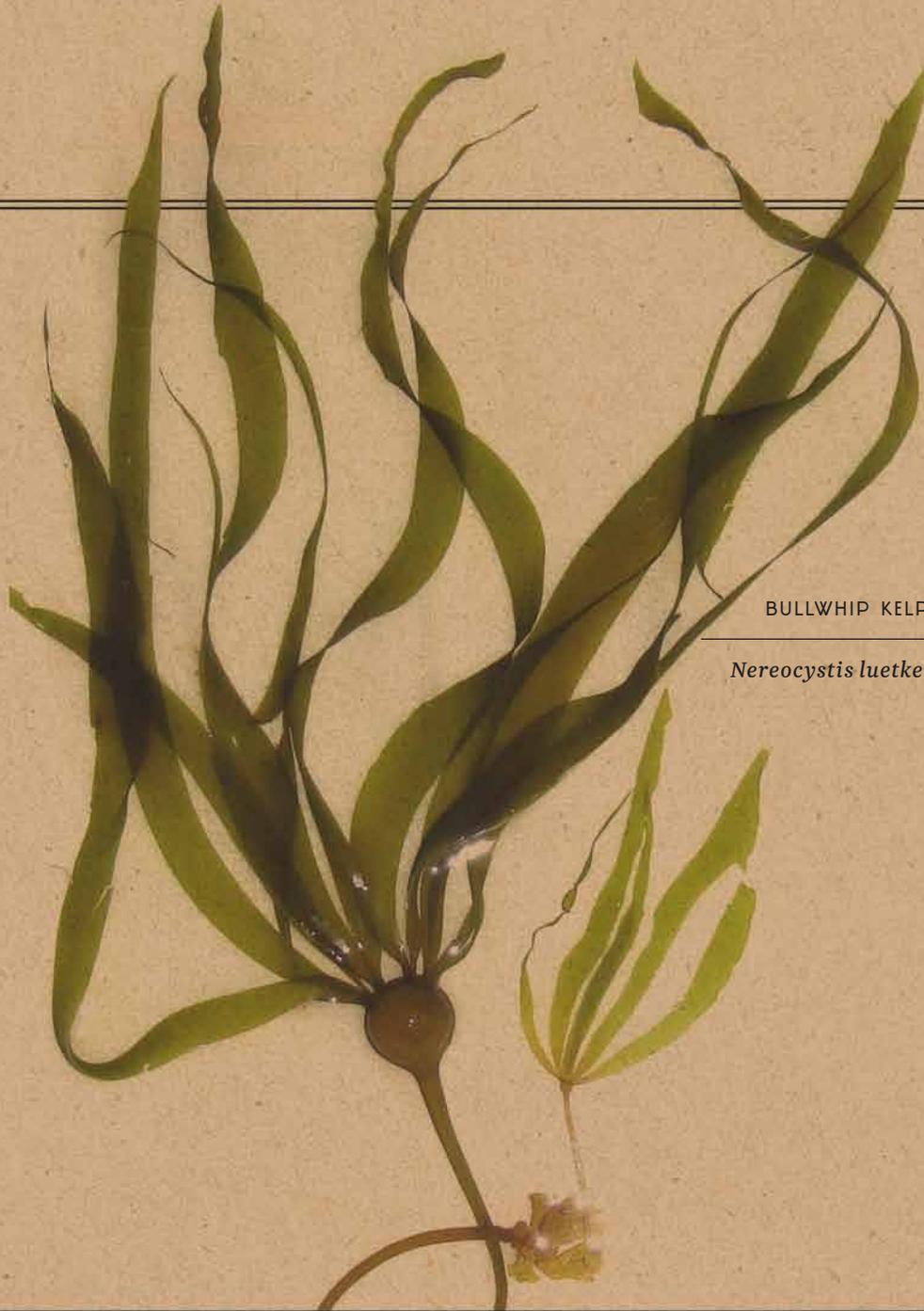


**INCORPORATING
ECOLOGICAL PRINCIPLES *into*
CALIFORNIA OCEAN *and* COASTAL MANAGEMENT:**

Examples from Practice



BULLWHIP KELP

Nereocystis luetkeana

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The Center for Ocean Solutions (www.centerforoceansolutions.org) is a collaboration among the Stanford Woods Institute for the Environment and Hopkins Marine Station of Stanford University, the Monterey Bay Aquarium, and the Monterey Bay Aquarium Research Institute.

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Front Cover Photo: "Adult and Baby Kelp." Courtesy of Louise Gaudet, BC Kelp.

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CHAPTER 1

INTRODUCTION

*Zostera
marina*

EELGRASS is considered a foundation species because it provides habitat and food for numerous economically and ecologically important species.

PHOTO SOURCE: Claire Fackler, CINMS, NOAA

1



INTRODUCTION



“Ecosystem management can be difficult logistically because ecosystem boundaries seldom coincide with political or departmental boundaries, [and] . . . marine ecosystem managers are currently much more dependent upon political boundaries than upon scientific knowledge for defining appropriate management units.”¹ “Comprehensive strategies for marine ecosystem management need not replace existing species management programs, but rather supplement them. Approaches to management must work together to make human activities compatible with maintaining natural systems. . . . [M]ore comprehensive marine ecosystem management can enhance current management regimes by offering integration among the management of separate resources and by ensuring reservoirs for marine species.”²



California ocean and coastal managers and decision-makers work within existing means, jurisdictions, and legislative authorities to manage important living coastal and marine resources while at the same time seeking to promote and maintain a healthy and productive coastal economy. Most coastal managers and decision-makers seek ways to incorporate and apply lessons from the theory and practice of ecosystem-based management (EBM) into their own management documents (e.g., development permits, leases, regulations), better analyze the range of impacts that human uses have on marine ecosystems, and use the best available science in their work.

In 2009, the Center for Ocean Solutions (COS) met with individuals from eight state agencies³ to better understand how science currently is used in their daily decision-making processes, what barriers exist to sharing data with other agencies, and the potential value of proactive and coordinated ecosystem-based ocean planning for each agency. As a result of these conversations, COS hosted workshops and produced research products aimed at furthering the discussion with agencies and exploring different ways that data, science, and ecological principles could be used by agencies, including: (1) the **Collaborative Geospatial Information and Tools for California Coastal and Ocean Managers Workshop**⁴ in August 2009 that brought together staff from state and federal

3. Agencies included: San Francisco Bay Area Conservation and Development Commission, California Environmental Protection Agency, California Energy Commission, California Coastal Commission, Department of Fish and Game, Department of Parks and Recreation, State Lands Commission, and State Water Resources Control Board (also met with the Coastal Conservancy, Ocean Protection Council, Southern California Coastal Watershed Research Project, and the U.S. Geological Survey).

4. CTR. FOR OCEAN SOLUTIONS, NOAA COASTAL SERV. CTR., CAL. OCEAN PROTECTION COUNCIL & CAL. OCEAN SCIENCE TRUST, COLLABORATIVE GEOSPATIAL INFORMATION AND TOOLS FOR CALIFORNIA COASTAL AND OCEAN MANAGERS WORKSHOP REPORT (2009), http://www.centerforoceansolutions.org/Spatial-Data-and-Tools/Workshop-2009/Geospatial_Report_Hi_res.pdf.

1. EUGENE H. BUCK, CONG. RESEARCH SERV., 93-679 ENR, MARINE ECOSYSTEM MANAGEMENT 3 (1993).

2. *Id.* at 10.

agencies to discuss barriers to sharing information across agencies and next steps for improving sharing and collaboration in the State; and (2) a “Desk Simulation” that shows how ecological principles, tradeoff analyses, and cumulative impact models could be used to increase the use of spatial data in permitting decisions and help make planning for new uses more proactive and transparent. Following these activities, agency staff who participated in the workshops asked for ideas on how to apply these concepts in practice while remaining grounded in their existing authorities and mandates. The following document (hereinafter referred to as a “Guide”) is an attempt to illustrate the application of EBM theory into practice.

APPLYING A MORE HOLISTIC ECOSYSTEM-BASED APPROACH TO COASTAL AND MARINE RESOURCE MANAGEMENT

This Guide is intended for use by agency staff tasked with making important decisions within daily permitting and regulatory processes that influence the state of the ecosystem. It presents opportunities for considering and applying a more holistic ecosystem-based approach to coastal and marine resource management. This Guide does not provide all the answers for how California coastal and marine agencies can incorporate EBM principles. Instead, it should be read as part of an important conversation about challenging assumptions and incorporating emerging data and methods to improve the overall health of our coastal and marine ecosystems for the benefit of current and future generations in California.

1.1. PURPOSE

The California Ocean Protection Act (COPA) finds that “[i]t is the [S]tate’s policy to incorporate ecosystem perspectives into the management of coastal and ocean resources, using sound science, with a priority of protecting, conserving, and restoring coastal and ocean ecosystems, rather than managing on a single species or single resource basis.”⁵ This Guide seeks to make this and other COPA policies tangible by enabling California ocean and coastal managers to consider and apply a more holistic ecosystem-based approach to management while still working within their enabling authorities and staying true to their missions.

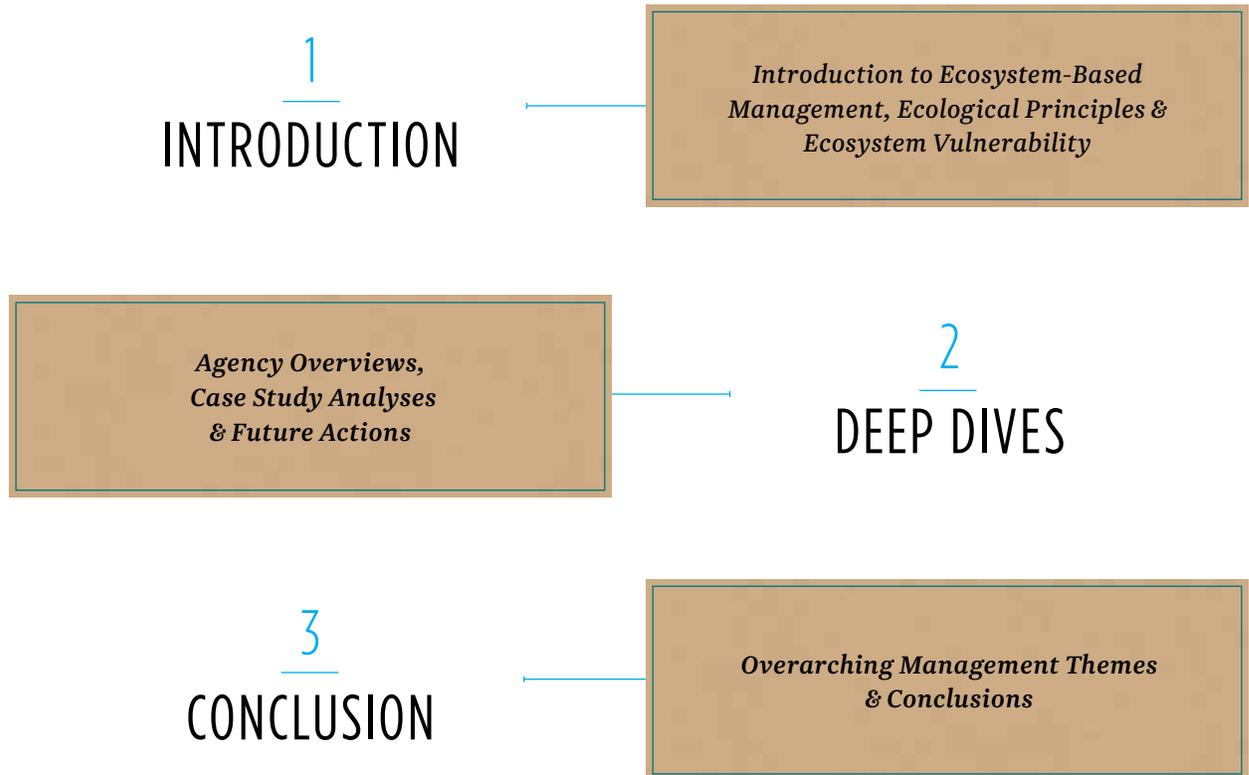
This Guide analyzes existing agency authorities and decision frameworks and locates where important ecological principles resonate within them. The document also walks through three agency-specific case studies to illustrate where ecological principles have been successfully incorporated and to identify where agency analyses and decisions could be in closer alignment with these principles. The ideas and suggestions in this Guide can be incorporated into management decisions today without additional legislative action.

To refine the ideas presented here, COS sought feedback from individuals at the four agencies profiled in the Guide, as well as from individuals with ocean and coastal policy, legislative, and advocacy expertise in California. Throughout this vetting process, we heard that agencies are already stretched thin and that lack of capacity, expertise, and funding present serious obstacles to implementing the ideas discussed in this Guide. We acknowledge these barriers throughout the Guide and, where possible, suggest priorities and recommendations to work within these limitations and creative strategies for breaking through the barriers.

⁵ CAL. PUB. RES. CODE § 35510(b)(3) (West 2012).

1.2. STRUCTURE

The Guide is divided into three sections:



The first section offers a brief introduction to EBM, the ecological principles, and ecosystem vulnerability in the context of ocean and coastal management. The second section takes a “deep dive” into four California agencies that play a significant role in the State’s coastal and ocean management. This section provides an overview of each agency’s enabling authorities and a discussion of how those authorities track with the ecological principles and ecosystem vulnerability. Each agency overview is followed by a case study analysis to demonstrate how agencies reference and utilize ecological principles and ecosystem vulnerability in current practice. The analysis also identifies concrete ways to further address and

incorporate these concepts into future management decisions, with particular attention placed on decisions with a strong spatial component. The agency sections also present prioritized checklists of questions and data for thinking about the ecological principals and ecosystem vulnerability in day-to-day permit and project review. While the checklists provided here are not exhaustive, they may nonetheless suggest data gathering and analyses that are beyond each agency’s current capacity. For this reason, the items appear in order of priority, with the top analyses considered most important for any decision. Finally, we conclude with a chapter on Overarching Themes that pertain to all four agencies and discuss potential strategies for tackling these issues.

1.3. AGENCY AND DECISION DOCUMENT FOCUS

This Guide focuses on four state agencies—the Department of Fish and Game (DFG), the Fish and Game Commission (FGC), the State Lands Commission (SLC), and the California Coastal Commission (CCC)—entrusted with making important permitting and management decisions that directly impact or regulate ocean and coastal resources in California. We chose to focus on these agencies for their leadership roles in California’s ocean and coastal resource management and for the diversity of enabling authorities they represent and permit applications they review.

All of these agencies engage in environmental review of their decisions, either pursuant to the California Environmental Quality Act (CEQA)⁶ or through a certified equivalent program. CEQA requires state and local agencies to identify significant environmental impacts of their actions and to avoid or mitigate those impacts, where possible.⁷ CEQA applies to “projects,” defined as activities “which ha[ve] a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment,”⁸ undertaken by or requiring approval by state and local government agencies.⁹

CEQA exempts certain state agency regulatory programs from requirements for preparation of Negative Declarations and Environmental Impact Reports (EIRs). Environmental regulatory programs that involve “essentially the same consideration of environmental issues as is provided by use of EIRs and Negative Declarations” and receive approval by the Natural Resources Agency are considered “Certified Equivalent Programs” under CEQA.¹⁰ Certified programs do not have to prepare EIRs and Negative Declarations but instead use other documentation to accomplish the same goals.¹¹ Fishery Management Plans developed by the DFG and the CCC’s development of staff reports and review of Coastal Development Permit applications are two examples of functionally equivalent programs.

One specific CEQA or CEQA-equivalent decision document (e.g., a permit, lease, regulation) issued by each agency that captures the nature of that agency’s coastal management authority and jurisdiction over the marine environment was chosen to provide a starting point for deeper discussions we hope this Guide will catalyze.

6. PUB. RES. §§ 21000-21178.

7. CAL. CODE REGS. tit. 14, § 15002(a) (2012).

8. *Id.* at § 15378.

9. *Id.* at § 15002(b).

10. *Id.* at § 15002(l).

11. *Id.* at § 15002.

THE FOLLOWING
DOCUMENTS
WERE SELECTED
TO SERVE AS
CASE STUDIES:

CASE STUDY NO 1

DEPARTMENT OF
FISH AND GAME &
FISH AND GAME
COMMISSION

2002

*White Seabass Fishery
Management Plan*

CASE STUDY NO 2

STATE LANDS
COMMISSION

2009

*Fiber Optic Cable General Lease
Right of Way Use for a submerged
cable project off of Morro Bay*

CASE STUDY NO 3

CALIFORNIA
COASTAL
COMMISSION

2006

*Coastal Development Permit issued
for the piping and disposal of
dredge material in Humboldt Bay*

1.3.1. CASE STUDY STRUCTURE

The case study approach is used to acknowledge how agencies are structured, review their enabling legislation and jurisdiction, and understand the analyses and processes involved in making management decisions. Following an agency overview, each case study identifies places where the agencies already incorporate ecological principles and ecosystem vulnerability into their decision-making processes. The discussion then identifies specific ideas and new frames of reference for thinking about the ecological principles and ecosystem vulnerability in the context of each case study, including identifying opportunities for managers to further address the principles and ecosystem vulnerability within their existing authorities and to take their management actions one step further along the EBM continuum.

The case study approach does have limitations as each case study selected represents only one agency decision in a specific place for a specific activity. Therefore, to the extent that the specific case study discussions fail to raise important points that are applicable on a broader agency scale, we provide a bigger picture discussion in an effort to make recommendations relevant to a broad range of agency decisions.

1.3.2. CASE STUDY SELECTION CRITERIA

The following criteria were used to select projects for case study analysis:

FIRST, each case study must be representative of the agency's enabling (legal) authorities.

SECOND, management decisions or permits that were both common and representative of the day-to-day decision making of an agency were identified and selected over rare or unique decision-making authorities held by the agencies. These first two criteria allowed us to draw out more generally applicable lessons from the case studies.

THIRD, each project must involve a spatial component in the marine environment that required state agency decision-makers to make spatial tradeoffs and weigh the impacts of activities on various location alternatives. The third requirement allowed us to place decisions in the broader context of EBM, which is an inherently place-based approach to management. For example, spatial information was used in the SLC permit process to identify where the fiber optic cable should connect on land in California as well as what path it should take through California state waters in route to its connection in Hawai'i.

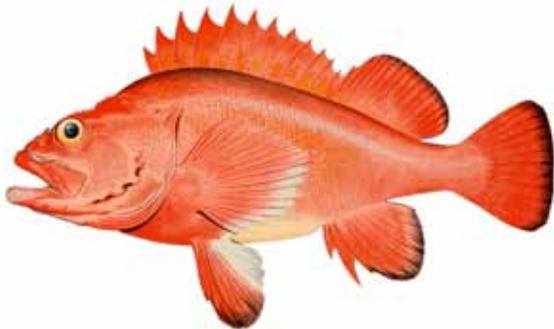
FOURTH, relatively current and recently issued decisions were preferred, with an aim for permits issued or regulations approved within the last ten years, so that we examined the agencies' current review standards and relied on recent scientific understanding.

FIFTH, geographic diversity for each project area was sought, aiming to select projects that represented California's diverse coastal and marine environments.

SIXTH, and finally, projects that engaged multiple agencies were preferred. For example, the fiber optic cable project required both a lease approval by the SLC as well as a coastal development permit issued by the CCC. Where multiple agencies were involved, we were able to consider the overlap and integration of agency actions.

1.4. HOW TO USE THIS GUIDE

This Guide is intended for use by agency staff tasked with making important EBM decisions within their daily permitting and regulatory processes. It is important to note that the Guide focuses on the ecological, rather than the human, dimensions of marine ecosystems, with the understanding that attention to both is critical to long-term sustainability. This Guide may be read in its entirety or users may wish to turn from this introductory section directly to their agency's overview and case study section. Each agency overview discussion is designed to be freestanding, so discussion of important concepts is repeated when there are overlapping issues between the agencies. Therefore, those reading this Guide in its entirety will find some repetition throughout, but may also glean additional strategies for incorporating ecological principles into decision making from all three of the agency discussions. The Overarching Themes chapter applies to each of the four agencies and considers additional concepts that were not discussed in the agency-specific chapters, including ideas for incorporating some of the more challenging concepts of EBM into daily decision making.



ROUGHEYE ROCKFISH

Sebastes aleutianus

2



ECOSYSTEM-BASED MANAGEMENT, ECOLOGICAL PRINCIPLES, AND ECOSYSTEM VULNERABILITY

2.1. ECOSYSTEM-BASED MANAGEMENT

As mentioned, the California Legislature spoke directly to the importance of EBM of the ocean environment by enacting the COPA. The Act finds that “[t]he preservation of the [S]tate’s ocean resources should be guided by principles of sustainability, ecosystem health, precaution, recognition of the interconnectedness between land and ocean, decisions informed by good science and improved understanding of coastal and ocean ecosystems, and public participation in decision-making.”¹² Furthermore, state agencies that make “decisions affecting coastal waters and the ocean environment”¹³ should manage “coastal or ocean resources . . . in a manner consistent with protection, conservation, and maintenance of healthy coastal and ocean ecosystems and restoration of degraded ocean ecosystems.”¹⁴ It is with these overarching findings and policies of the COPA in mind that we turn to the broader EBM conversation.

EBM is a framework that is meant to ensure that policy makers and resource managers consider the long-term sustainability of ecosystems and their associated social and economic systems as “a precondition rather than an afterthought” to sectoral management.¹⁵ This management system moves beyond single species, single system resource management. As defined by McLeod et al., EBM is “an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need.”¹⁶ The key to an EBM approach however is to “[m]ake protecting and restoring marine ecosystems and all their services the primary focus, even above short-term economic or social goals for single services. Only intact, healthy ecosystems can provide the complete range of benefits that humans want and need over long periods of time.”¹⁷

The underlying theory of EBM provides scientists, managers, policy makers, and stakeholders with a framework for implementing comprehensive ecosystem-based practices. Multiple spatial planning tools and processes that analyze and plan for current and future ocean uses have emerged around the world as a means of incorporating EBM lessons.

12. CAL. PUB. RES. CODE § 35505(c).

13. *Id.* at § 35510(b)(1).

14. *Id.* at § 35510(b)(5).

15. Norman L. Christensen et al., *The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management*, 6 *ECOLOGICAL APPLICATIONS* 665 (1996); Jack A. Stanford & Geoffrey C. Poole, *A Protocol for Ecosystem Management*, 6 *ECOLOGICAL APPLICATIONS* 741 (1996); D. Scott Slocombe, *Defining Goals and Criteria for Ecosystem-Based Management*, 22 *ENVTL. MGMT.* 483 (1998).

16. KAREN L. McLEOD ET AL., *SCIENTIFIC CONSENSUS STATEMENT ON MARINE ECOSYSTEM-BASED MANAGEMENT* (2005), http://www.compassonline.org/sites/all/files/document_files/EBM_Consensus_Statement_v12.pdf.

17. *Id.*

EBM IN ACTION

PUGET SOUND REGION, WASHINGTON STATE¹⁸

One example of a large-scale EBM process that continues to evolve is in the Puget Sound region of Washington State. By 2005 it was clear that the Puget Sound was in trouble—human population along the Sound was projected to triple in the next twenty years; analyses showed biophysical processes that supported the Sound ecosystem were disrupted or impaired; and the Sound was listed as one of five national “hotspots” for marine fishes at risk of extinction—all of this in a region that supports over forty species of birds, mammals, fishes, plants, and invertebrates listed as threatened, endangered, or candidates for listing under the Endangered Species Act.

In response to this crisis, Washington Governor Christine Gregoire appointed a public-private partnership to develop a plan for reversing ecosystem decline within the region. The partnership worked with its diverse membership, a science working group, and the broader Puget Sound community to articulate the following goals:

These goals were meant to be achieved by incorporating foundational ecosystem properties into future management strategies, including resilience to changes in environmental conditions, redundancy in its parts, and representation of diverse species and habitats.

In 2007, the partnership’s final recommendations were codified by the Washington State legislature and a new sub-cabinet agency—the Puget Sound Partnership (Partnership)—was created to realize the Puget Sound’s new vision. The Partnership continues to experience successes and setbacks in its approach to implementing science-based EBM, however it is a strong example of how detailed discussions among scientists, policy makers and the community helped refine the management objectives needed to achieve a healthy ecosystem. Many of the ecological principles emphasized in this Guide were also emphasized in the goals and objectives of the Partnership’s initial recommendations.

EBM GOALS

Puget Sound

- 1 species and food webs thrive;
- 2 habitats are protected and restored;
- 3 water quantity supports people, fish and wildlife, and the environment;
- 4 water quality is clean for marine and fresh waters; and
- 5 human health is supported and wellbeing is sustained, including economic, social, and cultural values.



Port Townsend, Puget Sound, Washington. Illustration by E. S. Glover, 1878.

18. Mary Ruckelshaus, Timothy Essington, and Phil Levin, *Puget Sound, Washington, USA*, in *ECOSYSTEM-BASED MANAGEMENT FOR THE OCEANS* (Karen L. McLeod and Heather Leslie eds., 2010). To read the latest developments of the Puget Sound Partnership and its efforts to support a healthy Puget Sound region, visit <http://www.psp.wa.gov/>.

BEST PRACTICES FOR ECOSYSTEM-BASED MANAGEMENT¹⁹:

- 1 EBM should be considered a process not an end state;
- 2 Contextual differences between locations necessitate flexible EBM implementation—there is not a single method for EBM;
- 3 Humans must be recognized as an integral part of the ecosystem and social effects of management decisions should be considered;
- 4 Decision making should be integrated and science-based;
- 5 Scientific, traditional, and management knowledge should be integrated so that decisions can be made based on a wider platform of knowledge;
- 6 A commitment to conservation and sustainability of ocean resources is necessary;
- 7 Management units should be determined based on ecological criteria, wherever possible;
- 8 Stakeholder engagement can increase buy-in and compliance through education; and
- 9 Adaptive management strategies that reflect changing conditions are necessary.

Note. The principal materials represented by larger symbols signifies Sunk Rocks

¹⁹ NORWEGIAN POLAR INST., REPORT SER. No. 129, BEST PRACTICES IN ECOSYSTEM-BASED OCEAN MANAGEMENT IN THE ARCTIC-111-112 (2010), <http://portal.sdwg.org/media.php?mid=1017>.

2.2. FUNDAMENTAL ECOSYSTEM ATTRIBUTES: THE ECOLOGICAL PRINCIPLES

Ecosystem functioning is determined by a suite of complex processes operating at multiple scales of space. Ecosystem functioning is determined by a suite of complex processes operating at multiple scales of space and time. Managing for this type of complexity is difficult at best, and intended management outcomes are often not realized. However, there are some foundational attributes of systems that can serve as indicators for broader ecosystem health due to their direct and indirect links to larger ecosystem processes.²⁰ In 2010, Foley et al. presented four guiding ecological principles for marine planning that are based on the fundamental attributes of healthy, functioning ecosystems, as determined from an extensive literature review and expert workshop.²¹ These principles distill the complexity of ecosystems into specific, measureable components that help inform how impacts to ecosystems can be evaluated in light of broad legislative goals, such as ecosystem health, healthy populations, and ecosystem preservation. These principles are also intended to be specific enough that they can be used to develop management objectives, monitoring programs, and adaptive management plans.

THE FIRST PRINCIPLE is to *maintain or restore native species diversity*. Native species diversity refers to the variety and abundance of species within an area or ecosystem.²² Numerous studies have demonstrated the connection between the loss of species diversity and the loss of ecosystem functioning.²³

This relationship implies that greater native species diversity supports greater ecosystem functioning. In addition, highly diverse ecosystems tend to be more productive and resilient, and less vulnerable to human and natural impacts.²⁴ Diverse ecosystems also tend to provide a greater, more desirable array of ecosystem goods and services.²⁵



THE SECOND PRINCIPLE is to *maintain or restore habitat diversity and heterogeneity*. Habitat diversity—the number of different habitat types within a given area—and habitat heterogeneity—the spatial arrangement and relationships among habitat patches across the seascape—play a crucial role in

20. Callum M. Roberts et al., *Ecological Criteria for Evaluating Candidate Sites for Marine Reserves*, 13 *ECOLOGICAL APPLICATIONS* S215 (2003).

21. Melissa M. Foley et al., *Guiding Ecological Principles for Marine Spatial Planning*, 34 *MARINE POL'Y* 955 (2010).

22. Roberts, *supra* note 20.

23. Jeremy B.C. Jackson et al., *Historical Overfishing and the Recent Collapse of Coastal Ecosystems*, 293 *SCIENCE* 629 (2001); Heike K. Lotze et al., *Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas*, 312 *SCIENCE* 1806 (2006).

24. Stephen R. Palumbi et al., *Ecosystems in Action: Lessons from Marine Ecology about Recovery, Resistance, and Reversibility*, 58 *BIO SCIENCE* 33 (2008); John J. Stachowicz et al., *Understanding the Effects of Marine Biodiversity on Communities and Ecosystems*, 38 *ANN. REV. ECOLOGY, EVOLUTION, & SYSTEMATICS* 739 (2007).

25. Terence P. Hughes, *Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef*, 265 *SCIENCE* 1547 (1994); Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem Services*, 314 *SCIENCE* 787 (2006).



SEA OTTER

Enhydra lutris

determining the survival and persistence of species from algae and invertebrates to fish and marine mammals.²⁶ High habitat diversity and heterogeneity increase the successful movement of individuals, nutrients, and important food sources between habitat types.²⁷ Habitat types may include sand beach, rocky intertidal, estuary, shallow sand, deep sand, shallow rock, deep rock, kelp, shallow canyon, and deep canyon.²⁸ In addition, habitat diversity and heterogeneity are positively correlated with species diversity,²⁹ and are linked with increased food web stability and the provision of ecosystem goods and services.³⁰

26. M. Julian Caley & Jill St. John, *Refuge Availability Structures Assemblages of Tropical Reef Fishes*, 65 J. ANIMAL ECOLOGY 414 (1996).

27. Fiorenza Micheli & Charles H. Peterson, *Estuarine Vegetated Habitats as Corridors for Predator Movements*, 13 CONSERVATION BIOLOGY 869 (1999); Michael W. Beck et al., *The Identification, Conservation, and Management of Estuarine and Marine Nurseries for Fish and Invertebrates*, 51 BIOSCIENCE 633 (2001); Peter J. Mumby et al., *Coral Reef Habitats as Surrogates of Species, Ecological Functions, and Ecosystem Services*, 22 CONSERVATION BIOLOGY 941 (2008).

28. CAL. DEP'T OF FISH & GAME, CALIFORNIA MARINE LIFE PROTECTION ACT MASTER PLAN FOR MARINE PROTECTED AREAS 35 (2008).

29. Roberts, *supra* note 20.

30. Elizabeth McLeod et al., *Designing Marine Protected Area Networks to Address*

THE THIRD PRINCIPLE is to *maintain or restore populations of key species*. Key species include: foundation species, such as kelp and seagrass;³¹ keystone species, including sea otters and seastars;³² top predators, like sharks, tuna, and sea lions;³³ and basal prey, such as sardines, anchovies, and mullet.³⁴ Key species create habitat for other species, have a disproportionately strong influence on community dynamics, and can drive food web structure. In addition, the role that key species play in a community is rarely duplicated by other species.³⁵ Fluctuations and decline of population sizes of key species can (1) have significant negative effects on ecosystem community structure and functioning, (2) increase vulnerability, (3) decrease resilience, and (4) alter the provision of ecosystem services.³⁶

the Impacts of Climate Change, 7 FRONTIERS ECOLOGY & ENVIRONMENT 362 (2009).

31. Foundation groups or species provide the template from which most additional species interactions and dynamics emerge by creating habitat and refuge for large numbers of other species. Paul K. Dayton, *Toward an Understanding of Community Resilience and the Potential Effects of Enrichments to the Benthos at McMurdo Sounds, Antarctica*, in PROCEEDINGS OF THE COLLOQUIUM ON CONSERVATION PROBLEMS IN ANTARCTICA (BC Parker ed., 1972).

32. Keystone species have community-level effects that are often disproportionate to their biomass. Mary E. Power et al., *Challenges in the Quest for keystones*, 46 BIOSCIENCE 609 (1996).

33. Top predators are species that are located at or near the top of the food chain that primarily eat other species and are rarely preyed on by other species (with the exception of humans). The importance of top predators in structuring ecosystems is reviewed by James A. Estes et al., *Trophic Downgrading of Planet Earth*, 333 SCIENCE 301 (2003).

34. Basal prey are species that are located near the bottom of the food chain that supply a large portion of the energy to species farther up the food chain (e.g., top predators). Because these species form the foundation of the food web, their removal can have significant impacts on ecosystem structure and functioning. ELLEN K. PIKITCH ET AL., LENFEST OCEAN PROGRAM, LITTLE FISH, BIG IMPACT: MANAGING A CRUCIAL LINK IN OCEAN FOOD WEBS (2012).

35. Fiorenza Micheli & Benjamin S. Halpern, *Low Functional Redundancy in Coastal Marine Assemblages*, 8 ECOLOGY LETTERS 391 (2005); David R. Schiel, *Rivets or Bolts? When Single Species Count in the Function of Temperate Rocky Reef Communities*, 338 J. EXPERIMENTAL MARINE BIOLOGY & ECOLOGY 233 (2006).

36. James A. Estes & David O. Duggins, *Sea Otters and Kelp Forests in Alaska: Generality and Variation in a Community Ecological Paradigm*, 65 ECOLOGICAL MONOGRAPHS 75 (1995); John M. Pandolfi et al., *Global Trajectories of the Long-Term Decline of Coral Reef Ecosystems*, 301 SCIENCE 955 (2003); Alan M. Springer et al., *Sequential Megafaunal Collapse in the North Pacific Ocean: An Ongoing Legacy of Industrial Whaling?*, 100 PROC. NAT'L ACAD. SCI. U.S. AMERICA 12223 (2003).

2.3. ECOSYSTEM VULNERABILITY

THE FOURTH AND FINAL PRINCIPLE is to *maintain or restore connectivity*, or the exchange of individuals, nutrients, and material between habitats and populations.³⁷ Many marine species exhibit “open” population dynamics, which involve dispersal or movement away from parent populations and/or throughout different life history stages.³⁸ Maintaining connectivity is crucial to the persistence of marine populations and ecosystem productivity and requires an understanding of oceanographic processes and the biological characteristics of marine species. Connectivity between habitats and populations increases productivity and resilience, and decreases the vulnerability of ecosystems to natural and human disturbances.³⁹

Accounting and managing for these attributes alone, however, does not necessarily advance marine management beyond single species or single sectors and may result in a failure to reach management objectives and sustain healthy, functioning ecosystems. It is therefore important to manage and account for these attributes within a broader context, taking into account the following additional ecosystem considerations that are likely to affect how human interactions influence marine ecosystems.

While the previously discussed foundational attributes drive ecosystem structure and function, there are additional characteristics—ecosystem vulnerabilities—that shape ecosystems, particularly by modifying the link between the human and biophysical components of the ecosystem.

Vulnerability is generally defined as the potential for loss. In the context of ecosystems, it is specifically defined as the likelihood that a species or habitat will incur losses due to a disturbance, natural or human-induced.⁴⁰ Understanding differential compatibility of human-ecosystem interactions across multiple habitat types and species life histories is particularly important because habitats and species do not necessarily respond in the same manner to a single impact. The vulnerability of a species or habitat can generally be assessed by evaluating the characteristics of a specific impact including:

- 1 susceptibility of a species and/or habitat to an impact;
- 2 frequency of the impact;
- 3 spatial scale of the impact; and
- 4 functional impact of the activity (i.e., on a single species vs. an entire ecosystem).⁴¹

In the following sections we explore the importance of understanding ecosystem vulnerability—specifically in the context of cumulative impacts and climate change—and highlight how these concepts influence the extent to which human activities impact ecosystems.

37. Gary A. Polis et al., *Toward an Integration of Landscape and Food Web Ecology: The Dynamics of Spatially Subsidized Food Webs*, 28 ANN. REV. ECOLOGY & SYSTEMATICS 289 (1997).

38. Robert K. Cowen et al., *Population Connectivity in Marine Systems: An Overview*, 20 OCEANOGRAPHY 14 (2007).

39. Geoffrey P. Jones et al., *Population Connectivity and Conservation of Marine Biodiversity*, 20 OCEANOGRAPHY 100 (2007); Simon F. Thrush et al., *The Effects of Habitat Loss, Fragmentation, and Community Homogenization on Resilience in Estuaries*, 18 ECOLOGICAL APPLICATIONS 12 (2008); Robert S. Steneck et al., *Thinking and Managing Outside the Box: Coalescing Connectivity Networks to Build Region-Wide Resilience in Coral Reef Ecosystems*, 28 CORAL REEFS 367 (2009).

40. Kerrie Wilson et al., *Measuring and Incorporating Vulnerability into Conservation Planning*, 35 ENVTL. MGMT. 527 (2005).

41. Benjamin S. Halpern et al., *Evaluating and Ranking the Vulnerability of Global Marine Ecosystems to Anthropogenic Threats*, 21 CONSERVATION BIOLOGY 1301 (2007).

2.3.1. CUMULATIVE IMPACTS

The level and extent of impact from human-ecosystem interactions can be shaped by the cumulative impact level—the number and intensity of other uses co-occurring in space and time—within an ecosystem.⁴² Although cumulative impacts are generally assumed to accumulate in a linear or additive fashion, they can also accumulate synergistically, such that the total impact is *greater* than the sum of all impacts; or antagonistically, where the overall impact is *less* than the sum of all impacts. A recent review of stressor experiments in marine systems revealed that over sixty percent of stressors interact in a non-additive fashion—either antagonistically or synergistically.⁴³ More importantly, when more than two stressors were present in a system, the number of synergistic interactions doubled and the cumulative impact was worse than predicted based on the results of single stressor experiments.⁴⁴



Cumulative impact map for state and federal waters off California

Image created using the California Current Cumulative Impacts Model at http://globalmarine.nceas.ucsb.edu/california_current.html.

