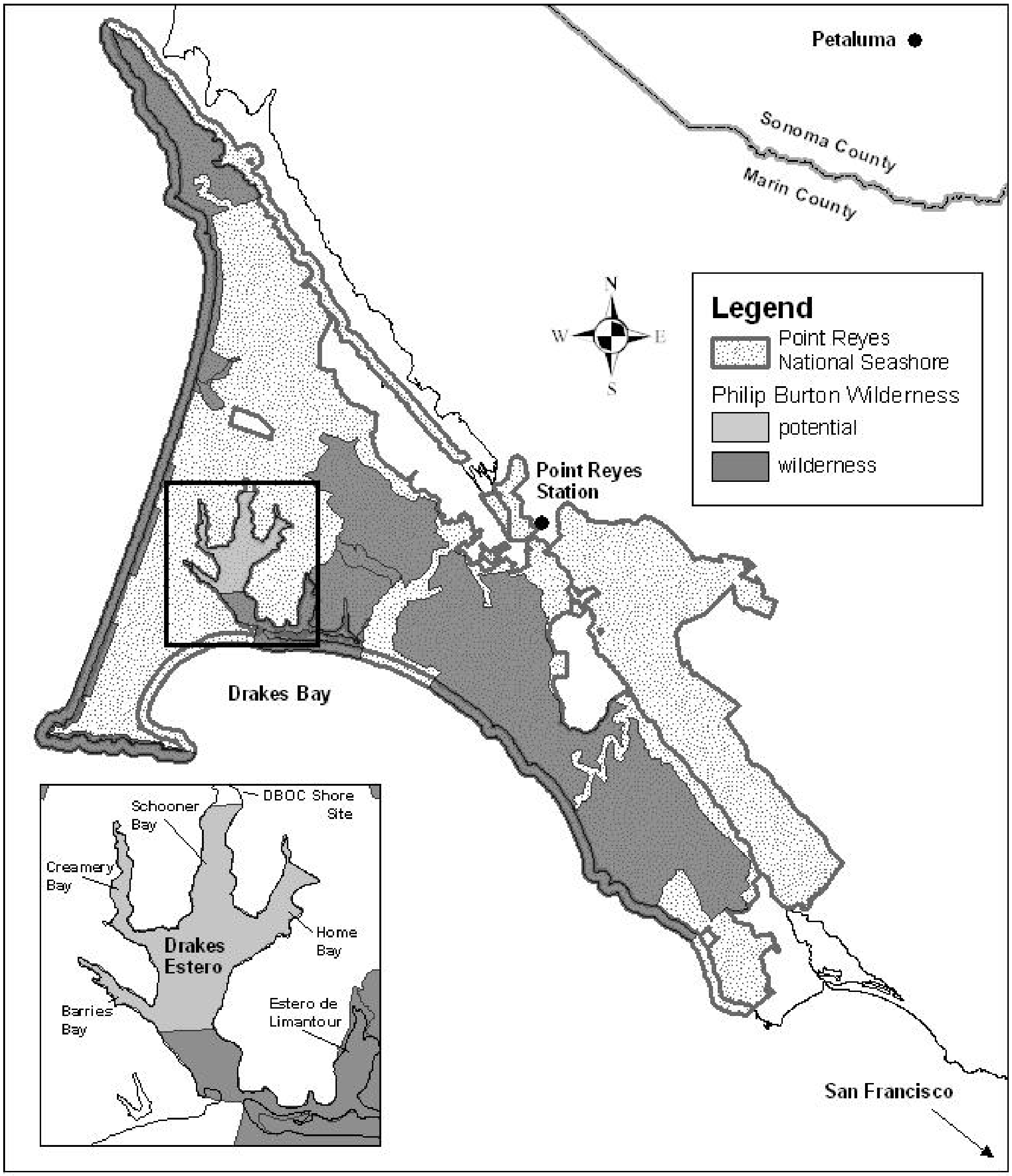

Figure 1.1. Drakes Estero is located within the Point Reyes National Seashore in Marin County, California. Inset provides larger view of Drakes Estero and shows the location of Drakes Bay Oyster Company. Map courtesy of David Press, NPS (reprinted from NRC, 2009).

PREPUBLICATION

Box 1.1
Four Alternatives Presented in the DEIS

Alternative A evaluates the "no action" alternative. If the Secretary of Interior does not approve renewal of the SUP, DBOC must terminate all shellfish mariculture, remove its personal property and nonconforming infrastructure, and undertake steps to restore the area to good order and condition.

The NPS DEIS also analyzes the impacts of three alternative scenarios with differing levels of shellfish production if the SUP were to be extended:

Alternative B would permit continued shellfish mariculture at the fall 2010 levels of operation (the date when NPS initiated evaluation under the EIS). Shellfish production would be limited to 600,000 lbs/yr; total acreage of the SUP area, both onshore and offshore, would be ~1,083 acres; Pacific and European flat oysters (*Ostrea edulis*, a non-indigenous species), and Manila clams could be grown in Area 1 (1,077 acres)[13], and purple-hinged rock scallops could be grown in Area 2 (1 acre); new lease boundaries would exclude shellfish culture from harbor seal protected areas with a 100 yard buffer; boat routes, to be approved by NPS, would avoid seal protected areas and minimize prop damage to eelgrass beds. DBOC operations would be subject to NPS harbor seal protection protocol.

Alternative C would require a reduction in the current scale of DBOC operations, consistent with the conditions and operations that existed at the time the current SUP was signed in April 2008. Shellfish production would be limited to 500,000 lbs/yr; total acreage of the SUP area, including both onshore and offshore areas, would be ~901 acres; Pacific and European flat oysters could be cultivated in Area 1 (896 acres), Manila clams and purple-hinged rock scallops could be grown only in Area 2 (1 acre); new lease boundaries would exclude harbor seal protected areas with a 100 yard buffer; boat routes, to be approved by NPS, would avoid seal protected areas and minimize damage prop to eelgrass beds. DBOC operations would be subject to NPS harbor seal protection protocol.

Alternative D permits an increase in the scale of operations, and an additional or modified onshore facilities and infrastructure as requested by DBOC as part of the EIS process. Shellfish production is limited to 850,000 lbs/yr; total acreage of the SUP area, including both onshore and offshore areas, would be ~1,087 acres; Pacific, Olympia and European flat oysters, Manila clams, and purple-hinged rock scallops may be grown in Area 1 (1082 acres; Area 2 would no longer be managed as a separate permitted area); new lease boundaries will exclude harbor seal protected areas with a 100 yard buffer; boat routes, to be approved by NPS, will avoid seal protected areas and minimize prop damage to eelgrass beds. DBOC operations would be subject to NPS harbor seal protection protocol.

The DEIS was open for public comment from September 23, 2011 to December 9, 2011, and three public open house meetings were held in the vicinity of the Seashore. More than 52,000 public comments were submitted to NPS during the comment period. The DOI commissioned an independent peer review of the DEIS (specifically Chapters 3 and 4) by Atkins, North America specifically targeted at the scientific underpinnings of the DEIS. The peer review was tasked to "examine the scientific and technical information and scholarly analysis presented in the document and assess whether: (1) appropriate scientific information was used; (2) reasonable conclusions were drawn from the information; (3) significant information was omitted from consideration; and (4) NPS interpretation of the information is reasonable" (Atkins report, pg 1). In addition, in December 2011, Congress requested an NRC review of the scientific foundation of the DEIS. In May 2012, the NPS commissioned the NRC to conduct the review reported herein.

[13] See DEIS p. 61 and Table 2.5 (pp. 122-125) for description of lease areas under the action alternatives and Figure 2-1 for map that shows locations of Areas 1 and 2

PREPUBLICATION

Statement of Task

The *ad hoc* committee was given two tasks by the NRC: (1) Assess the scientific information, analyses, and conclusions presented in the Draft Environmental Impact Statement (DEIS) for Drakes Bay Oyster Company Special Use Permit and (2) evaluate whether the peer review of the DEIS conducted by Atkins, North America for the U.S. Department of the Interior, is fundamentally sound and materially sufficient. The committee was asked not to perform an independent evaluation of the environmental impacts of the proposed alternatives, but will restrict its findings to the strength of the scientific arguments in the DEIS and identify concerns, if any, not covered in the Atkins peer review.

The DEIS identifies and evaluates twelve (12) resource categories that may be affected by continued commercial farming of shellfish. Of these, the committee's evaluation is limited to eight (8): wetlands, eelgrass, wildlife and wildlife habitat, special-status species, coastal flood zones, soundscapes, water quality, and socioeconomic resources. Because the impact assessments for the other four (4) categories covered in the DEIS (wilderness, visitor experience and recreation, and the National Park Service [NPS] operations) are not based primarily on scientific research and analysis, the current study will not cover these topics nor will it review any policy or legal information.

National Environmental Policy Act

The NPS DEIS discussed herein was developed under the National Environmental Policy Act (NEPA) process. NEPA requires federal agencies to prepare Environmental Impact Statements (EISs) for "major federal actions significantly affecting the quality of the human environment" (NEPA, Section 102(2)(C)). The NRC committee is mindful that the DEIS is a NEPA document and not a scientific paper subject to the rigorous requirements of professional journal articles. While a NEPA document must be scientifically rigorous (see: e.g., 40 CFR § 1502.24), EISs are prepared for a lay audience and to inform the public and agency decision-makers regarding the potential environmental impacts of a proposed action and reasonable alternatives.

In addressing the statement of task, the committee understands that to "assess the scientific information, analyses, and conclusions" in the DEIS means to address whether, in the committee's view, the data and analyses are consistent with academic scientific practice. The committee recognizes that such a standard may be different than those generally applied to documents prepared in conformance with NEPA. For example, scientists formulate conclusions based on the collection and analysis of data. By contrast, the EIS process requires formulation of conclusions based on the data and analyses that are available or that could be reasonably attained given time and resources, as long as it is sufficient to allow a decision maker to make a reasoned choice among alternatives. Therefore, in addition to evaluating the quality of the scientific information in the DEIS, the committee provides an assessment of the level of uncertainty in the conclusions reached in the DEIS to indicate the strength of the scientific evidence underlying these conclusions.

Approach and Organization of the Report

The NPS asked the NRC to provide a review of the DEIS on an expedited schedule of three months to fit within the timeframe of the NEPA analysis and the November 30, 2012 expiration of the Special Use Permit that allows DBOC to operate in Drakes Estero. As a consequence, the committee only convened one in-person meeting held at the National Academies' Beckman Center in Irvine, California on July 9-12, 2012. On July 10 of the meeting, the committee held a public session open to organizations that have been involved in the DEIS or that otherwise have an interest in the DEIS to participate either in person or via web conference. The public session was organized to allow the committee members to efficiently gather information of relevance to their review of the DEIS through a question and answer session. Time was also set aside for public comment. The agenda and list of participants in the pubic session is available in Appendix D. Organizations and members of the public were also encouraged to submit information for the committee's consideration in writing. These documents are part of the pubic

PREPUBLICATION

record for this study, available through the National Academies' Public Access Records Office,[14] and also were posted on the internet.[15]

The committee's evaluation of eight of the DEIS resource categories (wetlands, eelgrass, wildlife and wildlife habitat, special-status species, coastal flood zones, soundscapes, water quality and socioeconomic resources) was conducted in three stages as follows:

(1) Review and compare the information and analysis provided for alternatives A, B, C, and D for each resource category by addressing the following questions:
   - Are interpretations, analyses and conclusions scientifically sound based on (a) information and data provided in the DEIS, (b) additional results of scientific studies not considered in the DEIS, and (c) your expertise?
   - Are there alternate conclusions that are equally sound or logical based on current scientific knowledge?

(2) Evaluate the Final Report on Peer Review of the Science Used in the DEIS (the Atkins report) against the committee's evaluations of the DEIS to determine whether the peer review is fundamentally sound and materially sufficient.

(3) Provide suggestions for strengthening the scientific information in the final EIS.

The committee's review of the DEIS begins with a discussion of observations related to how the DEIS analysis was framed (Chapter 2). The committee then evaluates the information, analyses and conclusions presented in the DEIS (Chapter 3). The evaluation includes a discussion of the uncertainty underlying the conclusions in the DEIS and offers alternative interpretations of the existing information where appropriate. Following the committee's evaluation of the Atkins Peer Review (Chapter 4), the report concludes (Chapter 5) with a scientific assessment of the DEIS that leads to a set of suggestions for strengthening the science presented in the DEIS and reducing levels of uncertainty associated with the conclusions reported in the DEIS. The committee was not asked and hence does comment on the sufficiency of the DEIS to meet NEPA requirements.

[14] www8.nationalacademies.org/cp/ManageRequest.aspx?key=49463
[15] dels.nas.edu/global/osb/DrakeEstero

PREPUBLICATION

CHAPTER 2

Framing of the Draft Environmental Impact Statement

While reviewing the scientific information and analysis in the Draft Environmental Impact Statement (DEIS), the committee found common issues across resource categories that are related to how the DEIS is framed and merit discussion upfront.

Distinguishing Potential Impacts of Alternatives B, C, and D

Under the National Environmental Policy Act (NEPA), the agency analyzes the impacts of a "range of reasonable alternatives" that for this DEIS were developed "taking into consideration the results of internal discussions, review of public scoping comments, and consultation with local, state, and other federal agencies. Development of the action alternatives also was informed by the scope and scale of the existing Drakes Bay Oyster Company (DBOC) operations and facilities."[1] Although the DEIS states that the action alternatives (B, C, and D) refer to "differing levels of onshore facilities and infrastructure and offshore operations,"[2] with the exceptions of the larger permitted area for the Manila clam under alternatives B and D, and of the onshore facilities described for alternative D, the major difference among the alternatives is in the level of harvest permitted.

The level of harvest does not provide a clear distinction among alternatives B, C, and D. In mariculture, as in other forms of farming, operations are typically scaled in terms of three metrics: (1) the footprint of the area planted (2) the cultivation (bed or growing) area; and (3) the amount of product harvested (i.e., yield or production). Level of effort is assumed to scale with each of these metrics. The amount of product harvested (referred to as "production" in the DEIS; e.g., 585,277 lbs of oysters and 684 lbs of Manila clams harvested by DBOC in 2010)[3] has the greatest potential variability of these three metrics as a function of environmental conditions, shellfish diseases, harmful algal blooms, predation, and market conditions. For example, high interannual variability in oyster condition, indicative of the influence of environmental conditions on productivity, has been observed in Willapa Bay (Schoener and Tufts, 1987).

Hence differentiating alternatives B, C, and D primarily in terms of permitted levels of production (450,000-850,000 lbs/yr), not in terms of the footprint or acreage of growing areas or levels of effort,[4] introduces ambiguity with respect to assessing the relative impacts of the three action alternatives. Will interannual variations in production reflect differences in maximum production permitted, area planted and cultivated, or the effects of variable growing conditions? If the latter interpretation is correct, differences between B, C, and D would not reflect level of effort, and the alternatives would effectively be the same with respect to offshore activities. And indeed, the DEIS reaches the conclusion that impact levels of alternatives B, C, and D would be similar for each resource category relative to the no action alternative.

The National Park Service (NPS) would have greater ability to manage the footprint of DBOC offshore activities if they distinguished alternatives based on the actual mariculture footprint and how much of the permitted areas could be used as growing areas. In principle, DBOC could substantially change the mariculture footprint relative to current conditions independently of the production limit. However, there are also drawbacks to distinguishing alternatives based on areas where mariculture is allowed, or on the amount of effort allowed (for instance, hours of motorboat activity). For example, if DBOC planted a bed and then lost it to a bad batch of seed, they would not be able to replace it under a scheme where activities are limited by level of effort.

---

[1] DEIS, p.57
[2] DEIS, p. 1
[3] DEIS, Table 2.1
[4] Permitted areas available for cultivation specified in the Special Use Permit are 1,083 acres for alternative B and 1,087 acres for alternative D (DEIS, p. 58-60).

PREPUBLICATION

Baseline Conditions

The DEIS acknowledges that two baselines were used in assessing impacts:[5]

> "For the purposes of this document … The baseline against which the no-action alternative is assessed is generally existing conditions … The action alternatives, on the other hand, are…assessed using the no-action conditions as the baseline condition. In other words, the analysis of the action alternatives may be documented by contrasting the expected future conditions under each action alternative to the expected future conditions under the no-action alternative."

In other words, for alternative A, the DEIS assesses the expected impacts associated with the removal of DBOC's operations. The expected impacts are compared to the existing conditions, i.e. the continued operation of the shellfish farm. By contrast, impacts associated with alternatives B, C, and D are compared to the less certain, expected future conditions under alternative A (considered the "no action" alternative).

The committee recognizes that, in NEPA practice, the "no action" alternative is usually considered the "baseline" under which current environmental conditions are compared. In these situations, environmental conditions would not change under a "no action" alternative. However, in the case of the DBOC, if the Secretary of the Interior took no action, the Special Use Permit (SUP) would expire and alternative A would be implemented, which would change current conditions. Given that the environmental impacts associated with existing conditions are known with greater certainty than those associated with alternative A (potential future conditions), assessing the impacts of action alternatives B, C, and D against "no action" alternative A increases the level of uncertainty in conclusions about the impacts of alternatives B, C, and D. Also, the use of two baselines introduces asymmetry into the analysis such that the impacts of "no action" alternative A cannot be compared to the impacts of the action alternatives (alternatives B, C, and D). This becomes a particular problem in the Summary of Environmental Consequences[6] which presents the potential impacts of the four alternatives as if they were comparable, even though the impacts of the "no action" alternative A are assessed using a different baseline than that of the action alternatives (B, C, and D).

Scaling Impacts on Drakes Estero and Changes in Ecosystem Conditions

The DEIS[7] defines a "local" impact as one that would occur within the general vicinity of the project area and a "regional" impact as one that would affect localities, cities, or towns surrounding the Seashore. The DEIS[8] also defines a "direct" impact as one caused by an action that "occurs at the same time and place" and an "indirect" impact as one "caused by an action but is later in time or farther removed in distance, but still reasonably foreseeable." For seven of the resource categories examined in this study (wetlands, eelgrass, wildlife and wildlife habitat, special status species, coastal flood zones, water quality, and soundscapes), the committee used the spatial scale as they interpreted the definitions of "direct", i.e., the impact is direct when it causes a change in ecosystem state on the same scale as the impact source, and "indirect" if it is expressed on the scale of the Drakes Estero ecosystem.[9] Thus, the potential spatial footprints of DBOC operations (onshore facilities, culture racks and bags, and motor boat corridors) would correspond to local scales of impact. In this context, the total area permitted for onshore operations would be less than 1% of the Drakes Estero watershed and the total area designated for cultivation (138 acres under alternatives B, C, and D) would be ~5.5% of the entire Estero (including Estero de Limantour) and about 10% of the intertidal and subtidal acreage in the potential wilderness

[5] DEIS, p. 234
[6] DEIS, Table ES-4
[7] DEIS, p. 235
[8] DEIS, p. 235
[9] These definitions of "direct" and "indirect" are not relevant to the socioeconomic category since direct impacts are assessed in terms of human uses on larger scales (market value of shellfish, employment, recreational use of the Seashore, etc.).

PREPUBLICATION

area (Table 2.1). Actual utilized areas would likely be smaller. For example, the footprint of racks (7 acres) used in recent years are estimated to cover 13% of the subtidal culture beds. When considered in terms of habitat acreage in the project area, the footprint of rack culture is about 1% of the eelgrass acreage. It was in this context that the committee considered whether the direct scale of impact on Drakes Estero resources was reflected in potential adverse changes to the structure and function of the Drakes Estero ecosystem as a whole (indirect impacts). In so doing, the committee understands that the acreage for bag and rack culture, and associated motorboats and human activity, move from place to place within permitted areas as the DBOC attempts to optimize production. Consequently, the spatial footprints integrated over time are larger than the footprint at any given time.

Table 2.1. Spatial extent of Point Reyes National Seashore and the Drakes Estero ecosystem with acreage designated for DBOC's operations (all acreages came from the DEIS, except for wilderness and potential wilderness[10]). DBOC's operations take place on uplands near the head of Schooner Bay and in tidal wetlands and subtidal waters of Drakes Estero. In addition to rack and bottom bag cultures, floating bags are also deployed; these are predominantly located in intertidal culture beds.

The Seashore and Drakes Estero	Acres				
Point Reyes National Seashore	94,000				
Wilderness	27,122				
Potential wilderness	6,251				
Potential wilderness, Drakes Estero (inter- and sub-tidal only)	1,363				
Drakes Estero (Drakes Estero, includes Estero de Limantour)	2,500				
Drakes Estero Project (focus of the EIS)	1,700				
Drakes Estero Watershed	19,840				
Drakes Estero intertidal (mud, sand flats including Limantour)	1,152				
Drakes Estero eelgrass beds within the project area	737				
DBOC	**Current**	**A**	**B**	**C**	**D**
Special Use Permit (SUP) offshore	1,050	0	1,078.0	897.0	1,082.0
Upland DBOC facilities	4.6	0	4.3	4.3	4.3
Total acreage available for cultivation (intertidal + subtidal beds)	142.0	0	138.0	138.0	138.0
Culture beds for bottom bag culture (intertidal)	88.0	0	84.0	84.0	84.0
Culture beds for rack culture (subtidal)	54.0	0	54.0	54.0	54.0
Propeller scars in eelgrass beds[11]	~50.0	0	~50.0	~50.0	~>50.0
Area within which motorboat use occurs[12]	740	0	740	740	740

[10] FR Doc.99-29779, available at: www.nps.gov/pore/parkmgmt/upload/lawsandpolicies_fr_doc_99_29779.pdf
[11] The 50 acres corresponds to polygons within which propeller scars are found (NRC, 2009)
[12] These values assume that motorboat usage will stay roughly the same under the three action alternatives as assessed by the NPS for boat activity in 2010 (used for "current" in the table). However, this area could change for the action alternatives under which DBOC would follow an NPS-approved vessel transit plan.

PREPUBLICATION

CHAPTER 3

Review of the Scientific Information and Analysis Presented in the Draft Environmental Impacts Statement (DEIS)

The committee's task is to assess the scientific information, analysis, and conclusions presented in the DEIS and to determine whether the Atkins peer review "is fundamentally sound and materially sufficient." As discussed more fully in Chapter 1, the committee examined and has made findings regarding the scientific data and sources presented in the DEIS. The committee also provides here an assessment of the levels of uncertainty in the conclusions reached in the DEIS to indicate the strength of the scientific evidence underlying these conclusions. This is a separate issue from evaluating the sufficiency of the DEIS to meet NEPA requirements.