42. Benjamin S. Halpern et al., *A Global Map of Human Impacts on Marine Ecosystems*, 319 SCIENCE 948 (2008).

43. Caitlin M. Crain et al., *Interactive and Cumulative Effects of Multiple Human Stressors in Marine Systems*, 11 ECOLOGY LETTERS 1304 (2008); Emily S. Darling & Isabelle M. Côté, *Quantifying the Evidence for Ecological Synergies*, 11 ECOLOGY LETTERS 1278 (2008).

44. Crain, *supra* note 43.

2.3.2. CLIMATE CHANGE

Although the effects of climate change—including sea level rise, sea surface temperature increase, ocean acidification, and inundation—impact ocean ecosystems in and of themselves, they also change how humans and ecosystems interact by altering the provision of ecosystem services that humans rely upon (e.g., oxygen production, storm protection, food provisioning). Changes in climate will have dramatic impacts on the fundamental attributes of ecosystems, including shifts in species abundance and distribution,⁴⁵ loss of habitats due to erosion and inundation,⁴⁶ and loss of important commercial species due to failed larval development under increasingly acidic ocean conditions.⁴⁷

The pervasive effects of climate change also have the potential to further erode the resilience of marine and human communities by generating a “rising floor” of impacts. Additional physical and biological stressors associated with climate change are likely to increase the cumulative impacts on ecosystems, thereby increasing the vulnerability of ecosystems and decreasing the level of additional disturbance ecological and human communities can withstand.⁴⁸ For example, oyster hatchery operators in Washington and Oregon are already experiencing the impacts of ocean acidification, a condition linked to increased carbon dioxide in the earth’s atmosphere. Decreased pH levels have resulted in widespread death of larval stage oysters.⁴⁹ For California oyster farms that rely on a supply of juvenile oysters,

45. Andrew J. Brooks et al., *Declines in Regional Fish Populations: Have Species Responded Similarly to Environmental Change?*, 53 MARINE & FRESHWATER RES. 189 (2002); Victoria J. Fabry et al., *Ocean Acidification at High Latitudes: The Bellwether*, 22 OCEANOGRAPHY 160 (2009).

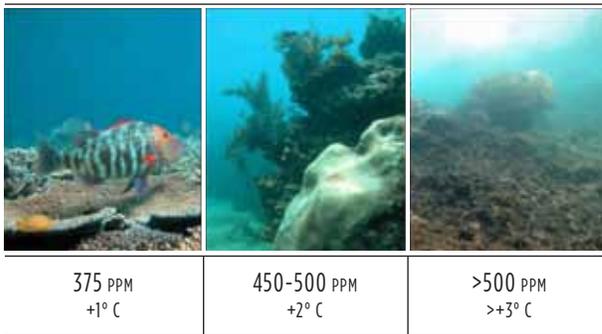
46. MATTHEW HEBERGER ET AL., CAL. CLIMATE CHANGE CTR., *THE IMPACTS OF SEA-LEVEL RISE ON THE CALIFORNIA COAST* (2009).

47. A. Whitman Miller et al., *Shellfish Face Uncertain Future in High CO2 World: Influence of Acidification on Oyster Larvae Calcification and Growth in Estuaries*, 4 PLOS ONE 1 (2009).

48. Benjamin S. Halpern et al., *Mapping Cumulative Human Impacts to California Current Marine Ecosystems*, 2 CONSERVATION LETTERS 138 (2009).

49. Elizabeth Grossman, *Northwest Oyster Die-offs Show Ocean Acidification Has Arrived*, YALE ENV'T 360, Nov. 21, 2011, http://e360.yale.edu/feature/northwest_oyster_die-offs_show_ocean_acidification_has_arrived/2466/.

this translates into supply irregularities and business uncertainty. As oyster populations are affected by ocean acidification their ability to buffer coastal waters from other impacts to water quality are greatly reduced. With declining water quality, commercial fishing communities and other recreational communities who rely upon good water quality and other goods and services that come from healthy coastal waters will experience both economic and human health impacts.



Coral reef communities have undergone declines in ecosystem health due to the combination of increasing ocean temperature and ocean acidification. These are stressors that are likely to impact temperate ecosystems found in California waters.

PHOTO: [https://confluence.furman.edu:8443/display/Lipscomb/Ocean+Acidification+\(EW\)](https://confluence.furman.edu:8443/display/Lipscomb/Ocean+Acidification+(EW))

The combination of climate stressors is having significant impacts to tropical ecosystems. Ongoing research is addressing the gaps in knowledge in temperate systems for both species and habitats that may be affected.⁵⁰

50. Gretchen E. Hofmann et al., *The Effect of Ocean Acidification on Calcifying Organisms in Marine Ecosystems: An Organism-to-Ecosystem Perspective*, 41 ANN. REV. ECOLOGY, EVOLUTION, & SYSTEMATICS 127 (2010); Pauline C. Yu et al., *The Ocean Acidification Seascape and its Relationship to the Performance of Calcifying Marine Invertebrates: Laboratory Experiments on the Development of Urchin Larvae Framed by Environmentally-Relevant pCO₂/pH*, 400 J. EXPERIMENTAL MARINE BIOLOGY & ECOLOGY 288 (2011).

3



RESILIENCE AS THE ULTIMATE ECOSYSTEM GOAL

3. CONCLUSION

The ultimate goal of an EBM approach is to safeguard ecosystem resilience. Ecosystem resilience is a measure of the persistence of systems and their ability to resist disturbance, or to return to a previous level of ecosystem structure and functioning following a disturbance.⁵¹ Healthy ecosystems have the natural capacity to absorb and recover from disturbances, but their resilience is finite—there are limits to the number and types of disturbances an ecosystem can withstand.⁵² Research in temperate and tropical ecosystems demonstrate that as the resilience of a system erodes, multiple characteristics of the ecosystem—such as the time it takes to recover from a disturbance and population variability—increase

HEALTHY ECOSYSTEMS HAVE
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dramatically as ecosystems approach thresholds or tipping points that shift systems into a new equilibrium. When ecosystems are pushed beyond resilience thresholds, either by natural or anthropogenic disturbances, they can be transformed to alternate ecosystem states composed of entirely different species that do not provide the same ecosystem services as the original state;⁵³ nor do they return easily, if ever, to the original state.⁵⁴ While resilience is often a difficult metric to measure, the ecological principles and ecosystem vulnerability characteristics identified in this Guide are at the heart of resilient, healthy ecosystems.

This brief overview of EBM, ecological principles, and ecosystem vulnerability set the stage for the discussions found in the following individual agency chapters and the Overarching Themes chapter. This overview also serves as the basis for the development of the prioritized checklists located in the back inside cover of the document as well as within each agency chapter. It is our hope that this Guide will ultimately serve as both a long-term informational reference text for agencies as well as a tool that helps staff make day-to-day recommendations on regulatory and permitting decisions.

⁵¹ Crawford S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS 1 (1973).

⁵² Heather M. Leslie & Ann P. Kinzig, *Resilience Science*, in ECOSYSTEM-BASED MANAGEMENT FOR THE OCEANS (Karen L. McLeod and Heather Leslie eds., 2010).

⁵³ James A. Estes & John F. Palmisano, *Sea Otters: Their Role in Structuring Near-shore Communities*, 185 SCIENCE 1058 (1974).

⁵⁴ Hughes, *supra* note 25.



CHAPTER 2 *Agency Deep Dive*

DEPARTMENT OF
FISH AND GAME /
FISH AND GAME
COMMISSION

*Sardinops
sagax*

PACIFIC SARDINES are basal prey species that are a critical component at the bottom of the food chain and support numerous intermediate and top predators including many fish species, dolphins, sea lions, and seabirds.

1
=
THE
MARINE LIFE
MANAGEMENT
ACT

The Marine Life Management Act (MLMA or the Act) confers management authority and responsibility over a variety of California’s marine wildlife to both the Department of Fish and Game (DFG) and the Fish and Game Commission (FGC).¹ The MLMA requires the State to develop an ecosystem-based perspective to marine life management extending well beyond fisheries.² The Act expands the authority of the FGC and the DFG for managing marine wildlife, prioritizes long-term benefits and sustainability over short-term gains, and places strong emphasis on science-based management.

The MLMA also sets a new foundation for the development and adoption of Fishery Management Plans (FMPs), acknowledging “the critical need to conserve, utilize, and manage the [S]tate’s marine fish resources” and requiring FMPs to be the means by which the State manages its fisheries.³

The DFG prepares FMPs and submits them to the FGC for adoption or rejection. The DFG is encouraged to “seek advice and assistance in developing a fishery management plan from participants in the affected fishery, marine scientists, and other interested parties” to the extent practicable.⁴ A proposed FMP is subject to public review for at least 30 days, within which time, the FGC must hold two hearings for public comments on the proposed plan.⁵ After

1. CAL. FISH & GAME CODE §§ 7050-7090 (West 2012). DFG and FGC share management authority over some species with the California Legislature.
2. *Id.* at § 7050.
3. *Id.* at § 7070.
4. *Id.* at § 7076.
5. *Id.* at § 7078(a).

THE MLMA REQUIRES
THE STATE TO DEVELOP
AN ECOSYSTEM-BASED
PERSPECTIVE TO MARINE LIFE
MANAGEMENT EXTENDING
WELL BEYOND FISHERIES

the required review period and public hearings, the FGC issues its decision to adopt or reject the plan.⁶

Development of an FMP is considered a “project” as defined in CEQA.⁷ However, FMP development is part of the DFG’s certified regulatory program, such that the adoption of regulations to implement a FMP is considered equivalent to the CEQA environmental review process and is exempt from CEQA’s Environmental Impact Review (EIR) requirement.⁸

6. *Id.*

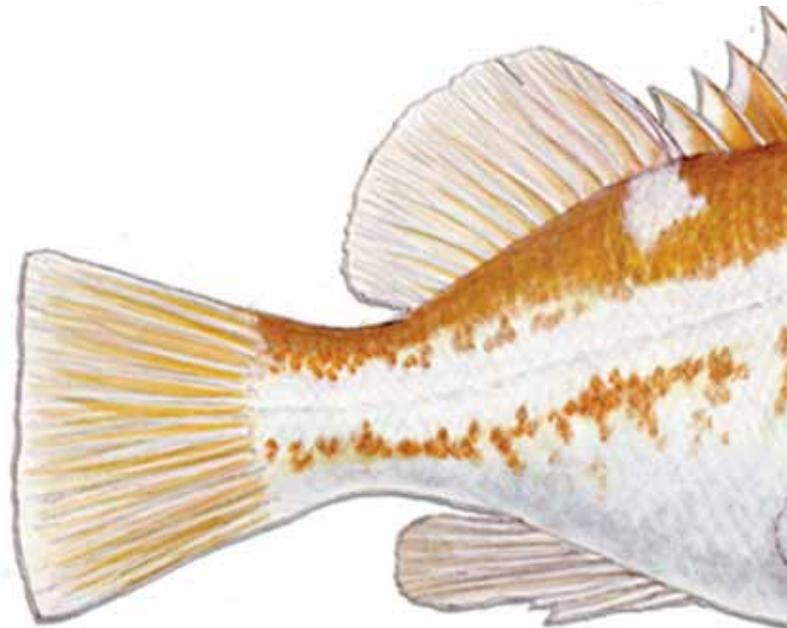
7. CAL. PUB. RES. CODE § 21065 (West 2012).

8. FISH & GAME § 7078(e); CAL. CODE REGS. tit. 14, § 15251 (2012). See Introduction of this Guide for more on certified regulatory programs under CEQA.



COPPER ROCKFISH

Sebastes caurinus



2



ECOLOGICAL PRINCIPLES AND THE MLMA

Given the strong policy goals and objectives of the MLMA and the wealth of specific language in the Act that seeks to ensure total ecosystem health, the DFG and the FGC have ample existing authority to apply ecological principles to all of their current management actions. The following comprehensive and proactive goals in the MLMA focus on ensuring conservation, restoration and sustainable use, and provide a strong foundation for EBM.

CONSERVATION OF THE ENTIRE SYSTEM: Exploited populations of marine life, as well as the species and habitats that make up the whole ecosystem of which they are a part, are to be conserved.⁹

CHARACTERIZING NON-CONSUMPTIVE BENEFITS: Aesthetic and recreational enjoyment, scientific study, education and the provision of other ecosystem goods and services (e.g., coastal protection, clean water) are non-consumptive benefits that should be valued.¹⁰

SUSTAINABILITY: Fisheries and other uses of marine living resources are to be sustainable so that long-term health is not sacrificed for short-term benefits.¹¹

HABITAT CONSERVATION: The habitat of marine wildlife is to be maintained, restored or enhanced, and any damage from fishing practices is to be minimized.¹²

9. See, e.g., FISH & GAME § 7050(b) (“It is the policy of the state to ensure the conservation, sustainable use, and, where feasible, restoration of California’s marine living resources for the benefit of all the citizens of the state.”).

10. See, e.g., *id.* at § 7050(b)(3) (“Recognize the importance of aesthetic, educational, scientific, and recreational uses that do not involve the taking of California’s marine living resources.”).

11. *Id.* at § 7056(a). The words “sustainability”, “sustainably”, or “sustainable” are used 16 times in the 10 sections of the Act. See, e.g., *id.* at § 7050(b)(2) (“[A]llow and encourage only those activities and uses of marine living resources that are sustainable.”).

12. See, e.g., *id.* at § 7056(b) (“The health of the marine fishery habitat is maintained and, to the extent feasible, habitat is restored, and where appropriate, habitat is enhanced.”).

RESTORATION: Depressed fisheries are to be rebuilt to the highest sustainable yields.¹³

LIMITING BYCATCH: The bycatch of marine living resources in fisheries is to be limited to acceptable types and amounts.¹⁴

MINIMIZING ADVERSE EFFECTS ON FISHING COMMUNITIES: Fisheries management should recognize the long-term interests of people and communities reliant on fishing for economic, cultural, and/or subsistence purposes.¹⁵

Armed with the MLMA's strong regulatory language and supportive tools, the DFG and the FGC are well poised to manage California's marine resources with a special focus and attention on the four ecological principles of maintaining or restoring *native species diversity, habitat diversity and heterogeneity, key species, and connectivity.*

TOOLS to MEET MLMA GOALS

SCIENCE: Management is to be based on the best available scientific information as well as other relevant information and be subject to expert review. Lack of information should not substantially delay taking action.¹⁶

CONSTITUENT INVOLVEMENT: Strong emphasis is given to transparent decision making involving people who are interested in or affected by management measures.¹⁷

FISHERY MANAGEMENT PLANS: Plans enable decisions to be based on comprehensive reviews of fisheries and on clear objectives and measures for fostering sustainable fisheries.¹⁸

MASTER PLAN: The Master Plan prioritizes fishery management plan development, giving the fisheries in greatest need of conservation and management measures the highest priority.¹⁹

STATUS OF THE FISHERIES REPORT: The DFG prepares an annual report on the status of California's fisheries and the effectiveness of management programs.²⁰

13. *Id.* at § 7056(c).

14. *Id.* at § 7056(d).

15. *See, e.g., id.* at § 7056(i) ("The fishery management system observes the long-term interests of people dependent on fishing for food, livelihood, or recreation.").

16. *Id.* at §§ 7050(b)(6), 7072(b) ("Manage marine living resources on the basis of the best available scientific information" and "Fishery management plans shall be based on the best scientific information that is available, on other relevant information that the department possesses, or on such scientific information or other relevant information that can be obtained without substantially delaying the preparation of the plan . . ."). *See also id.* at § 7050(b)(5) ("[S]upport and promote scientific research on marine ecosystems and their components").

17. *Id.* at § 7056(h) ("The management decision making process is open and seeks

the advice and assistance of interested parties so as to consider relevant information, including local knowledge.").

18. *Id.* at §§ 7070, 7078.

19. *Id.* at § 7073.

20. *Id.* at §§ 7065, 7066.

2.1. MAINTAINING OR RESTORING NATIVE SPECIES DIVERSITY

THE FIRST PRINCIPLE, *maintaining or restoring native species diversity*, is consistent with a number of statements in the MLMA including:

*“conserve the health and diversity of marine ecosystems and marine living resources”;*²¹

*“allow and encourage only those activities and uses of marine living resources that are sustainable”;*²²

*“ensure the conservation, sustainable use, and, where feasible, restoration of California’s marine living resources”;*²³ and

*“[t]he fishery is [to be] conducted sustainably so that long-term health of the resource is not sacrificed in favor of short-term benefits.”*²⁴

These statements all recognize the fact that maintaining and restoring species diversity means sustaining a productive and resilient ecosystem.²⁵ Higher species diversity leads to a more productive ecosystem²⁶ and a greater degree of ecosystem functioning.²⁷

21. *Id.* at § 7050(b)(1).

22. *Id.* at § 7050(b)(2).

23. *Id.* at § 7050(b).

24. *Id.* at § 7056(a).

25. Stephen R. Palumbi et al., *Ecosystems in Action: Lessons from Marine Ecology about Recovery, Resistance, and Reversibility*, 58 *BIO SCIENCE* 33 (2008); Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem Services*, 314 *SCIENCE* 787 (2006); John J. Stachowicz et al., *Understanding the Effects of Marine Biodiversity on Communities and Ecosystems*, 38 *ANN. REV. ECOLOGY, EVOLUTION, & SYSTEMATICS* 739 (2007).

26. J. Emmett Duffy, *Why Biodiversity is Important to the Functioning of Ecosystems*, 7 *FRONTIERS ECOLOGY & ENVIRONMENT* 437 (2009).

27. Callum M. Roberts et al., *Ecological Criteria for Evaluating Candidate Sites for Marine Reserves*, 13 *ECOLOGICAL APPLICATIONS* S215; Worm, *supra* note 25.

2.2. MAINTAINING OR RESTORING HABITAT DIVERSITY AND HETEROGENEITY

THE SECOND PRINCIPLE, *maintaining or restoring habitat diversity and heterogeneity*, is consistent with the language in multiple sections of the MLMA, including the following:

*“conserve the health and diversity of marine ecosystems”;*²⁸

*“support and promote scientific research on marine ecosystems and their components”;*²⁹

*“[t]he health of the marine fishery habitat is [to be] maintained and, to the extent feasible, habitat is restored, and where appropriate, habitat is enhanced”;*³⁰ and

*“[p]rograms for the conservation and management of the marine fishery resources of California shall be established and administered to . . . facilitate long-term protection and, where feasible, restoration of marine fishery habitats, and to achieve the sustainable use of the state’s fishery resources.”*³¹

The MLMA’s emphasis on the importance of habitat is crucial given that scientific evidence shows that a greater number of habitat types and varied spatial arrangements of those habitats helps maintain ecosystem function,³² species diversity,³³ and productivity.³⁴

28. FISH & GAME § 7050(b)(1).

29. *Id.* at § 7050(b)(5).

30. *Id.* at § 7056(b).

31. *Id.* at § 7055(b).

32. Peter J. Mumby et al., *Coral Reef Habitats as Surrogates of Species, Ecological Functions, and Ecosystem Services*, 22 *CONSERVATION BIOLOGY* 941 (2008).

33. Alan Hastings & Louis W. Botsford, *Persistence of Spatial Populations Depends on Returning Home*, 103 *PROC. NAT’L ACAD. SCI. U.S. AMERICA* 6067 (2006); Laura Airoidi et al., *The Gray Zone: Relationships Between Habitat Loss and Marine Diversity and their Applications in Conservation*, 366 *J. EXPERIMENTAL MARINE BIOLOGY & ECOLOGY* 8 (2008).

34. Robert S. Steneck et al., *Thinking and Managing Outside the Box: Coalescing Connectivity Networks to Build Region-Wide Resilience in Coral Reef Ecosystems*, 28 *CORAL REEFS* 367 (2009).

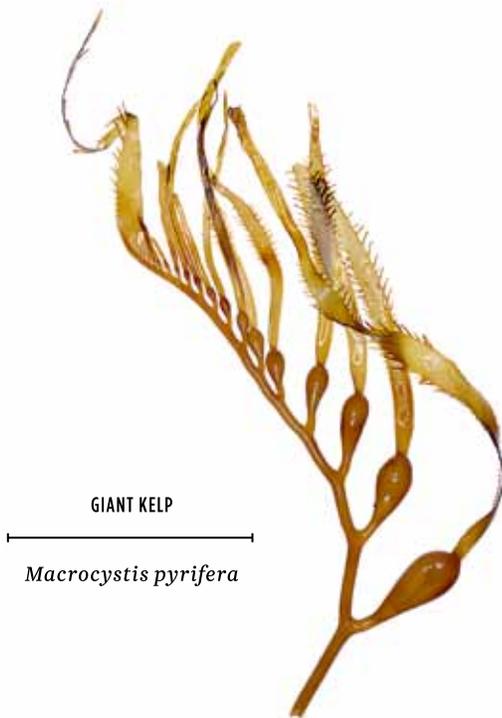
2.3. MAINTAINING OR RESTORING POPULATIONS OF KEY SPECIES

THE THIRD PRINCIPLE, *maintaining or restoring populations of key species*, is consistent with the MLMA's primary management goal of sustainability.³⁵ Managing for the sustainability of resources involves recognizing the importance of *other* components of the ecosystem beyond the managed species, including key species. By doing so, the MLMA, and more spe-

cifically, the Master Plan, recognize the importance of key species, including foundation species such as kelp and urchins,³⁶ the loss of which can lead to disproportionate impacts on ecosystem function.³⁷

The importance of key species is further captured within the MLMA's specific language seeking to limit the harmful effects of bycatch.³⁸ The MLMA broadly defines bycatch to include both fish and all other marine life "taken in a fishery but which are not the target of the fishery" including discards.³⁹ Bycatch often includes key species at both ends of the trophic spectrum—basal prey and top predators.⁴⁰ FMPs must determine the link between the bycatch species and managed fisheries and the resulting impact on ecosystems.⁴¹ Many fishing practices generate some form of bycatch, which often includes damage, harm, or death to key species.

Finally, as for native species diversity and habitat diversity and heterogeneity, "conserv[ing] the health and diversity of marine ecosystems and marine living resources" is consistent with maintaining or restoring key species, which are often dominant drivers of species and habitat diversity.⁴²



35. FISH & GAME § 7056.

36. CAL. DEP'T OF FISH & GAME, THE MASTER PLAN: A GUIDE FOR THE DEVELOPMENT OF FISHERY MANAGEMENT PLANS 3-8 (2001).

37. Robert T. Paine, *Food Webs – Linkage, Interaction Strength, and Community Infrastructure – the 3rd Tansley Lecture*, 49 J. ANIMAL ECOLOGY 667 (1980).

38. FISH & GAME § 7056(d) ("The fishery limits bycatch to acceptable types and amounts").

39. *Id.* at § 90.5.

40. Carrie V. Kappel, *Losing Pieces of the Puzzle: Threats to Marine, Estuarine, and Diadromous Species*, 3 FRONTIERS ECOLOGY & ENVIRONMENT 275 (2005).

41. MICHAEL L. WEBER & BURR HENEMAN, GUIDE TO CALIFORNIA'S MARINE LIFE MANAGEMENT ACT 21 (2000), <http://www.bu.edu/ecologyonline/projects/california/mlma.pdf>.

42. Paine, *supra* note 37; James A. Estes & John F. Palmisano, *Sea Otters: Their Role in Structuring Nearshore Communities*, 185 SCIENCE 1058 (1974).

2.4. MAINTAINING OR RESTORING CONNECTIVITY

The MLMA's primary goal of sustainability is also consistent with the final ecological principle of *maintaining or restoring connectivity*. Managing for sustainability ultimately involves managing for diverse species and habitats. Diversity and population persistence is often highly dependent on the connections that exist across the seascape—for populations, habitats, and food resources.⁴³ In order to “conserve the health and diversity of marine ecosystems and marine living resources”⁴⁴ it is necessary to maintain connectivity between populations and habitats.⁴⁵ By maintaining species and habitat diversity, as well as connectivity between species populations and their habitats, the MLMA further supports productivity and population persistence.⁴⁶

In calling attention to the importance of these ecological principles, the MLMA guides the DFG and the FGC towards comprehensive ecosystem planning where the entire suite of living marine resources are addressed and the four ecological principles can be applied toward achieving sustainable marine ecosystems.

43. Robert K. Cowen et al., *Population Connectivity in Marine Systems: An Overview*, 20 OCEANOGRAPHY 14 (2007); Gary A. Polis et al., *Toward an Integration of Landscape and Food Web Ecology: The Dynamics of Spatially Subsidized Food Webs*, 28 ANN. REV. ECOLOGY & SYSTEMATICS 289 (1997).

44. FISH & GAME § 7050(b)(1).

45. Hastings, *supra* note 33; Jesús Pineda et al., *Larval Transport and Dispersal in the Coastal Ocean and Consequences for Population Connectivity*, 20 OCEANOGRAPHY 22 (2007).

46. Cowen, *supra* note 43.

2.5. ECOSYSTEM VULNERABILITY

Finally, in addition to the MLMA's particular attention to the principles, the Act also highlights the importance of other ecological concepts that when accounted for increase ecosystem resilience, including:

- **CONTEXT:** “[c]oordinate and cooperate with adjacent states, as well as with Mexico and Canada, and encourage regional approaches to management of activities and uses that affect marine living resources. Particular attention shall be paid to coordinated approaches to the management of shared fisheries”;⁴⁷
- **UNCERTAINTY:** “[s]upport and promote scientific research on marine ecosystems and their components to develop better information on which to base marine living resource management decisions”;⁴⁸ and “[m]anage marine living resources on the basis of the best available scientific information and other relevant information that the commission or department possesses or receives.”⁴⁹
- **CLIMATE CHANGE:** to achieve the primary fishery management goal of sustainability, each fishery must have the following objective: “[t]he management system is proactive and responds quickly to changing environmental conditions and market or other socioeconomic factors and to the concerns of fisheries participants.”⁵⁰

These concepts as well as others will be developed in this chapter and in the Overarching Themes chapter. In the following pages we discuss the four ecological principles “in practice,” as well as the concept of ecosystem vulnerability, and its subcomponents cumulative impacts and climate change (see Introduction chapter for a detailed introduction to the ecological principles and ecosystem vulnerability).

47. *Id.* at § 7050(b)(9).

48. *Id.* at § 7050(b)(5).

49. *Id.* at § 7050(b)(6).

50. *Id.* at § 7056(l).

TABLE NO 1
QUICK VIEW *of* ECOLOGICAL PRINCIPLES
CAPTURED *in the* MLMA

| | NATIVE SPECIES DIVERSITY | HABITAT DIVERSITY AND HETEROGENEITY | KEY SPECIES | CONNECTIVITY |
|---|--------------------------|-------------------------------------|-------------|--------------|
| “‘Sustainable,’ ‘sustainable use,’ and ‘sustainability,’ with regard to a marine fishery, mean both of the following: (a) Continuous replacement of resources, taking into account fluctuations in abundance and environmental variability. (b) Securing the fullest possible range of present and long-term economic, social, and ecological benefits, maintaining biological diversity, and, in the case of fishery management based on maximum sustainable yield, taking in a fishery that does not exceed optimum yield.” ⁵¹ | ✓ | ✓ | ✓ | ✓ |
| “conserve the health and diversity of marine ecosystems and marine living resources” ⁵² | ✓ | ✓ | ✓ | ✓ |
| “allow and encourage only those activities and uses of marine living resources that are sustainable” ⁵³ | ✓ | | ✓ | ✓ |
| “ensure the conservation, sustainable use, and, where feasible, restoration of California’s marine living resources” ⁵⁴ | ✓ | | | |
| “[t]he fishery is conducted sustainably so that long-term health of the resource is not sacrificed in favor of short-term benefits” ⁵⁵ | ✓ | | | |
| “support and promote scientific research on marine ecosystems and their components” ⁵⁶ | ✓ | ✓ | ✓ | ✓ |
| “[t]he health of the marine fishery habitat is maintained and, to the extent feasible, habitat is restored, and where appropriate, habitat is enhanced” ⁵⁷ | | ✓ | ✓ | ✓ |
| “[p]rograms for the conservation and management of the marine fishery resources of California shall be established and administered to...facilitate long-term protection and, where feasible, restoration of marine fishery habitats, and to achieve the sustainable use of the state’s fishery resources” ⁵⁸ | | ✓ | ✓ | ✓ |
| “[t]he fishery limits bycatch to acceptable types and amounts” ⁵⁹ | ✓ | | ✓ | |
| Include “[a]nalysis of the amount and type of bycatch” ⁶⁰ | ✓ | | ✓ | |
| Summarize “[t]he natural history and population dynamics of the target species and the effects of changing oceanic conditions on the target species” ⁶¹ | | | | ✓ |
| “[i]dentify essential fishery information for the fishery, including, but not limited to, age and growth, minimum size at maturity, spawning season, age structure of the population” ⁶² | | | | ✓ |

51. FISH & GAME § 99.5.

52. *Id.* at § 7050(b)(1).

53. *Id.* at § 7050(b)(2).

54. *Id.* at § 7050(b).

55. *Id.* at § 7056(a).

56. *Id.* at § 7050(b)(5).

57. *Id.* at § 7056(b).

58. *Id.* at § 7055(b).

59. *Id.* at § 7056(d).

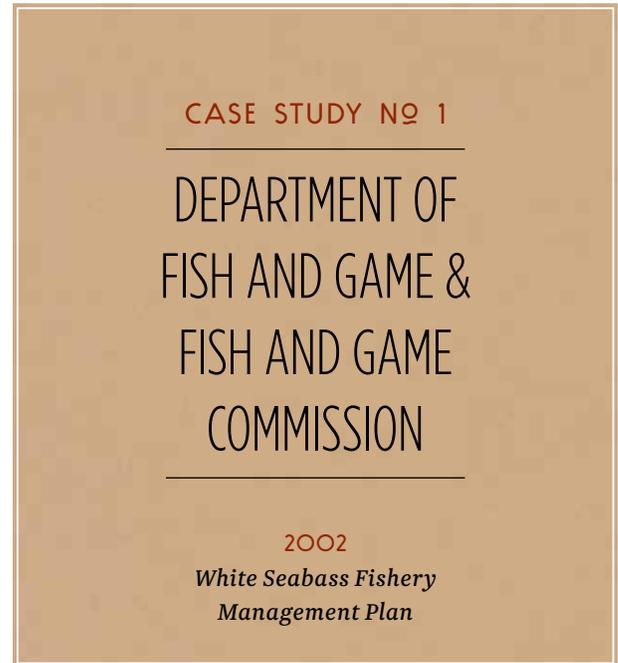
60. *Id.* at § 7085(b).

61. *Id.* at § 7080(b).

62. *Id.* at § 7081(b).

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WHITE SEABASS FISHERY MANAGEMENT PLAN (WSFMP)



Of the tools and management actions available to the DFG and the FGC, the development and approval of FMPs has proven the most significant since the enactment of the MLMA. FMPs “form the primary basis for managing California’s sport and commercial marine fisheries.”⁶³ In addition to conforming to the goals and objectives of the MLMA, every FMP must also be based on the best available science and other relevant scientific information that is possessed or may easily be attained by the DFG.⁶⁴ In this section we explore the White Seabass FMP (WSFMP) and address how it incorporates ecological principles into the management plan. We also provide ideas for where an increased and refined application of the principles and recognition of ecosystem vulnerability could be used in future management decisions. After the discussion of each ecological principle and component of ecosystem vulnerability, a prioritized checklist is provided to aid in the uptake of the ideas presented here for future management decisions.

⁶³. *Id.* at § 7072(a).

⁶⁴. *Id.* at § 7072(b).

3.1. CASE STUDY CRITERIA: SELECTION OF THE WSFMP

The WSFMP was selected as a case study because it is one of the few FMPs completed pursuant to the MLMA guidelines. Both the Abalone Recovery and Management Plan and the Market Squid Fishery Management Plan were developed and established pursuant to a variety of legislative actions. Although the Nearshore Fishery Management Plan was also developed solely pursuant to the MLMA guidelines, it outlines the management of nineteen nearshore species and is not representative of the DFG and the FGC's conventional single-species approach to management. Finally, while the other case studies are located along the central and northern California coastline, white seabass are mainly found from the Southern California Bight south into



CALIFORNIA WHITE SEA BASS

Atractoscion nobilis

Mexican waters. The WSFMP therefore affords the opportunity to discuss a management measure situated predominantly in the southern third of the state. Finally, we sought to evaluate only recent agency actions—specifically, we limited our review to actions taken within the last ten years. The WSFMP is exactly ten years old (completed in 2002) and has experienced a decade of annual reviews. Each year the White Seabass Scientific and Constituent Advisory Panel has reviewed the FMP incorporating additional data and information on the species to determine if any management changes should be recommended.⁶⁵ The WSFMP and the annual reviews provide a rich history of decision making and strong lessons for the DFG and the FGC.

⁶⁵. The most recent Annual Review of White Seabass Fishery Management is available at <http://www.dfg.ca.gov/marine/wsfmp/index.asp>.

WHILE THE GUIDE USES
CASE STUDIES TO PROVIDE
SPECIFIC EXAMPLES, THE TIPS
DRAWN FROM THE CASE
STUDIES ARE MEANT TO
APPLY BROADLY TO A WIDE
SPECTRUM OF COASTAL AND
MARINE MANAGEMENT
DECISIONS. CHECKLISTS ARE
PROVIDED AFTER EACH
SECTION TO HELP AGENCY
STAFF ACCOUNT FOR THESE
IMPORTANT PRINCIPLES WHEN
MAKING DAILY MANAGEMENT
RECOMMENDATIONS AND
DECISIONS.

CONTENTS *of a* FISHERY MANAGEMENT PLAN⁶⁶

FISHERY SUMMARY:

- Species, location, number of vessels and participants, fishing effort, historical landings, and a history of conservation and management measures affecting the fishery;
- The natural history and population dynamics of the target species, along with effects of changing oceanographic conditions on the target species;
- The habitat for the fishery or species and known threats to the habitat;
- The ecosystem role of the target species and the relationship of the fishery to that role;
- The economic and social factors related to the fishery.

FISHERY RESEARCH PROTOCOLS:

- A description of past and ongoing monitoring of the fishery;
- Essential Fishery Information (EFI) for the fishery and identification of additional information, resources, and time needed;
- Procedures for monitoring the fishery and for obtaining EFI.

NECESSARY CONSERVATION AND MANAGEMENT MEASURES:

- Limitations on the fishery;
- Creation or modification of a restricted access program that contributes to a more orderly and sustainable fishery;
- A procedure to establish, review, and revise a catch quota;
- Requirements for permits.

MEASURES TO minimize adverse effects on habitat caused by fishing.

INFORMATION AND ANALYSIS on the amount and type of bycatch associated with target species. Conservation and management measures must be implemented to minimize bycatch, and unavoidable mortality of discards.

CRITERIA FOR identifying when the stock is overfished and measures to address overfishing if occurring;

A PROCEDURE for review and amendment of the plan.

66. FISH & GAME §§ 7080-7088. See also CAL. DEP'T OF FISH & GAME, *supra* note 36, at 2-1, 2-2.

3.2. ECOLOGICAL PRINCIPLES IN ACTION

The following discussion showcases how the DFG and the FGC incorporated the ecological principles and components of ecosystem vulnerability into their review of the WSFMP. Excerpts from the FMP illustrate precise examples of where the ecological principles and ecosystem vulnerability are currently incorporated into management decisions. The discussion that follows the excerpts identifies concrete ways to advance ecosystem-based fisheries resource management further along the EBM and sustainability continuum. The ideas presented here need not apply only to FMPs. Other fisheries management measures can also be advanced by putting these EBM practices into action. Checklists following each section identify data and analyses necessary to account for the ecological principles and ecosystem vulnerability. While the checklists are not exhaustive, they may nonetheless suggest data gathering and analyses that are beyond the agency's current capacity. In addition, it is understood that the DFG and the FGC's management decisions necessarily involve both synergies and tradeoffs between their responsibilities to preserve the sustainability of both the ecological and social components of the ecosystem. For these reasons, the items in the checklist are presented in priority order, with the top analyses being most important to consider when accounting for the ecological principles in any decision.

3.2.1. MAINTAINING OR RESTORING NATIVE SPECIES DIVERSITY

SPECIES DIVERSITY is a measure of the number and types of species that occupy an area. Highly diverse ecosystems tend to be more productive and resilient and numerous studies have documented the connection between the loss of species diversity and the loss of ecosystem functioning.

Measuring species diversity usually conjures images of counting the number of different types of plants and animals in a defined area. Diversity, however, can also be measured within a single species by measuring genetic diversity across a population. Distinct patterns of genetic diversity within a population can be used to define a discrete stock of the population (Box 1).

Understanding the spatial patterns of genetic diversity in a species is necessary for fisheries management because stocks may be more or less resilient to human activities due to their genetic make-up. Patterns of genetic diversity are also likely to be indicative of oceanographic currents and barriers to dispersal, which can help agency staff determine the degree of connectedness between stocks. As we discuss in the connectivity section that follows, connectivity between stocks or populations both increases diversity and is necessary for maintaining future populations. The WSFMP recognizes the importance of understanding the genetic structure of the white seabass populations by including gene flow and genetic structure of the white seabass stock as Essential Fisheries Information (EFI) to be included in the WSFMP to inform management decisions.

BOX NO 1

NATIVE SPECIES DIVERSITY

DISTRIBUTION OF STOCKS

"A stock is a population unit that is selected for management purposes. It may be defined based on its ecology, genetics, and/or geographic separation. Discrete stocks of a given species may have very different growth rates, reproductive schedules and capacity, and even ecological

relationships. Stock distribution refers to where a stock is found, and is important in addressing jurisdictional issues. Specific EFI includes the depth and geographic range of a species, the amount of gene flow and genetic structure of the stock, and whether stocks are separate or continuous."⁶⁷

67. CAL. DEP'T OF FISH & GAME, FINAL WHITE SEABASS FISHERY MANAGEMENT PLAN 7-2 (2002) [hereinafter WSFMP].



Prioritize research, data analysis, and data collection to increase understanding of population genetic structure, movement, and larval dispersal.



Spatial information is critical for maintaining or restoring species diversity. Even in the context of single species management decisions, diversity is an important consideration. Maintaining the genetic diversity of a single species partly depends on maintaining connectivity across the species range. High genetic diversity can increase the resilience of the population to stressors, decreasing the risk of stock collapse due to a single disturbance event or changing ocean conditions.⁶⁸ Genetic diversity across populations of a single species can be used to inform appropriate harvest limits, as well as seasonal and area closures if the pathways of genetic connectivity are known (e.g., area closures could be created in areas known to be sources of larvae for the population). In addition, genetic data from multiple target species could be analyzed to determine if there are similar mechanisms driving connectivity across species. For the white seabass, there are currently not enough data characterizing stock distribution, migration, and larval dispersal—data gaps that are present across much of fisheries management—to effectively use genetic diversity in management applications at this time.

Addressing these data gaps does not necessarily require the collection of new data, but it does necessitate identifying existing data sources outside of the DFG, such as academic research programs, that could be included in EFI and analyzed as part of a FMP or other management measure. There are an increasing number of collaborative efforts between

fishermen and scientists that the DFG and the FGC could continue to be involved in to capitalize on external sources of existing data. For example, in 2008 the Ocean Protection Council (OPC) authorized disbursement of \$300,000 to the Pacific States Marine Fisheries Commission (PSMFC) to establish a Collaborative Fisheries Research organization to “develop, solicit, and fund projects with the goal of creating partnerships between fishermen and scientists to develop and collect fisheries data” needed by the DFG, the FGC, the PSMFC, and the OPC.⁶⁹ Since that time, the OPC has disbursed an additional \$1,500,000 to the PSMFC and the University of California Sea Grant Program to build out the organization.⁷⁰ The California Collaborative Fisheries Research Program was recently awarded three years of funding from California Sea Grant to integrate MLMA and Marine Life Protection Act (MLPA) data with data-limited tools as a means of improving California fisheries management.⁷¹ Public-private partnerships (PPPs), such as the MLPA Initiative, are another creative solution to address data availability and analyses gaps. PPPs pool resources and staff across local, state, and federal agencies, local communities, and private institutions such as non-governmental organizations (NGOs) to close important data gaps.



EFI and FMPs can be strengthened and uncertainty can be reduced by identifying relevant studies that have been conducted by other institutions and exploring alternative methods for analyzing data. Obtaining and analyzing such data would inform the development of a more robust scientific foundation across all fisheries management plans and other fisheries regulations.

68. Daniel E. Schindler et al., *Population Diversity and the Portfolio Effect in an Exploited Species*, 465 NATURE 609 (2010).

69. *Collaborative Fisheries Research Organization*, CAL. OCEAN PROT. COUNCIL, <http://www.opc.ca.gov/2010/08/collaborative-fisheries-research-organization/> (last visited May 11, 2012).

70. *The California Collaborative Fisheries Research Program*, CAL. SEA GRANT, <http://seagrant.mlml.calstate.edu/research/ccfrp/> (last visited May 11, 2012).

71. *Id.*

THE FOLLOWING
PRIORITIZED CHECKLIST
IDENTIFIES THE TYPES
OF INFORMATION
NECESSARY TO ACCOUNT
FOR THE MAINTENANCE OR
RESTORATION OF NATIVE
SPECIES DIVERSITY.

ACCOUNTING *for* SPECIES DIVERSITY (in order of priority)

- ✓ Identify the numbers and types of **species** impacted by the project
- ✓ Identify the numbers and types of **impacts** on species (e.g., anchor, burial, water quality)
- ✓ Map and analyze the **spatial distribution** of impacted species (e.g., rare vs. common species, population size, location)
- ✓ Evaluate the **duration and frequency** of each impact to species (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to species
 - Assess appropriate levels of duration and frequency of each impact to species
- ✓ Analyze the **seasonal characteristics** of the impacted species (e.g., spatial and temporal characteristics of breeding, spawning, and migration)
- ✓ Evaluate the **life history characteristics** of the impacted species (e.g., spatial movement of larvae, juveniles, and adults; lifespan; reproductive potential)
- ✓ Analyze the **genetic patterns** of managed and impacted species (e.g., subpopulation boundaries)

Stereolepis gigas

GIANT SEABASS can grow in excess of 200 pounds and range from Humboldt Bay, California, to the tip of Baja, Mexico. Juveniles have been found amongst mats of drifting kelp while adults are found on rocky reefs. Giant seabass form large spawning aggregations, which led to their near extinction from overfishing. Giant seabass are still listed as critically endangered.

PHOTO: 2007 Octavio Aburto / Marine Photobank

3.2.2. MAINTAINING OR RESTORING HABITAT DIVERSITY AND HETEROGENEITY

HABITAT DIVERSITY is a measure of the number and types of habitats that are found within an area.

HABITAT HETEROGENEITY is defined as the spatial arrangement of those habitats. High habitat diversity and heterogeneity help to increase the successful movement of individuals, nutrients, and important food sources between habitat types; are positively correlated with species diversity; and are linked with increased food web stability.

Habitat diversity and heterogeneity are fundamental components of EFI because white seabass use multiple types of habitat throughout their lives. Taken together, these habitats influence growth, survival, reproduction, movement, and ultimately population success. The WSFMP calls attention to these habitat types and potential impacts to them throughout the document (Box 2).



When making management decisions and drafting FMPs or other fisheries regulations:

- **Provide detailed location descriptions of where fish are found and explain the importance of different habitat types to target species.**
- **Identify the activities that could impact important habitats.**
- **Connect location descriptions, the importance of different habitat types, and the activities that could impact important habitats to the long-term sustainability of the fishery.**

BOX NO 2

HABITAT DIVERSITY & HETEROGENEITY

CRITICAL HABITAT

"Young-of-the-year (age 0) white seabass ranging in length from 6 to 57 mm (0.25 to 2.25 in.) inhabit the open coast at depths of from 4 to 9 m (12 to 30 ft). These young fish are closely associated with small drifting debris and algae in shallow areas just outside the surf zone. . . . By the time white seabass are two years old, some have moved into protected bays and are found in association with eelgrass beds. Larger juveniles (three and four years old) are caught off piers and jetties and in kelp beds. Large white seabass school over rocky substrate in or near the large kelp beds that fringe the beaches and offshore islands. They are also found several miles offshore in schools swimming at or near the surface."⁷²



A diverse number and a diverse spatial allocation of habitats can (1) provide refugia from competition and predation, (2) support a variety of prey species, and (3) influence connectivity by facilitating successful movement of individuals among multiple habitats.⁷³ An in-depth understanding of the managed species' habitats is thus important. Accordingly, the MLMA, the Master Plan and the FMPs emphasize both the importance of habitat health and an understanding of the types and roles of habitats

⁷². WSFMP, *supra* note 67, at 2-6 (citations omitted).

⁷³. Melissa M. Foley et al., *Guiding Ecological Principles for Marine Spatial Planning*, 34 *MARINE POL'Y* 955 (2010).

on which fisheries rely. Although the link between healthy habitats and achieving the MLMA's goal of sustainability is straightforward, actual descriptions of habitats and the important role they play in the lifecycle of targeted species specifically and in ecosystem health more broadly could be further fleshed out in the WSFMP, other FMPs, and the Master Plan.

Establishing increased confidence in the “where, how, and why” of different types of habitats for the white seabass and other managed species could help managers make more informed, scientifically-based decisions regarding which habitats are important to maintain and which spatial arrangements of habitats supports fish populations.

For example, Chapter 2 of the WSFMP includes a discussion of critical habitat, but the description of white seabass habitat is couched in uncertain terms. The WSFMP states, “[a]necdotal information indicate that [young-of-the-year white seabass] are occasionally caught mixed with bait fish (anchovy) schools.”⁷⁴ It also explains that some two year olds are found in eelgrass beds in protected bays and that some larger juveniles have been caught off piers and jetties and in kelp beds.⁷⁵ While these descriptions state spatially where some white seabass have been located, the description relies on anecdotal information and lists sporadic locations for the habitat. Habitat descriptions for managed species could be improved by analyzing the importance of the described habitat to the overall health or productivity of fish populations. For example, improved understanding of the importance of eelgrass beds to juvenile recruits and the importance of kelp beds to adults could be used to adjust regulations.

Chapter 6 of the WSFMP lists the activities that could impact important white seabass habitat

during examination of the proposed white seabass management alternatives. The expected habitat impacts of each alternative are reviewed, including threats such as anthropogenic debris, boat traffic and anchors,⁷⁶ noise disturbance, and non-consumptive uses. However, while these additional impact concerns are raised, they are largely dismissed (“no lasting effect on the kelp beds as a whole”).⁷⁷ A more in-depth discussion of why these impacts are dismissed—or why they shouldn't be dismissed—would be a valuable additional step to inform overall analysis of impacts on habitat.

Moreover, an entirely separate chapter of the WSFMP (Chapter 9) acknowledges a suite of stressors that could impact white seabass habitat including water and air quality, coastal development, wetland loss (juvenile white seabass habitat), and non-native species concerns in addition to other habitat losses, degradation, and modification.⁷⁸ This discussion also acknowledges that white seabass have different habitat needs throughout their life-cycles and that the habitats most influenced by human activities are nearshore waters, bays, and estuaries.⁷⁹ While it is good to raise these habitat concerns, it would be especially useful to discuss them in the same chapter or part of the regulation that discusses impacts (e.g., Chapter 6 in the WSFMP), since these considerations will affect which management alternative(s) is capable of reaching the goals of the MLMA.

Finally, in an effort to connect these three issues to overall sustainability, analyses should recognize the overall consequences of habitat loss and rewards from habitat preservation. For example, under the MLPA California established a system of marine protected areas in state waters, protecting habitat through state marine reserves, marine parks, and marine conservation areas. Some of this habitat pro-

74. WSFMP, *supra* note 67, at 2-6 to 2-7.

75. *Id.* at 2-7.

76. “The boats, ranging in size from 20 to 45 feet (6-14 m), will either drift or anchor within or adjacent to kelp beds.” *Id.* at 3-7.

77. *Id.* at 6-11 (citation omitted).

78. *Id.* at 9-7 to 9-8.

79. *Id.* at 9-7.

tection will ultimately help the long-term sustainability of the fishery, and taking those areas into account when managing the fishery is one way (but not an all inclusive way) to account for habitat diversity and heterogeneity in FMPs and other regulations.

The Near Shore FMP, for example, discusses the importance of habitat protection but relies solely on MPAs to “provide required non-target species benefits, ecological health benefits, non-commercial use benefits and habitat protection.”⁸⁰ In addition to acknowledging the importance of MPAs for habitat and species diversity, other management measures, such as decreasing fishing effort or implementing gear restrictions in certain marine environments, could be included in management measures to account for species and habitat benefits.⁸¹ These measures could provide additional habitat protection, thereby promoting species diversity, healthy key species, and increased connectivity.



Information on the abundance and spatial arrangement of habitats, including definitive descriptions of important habitats and the activities that could impact them, are necessary for making well-informed fishery management decisions and for evaluating project or management alternatives. This information could also be used to account for and incorporate habitat impact concerns into the management process. The analysis of important habitats and possible threats to them is particularly relevant when the DFG provides comments on EIRs for projects that are non-fishery related, especially if the activity could affect the DFG’s ability to manage the stock.

80. Michael Healey & Ralph Larson, *Science and the MLMA: A Working Paper 21* (Working Paper, 2010) (on file with the author).

81. *Id.* at 21.

THE INTERSECTION of the MLMA and the MLPA

MLPA implementation created a statewide network of marine protected areas through the designation of state marine reserves, state marine conservation areas, state marine parks, and state marine recreational management areas. Included in the goals of these MPAs are protecting the natural diversity and abundance of marine life; sustaining, conserving, and protecting economically important species; and protecting representative and unique habitats.⁸² These goals are complementary with the goals of the MLMA, and the designation of MPAs is consistent with the need to protect important habitats and dependent species for the sustainability of ecologically and economically important fished species.

The MLPA process resulted in the following habitat protection (as a percentage of available habitat in the region)⁸³:

| | NORTH COAST | NORTH CENTRAL COAST | CENTRAL COAST | SOUTH COAST |
|-----------------------|-------------|---------------------|---------------|-------------|
| Rocky Shores | 12% | 32% | 28% | 24% |
| Kelp | 8% | 39% | 44% | 13% |
| Shallow Rock | 8% | 36% | 29% | 17% |
| Mid-depth Rock | 22% | 33% | 26% | 21% |
| Deep Rock | 38% | N/A | 20% | 25% |
| Beaches | 10% | 11% | 21% | 13% |
| Shallow Sand | 12% | 6% | 19% | 17% |
| Mid-depth Sand | 15% | 24% | 11% | 19% |
| Deep Sand | 18% | 70% | 13% | 20% |
| Estuary | 3% | 23% | 54% | 8% |
| Marsh | 3% | 32% | 100% | 30% |
| Eelgrass | 37% | 50% | 100% | 14% |
| Tidal Flats | 1% | 34% | 69% | 20% |

82. FISH & GAME § 2853

83. Mary Gleason et al., *Designing a Statewide Network of Marine Protected Areas in California*, OCEAN & COASTAL MGMT. (forthcoming 2012).

THE FOLLOWING
PRIORITIZED CHECKLIST
IDENTIFIES THE TYPES
OF INFORMATION
NECESSARY TO ACCOUNT
FOR THE MAINTENANCE
OR RESTORATION OF
HABITAT DIVERSITY AND
HETEROGENEITY IN THE
MARINE ENVIRONMENT.

ACCOUNTING *for*
HABITAT DIVERSITY
and HETEROGENEITY
(in order of priority)

- ✓ Identify the numbers and types of **habitat** impacted and the role they play in the ecosystem (e.g., nursery, spawning, foundation)
- ✓ Identify the numbers and types of **impacts** on habitats (e.g., anchor, burial by sediment, water quality)
- ✓ Map and analyze the **spatial distribution** of impacted habitats (e.g., rare vs. common habitats, habitat size, location)
- ✓ Evaluate the **duration and frequency** of each impact to habitats (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to habitats
 - Assess appropriate levels of duration and frequency of each impact to habitats
- ✓ Identify the spatial and temporal characteristics of **dynamic habitats** (e.g., upwelling, fronts) and the role they play in the ecosystem (e.g., nutrient source, aggregation area)

*Macrocystis
pyrifera*

FORESTS OF GIANT KELP are found from central to southern California and provide important habitat for juvenile white seabass, among other managed species.

3.2.3. MAINTAINING OR RESTORING POPULATIONS OF KEY SPECIES

KEY SPECIES are individual species or a group of species that have a disproportionately strong impact on ecosystem structure and function, and may include foundation species, keystone species, top predators, or basal prey. Healthy populations of key species allow for stable, resilient ecosystems by creating habitat for other species, disproportionately influencing community dynamics, and driving food web structure.

There are multiple key species to be considered within the WSFMP. Kelp forests are recognized as a preferred habitat for adult white seabass, especially during spawning. Kelp species that comprise these forests are considered a type of key species—foundation species—providing habitat and food that would otherwise not exist. Second, a number of basal prey species are part of the white seabass diet, such as northern anchovy and Pacific sardine (Box 3). It is important to understand how key species influence the survival and sustainability of other species. Specifically, population fluctuations of basal prey species are an essential component of EFI included in fisheries management decisions because predator populations are also likely to fluctuate if there are not enough resources to sustain predators when basal prey populations are low.⁸⁴ These population fluctuations are critical to understand in

order for managers to set appropriate harvest limits from year to year that support sustainable fishing practices.



Analyze available data to understand how fish population fluctuations are related to population cycles of their predators, prey, important foundation species (e.g., kelp), and the interactions among them.



Key species tend to have strong interactions with the rest of the ecological community and therefore have a disproportionate impact on the health of an ecosystem. The loss or population reduction of a key species may result in a trophic cascade that causes indirect effects to reverberate throughout the food web. Paying attention to management measures that increase the presence of, and account for the impacts to key species could greatly increase overall ecosystem health.

The white seabass, as well as a variety of other managed species, consume anchovy and sardines as their primary source of prey. These two prey species are known to experience vast population swings that

BOX NO 3 KEY SPECIES

PREDATOR/PREY RELATIONSHIPS

"Knowledge of the food preferences and habits of white seabass are primarily anecdotal. However, mysid shrimp (Mysidae) made up a major portion of the diet of juvenile white seabass taken in and just outside of San Diego Bay. Adults are known to feed on northern anchovy (*Engraulis mordax*); market

squid (*Loligo opalescens*); Pacific sardine (*Sardinops sagax*); blacksmith (*Chromis punctipinnis*); silversides (Atherinopsidae species); and pelagic red crab (*Pleuroncodes planipes*). Large white seabass have been found to have eaten only Pacific mackerel (*Scomber japonicus*)."⁸⁵

84. ELLEN K. PIKITCH ET AL., LENFEST OCEAN PROGRAM, LITTLE FISH, BIG IMPACT: MANAGING A CRUCIAL LINK IN OCEAN FOOD WEBS (2012).

85. WSFMP, *supra* note 67, at 2-6 (citations omitted).

coincide with large-scale ocean circulation regimes.⁸⁶ While white seabass, and other managed species, may be able to switch prey sources under such conditions, it is critical to the sustainability of a fishery to have a better understanding of the proportional dependence of the managed species' diet on prey species which experience large population fluctuations. In addition, current knowledge of the type, distribution, and population status of predators of the species managed by the DFG and the FGC could be enhanced through the use of previously collected quantitative data from external research programs or qualitative data from fishermen. An increased understanding of the predators' needs would allow for an increased understanding of the overall pressures (both human and biological) on the managed species, allowing for these needs to be incorporated into allowable catch estimates of the species being managed. Alternative methods are increasingly being used at research institutions for determining prey sources and key predators in the ecosystem. One such method is stable isotope analyses, which use chemical fingerprints, rather than fragments from fish stomachs, to identify the prey species.⁸⁷ The data from these analyses can elucidate predator-prey relationships that would be difficult to determine by observations or stomach content analyses alone.

In addition to understanding the role basal prey species play in the white seabass fishery, another key species is important to white seabass populations. Kelp is considered a foundation species, creating productive and complex habitats⁸⁸ for a number of commercially important species, including white seabass. Therefore, management measures should adequately account for and mitigate impacts to this foundation species.



Many fished species interact with key species via their prey, predators, or habitat. Fluctuations in the abundance and presence of key species can have strong effects on managed species. The relationships between managed species and key species should be accounted for and included in management decisions with particular attention paid to how the fishery and other impacts may affect populations of key species.

The following prioritized checklist is provided to help staff identify the types of key species present in the marine environment and their contributions to ecosystem function.

ACCOUNTING *for* KEY SPECIES

(in order of priority)

- Identify the impacts to:
 - **Foundation Species** (e.g., kelp, seagrass)
 - **Basal Prey** (e.g., sardines, anchovies, mullet)
 - **Top Predators** (e.g., sharks, tuna, sea lions, elephant seals)
 - **Keystone Species** (e.g., sea otters, sea stars)
- Identify the impacted species' **contributions to ecosystem functioning** (e.g., weigh significance of the impacts)
- Evaluate whether the impacts will cause a **trophic cascade** in the system

⁸⁶. Francisco Chavez et al., *From Anchovies to Sardines and Back: Multidecadal Change in the Pacific Ocean*, 299 *SCIENCE* 217 (2003).

⁸⁷. Brian Fry & Evelyn B. Sherr, *Use of Stable Isotopes in Marine Ecology - A Review*, 6 *ESTUARIES* 303 (1983).

⁸⁸. Michael H. Graham et al., *Global Ecology of the Giant Kelp Macrocytistis: From Ecotypes to Ecosystems*, 45 *OCEANOGRAPHY & MARINE BIOLOGY* 39 (2007).

3.2.4. MAINTAINING OR RESTORING CONNECTIVITY

CONNECTIVITY is defined as the movement of individuals or materials (e.g., nutrients) between populations and habitats. Connectivity between habitats and populations increases productivity and resilience, and decreases the vulnerability of ecosystems to natural and human disturbances.

The WSFMP recognizes that movement patterns are essential for understanding connectivity among populations of white seabass, particularly in the face of changing oceanographic patterns and sea surface temperatures (Box 4).



Continue to use marked hatchery white seabass or other hatchery species to increase knowledge of the movement patterns of managed species and consider the importance of connectivity when assessing the impacts of hatchery fish on the overall ecosystem.



The previous discussions on species diversity and habitat diversity and heterogeneity are also directly related to connectivity. Connectivity across individual populations is important for maintaining genetic diversity across the species range. Heterogeneous distribution of habitats is one factor that helps to facilitate connectivity between populations for many species by providing “stepping stones” across the seascape. In addition, habitat diversity is an important feature of marine ecosystems as many species transition from one habitat to another as they progress through their life stages (e.g., larval, juvenile, adult). Managing for habitat connectivity is directly linked with habitat diversity and heterogeneity and is also necessary for maintaining species diversity. To understand the spatial and temporal characteristics of connectivity pathways, how-

ever, one must also understand where species and habitats are located and when they are used in order to deduce which areas and oceanographic features are driving connectivity. While we separate the principles here for ease of discussion, they are all inter-related.

BOX NO 4

CONNECTIVITY

MOVEMENT PATTERNS

“This information identifies the spatial distribution of fish and their residence time in specific habitats. Many species may exhibit movement patterns that are associated with specific oceanographic conditions. Certain species may aggregate in specific areas for spawning, move in predictable patterns, or move to certain locales that make them especially vulnerable to harvest. Insights into the movement patterns of fish are important to the development of management strategies based on regional catch quotas or marine protected areas. Specific EFI includes the home range, homing ability, seasonal migrations, environmental cues, and spawning grounds of a species.”⁸⁹

One method for increasing knowledge of the movements of white seabass is to use the data collected from the tagging of white seabass from the Ocean Resources Enhancement and Hatchery Program.⁹⁰ Fish are tagged at the hatchery and fishermen are

⁸⁹. WSFMP, *supra* note, 67 at 7-3.

⁹⁰. *Id.* at 4-4.

encouraged to report tagged fish when they are caught. These tags allow scientists to identify individual fish and the site of capture. While the tags do not provide continuous movement data, they are an important data source for understanding where fish occur.

In addition, data that were gathered to inform the MLPA scientific guidelines for network connectivity could be a valuable resource for incorporating connectivity—especially larval dispersal and adult movement potential—into management decisions.⁹¹



Fish populations do not exist in isolation; they are connected to other populations, habitats, and resources that influence their growth, survival, and reproductive success. The importance of considering connectivity in ocean and coastal management decisions is increasingly being recognized.⁹² Larval dispersal, adult movement and migration, and resource flow are all components of connectivity that can be considered as part of a fisheries management plan and other management decisions.

In recognition of these important connectivity concepts, we provide the following prioritized checklist to help staff further account for connectivity.

91. CAL. DEP'T OF FISH & GAME, CALIFORNIA MARINE LIFE PROTECTION ACT MASTER PLAN FOR MARINE PROTECTED AREAS 34 (2008).

92. Maria Beger et al., *Conservation Planning for Connectivity across Marine, Freshwater, and Terrestrial Realms*, 143 *BIOLOGICAL CONSERVATION* 565 (2010).

ACCOUNTING *for* CONNECTIVITY

(in order of priority)

- Identify the approximate **dispersal distance** of larvae of the impacted species (e.g., see MLPA “Size and Spacing” guidelines)⁹³
- Evaluate the **circulation patterns** in the project area (e.g., wind, waves, tides, currents, stream flow)
- Identify areas that may be important larval **retention features** (e.g., fronts, eddies, bays, lees of headlands)
- Evaluate overlap between agency jurisdiction and species ranges and consider any **biogeographic boundaries** that occur within the managed area
- Assess impacts on **migration patterns**

93. CAL. DEP'T OF FISH & GAME, *supra* note 91; David Siegel et al., *Lagrangian Descriptions of Marine Larval Dispersion*, 260 *MARINE ECOLOGY-PROGRESS SERIES* 83 (2003).

3.3. ECOSYSTEM VULNERABILITY

In the context of ecosystems, **VULNERABILITY** is specifically defined as the likelihood that a species or habitat will incur losses due to a disturbance, natural or human-induced. Vulnerable habitats or species are likely to sustain damage when exposed to a stressor or impact to which they are susceptible.

White seabass populations and essential habitat are vulnerable to a range of impacts from the fishery itself and impacts by other sectors. The frequency and magnitude of these impacts could significantly influence population persistence and sustainability. The WSFMP recognizes this and states that FMPs must include measures to minimize these non-fishery effects on fish populations (Box 5).



Develop management measures and thresholds for the activities to which white seabass and other managed species, and their dependent habitats

are vulnerable.



The WSFMP contains a brief section titled "Analysis of Impacts," which effectively points out many of the stressors that impact species diversity, habitat diversity, key species, and connectivity such as "physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other

components of the ecosystem."⁹⁴ The analysis also states that:

*[f]ishery management plans must include measures that minimize adverse effects on marine ecosystems from fishing, to the extent practicable, and identify conservation and enhancement measures. They must also contain an assessment of potential adverse effects of all fishing activities and should consider the relative impacts of all fishing equipment types used in different types of habitat.*⁹⁵

Future FMPs and fisheries regulations could take this analysis a step further by setting forth meaningful management measures that address these impacts, such as alternative gear restrictions coupled with incentives for gear switching when fishing in certain locations or evaluating the compatibility of fishing equipment types on different habitats.



The number and types of impacts from fishery and non-fishery activities on species and habitats should be considered and known vulnerabilities should be assessed.⁹⁶ This general vulnerability assessment can then be used for all management decisions to determine whether certain habitats or species will be disproportionately impacted by a change in management strategy or other non-fishery impacts.

^{94.} *Id.* at 3-27 to 3-28 (citation omitted).

^{95.} *Id.* at 3-28.

^{96.} Benjamin S. Halpern et al., *Evaluating and Ranking the Vulnerability of Global Marine Ecosystems to Anthropogenic Threats*, 21 *CONSERVATION BIOLOGY* 1301 (2007).

BOX Nº 5

ECOSYSTEM VULNERABILITY

ANALYSIS OF IMPACTS

"The adverse effects from fishing activities may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Fishery management plans must include measures that minimize adverse effects on marine ecosystems from fishing, to the extent practicable, and identify conservation and enhancement measures. They must also contain an assessment of the potential adverse effects of all fishing activities and should consider the relative impacts of all fishing equipment types used in different types of habitat.

The commercial and recreational fisheries for white seabass have exploited different age groups of the stock over the years. In general, the recreational fishery catches mostly smaller, younger individuals, whereas the commercial fishery lands relatively larger, older fish. . . . Taking smaller fish may have a negative effect on the overall abundance of the population by removing individuals that have not yet spawned. If the take of immature fish exceeds the rate at which these fish are being replaced, then the resource can become overfished. . . .

The catching, handling, and release of smaller white seabass may also have substantial impacts. These activities may cause injury, permanent damage, or death. White seabass may be particularly vulnerable due to their weak, soft mouths that are easily torn and their susceptibility to barotrauma. Barotrauma (trauma due to rapid changes in atmospheric pressure) injuries affecting the gas bladders of white seabass have been observed in fish brought up from depths as shallow as 10 feet (3 meters)."⁹⁷

97. WSFMP, *supra* note 67, at 3-27 to 3-28 (citations omitted).

IF THE TAKE OF IMMATURE
FISH EXCEEDS THE RATE
AT WHICH THESE FISH
ARE BEING REPLACED,
THEN THE RESOURCE CAN
BECOME OVERFISHED.

Atractoscion nobilis

WHITE SEA BASS are a species of croaker found from Magdalena Bay, Baja California, to Juneau, Alaska. They travel in schools over deep rocky bottoms and through forests of giant kelp.

PHOTO: Wikimedia Commons, Tomascastelazo. 2012.

3.3.1. COMPONENT OF ECOSYSTEM VULNERABILITY: CUMULATIVE IMPACTS

The level and extent of impact from human-ecosystem interactions can be shaped by the **CUMULATIVE IMPACT LEVEL**—the number and intensity of other uses co-occurring in space and time—within an ecosystem.

Numerous activities that are outside the jurisdiction of the DFG and the FGC, but still within the jurisdiction of other state and federal agencies, could potentially affect white seabass populations (Box 5a). These impacts are important to consider when setting OY and MSY so that the fishery can be sustained long-term.

BOX NO 5A
CUMULATIVE IMPACTS

OTHER ECOLOGICAL CONCERNS

“Even though living marine resources are managed, for the most part, through regulatory measures that limit or alter fishing effort, factors beyond regulatory management often influence the health of fisheries. In general, factors such as pollution, water quality, habitat degradation, coastal development and land use have not been addressed by fishery management. Increasing scientific evidence that irrefutably ties these factors to the degradation of nearshore ecosystems requires that management acknowledge, mediate, or accommodate for these influences on the nearshore environment.”⁹⁸

98. WSFMP, *supra* note 67, at 9-1.



While the importance of looking at the ecosystem holistically is identified in the MLMA, the Master Plan, and the FMPs developed to date, a comprehensive cumulative impact analysis should be undertaken to inform specific management actions that would reduce the effects of particularly impactful activities.



EBM, by definition, requires consideration of cumulative impacts of human uses.⁹⁹ “Habitat protection and restoration are part of the way that fishery management is envisioned in the MLMA” and therefore when designing and implementing any FMP, it is important to include not only an analysis of impacts on a cumulative scale, but also how they impair the productivity of the fish species and what can be done to halt and reverse their effects.¹⁰⁰ Anthropogenic impacts on the marine environment are of great importance to the broad ecosystem health objectives of the MLMA.¹⁰¹ CEQA also requires a cumulative impacts assessment, defining cumulative impacts as the combined effect of the proposed project with all other past and reasonably foreseeable projects.¹⁰² Given that FMPs function legally as CEQA equivalents, they should embody the functional equivalent of CEQA’s cumulative impact requirement. In addition to informing action under the DFG and the FGC’s own authority, such cumulative impacts analysis would serve the DFG well when, as a trustee agency, it reviews decisions under consideration by other agencies that may contribute to cumulative impacts on species and habitats over which the DFG and the FGC exercise jurisdiction.

99. KAREN L. McLEOD ET AL., SCIENTIFIC CONSENSUS STATEMENT ON MARINE ECOSYSTEM-BASED MANAGEMENT (2005), http://www.compassonline.org/sites/all/files/document_files/EBM_Consensus_Statement_v12.pdf.

100. Healey, *supra* note 80, at 9.

101. *Id.*

102. CAL. CODE REGS. tit. 14, § 15355 (2012).

For example, the WSFMP discusses the different user groups who impact white seabass, including recreational and commercial fishermen as well as divers and anglers, but the current level of impact is not specified. Moreover, in Chapter 9 the WSFMP touches on the “Other Ecological Concerns” raised in Chapter 3 and further delineates a whole host of additional ecological concerns, including: environmental variability; water quality (including municipal discharge, run-off, and industrial wastewater, dredge and non-dredge material disposal, impacts of coastal shipyards and industrial pollutants such as oil and gas production, and fuel use); air quality; and the importance of habitat loss, degradation, and modification (including impacts from coastal development and land use, gear use in the marine environment and noise effects on the marine environment) (Box 5a). However, as in Chapter 3, “the FMP does not speculate about the extent to which such changes may have impaired the productivity of white seabass. Nor does the FMP offer any suggestions about how to halt and reverse these impacts.”¹⁰³

While the FMP calls attention to the range of impacts affecting the fishery, discussion of those impacts is interspersed throughout multiple chapters and sections (e.g., Chapters 3, 6, and 9), rather than consolidated into one discussion. The Chapter 9 discussion exists apart from the overall analysis of proposed management alternatives, breaking up the review of possible impacts on the fishery, thereby portraying an incomplete picture, and arguably confusing the analysis. In addition, Chapter 6 separately analyzes the proposed management alternatives, including impacts of each alternative, but without referencing

any of the impacts and effects discussed in Chapters 3 and 9.¹⁰⁴ By including all impacts to the fishery and all impacts the fishery has on the environment into one inclusive cumulative impacts discussion, the full significance of the combined impacts could be better understood and synthesized for management purposes. Managers could then locate and map the impacts on a spatial scale, further informing their decision with visual as well as descriptive analyses of impacts. Where impacts and their causal activities are discussed, specific management actions designed to reduce the cumulative impacts of those activities can be identified. A comprehensive cumulative impacts analysis coupled with specific management recommendations that, if implemented, would eliminate, reduce or mitigate those impacts could help managers make more ecosystem-based and informed management decisions.



In order to increase the effectiveness of cumulative impacts analyses moving forward, FMPs and other management measures should analyze how combinations of regulations (such as gear requirements, bag limits, and seasons) may have negative consequences on the health of the ecosystem, and, conversely, the extent to which spatial management, such as marine protected areas, may have beneficial impacts on the fishery. Identifying overlapping impacts—regardless of what agency has jurisdiction over the impact—is an important first step in preparing cumulative impact analyses that can be used by all ocean and coastal management agencies.

¹⁰³. Healey, *supra* note 80, at 9.

¹⁰⁴. Understanding these impacts and their consequences on the marine environment is not only important for the decisions the FGC and the DFG must make, but also in the context of their responsibility over natural resources affected by other agency projects. As a trustee agency under CEQA, this information helps the DFG determine if impacts of a proposed project are detrimental to living marine resources. Therefore, through this analysis, the DFG and the FGC are able to identify issues in other agency decisions that they can and should weigh-in on as a trustee agency during the CEQA public comment process.

WE PROVIDE THE FOLLOWING PRIORITIZED CHECKLIST TO HELP THE DFG AND THE FGC STAFF IMPROVE CUMULATIVE IMPACTS ANALYSIS. A MORE DETAILED APPROACH FOR CONDUCTING A CUMULATIVE IMPACT ANALYSIS IS LOCATED IN THE OVERARCHING THEMES CHAPTER.

CONDUCTING CUMULATIVE IMPACTS ANALYSIS *(in order of priority)*

- ✓ Synthesize all **impact types** in one cumulative impacts analysis
- ✓ Identify **spatial and temporal overlap** of impacts from all past, present, and probable future projects, regardless of jurisdiction
- ✓ **Spatially map impacts** to inform analysis
- ✓ Categorize and evaluate **impact interactions**:
 - **Additive** (i.e., combination of impacts is equal to the sum of its parts)
 - **Synergistic** (i.e., combination of impacts may be greater than the sum of its parts)
 - **Antagonistic** (i.e., combination of impacts may be less than the sum of its parts)
- ✓ Identify and evaluate both the **impacts of the fishery** on the system and **impacts to the fishery**

The Fleet

COMMERCIAL FISHING VESSELS in California, such as these from Humboldt Bay, harvested 438 million pounds of commercial fish landings in 2010 worth \$180 million.

3.3.2. COMPONENT OF ECOSYSTEM VULNERABILITY: CLIMATE CHANGE

CLIMATE CHANGE represents a suite of system changes including increased temperature, altered ocean circulation, and rising sea level. These changes are likely to have dramatic impacts on the fundamental attributes of ecosystems, including shifts in species abundance and distribution, loss of habitats due to erosion and inundation, and loss of important commercial species due to failed larval development under increasingly acidic ocean conditions.

BOX Nº 5B

CLIMATE CHANGE

**DISTRIBUTION, GENETIC STOCK
STRUCTURE, AND MIGRATION**

"Recruitment of young white seabass to coastal habitats in southern California is probably related to the strength and persistence of northward flowing warm water currents. . . . Catch data indicate that white seabass move northward with seasonally warming ocean temperatures. . . . Since 1999, commercial and recreational catches of white seabass have increased north of Point Conception; possibly indicating a recent northward shift in the stock due to warmer waters brought up during the El-Niño/Southern Oscillation (ENSO) of 1997-1998."¹⁰⁵

Climate change effects—particularly altered oceanographic circulation and changes in ocean temperature—can substantially impact white seabass populations and models of population trends. Climate change may alter the movement, growth, reproduction, and recruitment of juveniles of any managed species, as well as impact the availability of prey and predator abundance. The WSFMP acknowledges this

by recognizing that changing environmental conditions can have an impact on white seabass stock distribution and abundance (Box 5b). Although in this case the FMP examines the impact of ENSO events on fish population dynamics, some of the ecosystem changes that occur due to this warm-water regime are likely to be similar to the effects of increased ocean temperatures. Changes in temperature and circulation within the California Current System (CCS) may result in a more stratified water column that is warmer than a well-mixed water column. In addition, changes in upwelling dynamics in the CCS may result in lower nutrient concentrations in surface waters and a decrease in productivity. These shifts are commonly seen during ENSO events and may be indicative of changes to come. Therefore, warming water temperatures as a result of climate change could cause white seabass populations to shift northward, similar to the change in distribution observed during ENSO events.



Build a discussion of how the effects of climate change could impact the population abundance and distribution of managed fish species, prey and predator species, habitats, and population connectivity into future management decisions.



While the exact impacts of climate change on fisheries remain largely unknown, increased ocean temperatures, altered ocean circulation patterns, reduction in oxygen levels, and increased acidification will all have some level of impact on the range, development, and abundance of marine resources. However, "[c]hanges in physical habitat that may result from climate change, such as changes in sea surface temperature, changes in seasonal upwelling, reduced freshwater inflow to coastal waters, and ocean acidification are not discussed in detail in the FMPs or other fishery management actions."¹⁰⁶ The

¹⁰⁵. WSFMP, supra note 67, at 2-2 (citations omitted).

¹⁰⁶. J. MICHAEL HARTY, ET AL., LESSONS LEARNED FROM CALIFORNIA'S MARINE LIFE MANAGEMENT ACT 26 (2010), http://opc.ca.gov/webmaster/ftp/project_pages/mlmall/FINAL%20MLMA%20LL%205-26-10.pdf.

2009 DFG Strategic Plan states that the DFG will “evaluate how priority species may be affected by climate change and will identify potential management actions . . . under its discussion of ecosystem based management.”¹⁰⁷ However, this kind of evaluation has not yet been incorporated into current fisheries management documents.