Science-Based Levels of Uncertainty

Scientific uncertainty as used in this report refers to the strength of the scientific information and logic available to assess a potential impact. Uncertainty can arise from a variety of factors such as: a lack of data, low resolution data or data with high levels of measurement error, conflicting scientific results, or a lack of scientific understanding of the underlying natural processes. All scientific information contains some level of uncertainty, but this does not mean that science does not provide actionable information for policy; rather the level of uncertainty is an attribute of scientific information that needs to be communicated as part of a scientific report (NRC, 2004). Given the importance of explicitly stating the strength of the underlying scientific data used in formulating conclusions to inform policy decisions, the committee assessed the available data and analysis to assign a level of uncertainty to the impact conclusions reached in the DEIS. For each resource category, the committee assigned a level of low, moderate, or high uncertainty to the impact intensity conclusions presented in the DEIS using the following criteria:

- **Low uncertainty** is assigned when the committee finds that substantial scientific evidence exists to support the conclusions reached, i.e., the evidence demonstrates a strong cause-effect relationship between Drakes Bay Oyster Company (DBOC) actions associated with an alternative and a measurable effect.
- **Moderate uncertainty** is assigned when the committee concludes that, while there is insufficient data and information for Drakes Estero, observations from other comparable ecosystems and current scientific understanding allow logical deductions concerning a possible cause-effect relationship between DBOC actions and a measureable effect.
- **High uncertainty** is assigned when the committee concludes that there is insufficient data and information for Drakes Estero; observations from other comparable ecosystems are not available; and scientific understanding is insufficient or controversial such that conclusions regarding a possible cause-effect between DBOC actions and a measurable effect can be made only by inference.

Environmental Impacts of the Alternatives

The primary conclusions in the DEIS are expressed as intensities of impact[1] on living and non-living resources of Drakes Estero. The summation of these levels of impact provides a semi-quantitative assessment of the expected consequences of the various alternatives (e.g., DEIS Table ES-4 and Table 2.6) and constitutes the principal communication of the expected consequences of the alternatives to decision makers and the public. Activities associated with each alternative are assessed as either

[1] DEIS, p. 250

PREPUBLICATION

beneficial, minor adverse, moderate adverse, or major adverse for short-term, long-term, and cumulative impacts according to intensity definitions specific for each resource topic. Beneficial is defined as "a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition", while adverse is defined as "a change that moves the resource away from a desired condition or detracts from its appearance or condition"[2]. It is noteworthy that only one category of beneficial impact is used, hence effects that may range from minor to major beneficial cannot be distinguished. In addition, the impact intensities do not allow for a finding of negligible impact, a category that is included in NPS NEPA guidance documents.[3] A complete list of the impact definitions from the DEIS for each of the resource categories is provided in Appendix C.

For each resource category, the committee (1) examined the interpretations, analyses, and conclusions given in the DEIS; (2) assessed the extent to which they are reasonable and scientifically sound based on information in the DEIS; (3) based on this evaluation, assessed the level of uncertainty associated with the impact intensity conclusions in the DEIS and, where appropriate, offered possible alternative conclusions that are equally reasonable and scientifically sound; and (4) determined if there is additional information and analyses that are not in the DEIS but that could be used to reduce levels of uncertainty.

The committee addressed the resource categories as they were presented in the DEIS, with an exception for a separate discussion on non-indigenous species. As was often indicated by cross-referencing in the DEIS, there are no clear boundaries between resource categories. The assessment of an impact on one resource may depend in part on the predicted effect to another resource. This is the nature of ecosystems, which are characterized by complex interactions among and between living and non-living components.

Wetlands

I. Quality of information and analysis and information gaps

The DEIS provides a qualitative inventory of wetlands in Drakes Estero and presents GIS maps of the distribution of the different types of wetlands. The focus of the DEIS is on the wetland area located between the mean low tide elevation and 100 ft landward of the high tide line.[4] These areas are characterized by mostly unvegetated substrates[5] among which mudflats dominate.[6] Inclusion of the unvegetated substrates is prompted by the DEIS integrated application of both the EPA/USACE and USFWS definitions of 'wetlands.' However, it is evident from the DEIS and from NPS statements at the committee's 11 July 2012 public meeting that some tidal-freshwater wetlands were excluded[7] even if they fit the operational definition of "100 ft landward of the high tide line" (assuming that the high tide line is correctly interpreted). Onshore wetland areas are also discussed in the section on Special Status Species.

The DEIS lists three DBOC activities that could impact wetlands under alternatives B, C, and D: continued use and maintenance of shellfish racks and bags in Drakes Estero; continued boat traffic; and installation of a new dock, including dredging. For alternative D, the DEIS adds potential impacts from increased production level, new onshore development, and placement of a new intake pipeline.

The wetland area currently permitted for culture bags (Table 2.1) will not change greatly under alternatives B, C, or D. However, the balance between bag and rack culture could change under alternatives B, C, and D and may vary from year-to-year as discussed in Chapter 2. The most important potential impacts on intertidal mud and sand flats are related to motor boat traffic; workers walking across the flats to place, turn and recover culture bags; and the number and placement of bags themselves. These activities may have a direct impact on turbidity, sediment dynamics, benthic fauna, harbor seals, birds, and spread of nonindigenous species. Impacts on benthic fauna, harbor seals, birds, and spread of nonindigenous species are discussed elsewhere in this chapter.

Boat generated waves may erode the edge of marsh vegetated areas and mudflats. Impacts on turbidity by motor boat traffic are also likely to be pulsed and rapidly dissipated, especially given tidal

[2] DEIS p. 235
[3] Director's Order 12, found at www.nature.nps.gov/protectingrestoring/do12site/pdf/tab12_imp.pdf
[4] DEIS, p. 166
[5] DEIS, p. 166
[6] DEIS, p. 249
[7] DEIS, Table 3-1 and Figures 3-1 and 3-2

PREPUBLICATION

mixing and advection in Drakes Estero. Over time the wetlands will recover under alternative A, but it is unlikely that the wetlands will return to historic conditions, in contrast to the statement in the DEIS that removal of DBOC structures "would increase the potential that the project area could be converted back to historic wetland habitat."[8] It is more likely that the wetlands will reach a new equilibrium depending on sediment dynamics and species colonizing the area (e.g., Villnas et al., 2011).

Shifting sediments following the removal of culture bag is a potential threat to benthic fauna (and eelgrass beds). Upon removal of the bags, which occurs under alternative A once and at the end of each crop cycle under alternatives B, C, and D, sediment surfaces will be exposed to currents and waves allowing for sediment reworking until a new equilibrium is reached. Although this is expected to be a short-term effect, management of sediment redistribution as described in the DEIS may be necessary to avoid burial of benthic invertebrates and eelgrass. Once sediment dynamics stabilize, risks of burial should be negligible. Some additional references on research on shellfish culture impacts on these types of benthic communities, such as the Bouchet and Sauriau (2008) paper on oyster culture on intertidal mudflats in France and reviews such as Forrest et al. (2009) would provide more context for this section of the DEIS.

II. Reasonableness of the conclusions, assessment of level of uncertainty, alternate conclusions

The committee finds that the impact definitions, review of scientific information, and conclusions on wetland impacts are reasonable. The DEIS concludes that the impact of DBOC activities including physical buildings and structures, boating operations, and mariculture practices, on wetlands will be moderate adverse, a conclusion that the committee finds to be reasonable and is associated with a moderate level of uncertainty. It is likely that alternatives B, C, and D would continue to have an adverse impact on wetlands over the next 10 years, and these impacts would continue to be localized.

The committee identified a few issues that could be clarified or expanded in the wetland section as follows. According to the DEIS, sediment erosion occurs along the edges of culture bags, but it is uncertain whether this is a short-term process that stabilizes once a new equilibrium between currents and sediments is reached or whether this is an ongoing, long-term process. If this point cannot be clarified, the committee would assign a moderate level of uncertainty to the conclusion that the bag culture has a moderately adverse impact.

Since potential impacts of DBOC operations are not necessarily confined to the project area *per se*, a more ecologically sound definition of the project area would be the Estero from the head of tide in Barries, Creamery, Schooner, and Home Bay to the mouth of the Estero with lateral boundaries determined by the landward extent of tidal wetlands. This would include the tidal freshwater wetlands at the heads of Schooner and Home Bays.

III. Ways to reduce the level of uncertainty

Observations on the effects of oyster bags and clam culture operations on the conformation of the mud and sand flats would reduce uncertainty with regard to impact intensity and duration. The DEIS[9] assumes that wetland disturbance will not be a long term impact: "After bags or clusters are removed for oyster harvest or transfer, natural processes would be expected to resume in E2US3 and E2US1/2 wetlands until new culture is placed there. The length of time required for natural processes to resume would vary depending on the level of disturbance (Wisehart et al., 2007; Zieman, 1976)." However, no details are provided on the approaches, methods, and evaluation that would be used for restoration of wetlands.

To achieve long-term recovery, adaptive management would be essential given uncertainties associated with restoration of many of these ecosystems (e.g., mudflats). This would require monitoring of sediment dynamics such as accretion and erosion rates in the marsh using SET-tables (Cahoon et al. 1995) and sediment grain size and organic content in the marshes as well as the mudflats.

[8] DEIS, p. 252
[9] DEIS, p. 253

PREPUBLICATION

Eelgrass

I. Quality of information and analysis and information gaps

Seagrass has high habitat value, as has been recognized by NOAA in its designation as essential fish habitat, therefore impacts on seagrass beds could have broad ecological implications.[10] As described in the DEIS, the seagrass *Zostera marina* (eelgrass) has undergone an expansion and is currently found throughout the Estero. It is denser in some areas (353 acres with 90 to 100% cover) and sparser in others (384 acres with 30 to 90% cover).[11] This expansion was not restricted to the Estero but was observed on a regional scale (NRC, 2009). In general, it is estimated that "eelgrass habitat within Drakes Estero has doubled from 1991 to 2007 (NRC, 2009)." However, interannual trends in spatial coverage are uncertain and would need to be validated, as feasible with the data available, based on year-to-year changes over that timeframe.

Seagrasses require light, nutrients and a stable substrate to grow. The spatial extent of eelgrass in Drakes Estero suggests that these requirements are generally being met. Potential impacts of shellfish mariculture are discussed according to source below.

Regarding scarring of eelgrass by motorboat propellers, it is highly likely that outboard motors used by the DBOC cause scarring in the eelgrass beds,[12] estimated to occur within polygons (motor boat corridors) of about 50 acres (NRC, 2009). In the DEIS, the estimated length of eelgrass beds affected by propeller scarring is 8.5 miles based on visible scarring seen in high resolution aerial photographs in 2010.[13] Since this method is limited to visible propeller scars, the DEIS states that this is likely an underestimate.[14] If the boat scar width is about 1 m on average, the committee estimates that the impact area would be approximately 13,700[15] m^2 (equivalent to approximately 3.4 acres).

In any event, the area of propeller scarring is likely small compared to the total acreage of eelgrass in the Estero, i.e., the impact is local and limited to the area directly impacted. Alternative A would allow the scars to heal while alternative D may cause further damage depending on whether motorboat trips to bag and rack culture areas increase. The latter could increase recovery times once DBOC operations cease. The duration for recovery of propeller scarred eelgrass beds is not adequately estimated for the Drakes Estero disturbance, or addressed on the basis of the current scientific literature. The DEIS estimates recovery time to be from weeks up to 5 years (recovery times for eelgrass gaps in west coast estuaries are available in Boese et al., 2009 and Ruesink et al., 2012), but it has been shown that some scars need remediation for seagrass recolonization (Kenworthy et al., 2002).

In general, the committee finds that the data support the DEIS findings; alternatives B and C would sustain the current level of adverse impact while alternative D could increase the amount of vegetation damaged if motorboat traffic increases and there are more motorboat corridors through eelgrass beds. Additional references to studies on the impacts of propeller scars on seagrass beds and recovery times would be useful in the,DEIS because some of the methods used to recover scars in tropical areas may also apply to temperate zones, e.g., filling of scars to minimize further erosion (Hammerstrom et al. 2007).

Regarding shading of eelgrass by boat-generated turbidity, the DEIS suggests that motorboats create levels of turbidity that are likely to reduce primary productivity, including that of eelgrass. It is known that the frequency of resuspension events affects the health of seagrasses (Moore et al., 1997), but that infrequent resuspension events resemble storm-induced turbidity events (Koch, 2002) which seagrasses tolerate well (Schaffelke et al., 2005). Given more frequent resuspension events, associated increases in turbidity may be an adverse impact of alternatives B, C, and D. However, the DEIS does not provide data on turbidity in Drakes Estero and, as discussed in the Water Quality section, water clarity would likely be more variable due to natural processes such as phytoplankton blooms, changes in bottom shear over a tidal cycle, and seasonal storms than indicated in the DEIS.[16] Thus, it is not known whether brief pulses of turbidity caused by the passage of motorboats are within the range of natural variability or whether these events cause measureable increases in turbidity that could limit light penetration and the

---

[10] www.fpir.noaa.gov/PRD/prd_critical_habitat.html; www.oregon.gov/DSL/SSNERR/tides/tidesA13_eelgrassfacts.pdf?ga=t
[11] DEIS, p. 172
[12] DEIS, Figure 3-4
[13] DEIS, p. 173
[14] DEIS, p. 261
[15] Using the DEIS estimate of 8.5 miles of scarring length, which is approximately 13,700m x 1m scarring width = 13,700 m^2
[16] DEIS, p. 267.

PREPUBLICATION

growth of eelgrass. At most, the relatively brief pulses of turbidity generated by motorboats may temporarily increase turbidity and reduce light levels reaching the bottom but, as previously discussed in the wetlands section, turbidity will probably be rapidly dissipated by strong tidal currents and mixing, and at low tide when eelgrass beds are only covered by a thin layer of water, water turbidity will have little effect on light availability for eelgrass growth (Koch and Beer, 1996).

Possibly, a more detrimental effect of resuspension by motorboats comes from the transport of the sediments into seagrass beds and deposition of sediments on the leaves. However, considering the high tidal currents and mixing in Drakes Estero, the impact is likely to be smaller than suggested by studies cited in the DEIS.

Despite some unclear statements in the DEIS regarding the impact of bags occupying space that otherwise might be colonized by eelgrass,[17] it is unlikely that bag culture has a direct impact on eelgrass beds. Therefore, the committee limits its analysis to the impacts of rack culture.[18] The area of DBOC racks in eelgrass beds is ~7 acres (Table 2.1). The density of eelgrass beneath culture racks in other studies has been observed to be lower compared to adjacent areas (e.g., Everett et al., 1995); potentially the result of shading, erosion, or pseudofeces produced by the filter-feeders. Together with boat scars (above), the evidence for a direct, cause-effect relationship between rack culture and an adverse impact on the growth of eelgrass is strong and is given a low level of uncertainty by the committee.

Regarding benthic-pelagic coupling and the availability of light, filter feeding shellfish can be beneficial to seagrasses by reducing turbidity and increasing the availability of light for growth (e.g., Newell and Koch, 2004). These findings are based on models and experimental close-system mesocosms. However, this might not be the case under natural conditions in the field (e.g., Booth and Heck, 2009), depending on ambient turbidity and water depth. The DEIS suggests that the water in Drakes Estero is not especially turbid and therefore, the benefit of oyster-filtration is likely to be minor.[19] However, as discussed in the Water Quality section (below), representative quantitative observations of water clarity are lacking for Drakes Estero.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

In general, conclusions related to the impacts of DBOC operations in the Drakes Estero system have a moderate level of uncertainty. The DEIS concludes that alternatives B, C, and D would result in long-term moderate adverse impacts on eelgrass. However, impacts may be less adverse because of the small footprint of motor boat operations and rack culture relative to the spatial extent of total eelgrass, and uncertainties related to the lack of data on turbidity in Drakes Estero. Based on literature from tropical seagrass beds, it is also possible that active restoration efforts may be needed to revegetate bare areas, especially where damage is caused by motorboat scars.

III. Ways to reduce the level of uncertainty

A more definitive conclusion on impacts could be reached with increased analysis of how motorboats are used in DBOC's operations and how increases in production under alternative D would affect motorboat traffic or expand motorboat corridors. The duration for recovery of propeller-scarred eelgrass beds is not adequately estimated for the impacts, nor addressed on the basis of the current scientific literature. This is an additional impetus for more complete and systematic analysis of the NPS's time series of aerial photography images to not only document the acreage and frequency of boat propeller scar disturbance but to also document, if possible, the time required for the scars to revegetate.

If one of the action alternatives is selected, ongoing assessment of DBOC impacts on seagrass beds could be improved by (1) documenting when and how frequently boats are used for both bag and rack culture relative to stage of tide and documenting motor boat routes relative to the distribution of eelgrass beds under current conditions; and (2) providing information on how the balance between bag culture and rack culture changes from year to year (acreage used, location and production). Monitoring the spatial extent and fragmentation of eelgrass beds, changes in sediment grain size, and deposition rates could make an important contribution to future assessments of impacts. Turbidity and the attenuation of downwelling light (e.g., Secchi disc readings) could be routinely measured in conjunction with motorboat operations.

[17] DEIS, p. 263
[18] DEIS, Compare Figures ES-2 and 3-3.
[19] DEIS, p. 175

PREPUBLICATION

Wildlife and Wildlife Habitat
Indigenous Benthic Fauna

I. Quality of information and analysis and info gaps

Three general mechanisms by which DBOC operations may influence indigenous benthic fauna are presented in the DEIS: disturbances, structures, and competition from cultured organisms. The committee agrees with the logic of these mechanisms, but notes that each has a different level of certainty and potential scale and intensity of impact. The committee distinguished nonindigenous species for treatment in a separate section, which follows the present section.

Disturbances to benthic fauna from shellfish mariculture: As pointed out in the DEIS, the placement, flipping, and harvest of bags could cause mortality of some individuals.[20] Similarly, any organisms that have colonized oyster racks will suffer when the oysters are cleaned at harvest. Dredging near the DBOC dock, as proposed in alternative D, would also likely result in direct mortality. Data relevant to assessing effects of disturbance would include, at a minimum, documentation of the organisms living in or on bags and oyster racks, which could be lost during harvest. Although some observations are available within Drakes Estero for organisms attached to racks (Grosholz, 2011) and for benthic infauna (Harbin-Ireland, 2004), these data are most relevant to response of benthic fauna to structures, covered in the following section. No quantitative data on organisms associated with oyster strings or bag culture, which would actually be removed at harvest, appear to exist. Whether losses of individuals would be expected to have impacts at the population or community level is unclear, particularly given rapid recovery rates of benthic communities following disturbance (Kaiser et al. 2006) and the small amount of area disturbed at any one time.

Response of benthic fauna to structures from shellfish mariculture: The DEIS correctly discusses the robust finding that structure increases diversity and abundance of organisms (Thomsen et al., 2010; Cruz Sueiro et al., 2011). Data from Drakes Estero relevant to structures come from a study comparing benthic infauna (within sediments) between racks and nearby eelgrass, where differences were negligible.[21] Different outcomes would be expected for culture structures in unstructured habitats (such as bags on sandbars or mudflats) than for culture structures in structured habitats (such as racks in eelgrass), as well as for epifauna, which inhabit structures above ground, in comparison to infauna. Studies of the impacts of oyster culture (or oysters more generally) on benthic community structure in other ecosystems have been conducted for a variety of habitats and structures, and have included both infauna and epifauna as response variables (i.e., Crawford, 2003; Rumrill and Poulton, 2004; Forrest and Creese, 2006; Hosack et al., 2006; Ferraro and Cole, 2011). Going forward, multivariate approaches to community-level data are likely to be more revealing of habitat differences than are univariate approaches of abundance and diversity. There is little reason to expect that any effects from adding structured habitat in the form of racks and bags would extend much beyond the immediate footprint of mariculture, therefore any changes in community structure might be expected to be small at the scale of Drakes Estero as a whole.

Competition from cultured organisms: Food competition between cultured shellfish and indigenous fauna could extend beyond the immediate footprint of mariculture because it is mediated through food availability in the water column. However, many studies have seen only local changes in phytoplankton concentrations in the vicinity of shellfish culture (Pilditch et al., 2001), and larger-scale food competition would be likely only if shellfish were close to ecological carrying capacity (Banas et al., 2007). In the Water Quality section (below), the committee raises the possibility that cultured bivalves may have filtration capacities on the order of water residence time in the finger bays of Drakes Estero. To the extent that water quality calculations are improved, an assessment of ecological carrying capacity could be conducted. At present, though, the extent of food competition between cultured shellfish and other filter feeding benthic organisms appears highly uncertain. The DEIS also raises the possibility of space competition through "native species displacement" but the citations in the DEIS and other that could be referenced regarding impacts of the Pacitic oyster in Europe (e.g., Diederich, 2006; Lejart and Hily, 2007) primarily apply to self-reproducing, "naturalized" populations of oysters and clams, not to

[20] DEIS, p. X
[21] DEIS, p. X

PREPUBLICATION

bivalves cultured with the methods used by DBOC. Establishment of nonindigenous species is addressed separately below.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

The intensity definitions for benthic fauna do not provide clear guidance on the three classifications of adverse impact. In particular, both moderate and major definitions reference impacts to "individuals or groups of species, communities, or natural processes".[22] Experimentally, it would be difficult to distinguish between impacts that "appreciably affect" and "substantially influence" individuals. For disturbances to benthic fauna from shellfish mariculture, scale may be small, intensity involves a short-term effect on individuals attached to bags or oyster strings, and uncertainty is moderate given the logic of mortality but no in situ counts of organisms on bags or oyster strings, which are most likely to be affected. For response of benthic fauna to structures provided by shellfish maricultures, scale would be small, intensity would be based on community-level change, and uncertainty, though currently high, could be reduced by applying multivariate approaches to data from Harbin-Ireland (2004) on benthic infauna near and away from racks, and by summarizing the most relevant work in other systems to address how the mariculture structures used by DBOC in the habitats in Drakes Estero may influence infauna and epifauna. Finally, the spatial scale could be large and intensity could reflect alteration of ecosystem processes for food competition between cultured shellfish and indigenous benthic fauna, but uncertainty is also high, in keeping with findings for water quality (below). It is worth noting that drawdown of water column resources by cultured shellfish could have different values attributed to it (e.g., filtration as an ecosystem service vs. filtration seen as food competition to indigenous filter feeders).

III. Ways to reduce the level of uncertainty

The potential impacts of DBOC operations on benthic fauna are confounded by the diversity of species and life histories of benthic organisms. Each potential impact may differ in magnitude and direction depending upon the habitat they occupy (e.g., infauna, epifauna, sessile, mobile) and their food source (e.g., suspension-feeders, deposit-feeders). This complexity results in a matrix of potential impacts (mechanisms of potential impacts vs. organisms), which could have different intensities and uncertainties. From the information provided in the DEIS, it is difficult to discern how this hypothetical matrix is distilled into a single moderate impact intensity conclusion. Literature on benthic impacts could be used more extensively to provide detail on the shifts in benthic communities that could be associated with shellfish culture.

Many of the suggested improvements to the Water Quality section could also help address the potential mechanism of impacts to benthic fauna via resource competition. The DEIS could include an analysis of the role cultivated shellfish may have in partitioning the food resource for indigenous filter-feeders; data for chlorophyll draw-down provides some support for the hypothesis that mariculture and natural benthic communities coexist at the current level of operations. Improved data on the composition of suspended particulate matter, and it's partitioning into phytoplankton, detrital organic material, and inorganic material, together with microphytobenthos would help to clarify the food sources available to both cultivated species and to indigenous benthic populations.

<u>Non-Indigenous Benthic Species</u>

I. Quality of information and analysis and info gaps

Non-indigenous species must first arrive, then establish and spread, and finally become sufficiently abundant or influential on a per-capita basis to constitute an impact (e.g., Williamson and Fitter, 1996; Theoharides and Dukes, 2007). The DEIS explores how first, that mariculture activities could lead to establishment of new non-indigenous species (directly cultured or hitchhiking on imports of larvae or spat); and second, that mariculture activities could facilitate the potential spread of existing non-indigenous species from mariculture structures.

Multiple non-indigenous species are already present in Drakes Estero (NRC, 2009), although their avenue of introduction is mostly unknown and they appear to be much less conspicuous than in nearby San Francisco Bay. Only *Didemnum* (a tunicate) and *Batillaria* (a snail) are called out from among established non-indigenous species for explicit consideration in the DEIS. An issue of concern for the

[22] DEIS, p 274

PREPUBLICATION

DEIS is whether current mariculture operations change the abundance (and therefore impact; Parker et al., 1999) of existing non-indigenous species in natural habitats. Augmenting the abundance of non-indigenous fouling organisms on hard surfaces of mariculture structures could in principle spill over to increase their abundance nearby (e.g., Bulleri and Chapman, 2010). Observations in New England indicate that invasive tunicates may be more likely to spread to natural habitats near artificial structures such as docks and mariculture gear than similar habitats away from artificial structures (Carman et al. 2009), although natural habitats away from hard substrates may also be vulnerable because “it is possible that there is little artificial substrate space available … leading invasive tunicates to colonize natural substrate not typically inhabited” (Carman et al., 2010).

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

A reasonable case is made in the DEIS that by increasing the propagule pressure of nonindigenous bivalves (Pacific oyster and Manila clam), the risk of their establishment in Drakes Estero also increases Establishment risk has been shown to increase with propagule pressure (Lockwood et al., 2005). The DEIS cites evidence that two cohorts of naturally-recruited Manila clams have been discovered recently in habitats outside of mariculture. Although the potential for Manila clams to become established is well documented in the scientific literature (Bourne, 1982; Wonham and Carlton, 2005; Humphreys et al., 2007; Dang et al., 2010), it is dependent on the number of clams cultured by DBOC in the future. As noted in the DEIS, Manila clams “could be produced on a much wider scale under [alternative B] than under existing conditions”[23] a statement that applies to alternative D as well. In contrast, in alternative C, “the area in which Manila clams will be grown is a small,”[24] (one acre, referred to as area 2 in the DEIS), which probably restricts total clam production and therefore propagule pressure. However, the DEIS indicates that the lack of sandbars near area 2 may also reduce risk of establishment, but planktonic clam larvae could disperse beyond the growing area, so absence of suitable habitat nearby would not lower the risk of establishment.

Temperature requirements for larval development are generally available for the non-indigenous species actually or potentially cultivated (e.g., Numaguchi, 1998). Therefore, water temperatures and residence time, applied to relevant areas for different cultivated species, could underpin establishment risk in the various alternatives. Overall, the committee agrees that the establishment of new species due to DBOC mariculture would constitute a sufficient shift in community composition to constitute a moderately adverse impact given the guidance in NPS *Management Policies 2006* for “maintenance and restoration of natural native ecosystems, including the eradication of exotic species.”[25] There is low uncertainty in the science because the general concepts have strong support (e.g., non-indigenous species permanently shift community composition, establishment increases with propagule pressure). However, moderate uncertainty exists about DBOC’s future culture practices, and additional uncertainty about whether Manila clams have already or will in future become established from cultured stock in DBOC or more distant larval sources.

III. Ways to reduce the level of uncertainty

Risk assessment protocols help predict whether a cultivated species is likely to establish outside of mariculture (e.g., ICES, 2005, Appendix B), and such protocols could be applied to nonindigenous species considered under the permit renewal (Pacific oysters, European flat oysters, Manila clams). Logically, with respect to Manila clams, the risk of establishment could be lower for alternative C than for alternatives B and D due to the smaller area available for culture. A risk assessment could provide guidance on whether this would lead to different intensities of impact among the three action alternatives. Data to evaluate the “spillover” of non-indigenous fouling species from mariculture structures to natural habitats would require quantitative field surveys in Drakes Estero to determine a spatial scale beyond the direct footprint of mariculture structures.

[23] DEIS, p. 278
[24] DEIS, p. 283
[25] DEIS, p. 276

PREPUBLICATION

Fish

I. Quality of information and analysis and info gaps

Although quality data regarding fish populations are lacking for Drakes Estero, observations from other comparable ecosystems and current scientific understanding of marine ecology allow logical deductions concerning potential causal relationships. Site-specific data for Drakes Estero is based solely on fish collections performed by Wechsler (2005). Wechsler concluded that fish richness and abundance did not differ among sampling times or habitats and that fish composition shifted to favor species associated with complex structures, attributable to the culture racks and bags. However, there is considerable uncertainty associated with the sampling methodology, design and statistical analyses that constrain the DEIS interpretations (NRC, 2009).

The argument that structure-associated species increase due to DBOC operations is based on sound logic given the Wechsler (2005) data, but the DEIS does not provide data to demonstrate species displacements or other changes that might suggest an ecological effect consistent with the DEIS conclusion that this is minor impact. For example, Allen et al.'s (2006) extensive analysis of California's estuary and bay fish assemblages indicates that, except for shiner perch (*Cymatogaster aggregata*), the embiotocids found to be more representative of the mariculture rack structure assemblage of fishes in the Estero ("Schooner Adjacent" Wechsler, 2005) are not prominent residents of northern California estuaries and would thus be considered relatively unique to the mariculture rack footprint.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

The DEIS concludes that the impacts of alternatives B, C, and D would be minor. Considering the small acreage of eelgrass disturbance (Table 2.1), the committee finds that this conclusion is appropriate, particularly because there is considerable uncertainty about whether eelgrass can be directly related to fish production. There is a general lack of knowledge about the association between eelgrass landscapes and "essential fish habitat"; the value of eelgrass as nursery habitat is challenging to test methodologically (Jackson et al., 2001), and there are few empirical data available for U.S. West Coast species. In general, only the abundance (rather than production, growth, and survival) of fishes in eelgrass compared to other habitats, or across gradients in eelgrass patch structure, has been documented (Allen et al., 2002; Rumrill and Poulton, 2004; Hosack et al., 2006; Macreadie et al., 2009; Moore and Hovel, 2010). However, Beck et al. (2001) provide a compelling argument that, even when comparing multiple potential fish and shellfish nursery habitats, an area might be considered an important nursery habitat only if it produces greater adult density compared to other juvenile habitats that the species uses. In addition to density, key indicators of the nursery function include growth and survival of juvenile animals, and juvenile movement to adult habitats. Only in the case of the bay pipefish, *Syngnathus leptorhynchus*, and shiner perch, *Cymatogaster aggregata*, can reproduction and trophic and production linkages be directly related to eelgrass with low uncertainty (Onuf and Quammen, 1983).

The committee considers the DEIS conclusion to have a moderate level of uncertainty given the lack of data and the uncertainty concerning whether eelgrass extent (and the extent of intertidal mud- and sand-flats) is directly related to abundance and diversity of fish species.

It may be reasonable to hypothesize that a small change in habitat such as eelgrass which has been identified by NOAA as essential fish habitat could result in a small change in fish abundances. Similarly, the effect of racks in attracting structure–associated fish in Drakes Estero is hypothetical because the Wechsler sampling design did not support that inference and there were no statistical tests supporting this hypothesis. Alternate conclusions, such as (1) a spatial redistribution of species or (2) subsidization of more structure-associated species, could also be posed.

The DEIS also draws a conclusion of minor adverse impacts for alternatives B, C, and D because small amounts of eelgrass habitat are replaced by racks. The propeller scars do not have any replacement structure, but may represent more than half of the area of eelgrass directly affected by mariculture practices. To evaluate such impacts would require a different sort of data regarding fish responses to gaps. The conclusions are to some extent dependent upon the values placed on different species and changes relative to wilderness conditions. For example, the racks (as well as bags in unstructured habitats) could potentially benefit some fish species through prey resource subsidies or refuge from predation, but this does not translate into a beneficial effect in the DEIS.

PREPUBLICATION

III. Ways to reduce level of uncertainty

Perhaps most importantly, uncertainty associated with the conclusions in the DEIS could be better explained through identification of the underlying assumptions and the projected impacts under different alternatives. Explicitly identifying and evaluating the relationships between the effects on eelgrass, benthic organisms, and fishes by relating predictable (low uncertainty) changes in different fish habitats to those changes in the prey component of the benthic fauna would be a significant contribution to evaluating the comprehensive and cumulative ecological responses to fishes of the DEIS alternatives. Although the extant data on fish assemblage structure and distribution of fishes in Drakes Estero is spatially and temporally deficient, the DEIS could also discuss the scientific evidence showing that variation and change (e.g., fragmentation) in the eelgrass landscape due to impacts such as mariculture could influence the functionality of that landscape for fishes (Boström et al., 2006; 2011).

The DEIS currently suggests that effects of shellfish mariculture on fishes in Drakes Estero are minor adverse, the lowest level of impact in the current framework. If the DEIS included a negligible impact intensity classification, it might arguably be appropriate to list these impacts as negligible given the small overall footprint of the mariculture activities.

<u>Harbor Seals</u>

I. Quality of information and analysis and information gaps

The assessment of impacts on harbor seals is based on information from a small number of publications on research in Drakes Estero, a regional marine mammal monitoring program, and the broader scientific literature on marine mammals. Research on the interactions of harbor seals and mariculture activities is limited to two peer-reviewed papers that analyze data from seal surveys in Drakes Estero and the surrounding region in relation to changes in mariculture levels and other potential population drivers such as El Niño conditions (Becker et al., 2009; 2011). These are the only studies worldwide that have attempted to assess the impacts of mariculture on the distribution and abundance of any pinniped. The DEIS mentions the collection of 250,000 photographs taken by remote cameras with a view of harbor seal haul-out areas, but dismisses them from further consideration in the DEIS "because the collection of these photos was not based on documented protocols and procedures."[26] Subsequent to the release of the DEIS, the Marine Mammal Commission issued the report, *Harbor Seals and Mariculture in Drakes Estero, California*, and referring to the same photographic record concludes that: "Photographs taken between 2007 and 2010 warrant further review to assess their usefulness for characterizing the rates and consequences of disturbance," (MMC, 2011). Finally, the DEIS cites other available data on disturbance impacts on harbor seals (e.g., from recreational activity), and is informed by the comprehensive review of this information in the 2009 NRC report.

The Becker et al. (2009, 2011) papers use statistical methods to test the effects of multiple potentially confounding factors to assess the influence of mariculture activities (through the proxy variable of oyster harvest level) on harbor seal usage of various haul-out sites in the Estero. The analyses in Becker et al. (2011) provide support for a relationship between levels of mariculture activity and harbor seal haul-out patterns, although the strength of this relationship is relatively weak and localized. The analyses also take account of other factors that are currently considered to affect seal distribution (e.g., El Niño, regional population size, and presence of aggressive elephant seals). However, the statistical correlation between seal distribution and mariculture harvest does not establish a cause-effect relationship. As highlighted in a 2011 Marine Mammal Commission (MMC) report[27] and the 2009 NRC report, the surveys underlying these analyses were not designed specifically to assess impacts of mariculture on the seal population. Indeed, no study worldwide has been designed to assess the impact of disturbance (from mariculture or other sources) on harbor seal haul-out distribution patterns. Consequently, "research that has been conducted in Drakes Estero cannot be used either to directly demonstrate any effects of the oyster farm on harbor seals or to demonstrate the absence of potential effects" (NRC, 2009).

The results of Becker et al. 2009 and 2011 have been subjected to significant scientific scrutiny following publication in peer-reviewed publications. A high degree of attention has focused on whether the

[26] DEIS, p. 295

[27] In Chapter 3 of the DEIS, the NPS states that the 2011 MMC "report will be reviewed and considered as part of the NEPA process for this EIS," (DEIS, p. 181).

PREPUBLICATION

statistical techniques and data used in the papers were correct. In particular, the MMC report (MMC, 2011) included reviews of this particular study by several statisticians. As a result, both the authors and other parties have employed a variety of different analytical techniques, and carried out analyses both with and without disputed data points. Where improvements have been identified, analyses have been adapted appropriately. This work has involved input from expert statisticians in the field and extensive discussion over the most appropriate statistical technique to use with this type of historical data which is common in many areas of science. The most comprehensive review of concerns about the analyses of the harbor seal data was carried out by experts convened by the MMC. The MMC oversaw additional statistical analyses in accordance with suggestions from an expert in statistical methods used to assess marine mammal populations (selected by the MMC), but these modifications did not significantly change the conclusions in Becker et al. (2011).

Both the DEIS and the MMC report recognize the high level of uncertainty in the scientific understanding of population consequences of disturbance, including disturbance specifically related to mariculture activities in the Estero. Importantly, the DEIS does not state that mariculture-related disturbance is likely to be a major driver of harbor seal population dynamics in Drakes Estero (compared, for example, with broader scale El Niño effects which depress seal populations due to decreased prey availability[28]). However, impacts from mariculture operations do appear to have a greater influence on harbor seal site choice and their resulting fine scale distribution within the Estero, than short-term human disturbance such as that from recreational activity (Becker et al., 2011). Information on daytime disturbance levels is highly uncertain, and no data on disturbance during non-daylight hours exist even though these could also potentially influence daily haul-out distribution, site selection, or behavior. There have been no studies that relate the medium or long-term impacts of mariculture to critical life functions such as reproduction and foraging. Overall, the harbor seal population has been increasing over the past two decades, coincident with the mariculture activities at high and low levels of production. It remains unknown whether mariculture activities have resulted in a lower rate of population increase within Drakes Estero relative to the level of increase observed in the wider regional population.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

Viewed alongside peer review results of short-term disturbance effects in other areas (reviewed in the NRC, 2009 report), the information presented in the DEIS supports the conclusion that alternatives B, C, and D would likely result in moderate adverse impacts on harbor seals due to potential displacement from preferred haul-out sites. The assumption that production level generally correlates with the level of mariculture activities is uncertain, preventing discrimination of the predicted impact levels based on measurable differences between alternatives B, C, and D. In contrast, alternative A, after the initial short-term impacts during equipment review removal, would be expected to lead to fine scale changes in harbor seal distribution that reflect natural site preference and responses to natural, as opposed to anthropogenic, environmental variation. The level of uncertainty associated with this predicted impact is high due to the lack of a definite cause-effect relationship between harbor seal disturbance and mariculture activities.

Overall, the best available scientific information was used in the DEIS. However, the studies were not designed to test specific hypotheses on the effects of disturbance (from DBOC or other activities), so confounding factors (e.g. coastal El Niño conditions, predator disturbance events at other haul out sites) preclude establishment of a cause-effect relationship unique to mariculture activities. The committee is not aware of any data supporting other hypotheses to explain these patterns, and given current understanding of potential disturbance effects in wildlife populations, support a conclusion that moderate impact of mariculture activity is the most parsimonious and reasonable conclusion to be drawn from available data. The suggestion that the extension of the DBOC lease (alternatives B, C, and D) will have moderate adverse impacts on harbor seals is consistent with the peer reviewed literature, and reasonable given current general understanding of the potential impacts of chronic and cumulative disturbance on pinnipeds and other wildlife populations.

Alternate hypotheses of impact on the harbor seals could be proposed based on scientific logic but even less information is available to support such hypotheses. For example, harbor seals may habituate to mariculture activities, in which case the conclusion of moderate long-term adverse impacts would be an overestimate of impact. Harbor seals have been shown to co-occur with other human

[28] www.nps.gov/pore/naturescience/harbor_seals.htm

PREPUBLICATION

activities in San Francisco Bay and other regions (Suryan and Harvey, 1999; Grigg et al., 2002; 2004; 2012). However, no studies have yet demonstrated that this reflects habituation, rather than tolerance (see Bejder et al., 2009). Thus, although harbor seals in Drakes Estero may have habituated to mariculture activities over the 80 years of farming in the Estero, it is equally plausible that they incur some fitness cost as a result of tolerating these mariculture activities. Nevertheless, one potential alternate conclusion to that reached in the DEIS is that there would be minor impacts of mariculture activities to habituated seals.

One of the biggest weaknesses throughout the harbor seal section is the focus on disturbance of seals on haul-out sites, and a lack of consideration and supporting evidence of how regular boat activity may influence underwater soundscapes, and thus may influence the behavior and distribution of seals on-land and underwater at all tidal levels. Boat activity at higher tide levels may be a more important factor influencing which parts of the Estero are used by seals (both in the water and on land) than occasional disturbance events at haul-out sites. However, this is a difficult hypothesis to test because it is impossible to identify parts of the harbor seals' extensive geographic range where motorized boats (whether they be skiffs used by hunters, commercial fishing boats, or supertankers) are absent from key breeding or foraging habitats.

III. Ways to reduce uncertainty

As noted above, the key strength of the DEIS assessment of potential impacts on harbor seals is the extensive analysis and review that has been carried out on distribution, abundance and disturbance effects. However, as discussed in both the 2009 NRC report and the 2011 MMC report, there are weaknesses due to the lack of directed research on disturbance of harbor seals in Drakes Estero, the limitations of the volunteer observer database, and lack of spatially explicit data on mariculture activities. The 2011 MMC report sums it up well: "The Marine Mammal Commission believes that the data supporting the above analyses are scant and have been stretched to their limit. Nevertheless, the analyses in Becker et al. (2011) provide some support for the conclusions that harbor seal habitat-use patterns and mariculture activities in Drakes Estero are at least correlated."

With regard to harbor seals, the conclusions in the DEIS could be strengthened in three major areas: (1) linking sound produced by DBOC activities to disturbance both in air and underwater (see Soundscape section), (2) discussing relative contribution of sources of harbor seal disturbance more thoroughly in association with cumulative impacts under alternative A, and (3) re-evaluating the definitions of impact based on biologically significant criteria.

Although the Cumulative Impact Analysis under alternative A acknowledges sources of harbor seal disturbance other than boats, it would be stronger if it included discussion of the limitations of the disturbance data. Given the prevalence of disturbance sources (predators, hikers, kayakers, and mariculture activities) the DEIS would be strengthened scientifically if it included more context for interpreting the level of disturbance created specifically by mariculture activities. More precise information about the activity of recreationists and DBOC boats/staff, and the relative influences of noises versus predictable or unpredictable approaches on harbor seal behavior, would enhance both the DEIS assessment and future monitoring datasets.

In reference to impact definitions, the parameters and levels selected to characterize the DEIS impacts levels for harbor seals are vague and not clearly associated with a biological impact. Responses of wildlife to human activities can be noticeable but not biologically relevant, or the responses can be adaptive through reduction of the risk of exposure or disturbance. Greater consideration of the uncertainty surrounding the impacts of disturbance could warrant a reassessment of the current DEIS conclusions of moderate adverse impacts.

<u>Birds</u>

I. Quality of information and analysis and info gaps

The DEIS presents a thorough overview of the issues regarding bird impacts under the various alternatives. It also provides a summary of the relevant literature and covers the history of special bird and conservation designations that this area and proximal areas (e.g., Seashore) have been given by Non-Governmental-Organizations. It is clear that Drakes Estero is an important location for foraging and migratory stopovers to a variety of shorebirds. Much of this section of the DEIS discusses the impacts on

PREPUBLICATION

shorebird behavior due to noise, and the primary literature cited is the same as in the Soundscapes section.

The Kelly et al. (1996) paper is the most relevant study concerning the impacts of mariculture activities on shorebird behavior and population distributions and it is referenced in the DEIS. Unfortunately, the DEIS contains several factual errors in Chapter 4 with regards to this paper:

The DEIS incorrectly cites the Kelly et al. (1996) paper[29], which did not in fact find that oyster operation staff altered the "normal biological activities of birds." In contrast Kelly et al. "observed no movements of shorebirds into or out of plots in response to human activity and the distributions of shorebirds were not significantly related to the presence of oyster workers on mariculture plots" (1996).

The DEIS also argues that "While birds that feed on prey on top of cultivation bags may experience a loss in foraging habitat (NRC, 2009), there is no evidence the cultivation bags provide the only foraging opportunity for these birds species and therefore adverse impacts resulting from removal of the bags are not expected."[30] To present a balanced discussion, this same argument would need to be presented when discussing the removal of the mariculture bags from the mudflats, i.e., there is no evidence that the birds are space limited; therefore, it is not clear why the removal of the bags would have beneficial impacts to the birds. The DEIS further incorrectly cites Kelly et al. (1996) because that paper does not discuss disturbance from sound or flushing due to human activity.[31] The paper focuses entirely on population distributions in undisturbed versus disturbed (mariculture) sites. There is also a lack of evidence supporting the DEIS claim that "… due to the abundance of probing shorebirds that forage on benthic prey covered by mariculture bags, DBOC's use of up to 84 acres of intertidal areas for bottom bag culture would be expected to have an adverse effect on the bird population and foraging habitat in Drakes Estero."[32] While it might be true that DBOC operations influence foraging behavior, it is not clear how they would have an adverse impact if the acreage available for foraging is not a limiting factor, especially since the actual acreage used for bag culture has been less than permitted acreage. The DEIS could be improved by correcting these factual errors regarding the Kelly et al. 1996 citation.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

The committee finds that, given the information provided in the DEIS and consistent with the NRC (2009) report on birds, the conclusions reached in the DEIS have moderate uncertainty as discussed below.

The committee finds that the DEIS conclusion that alternative A would have a beneficial impact, because habitat would improve for foraging and migratory birds, is valid and scientifically sound. For example, this alternative would have beneficial impacts to birds using the Estero to forage, rest during migratory stopovers, etc., by replacing 7 acres of oyster racks with eelgrass and allowing an estimated 50 acres (based on NRC 2009 calculations) of additional eelgrass to recover from boat scarring (although it is difficult to determine if such increases would have any detectable effect on species of concern like the black brant).

For alternative B, the conclusion that this alternative would result in long-term moderate adverse impacts on birds and bird habitat, because noise disturbances from DBOC motorboats and the displacement of natural habitat by shellfish racks and bags "would be clearly detectable and could appreciably affect natural processes," is scientifically sound according to current literature, but it has not been demonstrated in systems like those in Drakes Estero. Impacts also assume that habitat resources are limited. Additionally, given that the literature (e.g., White, 1999) shows that species richness and individual counts for Drakes Estero are high relative to other locations nearby despite ongoing mariculture operations, categorizing impacts associated with alternatives B, C, and D as "moderate" may overstate their impacts relative to alternative A. The committee agrees with the DEIS that alternatives B, C, and D are most likely to have the same impact levels. See the Soundscapes section for further comments on impacts of noise on wildlife.

[29] DEIS, p. 305
[30] DEIS, p. 305
[31] DEIS, p. 308
[32] DEIS, p. 309

PREPUBLICATION

III. Ways to reduce uncertainty

Given the numerous resources available for the Drakes Estero area on avian ecology, distributions and behavior, a bird species list (with frequency of occurrence) and assessment of population changes locally and regionally using Christmas Bird Counts and/or Breeding Bird Survey data could be included in the DEIS (or a species list from White, 1999). Analysis of these data could help to determine which species (based on trends in these long-term datasets) could be impacted by DBOC activities. Although data from bird count censuses performed by amateur bird enthusiasts is available and could be used to augment the DEIS, the quality of the data might not be as high as from a rigorous census performed for research purposes. These censuses reports are not designed to determine interactions between bird habitat use and DBOC activities but their inclusion could help to estimate relative abundance in the Estero and surrounding areas for establishing baselines.