Foley et al. emphasize the importance of prioritizing species vulnerability, resilience and adaptation to climate change when considering management decisions affecting the whole ecosystem. Future FMPs could do this. For example, Section 2.2 of the WSFMP discusses data available regarding the distribution, genetic stock structure, and migration of the species. It provides a physical and historical context of the fishery as well as spatial considerations, particularly by addressing possible shifts northward in species range due to warmer waters. When discussing this stock distribution and migration of species, the FMP could further address the possibility that a species range shift could result from changing climate conditions. Because these changes may weigh heavily on future ecosystem health decisions and specifically fishery stock status decisions, a more detailed and comprehensive analysis should be included in future management documents.



The vulnerability of fished species, their prey, predators, and habitats should be assessed during the decision-making process. A more in-depth analysis of how fish growth, reproduction, and survival may be affected by climate change would bolster management decisions.¹⁰⁸ Increased ocean tem-

peratures and ocean acidification will likely cause marine species to acclimatize, adapt, alter their phenology, migrate,¹⁰⁹ or go extinct, and while many of these impacts to species remain unknown and complex systems make them difficult to predict, some of these concerns can be addressed for certain species. For example, populations of anchovy and sardines fluctuate greatly based on ocean temperature and circulation, with sardines dominating during warm phases and anchovies dominating during cool phases.¹¹⁰ A climate change analysis could include these known patterns in species shifts to predict what species composition might look like in a warmer ocean, at least in the near term. In addition, highly mobile predators such as jumbo squid may expand their range as a result of changing warming ocean conditions, causing them to exploit new ecosystems.¹¹¹ As biophysical conditions continue to change, it will be important to incorporate data and information on species range shifts into FMPs and fishery management decisions. Climate change guidance documents can assist state agencies (as well as regional and local entities) as they address climate change impacts such as sea level rise.¹¹² We recognize that some of these guidance documents suggest preparation of full vulnerability assessments; however, given time, resource, and data constraints, a full assessment may not be attainable for every agency decision. However, information provided within these guidance documents can assist agencies to account for, plan around, and adapt to sea level rise throughout their decision-making processes.

107. CAL. DEP'T OF FISH & GAME, MARINE REGION STRATEGIC PLAN 23 (2009), <http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=36556>.

108. In their working paper on Science and the MLMA, Healey and Larson further suggests the following:

DFG should establish a technical advisory committee and initiate a series of workshops to assess the implications of both cyclical and long-term changes in ocean conditions on CA fish stocks and how knowledge of these effects could be incorporated into management. CalCOFI could be a good framework for assembling such a series of workshops, because it has long been a focus for the analysis of ocean climate variation and its effect on the marine biota of California. The CalCOFI Symposium in 2009 addresses “Forecasting Fishery Productivity in the California Current,” which could be an excellent starting point for workshops.

Healey, *supra* note 80, at 22.

109. Camille Parmesan, *Ecological and Evolutionary Responses to Recent Climate Change*, ANN. REV. ECOLOGY, EVOLUTION, & SYSTEMATICS 637 (2006).

110. Chavez, *supra* note 86.

111. John C. Field et al., *Range Expansion and Trophic Interactions of the Jumbo Squid, Dosidicus gigas, in the California Current*, 48 CAL. COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS REP. 131 (2007); Louis D. Zeidberg & Bruce H. Robison, *Invasive Range Expansion by the Humboldt Squid, Dosidicus gigas, in the Eastern North Pacific*, 104 PROC. NAT'L ACAD. SCI. U.S. AMERICA 12946 (2007).

112. See NICOLE RUSSELL & GARY GRIGGS, ADAPTING TO SEA LEVEL RISE: A GUIDE TO CALIFORNIA'S COASTAL COMMUNITIES (2012), http://calost.org/pdf/announcements/Adapting%20to%20Sea%20Level%20Rise_N%20Russell_G%20Griggs_2012.pdf.

ADDRESSING *the* RISKS *and*
IMPACTS *of* CLIMATE CHANGE
(in order of priority)

- ✓ Identify **potential risks** to the project from climate change (e.g., sea level rise, changes in ocean chemistry, changes in ocean circulation patterns, changes in ocean temperature)
- ✓ Identify **actual impacts** on managed species, habitats, and project locations from climate change (e.g., inundation, dissolution of calcareous skeletons, shifts in species range)
- ✓ Identify **opportunities for adaptation and/or mitigation** of identified risks and impacts (e.g., increase size of buffer zones, restore degraded habitats, ensure physical sturdiness of project materials)

THE FOLLOWING
PRIORITIZED CHECKLIST
WILL HELP STAFF ACCOUNT
FOR THE IMPACTS OF CLIMATE
CHANGE WHEN MAKING
MANAGEMENT DECISIONS.

**Monitoring
Surface
Temperatures**

A TAO BUOY is deployed in the Gulf of Mexico from the NOAA ship R/V Gordon Gunter. The buoy provides real-time data to help predict and detect El Niño and La Niña events.

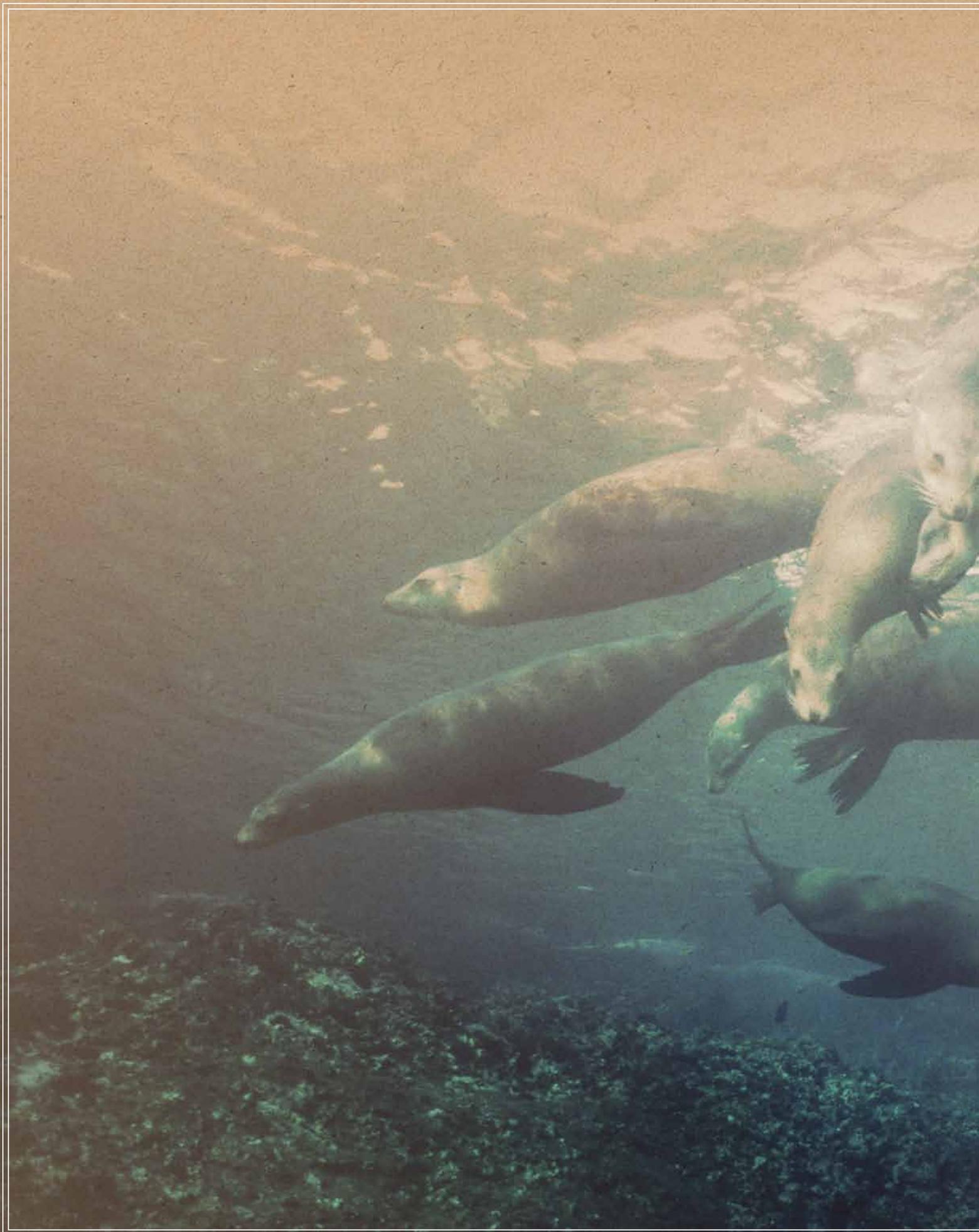
SUMMARY *of* TIPS *for*
CLOSER ALIGNMENT *with the* ECOLOGICAL PRINCIPLES

| | |
|---|---|
| ✓ | Prioritize research, data analysis, and data collection to increase understanding of population genetic structure, movement, and larval dispersal. |
| ✓ | When making management decisions and drafting FMPs, (1) provide detailed location descriptions of where fish are found and explain the importance of different habitat types to target species; (2) identify the activities that could impact important habitats; and (3) connect location descriptions, the importance of different habitat types, and the activities that could impact important habitats to the long-term sustainability of the fishery. |
| ✓ | Analyze available data to understand how fish population fluctuations are related to population cycles of their predators, prey, important foundation species (e.g., kelp), and the interactions among them. |
| ✓ | Continue to use marked hatchery fish of white seabass or other hatchery species to increase knowledge of the movement patterns of managed species and consider the importance of connectivity when assessing the impacts of hatchery fish on the overall ecosystem. |
| ✓ | Develop management measures and thresholds for the activities to which managed species, and their dependent habitats are vulnerable. |
| ✓ | Conduct a comprehensive cumulative impact analysis to inform specific management actions that would reduce the effects of particularly impactful activities. |
| ✓ | Build a discussion of how the effects of climate change could impact the population abundance and distribution of managed fish species, prey and predator species, habitats, and population connectivity. |



Marine Aquaculture

HATCHERY PROGRAMS such as the Ocean Resources Enhancement and Hatchery Program, have the potential to significantly enhance the white seabass population as well as contribute to a greater understanding of movement and life history characteristics.



CHAPTER 3 *Agency Deep Dive*

STATE LANDS COMMISSION

*Zalophus
californianus*

CALIFORNIA SEA LIONS are a top predator species that play a critical role in structuring ocean ecosystems through their interactions with species lower in the food web.

PHOTO: Gerick Bergsma 2010 / Marine Photobank

1
=
REGULATORY
AUTHORITY

The State Lands Commission’s (SLC) authority is anchored in the common law Public Trust Doctrine, California statutory law and through implementation of the California Environmental Quality Act (CEQA).

1.1. THE PUBLIC TRUST DOCTRINE

The SLC manages and protects approximately four million acres of sovereign lands.¹ These sovereign lands, also known as tidelands or public trust lands, include tide and submerged lands (lands located under navigable waters) entrusted to the State of California upon admission to the United States in 1850.² These lands are not owned by the State of California, but rather “held in trust for the people of the [S]tate, that they may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing therein, freed from the obstruction or interference of private parties.”³ The law that defines this relationship is known as the Public Trust Doctrine (PTD or Doctrine).

The SLC has authority to “exclusively administer and control all [public trust lands],” to “lease or otherwise dispose of such lands, as provided by law,”⁴ and to exercise the policies and principles underlying California’s PTD. As a trustee, the SLC’s duty is to ensure that sovereign lands are used in ways that benefit the people of California, not just for local

1. CAL. STATE LANDS COMM’N, LAND MANAGEMENT DIVISION, http://www.slc.ca.gov/Division_Pages/LMD/Documents/LMD_Brochure.pdf (last visited May 20, 2012).

2. CAL. PUB. RES. CODE § 6009(a) (West 2012); *City of Berkeley v. Superior Court*, 26 Cal. 3d 515, 521 (1980); *City of Long Beach v. Mansell*, 3 Cal. 3d 462, 482 (1970).

3. *Ill. Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 452 (1892).

4. PUB. RES. § 6301. In addition to the sovereign lands directly managed by the SLC, the agency has general oversight responsibility for the tide and submerged lands legislatively granted in trust to local jurisdictions. These local jurisdictions assume management and permitting responsibilities to ensure that uses of sovereign lands are consistent with the PTD and the legislative statutes under which they are held. *Id.* at § 6009(c).



Point Bonita, entrance to Bay of San Francisco. 1863.
Photographic Illustrations of the Pacific Coast, no. 1647.

populations or exclusively private purposes.⁵ The SLC has adopted both a Summary Document⁶ and a Policy Statement⁷ on the Doctrine and we rely on that articulation of the PTD in this Guide.

The SLC is often required to consider and prioritize competing trust uses when determining whether to issue a lease. The PTD “does not prevent the [S]tate from preferring one trust use over another.”⁸ Traditionally, public trust uses were limited to water-related commerce, navigation, and fishing. However, the California Supreme Court has interpreted the public trust as “sufficiently flexible to encompass changing public needs,”⁹ including the right of the public to use tidelands for swimming, bathing, boating, general recreation and environmental and aesthetic pro-

tection. Ancillary uses “that directly promote trust uses, are directly supportive and necessary for trust uses, or that accommodate the public’s enjoyment of trust lands, are also permitted.”¹⁰ Examples of permitted ancillary uses include facilities to serve visitors such as hotels, restaurants, shops, parking lots, restrooms, and water-dependent warehouses, cargo storage and oil and gas facilities. Uses that “are not trust related, do not serve a public purpose, and can be located on non-waterfront property” are generally not permitted on public trust lands.¹¹

Public and private entities may apply to the SLC to use sovereign lands for any public trust use. Applications “must include an outline of the proposed project, supporting environmental data, and payment of appropriate fees.”¹² In determining whether a proposed project is an appropriate use of public trust lands, the SLC will consider several factors, which include

the potential impacts on and the consistency with the Public Trust under which the Commission holds the State’s sovereign lands, protection of natural resources and other environmental values, and preservation or enhancement of the public’s access to State lands.¹³

5. *Ill. Cent. R.R. Co.*, 146 U.S. at 452-453 (1892). Pub. Res. § 6009(a), (e).

6. CAL. STATE LANDS COMM’N, PUBLIC TRUST POLICY FOR THE CALIFORNIA STATE LANDS COMMISSION, http://www.slc.ca.gov/policy_statements/public_trust/public_trust_policy.pdf (last visited May 20, 2012).

7. CAL. STATE LANDS COMM’N, PUBLIC TRUST DOCTRINE, http://www.slc.ca.gov/policy_statements/public_trust/public_trust_doctrine.pdf (last visited May 20, 2012).

8. *Carstens v. Cal. Coastal Comm’n*, 182 Cal. App. 3d 277, 289 (Cal. Ct. App. 1983) (citing *Nat’l Audubon Soc’y v. Superior Court*, 33 Cal. 3d 419, 439, n.21 (1983)).

9. *Marks v. Whitney*, 6 Cal. 3d 251, 259 (1971).

10. CAL. STATE LANDS COMM’N, *supra* note 6, at 1.

11. *Id.*

12. CAL. STATE LANDS COMM’N, *supra* note 1.

13. CAL. STATE LANDS COMM’N, APPLICATION GUIDELINES: GENERAL INFORMATION AND APPLICATION MATERIALS REGARDING LEASING OF STATE LANDS, i (revised 10/12/11).

1.2. THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

The SLC must also comply with the California Environmental Quality Act¹⁴ (CEQA) when issuing any lease, permit or other entitlement for use of public trust lands. The SLC's Division of Environmental Planning and Management is the division responsible for CEQA compliance. Projects requiring a lease for use of public trust lands often also require discretionary approvals from other agencies (e.g., California Coastal Commission).

When the SLC is the lead agency (the public agency with primary responsibility for carrying out or approving a project) for purposes of CEQA review, it must first determine whether the proposed project is exempt from CEQA.¹⁵ If the project is not exempt from CEQA, the SLC conducts an initial study to determine whether any impacts from the project are significant. The SLC circulates the initial study to responsible,¹⁶ trustee,¹⁷ and other interested agencies for review and comment. Based on the comments received and the agency's staff findings of "significance," the SLC prepares a negative declaration if it finds no significant impacts associated with the project or a mitigated negative declaration if the initial study identifies potentially significant impacts and the project is revised to eliminate or mitigate those impacts to less than significant levels.¹⁸ The agency prepares an environmental impact report (EIR) if it finds that the project will have significant impacts on

the environment.¹⁹

CEQA should be interpreted "to afford the fullest possible protection to the environment within the reasonable scope of the statutory language."²⁰

EIR REQUIREMENTS

- describe the project;
- describe the existing environmental setting around the project;
- identify and describe the project's significant environmental effects;
- discuss and analyze significant cumulative impacts;
- identify and describe feasible mitigation measures to reduce or avoid potentially significant environmental effects of the project; and
- describe a range of alternatives to the project, or to its location, including a no action alternative.²¹

When an EIR is required, the SLC will usually hire a third party consultant to prepare the document. The project applicant is responsible for the costs of preparing the environmental review documentation

14. California Environmental Quality Act, CAL. PUB. RES. CODE §§ 21000-21177 (West 2012).

15. A list of some CEQA exemptions is found in the SLC's administrative regulations. CAL. CODE REGS. tit. 2, § 2905 (2012). Additional exemptions are available in Title 14 of the California Code of Regulations. Examples of projects for which the SLC serves as the lead agency under CEQA include lease applications for subsea pipelines, oil and petroleum terminals, and mineral extraction.

16. A "responsible agency" is "a public agency, other than the lead agency, which has responsibility for carrying out or approving a project." PUB. RES. § 21069.

17. A "trustee agency" is "a state agency that has jurisdiction by law over natural resources affected by a project, that are held in trust for the people of the State of California." *Id.* at § 21070. Trustee agencies include the Department of Fish and Game, the State Lands Commission, the Department of Parks and Recreation, and the University of California. tit. 14, § 15386.

18. tit. 14, § 15002(k).

19. *Id.*

20. *Id.* at § 15003(f); *Friends of Mammoth v. Bd. of Supervisors*, 8 Cal. 3d 247, 259 (1972).

21. tit. 14, §§ 15120-15132.



Off the Coast at Monterey, California. 1885. Descriptive views of the American Continent, no. 153.

for the project. A Draft EIR is circulated to agencies and individuals interested in the project for a 45-day review period during which time a public hearing may be held. The SLC must respond to all comments and significant environmental concerns raised in the review process in the Final EIR. After certifying the Final EIR, the SLC either approves or denies the proposed project, including any recommended alterations or mitigation measures.²² Public agencies should only approve proposed projects “if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects.”²³

²² CAL. STATE LANDS COMM’N, *supra* note 13, at iii.

²³ CAL. PUB. RES. CODE § 21002 (West 2012). The CEQA Guidelines clarify that “CEQA establishes a duty for public agencies to avoid or minimize environmental damage where feasible.” tit. 14, § 15021(a).

If the agency finds that changes or alterations to the project are required to mitigate or avoid significant impacts on the environment pursuant to Section 20181(a) of the Act, CEQA’s mitigation reporting or monitoring requirement (Section 21081.6), is triggered.²⁴ Upon requiring mitigation measures to be implemented as permit approval conditions, the agency must develop a mitigation program that either reports on or monitors the mitigation measures. Whether an agency should develop a reporting program or a monitoring program is left to agency discretion.²⁵

²⁴ PUB. RES. § 21081.6.

²⁵ The Office of Planning and Research recommends that “reporting without detailed monitoring is suited to projects which have readily measureable or quantitative mitigation measures or which already involve regular review.” Alternatively, “[m]onitoring, rather than simply reporting, is suited to projects with complex mitigation measures, such as wetlands restoration or archeological protection, which may exceed expertise of the local agency to oversee, which are expected to be implemented over a period of time, or which require careful implementation to assure compliance.” GOVERNOR’S OFFICE OF PLANNING & RESEARCH, TRACKING CEQA MITIGATION MEASURES UNDER AB 3180, MITIGATION MONITORING OR REPORTING PROGRAMS, (3rd ed. 1996), available at ceres.ca.gov/ceqa/more/tas/CEQA_Mitigation/page3.html.

2

ECOLOGICAL PRINCIPLES AND THE SLC

2.1. ECOLOGICAL PRINCIPLES AND THE PUBLIC TRUST DOCTRINE

The SLC’s role as a trustee requires it to manage sovereign lands for the benefit of the public. As discussed previously, many different and often competing uses qualify as appropriate uses of the public trust. Case law does not prioritize trust uses, leaving the SLC to determine the best use of tidelands for the benefit of California’s citizens and future generations. When the SLC determines that preservation of public trust lands in their “natural state” is the appropriate use of sovereign lands, ecosystem health should be a priority consideration. Although the PTD does not prioritize resource preservation over resource use, the CEQA review process requires the SLC to consider the significant impacts of a project on the environment when making decisions.²⁶

In 1971, the California Supreme Court recognized that “the preservation of [public trust] lands in their natural state so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorably affect the scenery and climate of the area”²⁷ is an important use of sovereign lands. This preservation of sovereign lands “in their natural state” suggests an intact and functional

²⁶ tit. 14, §§ 15121(a), 15123, 15124, 15125(c), 15126, and 15126.2. CEQA does allow a decision-making agency to make a “statement of overriding considerations” when the “specific economic, legal, social, technological, or other benefits, including region-wide or statewide environmental benefits, of a proposed project outweigh the unavoidable adverse environmental effects.” *Id.* at § 15093. Where an agency does not make a statement of overriding considerations, CEQA requires agencies to avoid, minimize or mitigate adverse environmental impacts of a project. *Id.* at § 15121(a).

²⁷ Marks v. Whitney, 6 Cal. 3d 251, 259-60 (1971).

ecosystem. The ecological principles described in the Introduction—maintaining or restoring (1) *native species diversity*, (2) *habitat diversity and heterogeneity*, (3) *populations of key species*, and (4) *connectivity*—are intended to serve as indicators of healthy, intact and functional ecosystems that can aid the SLC’s natural resource decision making.

In 1983, the California Supreme Court further clarified how recreational and ecological values are protected by the PTD in the Mono Lake case.²⁸ In that case, environmental organizations asserted that water diversion from Mono Lake by the City of Los Angeles for domestic purposes violated the PTD. The plaintiffs argued that the water diversion caused decreasing water levels and increasing salinity, which negatively impacted the ecology of the lake. Important bird nesting areas were exposed to predators and brine shrimp populations that local and migratory birds relied on declined. In addition to reducing the economic, recreational and scenic value of the lake, the plaintiffs also claimed that the diversion created a public health risk due to the drying lakebed which allowed silt to become airborne irritating human and wildlife respiratory systems. The Supreme Court reaffirmed that recreational and ecological values, including scenic views, air quality, bird habitat, and food web integrity, are appropriate public trust uses²⁹ and held that the “[S]tate has an



Mono Lake, California, no. 969. 1865.

affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible.”³⁰

Given the strong, ecologically-based interpretations of the PTD in these two seminal California cases, all four ecological principles can be ascribed to facets of the Doctrine. The first principle, *maintaining or restoring native species diversity*, is consistent with the recognition that sovereign lands may contain ecologically and economically important bird and

²⁸. Nat’l Audubon Soc’y v. Superior Court, 33 Cal. 3d 419 (1983).

²⁹. *Id.* at 435.

³⁰. *Id.* at 446.

2.2. ECOLOGICAL PRINCIPLES AND CEQA

marine life. These environments also provide food and habitat for bird and marine life, including many migratory species, which is consistent with two additional ecological principles: *maintaining or restoring habitat diversity and heterogeneity and maintaining or restoring connectivity*. Finally, the Court's consideration of the impacts of water diversion from Mono Lake on brine shrimp populations, the driver of ecological interactions in the Mono Lake system, is consistent with the ecological principle of *maintaining or restoring populations of key species*.



BRINE SHRIMP

Artemia monica

PHOTO: Wikimedia Commons, Saul Dolgin. 2008.

Once the SLC determines that a project is not exempt from CEQA, it undertakes an initial study to determine whether any impacts from the project are significant. The CEQA Guidelines provide an Environmental Checklist Form (Environmental Checklist)³¹ to guide agencies through the initial study and provide a list of data and information needed to make a significance determination.

The Environmental Checklist requires attention to specific environmental factors (e.g., biological resources, hydrology/water quality, noise, and air quality) and poses a series of questions about each factor to highlight potential impacts, including direct, indirect, and cumulative impacts, from the proposed project. The questions listed in the Biological Resources section of the Environmental Checklist directly relate to the ecological principles.

The Environmental Checklist section titled, "Mandatory Findings of Significance" addresses broader concerns for the quality of the environment entirely consistent with all four ecological principles. Applicants must indicate the significance of cumulative impacts on the environment and any substantial direct or indirect effects on human communities.³² Cumulative impacts may be significant due to stressors that affect a single ecological attribute, but may also be considered significant when a project affects multiple ecological attributes. Finally, adverse impacts to human communities are intrinsically tied to the ecological principles, as the maintenance of these ecological attributes supports the provision of ecosystem goods and services that human communities rely on.

31. ASS'N OF ENVTL. PROF'LS, CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) STATUTE AND GUIDELINES 256 app. G (2012).

32. *Id.* at 270.

CEQA ENVIRONMENTAL CHECKLIST *and the* ECOLOGICAL PRINCIPLES

| | NATIVE SPECIES DIVERSITY | HABITAT DIVERSITY AND HETEROGENEITY | KEY SPECIES | CONNECTIVITY |
|--|--------------------------|-------------------------------------|-------------|--------------|
| Biological Resources—would the project: | | | | |
| a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | ✓ | ✓ | ✓ | |
| b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | | ✓ | | ✓ |
| c) Have any substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means? | | ✓ | | ✓ |
| d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites? | | ✓ | | ✓ |
| Mandatory Findings of Significance: | | | | |
| a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of major periods of California history or prehistory? | ✓ | ✓ | ✓ | ✓ |



City of Morro Bay, CA

PHOTO: *Wikimedia Commons, Kjkolb, 2006.*

If, based on the answers to the Environmental Checklist, the lead agency finds “significant” impacts and proceeds with EIR preparation, additional opportunities then arise to further identify and account for the ecological principles during the EIR’s actual development phases. These phases include:

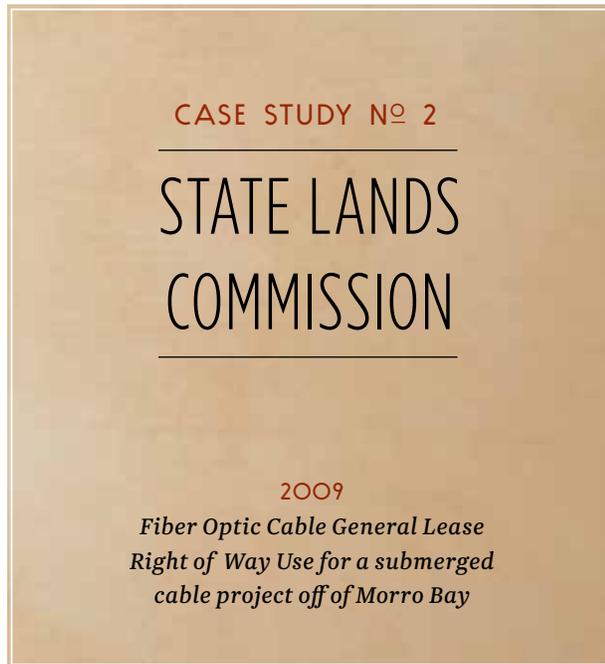
- 1 scoping;
- 2 preparing a description of resources that might be affected;
- 3 identifying impacts to resources and determining their significance;
- 4 describing impact mitigation measures;
- 5 developing project alternatives;
- 6 analyzing project alternatives; and
- 7 selecting preferred alternatives.

The matrix on pages 86 and 87 lays out some of these EIR development phases and details where and how the ecological principles are, or could be, accounted for during those phases.³³

In the following pages we discuss these four ecological principles “in practice,” as well as the concept of ecosystem vulnerability, and its subcomponents—cumulative impacts and climate change—previously reviewed in the Introduction.

³³. Although CEQA requires agencies to review the environmental impacts of their projects and to avoid, mitigate, or minimize those effects, CEQA does allow agencies to approve projects that have adverse environmental effects by making a “statement of overriding considerations.” CAL. CODE REGS. tit. 14, § 15093 (2012).

3
≡
MORRO BAY
FIBER OPTIC
CABLE PROJECT



In 2007, the SLC began reviewing a lease application submitted by AT&T Corporation to lay a fiber optic cable over 5.56 acres of sovereign lands in the Pacific Ocean near the city of Los Osos, San Luis Obispo County. The proposed fiber optic cable would run from Hawai'i to California as part of the Asia-America Gateway Fiber Optic Cable System and would be placed within one of five previously constructed steel conduits offshore of Montaña de Oro State Park near Morro Bay. The cable would land at an existing facility at the State Park and continue overland to the AT&T cable station near San Luis Obispo. The project was approved and the lease was issued in 2009.

In addition to the lease issued by the SLC, AT&T was required to consult with and obtain permits and approvals from several other agencies, including the Central Coast Regional Water Quality Control Board, the California Department of Fish and Game (DFG), the U.S. Army Corps of Engineers, and the California Coastal Commission (CCC).

3.1. CASE STUDY CRITERIA: SELECTION OF THE FIBER OPTIC CABLE PROJECT

The AT&T Fiber Optic Cable Project crosses submerged lands, thereby triggering the SLC's statutory jurisdiction and lease authority over public trust lands. The SLC's authority requires the agency to determine that the proposed use of submerged lands is consistent with California's PTD and to analyze the proposed project for environmental impacts through the CEQA process. The lease is also spatially relevant in that the cable and installation procedures impact the seafloor itself, requiring managers to make detailed planning decisions regarding the cable's physical location and its potential conflicts with the ecosystem and other existing uses in the marine environment. An approval or denial of a submerged lands lease such as the one chosen in this case study is also common and representative of the day-to-day decision-making authority of the SLC. In addition, it represents a fairly recent project, permitted in 2009. This case study is also geographically diverse from the other case studies selected; the leased land is located on the central coast in Morro Bay while the other case studies are located in northern and southern California. Finally, this project involved review by multiple agencies. Here, the fiber optic cable project required, among other things, both a lease approval by the SLC and a coastal development permit and consistency determination issued by the California Coastal Commission.

3.2. ECOLOGICAL PRINCIPLES IN ACTION

The following discussion showcases how the SLC incorporated the ecological principles and components of ecosystem vulnerability into its review of the fiber optic cable lease. Excerpts from the EIR illustrate precise examples of where the ecological principles and ecosystem vulnerability are currently incorporated into management decisions. The discussion that follows the excerpts identifies concrete ways to advance public trust resource management further along the EBM and sustainability continuum and can be applied well beyond fiber optic cable lease projects. Checklists following each section identify data and analyses necessary to account for the ecological principles and ecosystem vulnerability. While the checklists are not exhaustive, they may nonetheless suggest data gathering and analyses that are beyond the agency's current capacity. In addition, it is understood that the SLC's management decisions necessarily involve both synergies and tradeoffs between its responsibilities to preserve the sustainability of both the ecological and social components of the ecosystem. For this reason, the items in the checklist are presented in priority order, with the top analyses being most important to consider when accounting for the ecological principles in any decision.

WHILE THE GUIDE USES CASE STUDIES TO PROVIDE SPECIFIC EXAMPLES,
THE TIPS DRAWN FROM THE CASE STUDIES ARE MEANT TO APPLY BROADLY
TO A WIDE SPECTRUM OF COASTAL AND MARINE MANAGEMENT DECISIONS.
CHECKLISTS ARE PROVIDED AFTER EACH SECTION TO HELP AGENCY STAFF
ACCOUNT FOR THESE IMPORTANT PRINCIPLES WHEN MAKING DAILY
MANAGEMENT RECOMMENDATIONS AND DECISIONS.

3.2.1. MAINTAINING OR RESTORING NATIVE SPECIES DIVERSITY

SPECIES DIVERSITY is a measure of the number and types of species that occupy an area. Highly diverse ecosystems tend to be more productive and resilient, and numerous studies have documented the connection between the loss of species diversity and the loss of ecosystem functioning.

Although the SLC was not mandated to consider every species in the project area,³⁴ the agency required a detailed marine biological pre-project survey for the AT&T cable project (Box 1). This survey went beyond providing information on special status species, highlighting the agency's recognition of the importance of native species diversity when permitting activities.

In addition to this pre-project survey, the SLC also required a "post-lay" survey to assess the impact to organisms in rocky habitats during installation of the cable. After communicating with the CCC staff, this mitigation measure was revised in the Final EIR to accept video footage of the post-lay survey and to require contribution by AT&T to an approved hard bottom mitigation program in proportion to any impacts documented in the survey report.³⁵ The combination of pre- and post-lay surveys allowed the SLC to assess the project's impacts to species diversity and provided a mechanism for mitigating the identified impact by preserving or restoring hard-bottom habitat elsewhere.

34. See, e.g., ASS'N OF ENVTL. PROF'Ls, *supra* note 31, at 256.

35. CAL. STATE LANDS COMM'N, FINAL ENVIRONMENTAL IMPACT REPORT FOR THE AT&T ASIA AMERICA GATEWAY FIBER OPTIC CABLE PROJECT 3-34, 4-21 (February 2009) [hereinafter FEIR].

BOX NO 1

NATIVE SPECIES DIVERSITY

**SURVEY OF EPIBENTHIC COMMUNITY
STRUCTURE BEFORE CABLE LAYING AND
POST-LAY MITIGATION MEASURE**

"As part of its CEQA environmental review process, the California State Lands Commission requested that a new marine habitat and biota survey of the seafloor along the nearshore portions of the proposed cable route be conducted. . . . to describe the existing epibenthic community structure inhabiting both soft and hard-bottom habitat."³⁶

"[V]ideo footage of the seafloor taken by the ROV during cable lay operations within the "subcropping rock" and "outcropping rock" areas . . . will be provided to a California State Lands Commission- (CSLC-) approved marine biologist for review and assessment . . . [who] shall prepare a technical report that includes information on the area . . . and estimated number and species of organisms affected in rocky habitats The applicant shall contribute to a CSLC/CCC-approved hardbottom mitigation program proportional to impacts documented in the survey report."³⁷

36. APPLIED MARINE SCIENCES, REMOTELY OPERATED VEHICLE (ROV) BIOLOGICAL CHARACTERIZATION SURVEY OF THE ASIA AMERICA GATEWAY (AAG) S-5 PROJECT FIBER OPTIC CABLE ROUTE OFFSHORE MORRO BAY, CALIFORNIA 3-4 (revised May 2008), *appended to* CAL. STATE LANDS COMM'N, DRAFT ENVIRONMENTAL IMPACT REPORT FOR THE AT&T ASIA AMERICA GATEWAY FIBER OPTIC CABLE PROJECT (December 2008).

37. CAL. STATE LANDS COMM'N, STAFF REPORT: LEASE NO. PRC 8144.1, exhibit D, at 32-33 (February 2009).



Survey results should be used in the future to ameliorate impacts to species diversity in *all* habitats, not just hard-bottom habitats.



The pre-survey report showed that species diversity associated with soft sediment habitat was as high or higher than species diversity associated with hard-bottom habitat.³⁸ Although the principle reason for conducting the pre- and post-lay surveys was to assess the impact of the cable installation on hard-bottom habitats, which are thought to be more vulnerable to this type of impact, the survey information could have also been used to avoid species rich areas in the soft sediment habitat. Considering that approximately 85% of the cable route was soft sediment and the species found there consisted of many non-mobile species,³⁹ the potential to significantly impact species diversity in these types of communities is high. In addition, the ROV surveys only considered what was on the surface of the soft sediment communities, ignoring the infaunal (species that live within the sediment) community that would also be displaced during the burial of the fiber optic cable.



Although we detail the SLC's treatment of species diversity as it relates specifically to this cable project, similar adjustments to the SLC's review of impacts to wildlife and plants is important for all of the SLC's determinations. Understanding the status of only legally protected plants and wildlife does not accurately represent overall native species diversity or indicate the productivity, resilience, and functioning of the underlying ecosystem.

³⁸. APPLIED MARINE SCIENCES, *supra* note 36, at 24-25 tbl. 4.

³⁹. *Id.* at 10, 17-20 tbl. 2.

The following prioritized checklist identifies the types of information necessary to account for the maintenance or restoration of native species diversity.

ACCOUNTING for SPECIES DIVERSITY

(in order of priority)

- Identify the numbers and types of **species** impacted by the project
- Identify the numbers and types of **impacts** on species (e.g., anchor, burial, water quality)
- Map and analyze the **spatial distribution** of impacted species (e.g., rare vs. common species, population size, location)
- Evaluate the **duration and frequency** of each impact to species (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to species
 - Assess appropriate levels of duration and frequency of each impact to species
- Analyze the **seasonal characteristics** of the impacted species (e.g., spatial and temporal characteristics of breeding, spawning, and migration)
- Evaluate the **life history characteristics** of the impacted species (e.g., spatial movement of larvae, juveniles, and adults; lifespan; reproductive potential)

3.2.2. MAINTAINING OR RESTORING HABITAT DIVERSITY AND HETEROGENEITY

HABITAT DIVERSITY is a measure of the number and types of habitats that are found within an area.

HABITAT HETEROGENEITY is defined as the spatial arrangement of those habitats. High habitat diversity and heterogeneity help to increase the successful movement of individuals, nutrients, and important food sources between habitat types; are positively correlated with species diversity; and are linked with increased food web stability.