Special Status Species

I. Quality of information and analysis and info gaps

Special-status species outlined in the DEIS include plant and animal species that currently have federal regulatory protection under the Endangered Species Act, and state protection under the California Endangered Species Act. The DEIS identifies no federally listed plant species and seven federally listed animal species or their critical habitat as likely to occur in the project area and potentially be affected by the proposed alternatives.[33] The committee's comments on these are summarized below.

Myrtle's Silverspot Butterfly: Given data and literature presented and the spatial extent of the Myrtle's silverspot butterfly with respect to DBOC activities, the committee finds substantial scientific evidence to support the conclusions in the DEIS. Although offshore activities are not likely to influence local butterfly populations, the evidence in the DEIS supports a strong potential cause-effect relationship between onshore DBOC activities in alternatives B, C, and D associated with (1) road traffic and (2) onsite buildings, suggesting that silverspot butterfly survival and habitat will suffer minor long-term adverse impacts. It is also logical that there would be short-term adverse impacts of alternative A for two months as DBOC operations are closed and infrastructure removed, followed by long-term beneficial impacts. The presentation in the DEIS would benefit from inclusion of a map of the preferred habitat to illustrate how roads and DBOC onshore operations do or do not overlap with butterfly habitat.

California Red-legged Frog: Threats to the California red-legged frog identified in the DEIS include (1) road-associated mortality and (2) impacts to non-breeding onshore dispersal habitats, some of which are in DBOC project areas. These are well known types of threats to most amphibians. The data and literature presented and the spatial extent of the California red-legged frog within the project area support the DEIS conclusion that alternative A would provide potential long-term improvement of non-breeding habitat and reduced mortality (following short-term adverse impacts associated with close-out procedures). Long-term minor adverse impacts of alternatives B, C, and D would be associated with degradation of a relatively small proportion of habitat and road activity, with potentially elevated impacts under alternative D due to increased production levels if this leads to additional traffic to and from DBOC. A map of potential breeding ponds in the DEIS would help to illustrate how roads and DBOC onshore operations overlap with critical habitat.

Western Snowy Plover: The committee finds that there is a lack of quality data and information related to western snowy plover populations for the Estero. Nonetheless, the data and literature presented in the DEIS, consideration of potential climate change impacts on distributions, observations from other comparable ecosystems and current scientific understanding of marine ecology allow for some logical deductions concerning cause-effect, leading to the DEIS findings that potential impacts of alternative B, C, and D are likely to be minor. The western snowy plover does not currently breed in Drakes Estero (although it does nest along Limantour Spit), nor does it forage in the project area. There is some possibility that over the next several decades, climate change could make the Estero more favorable, and thus a more significant habitat for plovers, as Drakes Estero represents the northern extent of significant

[33] DEIS, p. 185

overwintering populations. There is an error in DEIS where it states "provide the *tern* with an improved potential foraging habitat;" it is likely that the authors meant to state "plover."[34]

California Least Tern: Based on the fact that Drakes Estero represents potential habitat for the California least tern, substantial scientific evidence about the distribution, biology and habitat exists to support the DEIS conclusions that alternative B, C, and D could have a minor adverse impact. However, although the tern has the potential to use the Drakes Estero for staging, the DEIS notes it does not do so now, nor has it been observed foraging in the Drakes Estero. The DEIS states that California least tern foraging behavior is likely to be disturbed from boat traffic soundscape noise and/or from habitat loss to oyster culture bags, but no data or citations are provided to support these inferences. Both California least terns and western snowy plovers are known to nest in urban environments and noisy areas (Powell and Collier, 2000; Schuetz, 2011), and there may be more parsimonious explanations for their absence, such as environmental conditions, predator access to colony areas (e.g., coyotes), the local prey base, and the need for a "critical mass" of colonizing birds.

Central California Coho, Oncorhynchus kisutch (Critical Habitat): The DEIS does not include references to support the conclusions regarding coho salmon in the Estero. Coho are not currently found in Drakes Estero, but "the watershed is included in the critical habitat designation because it has habitat elements required by the coho salmon."[35] Observations from other comparable ecosystems and current scientific understanding of their nearshore marine ecology allow some logical deductions concerning cause-and-effect with regards to this DEIS.

Although coho salmon populations are not established in the natal freshwater streams feeding Drakes Estero, the DEIS properly concludes that the Estero would constitute essential fish habitat for juvenile strays, or "nomads," that originate from adjacent coastal rivers and streams. Although no data or citations are provided in the DEIS, there is ample scientific evidence that juvenile (especially sub-yearling) coho will rear in adjacent, non-natal estuaries before either continuing their migration to open ocean habitats or reversing their migration back into freshwater (e.g., Koski, 2009; Roni et al., 2012; Satterthwaite et al., 2012). Accordingly, juveniles from at-risk coho populations that originate from adjacent west Marin-Sonoma and watersheds further north (King, 2004) could potentially occupy the Estero.

While the DEIS conclusions about coho responses to the various alternatives are logical, the scientific evidence regarding the link between eelgrass and coho salmon critical habitat is equivocal. Compared to the scientific literature documenting the more direct habitat association and function of eelgrass for juvenile chum (e.g., Salo, 1991; Fresh et al., 2009) and Chinook salmon (e.g., Semmens, 2008), the paucity of literature substantiating the importance of eelgrass for juvenile coho (see Harris et al., 2008) makes the DEIS conclusion highly uncertain.

Central California Steelhead, Oncorhynchus mykiss: The committee concludes that there is a lack of quality data and information regarding steelhead for the Estero, resulting in some marginally supportable assumptions and several unaddressed mechanisms of mariculture effects. But logical deductions could be made using observations from other comparable ecosystems and current scientific understanding of their estuarine and nearshore marine ecology. As described for central California coho, above, the assumptions and interpretations that changes in eelgrass will significantly affect juvenile steelhead habitat because "… eelgrass beds serve as a direct food source for steelhead and steelhead prey, and provide cover for predator avoidance (PFMC, 2003)" require more substantiation from the scientific literature. Information from relatively comparable estuarine/lagoon settings would suggest that eelgrass is not a requisite habitat, that prey resources are not unique to eelgrass, and that carrying capacity is not necessarily limiting. Although no data appear to exist for the Estero, juvenile steelhead rearing in other coastal California, Mediterranean-climate estuaries suggest that gammarid amphipods (e.g., *Gammarus* spp.; *Corophium* spp.; *Eogammarus* spp.), isopods (*Gnorimosphearoma* spp.) mysids (*Neomysis* spp.) and corixid beetles typically constitute the predominant prey resources in these systems (Needham, 1939; Salamunovich, 1987; Martin, 1995; Bond, 2006). These taxa are not unique, or in some cases even

[34] DEIS, p. 319
[35] DEIS, p. 317

common, to eelgrass habitats and in some cases (*Corophium* spp.) are more typical of unconsolidated, unvegetated estuarine sediment environments.

The DEIS also appropriately recognizes that racks used in commercial shellfish operations may have implications to juvenile steelhead use of Drakes Estero, although the potential mechanism are likely to differ from those proposed. While there has been documentation of structures in other shallow estuaries attracting predatory fish and birds, most or all of that evidence (e.g., The Watershed Company, 2000) originates from lakes or large structures in estuaries, and relatively few from intertidal structures such as those utilized in Drakes Estero. However, observations and experiments have extensively documented that shading by the structures can cause adverse behavioral responses by juvenile salmon migrating in estuarine and nearshore waters (Nightengale and Simenstad, 2001; Ono et al., 2010). This alternative mechanism, while not developed in the DEIS, would lend support to impact conclusions related to central California steelhead.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

For each species, the DEIS categorizes alternative A as being long-term beneficial, and alternatives B, C, and D as having long-term minor adverse impacts. The committee proposes no alternate conclusions to the DEIS findings for special-status species. The conclusions regarding the Myrtle's silverspot butterfly, California red-legged frog and California least tern are determined to have low levels of uncertainty. Although the paucity of data associated with impacts of the proposed alternatives on western snowy plover, central California coho and central California steelhead leaves these conclusions with moderate uncertainty, the committee finds that overall, reasonable deductions were drawn using the available scientific information as applied under the impact definitions used in the DEIS. However, some of the impacts currently ranked as minor could arguably be reclassified as negligible if that impact category were included.

III. Ways to reduce uncertainty

Myrtle's Silverspot Butterfly – None.

California Red-legged Frog – None.

Western Snowy Plover – A more careful description of breeding and over wintering ranges regionally would place impacts to this special-status species in better context. Drakes Estero is within the northern ranges for both, and likely on the northern fringe of the breeding range with a majority of the overwintering populations occurring from just north of Drakes Estero down to Baja California.

California Least Tern – Data from Christmas Bird Counts and/or Breeding Bird Survey could provide insights on the temporal changes in the occurrence of this bird species locally and regionally.

Central California Coho, Oncorhynchus kisutch – The effects of the proposed alternatives on juvenile coho salmon in Drakes Estero are supported under the designation of "critical habitat" but the connection between DBOC activities and coho habitat quality are not documented. As described in the Impacts on Fish and Wildlife Habitat-Fish resource section, Beck et al. (2001) make a strong argument that nearshore fish habitats provide nursery functions for juveniles if they contribute disproportionately to the size and numbers of adults relative to other juvenile habitats; stating "It is not sufficient to measure a single factor such as density of juveniles." If changes in the conditions of Drakes Estero could potentially alter nursery habitat functions such as refuge from predation, foraging habitat and prey resources for juvenile coho salmon, the DEIS should specifically describe how those functions would be significantly affected by the alternatives.

For purposes of analysis appropriate to the life history of juvenile coho, tidal freshwater wetlands should also be included in the project area. The statement that "While the designated critical habitat in these creeks is close to Drakes Estero, location coordinates of the upstream and downstream limits provided by NMFS show that they are not included in the project area (NMFS, 2005)" seems to assume that freshwater constitutes the only critical habitat for steelhead, when in fact the Estero itself is overall critical habitat. However, important physiological transition zones for juvenile coho in the tidal freshwater reaches of Schooner Bay and Home Bay should be included in the DEIS assessment.

PREPUBLICATION

As with central California steelhead, the effects of culture racks on the natural behavior of juvenile coho salmon, induced primarily by shading, would suggest that changes in these structures under the different alternatives could induce changes in coho habitat utilization.

Central California Steelhead, Oncorhynchus mykiss – The nursery function of the Estero for juvenile steelhead should be examined in more specific detail by analysis of the trophic linkages to different habitats in the Estero. Most notably, DEIS analyses related to the documented prey resources of juvenile steelhead in estuaries and lagoons (i.e., Impacts on Wildlife and Wildlife Habitat-Benthic Fauna) should be considered in regard to juvenile salmonid habitats. Those habitats, in addition to eelgrass, should be considered in the assessment of potential impacts to steelhead under the DEIS alternatives.

Coastal Flood Zone

I. Quality of information and analysis and info gaps

Floodplains are fluvial lands formed from freshwater streams and rivers that receive floodwaters once the water has overtopped the bank of the main channel. In contrast, flood zones are geographic areas defined by the Federal Emergency Management Agency (FEMA) based on flood risks. FEMA has not mapped the flood zone for Drakes Estero. For purposes of the DEIS, an elevation of 9.0 feet NAVD-88 was estimated as the flood zone elevation for Drakes Estero, based on a land survey at the onshore facilities and gauge data from the Point Reyes Light Station. Drakes Estero (including the waters of the Estero and surrounding lands up to ~9.0 feet above sea level) falls within the coastal flood zone (an area with a probability of being inundated at least once every 100 years due to coastal storms and tsunamis). Alternatives A, B, and C do not include any new upland structures. Only alternative D would include new or modified structures within the flood zone, requiring the need for a Statement of Findings in accordance with NPS Director's Order 77-2 to ensure the structure is properly designed and constructed in a way to minimize impacts to the flood zone.

Vegetated intertidal wetlands, sand bars and subtidal eelgrass beds buffer uplands against storm surges and tsunami. These are prominent habitats in the project area. Mud flats and sandbars dominate the intertidal throughout the project area, except at the heads of the bays where vegetative wetlands predominate.[36] Regarding coastal flood zones in Drakes Estero, at least two aspects of impact are relevant for the DEIS: the extent that DBOC operations impact habitat buffers in the flood zone during and after flooding events; and the flood water storage volume of the floodplain.

Impacts on habitat buffers in the flood zone (e.g., the extent and fragmentation of vegetated tidal wetlands) are not addressed in the DEIS. The DEIS states that removal of DBOC infrastructure would result in relative long-term beneficial impacts under alternative A by eliminating risks associated with "dislodged and damaged materials floating and washing ashore during a flood event."[37] Assuming that DBOC would remove and dispose of debris that washes ashore in a timely fashion, these events are unlikely to have measurable long-term adverse impacts on Drakes Estero habitats and the resources they support. Beyond short-term adverse impacts on the near shore environment, it is not clear how resources in the Estero would experience "damage"[38] in the long term. The DEIS also states that alternative A would remove "materials that have the potential to adversely affect water quality if spilled during a flood event, such as stored fuels and wastewater."[39] These potential impacts should be considered in the context of the tidal flushing dynamics of Drakes Estero and the magnitude of post-flooding runoff that could disperse and/or export the contaminants.

The DEIS also states that the potential displacement volume of infrastructure and shell piles within the floodplain under alternatives B, C, and D may reduce the storage capacity for floodwaters in Drakes Estero (which would increase the height and spatial extent of a flood event). Conversely, the long term beneficial impact of alternative A is described as an increase in flood water storage, attributed to the removal of existing onshore infrastructure and shell piles, the displacement volume of which would be replaced by flood waters. However, in the absence of a quantitative analysis, this is little more than speculation. What is the volume of the shell pile and infrastructure in the flood zone that would be

[36] DEIS, p.166
[37] DEIS, p. 330
[38] DEIS, p. 331
[39] DEIS, p. 330

PREPUBLICATION

submerged in a 100 year flood relative to the total volume of water in a storm surge that reaches 9 ft NAVD-88?

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

Given the lack of information on the displacement volume of onshore structures described above, the uncertainty level is high that flood zone impacts in alternatives B, C, and D would be moderately adverse. It is the conclusion of the committee that a quantitative analysis is important for determining the magnitude of the impact. For example, alternatives B, C, and D were judged to have the same “moderate” intensity of impact even though the displacement volume of existing structures was not calculated and alternative D would include new or modified infrastructure.

III. Ways to reduce uncertainty

Since most of the vegetated wetlands are located near the heads of the bays (Figure 3.1), it appears unlikely that the DBOC upland footprint (which is seaward of vegetated wetlands) measurably impacts the resilience of the Estero to storm surge and tsunami. However, calculation of the volume of water displaced by the DBOC structures relative to the volume of 100-year floodwater in Drakes Estero would provide a quantitative basis for assessing impacts of DBOC on the flood plain and thereby reduce uncertainty. Sea level rise over the next 10 years (estimated at up to 5.9 inches for the California coastal zone)[40] has the potential of increasing the vulnerability of near shore infrastructure and terrestrial ecosystems to storm surge and tsunami. Thus, it would be useful to determine the spatial extent of inundation that would result given a 5.9 inch rise in sea level. Further analysis of the flushing rate of Drakes Estero (as discussed in the Water Quality section below) would also help inform the potential ecological impacts of flood-related contaminants from DBOC operations.

Water Quality

I. Quality of information and analysis and information gaps

In practice, water quality is generally assessed in terms of a set of key indicators which usually include the following: concentrations of xenobiotics (pesticides, herbicides), enteric coliform bacteria, toxic phytoplankton, nutrient concentrations, turbidity, phytoplankton biomass, suspended particulate organic matter, the attenuation of downwelling radiation, and the spatial extent and condition of submerged aquatic vegetation (e.g., eelgrass) (Hoffman et al., 2003; Bricker et al., 2007). In the DEIS however, quantitative indicators of water quality are limited to xenobiotics in sediments, enteric coliform bacteria, and the occurrence of toxic phytoplankton events. Coliform bacteria levels (an indicator of land-based waterborne pathogens) have been used to classify areas as prohibited for shellfish harvesting, limited to the upper reaches of Barnes, Creamery and Home Bays where contamination from cattle occurs. Therefore, DBOC does not use these areas for shellfish cultivation.[41] Concentrations of these indicators are of concern to shellfish producers and consumers; however they have not been associated with impacts of DBOC operations on water quality.

To evaluate the impacts of DBOC operations on water quality requires information on potential impacts of human activities (e.g., land-based inputs of pollutants via impervious surfaces, recycling water from the Estero through settling tanks and washing stations, sediment re-suspension by motor boats, leakage of oil and gas from engines) and of cultured shellfish (filtration of particulate matter, deposition of feces and pseudofeces, nutrient recycling) on water quality. However, there is a paucity of data on these water quality parameters for Drakes Estero.

The DEIS states that, “the positive ecosystem effects typically attributed to bivalves, such as nutrient cycling and water clarity, would be expected to be relatively minor in west coast estuaries like Drakes Estero. This is because the nutrient dynamics in these systems are driven by coastal upwelling and a strong tidal cycle which flushes small estuaries like Drakes Estero on a daily basis.”[42] The DEIS assumes that supplies of nutrients and changes in phytoplankton biomass are driven primarily by imports from adjacent coastal waters and not by processes within the Estero (e.g., nutrient regeneration,

[40] DEIS, p. 170
[41] DEIS, p. 199, Figure 3-7
[42] DEIS, p. 341

PREPUBLICATION

phytoplankton blooms, draw-down of phytoplankton biomass), but does not provide a firm basis for this assumption as discussed below.

The flushing time of coastal lagoons is an important parameter for determining the impacts of human activities and natural processes on water quality and its capacity to support living resources. Thus, quantifying flushing times is important to understanding and managing environmental impacts. The estimate of flushing time used in the DEIS for Drakes Estero is about one day, assuming that the water is completely mixed from the head of the Bays to the mouth of Drakes Estero during the semidiurnal tidal cycle.[43] If this were the case, horizontal gradients in salinity and temperature from head to mouth would not develop. However, such horizontal gradients have been observed and salt balance calculations suggest that flushing times range from approximately 16.4 days in the upper reaches of the bays to about 7.6 days at the base of Schooner Bay (where it joins the main waters of Drakes Estero) (Robart and Largier, 2008 abstract). Since phytoplankton growth rates are well within this range (e.g., phytoplankton cells double every 1 to 5 days), phytoplankton blooms within Drakes Estero could reduce light penetration and increase the food supplies for filter feeders. Under these circumstances, water properties in the finger bays of the Estero where shellfish are grown could be influenced more by these filter feeders than assumed in the DEIS. In fact, phytoplankton blooms have been observed during summer in parts of Drakes Estero (Buck et al., 2011 abstract).

Observations reported in an abstract by Buck et al. (2012) provide some evidence that oyster-filtration could impact phytoplankton biomass in the Estero. Specifically, Chlorophyll-a distributions (an index of phytoplankton biomass and component of turbidity and suspended organic matter) were found to be high near the mouth of Drakes Estero and to decrease by about 30% near the mouth of Schooner Bay where culture racks are located. Thus, distributions of salinity and chlorophyll-a in the Estero provide circumstantial evidence that oyster filtration could reduce suspended organic matter in Drakes Estero. Likewise, there is preliminary evidence from distributions of ammonium that nutrient recycling may provide an important source of regenerated nutrients within Drakes Estero (Buck et al., 2012 abstract).

A second approach to assessing the potential impact of cultured oysters on water quality is to compare estimates of flushing times of the Estero with estimates of the time required for cultured oysters to filter a volume of water equivalent to that of the project area at mean high water. Estimates of filtration rates of oysters range from 20 to 50 gallons/oyster/day (0.075 – 0.190 m^3/oyster/day) during the growing season (NOAA, 2011;[44] Powell et al., 1992). These must be considered rough estimates because they assume that oyster filtration rates are constant regardless of species, body size, current speed, temperature, and the concentration of food particles (e.g., phytoplankton). For example, Gerdes (1983) reports a wide range of filtration rates for Pacific oysters in experiments at 20°C using different concentrations of *Isochrysis galbana* as food (0.01 – 0.13 m^3/day/oyster). Given the volume of Drakes Estero[45] (7,680,000 m^3; NOAA, 2011), rough estimates of the mean volume of water in the project area can be made based on two assumptions: (1) the volume of the project area is proportional to its area relative to the area of Drakes Estero (acreage), and (2) the volume of the project area is equal to its surface area times the mean depth of Drakes Estero as follows:

Volume of project area using assumption (1) = (7,680,000 m^3) x (1,700/2,500) = 5,222,400 m^3

Volume of project area using assumption (2) = 74,052,000 ft^2 x 6.5 ft = 481,338,000 ft^3 or 13,629,974 m^3

Mean annual production of oysters during 2007-2009 has been estimated to be 5,340,000 oysters.[46] Using an oyster filtration rate of 0.075 m^3/oyster/day, the volume of water filtered by cultured oysters would be on the order of 400,500 m^3/day. Using estimates of the volume of water in the project area, the time required for cultured oysters to filter that volume of water (project area volume/oyster filtration volume) could be in the range of 13 - 34 days on average. Although these are clearly rough estimates, they encompass the flushing times estimated by Robart and Largier (Abstract, 2008). This suggests that the potential effects of cultivated oysters on water quality in Drakes Estero could be significant, an

[43] DEIS, p. 159
[44] http://www.habitat.noaa.gov/abouthabitat/oysterreefs.html
[45] Assumes that NOAA volume estimate for Drakes Estero includes Estero de Limantour
[46] DEIS, Chapter 2, p. 62

PREPUBLICATION

observation that is consistent with the occurrence of phytoplankton blooms within the Estero and the draw down in phytoplankton biomass in the vicinity of the culture racks observed by Buck et al. (2012 abstract).

The DEIS concludes that ecosystem services by bivalves related to reductions in suspended particulate matter (turbidity), increases in light penetration (downwelling radiation) and levels of eelgrass production only provide "localized benefits to water quality"[47] because of the short flushing time (1 day) and the assumption that turbidity is low. However, concentrations of suspended particulate matter appear to be appreciable (up to 100 mg $liter^{-1}$) in both Estero de Limantour and the higher reaches of Drakes Estero, and Secchi disk depth readings as shallow as 0.45 m have been observed in winter (Wechsler, 2005). This, and the discussion above, suggests that water filtration by cultured oysters may, at times, provide these ecosystem services.

II. Reasonableness of the conclusions, assessment of the level of uncertainty, alternate conclusions

Summing across the parameters contributing to water quality, the DEIS concludes that the action alternatives would have a minor adverse impact. This is based on assessment of minor adverse impacts from increased turbidity due to sediment disturbance, leachates from lumber used in the docks and racks, and a small amount of stormwater runoff, outweighing "local" beneficial impacts from filtration by the cultured shellfish. However, data on water quality parameters that could be affected by shellfish culture (e.g., turbidity, suspended organic matter, phytoplankton biomass, nutrient concentrations) were not provided in support of this conclusion. Thus, given the small amount of information provided in the DEIS related to water quality impacts by DBOC, conclusions reported in the DEIS concerning impacts of DBOC operations on water quality are assigned a high level of uncertainty by the committee.

As discussed above, research on filtration rates of oysters in shallow estuaries such as Drakes Estero suggests that oyster mariculture could increase water clarity under alternatives B, C, and D compared to alternative A. However, a simple calculation of the chlorophyll-a equivalent fraction of total particulate organic carbon suggests that phytoplankton biomass may be a small fraction of total suspended organic carbon.[48] This can be interpreted in two ways. If phytoplankton biomass accounts for most of the suspended organic carbon (which is unlikely given the potential supply of organic detritus from decaying eelgrass), oyster filtration may be insignificant relative to tidal flushing. Alternatively, decaying eelgrass may account for most suspended organic carbon, and oyster filtration could be an important process regulating accumulations of organic matter and nutrient recycling within Drakes Estero. This casts further uncertainty concerning the impacts of oyster mariculture on water quality, and suggests an alternate conclusion could be equally reasonable, i.e., impacts of alternatives B, C, and D may be negligible or even beneficial.

III. Ways to reduce the level of uncertainty

The level of uncertainty could be reduced if all data from Drakes Estero currently available for assessing water quality were compiled and evaluated. In addition, the DEIS could be strengthened by an explicit treatment of the factors needed to evaluate the effects of shellfish cultivation on concentrations of suspended particulate matter, nutrient cycling, benthic-pelagic coupling and the spatial extent and condition of eelgrass beds in Drakes Estero as a whole.

To diagnose water quality status and trends in Drakes Estero in the future, the use of appropriate indicators and mathematical models would be necessary and is common practice in the management of water quality and living resources. This would require collection of additional data not currently available on water quality parameters (as discussed above) to enable implementation of validated numerical models of hydrodynamics and water quality.

[47] DEIS, p. 342

[48] Using a C/Chlorophyll ratio of 50 (by weight) to convert chlorophyll to particulate organic carbon (POC) and a factor of 3 to convert POC to particulate organic matter (POM, or dry weight), 3 µg $liter^{-1}$ of chlorophyll equates to 150 µg $liter^{-1}$ of POM which is a small fraction of the material in suspension.

PREPUBLICATION

Soundscapes

I. Quality of information and analysis and info gaps

The DEIS contains some excellent background information in Chapter 3 on (1) NPS soundscapes management policies that have been created in the last 10-12 years, (2) sound levels and effective communication distances (to provide perspective on the sound level for the general reader), (3) how sound levels are measured and reported traditionally, and (4) how sound is impacted by the sender, receiver and medium through which it passes.

The DEIS concludes that implementation of alternative A, after an initial increase in sound levels associated with removing the DBOC footprint, will reduce overall anthropogenic noise levels and restore Drakes Estero soundscapes to a more natural state. This conclusion is well supported. The DEIS concludes that alternatives B, C, and D would be expected to result in major adverse impacts due to louder soundscapes compared to alternative A.

Originally, the term "soundscape" was used to describe the acoustic environment as perceived by humans (e.g., Schaefer, 1969). Although no standards exist yet for documenting soundscapes, the field is starting to define features needed to characterize soundscapes for humans (e.g., Raimbault and Dubois, 2005), including soundscapes in parks and wilderness areas (Fidell et al., 1979; Miller, 2008; Schomer et al., 2009; Benfield et al., 2010). NPS has developed regulations to manage soundscapes and preserve natural quiet as experienced by people based on detectability of human-made noise (Miller, 2008).

The meaning of "soundscapes" for wildlife is less understood, but in principal would also require documenting the acoustic environment in space and time. Although NPS has considered its regulations in relation to wildlife management (Hatch & Fristrup, 2009), there hasn't been a focused effort to define soundscapes for wildlife management in the U.S. Directed efforts are currently underway in Europe (Pijanowski et al., 2011; Villanueva-Rivera et al., 2011).

The DEIS uses the term soundscape to refer to all aspects of the acoustic environment, without distinguishing between the perceived sound environment and the measured sound captured by the monitoring equipment. An essential feature of a soundscape is the variation over space and time. However, the environmental sound levels presented within the DEIS were based on measurements taken from a single location (on a bluff above Drakes Estero) over 30 days in late summer. This does not accurately represent the temporal or spatial variability of the project area. Using data from a single month misses variability due to seasonal weather and wind patterns. At the same time, limiting measurements to a single location cannot capture gradients in sound levels with distance from the source. Propagation characteristics are complex in coastal regions and extrapolating a single set of measurements to an area as large as Drakes Estero does not capture this complexity or variability.

Moreover, insufficient information is provided for an accurate representation of the spatial and temporal variability of ambient sound levels. In addition to L50 values, which gives an estimate of the mean, the ranges of those measurements are needed as well as the unit of analysis used in the calculations. For example, an L50 of 50 dBA could be calculated from data with a range of 30-70 dBA or from 10-90 dBA. A Leq[49] measurement gives a more representative value because it accounts for duration, although it tends to overestimate noise in quiet environments because it is sensitive to high amplitude transients. Alternatively, characterizing the variability of sound could also be accomplished using several percentiles (e.g., L90, L50, L5). Volpe (2011) reports both L50 and Leq values, which differ by up to 6 dBA, a difference large enough to affect the estimated levels of impact of the alternatives which compare ambient sound levels for equipment similar to those used by DBOC. Assessment of the natural variability of the Drakes Estero soundscapes is essential for providing the proper context in which to analyze the influence of DBOC activities on the soundscapes.

As noted above, the site for audio recording was located on a bluff above Drakes Estero. It is not known how representative that measurement is of the soundscapes in the project area where impacts were assessed by the DEIS. Soundscape patterns also differ considerably between day and night so there could be a range of impacts dependent on whether sounds from DBOC activities occur during biologically sensitive times of day (e.g., dawn chorus, peak foraging times). This would require day and night measurements of DBOC activities at ambient levels. The DEIS states that "daytime and nighttime

[49] Leq is defined as the sound pressure level of a noise fluctuating over a period of time T, expressed as the amount of average energy.

PREPUBLICATION

hours" are treated essentially the same[50]; however, the literature shows that nighttime natural sounds are much more complex in terrestrial environments than daytime sounds and that the dawn and dusk chorus have the most complex natural sounds (Pijanowski et al., 2011).

Another important consideration is the frequencies of noise and the potential for acoustic masking of vocalizations of many of bird, mammal and amphibian species that occur in the project area. There is strong evidence in the literature to suggest that many bird species will raise the pitch of their songs or sing at night if noise is produced at frequencies that would mask their communication (Warren et al., 2006). This additional energy expenditure may affect the fitness of an individual. This type of data could be readily obtained from a set of acoustic recorders to capture all sounds.

The duration of sounds produced by DBOC activities were not well presented in the DEIS. For instance, the DEIS did not take into account the duty cycle (i.e., activity pattern) or the closest point of approaches for boats, the number of vessel events, peak sound level, etc. The time period over which a pneumatic drill is used is not equivalent to the time the drill is in operation. It is especially critical to distinguish between continuous, intermittent, and impulse sources. Assuming that the 71 dBA value reported in DEIS Table 3-3 for the boat is during the closest point of approach, a single observation point (such as a visitor hearing the boat from shore), measures the maximum approach sound level which is only experienced for a short period of time. A more accurate measure would account for the range in sound level experienced from a single location for the duration of the audible boat noise.

The DEIS presents measurements and calculations based on dBA weighting which is directly related to human hearing. Weighted ambient and source levels provide only one measure of sound occurrence. The use of A-weighted[51] measurements is standard in human noise impact studies, but their use in wildlife impact assessments is still unproven. The committee finds that, given that the Acoustic Society of America is considering standards for reporting sound levels in quiet areas, using unweighted and 1/3 octave values, this might be more informative in combination with the A-weighted measurements. The lack of standards in soundscape measurements leads to a large level of uncertainty in the use of single metrics to assess noise impacts on wildlife.

The committee is unaware of any data with uniform sound levels or propagation effects over the course of a full day as stated in the DEIS.[52] The opposite is more reasonable due to bird choruses at specific times of day, daily wind patterns, human activity, etc. Assuming uniform sound levels means that the DEIS may have underestimated impacts to humans and animals active during the day. However, it is also true that the impacts may be overestimated for nocturnal animals.

Although the DEIS acknowledges there could be potential impacts on harbor seals from underwater sound generated by DBOC motor boats, no underwater measurements were given upon which to base conclusions on underwater soundscapes under any of the alternatives. The DEIS gives a brief but accurate description of the literature related to impacts of noise on harbor seals and marine mammals.[53] There are ample peer-reviewed papers on the short-term impacts of underwater noise on marine mammals at an individual level for a few species, but little scientific evidence is available to determine the effects of noise on marine mammals at the population level (NRC, 2003; see Harbor Seal section).

There are many propagation models available to model sound from a source to a receiver. The DEIS provides sound levels from motorboats and associated consequences[54]. The committee assumes simple spherical spreading was used for these calculations, as this method was used elsewhere in the DEIS. Simple spherical spreading is often not the most accurate model to use. In addition, consequences for communication disruption within 50 ft of a source would only realistically impact DBOC staff near the source. Kayakers or park visitors would be unlikely to spend time in such close proximity to DBOC activities and sources. It would be more accurate to show propagation model results from sources in different places around the area of DBOC operations to more accurately illustrate propagation between sources and potential receivers.

---

[50] DEIS, p. 351

[51] A-weighting is the most commonly used weighting scale for sound, because it indicates the risk of damage to the human ear. Sound level meters set to the A-weighting scale will filter out much of the low-frequency noise they measure, similar to the response of the human ear. Noise measurements made with the A-weighting scale are designated dBA.

[52] DEIS, p. 351

[53] DEIS, p. 207

[54] DEIS, p. 355

PREPUBLICATION

The proper application of propagation modeling also pertains to the conclusions made in the DEIS in regard to estimating the number of 60 dBA sources at 50 ft (NPS regulation) when describing the difference between ambient levels and DBOC activity impacts.[55] The DEIS compares 316 regulation sources to the 25 dBA difference between pneumatic drill levels and ambient levels and gives a worst case scenario. The worst case scenario most likely assumes the sources are incoherent and additive, but these assumptions are not clearly stated.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

The DEIS concludes that alternatives B, C, and D would present a major adverse impact. The committee assigns a high level of uncertainty to this conclusion regarding impacts of DBOC operations on the soundscape because there are no data on underwater sound, lack of a scientifically-based sampling scheme (e.g., poor spatial and temporal coverage), lack of direct measurements of sound levels associated with DBOC activities, limited data on how noise impacts harbor seals at the population level, unknowns related to boat traffic with potential decreases or increases in production, and uncertainty associated with potential changes in human noise from onshore improvements proposed in alternative D. Because of these unknowns, the committee finds that other conclusions could be reached for alternatives B, C, and D, i.e., adverse impacts could be classified as moderate or minor, rather than major, even with the impact criteria used in the DEIS. The committee concurs with and assigns a low level of uncertainty to the conclusion that alternative A would have beneficial impacts since anthropogenic noise levels would be reduced in the long-term.

III. Ways to reduce uncertainty

The high levels of uncertainty for the assessed impact levels for alternatives B, C, and D are due to the lack of information on underwater soundscapes, in-air soundscape variability, and presentation of unweighted sound levels to best interpret impacts on animals such as birds and harbor seals.

Some of the uncertainty could be reduced if the DEIS used data more fully representative of the temporal and spatial variability in ambient sound levels, by using all of the data (winter and summer for all stations) provided in Volpe (2011). In addition, the DEIS could better capture the total ambient sound level variability by including values for min/max, quantiles, as well as details of the environmental sound study such as the specific dates and continuity of data collection.

To better account for effects of sound on humans and wildlife would require presenting both dBA and unweighted values, the latter presented as peak values and root-mean square values with specified frequency bandwidths and duration. Spectra across a wide frequency range would be most appropriate. Uncertainty with regards to impacts on harbor seals could be reduced through measurement of underwater sound levels and characterization of underwater contributions from all sound sources.

Additionally, collection of ambient sound levels inside the project area closer to the impacted fauna and to some of the Seashore visitors, such as hikers and kayakers, would provide a more realistic baseline for assessing sound sources from DBOC. There would be less uncertainty in the DBOC sounds sources if the DEIS did not use proxies for sound levels and if the measurements accounted for duty cycle (continuous vs. intermittent vs. impulse sources) to estimate the percent of time various DBOC activities impact the soundscape.

Socioeconomic Resources

I. Quality of information and analysis and information gaps

A socioeconomic assessment in a NEPA document typically identifies potential changes in employment levels, housing requirements, public service needs, and tax revenues as a result of implementing the proposed action and alternatives. This is the approach taken in the DBOC SUP DEIS, but it does not constitute a scientifically sound economic cost-benefit analysis and these metrics are not accepted metrics of impact or value in economics. Although not required by NEPA (see 40 CFR § 1502.23), the committee concluded that a cost-benefit analysis using economic metrics of value, incorporated by reference or appended to a final EIS, would more fully inform decision makers on the socioeconomic consequences of the proposed alternatives for the DBOC SUP. The remainder of this

[55] DEIS, p. 354

section describes the features of a cost-benefit analysis and explains why it would be more informative than the assessment presented in the DEIS.

In a cost-benefit analysis, socioeconomic impact is the impact on society, including the economic value to society of the impact, whether beneficial or adverse. The economic impact includes both market and non-market impacts such as the impact on producers and consumers of shellfish (a market impact), and the impact on recreational enjoyment (both a market and a non-market impact).

For producers and workers, the economic measure of a change in their wellbeing is the change in income and profits in that industry.[56] For consumers, a change in their wellbeing is measured in monetary terms through an income equivalent – namely, the change in income that is equivalent in its impact on their wellbeing to the change being evaluated (say, a change in prices). Conceptually, there are two possible measures of income equivalence: the maximum amount of income that the person would be willing to give up (to pay) in order to secure the change, or the minimum amount of additional income that the person would want to receive as compensation for foregoing the change; the former is known as the willingness to pay (WTP) measure, while the latter is the willingness to accept (WTA) measure.[57]

For a marketed good such as shellfish, the economic metric for the impact on producers and consumers is the change in producer's plus consumer's surplus. In the case of recreation, there may not be a change in the supply of recreation per se but, rather, a change in the quality of the recreation and therefore the degree of enjoyment. This, too, can be measured by the income equivalence measures of WTP or WTA.

The change in the consumer's surplus from recreation is an example of what is known as a *use value*. The valuation of wilderness can also involve what is known as *non-use value*. A person might value the establishment of a new wilderness area because she wishes to experience it herself, for example by viewing wildlife there or hiking; that would be a use value. Or, she might place a value on the establishment of a new wilderness area even if she knew that she herself would never visit it. She might feel it desirable that more wild places should exist in California and she might be willing to pay money out of her own pocket to bring this about, even if she had no plan to visit them herself; that would be a non-use value.[58]

The economic metrics, whether for marketed or non-marketed items and whether for producers or consumers, are measures of *net* value (i.e., gross value minus cost). Consumer expenditures are not an accurate metric of value. A consumer may spend $50 per month on shellfish, but this only provides a lower bound on the gross value, because the consumer may place greater value in eating shellfish, thus yielding a consumer surplus in terms of his net value.

These concepts are well understood in economics and have been employed for almost 30 years in economic evaluations of environmental and other programs by the federal and state agencies. A major example in California was the Mono Lake EIR (Jones and Stokes, 1992), which considered use values for marketed items, including water supply and hydropower, and use and non-use value for non-market items such as recreation and the alternative levels of inflow to Mono Lake.

The socioeconomic assessment presented in the DEIS includes an impact analysis and a cumulative impact analysis. As defined in the DEIS, cumulative impacts are those which reflect both the impacts of the proposed action and impacts of other past, present, and reasonably foreseeable future actions. A well-established principle in cost-benefit analysis is that the analysis should involve a "with and without" comparison. With the application of this principle, a project would be assessed "based on the most likely conditions expected to exist in the future with and without the project," and is a requirement for an economic cost-benefit analysis conducted by a federal agency.[59] Hence, in a cost-benefit analysis an assessment of cumulative impacts would be valid if it compared the cumulative impact of "other past, present, and reasonably foreseeable future actions" for the baseline (e.g. no action alternative A) with the cumulative impact of the alternative (e.g. action alternative B, C, or D).

The DEIS identifies socioeconomic impacts associated with commercial shellfish culture and recreation/tourism. While the DEIS focuses on a change in shellfish production, which by itself is not an accepted economic metric, a cost-benefit analysis would focus on the change in consumer's plus producer's surplus in the California (or San Francisco Bay Area) shellfish market. This economic metric

[56] This is also referred to as the change in *producer's surplus*.
[57] The two measures are often referred to as the change in *consumer's surplus.*
[58] The two values are not mutually exclusive: a person might have both a use value and a non-use value for the same item.
[59] *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983); para 1.4.9, page 4.(http://planning.usace.army.mil/toolbox/library/Guidance/Principles_Guidelines.pdf)

PREPUBLICATION

allows for the possibility of substitution of other sources of supply which could mitigate to some degree the elimination of production by DBOC.[60]

Further, with regard to the socioeconomic impact on recreation and tourism, the DEIS notes correctly that (1) visitation of DBOC accounts for a very small share (about 2.5%) of total visitation to the Seashore, and (2) some of these visitors may have been participating in other types of recreation at the Seashore in addition to visiting DBOC and therefore could be expected to continue to come to the Seashore even without DBOC. The DEIS also indicates that the creation of additional wilderness acreage under alternative A might attract some additional visitation. Although the DEIS discusses changes in the number of visits, the DEIS would need to consider the possibility of a change in consumer's surplus per visit for a scientifically valid cost-benefit analysis.

Under alternative D, which includes construction of a new and potentially more attractive building at DBOC, the DEIS states: "This improvement to visitor experience (described further in the "Impacts on Visitor Experience and Recreation" section of this chapter), could minimally increase annual visitation to DBOC."[61] The empirical basis for this assertion, that there would be little change in the number of visitors to DBOC, is not clear. A scientifically valid cost-benefit analysis would account for a potential change in the consumer's surplus per visit as a consequence of the new visitor center.

In addition to consumer's surplus from recreation, a cost-benefit analysis would also consider the non-use value for an increase in wilderness area. Alternative A extends by 8,530 acres what is the only marine wilderness area (currently at 24,200 acres) on the west coast. As is evident from the public comments submitted on the DEIS, some members of the public have a significant non-use value for the removal of DBOC and the creation of additional wilderness area under alternative A. But others may not.[62] A quantitative estimate of the percent of the area population with a positive non-use value for this increment in wilderness area, and of the typical amount of that non-use value, would be a useful addition to the EIS.

As mentioned in chapter 2 of the committee's report, there are no gradations for beneficial impacts in parallel with the minor, moderate, and major gradations of adverse impacts. This results in an asymmetric assessment of the no action (A) and action alternatives (B, C, and D) in the DEIS. For instance, under alternative B, DBOC's operations would be largely unchanged from existing conditions, while under alternative A, DBOC would cease operation. Alternative A "could result in long-term major adverse impacts to California's shellfish market."[63] Alternative B "would result in a long-term beneficial impact to shellfish production in California."[64] If eliminating DBOC entails a major adverse impact, then maintaining DBOC should lead to a major beneficial impact.

II. Reasonableness of the conclusions, assessment of uncertainty, alternate conclusions

The conclusions reached in the DEIS might change if a more rigorous, cost-benefit analysis were conducted. The committee makes no finding as to whether the DEIS socioeconomic analysis is sufficient to meet NEPA requirements for such an analysis. However, the committee finds that what is in the DEIS does not constitute a scientifically valid economic analysis. Because the DEIS economic impact assessments were not based on quantitative metrics, it includes inferences and interpretations of impacts that have a high level of uncertainty. For example, even if a person who visited DBOC still continued to visit the Seashore for other types of recreation if DBOC closed under implementation of alternative A, there could be some reduction in consumer's surplus for this person.[65] Therefore, the committee finds the overall analysis of socioeconomic impact intensities in the DEIS to have a high level of uncertainty.

---

[60] We understand from a DBOC letter dated 6/5/12 that the company provided cost and revenue information to NPS in November 2010, but requested that this information remain confidential. Based on that request, the NPS did not report these data in the DEIS nor use them in the DEIS analysis. In the agricultural economics literature, changes in consumer's plus producer's surplus are often estimated by making estimates (or guesses) about demand and supply elasticities and then applying well established formulas based on first-order approximations. Hence, DBOC's request for confidentiality regarding this data is not an insurmountable barrier to conducting an economic analysis of the change in consumer's plus producer's surplus in the California shellfish market.

[61] DEIS, p. 401.

[62] A 2003 survey of visitors to the Seashore survey asked respondents (Question 17): "Overall, would you like to see the amount of wilderness at Point Reyes National Seashore increase, decrease, or remain about the same?" Of 418 respondents, 43% said increase; 38% said remain about the same; 2% said decrease; and 18% said don't know.

[63] DEIS, p. 393

[64] DEIS, p. 397

[65] The DEIS notes under the resource category on visitor experience and recreation: "Visitor services are defined by law as public accommodations, facilities, and services that are necessary and appropriate for public use and enjoyment of the Seashore (36 CFR

PREPUBLICATION

III. Ways to reduce the level of uncertainty

Conclusions on socioeconomic impacts in the DEIS would be less uncertain if an economic cost-benefit analysis were conducted that included: estimates of change in producer's plus consumer's surplus for shellfish; estimates of possible changes in consumer's surplus through analysis of data available on the consumer's surplus for various recreational activities;[66] and an assessment of the significance of the survey data on attitudes with regard to the impact on non-use value.

section 51.3)." DEIS pp.382-3, However, it is conventionally considered in socio-economic cost-benefit analysis of this type of program.

[66] Kaval and Loomis (2003) provided information to NPS on the average consumer's surplus per person by region for various types of outdoor recreation activity. The DEIS should have considered whether it could have extracted useful information from this or other sources regarding potential changes in consumer's surplus.

PREPUBLICATION

CHAPTER 4

Review of the Atkins Report

In 2011, the Department of the Interior (DOI) commissioned an independent peer review of the Draft Environmental Impact Statement (DEIS) to determine if (1) appropriate scientific information was used, (2) conclusions drawn from the information are reasonable, (3) significant information was omitted from consideration, and (4) interpretations of the information by the NPS are reasonable. The peer review focused on the scientific underpinning of the DEIS. The *Final Report on Peer Review of the Science Used in the National Park Service's Draft Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit* (Atkins Project No. 100025958; referred to here as the "Atkins report") was released in March 2012. The committee was asked to evaluate whether the Atkins report is "fundamentally sound and materially sufficient."

Overall Evaluation

The Atkins report peer review was limited to scientific information contained in chapters 3 and 4 of the DEIS. The review did not include "the intensity definitions or their conclusions" nor did they "make recommendations on whether a particular alternative should be implemented or whether they would have conducted the impact analysis in a similar manner," (Atkins, p. 1). Atkins selected 5 external reviewers based on their qualifications and expertise in the 4 topics identified by DOI: (1) Marine Estuarine Ecology and Coastal Zone Management; (2) Water Quality; (3) Soundscapes; and (4) Socioeconomics. Each reviewer conducted their assessment independently. The Atkins report includes a summary prepared by their staff in addition to the individual reviews from the selected experts.