The SLC explicitly recognized the interaction between species diversity and habitat heterogeneity in the EIR (Box 2). Much of the discussion of marine biological resources and impacts focuses on hard-bottom habitats and the species that rely on them. To minimize impacts to hard-bottom habitat, the SLC required AT&T to provide a grapnel survey plan to mitigate potential rocky substrate disturbance during the pre-lay grapnel survey.⁴⁰ This mitigation measure further highlights that the SLC recognized the importance of habitat diversity and heterogeneity; however, the SLC should also recognize the importance of sensitive habitats besides hard bottom. In addition, by requiring the project proponent to realign the cable route in order to reduce the amount of hard bottom habitat—particularly high-relief habitat—impacted during cable installation, the spatial arrangement of these important habitats is relatively well preserved. The protection of hard-bottom habitat also supports connectivity of the populations that rely on these habitats.

40. CAL. STATE LANDS COMM'N, *supra* note 37, at 32.

BOX NO 2
HABITAT DIVERSITY & HETEROGENEITY

THE ROLE OF ROCKY SUBSTRATES IN DIVERSITY; MITIGATION MEASURE FOR IMPACTS TO HARD BOTTOM; REDUCED IMPACTS TO HABITAT OF REALIGNED ROUTE

“The rocky subtidal habitats within the region supported relatively diverse plant, invertebrate, and fish communities, the composition of which depends on the habitat heterogeneity and influence of physical factors such as currents, light, temperature, nutrients and sedimentation. Rocky substrates are generally more productive and support a greater diversity of species than soft-bottom habitats.”⁴¹

“The CSLC shall be provided with a grapnel survey plan that includes a figure that depicts the areas where the grapnel will be deployed and, within those areas of the marine segment that have rocky seafloor substrate, delineates where the grapnel will not be used.”⁴²

41. CAL. STATE LANDS COMM'N, DRAFT ENVIRONMENTAL IMPACT REPORT FOR THE AT&T ASIA AMERICA GATEWAY FIBER OPTIC CABLE PROJECT 4.3-68 to 4.3-69 (December 2008) (citation omitted) [hereinafter DEIR].

42. CAL. STATE LANDS COMM'N, *supra* note 37, at 32.



Recognize other habitats that are sensitive to impacts in addition to hard-bottom habitat.



The applicant prefers to bury the cable in soft sediment to protect its investment, and the SLC recognizes that cable laid over hard bottom is at greater risk of being hooked and damaged by other ocean users. The SLC also assumes that soft bottom habitat is more resilient to disturbance than hard bottom and worked with AT&T to revise the cable route to avoid hard-bottom habitats. However, the marine biological survey of biota affiliated with various habitat types indicated that soft bottom habitats supported nearly the same species diversity as hard-bottom habitats.⁴³ Soft-bottom areas provide habitat for epifauna and infaunal organisms (organisms on top of and in the soft sediment substrate) and the ROV survey clearly showed that this is an important habitat for many species. Although a relatively narrow swath of habitat will be disturbed during the cable installation process, these areas may not be repopulated quickly following the disturbance if there are not adequate populations nearby that are able to recolonize the project area. A more in-depth analysis of the differential vulnerability of these two

habitat types and their associated communities would help to clarify the SLC's decision to prioritize hard-bottom habitats. For instance, post-lay surveys should have also assessed the impacts of the project on species diversity in soft sediment areas. These data could help the SLC determine if habitat prioritization for the sake of species diversity is the best impact avoidance technique (we recognize that there are additional project concerns, including protecting the cable from damage by fishing vessels, that contribute to the decision to avoid hard-bottom habitat).



Given that many of the SLC's permitting decisions impact seafloor habitat, completing the analyses suggested in the previous discussion would be useful to track the sensitivity of different habitat types to different activities. Such analyses could also aid the SLC in making future lease decisions that, where appropriate, reduce the vulnerability of the system to future impacts.

⁴³. APPLIED MARINE SCIENCES, *supra* note 36, at 17-21 tbl. 2.

THE FOLLOWING
PRIORITIZED CHECKLIST
IDENTIFIES THE TYPES
OF INFORMATION
NECESSARY TO ACCOUNT
FOR THE MAINTENANCE
OR RESTORATION OF
HABITAT DIVERSITY AND
HETEROGENEITY IN THE
MARINE ENVIRONMENT.

ACCOUNTING *for*
HABITAT DIVERSITY
and HETEROGENEITY
(in order of priority)

- ✓ Identify the numbers and types of **habitat** impacted and the role they play in the ecosystem (e.g., nursery, spawning, foundation)
- ✓ Identify the numbers and types of **impacts** on habitats (e.g., anchor, burial from sediment, water quality)
- ✓ Map and analyze the **spatial distribution** of impacted habitats (e.g., rare vs. common habitats, habitat size, location)
- ✓ Evaluate the **duration and frequency** of each impact to habitats (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to habitats
 - Assess appropriate levels of duration and frequency of each impact to habitats
- ✓ Identify the spatial and temporal characteristics of **dynamic habitats** (e.g., upwelling, fronts) and the role they play in the ecosystem (e.g., nutrient source, aggregation area)

**Habitat
Diversity**

TIDEPOLS are found in rocky intertidal habitats and contain a diverse array of algal, invertebrate, and vertebrate species. Tidepool exploration is one of the primary ways Californians and tourists interact with the marine ecosystem.

3.2.3. MAINTAINING OR RESTORING POPULATIONS OF KEY SPECIES

KEY SPECIES are individual species or a group of species that have a disproportionately strong impact on ecosystem structure and function, and may include foundation species, keystone species, top predators, or basal prey. Healthy populations of key species allow for stable, resilient ecosystems by creating habitat for other species, disproportionately influencing community dynamics, and driving food web structure.

BOX NO 3 KEY SPECIES

IMPACTS OF VESSEL ANCHORING ON KELP OR SEAGRASS

“Potentially significant impacts could, however, occur if anchors are placed upon or anchor lines cross high-relief rock habitat or other Habitats of Concern such as kelp or seagrasses. No kelp or seagrass has, however, been reported in the project area.”⁴⁴

The SLC’s consideration of impacts to key species, such as kelp or seagrass, is apparent throughout the EIR (Box 3). For example, the marine biological survey noted that while detrital⁴⁵ specimens of kelp and seagrass were observed along the survey route, none “were observed along the cable right-of-way.”⁴⁶



Continue to evaluate the impacts of proposed activities on the health and persistence of key species, such as kelp and seagrass.



Given the significant influence populations of key species can have on the health and sustainability of an ecosystem, it is important to account for the number and types of key species that may be impacted by a proposed project and analyze and address the consequences of those impacts on the ecosystem.

44. DEIR, *supra* note 41, app. G, at G-10.

45. Detrital used here refers to free floating specimens, rather than anchored specimens. David O. Duggins et al., *Magnification of Secondary Production by Kelp Detritus in Coastal Marine Ecosystems*, 245 SCIENCE 170 (1989).

46. APPLIED MARINE SCIENCES, *supra* note 36, at 45.

THE FOLLOWING
PRIORITIZED CHECKLIST
IS PROVIDED TO HELP
STAFF IDENTIFY THE
TYPES OF KEY SPECIES
PRESENT IN THE MARINE
ENVIRONMENT AND
THEIR CONTRIBUTIONS TO
ECOSYSTEM FUNCTION.

ACCOUNTING *for* KEY SPECIES (in order of priority)

- ✓ Identify the impacts to:
 - **Foundation Species** (e.g., kelp, seagrass)
 - **Basal Prey** (e.g., sardines, anchovies, mullet)
 - **Top Predators** (e.g., sharks, tuna, sea lions, elephant seals)
 - **Keystone Species** (e.g., sea otters, sea stars)
- ✓ Identify the impacted species' **contributions to ecosystem functioning** (e.g., weigh significance of the impacts)
- ✓ Evaluate whether the impacts will cause a **trophic cascade** in the system

Enhydra lutris

SEA OTTERS are a keystone species that exert strong control on kelp forest habitats. When sea otters are absent, urchin populations increase and giant kelp decrease or disappear. When sea otters are present, urchin populations are kept in check and giant kelp flourishes.

PHOTO: Wikimedia Commons, Mike Baird. 2007.

3.2.4. MAINTAINING OR RESTORING CONNECTIVITY

CONNECTIVITY is defined as the movement of individuals or materials (e.g., nutrients) between populations and habitats. Connectivity between habitats and populations increases productivity and resilience, and decreases the vulnerability of ecosystems to natural and human disturbances.

BOX NO 4

CONNECTIVITY

**REDUCED IMPACTS TO
HABITAT OF REALIGNED ROUTE**

“[S]ubsequent to the conduct of the ROV Biological Survey in October 2007, new data from a multi-beam side-scan sonar survey of the initial cable route, combined with observations and habitat mapping from the ROV Biological Survey, resulted in changes in the initial proposed cable route to avoid concentrated areas of hard-bottom habitat. . . . The proposed cable alignment significantly reduced the amount of hard-bottom habitat over which the cable will be located, and avoids all but one potentially minor area (<10 m) of high-relief habitat.”⁴⁷

The SLC prioritized protection of hard-bottom habitat areas by rerouting the cable to avoid this habitat

type (Box 4). As previously noted, this rerouting is also important for maintaining habitat diversity and heterogeneity. By requiring the project proponent to realign the cable route in order to reduce the amount of hard-bottom habitat crossed, the spatial arrangement of these important habitats is relatively well preserved. This preservation supports connectivity of the populations that rely on these habitats and allows resource subsidies (e.g., detritus) to be delivered to species living in adjacent habitats. Although prioritizing hard-bottom habitat results in greater connectivity among populations that rely on that habitat type, it is nonetheless a tradeoff that may cause a reduction in connectivity among populations that rely on soft bottom habitats.



Continue to assess how permit activities will impact connectivity across the seascape for individuals and resources.



Connectivity is increasingly recognized as an important component of sustaining ecosystem health and functioning.⁴⁸ Mechanisms that may impact connectivity include species removal, habitat removal or damage, and water quality reduction. Changes to these characteristics of the ecosystem can result in changes to larval dispersal, adult movement and migration, and resource flow. These are all components of connectivity that can be considered in the permitting process.

47. *Id.* at 10.

48. Maria Beger et al., *Conservation Planning for Connectivity Across Marine, Freshwater, and Terrestrial Realms*, 143 *BIOLOGICAL CONSERVATION* 565 (2010).

IN RECOGNITION OF
THESE IMPORTANT
CONNECTIVITY CONCEPTS,
WE PROVIDE THE
FOLLOWING PRIORITIZED
CHECKLIST TO HELP
FURTHER ACCOUNT FOR
CONNECTIVITY.

ACCOUNTING for CONNECTIVITY (in order of priority)

- ✓ Identify the approximate **dispersal distance** of larvae of the impacted species (e.g., see MLPA “Size and Spacing” guidelines)⁴⁹
- ✓ Evaluate the **circulation patterns** in the project area (e.g., wind, waves, tides, currents, stream flow)
- ✓ Identify areas that may be important larval **retention features** (e.g., fronts, eddies, bays, lees of headlands)
- ✓ Evaluate overlap between agency jurisdiction and species ranges and consider any **biogeographic boundaries** that occur within the project area
- ✓ Assess impacts on **migration patterns**

49. CAL. DEPT OF FISH & GAME, CALIFORNIA MARINE LIFE PROTECTION ACT MASTER PLAN FOR MARINE PROTECTED AREAS (2008); David Siegel et al., *Lagrangian Descriptions of Marine Larval Dispersion*, 260 MARINE ECOLOGY-PROGRESS SERIES 83 (2003).

Sebastes carnatus

GOPHER ROCKFISH are a long-lived species associated with hard-bottom habitat. Gopher rockfish are part of a complex of rockfish species important to commercial and recreational fisheries in California.

3.3. ECOSYSTEM VULNERABILITY

In the context of ecosystems, **VULNERABILITY** is specifically defined as the likelihood that a species or habitat will incur losses due to a disturbance, natural or human-induced. Vulnerable habitats or species are likely to sustain damage when they are subjected to a stressor or impact to which they are susceptible.

Small changes can easily increase or decrease the vulnerability of a marine ecosystem. If the marine environment's resilience is decreased, it may have trouble bouncing back from impacts in the future, which could eventually lead to undesirable "tipping points" being crossed. For this reason it is important to be particularly aware of the impacts that each phase of a project may have on the project area.



Analyze the impact that each component of the project (i.e., pre-lay grapnel, cable plow, and post-lay burial) has on individual habitats and species as well as the total impact of the entire project on the ecosystem as a whole.



Although the SLC concluded that the marine project components would be less harmful to soft-bottom than hard-bottom habitat, the EIR did not discuss the potential impacts of the pre-lay grapnel,⁵⁰ cable plow, and post-lay burial procedures on in-

dividual species (or overall diversity) found within soft- and hard-bottom habitats. These project components require significant contact with the seafloor causing increased turbidity in the water. Increased turbidity in the water column can impact sessile benthic invertebrates, larvae, and primary productivity by clogging feeding structures and reducing the amount of available light. Areas disturbed in depths beyond 120 feet are expected to take several years to recover compared to several weeks in shallower depths with more active sediment transport, light, and productivity.



Analyzing the impact each component of a project has on individual habitats and species can help to better establish the overall impact of a project and whether that impact will ultimately increase or decrease the vulnerability of the system. Understanding the impacts at each stage of the project will enable staff to determine whether activities at each project stage should be altered to reduce environmental sensitivity. This general vulnerability assessment could be used with each permit application to allow the SLC to make a better-informed decision as to whether certain habitats or species will be disproportionately impacted by the permitted activity at each stage and on the whole.

⁵⁰. "The purpose of a pre-lay grapnel clearance is to remove debris, such as discarded fishing gear, from the seafloor within the offshore portion of the cable corridor and along the proposed cable alignment areas where the cable will be buried. To accomplish this, a grapnel, typically of the 'flatfish' type, will be dragged along the cable route prior to cable installation." DEIR, *supra* note 41, at 2-42.

3.3.1. COMPONENT OF ECOSYSTEM VULNERABILITY: CUMULATIVE IMPACTS

The level and extent of impact from human-ecosystem interactions can be shaped by the **CUMULATIVE IMPACT** level—the number and intensity of other uses co-occurring in space and time—within an ecosystem.

BOX NO 5A

CUMULATIVE IMPACTS

DESCRIPTION OF CUMULATIVE PROJECTS

- Morosin Minor Use Permit
- Twisselman Conditional Use Permit
- Morro Bay State Park Golf Course Redesign
- Chevron Estero Marine Terminal Decommissioning Project
- Highland Ranch Ag Cluster
- Los Osos Water Treatment Plant
- Morro Bay Marina Renovation Project
- Morro Bay Wastewater Treatment Plant Upgrade
- Dynergy Morro Bay Power Plant Marine Terminal Decommissioning Project⁵¹

As no other marine construction projects were scheduled during this project, the SLC concluded that no cumulative impacts would be expected that could further increase the vulnerability of the under-

lying systems in the marine environment. The EIR did take into account nine projects (Box 5a); however, none of the projects listed were located in the marine environment. Missing from this list are the five previous cable projects that were developed in the current project location.



The total impact from previous cable projects as well as concurrent projects could be incorporated into the discussion of cumulative impacts.



The SLC is obligated to consider the cumulative impacts of additional projects in the EIR. CEQA defines cumulative impacts as:

two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.

(a) The individual effects may be changes resulting from a single project or a number of separate projects.

(b) The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.⁵²

⁵¹ *Id.* at 3-15 to 3-22.

⁵² CAL. CODE REGS. tit. 14, § 15355 (2012).

Five previous telecommunications cable projects were located in the project area between 1991 and 2001. CEQA's description of cumulative impacts includes the "incremental impact of the project when added to other closely related *past*, present, and reasonably foreseeable probable future projects."⁵³ However, the EIR for the AT&T cable project did not discuss the impacts of those previous cable projects to marine habitats and species, and did not address whether any existing impacts from those prior projects might have any significant cumulative impact in combination with the current project. Repeated disturbance to an area can negatively affect the ability of the system to recover to a predisturbance state.⁵⁴ A discussion of the potential for cumulative impacts based on repeated activity disturbing habitats and species would strengthen the cumulative impacts discussion.



Addressing and accounting for cumulative impacts is one of the most difficult tasks facing any agency dealing with regulatory permitting. Assessing cumulative impacts in coastal ecosystems can be especially challenging given the high variability within these ecosystems.

An inadequate cumulative impacts analysis for a lease project can result in insufficient conditions and mitigation measures, leading to detrimental, lasting, and sometimes irreversible impacts on ecosys-

tem health and function from the permitted activity. Analyzing impacts from similar permit activities that occur over time in the same area, in addition to concurrent projects, is an excellent way to improve cumulative impacts analysis. In addition, it is important to consider the total cumulative effect on the ecosystem from all stressors that overlap in space and time rather than the cumulative effect of individual activities of one stressor (e.g., consider the cumulative effect of *all* impacts from reduced water quality, habitat diversity, and connectivity on ecosystem condition rather than the cumulative effect of all impacts on water quality alone).

As a preliminary issue, establishing the correct baseline on which to begin determining cumulative impacts and taking each and every impact into account is also extremely important for achieving the overarching goals of CEQA. While setting a proper baseline grounded on historical conditions is difficult and contentious, current case law shows that CEQA analysis does not require a historic baseline.⁵⁵ However, a static baseline should be considered for effective, long-term management of the State's public trust resources. For more on the discussion of cumulative impacts, including a comparison of the legal versus scientific approaches to cumulative impacts analyses, see the Overarching Themes chapter.

⁵³. *Id.* (emphasis added).

⁵⁴. Joseph H. Connell, *Diversity in Tropical Rainforests and Coral Reefs*, 199 SCIENCE 1302 (1978).

⁵⁵. See, e.g., *Citizens for East Shore Parks v. Cal. State Lands Comm'n*, 202 Cal. App. 4th 549 (Cal. Ct. App. 2011).

WE PROVIDE THE FOLLOWING PRIORITIZED CHECKLIST TO HELP THE SLC STAFF IMPROVE CUMULATIVE IMPACTS ANALYSIS. A MORE DETAILED DISCUSSION OF CUMULATIVE IMPACT ANALYSIS IS LOCATED IN THE OVERARCHING THEMES CHAPTER.

CONDUCTING CUMULATIVE IMPACTS ANALYSIS *(in order of priority)*

- ✓ Synthesize all **impact types** in one cumulative impacts analysis
- ✓ Identify **spatial and temporal overlap** of impacts from all past, present, and probable future projects, regardless of jurisdiction
- ✓ **Spatially map impacts** to inform analysis
- ✓ Categorize and evaluate **impact interactions**:
 - **Additive** (i.e., combination of impacts is equal to the sum of its parts)
 - **Synergistic** (i.e., combination of impacts may be greater than the sum of its parts)
 - **Antagonistic** (i.e., combination of impacts may be less than the sum of its parts)

Morro Rock

MONTAÑA DE ORO STATE PARK is the starting point for the AT&T Asia-America Gateway Fiber Optic Cable System project.

PHOTO: Wikimedia Commons, Basar. 2006.

3.3.2. COMPONENT OF ECOSYSTEM VULNERABILITY: CLIMATE CHANGE

CLIMATE CHANGE represents a suite of system changes including increased temperature, altered ocean circulation, and rising sea level. These changes are likely to have dramatic impacts on the fundamental attributes of ecosystems including shifts in species abundance and distribution, loss of habitats due to erosion and inundation, and loss of important commercial species due to failed larval development under increasingly acidic ocean conditions.

BOX NO 5B
CLIMATE CHANGE

**MITIGATION OF
GREENHOUSE GAS EMISSIONS**

“Mitigation Measure AQ-2: Prior to the start of construction, the applicant shall purchase carbon offsets . . . Within 60 days of completing construction, the applicant shall submit a report for Executive Officer review and approval that identifies all construction-related emissions and the offsets that were purchased from approved programs that results in a zero net increase in air emissions from project construction.”⁵⁶



The SLC required the project proponent to purchase carbon offsets for the project emissions, a mitigation measure to address compliance with AB 32, California’s Global Warming Solutions Act (Box 5b).



Continue to enforce compliance with AB 32 for all projects. In addition, assess the potential impacts of other climate-related changes—such as sea level rise and altered ocean circulation—that may emerge within the lifetime of a project and increase the total impact of that project.



Pursuant to AB 32 the CEQA Guidelines were updated to assist lead agencies in “the mitigation of greenhouse gas emissions or the effects of greenhouse emissions as required [by CEQA], including, but not limited to effects associated with transportation or energy consumption.”⁵⁷ The Guidelines require every EIR to analyze the level of greenhouse gas (GHG) emissions a project produces and set forth general suggestions for assessing emissions of individual project components and guidance on analyzing whether projects exceed thresholds of significance. However, while current climate change analyses in the CEQA Guidelines only focus on impacts to air quality, thinking through the risks and impacts of climate change on the entire ecosystem (including sea level rise and ocean warming), and how those risks may add to the impacts of a project being permitted is equally necessary. We recognize the limitations of the data, information, and guidance available to do this; however, even working within existing constraints, meaningful analysis of risks, impacts, and adaptation measures can be undertaken. The SLC recognizes that lands under their jurisdiction are particularly vulnerable to the impacts of sea level rise and plans for those consequences when making decisions.⁵⁸ Climate change guidance documents can assist state agencies (as well as regional and local entities) as they address climate change impacts such as sea level rise.⁵⁹ We recognize that some of these guidance documents suggest preparation of full vulnerability assessments; however, given time, resource, and data constraints, a full assessment may not be attainable for every agency decision. However, information provided within these guidance documents can assist agencies to account for, plan around, and adapt to sea level rise throughout their decision-making processes.

⁵⁶. FEIR, *supra* note 37, at 4-15.

⁵⁷. CECILY TALBERT BARCLAY, CURTIN’S CALIFORNIA LAND USE AND PLANNING LAW 636 (Solano Press, 31st ed. 2011).

⁵⁸. *Sea Level Rise*, CAL. STATE LANDS COMM’N, http://www.slc.ca.gov/Sea_Level_Rise/index.html (last visited May 21, 2012).

⁵⁹. *E.g.*, NICOLE RUSSELL AND GARY GRIGGS, ADAPTING TO SEA LEVEL RISE: A GUIDE TO CALIFORNIA’S COASTAL COMMUNITIES (2012), http://calost.org/pdf/announcements/Adapting%20to%20Sea%20Level%20Rise_N%20Russell_G%20Griggs_2012.pdf.

THE FOLLOWING
PRIORITIZED CHECKLIST
WILL HELP STAFF ACCOUNT
FOR THE IMPACTS OF
CLIMATE CHANGE WHEN
MAKING MANAGEMENT
DECISIONS.

ADDRESSING *the* RISKS *and*
IMPACTS *of* CLIMATE CHANGE
(in order of priority)

- ✓ Identify **potential risks** to the project from climate change (e.g., sea level rise, changes in ocean chemistry, changes in ocean circulation patterns, changes in ocean temperature)
- ✓ Identify **actual impacts** on managed species, habitats, and project locations from climate change (e.g., inundation, dissolution of calcareous skeletons, shifts in species range)
- ✓ Identify **opportunities for adaptation and/or mitigation** of identified risks and impacts (e.g., increase size of buffer zones, restore degraded habitats, ensure physical sturdiness of project materials)

Mytilus californianus

OCEAN ACIDIFICATION makes it more difficult for shellfish, such as mussels and oysters, to build a shell, reducing survival rates and ultimately impacting the California shellfish industry.

PHOTO SOURCE: Dr. Dwayne Meadows, NOAA/NMFS/OPR

SUMMARY *of* TIPS *for*
CLOSER ALIGNMENT *with the* ECOLOGICAL PRINCIPLES

| | |
|---|---|
| ✓ | Survey results should be used in the future to ameliorate impacts to species diversity in all habitats not just hard-bottom habitats. |
| ✓ | Recognize other habitats that are sensitive to impacts in addition to hard-bottom habitat. |
| ✓ | Continue to evaluate the impacts of proposed activities on the health and persistence of key species, such as kelp and seagrass. |
| ✓ | Continue to assess how permit activities will impact connectivity across the seascape for individuals and resources. |
| ✓ | Analyze the impact that each component of the project has on individual habitats and species as well as the total impact of the entire project on the ecosystem as a whole. |
| ✓ | The total impact from previous cable projects as well as concurrent projects should be incorporated into the discussion of cumulative impacts. |
| ✓ | Continue to enforce compliance with AB 32 for all projects. In addition, assess the potential impacts of other climate-related changes—such as sea level rise and altered ocean circulation—that may emerge within the lifetime of a project and increase the total impact of that project. |

I. EIR SCOPING PHASE: “Scoping has been helpful to agencies in identifying the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in an EIR and in eliminating from detailed study issues found not to be important.”⁶⁰

II. EIR DRAFTING PHASE:

1. SUMMARY: The brief project summary is a summary of the project and its consequences; mandatory contents are: “(1) Each significant effect with proposed mitigation measures and alternatives that would reduce or avoid that effect; (2) Areas of controversy known to the Lead Agency including issues raised by agencies and the public; and (3) Issues to be resolved including the choice among alternatives and whether or how to mitigate the significant effects.”⁶¹

2. PROJECT DESCRIPTION: The project description “should not supply extensive detail beyond that needed for evaluation and review of the environmental impact.”⁶² However, “[a] curtailed or distorted project description may stultify the objectives of the reporting process. Only through an accurate view of the project may affected outsiders and public decision-makers balance the proposal’s benefit against its environmental cost, consider mitigation measures, assess the advantage of terminating the proposal (i.e., the “no project” alternative) and weigh other alternatives in the balance.”⁶³

3. ENVIRONMENTAL SETTING: “An EIR must include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the notice of preparation is published, or if no notice of preparation is published, at the time environmental analysis is commenced, from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant. The description of the environmental setting shall be no longer than is necessary to an understanding of the significant effects of the proposed project and its alternatives.”⁶⁴

4. CONSIDERATION AND DISCUSSION OF SIGNIFICANT ENVIRONMENTAL IMPACTS: “All phases of a project must be considered when evaluating its impact on the environment: planning, acquisition, development, and operation.”⁶⁵ The EIR must focus on significant effects on the environment, which should be “discussed with emphasis in proportion to their severity and probability of occurrence.”⁶⁶ “Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and . . . other aspects of the resource base such as water, historical resources, scenic quality, and public services.”⁶⁷

5. SIGNIFICANT ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED: “Describe any significant impacts, including those which can be mitigated but not reduced to a level of insignificance. Where there are impacts that cannot be alleviated without imposing an alternative design, their implications and reasons why the project is being proposed, notwithstanding their effect, should be described.”⁶⁸

6. CONSIDERATION AND DISCUSSION OF MITIGATION MEASURES PROPOSED TO MINIMIZE SIGNIFICANT EFFECTS: Generally, mitigation includes “(a) [a]voiding the impact altogether by not taking a certain action or parts of an action”; “(b) [m]inimizing impacts by limiting the degree or magnitude of the action and its implementation”; “(c) [r]ectifying the impact by repairing, rehabilitating, or restoring the impacted environment”; “(d) [r]educing or eliminating the impact over time by preservation and maintenance operations during the life of the action”; and “(e) [c]ompensating for the impact by replacing or providing substitute resources or environments.”⁶⁹

7. ALTERNATIVES TO THE PROPOSED ACTION: “An EIR shall describe a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives.”⁷⁰

8. SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES: “For certain kinds of projects, a draft EIR must analyze the extent to which the proposed project’s primary and secondary effects will commit nonrenewable resources to uses that future generations will probably be unable to reverse.”⁷¹

9. GROWTH INDUCING IMPACT OF THE PROPOSED PROJECT: “Discuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment.”⁷²

10. EFFECTS FOUND NOT TO BE SIGNIFICANT: “An EIR shall contain a statement briefly indicating the reasons that various possible significant effects of a project were determined not to be significant and were therefore not discussed in detail in the EIR.”⁷³

11. ORGANIZATIONS AND PERSONS CONSULTED: “The EIR shall identify all federal, state, or local agencies, other organizations, and private individuals consulted in preparing the draft EIR, and the persons, firm, or agency preparing the draft EIR, by contact or other authorization.”⁷⁴

12. CUMULATIVE IMPACTS: “[A] cumulative impact consists of an impact which is created as a result of the combination of the project evaluated in the EIR together with other projects causing related impacts.”⁷⁵

13. ECONOMIC AND SOCIAL EFFECTS: Economic and social effects “should not be treated as significant effects on the environment,” however, a discussion of them should be included in an EIR.⁷⁶

60. CAL. CODE REGS. tit. 14, § 15083(a) (2012); *Citizens of Goleta Valley v. Bd. of Supervisors*, 52 Cal. 3d 553, 569 (1990).

61. tit. 14, § 15123(b).

62. *Id.* at § 15124.

63. *County of Inyo v. City of Los Angeles*, 71 Cal. App. 3d 185, 192-193 (Cal. Ct. App. 1977).

64. tit. 14, § 15125(a).

65. *Id.* at § 15126.

66. *Id.* at § 15143.

67. *Id.* at § 15126.2(a).

68. *Id.* at § 15126.2(b).

69. *Id.* at § 15730(a)-(e).

70. *Id.* at § 15126.6.

71. MICHAEL H. REMY ET AL., *GUIDE TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT 460* (11th ed. 2007) citing CAL. PUB. RES. CODE § 21100(b)(2)(B) (West 2012); tit. 14, §§ 15126(c), 15126.2(c), 15127.

72. tit. 14, § 15126.2(d).

73. *Id.* at § 15128.

74. *Id.* at § 15129.

75. *Id.* at § 15130(a)(1).

76. *Id.* at § 15131.

SUMMARY OF OPPORTUNITIES FOR INCORPORATING THE ECOLOGICAL PRINCIPLES INTO EIR SECTIONS:

As discussed at the beginning of this chapter, the following table presents opportunities for incorporating the ecological principles into the various stages of

an EIR. This table is not exhaustive; however, it illustrates the variety of opportunities to account for the ecological principles within the CEQA EIR process.

PHASES *of an* EIR: OPPORTUNITIES *to* INCORPORATE *the* ECOLOGICAL PRINCIPLES

| SPECIES DIVERSITY | HABITAT DIVERSITY & HETEROGENEITY | KEY SPECIES | CONNECTIVITY |
|---|--|---|---|
| <p>PHASE I: SCOPING PHASE: The information gathered during the EIR scoping phase is crucial to the subsequent EIR drafting phase. By identifying and analyzing as much of the information detailed in the contents of this table during the scoping phase, the preparer will be able to account for all possible significant environmental effects at the outset of the drafting phase.</p> | | | |
| <p>PHASE II: DRAFTING PHASE:</p> | | | |
| <p>3. ENVIRONMENTAL SETTING:</p> | | | |
| <ul style="list-style-type: none"> Account for species diversity of relevant geography and species complementarity Describe the spatial relationship of proposed activities to areas of high and low diversity Describe the historical context and trend of resources, species, and the activities that have contributed to those trends Account for the effects of climate change on species ranges Identify how the reduction or removal of the target species affects intra- and interspecies diversity of the system and all species interactions. | <ul style="list-style-type: none"> Identify all habitat types Identify spatial arrangement and structural complexity of habitats Account for connectivity between habitats and stressors affecting them Account for species dependent on affected habitats Account for the effects of climate change on habitats Identify potential for catalyzing the establishment or movement of non-native species | <ul style="list-style-type: none"> Identify presence, numbers, distribution, roles, and habitat dependency of key species Identify impacts to population size, age structure, size structure, recruitment potential, fecundity, and ecological role (e.g., foundation, keystone, top predator, basal prey) Identify effects of climate change on populations of key species Identify the potential for creating or enhancing the foothold of invasive species | <ul style="list-style-type: none"> Identify and assess biogeographical distribution of species and habitats Identify corridors and spatial significance of habitats related to life history of species Identify mechanisms of connectivity (e.g., wind, waves, tides, currents) Identify species of concern and estimate their larval dispersal ranges Identify larval retention areas Identify effects of altered ocean circulation patterns due to climate change |
| <p>4. CONSIDERATION AND DISCUSSION OF SIGNIFICANT ENVIRONMENTAL IMPACTS:</p> | | | |
| <p>Based on analysis resulting from the Scoping Phase and Environmental Setting:</p> <ul style="list-style-type: none"> Determine impacts of all project activities on species diversity | <p>Based on analysis resulting from the Scoping Phase and Environmental Setting:</p> <ul style="list-style-type: none"> Determine whether a particular habitat type would be destroyed or degraded beyond functionality Determine whether the project would affect the patchiness of habitats in an area (e.g., fragmentation) | <p>Based on analysis resulting from the Scoping Phase and Environmental Setting:</p> <ul style="list-style-type: none"> Determine if impacts on populations of key species result in a loss of ecological role | <p>Based on analysis resulting from the Scoping Phase and Environmental Setting:</p> <ul style="list-style-type: none"> Determine if connectivity is altered beyond the capacity to sustain populations |

PHASES *of an* EIR: OPPORTUNITIES *to* INCORPORATE *the* ECOLOGICAL PRINCIPLES

| SPECIES DIVERSITY | HABITAT DIVERSITY & HETEROGENEITY | KEY SPECIES | CONNECTIVITY |
|--|---|---|---|
| 6. CONSIDERATION AND DISCUSSION OF MITIGATION MEASURES PROPOSED TO MINIMIZE SIGNIFICANT EFFECTS: | | | |
| Determine the availability of mitigation measures to reduce impacts to species diversity | Determine the availability of mitigation measures to reduce impacts on or restore habitats (e.g., mitigation banking) | Determine the availability of mitigation measures to reduce impacts on populations of key species | Determine the availability of mitigation measures to reduce impacts on connectivity |
| 7. ALTERNATIVES TO THE PROPOSED ACTION: | | | |
| Describe the comparative effects of each alternative with respect to species diversity; | Describe the comparative effects of each alternative with respect to habitat diversity and heterogeneity | Describe the comparative effects of each alternative with respect to populations of key species | Describe the comparative effects of each alternative with respect to connectivity |
| 12. CUMULATIVE IMPACTS: | | | |
| <p>Based on information gathered for the above EIR phases:</p> <ul style="list-style-type: none"> Identify species that may be affected by direct or indirect impacts of the proposed activity Describe the current and historical state of species diversity Identify reasonably foreseeable actions that may impact species diversity Identify strategies to avoid, minimize, and / or mitigate significant impacts to species diversity | <p>Based on information gathered for the above EIR phases:</p> <ul style="list-style-type: none"> Identify habitats that may be affected by direct or indirect impacts of the proposed activity Describe the current and historical state of habitat diversity and heterogeneity Identify reasonably foreseeable actions that may impact habitat diversity and heterogeneity Identify strategies to avoid, minimize, and / or mitigate significant impacts to habitat diversity and heterogeneity | <p>Based on information gathered for the above EIR phases:</p> <ul style="list-style-type: none"> Identify key species that may be affected by direct or indirect impacts of the proposed activity Describe the current and historical state of populations of key species Identify reasonably foreseeable actions that may impact populations of key species Identify strategies to avoid, minimize, and / or mitigate significant impacts to populations of key species | <p>Based on information gathered for the above EIR phases:</p> <ul style="list-style-type: none"> Identify mechanisms of connectivity that may be affected by direct or indirect impacts of the proposed activity Describe the current and historical state of connectivity between populations and habitats Identify reasonably foreseeable actions that may impact connectivity Identify strategies to avoid, minimize, and / or mitigate significant impacts to connectivity |
| 13. ECONOMIC AND SOCIAL EFFECTS: | | | |
| Assess the synergies and tradeoffs between maintaining species diversity and resilient economic and social systems | Assess the synergies and tradeoffs between maintaining habitat diversity and heterogeneity and resilient economic and social systems | Assess the synergies and tradeoffs between maintaining populations of key species and resilient economic and social systems | Assess the synergies and tradeoffs between maintaining connectivity and resilient economic and social systems |



CHAPTER 4 *Agency Deep Dive*

CALIFORNIA COASTAL COMMISSION

*Pisaster
ochraceus*

THE OCHRE SEA STAR is a keystone species that facilitates increased species diversity in rocky intertidal areas by controlling populations of *Mytilus californianus*, California mussels, that out compete many other species for space.

PHOTO: Wikimedia Commons, Wing-Chi Poon. 2006.

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THE
COASTAL ACT

The California Coastal Act¹ grants the California Coastal Commission (CCC or Coastal Commission) jurisdiction over the coastal zone, a statutorily defined region extending from three miles offshore to an inland boundary that ranges from several hundred yards to several miles from the shoreline.

THE COASTAL COMMISSION'S
JURISDICTION COVERS A
WIDE ARRAY OF ACTIVITIES
AND RESOURCES IN THE
COASTAL ZONE.

The Coastal Act provides a framework for balancing coastal development with resource protection and public access. The CCC's jurisdiction covers a wide array of activities and resources in the coastal zone, including public access, recreation, terrestrial and marine habitat, and residential and industrial development. The Coastal Commission implements a well-established permitting and planning program, including issuing coastal development permits (CDPs), certifying local governments' Local Coastal Programs (LCPs), reviewing appeals of locally issued CDPs, and conducting federal consistency review pursuant to the Coastal Zone Management Act (CZMA). The enforceable policies of the Coastal Act, found in Chapter 3, constitute the CCC's legal standard of review² to evaluate permit applications and

1. California Coastal Act of 1976, CAL. PUB. RES. CODE §§ 30000-30900 (West 2012).

2. The Coastal Act's legal "standard of review" represents the basis against which all permit and LCP decisions must be compared. In this case, the CCC's legal standard of review for a consolidated coastal development permit application "shall follow Chapter 3 . . . with the appropriate local coastal program used as guidance." Pub. Res. § 30601.3. Specifically, Chapter 3 "shall constitute the standards by which the adequacy of local coastal programs, . . . and, the permissibility of proposed developments subject to the provisions of this division are determined." *Id.* at § 30200.

new or amended LCPs. For appeals where a certified LCP is in place, the CCC applies *that* LCP as the standard of review. Upon certification of a LCP, the local government takes over primary permitting authority within the LCP boundaries. However, the CCC retains original permit jurisdiction over development on historic wetlands, tidelands, submerged lands, and public trust lands; and retains appeals jurisdiction over properties located seaward of the first public road along the coast.