Although the reviewers selected by Atkins are well-qualified, the committee found that the range of expertise covered by these experts was insufficient to address all of the scientific topics covered in chapters 3 and 4 of the DEIS. In particular, the committee felt that additional expertise in water quality, wildlife (e.g., harbor seals, fish), and terrestrial soundscapes would be needed to provide a thorough peer review. The Atkins report identified several instances where scientific evidence, interpretations or citations were insufficient or where alternate conclusions could have been reached, particularly in the discussion of marine estuarine ecology. The exception was the DEIS treatment of socioeconomics which the Atkins reviewer judged to be "vague at best, and misleading at worst" (Atkins, p. 5, 88). Apart from the critique of the DEIS socioeconomic section, the Atkins report concludes: "In general, the reviewers found the DEIS to be well-written with adequate analysis and use of available scientific information." The committee reviewed the Atkins report and identifies issues that were not covered or where there was some disagreement with the Atkins report. As a consequence of the limited range of expertise of the reviewers and the constraints placed on the review (limited to DEIS chapters 3 and 4, did not include the intensity definitions or conclusions), the committee does not consider the Atkins report to be "fundamentally sound and materially sufficient."

Specific comments on the individual reviews in the Atkins report are provided below. The committee notes that not all of the resource categories in the DEIS were reviewed in the Atkins report. The Atkins report covered wetlands, birds, bivalve aquaculture, eelgrass, and benthos under the topic "Marine Estuarine Ecology and Coastal Zone Management" and included the following DEIS categories: water quality, soundscapes, and socioeconomics. Impacts on harbor seals, special status species, and the coastal flood zone were not addressed.

Resource Categories Addressed in the Atkins Report
Marine Estuarine Ecology and Coastal Zone Management
Wetlands and Birds (p. 57-66)

This review focused on wetlands and birds, but also incorporated comments on other sections. The committee agrees with this review comments related to wetlands, birds, and eelgrass overall. The review stated that given the limited available data for many of these topics, the conclusions are reasonable and generally well supported. The review found that the DEIS also does an acceptable job of presenting the limitations posed by the data, although some topics and interpretations were "either lacking support or fundamentally incorrect" (Atkins, p. 57).

With regard to birds, the review found that the DEIS reasonably describes the ecological importance of Drakes Estero and the potential disturbances due to noise and presence of small boats under alternatives B, C, and D. The review did not agree with the argument that potential invasive invertebrate fouling of eelgrass blades would reduce consumption by migratory Brant (Atkins, p. 58). It also disagreed with the DEIS on recreational clamming; while the DEIS dismissed these effects, the review found that these activities could result in extensive and long-term disturbances to the benthos.

In general, the review emphasized that the DEIS should recognize the substantial uncertainty associated with many of the conclusions, such as those regarding the impacts of mariculture on shorebird behavior, estimates of eelgrass cover, and the contribution of mariculture to the spread of non-indigenous species in the Drakes Estero ecosystem. It critiques the use of data from San Francisco Bay to address issues of eelgrass and water quality impacts because it is not a comparable embayment and provides little insight into the dynamics of Drakes Estero. The review finds that it "remains an open question entirely whether oyster filter feeding has any effect positive or negative on eelgrass" (Atkins, p. 61), The committee concurs with this review's appraisal of these issues in the DEIS.

Bivalve Mariculture (p. 67-75)

The committee found this review overall scientifically sound and balanced with a few exceptions. The review brought up many relevant points and provided an extensive list of additional references.

The committee did not agree with the suggestion that "… there are no data to support a notion that in this system aquaculture improves water quality or habitat quality for eelgrass," (pp. 68-69) The committee agrees with the review that there is no direct evidence that oyster culture benefits eelgrass in Drakes Estero. However, as discussed in Chapter 3 under water quality, sufficient data exists on oysters, including the Pacific oyster, to suggest that oyster mariculture in Drakes Estero could increase water clarity. At the same time, there is evidence from other ecosystems for causal relationships between bivalve growth and seagrass productivity that show both positive (Peterson and Heck, 1999; Peterson and Heck, 2001a; 2001b; Carroll et al., 2008) and negative (Vinther et al., 2008) relationships. The committee concluded that the DEIS would be unbalanced if it only discussed the adverse impacts of oyster mariculture in Drakes Estero.

This review in the Atkins report is consistent with the committee's conclusions in highlighting the risk of spreading nonindigeneous species through mariculture operations. The review of benthic fauna is consistent with the committee's assessment of these issues.

Water Quality (p. 77-79)

This review covered the topic of chemical toxicology thoroughly, but did not include other aspects of the effects of DBOC operations on water quality that the committee regarded as important for a thorough review of the DEIS.

The review focused on the potential effects of chromated copper arsenate (CCA) leached from pressure-treated wood used by DBOC for docks and oyster cultivation racks, and presented this as the primary source of uncertainty concerning impacts of DBOC operations on water quality. The review concluded that (1) the analyses and interpretations of environmental impacts of oyster mariculture on marine water quality are reasonable and appropriate, and (2) the DEIS includes and applies the best available science on the impacts of shellfish mariculture. Water quality parameters that could be affected

PREPUBLICATION

by DBOC operations were not discussed in the DEIS, in part because such data do not exist or are limited in scope (e.g., turbidity, suspended organic matter, nutrient concentrations, phytoplankton biomass). Thus, the committee disagrees with conclusion (1).

In contrast to this review in the Atkins report, the committee determined that an alternate conclusion on the overall impact of DBOC operations could be reached, with the beneficial effects of shellfish filtration outweighing the adverse impacts from sediment disturbance and the low levels of contaminants generated by DBOC activities.

Soundscapes (p. 81-86)

The Atkins review concludes that the scientific interpretation and analyses in the DEIS are reasonable, supported by the available data, and adhere to standard techniques and metrics. The committee agrees with the following comments made in the Atkins review:

- The section on basic acoustics and concepts was well written and comprehensible to a broad audience (with the exception that the definition of dBA was incorrect);
- The DEIS provides a good review of the effects of noise on wildlife "basic life functions" referencing key papers. Several new studies have emerged in the last two years that point to more evidence that noise negatively impacts wildlife;
- There is evidence that noise detracts from a positive park visitor experience and noise generated by DBOC activities negatively affects the human wilderness experience;
- Noise maps (spatial-temporal) of DBOC sound sources would be beneficial for explaining impacts on human and wildlife acoustic space;
- Alternatives B and C are likely to have the same level of impacts on soundscapes; and
- More supporting information is needed for assumptions about nighttime versus daytime ambient noise and propagation.

The committee disagrees with the following conclusions of this section of the Atkins report:

- The evidence presented in the DEIS is "robust." The committee concludes that the acoustic data, which were collected for other purposes, are not adequate to provide information on (1) spatial-temporal natural sounds, and (2) DBOC levels of noise from various activities and other transient human-related sounds (e.g., air flights, kayakers, etc.).
- L50 is an adequate measure of noise. L50 does *not* capture high and low extreme values of the amplitude of noise to provide adequate context (range and variability) of noise sources. To characterize the statistical properties of noise in a given environment, a number of measures should be presented.
- Table 3-3 of the DEIS "shows noise level values within close proximity to DBOC noise sources."[1] In reality, several of these values are reported from a 1995 study (Noise Unlimited, Inc., 1995). Apparently, the Atkins reviewer misinterpreted these as in situ data. Table 3-3 data are not from DBOC noise sources at the site and may not be representative of DBOC sound sources.
- The committees disagrees that there is sufficient evidence presented to conclude that alternatives B and C have "major" impacts (Atkins, p. 85). The committee disagrees with the statement that alternative D would have a "greater" (Atkins, p. 85) impact on soundscapes than alternatives B or C. For example, a new building could be constructed to reduce noise from onshore DBOC operations and mitigation measure are available that could reduce noise associated with motorboat activity.

The committee identified additional shortcomings in the DEIS that are not mentioned by this review, including a lack of underwater soundscape assessments (underwater acoustic data collection). Also, the Atkins review did not mention that additional relevant information was available in the Volpe (2011) study that was not included in the DEIS analysis.

[1] DEIS, p. 204

Socioeconomics

The review states that the DEIS does not embody the best available science on socioeconomic impacts. This review identifies major short-comings of this section and concludes that “the methods used … do not follow accepted economic impact analysis practice.” The reviewer also notes: “Economic impacts are assessed using qualitative judgments instead of quantitative measurements leading to unsubstantiated inferences and interpretations of impacts that are difficult to judge reasonable.” The committee agrees with the review and also finds the section on socioeconomic impacts seriously deficient (see Chapter 3).

PREPUBLICATION

CHAPTER 5

Conclusions

Overall Assessment of Conclusions Presented in the DEIS

Across the eight resource categories reviewed by the committee, the most common concern that arose was the lack of an assessment of the level of uncertainty associated with the scientific information on which conclusions were based. An assessment of the level of uncertainty, based on the availability and quality of data and level of scientific consensus on interpretation, is a key component of communicating scientific findings to decision makers (NRC, 2007).

The DEIS provides definitions of impact intensities for each resource category, as recommended in NPS Directors Order 12, to guide analyses of the severity of impacts and magnitude of change. Hence, the intensity definitions are integral to the conclusions on level of impact. In this DEIS, only one category of beneficial impact is used, such that effects that may range from minor to major beneficial could not be distinguished. In contrast, adverse definitions are described as minor, moderate, and major in the DEIS (Table 5.1). The DEIS did not include negligible as an impact level, although negligible is included in NPS NEPA guidance documents.[1] In some cases, the committee concluded that an impact on a resource category could most accurately be described as negligible.

The scientific literature on Drakes Estero is not extensive and research on the potential impacts of shellfish mariculture on the Estero is even sparser (NRC, 2009). Consequently, for most of the resource categories the committee found that there is a moderate or high level of uncertainty associated with impact assessments in the DEIS. The committee estimated the level of uncertainty using the criteria described in Chapter 3 (Table 5.2). Only three impact assessments were considered by the committee to have a low level of uncertainty and these were for three special status species (Myrtle's silverspot butterfly, California red-legged frog, and California least tern) for which no alternative conclusions were identified. Impact assessments for harbor seals, the coastal flood zone, water quality, soundscapes, and socioeconomics were all considered to have a high level of uncertainty, and the committee determined that alternate conclusions could reasonably be reached for these (Chapter 3). Eight of the remaining 16 categories were assigned moderate levels of uncertainty, and for these the committee determined that there could be reasonable, equally scientific, alternate conclusions for impact intensity.

[1] Director's Order 12, found at: www.nature.nps.gov/protectingrestoring/do12site/pdf/tab12_imp.pdf.

PREPUBLICATION

Table 5.1. Summary of definitions of impact intensities given in the DEIS. Definitions are effectively the same for some resource categories (wetlands, eelgrass, and wildlife and wildlife habitat) while others are specific to the resource category (special status species, coastal flood zones, water quality and soundscapes).

Language	Resource Category	Minor	Moderate	Major
Common Across Categories	Wetlands, Eelgrass, and Wildlife	Localized, slightly detectable, no affect on community structure	Clearly detectable; could appreciably effect individuals, communities or natural processes	Highly noticeable, would substantially influence individuals, communities or natural processes
Resource-Specific Language	Special Status Species	Changes to an individual, population or critical habitat are possible	Some changes to an individual, population, or critical habitat would result	A noticeable change to an individual, population or critical habitat would result
	Coastal Flood Zones	Takes place in the floodplain or flood zone, no increase in potential flood damage to other areas (or is exempt from NPS floodplain management guidelines)	Takes place within the floodplain or flood zone, would result in increased potential for flood damage to property or environmental contamination at the project site.	Would have a measurable impact on potential flood damage or environmental contamination to the site and to adjacent & downstream properties
	Water Quality	Temporary and localized, may or may not be detectable, would not have long-lasting effects, & would be within historical or desired water quality conditions.	Short- and long-term detectable impacts would change the chemical, physical, or biological integrity of water quality that would alter the historical baseline or desired water quality conditions	Short-term and long-term detectable impacts would change the chemical, physical, or biological integrity of waters of Drakes Estero that would alter the historical baseline or desired water quality conditions.
	Soundscapes	Human-noise at a level that makes vocal communication difficult between people separated by more than 32 ft, and the natural soundscape is interfered with < 5% of the time.	Human-noise at a level that makes vocal communication difficult between people separated by 32-16 ft, and the natural soundscape is interfered with 5-10% of the time.	Human-noise at a level that causes vocal communication difficult between people separated by < 16 ft, and the natural soundscape is interfered with > 10% of the time.

PREPUBLICATION

The committee's conclusions in Table 5.2 may be explained in part by the definitions of impact intensities used in the DEIS. For resource categories with common definitions for impact intensities across resource categories (Table 5.1; Appendix C), the committee found the definitions to be ambiguous and challenging to use for distinguishing among adverse impact levels. For example, a moderate adverse impact is characterized as having an "appreciable effect" that is "clearly detectable" while a major impact is characterized as having a "substantial influence" that is "highly noticeable." In addition, adverse impacts are considered to be moderate or major if an individual organism is affected while an impact is considered to be minor if it has no affect on community structure. Does this mean that an impact on an individual organism may be considered to be moderate or major, but not minor? All impact intensities could be improved by clearly scaling the definitions in terms of their effects on individuals and populations within the Drakes Estero ecosystem as well as the community of populations that make up the biota of the ecosystem. Likewise, as discussed in Chapter 2, the scale of an impact may match the scale of the pressure (or source), or it may be on a much larger scale, e.g., the scale of Drakes Estero. However, adverse impacts that are judged to be minor are characterized as being "localized," while definitions in the DEIS are silent on the temporal and spatial scales of moderate and major impacts. To provide distinct levels of impact, the definitions of impact intensities need to distinguish between impacts on the same scale as the pressure (e.g., direct impacts such as eelgrass scarring caused by propellers) and impacts on the larger scale of the Drakes Estero ecosystem (e.g., indirect impacts such as the dispersal of propagules). The definitions do not provide distinct criteria for assessing the temporal and spatial scale of the impact, and hence limit the effectiveness with which the DEIS conveys the impacts of DBOC operations on the Drakes Estero ecosystem and its natural resources.

Table 5.2. Summary of impact intensities from the DEIS and the committee's assessment of the analyses and conclusions reached in the DEIS for each resource category. Level of uncertainty for each resource category, as estimated by the committee, is indicated by a white dot (low uncertainty), gray dot (moderate uncertainty) or black dot (high uncertainty). For additional details see Chapter 3.

PREPUBLICATION

Resource Category[1]		DEIS Impact Levels: Beneficial	DEIS Impact Levels: Adverse Level: Minor	DEIS Impact Levels: Adverse Level: Moderate	DEIS Impact Levels: Adverse Level: Major	Committee's Comments on DEIS Analysis & Conclusions: Comments	Uncertainty (Low ○ / Mod. ◍ / High ●)	Possible Alternate Conclusion
Wetlands		A		B,C,D		• Lacks assessment of tidal freshwater wetlands • Benthic disturbance from bag & rack cultures not well differentiated	Mod.	Impacts could be minor or moderate adverse depending on level of sediment disturbance
Eelgrass		A		B,C,D		• Data not available on turbidity for evaluating impacts of DBOC operations (sediment resuspension & oyster filtration) • Analysis of aerial photographs could be used more extensively to assess changes in extent & fragmentation	Mod.	Impact may be minor at the population level given the local scale of the DBOC footprint
Wildlife	Benthic fauna	A		B,C,D		• Impacts may differ between analyses of non-indigenous species and analyses of DBOC impacts on native species • Too little differentiation among the individual/population/community impact definitions	Mod.	Impacts may be minor given rapid recovery of benthic fauna & local scale of the DBOC footprint
Wildlife	Fish	A	B,C,D			• Possibility of indirect effects on prey resources (i.e. benthic infauna)	Mod.	Impact may be negligible given the small overall footprint of the mariculture activities
Wildlife	Harbor Seals	A		B,C,D		• Insufficient consideration of cumulative impacts under alternative A • Impact definitions not linked to biologically significant criteria	High	Seals may tolerate or habituate to DBOC activities resulting in minor impacts
Wildlife	Birds	A		B,C,D		• Additional data available from species list & survey data that could indicate population trends	Mod.	Impact may be minor given high abundance & species richness
Special Status	Butterfly	A	B,C,D			• Description of species preferred habitat would inform the impact assessment	Low	
Special Status	Frog	A	B,C,D			• Map of potential breeding grounds needed to assess impact of DBOC onshore operations	Low	
Special Status	Plover	A	B,C,D			• Need more detailed description of breeding & overwintering grounds	Mod.	
Special Status	Tern	A	B,C,D			• Time-series of abundance from Christmas birds counts & other publically available surveys could be included	Low	
Special Status	Coho	A	B,C,D			• Include critical juvenile habitat (freshwater tidal wetlands) in the project area	Mod.	
Special Status	Steelhead	A	B,C,D			• Could consider prey resource habitats in the impact assessment	Mod.	
Coastal Flood Zone		A		B,C,D		• Lacks quantitative assessment of floodplain displacement volume under different alternatives • Effects of sea level rise were not included in assessment	High	Given the small upland footprint of the DBOC operation, impacts may be minor
Water Quality		A	B,C,D			• Lacks data on water quality parameters needed to assess the impacts of DBOC operations • Underestimates the potential of biological processes within DE on water quality	High	Impacts of alternatives B, C, and D may be negligible or beneficial if shellfish filtration provides a beneficial ecosystem service
Soundscape		A			B,C,D	• No data available on underwater soundscape • Additional data available (not used) to assess temporal & spatial variability • Sound levels presented in dBA makes it more difficult to assess impacts on wildlife • Lack of direct measurements of sound levels related to DBOC operations in DE	High	Based on the data presented in the DEIS, impacts could be moderate to minor
Socio-economics		B,C,D	A			Lacks assessment of change: • in producer's plus consumer's surplus for commercial shellfish[2] • in consumer's surplus for recreation • in non-use value	High	

[1] Since Drakes Estero does not contain the habitat required for leatherback turtles, this resource category is not included here.

[2] Surplus refers to the net value of the commodity or service. For a producer, this value would be equivalent to profit (sales minus expenses). For a consumer, this represents the difference between the value of the item (e.g. what the consumer would be willing to pay) and the cost of the item.

PREPUBLICATION

In addition, the committee found that the relationship of impact intensities across resource categories was not well articulated. For example, impacts on eelgrass habitat across alternatives B, C, and D were classified as “moderate”, while impacts on the fish species utilizing eelgrass habitat were determined to be “minor.” Similarly, soundscape impacts were identified as “major” for alternatives B, C, and D, while impacts on birds and harbor seals that would be affected by that soundscape were defined as “moderate.”

The committee’s concerns with definitions that are specific to each resource category (Table 5.2) can be summarized as follows:

- Special status species: Impacts may be minor, moderate or major even if only one individual in a population is affected. Also, an impact is considered to be moderately adverse if some changes are detected, but major if changes are noticeable. Because the difference between “detectable” and “noticeable” is unclear, the distinction between moderate and major is unclear.
- Coastal flood zones: No distinction is made between flood zones and the flood plain. The distinction between “moderate” and “major” seems to be that a moderate impact is confined to the project site while a major impact includes the project site and beyond. Is “project site” synonymous with “project area”? For “minor, is there an increase in flood risk at the project site? What is meant by “other areas”?
- Water quality: Impacts classified as minor may not be detectable, which would correspond to a negligible impact from the committee’s perspective. While a minor impact is defined as a local occurrence, the corresponding moderate and major impacts are not well defined in terms of scale. Moderate and major impacts appear to be on an ecosystem scale, but this is not clear. Additionally, the definitions for “moderate” and “major” impacts are identical in the DEIS. Quantitative indicators of water quality are not specified as they are for many estuaries in the U.S. This raises several questions: What is meant by “detectable”? What attributes of “chemical, physical or biological integrity” need to be changed and by how much? Assuming historical baselines are not available, what are the desired water quality conditions as quantified by accepted indicators of water quality (turbidity, chlorophyll-a concentration, nutrient concentration, etc.)?
- Soundscapes: Adverse levels of impact are based on distance between people communicating (minor by >32 ft, moderate by 16-32 ft, and major by <16 ft) and the proportion of time the soundscape is interfered with (5%, 5-10%, and >10%). The basis for these thresholds are not specified and do not appear to be based on scientifically established criteria. The adverse impact categories presented by the NPS, while useful in the sense of providing clear, readily measureable criteria; do not address the impacts of anthropogenic sounds on wildlife. Criteria that evaluate the responses of wildlife, as well as humans, to various sound sources would provide a more comprehensive assessment of this potential environmental impact. However, because sensitivities to sound vary among species, simple numerical measurements of sound levels would not be sufficient for assessing impact.

Suggestions for DEIS Revisions and Reducing Uncertainty in the Conclusions

The following comments are based on the committee’s review of the scientific foundation of the DEIS and should not be interpreted as a conclusion that the DEIS does not meet NEPA requirements. As discussed in Chapter 2, determination of the sufficiency of the DEIS to meet NEPA requirements was not part of the committee’s statement of task.

Recognizing that the final EIS will be issued based on currently available information, the committee provides the following suggestions for consideration in revising the DEIS:

PREPUBLICATION

- Re-define levels of impact intensity using criteria that clearly distinguish levels of impact (negligible, minor, moderate and major) that are comparable across levels (e.g., direct and indirect impacts; impacts at individual, population and community levels of organization).
- Qualify each impact intensity conclusion in terms of levels of uncertainty such as those used by the committee.
- Clearly identify and explain all assumptions made in reaching conclusions concerning impact intensities.
- Describe potential alternate conclusions as appropriate (e.g., Table 5-2).
- Segregate impact assessments for alternative A from alternatives B, C, and D and indicate that the assessments are not comparable due to use of different baselines.
- Use all relevant and available information, especially for water quality and soundscapes, such as additional measurements reported in Volpe (2011); analyze sound levels based on both dBA and unweighted values across a wide frequency range; and consider duty cycles when estimating the fraction of time DBOC activities impact the soundscape.
- Additional mitigation options could be included as possible permit conditions for the action alternatives to reduce impacts, e.g., an option to cease the culture of Manila clams would address some concerns about the establishment of that non-indigenous species in Drakes Estero; impacts of many DBOC practices (i.e., boat use, culture species and techniques, marine debris, soundscape effects) could potentially be reduced by the implementation of appropriate mitigation measures.
- Assess impacts associated with the potential establishment of non-indigenous species as a separate category.
- Provide greater consideration of the potential influence of climate change on DBOC operations and their associated impacts, e.g., rising sea level over the next 10 years could influence the spatial extent of inundation, potentially impacting resource categories such as vegetated tidal wetlands and the coastal flood zone (NRC, 2012); geographic ranges of warm water marine species are already extending poleward (e.g., Sorte et al., 2010; Doney et al., 2012), a trend that could exacerbate problems associated with invasive non-indigenous species, including increasing the potential for establishment of reproductive populations of the nonnative Pacific oyster in Drakes Estero.

The committee found that many of the impact assessments for the resource categories were limited by a lack of scientific information, resulting in moderate to high uncertainty in the conclusions. Although the feasibility of gathering new data within the given time constraints may be limited, the committee identified the following approaches for reducing scientific uncertainty in the DEIS:

- To the extent feasible, monitor how frequently boats are used for both bag and rack culture relative to stage of tide, motor boat routes relative to the distribution of seagrass beds and harbor seal protected areas, and more details on how the balance between bag culture and rack culture has changed from year to year and may change in the future (acreage used, location and production).
- Document the air and underwater soundscape, including evaluation of both natural and anthropogenic noise sources.
- Apply scientific methods to the assessment of socioeconomic impacts. Consider the use of qualitative modeling techniques to integrate across environmental, fishery, and socio-economic information.
- Assess the abundance and distribution of native and nonindigenous benthic invertebrates (infauna, epifauna, sessile and mobile species on hard, soft, and biological surfaces).
- Develop more accurate estimates of the seasonal flushing rate in the culture areas and use those for developing simple models of the contribution of cultured shellfish to water quality and food resource competition.
- Conduct a rigorous and comprehensive analysis of aerial photographs to resolve uncertainty in issues such as eelgrass extent and change, bag and rack culture area, and propeller scarring and other disturbance effects on eelgrass.

- Measure temporal (day/night) and spatial variability (distance from sources) within Drakes Estero using unweighted measures of ambient and source sound levels.

In Drakes Estero, as in many highly valued coastal areas, sustained monitoring of key variables (e.g., water quality parameters such as current velocities, temperature, salinity, dissolved nutrients, phytoplankton biomass, suspended organic matter, attenuation of downwelling radiation, and turbidity; abundance and distributions of benthic fauna, fish, birds, harbor seals, and nonindigenous species; extent and condition of eelgrass beds and tidal marshes) would reduce the uncertainty of impact assessments. These types of monitoring programs have been established through programs such as the National Estuarine Research Reserve System and the Integrated Ocean Observing System. Monitoring data on some of these key variables would inform adaptive, ecosystem-based management of the impacts of human uses on soundscapes, water quality, benthic habitats, biodiversity, and living resources in Drakes Estero.

PREPUBLICATION

REFERENCES

Allen, L.G., A.M. Findlay, and C.M. Phalen. 2002. Structure and standing stock of the fish assemblages of San Diego Bay, California from 1994 to 1999. *Bulletin of the Southern California Academy of Sciences* 102(2).

Allen, L.G., M.M. Yoklavich, G.M. Cailliet, and M.H. Horn. 2006. Bays and Estuaries in *Ecology of Marine Fishes: California and Adjacent Waters*. Allen, L.G., D.J. Pondella, and M.H. Horn (eds.), University of California Press, Berkeley, CA.

Atkins Peer Review. 2012. Final Report on Peer Review of the Science Used in the National Park Service's Draft Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit. Atkins Project No.: 100025958. March 2012. 96 pp.

Beck, M.W., K.L. Heck Jr., K.W. Able, D.L. Childers, D.B. Eggleston, B.M. Gillanders, B. Halpern, C.G. Hays, K.Hoshino, T.J. Minello, R.J. Orth, P.F. Sheridan, and M.P. Weinstein. 2001. The identification, conservation and management of estuarine and marine nurseries for fish and invertebrates. *Bioscience* 51(8):633-641.

Becker, B.H., D.T. Press, and S.G. Allen. 2009. Modeling the effects of El Niño, density dependence, and disturbance on harbor seal (*Phoca Vitulina*) counts in Drakes Estero, California: 1997–2007. *Marine Mammal Science* 25(1):1-18.

Becker, B.H., D.T. Press, and S.G. Allen. 2011. Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades. *Aquatic Conservation: Marine and Freshwater Ecosystems* 21: 247-260.

Bejder, L., A. Samuels, H. Whitehead, H. Finn, and S. Allen. 2009. Impact assessment research: Use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series* 395:177-185.

Benfield, J.A., P.A. Bell, L.J. Troup, and N.C. Soderstorm. 2010. Aesthetic and affective effects of vocal and traffic noise on natural landscape assessment. *Journal of Environmental Psychology* 30:103-111.

Boese, B.L., J.E. Kaldy, P.J. Clinton, P.M. Eldridge, and C.L. Folger. 2009. Recolonization of intertidal *Zostera marina* L. (eelgrass) following experimental shoot removal. *Journal of Experimental Marine Biology and Ecology* 374(1):69-77.

Bond, M.H. 2006. *Importance of estuarine rearing to central California steelhead (Oncorhynchus mykiss) growth and marine survival*. M.S. thesis, University of California-Santa Cruz, Santa Cruz, CA. 59 pp.

Booth, D.M. and K.L. Heck Jr. 2009. Effects of the American oyster *Crassostrea virginica* on growth rates of the seagrass *Halodule wrightii*. *Marine Ecology Progress Series* 389:117-126.

Boström, C., E.L. Jackson, and C.A. Simenstad. 2006. Seagrass landscapes and their effects on associated fauna: A review. *Estuarine and Coastal Shelf Science* 68:383-403.

Boström, C., S.J. Pittman, C. Simenstad, and R.T. Kneib. 2011. Seascape ecology of coastal biogenic habitats: Advances, gaps, and challenges. *Marine Ecology Progress Series* 427:191-217.

Bouchet, V.M.P. and P-G. Sauriau. 2008. Influence of oyster culture practices and environmental conditions on the ecological status of intertidal mudflats in the Pertuis Charentais (SW France): A multi-index approach. *Marine Pollution Bulletin* 56:1898-1912.

Bourne, N. 1982. Distribution, reproduction, and growth of Manila clam, *Tapes philippinarum* (Adams and Reeve), in British Columbia. *Journal of Shellfish Research* 2:47-54.

Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment *In the Nation's Estuaries: A Decade of Change*. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, Silver Spring, MD. 328 pp.

Buck, C., F. Wilkerson, A. Parker, and J. Largier. 2011. *The influence of coastal nutrients on phytoplankton blooms in a low-inflow estuary [abstract]*. 58th Eastern Pacific Ocean Conference.

Buck, C., F. Wilkerson, J. Largier, and A. Parker. 2012. *The influence of seasonal nutrient supply on phytoplankton blooms in a low inflow estuary [abstract]*. American Society of Limonology and Oceanography. Salt Lake City, Utah.

Bulleri, F. and M.G. Chapman. 2010. The introduction of coastal infrastructure as a driver of change in marine environments. Journal of Applied Ecology 47(1):26-35.

Cahoon, D.R., D.J. Reed, and J.W. Day, Jr. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. *Marine Geology* 128:1-9.

Carman, M.R., K.E. Hoagland, E. Green-Beach, and D.W. Grunden. 2009. Tunicate faunas of two North Atlantic-New England Islands: Martha's Vineyard, Massachusetts, and Block Island, Rhode Island. *Aquatic Invasions* 4(1):65-70.

Carman, M.R., J.A. Morris, R.C. Karney, and D.W. Grunden. 2010. An initial assessment of native and invasive tunicates in shellfish aquaculture of the North American east coast. *Journal of Applied Ichthyology, Special Issue: Alien Species in Aquaculture and Fisheries* 26(s2):8-11.

Carroll, J., C.J. Gobler, and B.J. Peterson. 2008. Resource-restricted growth of eelgrass in New York estuaries: Light limitation, and alleviation of nutrient stress by hard clams. *Marine Ecology Progress Series* 369:51-62.

Crawford, C. 2003. Environmental management of marine aquaculture in Tasmania, Australia. *Aquaculture* 226:129-138.

Cruz Sueiro, M., A. Bortolus, and E. Schwindt. 2011. Habitat complexity and community composition: Relationships between ecosystem engineers and the associated macroinvertebrate assemblages. *Helgoland Marine Research* 65:467-477.

Dang, C., X. de Montaudouin, M. Gam, C. Paroissin, N. Bru, and N. Caill-Milly. 2010. The Manila clam population in Arcachon Bay (SW France): Can it be kept sustainable? *Journal of Sea Research* 63:108-118.

Diederich, S. 2006. High survival and growth rates of introduced Pacific oysters may cause restrictions on habitat use by native mussels in the Wadden Sea. *Journal of Experimental Marine Biology and Ecology* 328:211-227.

Doney, S.C., M. Ruckelshaus, J.E. Duffy, J.P. Barry, F. Chan, C.A. English, H.M. Galindo, J.M. Grebmeier, A.B. Hollowed, N. Knowlton, J. Polovina, N.N. Rabalais, W.J. Sydeman, and L.D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science* 4:11-37.

Everett, R.A., Ruiz, G.M., and J.T. Carlton. 1995. Effect of oyster mariculture on submerged aquatic vegetation- an experimental test in a pacific-northwest estuary. *Marine Ecology Progress Series* 125(1-3):205-217.

Ferraro, S.P. and F.A. Cole. 2011. Ecological periodic tables for benthic macrofaunal usage of estuarine habitats in the US Pacific Northwest. *Estuarine, Coastal and Shelf Science* 94(1):36-47.

Fidell, S., S. Teffeteller, R. Horonjeff, and D.M. Green. 1979. Predicting annoyance from detectability of low-level sounds. *Journal of the Acoustical Society of America* 66:1427-1434.

Forrest, B.M. and R.G. Creese. 2006. Benthic impacts of intertidal oyster culture, with consideration of taxonomic sufficiency. *Environmental Monitoring and Assessment* 112:159-176.

Forrest, B.M., N.B. Keeley, G.A. Hopkins, S.C. Webb, and D.M. Clement. 2009. Bivalve aquaculture in estuaries: Review and synthesis of oyster cultivation effects. *Aquaculture* 298:1-15.

Fresh, K.L., W. Graeber, K.K. Bartz, J.R. Davies, M.D. Scheuerell, A.D. Haas, M.H. Ruckelshaus, and B.L. Sanderson. 2009. Incorporating spatial structure and diversity into recovery planning for anadromous pacific salmonids. *in* Knudsen, E.E. and J.H. Michael, Jr. (Eds.) *Pacific Salmon Environmental and Life History Models: Advancing Science for Sustainable Salmon in the Future*. American Fisheries Society, Bethesda, Maryland. Pp. 403-428.

Gerdes, D. 1983. The Pacific oyster *Crassostrea gigas*: Part II. Oxygen consumption of larvae and adults. *Aquaculture* 31(2-4):221-231.

Grigg, E., D. Green, S. G. Allen, and H. Markowitz. 2002. Nocturnal and diurnal haul-out patterns of harbor seals (*Phoca vitulina richardsi*) at Castro Rocks, San Francisco Bay, California. *California Fish and Game* 88:15-27.

Grigg, E.K., S.G. Allen, D.E. Green, and H. Markowitz. 2004. Harbor seal, *Phoca vitulina richardii*, population trends in the San Francisco Bay estuary, 1970-2002. *California Fish and Game* 90:51-70.

Grigg, E.K., S.G. Allen, D.E. Craven-Green, A.P. Klimley, H. Markowitz, and D.L. Elliott-Fisk. 2012. Foraging distribution of Pacific harbor seals (*Phoca vitulina richardii*) in a highly impacted estuary. *Journal of Mammalogy* 93(1):282-293.

Grosholz, E. 2011. *Estimating the Relative Abundances of Naturalized Manila Clams and Invasive Fouling Species in Drakes Estero*. Report to National Park Service, OP Fund #42498.

Hammerstrom, K.K., W.J. Kenworthy, P.E. Whitfield, and M.F. Merello. 2007. Response and recovery dynamics of seagrasses *Thalassia testudinum* and *Syringodium filiforme* and macroalgae in experimental motor vessel disturbances. *Marine Ecology Progress Series* 345:83-92.

PREPUBLICATION

Harbin-Ireland, A.C. 2004. *Effects of Oyster Mariculture on the Benthic Invertebrate Community in Drakes Estero. Pt. Reyes Peninsula, California*. MS thesis, University of California, Davis.

Harris, P.M., A.D. Neff, S.W. Johnson, and J.F. Thedinga. 2008. *Eelgrass habitat and faunal assemblages in the City and Borough of Juneau, Alaska*. NOAA Technical Memo. NMFSAFSC-182. U.S. Department of Commerce, 46 pp.

Hatch, L.T. and K.M. Fristrup. 2009. No barrier at the boundaries: Implementing regional frameworks for noise management in protected natural areas. *Marine Ecology Progress Series* 395:223-244.

Hoffman, D.J., B.A. Rattner, G.A. Burton, Jr., and J. Cairns, Jr. (Editors). 2003. *Handbook of Ecotoxicology*. 2nd edition. CRC Press, Boca Raton, FL. 1290 pp.

Hosack, G.R., B.R. Dumbauld, J.L. Ruesink, and D.A. Armstrong. 2006. Habitat associations of estuarine species: Comparisons of intertidal mudflat, seagrass (*Zostera marina*), and oyster (*Crassostrea gigas*) habitats. *Estuaries and Coasts* 29(6):1150-1160.

Humphreys, J., R.W.G. Caldow, S. McGrorty, A.D. West, and A.C. Jensen. 2007. Population dynamics of naturalised Manila clams *Ruditapes philippinarum* in British coastal waters. *Marine Biology* 151(6):2255-2270.

International Council for the Exploration of the Sea (ICES). 2005. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005. Appendix B. 30 pp. [Online]. Available at: http://www.ices.dk/pubs/Miscellaneous/Codeofpractice.asp.

Jackson, E.L., A.A. Rowden, M.J. Attrill, S.J. Bossey, and M.B. Jones. 2001. The importance of seagrass beds as a habitat for fishery species. *Oceanography and Marine Biology—An Annual Review* 39:269-303.

John A. Volpe National Transportation Systems Center (Volpe). 2011. *Baseline Ambient Sound Levels in Point Reyes National Seashore*. Final Report. March. Western-Pacific Region, Los Angeles, CA. 131 pp.

Jones and Stokes. 1992. *Expert testimony on Yuba River fisheries issues by Jones & Stokes Associates' aquatic and environmental specialists representing Yuba County Water Agency*. January 20, 1992. Prepared for the California State Water Resources Control Board Water Rights Hearing on Lower Yuba River, February 10, 11, and 13, 1992. Sacramento, CA.

Kaiser, M.J., K.R. Clarke, H. Hinz, M.C.V. Austen, P.J. Somerfield, and I. Karakassis. 2006. Global analysis of response and recovery of benthic biota to fishing. *Marine Ecology Progress Series* 311:1-14.

Kaval, P. and J. Loomis. 2003. *Updated Outdoor Recreation Use Values with Emphasis on National Park Recreation*. Report Prepared for Dr. Bruce Peacock, National Park Service, Fort Collins, CO under Cooperative Agreement CA 1200-99-009, Project number IMDE-02-0070. 48 pp.

Kelly, J.P. J.G. Evens, R.W. Stallcup, and D. Wimpfheimer. 1996. Effects of oyster culture on habitat use by wintering shorebirds in Tomales Bay, California. *California Fish and Game* 82(4):160-174.

Kenworthy W.J., M.S. Fonseca, P.E. Whitfield, and K.K. Hammerstrom. 2002. Analysis of seagrass recovery in experimental excavations and propeller-scar disturbances in the Florida Keys National Marine Sanctuary. *Journal of Coastal Research* 37:75-85.

PREPUBLICATION

King, N. 2004. *Compilation of information on coho salmon and steelhead trout collected between 1994-2003 in the Tomales Bay watershed with recommendations for future actions, and a list of partners and selection criteria for future salmonid restoration projects*. Tomales Bay Watershed Council, Point Reyes Station, CA. 47 pp.

Koch, E.W. 2002. Impact of Boat-Generated Waves on a Seagrass Habitat. *Journal of Coastal Research* (Special Issue) 37:66-74.

Koch, E.W. and S. Beer. 1996. Tides, light and the distribution of *Zostera marina* in Long Island Sound, USA. *Aquatic Botany* 53:97-107.

Koski, K.V. 2009. The fate of coho salmon nomads: The story of an estuarine-rearing strategy promoting resilience. *Ecology and Society* 14(1):4. [Online]. Available at: http://www.ecologyandsociety.org/vol14/iss1/art4/.

Lejart, M. and C. Hily. 2011. Differential response of benthic macrofauna to the formation of novel oyster reefs (*Crassostrea gigas*, Thunberg) on soft and rocky substrate in the intertidal of the Bay of Brest, France. *Journal of Sea Research* 65:84-93.

Lockwood, J.L., P. Cassey, T. Blackburn. 2005. The role of propagule pressure in explaining species invasions. *Trends In Ecology and Evolution* 20(5):223-228.

Macreadie, P.I., J.S. Hindell, G.P. Jenkins, R.M. Connolly, and M.J. Keough. 2009. Fish responses to experimental fragmentation of seagrass habitat. *Conservation Biology* 23:644-652.

Marine Mammal Commission (MMC). 2011. Mariculture and harbor seals in Drakes Estero, California. 22 November 2011. 70 pp.

Martin, J.A. 1995. *Food habits of some estuarine fishes in a small, seasonal central California lagoon*. M.S. thesis, San Jose State University, San Jose, CA. 48 pp.

Miller, N.P. 2008. US national parks and management of park soundscapes: A review. *Applied Acoustics* 69:77-92.

Moore, K.A., R.L. Wetzel, and R.J. Orth. 1997. Seasonal pulses of turbidity and their relations to eelgrass (*Zostera marina* L.) survival in an estuary. *Journal of Experimental Marine Biology and Ecology* 215:115-134.

Moore, E.C. and K.A. Hovel. 2010. Relative influence of habitat complexity and proximity to patch edges on seagrass epifaunal communities. *Oikos* 119:1299-1311.

National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration. 2005. Designation of Critical Habitat for Seven Evolutionary Significant Units of Pacific Salmon and Steelhead in California. *Federal Register*. 70(179):52488-52627.

National Oceanic and Atmospheric Administration (NOAA). 2011. *NOAA's Estuarine Eutrophication Survey, Volume 5: Pacific Coast Region*. Silver Spring, MD: Office of Ocean Resources Conservation and Assessment. [Online]. Available at: http://ccma.nos.noaa.gov/stressors/pollution/eutrophication/eutrocards/drakes.pdf.

National Park Service (NPS). 2001. *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making*. NPS Office of Policy.

PREPUBLICATION

National Park Service. 2007. *Point Reyes National Seashore Drakes Estero: A Sheltered Wilderness Estuary*. Version III. Department of the Interior, Point Reyes National Seashore, California. May 8, 2007, 21p.

National Park Service, U.S. Department of the Interior (DEIS). 2011. Draft Environmental Impact Statement: Drakes Bay Oyster Company Special Use Permit. September 2011. 74 pp. [Online]. Available at: http://parkplanning.nps.gov/document.cfm?parkID=333&projectID=33043&documentID=43390.

National Research Council (NRC). 2003. *Marine Mammal Populations and Ocean Noise: Determining When Noise causes Biologically Significant Effects*. National Academies Press, Washington, DC.

National Research Council. 2004. *Nonnative Oysters in the Chesapeake Bay*. National Academies Press, Washington, DC.

National Research Council, 2007. *Analysis of Global Change Assessments: Lessons Learned.* National Academies Press, Washington, DC.

National Research Council. 2009. *Shellfish Mariculture in Drakes Estero, Point Reyes National Seashore, California*. National Academies Press, Washington, DC.

National Research Council. 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.* National Academies Press, Washington, DC.

Needham, P.R. 1939. Quantitative and qualitative observations on fish foods in Waddell Creek Lagoon. *Transactions of the American Fisheries Society* 69:178-186.

Newell, R.I.E. and E.W. Koch. 2004. Modeling seagrass density and distribution in response to changes in turbidity stemming from bivalve filtration and seagrass sediment stabilization. *Estuaries* 27: 793-806.

Nightengale, B. and C.A. Simenstad. 2001. *Overwater structures—marine issues*. White Paper Research Project T1803, Task 35. Washington State Transportation Center (TRAC), University of Washington, Seattle, WA. 133 pp + append.

Noise Unlimited, Inc.1995. *Boat Noise Tests Using Static and Full-Throttle Measurement Methods for the New Jersey State Police*.

Numaguchi, K. 1998. Preliminary experiments on the influence of water temperature, salinity and air exposure on the mortality of Manila clam larvae. *Aquaculture International* 81:77-81.

Ono, K., C.A. Simenstad, J.D. Toft, S.L. Southard, K.L. Sobocinski, and A. Borde. 2010. *Assessing and mitigating dock shading impacts on the behavior of juvenile Pacific salmon (Oncorhynchus spp.): Can artificial light mitigate the effects?* Res. Report WA-RD 755.1, Washington State Department of Transportation, Olympia, WA. 74 pp + append.

Onuf, C.P. and M.L. Quammen. 1983. Fishes in a California coastal lagoon: Effects of major storms on distribution and abundance. *Marine Ecology Progress Series* 12:1-14.

Pacific Fishery Management Council (PFMC). 2003. *Pacific Coast Salmon Plan: Fisheries Management for Commercial and Recreational Salmon Fisheries off the Coast of Washington, Oregon, and California, as Revised through Amendment 14*. September.

PREPUBLICATION

Parker, I.M., D. Simberloff, W.M. Lonsdale, K. Goodell, M. Wonham, P.M. Kareiva, M.H. Williamson, B. Von Holle, P.B. Moyle, J.E. Byers, and L. Goldwasser. 1999. Impact: Toward a Framework for Understanding the Ecological Effects of Invaders. *Biological Invasions* 1(1):3-19.

Peterson, B.J. and K.L. Heck Jr. 1999. The potential for suspension feeding bivalves to increase seagrass productivity. *Journal of Experimental Marine Biology and Ecology* 240(1):37-52.

Peterson, B.J. and K.L. Heck Jr. 2001a. Positive interactions between suspension-feeding bivalves and seagrass—a facultative mutualism. *Marine Ecology Progress Series* 213: 143-155.

Peterson, B.J. and K.L. Heck Jr. 2001b. An experimental test of the mechanism by which suspension feeding bivalves elevate seagrass productivity. *Marine Ecology Progress Series* 218:115-125.

Pijanowski, B.C., L.J. Villanueva-Rivera, S.L. Dumyahn, A. Farina, B.L. Krause, B.M. Napoletano, S.H. Gage, and N. Pieretti. 2011. Soundscape Ecology: The Science of Sound in the Landscape. *BioScience* 61(3):203-216.

Pilditch, C.A., J. Grant, and K.R. Bryan. 2001. Seston supply to sea scallops (*Placopecten magellanicus*) in suspended culture. *Canadian Journal of Fisheries and Aquatic Sciences* 58:241-253.

Powell, A.N. and C.L. Collier. 2000. Habitat use and reproductive success of western snowy plovers at new nesting areas created for California least terns. *Journal of Wildlife Management* 64:24-33.

Powell, E.N., E.E. Hoffman, J.M. Klinck, and S.M. Ray. 1992. Modeling oyster populations I. A commentary on filtration rate. Is faster always better? *Journal of Shellfish Research* 11:387-398.

Raimbault, M. and D. Dubois. 2005. Urban soundscapes: Experiences and knowledge. *Cities* 22(5):339-350.

Robart, M., and J.L. Largier. 2008. *Tidal flushing of a low-inflow estuary during summer: Salt balance and chlorophyll in Drake's Estero, California [abstract].* Bodega Marine Laboratory, University of California Davis.