Permit review is one of the CCC's fundamental functions. For each permit application received, CCC staff use the best available science to prepare a staff report and recommendation for action.³ Staff reports must include specific findings, "including a statement of facts, analysis, and legal conclusions," as to whether a development conforms to the Coastal Act and the California Environmental Quality Act (CEQA),⁴ as well as "[r]esponses to significant environmental points" raised during any related CEQA analysis.⁵ CCC staff evaluate the individual and cumulative impacts of proposed activities based on reports, peer-reviewed literature, and communication with experts.⁶ In the rare occasion that the CCC is the only agency involved in permitting a project, an EIR is not required because a CDP is considered the functional equivalent under CEQA.⁷ Following agency review and public comment, the commissioners



United States Coast Survey, 1855.

vote to approve, condition, or reject the CDP. The CCC is often the last stop in an applicant's permitting process, which places the CCC in a pivotal role, requiring careful evaluation of the significance of impacts from a project on the State's marine ecosystem and coastal resources.

3. *Id.* at § 30006.5. "The Legislature further finds and declares that sound and timely scientific recommendations are necessary for many coastal planning, conservation, and development decisions and that the commission should... interact with members of the scientific and academic communities in the social, physical, and natural sciences so that the commission may receive technical advice and recommendations with regard to its decisionmaking, especially with regard to issues such as coastal erosion and geology, marine biodiversity, wetland restoration, the question of sea level rise, desalination plants, and the cumulative impact of coastal zone developments."

4. CAL. CODE REGS. tit 14, § 13057(c)(1), (2) (2012).

5. *Id.* at § 13057(c)(3).

6. This statement is based on a review of a sample of CCC staff reports and personal communication with Coastal Commission staff.

7. tit. 14, § 15251(c).

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ECOLOGICAL PRINCIPLES AND THE COASTAL ACT

The language of the Coastal Act provides a solid foundation for incorporating fundamental attributes of ecosystems—or ecological principles—into the CCC’s decision-making process. The Act specifies that one of the State’s primary goals is to “protect, maintain, and where feasible, enhance and restore the overall quality of the coastal zone environment and its natural and artificial resources,”⁸ in balance with the social and economic needs of the State. This overarching goal is also reflected in the language set forth in Chapter 1 of the Act, which more explicitly defines the features of healthy ecosystems and the need to protect them:

“the California coastal zone is a distinct and valuable natural resource of vital and enduring interest to all the people and exists as a delicately balanced ecosystem”;

“the permanent protection of the state’s natural and scenic resources is a paramount concern to present and future residents of the state and nation”; and

the ecological balance of the coastal zone needs to be protected in order “to promote the public safety, health, and welfare, and to protect public and private property, wildlife, marine fisheries, and other ocean resources, and the natural environment.”⁹

Article 4 of Chapter 3 outlines the Act’s enforceable policies relating specifically to the marine environment. Section 30230 provides the following overarching ecosystem protection framework embodied by the remainder of the Article:

8. Pub. Res. § 30001.5(a).

9. *Id.* at § 30001(a)-(c).



Big Sur near Julia Pfeiffer Burns State Park

PHOTO: Wikimedia Commons , Joseph Plotz. 2010.

[m]arine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.¹⁰

In addition, Section 30231 states that “[t]he biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained”¹¹

The CCC possesses clear legal authority to apply the ecological principles during its review process (e.g., for LCPs, CDPs, and federal consistency) to support ecosystem-based management decisions. Many of the themes in the Coastal Act invoke several ecological principles at once. Although some of the Coastal Act’s enforceable policies detailed in the following paragraphs apply to specific types of development (e.g., specific policies related only to dredging activities or to development in wetlands), additional broad language that is consistent with the ecological principles appears throughout Chapter 3. In the paragraphs that follow, we highlight each of the principles and point to sections of the Coastal Act that support implementation of the ecological principles, bearing in mind that some of the sections apply only to very specific types of development while others apply regardless of the specific nature of the permit.

¹⁰. *Id.* at § 30230.

¹¹. *Id.* at § 30231.

2.1. MAINTAINING OR RESTORING NATIVE SPECIES DIVERSITY

The **FIRST PRINCIPLE**, *maintaining or restoring native species diversity*, is consistent with a number of provisions in Chapter 3, Article 4 of the Coastal Act including:

protect “areas and species of special biological or economic significance”;¹²

sustain, maintain, or restore “biological productivity”;¹³

“maintain healthy populations of all species”;¹⁴ and

“maintain or enhance the functional capacity of the wetland or estuary.”¹⁵

These Coastal Act provisions are consistent with current scientific understanding that ecological communities with higher species diversity are more productive,¹⁶ have a greater degree of ecosystem functioning,¹⁷ and are more resilient to change.¹⁸

2.2. MAINTAINING OR RESTORING HABITAT DIVERSITY AND HETEROGENEITY

The **SECOND PRINCIPLE**, *maintaining habitat diversity and heterogeneity*, is specifically identified in the Act’s provisions regarding diking, filling, and dredging in stating that “[d]redging and spoils disposal shall . . . avoid significant disruption to marine and wildlife habitats and water circulation.”¹⁹ Moreover, the following Coastal Act provisions associated with maintaining or restoring native species diversity also pertain to habitat diversity and heterogeneity:

protect “areas and species of special biological or economic significance”;²⁰ and

“maintain or enhance the functional capacity of the wetland or estuary.”²¹

These concepts are consistent with habitat diversity and heterogeneity in that a greater number of habitat types and varied spatial arrangements of those habitats helps to maintain ecosystem functioning,²² species diversity,²³ and productivity.²⁴

12. *Id.* at § 30230.

13. *Id.* at §§ 30230-30231.

14. *Id.* at § 30230.

15. *Id.* at § 30233(c).

16. J. Emmett Duffy, *Why Biodiversity is Important to the Functioning of Ecosystems*, 7 *FRONTIERS ECOLOGY & ENVIRONMENT* 437 (2009).

17. Callum M. Roberts et al., *Ecological Criteria for Evaluating Candidate Sites for Marine Reserves*, 13 *ECOLOGICAL APPLICATIONS* S215 (2003); Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem Services*, 314 *SCIENCE* 787 (2006).

18. Stephen R. Palumbi et al., *Ecosystems in Action: Lessons from Marine Ecology about Recovery, Resistance, and Reversibility*, 58 *BIOSCIENCE* 33 (2008).

19. PUB. RES. § 30233(b).

20. *Id.* at § 30230.

21. *Id.* at § 30233(c).

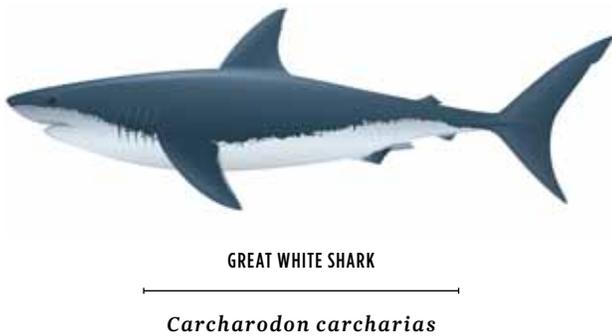
22. Peter J. Mumby & Robert S. Steneck, *Coral Reef Management and Conservation in Light of Rapidly Evolving Ecological Paradigms*, 23 *TRENDS ECOLOGY & EVOLUTION* 555 (2008).

23. Alan Hastings & Louis W. Botsford, *Persistence of Spatial Populations Depends on Returning Home*, 103 *PROC. NAT’L ACAD. SCI. U.S. AMERICA* 6067 (2006); Laura Airoidi et al., *The Gray Zone: Relationships Between Habitat Loss and Marine Diversity and their Applications in Conservation*, 366 *J. EXPERIMENTAL MARINE BIOLOGY & ECOLOGY* 8 (2008).

24. Robert S. Steneck et al., *Thinking and Managing Outside the Box: Coalescing Connectivity Networks to Build Region-Wide Resilience in Coral Reef Ecosystems*, 28 *CORAL REEFS* 367 (2009).

2.3. MAINTAINING OR RESTORING POPULATIONS OF KEY SPECIES

The **THIRD PRINCIPLE**, *maintaining or restoring populations of key species*, is consistent with the Act's requirement that special protection be given to "areas and species of special biological or economic significance."²⁵ Key species, including foundation and top predators such as giant kelp and white sharks are often the cornerstone of ecological communities and their loss can lead to changes in ecosystem composition²⁶ as well as the number and types of ecosystem services provided.²⁷



2.4. MAINTAINING OR RESTORING CONNECTIVITY

Maintaining or restoring connectivity, the **FOURTH ECOLOGICAL PRINCIPLE**, is also consistent with requirements articulated in Chapter 3 of the Coastal Act. Connectivity between populations of species and between habitats is important for maintaining diversity, productivity, and population persistence.²⁸ The requirement that special protection be given to "areas and species of special biological or economic significance" could apply to spawning or breeding areas that enable species persistence.²⁹ In addition, the Act states that dredging and spoils disposal shall "avoid significant disruption to marine and wildlife habitats and *water circulation*"³⁰ and therefore could involve consideration of larval movement and delivery, particularly by oceanographic fronts,³¹ when activities that disrupt water circulation are being permitted. Similarly, to "maintain optimum populations of marine organisms,"³² it is important to maintain connectivity between populations and habitats.³³

25. PUB. RES. § 30230.

26. James A. Estes & John F. Palmisano, *Sea Otters: Their Role in Structuring Nearshore Communities*, 185 SCIENCE 1058 (1974); Robert S. Steneck et al., *Kelp Forest Ecosystems: Biodiversity, Stability, Resilience and Future*, 29 ENVTL. CONSERVATION 436 (2002).

27. Worm, *supra* note 17.

28. Robert K. Cowen et al., *Population Connectivity in Marine Systems: An Overview*, 20 OCEANOGRAPHY 14 (2007).

29. PUB. RES. § 30230.

30. *Id.* at § 30233(b) (emphasis added).

31. C. Brock Woodson et al., *Northern Monterey Bay Upwelling Shadow Front: Observations of a Coastally and Surface-Trapped Buoyant Plume*, 114 J. GEOPHYSICAL RES.-OCEANS C12013 (2009).

32. PUB. RES. § 30231.

33. Hastings, *supra* note 23; Jesús Pineda et al., *Larval Transport and Dispersal in the Coastal Ocean and Consequences for Population Connectivity*, 20 OCEANOGRAPHY 22 (2007).

TABLE NO 1
 QUICK VIEW *of* ECOLOGICAL PRINCIPLES
 CAPTURED *in the* COASTAL ACT

| | NATIVE SPECIES DIVERSITY | HABITAT DIVERSITY AND HETEROGENEITY | KEY SPECIES | CONNECTIVITY |
|--|--------------------------|-------------------------------------|-------------|--------------|
| protect “areas and species of special biological or economic significance” ³⁴ | ✓ | ✓ | ✓ | ✓ |
| “sustain the biological productivity of coastal waters” ³⁵ | ✓ | ✓ | | ✓ |
| “maintain or restore “biological productivity” ³⁶ | ✓ | ✓ | | ✓ |
| “maintain healthy populations of all species” ³⁷ | ✓ | | ✓ | |
| “maintain or enhance the functional capacity of the wetland or estuary” ³⁸ | ✓ | ✓ | ✓ | ✓ |
| “avoid significant disruption to marine and wildlife habitats and water circulation” ³⁹ | | ✓ | | ✓ |
| “maintain optimum populations of marine organisms” ⁴⁰ | ✓ | | ✓ | ✓ |

34. Pub. Res. § 30230

35. *Id.*

36. *Id.* at § 30231.

37. *Id.* at § 30230.

38. *Id.* at § 30233(c).

39. *Id.* at § 30233(b).

40. *Id.* at § 30231.

Balanopyllia elegans

THE ORANGE CUP CORAL is a true coral and one of only a few species that grows in shallow, temperate rocky habitats. The dispersal distance for this species is very short. Larvae develop within the female cup coral and crawl away to a nearby available rock surface to settle and metamorphose.

PHOTO: Wikimedia Commons, Tewy, 2006.

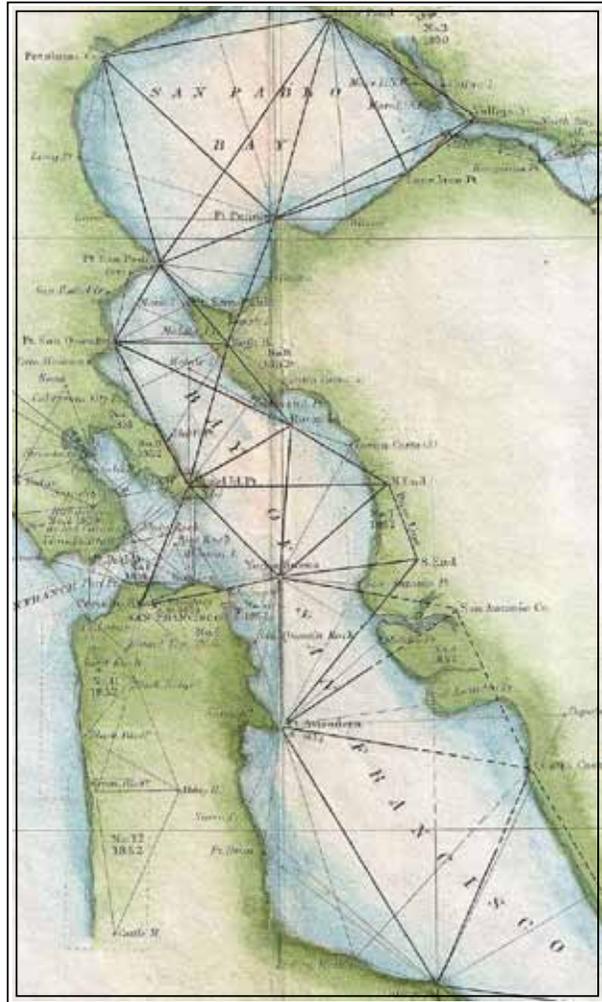
2.5. ECOSYSTEM VULNERABILITY

Finally, Chapter 2 of the Act defines additional ecological concepts, including

- **CUMULATIVE EFFECTS:** “‘Cumulatively’ or ‘cumulative effect’ means the incremental effects of an individual project shall be reviewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects”;⁴¹
- **ENVIRONMENTALLY SENSITIVE AREAS:** “any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments”;⁴²
- **SENSITIVE COASTAL RESOURCE AREAS:** “those identifiable and geographically bounded land and water areas within the coastal zone of vital interest and sensitivity.”⁴³ These areas include “[s]pecial marine and land habitat areas, wetlands, lagoons, and estuaries”;⁴⁴ and
- **SPECIAL TREATMENT AREA:** “an identifiable and geographically bounded forested area within the coastal zone that constitutes a significant habitat area, area of special scenic significance, and any land where logging activities could adversely affect public recreation area or the biological productivity of any wetland, estuary, or stream especially valuable because of its role in a coastal ecosystem.”⁴⁵

Each of these EBM concepts are important to consider in the planning and permitting context. These definitions speak to the vulnerability of ecological systems to disturbance, whether natural or human induced.

In the following pages we discuss the four ecological principles “in practice,” as well as the concept of ecosystem vulnerability, and its subcomponents, cumulative impacts and climate change (see earlier discussion in the Introduction).



San Francisco Bay
United States Coast Survey, 1852.

⁴¹. *Id.* at § 30105.5.

⁴². *Id.* at § 30107.5.

⁴³. *Id.* at § 30116.

⁴⁴. *Id.* at § 30116(a).

⁴⁵. *Id.* at § 30118.5.

3



CASE STUDY: HUMBOLDT BAY DREDGE DISPOSAL PROJECT

CASE STUDY Nº 3

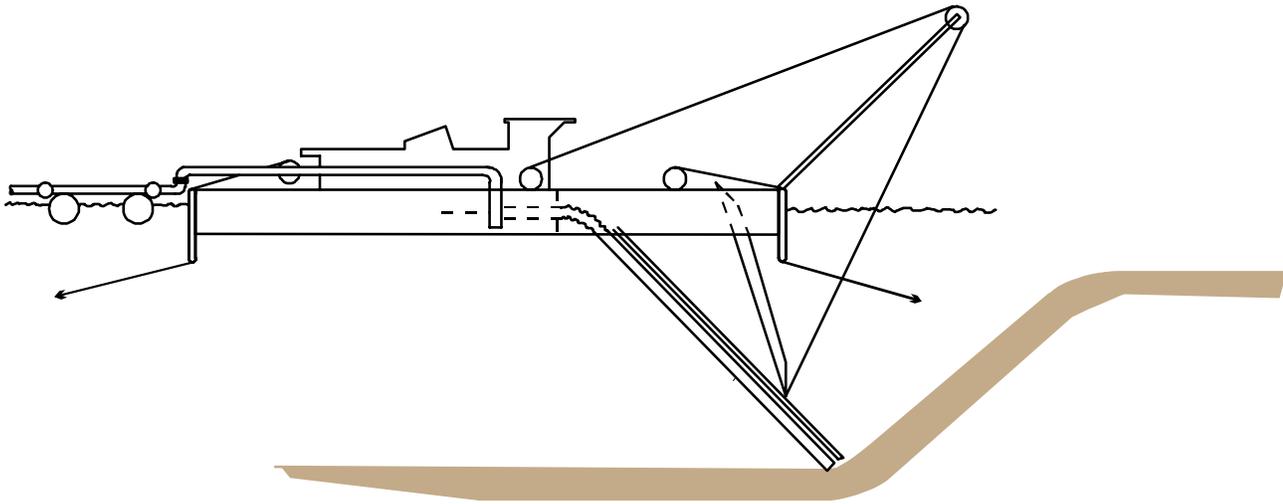
CALIFORNIA
COASTAL
COMMISSION

2006

*Coastal Development Permit issued
for the piping and disposal of
dredge material in Humboldt Bay*

In 2005, the Coastal Commission reviewed a permit application from the City of Eureka to dispose of approximately 80,000 cubic yards of dredge material—equivalent to approximately 8,000 dump truck loads—taken from ten locations along the Eureka waterfront. Although this project did not require a CDP for the maintenance dredging activity because the amount to be dredged was less than 100,000 cubic meters,⁴⁶ a CDP was required for disposal of the dredged material. The dredge material was proposed

⁴⁶. Pursuant to CAL. PUB. RES. CODE § 30610(d) and CAL. CODE REGS. tit. 14, § 13252(a)(2)(A), routine maintenance dredging that involves the dredging of less than 100,000 cubic yards within a twelve month period does not require a CDP. In this case study, because the City of Eureka dredged 80,000 cubic yards of material, it did not require a CDP for the routine maintenance dredging.



Suction Dredger

This type of dredger discharges the material direct via pipeline to the disposal site.

to be disposed in the nearshore ocean close to the Samoa Peninsula, the western boundary of Humboldt Bay. The proposed dredge disposal site, located in the surf zone, has been used multiple times for other dredge disposal projects, including 1.8 million cubic yards in 1977, 131,000 cubic yards in 1988, and 226,238 cubic yards in 1998. In addition, a dredge project at Woodley Island Marine boat basin was also permitted⁴⁷ to use the Samoa Peninsula nearshore disposal site to dispose of an additional 158,000 cu-

bic yards of dredged material during the same time period. Dredging activities in both areas were being undertaken by the same contractor; however, they were permitted separately because the area to be dredged at Woodley Island Marina was administered by a different public entity—the Humboldt Bay Harbor, Recreation, and Conservation District—pursuant to a separate legislative grant of tidelands. Dredging was scheduled to take place between November 2005 and March 2006 for both projects.

⁴⁷ CAL. COASTAL COMM'N, STAFF REPORT: APPLICATION NO. 1-05-040, at 14 (January 27, 2006), <http://documents.coastal.ca.gov/reports/2006/2/Th7c-2-2006.pdf>. The Coastal Commission granted Coastal Development Permit No. 1-05-039 on February 9, 2006 for the Woodley Island Marine boat basin project. On February 16, 2007, the CCC approved Coastal Development Permit Amendment No. 1-05-039-A1 increasing the "maximum sediment extraction and beach disposal volumes." CAL. COASTAL COMM'N, MEMORANDUM: CONDITIONAL COMPLIANCE REVIEW OF COASTAL DEVELOPMENT PERMIT NO. 1-05-039-A1, at 1 (January 10, 2008), <http://documents.coastal.ca.gov/reports/2008/1/F5a-1-2008.pdf>.

3.1. CASE STUDY CRITERIA: SELECTION OF THE DREDGE DISPOSAL PROJECT

In addition to the CDP issued by the CCC for dredge disposal, the City of Eureka needed local approval for the project including a Humboldt County Coastal Development Permit and a Humboldt Bay Harbor, Recreation, and Conservation District Permit. The City also needed approval from the State Lands Commission, the North Coast Regional Water Quality Control Board, and the U.S. Army Corps of Engineers. As is often the case, the CCC issued the last state agency permit approval required for the project to proceed, and the permit applicant was required to provide copies of the other permits and environmental review documents to CCC.⁴⁸ As a “responsible agency” under CEQA, the CCC provided input into the environmental review conducted by the other permitting agencies.

The CCC reviews permits for a variety of activities on the “wet” side of the coastal zone, including submarine cables, desalination plant and wastewater treatment facility outfall pipes, and dredging and disposal activities. The Humboldt disposal project presents a compelling case study because the project contains a strictly marine component (where many other CCC proposals pertain to activities occurring on land). Furthermore, dredge and disposal permits such as the Humboldt project are common and representative of a typical CCC management decision in that they impact marine ecosystems and present tradeoffs between economic and ecological services that are important to human communities. The CDP was also a relatively recent CCC determination, issued in 2005, and yet not so recent that its close examination might prevent the kind of objectivity that comes with time. This project also engaged multiple agencies for review and multiple permits were required from other agencies, providing insight into interagency communication. Finally, this project included an interesting cumulative impacts component in that multiple projects had been permitted to use the same site for dredge disposal in the past.

⁴⁸ While the CCC is quite often the last *state* agency to review a given project, the United States Army Corps of Engineers (USACE) approval usually follows final decisions of the CCC for projects within USACE jurisdiction, making the USACE the final agency to review any project. Personal communication with Coastal Commission staff.

3.2. ECOLOGICAL PRINCIPLES IN ACTION

As previously mentioned, Coastal Act provisions throughout and specifically in Chapter 3 capture the four ecological principles that are the focus of this analysis. The following discussion showcases how the CCC Staff Report specifically operationalized the ecosystem-based language of the Coastal Act in its review of the City of Eureka's dredge disposal project.⁴⁹ Excerpts from the Staff Report are used to illustrate precise examples of where the ecological principles and ecosystem vulnerability are currently incorporated into management decisions. The discussion that follows the excerpts identifies concrete ways to advance coastal resource management further along the EBM and sustainability continuum. The ideas presented here apply well beyond dredge disposal CDPs. Other coastal resource and devel-

opment decisions can also be advanced by putting these EBM practices into action. Checklists following each section identify data and analyses necessary to account for the ecological principles and ecosystem vulnerability. While the checklists are not exhaustive, they may nonetheless suggest data gathering and analyses that are beyond the agency's current capacity. In addition, it is understood that the CCC's management decisions necessarily involve both synergies and tradeoffs between its responsibilities to preserve the sustainability of both the ecological and social components of the ecosystem. For these reasons, the items in the checklist are presented in priority order, with the top analyses being most important to consider when accounting for the ecological principles in any decision.

WHILE THE GUIDE USES CASE STUDIES TO PROVIDE SPECIFIC EXAMPLES,
THE TIPS DRAWN FROM THE CASE STUDIES ARE MEANT TO APPLY BROADLY
TO A WIDE SPECTRUM OF COASTAL AND MARINE MANAGEMENT DECISIONS.
GENERAL QUESTIONS AND CHECKLISTS ARE PROVIDED AFTER EACH SECTION
SO THAT AGENCY STAFF CAN REFERENCE THESE IMPORTANT PRINCIPLES
AND ASK QUESTIONS ABOUT WAYS TO BEST ACCOUNT FOR THEM WHEN
MAKING DAILY MANAGEMENT RECOMMENDATIONS AND DECISIONS.

⁴⁹. Coastal Development Permit Application No. 1-05-040 (on file with the authors).

3.2.1. MAINTAINING OR RESTORING NATIVE SPECIES DIVERSITY

SPECIES DIVERSITY is a measure of the number and types of species that occupy an area. Highly diverse ecosystems tend to be more productive and resilient and numerous studies have documented the connection between the loss of species diversity and the loss of ecosystem functioning.

The CCC addressed species diversity by requiring a three-year monitoring program, including monitoring of a control site, for permit approval (Box 1).

BOX № 1

NATIVE SPECIES DIVERSITY

MONITORING FOR SPECIES IMPACTS

Special Condition No. 1: Monitoring Report. "Prior to issuance of Coastal Development Permit No. 1-05-040, the applicant shall submit for the review and approval of the Executive Director a surf zone disposal monitoring plan that provides for monitoring over a five year period of: . . . the species composition and abundance of intertidal invertebrates in areas directly affected by the disposal of dredge spoils and at a control site near the disposal area over a three year period."⁵⁰

50. CAL. COASTAL COMM'N, STAFF REPORT: APPLICATION NO. 1-05-040, at 10 (January 27, 2006), <http://documents.coastal.ca.gov/reports/2006/2/Th7c-2-2006.pdf>.



Require mitigation monitoring programs as a condition of application approval and provide guidance for specific ecosystem attributes, such as species diversity, that should be measured as part of each required program.



A three-year monitoring program, which included monitoring of a control site, was required for permit approval. Specifically, the applicant was required to develop a monitoring plan to track the "species composition and abundance of intertidal invertebrates in areas directly affected by the disposal of dredge spoils and at a control site near the disposal area over a three year period."⁵¹ While this degree of monitoring is a critical step, this monitoring program could have gone one step further by requiring a Before-After-Control-Impact (BACI)⁵² monitoring design to establish a proper pre-project baseline of species diversity. Establishing a baseline is important for monitoring the recovery of the ecosystem following the impact of a specific project, but it is also important for additional projects that may occur in the same area in the future. While it may be difficult to implement a BACI design for smaller projects, this monitoring scheme would provide the biggest payoff for large projects with greater impacts. In addition, results from BACI monitoring may inform the

51. *Id.* at 10.

52. ROGER H. GREEN, SAMPLING DESIGN AND STATISTICAL METHODS FOR ENVIRONMENTAL BIOLOGISTS (1979); Allan Stewart-Oaten & James R. Bence, *Temporal and Spatial Variation in Environmental Impact Assessment*, 71 *ECOLOGICAL MONOGRAPHS* 305 (2001).

selection of proper control sites for smaller projects. Monitoring how ecosystems respond to impacts and how they recover is crucial for making management decisions that successfully maintain species diversity, in addition to habitat diversity and heterogeneity, key species, and connectivity.

Monitoring surveys from 1998 (following previous dredge disposal activity) indicate that “species abundance and composition recovered to near pre-project levels within four months of deposition of material at the site.”⁵³ There is, however, no further information in the permit application that indicates the volume of dredge spoils deposited in this area prior to the monitoring survey in 1998. Pre-surveys are important for establishing a pre-impact picture of what the biological community composition is in that location so that progress towards a specific management goal for species diversity and habitat diversity and heterogeneity can be measured.



While we address the CCC’s approach to species diversity as it relates specifically to this dredge and fill project, similar adjustments to monitoring programs that may be required as conditions of approval for future projects will be important to help maintain species diversity within and around the project site regardless of the subject of the coastal

development permit. In addition, such monitoring programs are also highly important to maintaining habitat diversity and heterogeneity, key species, and connectivity along the coast because monitoring data can alert the agency to losses associated with approved projects. While the CCC cannot use these data to revise a project once it is approved, it can apply the information to future similar projects by requiring additional or alternative mitigation measures.

It is important to note that the CCC cannot directly require monitoring alone as a special condition to permit approval. Instead, a monitoring program can be required as part of mitigation measures that the applicant is required to complete for permit approval. However, the CCC can obtain pre-project biological survey data (for the site to be impacted and for a control site) by requiring the project applicant to submit a resource assessment as part of its application package before the application is considered “complete” and filed for review.

Although CEQA does not require use of historic baselines, identifying and monitoring resources against historical baselines rather than allowing the baseline to shift with each successive project⁵⁴ would provide the CCC a more detailed understanding of species diversity, habitat diversity and heterogeneity, key species, and connectivity. Establishing an his-

⁵³. CAL. COASTAL COMM’N, *supra* note 50, at 5.

⁵⁴. Jeremy B.C. Jackson et al., *Historical Overfishing and the Recent Collapse of Coastal Ecosystems*, 293 SCIENCE 629 (2001).

toric baseline for the ecosystem area that is facing impacts from coastal development more broadly is important to all CCC coastal permitting decisions. A BACI design could be incorporated into all monitoring programs required by the CCC's permit approval conditions. Making this baseline a part of each monitoring condition will better inform future decisions, allowing decision makers to evaluate whether the ecosystem is rebounding to historic baselines for species and habitat diversity and heterogeneity and whether additional impacts will cause the ecosystem to deviate sharply from the baseline.

For additional discussion of monitoring and mitigation requirements, please see the Overarching Themes chapter in this Guide.

The following prioritized checklist identifies the types of information necessary to account for the maintenance or restoration of native species diversity.

ACCOUNTING *for* SPECIES DIVERSITY
(in order of priority)

- ✓ Identify the numbers and types of **species** impacted by the project
- ✓ Identify the numbers and types of **impacts** on species (e.g., anchor, burial, water quality)
- ✓ Map and analyze the **spatial distribution** of impacted species (e.g., rare vs. common species, population size, location)
- ✓ Evaluate the **duration and frequency** of each impact to species (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to species
 - Assess appropriate levels of duration and frequency of each impact to species
- ✓ Analyze the **seasonal characteristics** of the impacted species (e.g., spatial and temporal characteristics of breeding, spawning, and migration)
- ✓ Evaluate the **life history characteristics** of the impacted species (e.g., spatial movement of larvae, juveniles, and adults; lifespan; reproductive potential)

3.2.2. MAINTAINING OR RESTORING HABITAT DIVERSITY AND HETEROGENEITY

HABITAT DIVERSITY is a measure of the number and types of habitats that are found within an area.

HABITAT HETEROGENEITY is defined as the spatial arrangement of those habitats. High habitat diversity and heterogeneity help to increase the successful movement of individuals, nutrients, and important food sources between habitat types; are positively correlated with species diversity; and are linked with increased food web stability.

BOX NO 2

HABITAT DIVERSITY & HETEROGENEITY

HABITAT IMPACTS AT DISPOSAL SITES

“Impacts to the habitat are expected to be similar to the impacts that occurred in 1998. According to the 1998 monitoring study, the habitat area recovered rapidly:

Based on the present study, negative effects of temporary discharge of dredge spoils on intertidal fauna of Samoa Beach were localized and transitory, primarily affecting the abundance of characteristic beach species in the immediate vicinity of the disposal outfall. Within 1 month following the end of disposal operations, most species characteristic of this beach were present at the outfall site, although at reduced densities. Approximately 4 months following termination of beach disposal, populations at the Disposal Site had recovered to levels comparable to those at the Control Site.

Thus, based on the result of the 1998 monitoring report, the impacts of the proposed discharge of dredged material on the surf zone habitat can be expected to be temporary and insignificant.”⁵⁵

In considering the impact of the dredge spoil disposal activity on nearshore habitats, the CCC used data from previous monitoring efforts to conclude that there would not be a long-term, significant impact to the surf zone habitat (Box 2).



Expand monitoring requirements to include measuring identified indicators (e.g., turbidity levels) prior to, during, and after coastal development activities.



One of the main impacts to the ecosystem during and after dredge disposal is increased turbidity in the vicinity of the disposal site. Increased turbidity can affect multiple species and bury habitat if the plume persists for an extended period of time. The CCC Staff Report sets a threshold for the acceptable level of increased turbidity at twenty percent above background levels.⁵⁶ However, provisions for monitoring turbidity during dredge disposal were not included in the Staff Report. Without active monitoring during disposal activity, it is impossible to know if the turbidity threshold is being exceeded and if the impact to species (particularly algae, filter feeders, and larvae) and habitat are subjected to conditions beyond an acceptable range.

55. CAL. COASTAL COMM’N, *supra* note 50, at 24.

56. *Id.* at 10.

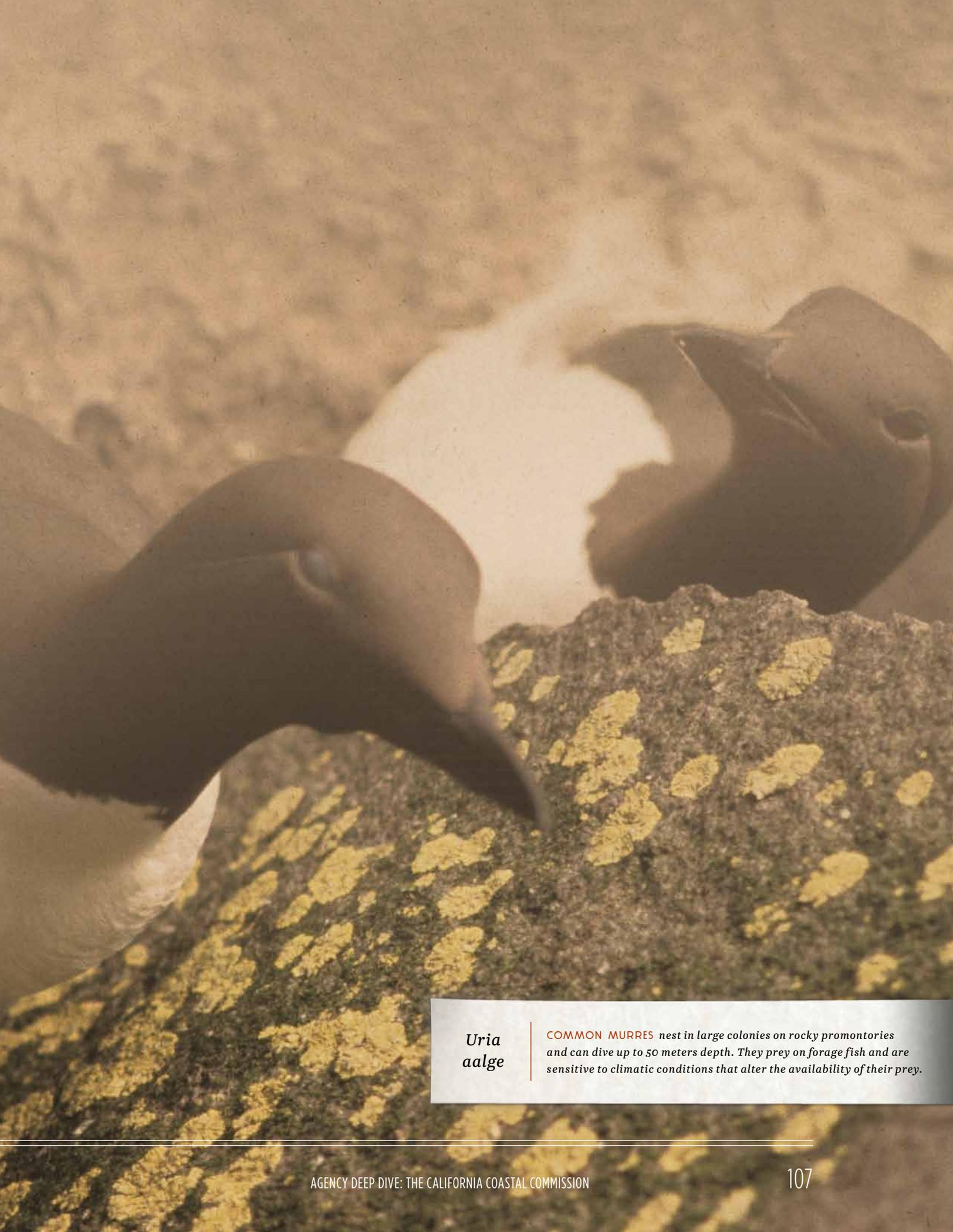


The CCC has the opportunity to further improve all of its mitigation monitoring conditions by requiring monitoring while the activity is occurring regardless of the type of permitted activity. Mitigation monitoring requirements that span the entire duration of a permitted project—prior to, during, and after the development activity—allow the CCC to establish whether previous estimates or thresholds are being met or exceeded in real time. If exceeded, steps could be taken immediately to remedy the activity to create fewer disturbances. Regardless, the CCC could then rely on such monitoring results to analyze species diversity, habitat diversity and heterogeneity, key species, and/or connectivity, for example, when evaluating future development decisions with similar circumstances, thereby helping staff to develop more refined threshold levels in the future.

The following prioritized checklist identifies the types of information necessary to account for the maintenance or restoration of habitat diversity and heterogeneity in the marine environment.

ACCOUNTING *for* HABITAT DIVERSITY *and* HETEROGENEITY *(in order of priority)*

- ✓ Identify the numbers and types of **habitat** impacted and the role they play in the ecosystem (e.g., nursery, spawning, foundation)
- ✓ Identify the numbers and types of **impacts** on habitats (e.g., anchor, burial, water quality)
- ✓ Map and analyze the **spatial distribution** of impacted habitats (e.g., rare vs. common habitats, habitat size, location)
- ✓ Evaluate the **duration and frequency** of each impact to habitats (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to habitats
 - Assess appropriate levels of duration and frequency of each impact to habitats
- ✓ Identify the spatial and temporal characteristics of **dynamic habitats** (e.g., upwelling, fronts) and the role they play in the ecosystem (e.g., nutrient source, aggregation area)



*Uria
aalge*

COMMON MURRES nest in large colonies on rocky promontories and can dive up to 50 meters depth. They prey on forage fish and are sensitive to climatic conditions that alter the availability of their prey.