Roni, P., T. Bennett, R. Holland, G. Pess, K. Hanson, R. Moses, M. McHenry, W. Ehinger, and J. Walter. 2012. Factors affecting migration timing, growth, and survival of juvenile coho salmon in two coastal Washington watersheds. *Transactions of the American Fisheries Society* 141(4):890-906.

Ruesink, J.L., J.P. Fitzpatrick, B.R. Dumbauld, S.D. Hacker, A.C. Trimble, E.L. Wagner, and L.M. Wisehart. 2012. Life history and morphological shifts in an intertidal seagrass following multiple disturbances. *Journal of Experimental Marine Biology and Ecology* 424-425:25-31.

Rumrill, S.S. and V.K. Poulton. 2004. *Ecological role and potential impacts of molluscan shellfish culture in the estuarine environment of Humboldt Bay, CA*. Annual Report. Western Regional Aquaculture Center. November 2004. 44 pp. [Online]. Available at: www.humboldtbay.org/harbordistrict/documents/other/Shellfish%20Culture%20Impact.pdf.

Salamunovich, T.J. 1987. *Fish food habits and their interrelationships in lower Redwood Creek, Humboldt County, California*. M.S. thesis, Humboldt State University, Arcata, CA.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*) in *Pacific Salmon Life Histories*. Groot, C. and L. Margolis (eds.). UBC Press, Vancouver, BC. Canada. Pp. 231-309.

PREPUBLICATION

Satterthwaite, W.H., S.A. Hayes, J.E. Merz, S.M. Sogard, D.M. Frechette, and M. Mangel. 2012. State-dependent migration timing and use of multiple habitat types in anadromous salmonids. *Transactions of the American Fisheries Society* 141(3):781-794.

Schafer, R.M. 1969. *The New Soundscape*. Vienna: Universal Edition.

Schaffelke, B., J. Mellors, and N.C. Duke. 2005. Water quality in the Great Barrier Reef region: Responses of mangrove, seagrass and macroalgal communities. *Marine Pollution Bulletin* 51:279-296.

Schoener, A. and D.F. Tufts. 1987. Changes in oyster condition index with El Nino-southern oscillation events at 46°N in an eastern pacific bay. *Journal of Geophysical Research* 92(C13):14429-14435.

Schomer, P.D., G.F. Stanley, and W. Chang. 2009. Visitor perception of park soundscapes: A research plan. *Noise/News International* 17(2):51-56.

Schuetz, J. 2011. Reproductive declines in an endangered seabird: Cause for concern or signs of conservation success? *Public Library of Science ONE* 6(5):e19489.

Semmens, B.X. 2008. Acoustically derived fine-scale behaviors of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) associated with intertidal benthic habitats in an estuary. *Canadian Journal of Fisheries and Aquatic Sciences* 65(9):2053-2062.

Sorte, C.J.B., S.L. Williams, and J.T. Carlton. 2010. Marine range shifts and species introductions: Comparative spread rates and community impacts. *Global Ecology and Biogeography* 19(3):303-316.

Suryan, R., and J. Harvey. 1999. Variability in reactions of Pacific harbor seals, *Phoca vitulina richardsi*, to disturbance. *Fishery Bulletin* 97:332-339.

The Watershed Company. 2000. *A Summary of the Effects of Bulkheads, Piers, and Other Artificial Surfaces and Shoreline Development on ESA-listed Salmonids in Lakes*. Final Report. July 13.

Theoharides, K.A. and J.S. Dukes. 2007. Plant invasion across space and time: Factors affecting nonindigenous species success during four stages of invasion. *New Phytologist* 176:256-273.

Thomsen, M.S., T. Wernberg, A.H. Altieri, F. Tuya, D. Gulbransen, K.J. McGlathery, M. Holmer, and B.R. Silliman. 2010. Habitat cascades: The conceptual context and global relevance of facilitation cascades via habitat formation and modification. *Integrative and Comparative Biology* 50:158-175.

Villanueva-Rivera, L.J., B.C. Pijanowski, J. Doucette, B. Pekin. 2011. A primer of acoustic analysis for landscape ecologists. *Landscape Ecology* 26:1233-1246.

Villnas, A., J. Perus, and E. Bonsdorff. 2011. Structural and functional shifts in zoobenthos induced by organic enrichment - Implications for community recovery potential. *Journal of Sea Research* 65(1):8-18.

Vinther, H.F., J.S. Laursen, and M. Holmer. 2008. Negative effects of blue mussel (*Mytilus edulis*) presence in eelgrass (*Zostera marina*) beds in Flensborg fjord, Denmark. *Estuarine, Coastal and Shelf Science* 77(1):91-103.

Warren, P.S., M. Katti, M. Ermann, and A. Brazel. 2006. Urban bioacoustics: It's not just noise. *Animal Behaviour* 71:491-502.

Wechsler, J.F. 2005. Assessing the Relationship between the Ichthyofauna and Oyster Mariculture in a Shallow Coastal Embayment, Drakes Estero, Point Reyes National Seashore. MA Thesis, University of California, Davis, 42 pp.

White, J.D. 1999. *Bird Inventory of Three National Parks of the San Francisco Bay Area: Wintering Waterbirds and Shorebirds*. Point Reyes Bird Observatory, Stinson Beach, California. March.

Williamson, M.A. and A. Fitter. 1996. The varying success of invaders. *Ecology* 77:1661-1666.

Wisehart, L.M., J.L. Ruesink, S.D. Hacker, and B.R. Dumbauld. 2007. Importance of eelgrass early life history stages in response to oyster aquaculture disturbance. *Marine Ecology Progress Series* 344:71-80.

Wonham, M. and J. Carlton. 2005. Trends in marine biological invasions at local and regional scales: The Northeast Pacific Ocean as a model system. *Biological Invasions* 7:369-392.

Zieman, J. 1976. The ecological effects of physical damage from motor boats on turtle grass beds in southern Florida. *Aquatic Biology* 2:127-139.

PREPUBLICATION

APPENDIX A

Statement of Task

An ad hoc committee will assess the scientific information, analysis, and conclusions presented in the Draft Environmental Impact Statement (DEIS) for Drakes Bay Oyster Company Special Use Permit and evaluate whether the peer review of the DEIS conducted by Atkins, North America for the U.S. Department of the Interior, is fundamentally sound and materially sufficient. The committee will not perform an independent evaluation of the environmental impacts of the proposed alternatives, but will restrict its findings to the strength of the scientific arguments in the DEIS and identify concerns, if any, not covered in the Atkins peer review.

The DEIS identifies and evaluates twelve (12) issues for their potential to be affected by continued commercial mariculture activities. Of these, the committee's evaluation will be limited to the eight (8) science issues: wetlands, eelgrass, wildlife and wildlife habitat, special-status species, coastal flood zones, soundscapes, water quality, and socioeconomic resources. Because the impact assessments for the other four (4) issues covered in the DEIS (wilderness, visitor experience and recreation, and the National Park Service [NPS] operations) are not based primarily on scientific research and analysis, the current study will not cover these topics nor will it review any policy or legal information.

PREPUBLICATION

APPENDIX B

Committee Biographies

Thomas C. Malone, *(Chair),* received a Ph.D. (biology) from Stanford University, a M.S. (oceanography) from the University of Hawaii, and a B.A. (zoology) from Colorado College. He has held faculty appointments at The City College of New York, Lamont-Doherty Geological Observatory of Columbia University, and the Oceanographic Division of Brookhaven National Laboratory. Dr. Malone has published over 100 peer-reviewed papers on phytoplankton ecology, coastal eutrophication, science and ocean policy, and integrated ocean observing systems. Currently, he is a Professor Emeritus at the University of Maryland Center for Environmental Science (UMCES). During his tenure at UMCES, Dr. Malone served as Interim President of UMCES (1988-1990); Director of the Horn Point Laboratory of UMCES (1990-2001); Director, EPA Multiscale Experimental Ecosystem Research Center (1992-1996); President of the American Society of Limnology and Oceanography (1998-2000); Chair, IOC-WMO-UNEP-ICSU Coastal Global Ocean Observing System Panel (1998-2000); Chair, Heinz Center Technical Committee on Indicators of Coastal and Ocean Ecosystem Condition (2000-2004); Co-Chair, IOC-WMO-UNEP-ICSU Coastal Ocean Observations Panel (2002-2005); Director of the Ocean.US Office for Sustained and Integrated Ocean Observations (2003-2006); Council Member, Sir Alister Hardy Foundation for Ocean Science (2005-2010). In addition, he has served on four NRC committees, including as chair of the committee on the Assessment of Regional Marine Research Programs. He has also served on the Steering committees for many workshops over the last 20 years, most recently for a FLAD-NOAA-IOC Conference on *A Unified Approach for Sustainability in a Changing World: From Ocean Policy to Observations* sponsored by NOAA, the Luso-American Foundation, and the Intergovernmental Oceanographic Commission. Dr. Malone received the University of Maryland Reagent's Award for outstanding public service in 2002 and The Colorado College Louis T. Benezet Award for "outstanding achievement in one's chosen field, excellence through unusual success or contribution, and research that has advanced a profession and improved people's lives" in 2003.

Joao Ferreira is a tenured Associate Professor with the Department of Environmental Science and Engineering, Faculty of Sciences and Technology at the New University of Lisbon. His areas of expertise include water quality and ecological modeling solutions (both turnkey and cooperative development), Environmental Impact Assessment (EIA) work, database development in coastal management projects, management for transitional and coastal waters, and water related web projects, dynamic linkage to databases, and software solutions. Dr. Ferreira received his B.Sc. with honors in Biology (with Oceanography) from Southampton University, United Kingdom, and his Ph.D. in Environmental Sciences from the New University of Lisbon.

W. Michael Hanemann joined the ASU Department of Economics and the Center for Environmental Economics and Sustainability Policy in 2011 where is a Wrigley Chair in Sustainability. He came to ASU from the University of California, Berkeley, where he was a Chancellor's Professor in the Department of Agricultural and Resources Economics and the Goldman School of Public Policy. His research interests include non-market valuation, the economics of water and of climate change, environmental policy, adaptive management, and demand modeling for market research. Dr. Hanemann has served on many NRC committees and was elected to the National Academy of Sciences in 2011. He is currently a lead author and a contributing lead author for Working Group III of the IPCC Fifth Assessment Report on Climate Change. Dr. Hanemann received his B.A. degree from Oxford University in philosophy, politics, and economics, his M.S. from the London School of Economics in development economics, and his M.A. and Ph.D. from Harvard University in Public Finance and Decision Theory and Economics. He received an honorary Ph.D. from the Swedish University of Agricultural Sciences and the Lifetime Award for Outstanding Achievement from the European Association of Environmental & Resource Economists. He is an inaugural Fellow of the Association of Environmental and Resource Economists and a Fellow of the American Association of Agricultural Economics.

PREPUBLICATION

Evamaria Koch is an Associate Professor at Horn Point Laboratory at the University of Maryland's Center for Environmental Science. Her areas of expertise include seagrass ecology, hydrodynamically-mediated processes in seagrass beds and coastal plant communities in a globally-changing world. Projects she is currently working on include the impact of coastal structures on submersed aquatic vegetation, and habitat requirements needed to improve seagrass restoration, especially the sediment they colonize. She is also working on conditions necessary for the successful recruitment and establishment of seagrass seeds. She is a member of the Estuarine Research Federation, the American Society of Limnology and Oceanography, the American Geological Union, and Sigma Xi Scientific Research Society. She previously worked on the NRC Committee on Mitigating Shore Erosion Along Sheltered Coasts. Dr. Koch received her Ph.D. in Marine Science from the University of South Florida.

Jennifer Miksis-Olds is a Senior Research Associate in the Applied Research Laboratory at Penn State University. She is also an Assistant Professor in the Graduate Program in Acoustics, College of Engineering and in Wildlife and Fisheries Sciences in the College of Agriculture. Her research employs acoustic methodologies to answer biological questions in both the marine and terrestrial environments. Her primary interests include animal behavior and communication, the effect of anthropogenic activities on animals and their environment, and the development of technology to observe animals in their natural environment. Aspects of acoustics, biology, oceanography, ecology, and engineering are combined to create the interdisciplinary approach necessary to extend the study of animals in their natural environment beyond where it is today. Dr. Miksis-Olds received her A.B. cum laude in Biology from Harvard University, her M.S. in Biology from the University of Massachusetts Dartmouth, she was a guest student at Woods Hole Oceanographic Institution, and then received her Ph.D. in Biological Oceanography from the University of Rhode Island.

Bryan Pijanowski is a Professor in the Department of Forestry and Natural Resources at Purdue University. He is interested in the impacts of land use and climate change on ecosystem services. He is leading an effort to study the soundscape in diverse ecosystems and how natural and man-made sounds interact. Dr. Pijanowski has numerous publications and is a member of the Global Land Project, the American Association for the Advancement of Science, the American Association of Geographers, the American Geophysical Union, and the International Association of Landscape Ecology. He received his B.S. in Biology from Hope College and his Ph.D. in Zoology from Michigan State University. Presently, he has been working on the development and application of spatial models for use in natural resource management, and is interested in land use/cover change and climate change and how these impact societies.

Jennifer Ruesink is an Associate Professor in the Department of Biology at the University of Washington. Her areas of interest include marine community ecology, especially food web interactions; species invasions; and conservation. In particular, she looks at the interactions between oysters and non-native oyster drills as well as the impact of aquaculture on the natural habitat, including eelgrass. She is currently a member of the Ecological Society of America, the National Shellfisheries Association, the Coastal and Estuarine Research Federation, and the Western Society of Naturalists. She has served on two previous NRC committees. Dr. Ruesink received her B.A. in Biology, Summa Cum Laude (Cornell University); her M.Phil. in Botany (Cambridge University, England); and her Ph.D. in Zoology (University of Washington).

Charles Simenstad is a Research Professor at the School of Aquatic and Fishery Sciences, University of Washington. He studies shallow-water community and food web structure, and restoration ecology, of estuarine and coastal marine ecosystems along the Pacific Northwest coast, from San Francisco Bay, the Oregon and Washington coasts, Puget Sound, and Alaska. Ecosystems that have especially attracted his interests include: coastal marshes, mudflats and eelgrass of Pacific Northwest estuaries; nearshore, kelp-dominated shores of the Aleutian Islands, Alaska; and San Francisco Bay-Delta. Since 1990, he has been particularly dedicated to coordinating the Wetland Ecosystem Team (WET), a small team of research scientists, educators, and graduate students that conducts both basic and applied research on these topics. Current research initiatives include: leading WET's CALFED research on tidal freshwater wetland restoration patterns and rates in the Sacramento-San Joaquin rivers delta (BREACH studies); evaluating the importance of estuarine life history diversity of juvenile Pacific salmon in population resilience and recovery, and the potential role of estuarine habitat restoration in increasing life history diversity; restoration of natural ecosystem processes as a sustainable approach to recovery of endangered salmon; and the practical application of landscape ecology concepts and quantitative metrics to planning and implementing coastal ecosystem restoration. Much of Simenstad's concentration is presently focused on strategic planning restoration of nearshore ecosystems in Puget Sound under the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), under which he chairs the Nearshore Science Team (NST). Simenstad previously served on the NRC Committee on Mitigating Wetland Losses.

Lucinda Low Swartz, Esq., is a nationally known NEPA specialist providing extensive NEPA compliance services to federal agencies and private entities. She is a regular speaker on NEPA issues at environmental conferences and training seminars and is the co-author of The NEPA Reference Guide and Endangered Species: Legal Requirements and Policy Guidance. Ms. Swartz is also the former Deputy General Counsel of the Council on Environmental Quality, the office within the Executive Office of the President that oversees federal agency compliance with NEPA. With over 30 years of experience in environmental law and regulation in government and consulting, she has been operating her small, woman-owned business since May 2008. She received her J.D. from the Washington College of Law, The American University.

Paul Thompson is the chair in Zoology at the Institute of Biological and Environmental Sciences at the University of Aberdeen. He established the Lighthouse Field Station in 1990 after he completed his graduate and postdoctoral studies in Aberdeen. He became a Lecturer in 1994, and has held a Personal Chair in Zoology since 2005. His current research aims to assess how natural and anthropogenic environmental variations influence the behavior, physiology, and dynamics of marine mammal and seabird populations. These questions have been approached by conducting long-term and comparative studies of key populations such as dolphins, harbor seals, and seabirds. He became a Fellow of the Royal Society of Edinburgh in 2011, and is currently a member of the Marine Scotland Science Advisory Board. Professor Thompson previously served on the NRC study *Best Practices for Shellfish Mariculture and the Effects of Commercial Activities in Drake's Estero, Pt. Reyes National Seashore, California*. He received his Ph.D. in Zoology from the University of Aberdeen.

PREPUBLICATION

APPENDIX C

NPS Intensity Definitions

As stated in the DEIS: "Determining intensity definitions is a common method in applying Director's Order 12 (NPS, 2001)."

NPS defined the impacts as following:

"The following terms are used for all impact topics:
Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
Direct: An impact that is caused by an action and occurs at the same time and place.
Indirect: An impact that is caused by an action but is later in time or farther removed in distance, but still reasonably foreseeable."

The DEIS distinguishes between short-term and long-term impacts in the following way:
"**Short-term**: Impacts that last a relatively brief time following an action and/or are temporary in nature. Short-term impacts typically are less than 1 year in duration.
Long-term: Impacts that last a relatively long time following an action and/or may be permanent. Long-term impacts typically are longer than 1 year in duration."

The context distinctions the DEIS uses are as follows:
"**Local**: The impact would occur within the general vicinity of the project area.
Regional: The impact would affect localities, cities, or towns surrounding the Seashore."

Intensity Definitions

<u>Wetlands</u>
Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community.
Moderate: Impacts would be clearly detectable and could appreciably affect individuals or groups of species, communities, or natural processes.
Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or groups of species, communities, or natural processes.

<u>Eelgrass</u>
Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community. Impacts would not result in a measurable change to eelgrass ecosystem health on a local or regional scale.
Moderate: Impacts would be clearly detectable and could appreciably affect individual plants, eelgrass beds, or natural processes (such as eelgrass colonization and/or regeneration). Impacts would result in measurable changes to eelgrass ecosystem health. Measurable changes could include modifications in biomass or in the diversity of species that typically use eelgrass beds for foraging or nursery grounds.
Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or individual plants, eelgrass beds, or natural processes (such as eelgrass

PREPUBLICATION

colonization and/or regeneration). Impacts would result in substantial changes to eelgrass ecosystem health, which would be evident through.

Wildlife and Wildlife Habitat: Benthic Fauna

Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community.

Moderate: Impacts would be clearly detectable and could appreciably affect individuals or groups of species, communities, or natural processes.

Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or groups of species, communities, or natural processes.

Wildlife and Wildlife Habitat: Fish

Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community.

Moderate: Impacts would be clearly detectable and could appreciably affect individuals or groups of species, communities, or natural processes.

Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or groups of species, communities, or natural processes.

Wildlife and Wildlife Habitat: Harbor Seals

Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community.

Moderate: Impacts would be clearly detectable and could appreciably affect individuals or groups of species, communities, or natural processes.

Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or groups of species, communities, or natural processes.

Wildlife and Wildlife Habitat: Birds

Minor: Impacts would be localized and slightly detectable, but would not affect the overall structure of any natural community.

Moderate: Impacts would be clearly detectable and could appreciably affect individuals or groups of species, communities, or natural processes.

Major: Impacts would be highly noticeable and would substantially influence natural resources, e.g., individuals or groups of species, communities, or natural processes.

Special-Status Species

Minor: The action could result in a change to a population or individuals of a species or designated critical habitat.

Moderate: The action would result in some change to a population or individuals of a species or designated critical habitat.

Major: The action would result in a noticeable change to a population or individuals of a species or designated critical habitat.

Coastal Flood Zones

Minor: The action would take place within the floodplain or flood zone, but would not result in an increase in potential flood damage to other areas, or is exempt from NPS floodplain management guidelines.

Moderate: The action would take place within the floodplain or flood zone and would result in increased potential for flood damage to property or environmental contamination at the project site.

Major: The action would have a measurable impact on potential flood damage or environmental contamination to the site as well as adjacent and downstream properties.

PREPUBLICATION

Water Quality

Minor: Minor water quality impacts would include temporary, localized impacts that may or may not be detectable, would not have long-lasting effects on water quality, and would be within historical or desired water quality conditions.

Moderate: Moderate impacts are short-term and long-term detectable impacts that would change the chemical, physical, or biological integrity of water quality to the degree that the action would alter the historical baseline or desired water quality conditions of Drakes Estero.

Major: Major impacts are short-term and long-term detectable impacts that would change the chemical, physical, or biological integrity of waters of Drakes Estero to the degree that the action would alter the historical baseline or desired water quality conditions.

Soundscapes

Minor: Human-caused noise would be at a level that causes vocal communication to be difficult between people separated by more than 32 feet, and the natural soundscape is interfered with less than 5 percent of the time.

Moderate: Human-caused noise would be at a level that causes vocal communication to be difficult between people separated by 32 to 16 feet, and the natural soundscape is interfered with 5 to 10 percent of the time.

Major: Human-caused noise would be at a level that causes vocal communication to be difficult between people separated by less than 16 feet, and the natural soundscape is interfered with more than 10 percent of the time.

Socioeconomics

Minor: Impacts may be detectable but would not affect the overall regional economy or the statewide production of shellfish.

Moderate: Impacts would be clearly detectable but would not considerably affect the regional economy or the statewide production of shellfish.

Major: Impacts would be highly noticeable and would substantially influence the regional economy or the statewide production of shellfish.

PREPUBLICATION

APPENDIX D

Committee Meeting Agenda and Participant List

July 9-12, 2012
The National Academies' Beckman Center

Monday, July 9, 2012
CLOSED SESSION (8:30 a.m. – 5:30 p.m.)

Tuesday, July 10, 2012
CLOSED SESSION (8:30 a.m. – 1:00 p.m.)

OPEN SESSION (Room: Huntington)

1:00 p.m. **Welcome and Introduction** *Warren Muir, Exec. Director, Division on Earth and Life Studies, NAS/NRC*

1:15 p.m. **Discussion of the process and science used to prepare the following documents:**

- *Draft Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit* (NPS, 2011)
- *Final Report on Peer Review of the Science Used in the National Park Service's Draft Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit* (Atkins, 2011)
- *Comments on Drakes Bay Oyster Company Special Use Permit Environmental Impact Statement Point Reyes National Seashore* (Environ, 2011)
- *Mariculture and Harbor Seals in Drakes Estero, California* (MMC, 2011)

3:00 p.m. **Break**

3:30 p.m. **Public Comments and Discussion**

5:30 p.m. **Open Session Adjourns**

Wednesday, July 11, 2012
CLOSED SESSION (8:30 a.m. – 6:00 p.m.)

Thursday, July 12, 2012
CLOSED SESSION (8:30 a.m. – 4:00 p.m.)

PREPUBLICATION

Participant List

(Limited to those who participated in person)

Gordon Bennett, SOS

Julie Cart, LA Times

Jeffrey Creque, Alliance for Sustainable Agriculture

Melanie Gunn, National Park Service

Brannon Ketcham, National Park Service

Kevin Lunny, Drakes Bay Oyster Company

Cicely Muldoon, National Park Service

Dominique Richard

Amy Trainer, EAC