3.2.3. MAINTAINING OR RESTORING POPULATIONS OF KEY SPECIES

KEY SPECIES are individual species or a group of species that have a disproportionately strong impact on ecosystem structure and function, and may include foundation species, keystone species, top predators, or basal prey. Healthy populations of key species allow for stable, resilient ecosystems by creating habitat for other species, disproportionately influencing community dynamics, and driving food web structure.

BOX № 3

KEY SPECIES

EVALUATING PROJECT ALTERNATIVES - IMPACTS ON EELGRASS

“The dredging areas are located along the shallower margins of the bay which include sensitive shallow water habitats, including extensive eelgrass beds. The eelgrass beds provide important spawning, rearing, feeding, and resting habitat for numerous fish and other estuarine species. In addition, the shallow waters of Humboldt and Arcata Bays support extensive commercial shellfish operations that can be adversely affected by high turbidity. Given the more sensitive nature of the estuarine habitat within Humboldt Bay as compared to the ocean surf zone, the overall impact of use of the HOODS site is much greater than the impacts of the project as proposed.”⁵⁷

One keystone species, eelgrass, was considered when evaluating project alternatives. In order to avoid sensitive nearshore habitats, an alternative was proposed that involved dumping the dredge spoils at the offshore Humboldt Open Ocean Disposal Site (HOODS) located three to four miles offshore of Humboldt Bay. However, the CCC concluded that this was not a less environmentally damaging alternative to the nearshore disposal site because the dredge spoils would need to be transferred to a barge for transport to HOODS. This activity would result in increased turbidity at the dredging site, which is likely to have a negative impact on the sensitive shallow water habitats, including eelgrass (Box 3). Given the distance of the HOODS site offshore, a pipeline could not be used for disposal because it was cost prohibitive⁵⁸ and turbidity would have increased in and around the area being dredged.⁵⁹



Continue to consider the effects of proposed projects on key species, including, but not limited to, seagrass habitat, fish spawning habitat, and juvenile fish populations.



Eelgrass, a type of seagrass, is a foundation species that creates habitat and provides shelter, nourishment, and protection for a number of other species at different stages in their life history.⁶⁰ The amount of seagrass habitat worldwide is in decline

57. CAL. COASTAL COMM'N, STAFF REPORT: APPLICATION No. 1-05-040, at 36 (September 1, 2005), <http://www.google.com/url?q=http://www.coastal.ca.gov/eureka/W6c-9-2005.pdf>.

58. Cost was the primary reason for not selecting the HOODS site as the disposal site. The estimated HOODS disposal cost (\$3.8 million) was almost double the estimated cost of disposal in the surf zone (\$2 million). *Id.* at 35.

59. Turbidity would have increased because a different type of dredging process would have been used for the ship transport to the HOODS site. When transporting dredge material by barge or hopper to an offshore site, dredged material (in this case 80% water and 20% sediment) must first be decanted before transport. Decanting requires that the water used in the suction dredge method be discharged back into the dredging area, which increases the turbidity at the dredging site. *Id.* at 36.

60. Emma L. Jackson et al., *The Importance of Seagrass Beds as a Habitat for Fishery Species*, 39 OCEANOGRAPHY & MARINE BIOLOGY 269 (2001).

mainly due to habitat alteration (marine and terrestrial) and climate change.⁶¹ The CCC should continue to carefully evaluate impacts to this key species and recognize its ecological and economic value.



Protection of key species is important across all CCC permitting decisions. Regardless of the project type, protection, maintenance, or restoration of key species populations that are present in the permit region should be taken into account. Population reduction or loss of key species can have cascading effects on the rest of the system—including species diversity, habitat diversity, and connectivity—due to key species’ strong influence on food web dynamics.

The Coastal Act’s Environmentally Sensitive Habitat Areas (ESHA) provision is a tool that has been used infrequently in the marine environment. Section 30240 protects “environmentally sensitive habitat areas” against “any significant disruption of habitat values” and significantly limits uses of those resources and development in adjacent areas.⁶² Staff memoranda regarding environmentally sensitive habitat determinations and mitigation ratio and buffer dimension decisions have traditionally been specific to terrestrial and wetland habitats. However, CCC has interpreted Section 30240 of the Coastal Act to apply to sensitive marine habitats, such as eelgrass beds.⁶³ For example, in a 2011 staff report regarding a CDP application, the CCC found that “[t]he waters of Humboldt Bay, as well as many of the plants and

animals inhabiting the bay, including eelgrass, constitute ESHA.”⁶⁴ The Commission concluded that an eelgrass enhancement plan proposed to take place within eelgrass ESHA in Humboldt Bay was consistent with Section 30240.⁶⁵ Important marine habitats that meet the criteria for ESHA designation, like eelgrass, can be designated as ESHA under the Coastal Act, thereby providing an important and consistent tool for protecting sensitive key marine species.

ACCOUNTING *for* **KEY SPECIES**
(in order of priority)

- ✓ Identify the impacts to:
 - **Foundation Species** (e.g., kelp, seagrass)
 - **Basal Prey** (e.g., sardines, anchovies, mullet)
 - **Top Predators** (e.g., sharks, tuna, sea lions, elephant seals)
 - **Keystone Species** (e.g., sea otters, sea stars)
- ✓ Identify the impacted species’ **contributions to ecosystem functioning** (e.g., weigh significance of the impacts)
- ✓ Evaluate whether the impacts will cause a **trophic cascade** in the system

61. Robert J. Orth et al., *A Global Crisis for Seagrass Ecosystems*, 56 *BIOSCIENCE* 987 (2006).

62. CAL. PUB. RES. CODE § 30240.

63. CAL. COASTAL COMM’N, STAFF REPORT: APPLICATION NO. 1-11-004 (July 1, 2011), <http://documents.coastal.ca.gov/reports/2011/7/Th18c-7-2011.pdf>.

64. *Id.* at 15.

65. *Id.* at 15-16.

3.2.4. MAINTAINING OR RESTORING CONNECTIVITY

CONNECTIVITY is defined as the movement of individuals or materials (e.g., nutrients) between populations and habitats. Connectivity between habitats and populations increases productivity and resilience, and decreases the vulnerability of ecosystems to natural and human disturbances.

BOX NO 4 CONNECTIVITY

EVALUATING LOSS OF BIOLOGICAL PRODUCTIVITY OF EELGRASS

“The routes of the proposed dredge spoils pipeline through Humboldt Bay provide soft bottom habitat that may be habitat for a variety of benthic organisms. In addition, sparse clumps of eelgrass have materialized sporadically in various berthing areas since the previous dredging was performed. The placement of the pipeline may temporarily disturb some of this soft bottom habitat area. However, the impact is not judged to be significant. The loss of the sparse patches currently existing along the pipeline routes would not result in a significant loss of biological productivity. In addition, the pipeline routes can be expected to be re-colonized by the flora and fauna that would be temporarily displaced by the project. These organisms grow in sufficient abundance in areas adjacent to the pipeline routes that a ready source of colonizers exists to replace the organisms that are lost.”⁶⁶

In evaluating the impact of the dredge spoils pipeline placement, the CCC revisited the effect on eelgrass populations, but in the context of population connectivity. Since the last dredging operation in 1998, patches of eelgrass have established along the pipeline route. These patches were likely to be lost during the next pipeline installation process. The CCC determined that this habitat/species loss would not have a significant effect on eelgrass biological productivity because there were additional populations of eelgrass adjacent to the impacted area that were likely to supply recruits and recolonize the area (Box 4).

The CCC recognizes that eelgrass is a unique and fragmented habitat; allowing the pipeline to disturb eelgrass habitat within the harbor in this case study is not representative of the CCCs normal course of action. More recent CCC CDPs have required project applicants to avoid existing eelgrass or replace impacted eelgrass if any is impacted by development.⁶⁷



Use wind, current, and wave data provided through the Central and Northern California Ocean Observing System (CeNCOOS)⁶⁸ to better understand ocean circulation patterns relevant to assessing project impacts on sensitive biological communities.



Disposal activities during the winter months are assumed to be ideal because increased river flow and currents will help to dissipate sediment

66. CAL. COASTAL COMM'N, *supra* note 50, at 25.

67. See, e.g., NOAA'S NAT'L MARINE FISHERIES SERV. SOUTHWEST REG'L OFFICE, SOUTHERN CALIFORNIA EELGRASS MITIGATION POLICY (revision 11, adopted July 31, 1991), http://swr.nmfs.noaa.gov/hcd/HCD_webContent/aboutus/policies.htm; CAL. COASTAL COMM'N, STAFF REPORT: APPLICATION No. 5-11-258 (March 22, 2012), <http://documents.coastal.ca.gov/reports/2012/4/Th6a-4-2012.pdf>.

68. CENT. & N. CAL. OCEAN OBSERVING SYS. (CeNCOOS), <http://www.cencoos.org> (last visited May 20, 2012).



Mouth of Eel River

PHOTO: *Kenneth & Gabrielle Adelman, California Coastal Records Project*

away from the disposal site.⁶⁹ Although the Eel River has higher discharge rates during the rainy season, these rates are not constant, and circulation patterns may significantly fluctuate from November to March (proposed disposal time period). Variability in circulation patterns and the formation of eddies may alter the rate at which sediment is transported away from intertidal and nearshore habitats that are sensitive to increased turbidity and burial. Ocean circulation data made available through CeNCOOS show the dominant circulation and current directions, which would

allow for a better understanding of Eel River conditions during different seasons. These data can be used to determine if the disposed dredge spoils will be transported away from biological communities as expected, or if dredge spoils would instead be trapped close to shore. Topographically complex coastlines, such as Humboldt Bay, can drive the formation of circulation eddies. These eddies can trap sediment close to shore rather than transport it to offshore areas.⁷⁰ If eddy formation is a regular feature of the area, alternative sites for dredge disposal

⁶⁹. CAL. COASTAL COMM'N, *supra* note 50, at 19.

⁷⁰. Jonathan A. Warrick et al., *River Plume Patterns and Dynamics Within the Southern California Bight*, 27 CONTINENTAL SHELF RES. 2427 (2007).

could be identified to ensure that the impacts from increased turbidity are not greater than expected.

A range of variables contribute to ocean circulation patterns, including river flow, wind, waves, tides and currents. The loss of connectivity has a widespread impact on species diversity, habitat diversity and heterogeneity,⁷¹ as well as the overall context of an ecosystem under pressure by coastal development (e.g., if the system is capable of recovering following a disturbance caused by a permitted activity). Therefore, during each CCC permit review process, impacts on the mechanisms of connectivity—including but not limited to: larval retention features,⁷² seasonal circulation patterns, biogeographic boundaries, and zones of aggregation—could be analyzed to ensure that the permitted activity is consistent with maintaining or increasing the connectivity of the ecosystem. Research on the mechanisms of connectivity is an emerging field, but general patterns of larval dispersal distances and larval retention features have been synthesized and used in many of the State’s marine resource decision-making processes, including the MLPA Initiative.⁷³

In recognition of these important connectivity concepts, we provide the following prioritized checklist to help staff further account for connectivity.



ACCOUNTING for CONNECTIVITY

(in order of priority)

- ✓ Identify the approximate **dispersal distance** of larvae of the impacted species (e.g., see MLPA “Size and Spacing” guidelines)⁷⁴
- ✓ Evaluate the **circulation patterns** in the project area (e.g., wind, waves, tides, currents, stream flow)
- ✓ Identify areas that may be important larval **retention features** (e.g., fronts, eddies, bays, lees of headlands)
- ✓ Evaluate overlap between agency jurisdiction and species ranges and consider any **biogeographic boundaries** that occur within the project area
- ✓ Assess impacts on **migration patterns**

71. Marcus Sheaves, *Consequences of Ecological Connectivity: The Coastal Ecosystem Mosaic*, 391 MARINE ECOLOGY-PROGRESS SERIES 107 (2009).

72. Stephen R. Wing et al., *Coastal Retention and Longshore Displacement of Meroplankton Near Capes in Eastern Boundary Currents: Examples from the California Current*, 19 S. AFR. J. MARINE SCIENCE 119 (1998); MARINE METAPOPULATIONS (Jacob P. Kritzer & Peter F. Sale eds., 2006).

73. CAL. DEP’T OF FISH & GAME, CALIFORNIA MARINE LIFE PROTECTION ACT MASTER PLAN FOR MARINE PROTECTED AREAS (2008); David Siegel et al., *Lagrangian Descriptions of Marine Larval Dispersion*, 260 MARINE ECOLOGY-PROGRESS SERIES 83 (2003).

74. *Id.*



***Numenius
americanus***

LONG BILLED CURLEW eating a sand crab on Morro Strand State Beach. Long-billed curlews overwinter in California's wetlands and on sandy beaches where populations are vulnerable to habitat loss due to coastal development and projected sea level rise.

PHOTO: Wikimedia Commons, Mike Baird, 2008.

3.3. ECOSYSTEM VULNERABILITY

In the context of ecosystems, **VULNERABILITY** is specifically defined as the likelihood that a species or habitat will incur losses due to a disturbance, natural or human-induced. Vulnerable habitats or species are likely to sustain damage when they are subjected to a stressor or impact to which they are susceptible.

BOX NO 5 ECOSYSTEM VULNERABILITY

HABITAT VULNERABILITY

“The Commission must examine the potential impacts of the project on marine and estuarine resources for the non-exempt portions of the project within its jurisdictional area (i.e., excluding the actual suction dredging intake of the materials from the eleven berthing sites and the project portions within the County of Humboldt’s permitting jurisdiction). The project could have five potential adverse effects on such resources, including: (1) increasing turbidity levels during installation and removal of the dredge spoils pipeline; (2) the covering of estuarine intertidal habitat along the route of the dredge spoils pipeline within Humboldt Bay; (3) accidental releases of the dredge spoils slurry and/or pumping related fuels or lubricants; (4) disturbing marine intertidal habitat at the dredged material disposal site; (5) degrading water quality at the near-shore dredged materials disposal site; and (6) release of hydrogen sulfide. None of these impacts, however, have been determined to be significant.”⁷⁵

Individual species and habitats may be vulnerable to different stressors or combinations of stressors.

The idea of differential vulnerability of habitats was considered by the CCC in its discussion of potential adverse effects of the dredge project on marine and estuarine resources. Although none of these impacts were determined to be significant in this case, it is important for the agency to recognize the full suite of potential impacts to habitats and species so that alternative and mitigation measures can be fully explored (Box 5).



Analyze the impact that each component of the development project (i.e., pipeline installation, dredge disposal) has on individual habitats and species as well as the combined impact of the entire project on the ecosystem as a whole.



There are a number of impacts associated with dredge disposal to which species and habitats may be more vulnerable. Increased turbidity in the water column can impact sessile benthic invertebrates, larvae, and primary productivity due to clogging of feeding structures and reduction in light. Increased sediment in the disposal area can reduce habitat diversity and heterogeneity due to burial. Installation of the disposal pipeline disturbs wetland and tidal habitats. Finally, disposal will also temporarily degrade water quality in the area. While different pieces of the ecosystem are more or less vulnerable to these impacts, it is also important to be able to look at the broader context of these impacts to determine if they are acceptable as a whole.



Analyzing the impact that each component of a project permitted by the CCC has on habitats and species can help to better establish the overall im-

⁷⁵ CAL. COASTAL COMM’N, *supra* note 50, at 22.



Dredging operation in Morro Bay

PHOTO: Mike Baird, 2009

impact a new project will have on ecosystem vulnerability. By considering the impacts at each stage, as well as combining all impacts together, this analysis could provide both a stage-by-stage and a holistic view of ecosystem vulnerability. The resulting vulnerability matrix could be used to inform all marine permitting decisions and would allow the CCC to make better-informed decisions (within the broader ecosystem vulnerability context) as to whether certain species will be disproportionately impacted by the permitted activity.

This step-by-step analysis may be more or less difficult to implement, depending on the project and available resources. However, it can help engaged agencies improve the quality of their decisions by guiding them to think through impacts at all stages of development. Rather than conducting this step-by-step analysis of project impacts to ecosystem

vulnerability, the CCC could develop a matrix that focuses on the compatibility of impact types (as opposed to uses) and ecosystem components (e.g., benthic fauna). A compatibility matrix could improve the efficiency of project review by highlighting impacts to ecosystem components that warrant special attention, including conditions of approval or mitigation measures.

A COMPATIBILITY MATRIX COULD IMPROVE THE EFFICIENCY OF PROJECT REVIEW

Additional important aspects of ecosystem vulnerability include cumulative impacts and climate change, both of which are further fleshed out in the following discussions.

3.3.1. COMPONENT OF ECOSYSTEM VULNERABILITY: CUMULATIVE IMPACTS

The level and extent of impact from human-ecosystem interactions can be shaped by the **CUMULATIVE IMPACT** level—the number and intensity of other uses co-occurring in space and time—within an ecosystem.

BOX NO 5A
CUMULATIVE IMPACTS

BIOACCUMULATION

“To prevent potential impacts to coastal water quality and the direct and cumulative impacts to biological resources that could result from exposure to and bioaccumulation of these toxic compounds, the Commission attaches Special Condition No. 9. Special Condition No. 9 prohibits the ocean disposal of dredged materials originating from Dredging Area No. 4 - Coast Seafoods Company Dock.”⁷⁶

The CCC touches on cumulative impacts in the Staff Report in reference to disposing toxic sediment in the nearshore ocean. The bioaccumulation of the toxic substances was considered to be a significant risk and potential cumulative impact on nearshore benthic species. Consequently, disposal of toxic sediment in the nearshore ocean was not allowed under the conditions of the coastal development permit.



The CCC is obligated to consider the cumulative impact of projects in the project area. The combined impact from previous projects as well as concurrent and reasonably foreseeable projects in the area should be incorporated into the discussion of cumulative impacts.



The Coastal Act defines cumulative impacts as follows: “‘cumulatively’ or ‘cumulative effect’ means the incremental effects of an individual project shall be reviewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.”⁷⁷ Three previous dredge projects used the Samoa Peninsula site to dispose of dredge spoils between 1977 and 1998, and another permit was under review by the CCC to dispose of dredge spoils at the same location and during the same period of time as the project discussed here. While the disposal from the permitted activity in this case study was less than 100,000 cubic yards, the combination of the two projects yielded over 200,000 cubic yards of material being disposed in one location. The CCC considered the impacts of these two projects separately because the dredge projects fell under different jurisdictional authorities (and therefore different project applicants). The result was that the cumulative impact of all proposed and reasonably foreseeable activities in the area was not considered for either project.

⁷⁶. *Id.* at 27-28.

⁷⁷. CAL. PUB. RES. CODE § 30105.5 (West 2012).

Although past monitoring data suggest that species and habitat in the area recover after a few months, it is unclear how resilient the ecosystem is and what magnitude and frequency of dredge disposal will push the system beyond its ability to recover. One of the species most likely to be affected by the cumulative impact of multiple disposal events is eelgrass, which is a key species in intertidal ecosystems and provides erosion control for coastal communities.



Addressing and accounting for cumulative impacts is one of the most difficult tasks facing any agency that deals with regulatory permitting and development.

Assessing cumulative impacts in coastal ecosystems can be especially challenging given the high variability within these ecosystems. Nonetheless, establishing the correct baseline from which to begin determining cumulative impacts and taking all impacts into account—across jurisdictions and sectors—is extremely important for achieving the overarching goals of the Coastal Act. If a cumulative impacts analysis is not done correctly for a coastal development project, and insufficient conditions or mitigations are required as a result, that activity could have detrimental and lasting, and sometimes irreversible effects on ecosystem health and function. Analyzing impacts of permit activities that co-occur in separate jurisdictions, but within adjacent spaces is an excellent way to begin improving cumulative impacts analysis.⁷⁸

We provide the following prioritized checklist to help the CCC staff to improve cumulative impacts analysis. A more detailed approach for conducting a cumulative impact analysis is located in the Overarching Themes chapter.

CONDUCTING CUMULATIVE IMPACTS ANALYSIS

(in order of priority)

- ✓ Synthesize all **impact types** in one cumulative impacts analysis
- ✓ Identify **spatial and temporal overlap** of impacts from all past, present, and probable future projects, regardless of jurisdiction
- ✓ **Spatially map impacts** to inform analysis
- ✓ Categorize and evaluate **impact interactions**:
 - **Additive** (i.e., combination of impacts is equal to the sum of its parts)
 - **Synergistic** (i.e., combination of impacts may be greater than the sum of its parts)
 - **Antagonistic** (i.e., combination of impacts may be less than the sum of its parts)

⁷⁸. See, MICHAEL H. REMY ET AL., GUIDE TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT 471 (11th ed. 2007). Section 15130 of the CEQA Guidelines requires “[a] list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects *outside the control of the agency*.” CAL. CODE REGS. tit. 14, § 15130(b)(1)(A) (2012).

3.3.2. COMPONENT OF ECOSYSTEM VULNERABILITY: CLIMATE CHANGE

CLIMATE CHANGE represents a suite of system changes including increased temperature, altered ocean circulation, and rising sea level. These changes are likely to have dramatic impacts on the fundamental attributes of ecosystems including shifts in species abundance and distribution, loss of habitats due to erosion and inundation, and loss of important commercial species due to failed larval development under increasingly acidic ocean conditions.



Consider opportunities for climate change adaptation associated with projects.



The Staff Report determined that the dredge material was not suitable for beach replenishment due to the high silt composition of the material (~85% clay and silt). However, there are a number of wetland and tidal areas within Humboldt Bay that are being encroached upon by rising sea level.⁷⁹ If natural accretion rates of sediment are not high enough to counteract rising storm surges and sea level, dredge material could be used to increase the height of these important intertidal habitats aiding in their longevity. Reuse of dredge material can help to restore ecosystems that provide flood and erosion control, functions that are becoming more important in the coastal zone as sea level rises and storms become more intense.⁸⁰



The boom of a sidecast dredger directs a slurry of water and dredged material away from the navigation channel.

PHOTO: Hank Heusinkveld



Discussions surrounding the impacts from climate change, and specifically sea level rise, are not new to the CCC.⁸¹ The Commission's website provides important resources on climate change, including guidance for CDP applicants on ways to reduce the carbon footprint of proposed developments.⁸² CCC staff are also actively analyzing the California Coastal Act to determine how it can be used to ad-

79. Kevin L. Hoover, *Where will Sea Level Rise Strike First?*, Arcata Eye, Jan. 5, 2011, <http://www.arcataeye.com/2011/01/where-will-sea-level-rise-strike-first-%E2%80%93-january-5-2011/>.

80. Staff of the State Coastal Conservancy recently approved a grant to fund a feasibility study on this issue for Humboldt Bay. STATE COASTAL CONSERVANCY, STAFF RECOMMENDATION: HUMBOLDT BAY DREDGED MATERIALS REUSE FEASIBILITY STUDY, PROJECT NO. 11-065-01 (January 19, 2012).

81. CAL. COASTAL COMM'N, A SUMMARY OF THE COASTAL COMMISSION'S INVOLVEMENT IN CLIMATE CHANGE AND GLOBAL WARMING ISSUES FOR A BRIEFING TO THE COASTAL COMMISSION (December 12, 2008), <http://documents.coastal.ca.gov/reports/2008/12/F3.5-12-2008.pdf>.

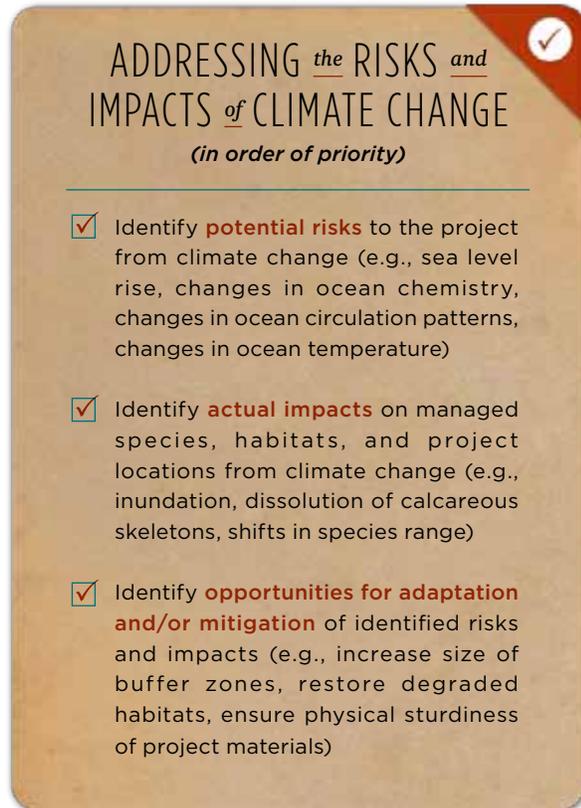
82. *Reduce the Climate Impact of a Proposed Coastal Development*, CAL. COASTAL COMM'N, <http://www.coastal.ca.gov/climate/applicantguidance.html> (last visited May 21, 2012).

dress the novel challenges that climate change is presenting to the State. Adaptation strategies are important tools for addressing climate change impacts and the CCC is uniquely positioned to address the coast's adaptation needs. Each permit approval could contain a discussion and acknowledgement of what impacts, if any, climate change has already had and may eventually have on the marine and coastal resources affected by the coastal development being permitted, as well as a set of actions-or conditions-that the permittee should undertake to ensure adequate adaptation measures are implemented to address those impacts. In addition, much like on land, many marine species are likely to migrate to higher latitudes due to increasing ocean temperature. Using the best available science to review known species movements will also help to determine if there are potentially novel species moving into the area that a permitted activity may impact.

Management resources can assist state agencies (as well as regional and local entities) as they address climate change impacts such as sea level rise.⁸³ We recognize that some of these guidance documents suggest preparation of full vulnerability assessments; however, given time, resource, and data constraints, a full assessment may not be attainable for every agency decision. However, information provided within these resource documents can assist agencies to account for, plan around, and adapt to sea level

rise throughout their decision-making processes.

The following prioritized checklist will help staff ask important questions when making management decisions whose impacts may be exacerbated by the impacts of climate change.



ADDRESSING *the* RISKS *and* IMPACTS *of* CLIMATE CHANGE
(in order of priority)

- ✓ Identify **potential risks** to the project from climate change (e.g., sea level rise, changes in ocean chemistry, changes in ocean circulation patterns, changes in ocean temperature)
- ✓ Identify **actual impacts** on managed species, habitats, and project locations from climate change (e.g., inundation, dissolution of calcareous skeletons, shifts in species range)
- ✓ Identify **opportunities for adaptation and/or mitigation** of identified risks and impacts (e.g., increase size of buffer zones, restore degraded habitats, ensure physical sturdiness of project materials)

⁸³. NICOLE RUSSELL & GARY GRIGGS, ADAPTING TO SEA LEVEL RISE: A GUIDE TO CALIFORNIA'S COASTAL COMMUNITIES (Jan. 2012), http://calost.org/pdf/announcements/Adapting%20to%20Sea%20Level%20Rise_N%20Russell_G%20Griggs_2012.pdf.

SUMMARY *of* TIPS *for*
CLOSER ALIGNMENT *with the* ECOLOGICAL PRINCIPLES

| | |
|---|---|
| ✓ | Require mitigation monitoring programs as a condition of application approval and provide guidance for specific ecosystem attributes, such as species diversity, that should be measured as part of each required program. |
| ✓ | Expand monitoring requirements to include measuring identified indicators (e.g., turbidity levels) prior to, during, and after coastal development activities. |
| ✓ | Continue to consider the effects of proposed projects on key species, including, but not limited to, impacts on seagrass habitat, fish spawning habitat, and juvenile fish populations. |
| ✓ | Use wind, current, and wave data provided through the Central and Northern California Ocean Observing System (CeNCOOS) to better understand ocean circulation patterns relevant to assessing project impacts on sensitive biological communities. |
| ✓ | Analyze the impact that each component of the development project has on individual habitats and species as well as the combined impact of the entire project on the ecosystem as a whole. |
| ✓ | Incorporate the combined impact from previous projects as well as concurrent and reasonably foreseeable projects in the area into the discussion of cumulative impacts. |
| ✓ | Consider opportunities for climate change adaptation associated with projects. |



***Caranx
sexfasciatus***

SPAWNING BIGEYE TREVALLY aggregate by the thousands at dusk and during certain lunar phases as a part of their courtship, forming extraordinary shapes.

PHOTO: Octavio Aburto-Oropeza / Marine Photobank



CHAPTER 5

OVERARCHING THEMES IN MANAGEMENT

*The
Sonoma
Coast*

ARCHED ROCK as seen from Goat Rock Beach.
The beach is a regular habitat for gulls, sea otters,
elephant seals, harbor seals, and sea lions.

PHOTO: *Wikimedia Commons, Frank Schulenburg, 2012.*

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**INTRODUCTION
TO OVERARCHING
THEMES**

There are additional themes and issues within coastal and ocean management that are important for all agencies to consider, regardless of the resource managed or the project type. In this chapter, the concept of ecosystem-based management (EBM) is revisited along with additional key concepts—or “overarching themes”—that apply to coastal and ocean management. These overarching themes include interagency communication, uncertainty, context, cumulative impacts, monitoring and mitigation, and adaptive management. This Guide explores these six topics in further detail because, while their integration continues to be challenging, they can greatly improve coastal and ocean management decisions.

As set forth in the Introduction, EBM is an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain ecosystems in a healthy, productive, and resilient condition.¹ EBM differs from most current management approaches that largely focus on a single species, sector, activity, or concern; instead EBM considers how activities and management measures interact in the ecosystem across time, space, and different sectors. EBM is not an endpoint, but rather is a process by which ecological and social principles are systematically incorporated into resource management decisions.

California’s ocean and coastal agencies are well poised to advance the incorporation of EBM practices into management decisions. In the context of fisheries, for example, the Marine Life Management Act (MLMA) recognizes the importance of an EBM approach for resource management and prescribes it to achieve the MLMA’s overarching goal of sustainable marine ecosystem management.² Additionally,

1. KAREN L. McLEOD ET AL., SCIENTIFIC CONSENSUS STATEMENT ON MARINE ECOSYSTEM-BASED MANAGEMENT (2005), http://www.compassonline.org/sites/all/files/document_files/EBM_Consensus_Statement_v12.pdf.

2. CAL. FISH & GAME CODE § 7056 (West 2012).

the 2009 Marine Region Strategic Plan states that the Department of Fish and Game (DFG) will work toward EBM as a “model for resources stewardship,” and “work with constituents to develop a working definition and model for ecosystem-based management based on scientific and management literature” and to incorporate that definition into the MLMA Master Plan.³ The California Coastal Act instructs the California Coastal Commission (CCC) to “protect, maintain, and where feasible, enhance and restore the overall quality of the coastal zone environment and its natural and artificial resources.”⁴ While this statutory mandate predates most EBM literature, EBM approaches are designed to achieve comparable goals. For the State Lands Commission (SLC), the Public Trust Doctrine (PTD) requires that public lands be managed in a way that benefits the people of California.⁵ “[P]reservation of [public trust] lands in their natural state”⁶ to maintain or restore ecosystem function is an appropriate use of public trust lands, which is consistent with the EBM approach to achieve ecological values. In addition, the California Environmental Quality Act (CEQA) requires agencies “to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.”⁷ These statutes, plans, and policies support implementation of the central tenets of EBM and equip agencies with the authority to consider the ecosystem as a whole when making management and long term planning decisions.

Successful EBM implementation requires setting objectives for the desired state of an ecosystem, identifying and filling data gaps that are needed to iden-

tify possible management actions, and incorporating data and objectives into management decisions.⁸ The ecological principles discussed in this Guide provide a starting point for identifying data necessary for an EBM approach and also provide a common language between science and management, helping to integrate the two. For management, the ecological principles are specific attributes of the ecosystem that can focus management and be monitored over time. For scientists, temporal and spatial patterns of these ecological attributes can be used to evaluate how well ecosystems are functioning and identify trends in ecological communities. In addition, the ecological principles make it clear to scientists what types of scientific information managers need to make a decision. In the following pages we highlight themes and issues for agencies to consider in tandem with the core ecological principles. While the ecological principles form the foundation for an EBM approach, these additional considerations can help managers incorporate the principles into an EBM framework.

SUCCESSFUL EBM IMPLEMENTATION REQUIRES SETTING OBJECTIVES FOR THE DESIRED STATE OF AN ECOSYSTEM.

3. CAL. DEP'T OF FISH & GAME, MARINE REGION STRATEGIC PLAN 23 (2009), <http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=36556>. This definition has not yet been incorporated into the Master Plan. The Master Plan was developed in 2001, and it is to be updated every 5 years; however it has not been revisited since adoption.

4. CAL. PUB. RES. CODE § 30001.5 (West 2012).

5. Ill. Cent. R.R. Co. v. Illinois, 146 U.S. 387, 452-453 (1892); PUB. RES. § 6009(a),(e).

6. Marks v. Whitney, 6 Cal.3d 251, 259-60 (1971); accord Nat'l Audubon Soc'y v. Superior Court, 33 Cal.3d 419, 435 (1983).

7. CAL. CODE REGS. tit. 14, § 15002(f) (2012); Friends of Mammoth v. Bd. of Supervisors, 8 Cal. 3d 247 (1972).

8. Michael Healey & Ralph Larson, *Science and the MLMA: A Working Paper 20* (Working Paper, 2010) (on file with the author).

2



INTERAGENCY COMMUNICATION

Ocean and coastal EBM approaches include a clear process for agencies with overlapping jurisdiction over marine and coastal resources to interact and share information throughout their decision-making processes. As mentioned in the Introduction, it is important that agencies continue to consistently communicate with each other throughout their permitting and resource management processes. By taking a more holistic view of the entire permitting cycle early in the process, agencies can identify new ways to anticipate and better address each other's needs, making successive agency decisions better informed and more streamlined. In addition, clear communication between agencies translates to clearer requirements for project applicants at the outset of the permitting process. In the absence of discussions that investigate the interactions between one agency's managed resources and resources managed by other agencies, it is difficult to fully understand how ecosystems and sectors are connected, and thus implement EBM approaches.

For example, the DFG and the Fish and Game Commission (FGC) are responsible for promoting healthy fish stocks; therefore, it is important for them to communicate with both the CCC (because it has authority to make decisions regarding coastal development in and around areas that are essential to fish habitat) and the SLC (which has authority to approve projects that contact the seafloor). In this example, the DFG and the FGC rely on the CCC and the SLC to make progressive decisions that protect fish habitat from degradation. Safeguarding fish habitat ultimately supports species abundance and diversity of fished and non-fished species alike as well as habitat diversity and heterogeneity.

The interagency consultation protocol required by CEQA is aimed at producing more successful, efficient, and streamlined management decisions (Box 1). If a project requires approvals from more than one agency, CEQA requires one of the relevant agencies to serve as the “lead agency” to complete the required environmental review process.⁹ A “responsible agency” is “a public agency, other than the lead agency, which has responsibility for carrying out or approving a project.”¹⁰ Finally, a “trustee agency” is “a state agency that has jurisdiction by law over natural resources affected by a project, that are held in trust for the people of the State of California.”¹¹ Trustee agencies include the Department of Fish and Game, the State Lands Commission, the Department of Parks and Recreation, and the University of California.¹² CEQA provides a specific protocol for lead agencies that structures mandatory interagency consultation with each responsible agency, trustee agency, and public agency that has jurisdiction by law.¹³ However, time and staff constraints may prevent agencies from engaging in consultation and incorporating other agencies’ concerns into their decision making to the extent intended by CEQA. In some cases, due to overextended staff, responsible and trustee agencies do not provide comments on projects unless they are large in scale or are directly related to an issue of concern for the non-lead agencies.¹⁴

IT IS CLEAR FROM DISCUSSIONS
WITH AGENCY STAFF THAT
INTERAGENCY COORDINATION
AND COMMUNICATION DOES
OCCUR AMONG AGENCIES THAT
SHARE JURISDICTION OVER
COMMON COASTAL AND MARINE
RESOURCES.

9. tit. 14, § 15050(a).

10. CAL. PUB. RES. CODE § 21069 (West 2012).

11. *Id.* at § 21070; tit. 14, § 15386.

12. tit. 14, § 15386.

13. PUB. RES. § 21104.

14. Personal communications with California agency staff.

BOX NO 1

PURPOSE *of* INTERAGENCY
REVIEW *of* CEQA EIRS
and NEGATIVE DECLARATIONS¹⁵.

- a) Sharing expertise,
- b) Disclosing agency analyses,
- c) Checking for accuracy,
- d) Detecting omissions,
- e) Discovering public concerns, and
- f) Soliciting counter proposals.

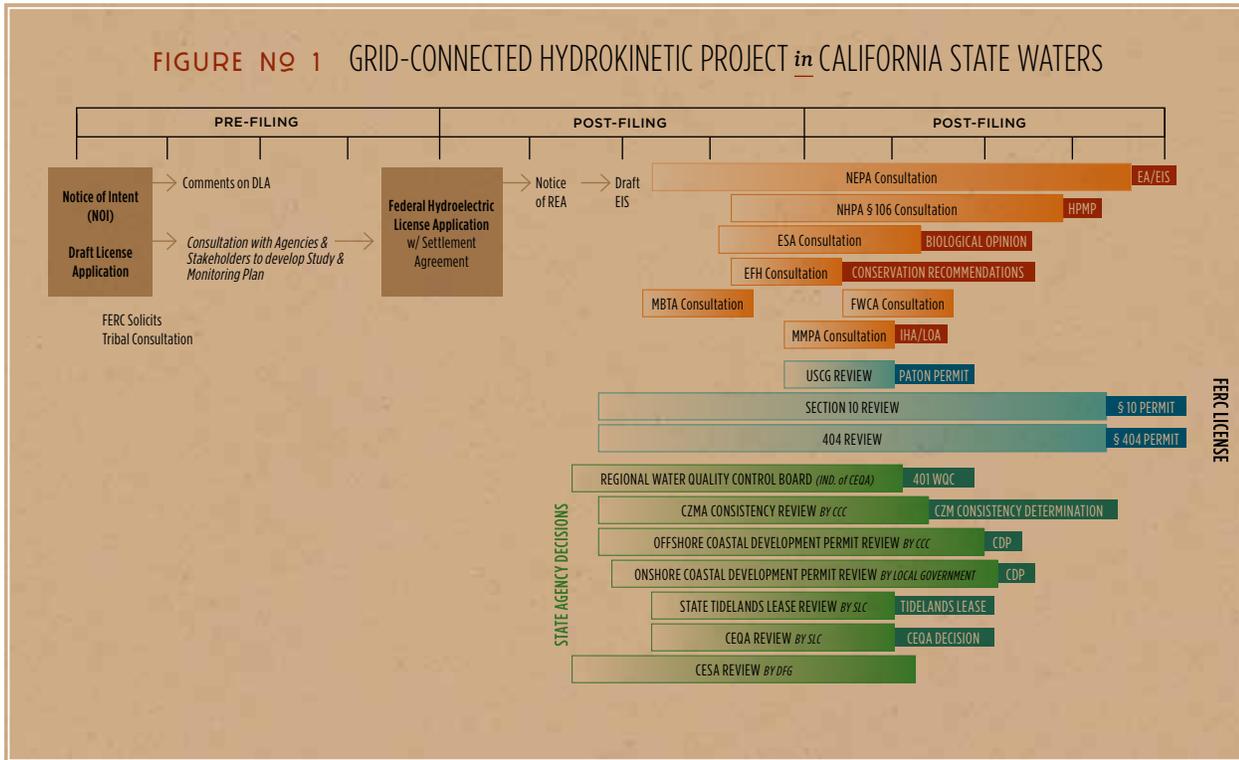
Although interagency communication may reduce backlogs or clarify uncertainties in the decision process, recommendations or ideas from other agencies need only be *addressed* by the lead agency in their final review documents. In other words, other agency comments, ideas, and recommendations are not necessarily incorporated into management actions. For example, if the SLC is reviewing a project proposal that would impact a specific benthic habitat important for a fish species that is not threatened or endangered, the DFG can provide comments on the draft EIR that encourages the SLC to consider an alternative project proposal that does not impact or substantially reduce the impact to benthic habitat. The SLC is obligated to address the DFG's comments, but is not required to re-site the project if other reasons support the SLC's preferred project location.

Even when a project requires permits from multiple agencies, recommendations from a subsequent permitting agency are not legally binding on any preceding agency action. For example, if the CCC knows the SLC is developing an EIR for a lease application that the CCC will also need to review, the CCC may recommend that the SLC include specific data in the EIR to better inform project evaluation and ultimately each agency's management decision. While the SLC could certainly take the CCC's recommendation into consideration and require the applicant to provide such data, the SLC is not legally obliged to do so unless the SLC determines that the information is necessary for its own decision making. However, once the application is squarely before the CCC, the applicant would still need to provide those data. The additional information requested by the CCC could significantly alter the determination of impacts and/or statutory conformance in either agency's review of the project.

It is recommended that, regardless of mandatory requirements for agency interaction (e.g., CEQA), agencies can and should proactively communicate with other agencies involved in a project's permitting process so that issues, information needs, and ideas for bringing the project in line with statutory requirements are made known and can be addressed early in the project's permitting process. The CEQA EIR matrix found at the end of Chapter 3 (State Lands Commission) showcases how agencies can analyze, emphasize, and account for the ecological principles in a variety of EIR sections for analysis.

¹⁵. tit. 14, § 15200.

FIGURE NO 1 GRID-CONNECTED HYDROKINETIC PROJECT *in* CALIFORNIA STATE WATERS



Roadmap showing estimated timing and sequence of the primary federal and state consultation, permitting and environmental review processes for siting of hydrokinetic projects in California. Adapted from the California Roadmap developed by Pacific Energy Ventures, available at www.advancedh2opower.com

The matrix also provides a common template that agencies can use to determine the types of data and information that should be required of a project proponent. If all agencies are starting at the same place and using a common template, then all of the data and information that will be required by successive agencies in the process will already be gathered, increasing the efficiency and transparency of the permitting process.

The CCC and the California Energy Commission are two state agencies that formalized their interagency communication and data procurement process for coastal power plant permitting to improve “substantive and procedural issues likely to come up during future reviews” (e.g., timeliness of data procurement, adequacy of information generation, and ultimately decision-making efficiency) for both agencies.¹⁶

¹⁶ CAL. COASTAL COMM’N. THE 2006 UPDATED ASSESSMENT OF THE CALIFORNIA COASTAL MANAGEMENT PROGRAM (CCMP) 17 (2006) (Draft for Public Review and Comment), <http://www.coastal.ca.gov/fedcd/ccmp2006assessment.pdf>; accord CAL. ENERGY COMM’N & CAL. COASTAL COMM’N, MEMORANDUM OF AGREEMENT BETWEEN THE CALIFORNIA ENERGY COMMISSION AND THE CALIFORNIA COASTAL COMMISSION REGARDING THE COASTAL COMMISSION’S STATUTORY ROLE IN THE ENERGY COMMISSION’S AFC PROCEEDINGS (April 14, 2005). Other agencies (state and federal) in analogous situations—such as siting solar power facilities in the California

desert—have developed memoranda of understanding to streamline and coordinate their environmental reviews. See BUREAU OF LAND MGMT. & CAL. ENERGY COMM’N, MEMORANDUM OF UNDERSTANDING BETWEEN THE U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT, CALIFORNIA DESERT DISTRICT AND THE CALIFORNIA ENERGY COMMISSION STAFF CONCERNING JOINT ENVIRONMENTAL REVIEW FOR SOLAR THERMAL POWER PLANT PROJECTS (August 8, 2007), http://www.energy.ca.gov/siting/solar/BLM_CEC_MOU.PDF.



One way to facilitate more in-depth coordination and proactive communication between agencies with management responsibility for marine resources in light of limited staff, time and resources is through an agency exchange to illuminate: (1) the types of data and information that each agency requires to make their permit decisions; (2) the expectations each agency has of their permit applicants, including clarification of what applicants need to prepare and submit; and (3) the standard for determining significance of one or more impacts within each agency's cumulative impacts analysis. The lessons learned from this type of exchange could encourage future interagency communication and an increased understanding of other agency's requirements and processes (Figure 1).

It would also be valuable for agencies to develop a standard set of questions regarding a new permit application that, if answered in the affirmative, would trigger an agreement to coordinate with relevant agencies throughout the decision-making processes (Box 2).

Data coordination and sharing across agencies through the use of a geospatial portal would facilitate interagency communication and reduce redundancies that occur when multiple agencies are involved in a permitting process.

BOX NO 2

QUESTIONS *to ASK in* INTERAGENCY COMMUNICATIONS:

1. Will subsequent agencies' permitting or regulatory review processes require more information/data than your present review process requires? Would communication among the collective agencies better inform any one individual agency decision because another agency may have more information, guidance, documentation, or data regarding management measures and impacts?
2. Do additional information and data exist? Who has them? How would your agency obtain them?
3. What processes could be set in motion by any of the agencies or the applicant in order to fill these identified information/document gaps?
 - Information sharing
 - Analysis synthesis
4. Are there stakeholder issues on the horizon that all agencies involved could collaboratively begin to address? If yes, what do the agencies and the applicant need to do to proceed?

3



UNCERTAINTY

Ocean and coastal management decisions almost always involve uncertainties (e.g., the magnitude of impacts, indirect effects, or climate change interactions) and is not an issue unique to EBM. These uncertainties frequently surface within the fisheries management context;¹⁷ however, uncertainty arises within other coastal management decisions as well.¹⁸ However, by considering the entire ecosystem those uncertainties are more transparent allowing for a better understanding of the risk associated with different management decisions. Despite the reality that uncertainty is an inherent component of all ecosystem dynamics, coastal and ocean managers can take meaningful steps to minimize the uncertainty associated with their decisions.¹⁹

17. One of the most pervasive barriers facing comprehensive fisheries management is the lack of data available on specific species and their relationships to the broader marine environment. The MLMA requires the DFG to base Fishery Management Plans on the best available scientific information, identify gaps in essential fishery information, and include steps to close those gaps. CAL. FISH & GAME CODE §§ 7072(b), 7081 (West 2012). The Master Plan acknowledges that factors such as cost, available technology, appropriate expertise, jurisdictional limitations, and availability and quality of baseline information all significantly influence where and in what priority fisheries resources will be able to acquire necessary data. CAL. DEP'T OF FISH & GAME, FINAL WHITE SEABASS FISHERY MANAGEMENT PLAN (hereinafter WSFMP) 4-15 (2002). With such a lack of available data, accounting for uncertainties in management decisions is difficult. It is therefore important to take a precautionary approach to management when making decisions impacting data-limited or data-moderate resources. Chapter 5 of the WSFMP notes the importance of the precautionary approach in stating: "[i]t is not uncommon that the status of knowledge for a given stock is limited to the catch history and incomplete life history information. A precautionary approach to calculating [optimum yield] in data-moderate or data-poor situations is to multiply [maximum sustained yield], or its proxy, by a fraction." *Id.* at 5-5.

18. For the CCC, agency staff point out that one of the largest areas of uncertainty is in accurately anticipating the scope of and determining the likely impacts of permitted activities on the ecosystem (ecological and social). The scope, nature, direction, and magnitude of change/impact are all critical to properly scoping a request for background information, accurately structuring monitoring activities, and appropriately capturing the costs of an impact in order to correctly account for that impact in the project mitigation fee structure.

19. Melissa M. Foley et al., *Guiding Ecological Principles of Marine Spatial Planning*, 34 MARINE POL'Y 955 (2010).



Uncertainty in ocean ecosystems, whether due to a lack of data, access to data, or complex ecological interactions, makes taking a precautionary approach to resource management²⁰ imperative to ensure that the absence of information on the effect of an activity is not interpreted as the absence of impact or harm to the ecosystem.²¹

In the face of uncertainty, it is critical to manage the system so that multiple species or habitats play overlapping roles in the ecosystem (especially among key species and drivers of ecosystem structure, such as productivity).²² Redundancy in species' roles and habitat buffers provide "insurance policies" against environmental changes and protect ecosystem function.

Information gap analyses, such as the Agency Science Needs Assessment undertaken by the California Ocean Science Trust, are an emerging strategy designed to evaluate scientific information and data gaps and develop a strategy to gather data that address and inform key management priorities and improve the use of science in management decisions.²³

Public-private partnerships (PPPs) can be a creative solution to staff and funding limitations facing many of California's resource agencies. PPPs, such as the

Central Coast Groundfish Project, pool resources and staff across local, state, and federal agencies, local communities, and non-governmental organizations (NGOs).²⁴

Collaborative research projects, much like data synthesis projects, can create novel partnerships between industry, academia, and management. The Sustainable Fisheries Project at the University of California Santa Barbara has been a successful model for creating partnerships between academia, fishers, and NGOs that foster more targeted research and more efficient uptake of data and analyses by fisheries management agencies.²⁵

Recognition of the limitations that current data have can inform new methods for data analysis. Methods for conducting stock assessments for data-limited fisheries, for example, were developed specifically for high quality but low quantity data situations.²⁶

20. Richard S. Appeldoorn, *Transforming Reef Fisheries Management: Application of an Ecosystem-Based Approach in the USA Caribbean*, 35 ENVTL. CONSERVATION 232 (2008).

21. Food & Agric. Org. of the U.N., *FAO Technical Guidelines for Responsible Fisheries No. 8, Indicators for Sustainable Development of Marine Capture Fisheries* (1999), <http://www.fao.org/docrep/004/x3307e/x3307e00.htm>.

22. Callum M. Roberts et al., *Ecological Criteria for Evaluating Candidate Sites for Marine Reserves*, 13 ECOLOGICAL APPLICATIONS S215 (2008).

23. *Agency Science Needs Assessment*, CAL. OCEAN SCIENCE TRUST, <http://calost.org/science-initiatives/?page=mripp> (last visited May 14, 2012).

24. *California Central Coast Groundfish Project*, THE NATURE CONSERVANCY, <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/howwe-work/central-coast-groundfish-project.xml> (last visited May 14, 2012).

25. *Improving the Sustainability of Ocean Ecosystems*, SUSTAINABLE FISHERIES GROUP, <http://sfg.msi.ucsb.edu/about-us> (last visited May 14, 2012).

26. Kristen T. Honey et al., *From Rags to Fishes: Data-Poor Methods for Fishery Managers*, 1 MANAGING DATA-POOR FISHERIES: CASE STUDIES, MODELS & SOLUTIONS 159 (2010).

4

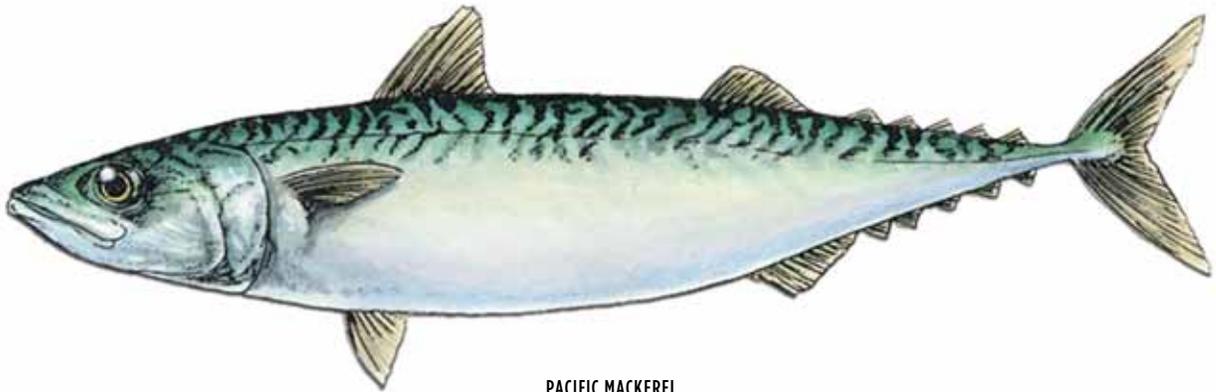


CONTEXT

Contextual factors, such as geomorphology and biogeography, as well as the type, distribution, frequency, and intensity of existing and future ocean uses must be considered when applying the ecological principles in a management process. Ecological processes occur on a variety of scales from meters (e.g., site specific species diversity) to thousands of kilometers (e.g., ocean currents), and management boundaries often do not align with ecological boundaries.

MANAGEMENT BOUNDARIES OFTEN DO NOT ALIGN WITH ECOLOGICAL BOUNDARIES

It is important for agencies to consider the alignment (or misalignment) of scales when making management decisions. For example, if the population distribution of a species exists entirely within the jurisdictional boundaries of an agency, it is likely to be easier to make management decisions regarding that species because there tend to be fewer extrinsic factors affecting the population dynamics of that species. However, it would also be important in this context to pay special attention to the types of activities within and outside the agency's jurisdiction that negatively affect that species since there is no possibility of individuals recolonizing the population from outside the area. Similarly, communication with other agencies is necessary in this example because other activities may be permitted that have an impact on that species.



PACIFIC MACKEREL

Scomber australasicus

WHEN THE SCALE OF A RESOURCE IS MUCH LARGER THAN AN AGENCY'S JURISDICTION, THE AGENCY'S ABILITY TO ACHIEVE ITS OWN MANAGEMENT OBJECTIVES FOR THAT RESOURCE IS OFTEN INFLUENCED BY ACTIVITIES THAT OCCUR OUTSIDE OF ITS JURISDICTION

When the scale of a resource is much larger than an agency's jurisdiction, the agency's ability to achieve its own management objectives for that resource is often influenced by activities that occur outside of its jurisdiction—in addition to biophysical forces that occur at very large scales—substantially increasing the uncertainty of population dynamics or the outcome of a management decision.



Assess the spatial and temporal scales of resources managed or impacted by a project and the spatial scale of the management decision.

These composite maps can help to determine the level of precaution that should be taken when making a management decision or siting permitted activities.

5

CUMULATIVE IMPACTS

Continued ecosystem decline, despite increasingly stringent environmental standards and reviews, is caused by the cumulative impact of activities that co-occur in time or space. Multiple activities with a similar impact or with a variety of impacts can substantially alter the structure and functioning of marine ecosystems. In particular, activities that combine to produce a synergistic impact—a total impact that is greater than the sum of all the parts—are of immediate concern. However, due to the nature of incremental change, many instances of cumulative impacts on the ecosystem go unnoticed until an ecosystem threshold is crossed and drastic changes have ensued.²⁷

Comprehensive cumulative impacts analyses are complicated and difficult to conduct, but developing a standardized protocol is becoming a priority because cumulative impacts are increasingly being recognized as one of the leading causes of ocean health decline.²⁸ Research from temperate and tropical systems demonstrate how impacts can accumulate in an ecosystem resulting in complete ecosystem shifts.²⁹ Understanding these particularly detrimental combinations should be a priority for ocean and coastal managers.

Although CEQA and CEQA-equivalent regulatory processes (e.g., Coastal Development Permits and

²⁷. Heather M. Leslie & Ann P. Kinzig, *Resilience Science*, in *ECOSYSTEM-BASED MANAGEMENT FOR THE OCEANS* (Karen L. McLeod & Heather Leslie eds., 2010).

²⁸. Benjamin S. Halpern et al., *A Global Map of Human Impact on Marine Ecosystems*, 319 *SCIENCE* 948 (2008); Caitlin M. Crain et al., *Interactive and Cumulative Effects of Multiple Human Stressors in Marine Systems*, 11 *ECOLOGY LETTERS* 1304 (2008).

²⁹. James A. Estes & David O. Duggins, *Sea Otters and Kelp Forests in Alaska: Generality and Variation in a Community Ecological Paradigm*, 65 *ECOLOGICAL MONOGRAPHS* 75 (1995) (the loss of sea otters due to hunting and disease altered the presence of kelp forest communities); Terence P. Hughes, *Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef*, 265 *SCIENCE* 1547 (1994) (the cumulative impact from overfishing, disease, and coral bleaching contributed to the loss of coral communities in the Caribbean).



Kelp forest underwater at Casino Point, Catalina Island, California.

THE PREVAILING SCIENTIFIC DEFINITION OF CUMULATIVE IMPACTS DOES NOT MATCH THE LEGAL DEFINITION ARTICULATED IN CEQA

Fishery Management Plans) require an analysis of cumulative impacts, there are no standards that define the scope of the analysis or methods to evaluate the cumulative impacts of a project.³⁰ In addition, the prevailing scientific definition of cumulative impacts does not match the legal definition articulated in CEQA, further confounding the development of analysis techniques that are consistent with both science and the law. It is important to note that the scientific

definition and approach to cumulative impacts analysis varies greatly from what has been deemed legally sufficient and consistent with existing policy approaches. While agencies must work within existing legal mandates, it is useful to highlight the scientific approach to cumulative impacts analysis and some of the differences between the science and policy of cumulative impacts as implemented now (Box 3).

³⁰. “The statutory direction and the CEQA Guidelines . . . are complicated and somewhat circular.” Nicole Hoeksma Gordon & Al Herson, *Demystifying CEQA’s Cumulative Impact Analysis Requirements: Guidance for Defensible EIR Evaluation*, 2011 CAL. ENVTL. L. REP. 379, 380 (citation omitted). “EIR preparers frequently ask whether the ‘significance’ of a cumulative impact should be determined using the same significance threshold as that used for project specific impacts. Neither the Guidelines nor the case law provide any guidance.” *Id.* at 381.



CUMULATIVE IMPACTS SCIENTIFIC APPROACH

DEFINITION

The temporal and spatial accumulation of environmental change due to impacts from an individual activity that recurs over time and/or space or impacts from multiple activities with temporal and/or spatial overlap.³¹

IN PRACTICE

The total impact from direct and indirect impacts on ecosystems due to multiple types of stressors that overlap in space and time.

APPROACH

- Start with a historical baseline.³²
- Include all impacts in the analysis regardless of their individual status of significance.
- Include all projects in the analysis regardless of the type of impact they have on the ecosystem.
- Determine significance of interactions based on laboratory and field experiments.³³
- Use laboratory and field experiments to determine if impact combinations act in synergistic, antagonistic, or additive ways.³⁴
- Use models to enumerate impact to the ecosystem using a combination of habitat, activity, and ecosystem vulnerability data.³⁵



CUMULATIVE IMPACTS LEGAL & POLICY APPROACH

DEFINITION

“‘Cumulative impacts’ refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.

- a) The individual effects may be changes resulting from a single project or a number of separate projects.
- b) The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.”³⁶

IN PRACTICE

Project specific analysis that tends to be sector specific.

APPROACH

- Start with a baseline of current conditions.³⁷
- Only consider project impacts if (1) when combined with impacts of other past, present and future projects they are cumulatively significant and (2) the incremental effects of the project is cumulatively considerable.³⁸
- Only consider projects that may cause impacts similar to, or related to, the impacts caused by the proposed project.³⁹
- “[T]he more severe existing environmental problems are, the lower the threshold should be for treating a project’s contribution to cumulative impacts as significant.”⁴⁰

31. Harry Spaling & Barry Smit, *Cumulative Environmental Change: Conceptual Frameworks, Evaluation Approaches, and Institutional Perspectives*, 17 ENVTL. MGMT. 587 (1993).

32. Loren McClenachan et al., *From Archives to Conservation: Why Historical Data are Needed to Set Baselines for Marine Animals and Ecosystems*, CONSERVATION LETTERS (2012) [10.1111/j.1755-263X.2012.00253.x].

33. Emily S. Darling & Isabelle M. Côté, *Quantifying the Evidence for Ecological Synergies*, 11 ECOLOGY LETTERS 1278 (2010).

34. Crain, *supra* note 28.

35. Benjamin S. Halpern et al., *Mapping Cumulative Human Impacts to California Current Marine Ecosystems*, 2 CONSERVATION LETTERS 138 (2009).

36. CAL. CODE REGS. tit. 14, § 15355 (2012).

37. *Id.* at § 15125; *Fat v. Cnty. of Sacramento*, 97 Cal. App. 4th 1270, 1278 (Cal. Ct. App. 2002).

38. *Id.* at § 15064(h)(1) (“‘Cumulatively considerable’ means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.”).

39. *Id.* at § 15130(a)(1).

40. MICHAEL H. REMY ET AL., *GUIDE TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT* 481 (11th ed. 2007) (summarizing *Kings Cnty. Farm Bureau v. City of Hanford*, 221 Cal. App. 3d 692, 718-721 (Cal. Ct. App. 1990)).

Within the cumulative impact section of each agency chapter, we provide tips specific to each agency for moving forward with cumulative impact analyses. In the following paragraphs we provide a more generalized list of management practices for all coastal agencies that are required to conduct a cumulative impacts analysis (Box 4). The list is adapted from the California Department of Transportation's *Guidance for Preparers of Cumulative Impact Assessments*.⁴¹ This analysis is based on the definitions and requirements of both NEPA and CEQA and presents steps from identifying potentially impacted resources, to describing current and historical conditions, to assessing options for avoiding, minimizing, and mitigating significant impacts. We have adapted the list to be more cognizant of the entire ecosystem and its linkages rather than individual affected resources (Box 4).



Include a description of ecological conditions, existing uses, and *all* ecosystem impacts as baseline conditions that are submitted as a part of the environmental setting section of the EIR (or its equivalent). Use these baseline conditions to structure the cumulative impacts discussion section of the document.

Spatially map ecosystem impacts to better inform cumulative impact analysis.

Account for all impacts that may arise from surrounding projects, not just those projects with impacts similar to the one proposed or impacts within the permitting agency's jurisdiction.

Impacts accrue over space and through time. Consider the impacts of projects that have similar temporal and spatial footprints.

Work with other state agencies to develop a state-wide system that tracks projects in their various stages of permit review. This would allow analysts to easily determine the location, number, and type of projects that are currently in the permitting pipeline.

BOX NO 4 COMPONENTS *of a* CUMULATIVE IMPACT ANALYSIS⁴²

1. Identify resources and ecological attributes that may be affected by the proposed activity
 - include direct and indirect impacts
 - give special focus to resources/attributes that are significantly impacted, rare, highly vulnerable, or in poor or declining health
2. Define the area of impact for the project
 - define the spatial and temporal boundaries for the analysis
3. Describe the current health and historical context for each resource and ecosystem condition
 - provide a narrative of the current health or status of a resource/attribute and its historical trajectory (i.e., stable, improving, declining) including the activities that have contributed to the current condition of the resource/attribute
4. Identify the direct and indirect impacts of the proposed project that could contribute to a cumulative impact
 - consider direct and indirect impacts that affect the resources/attributes identified in Step 1
5. Identify other reasonably foreseeable actions that might impact the resources and ecological attributes identified in Step 1.
 - determine if those actions have direct or indirect impacts on a resource/attribute
6. Assess potential cumulative impacts
 - analyze overlap of impacts on resources/attributes and determine if impact is significant
7. Report the results
 - produce a summary of the analysis consistent with CEQA disclosure requirements that identifies the resources/attributes considered, the spatial and temporal scope of the analysis, and the context of the resource.
 - describe methods for analysis and any assumptions used in the analysis
8. Assess the need to avoid, minimize, and mitigate
 - compare the expected cumulative impact to the accepted impact threshold to determine if alternative management measures are required that firstly avoid sensitive species, habitats, or attributes; that secondly minimize the cumulative impact; or lastly mitigate the impact

41. CAL. DEP'T OF TRANSP., GUIDANCE FOR PREPARERS OF CUMULATIVE IMPACT ASSESSMENTS: CEQA GUIDELINES FOR CUMULATIVE AND INDIRECT IMPACTS (2005), http://www.dot.ca.gov/ser/cumulative_guidance/downloads/CEQA_Guidelines_for_Cumulative_and_Indirect_Impacts.pdf.

42. Adapted from *Id.*

6

MONITORING AND MITIGATION

One of the most effective ways to ensure a project is not exceeding its expected impact on the ecosystem is by monitoring the project area after development is underway and/or completed. By monitoring the impact to species diversity, habitat diversity and heterogeneity, key species, and connectivity, managers can determine if the conditions of permit approval are met and if the impact on the ecosystem is consistent with expectations. If impacts are within the range of what was expected, the agency would know that its permit review process and any conditions imposed were acceptable for that use. If impacts exceed the expected range, managers with permits that include adaptive management provisions would then have the opportunity to adjust permit conditions to account for the additional negative impacts uncovered by the monitoring activity.

It is important to note that monitoring programs are only as good as the data collected and data analyses following collection. If data are collected haphazardly, managers will not be able to use the data effectively. Similarly, if data are collected appropriately but not analyzed, the monitoring program will not be able to provide analyses that can inform mid-project course correction, measure the success of current management decisions, or improve the content of future management decision conditions.

Monitoring for compliance and effectiveness of mitigation measures can be required as a condition of permit approval under CEQA and the Coastal Act.⁴³ However, there must be a nexus between a project's expected impacts and the conditions imposed on the project proponent—such as conditions requiring mitigation, restoration or monitoring. For instance, the

⁴³ CAL. PUB. RES. CODE § 21081.6(a)(1) (West 2012).

CCC could require a project proponent to develop a monitoring program that measures the effectiveness of a wetland restoration project. However, conversations with Coastal Commission staff demonstrate that under existing practice the CCC cannot require the project proponent to monitor the impacts an activity has on a wetland over the course of a project. This limitation makes it difficult for agencies to understand the true impact of projects and long-term effectiveness of mitigation on the ecosystem.

Mitigation measures are conditions of permit approval if the impacts from a project are significant. Mitigation measures aim to ameliorate the harm caused by the project to less than a significant level, but prior to 1999 were often proposed in a different location than the project site (e.g., destruction of eelgrass at one location to be mitigated by restoring eelgrass in another location).⁴⁴ Although mitigation measures are common, it is often more efficient and cost-effective to avoid impacts from the onset rather than developing mitigation measures for every significant ecosystem impact. CEQA requires agencies to avoid impacts whenever possible. If avoidance is not possible, impacts should be minimized to the greatest extent possible. If minimization is not an option, then and only then should mitigation measures be considered that would offset project impacts. If the agency finds that changes or alterations of the project are

⁴⁴. See, e.g., NOAA'S NAT'L MARINE FISHERIES SERV. SW. REG'L OFFICE, SOUTHERN CALIFORNIA EELGRASS MITIGATION POLICY (revision 11, adopted July 31, 1991), http://swr.nmfs.noaa.gov/hcd/HCD_webContent/aboutus/policies.htm; CAL. COASTAL COMM'N, STAFF REPORT: APPLICATION No. 5-10-205, at 5 (2011), <http://documents.coastal.ca.gov/reports/2011/10/Th9b-10-2011.pdf>. *But see* *Bolsa Chica Land Trust v. Superior Court*, 71 Cal. App. 4th 493, 507 (Cal. Ct. App. 1999) (finding Coastal Act section 30240 requires ESHA mitigation to take place onsite because it cannot be "recreated in another location.")

MONITORING PROGRAM RECOMMENDATIONS

1. Require monitoring before, during, and after project development.
2. Require monitoring to continue until the ecosystem has recovered to its pre-disturbance state or an acceptable alternative.
3. Implement mechanisms to accurately enforce monitoring conditions.
4. Implement mechanisms to accurately review and analyze monitoring data.
5. Develop thresholds and indicators based on desired ecosystem conditions.
6. Implement mechanisms to incorporate new monitoring data results into future management decisions through an adaptive management process.

required to mitigate or avoid significant impacts on the environment pursuant to Section 20181(a) of the Act, CEQA's mitigation reporting or monitoring requirement (Section 21081.6) is triggered.⁴⁵ Upon requiring mitigation measures to be implemented as permit approval conditions, the agency must de-

⁴⁵. PUB. RES. § 21081.6.

velop a mitigation program that either reports on or monitors the mitigation measures.⁴⁶



Avoid impacts first; mitigate as a last resort.

Update monitoring requirements included in mitigation monitoring to ensure that monitoring requirements reflect the best available science and understanding of impacts and ecosystem vulnerabilities.

Require mitigation monitoring programs to incorporate the ecological principles by measuring the effectiveness of mitigation in maintaining or restoring native species diversity, habitat diversity and heterogeneity, populations of key species, and connectivity.

Require applicants to monitor the impacts of the project on ecological attributes so that mitigation can be better aligned with impact. Ideally, this approach includes adaptive management conditions that are tied to the monitoring results. Monitoring results from previous projects can also inform the design of monitoring measures applied to future projects.



Marbled Godwits in front of Scripps Pier, La Jolla, California
PHOTO: Wikimedia Commons, Mkeipper, 2009.

⁴⁶ The Office of Planning and Research recommends that “reporting without detailed monitoring is suited to projects which have readily measureable or quantitative mitigation measures or which already involve regular review.” GOVERNOR’S OFFICE OF PLANNING & RESEARCH, TRACKING CEQA MITIGATION MEASURES UNDER AB 3180, MITIGATION MONITORING OR REPORTING PROGRAMS, (3rd ed. 1996), *available at* ceres.ca.gov/ceqa/more/tas/CEQA_Mitigation/page3.html. Alternatively, “[m]onitoring, rather than simply reporting, is suited to projects with complex mitigation measures, such as wetlands restoration or archeological protection, which may exceed expertise of the local agency to oversee, which are expected to be implemented over a period of time, or which require careful implementation to assure compliance.” *Id.*

7

ADAPTIVE MANAGEMENT

An additional crucial component of the EBM approach is adaptive management—where managers and regulatory systems both generate and are adaptive and responsive to new information. Adaptive management begins “with the central tenet that management involves a continual learning process that cannot conveniently be separated into functions like ‘research’ and ‘ongoing regulatory activities,’ and probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity.”⁴⁷ In 1998, Bormann et al. published the following adaptive management process, which, in its most simple form, serves as the basis by which most environmental planning and decisions are set: **PLAN, ACT, MONITOR, AND EVALUATE.**⁴⁸ In sum, adaptive management contains two key elements: (1) a monitoring system that measures ecological attributes as indicators of the current ecosystem state, and (2) a response system that allows for the modification of those indicators and management action.⁴⁹ Successful long-term management depends on “experimentation” and hypothesis testing. Adaptive management is an important part of the overall EBM approach because it provides a mechanism for lessons learned to be incorporated into management decisions, allowing managers to analyze past management decisions based on new data and information where there were previous gaps and to flexibly alter future management decisions.

For example, the Marine Life Protection Act requires the network of marine protected areas (MPAs) in each planning region to be reviewed five years after implementation. The data being used for the five-

47. CARL WALTERS, *ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES* (1986); CRAWFORD S. HOLLING, *ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT* (1978).

48. BERNARD T. BORMANN, USDA FOREST SERV., PAC. NW. RESEARCH STATION, *ECOSYSTEM SUSTAINABILITY THROUGH ADAPTIVE MANAGEMENT RESEARCH* (1998), available at <http://www.fs.fed.us/eco/s27pre.htm>.

49. Ray Hilborn & John Sibert, *Adaptive Management of Developing Fisheries*, 12(2) *MARINE POL'Y* 112 (1988).

year review, which includes monitoring data from sites inside and outside of the recently established MPAs, is being analyzed and synthesized by the MPA Monitoring Enterprise. The central coast is the first region that has been evaluated and a full report will be released in late 2012. This report, which will include thorough analysis, synthesis, and interpretation of monitoring data, will help to inform the effectiveness of the MPA network, determine future management actions, and establish a baseline against which all future monitoring data will be compared. The DFG, in particular, will use this information to develop management recommendations pertaining to the network of MPAs that will be presented to the FGC in late 2013. The adaptive management recommendations could include either altering the size and spatial arrangement of MPAs, if they are not meeting the objectives of the MLPA, changing fishing regulations outside the MPAs, or "staying the course" and maintaining the current MPA network and fishing regulations.



Analyze existing and forthcoming mitigation monitoring data to determine if impacts are greater than, less than, or commensurate with expectations. While these analyses cannot be used to alter past projects, absent adaptive management mechanisms, they can inform future permitting decisions by providing a better understanding of the realized impacts of different activities.

Include adaptive management mechanisms (e.g., milestones for evaluating effectiveness of project conditions, use of indicators to help inform whether thresholds and/or project objectives are being reached, and contingency plans to direct action in the event specific triggers are met) in project approval documents so that adjustments in project implementation can be made if monitoring data and analyses demonstrate the need.

8



CONCLUSION

These six overarching themes are complex topics that all ocean and coastal management agencies in California consider during the decision-making process. The implementation of these themes depends on an understanding and incorporation of the ecological principles. In addition, application of these overarching themes will help to move California's ocean and coastal management agencies further along the path of successful implementation of EBM principles.

CHAPTER 6

CONCLUDING REMARKS

Homo sapiens

BEACHGOERS enjoying Huntington Beach, California. The California Coastal Act protects access to public beaches throughout California—and 63% of Californians visit at least one beach per year, generating over \$3 billion for coastal communities (from California's Ocean Economy Report, 2005).

PHOTO: Wikimedia Commons, ChrisYarzab. 2010.

The themes, issues, and principles discussed in this Guide are all components of the ultimate goal of coastal and ocean management—ecosystem resilience. As stated in the Introduction, ecosystem resilience is a measure of the persistence of ecosystems and their ability to resist disturbance, or to rebound to a previous (and desirable) level of ecosystem structure and functioning following a disturbance.¹ California's coast and ocean are becoming increasingly crowded and impacted due to a growing number of human uses and changing environmental conditions. Understanding the foundational attributes of ecological communities and incorporating them into management decisions is a step toward maintaining and enhancing California's ocean ecosystem and economy.

Many tools can help agencies improve their incorporation of the ecological principles and ecosystem vulnerability concepts in their decision-making processes. For example, the West Coast Governors' Alliance is currently working to develop a data portal for ocean and coastal ecosystems in Washington, Oregon, and California.² This portal would serve as a centralized access point for relevant data from trusted sources. The availability of these data will help agencies address many of the tips provided in this Guide. Decision support tools—software that use GIS to map resources, explore alternative proposals, and engage stakeholders—are also increasingly available. MarineMap was used for the MLPA process and Atlantis was used to develop alternative fisheries management scenarios for the California Current.³

1. Crawford S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS 1 (1973).

2. *Regional Data Framework ACT Documents*, W. COAST GOVERNORS ALLIANCE ON OCEAN HEALTH, <http://www.westcoastoceans.org/index.cfm?content.display&pageID=157> (last visited May 21, 2012).

3. For more information on decision support tools, see CTR. FOR OCEAN SOLUTIONS, DECISION GUIDE: SELECTING DECISION SUPPORT TOOLS FOR MARINE SPATIAL PLANNING (Woods Inst. for the Env't, Stanford Univ., 2011), http://www.centerforoceansolutions.org/sites/default/files/cos_msp_guide_6.pdf.

THE FUTURE OF CALIFORNIA'S COAST AND OCEAN DEPEND ON A HOLISTIC APPROACH

Above anything else, this Guide is meant to help agencies better understand the foundational science that underpins the EBM approach, and how that science can be more effectively accounted for and incorporated into daily management decisions—especially as those decisions gain increased relevancy in an ocean planning context (e.g., siting new ocean uses). While the Guide uses case studies to provide specific examples, the tips drawn from the case studies are meant to apply broadly to a wide spectrum of coastal and marine management decisions. It is for this reason that checklists are provided after each section so that agency staff can reference these important principles and ask questions about ways to best account for them when making daily management recommendations and decisions. Incorporating EBM approaches into everyday decisions requires time, resources, and expertise that many staff feel are currently unavailable in their agency. The tips in this Guide were written in recognition of these challenges. The Guide also strives to provide examples of ways to move beyond these challenges in cooperation with other agencies and institutions and to help build the required expertise within agencies.

The future of California's coast and ocean depend on a holistic management approach that incorporates the entire ecosystem rather than just a few of its pieces. The ecological principles, ecosystem vulnerability, and overarching themes presented throughout this Guide are resources for doing just that. Working systematically and together, the goals of EBM and a healthy, resilient ocean can be achieved in California.

THE CHECKLISTS PRESENTED IN ALL THREE OF THE AGENCY
DEEP DIVE CHAPTERS ARE RECREATED HERE. THE CHECKLISTS
ARE INTENDED TO HELP AGENCY STAFF ACCOUNT FOR THE
ECOLOGICAL PRINCIPLES AND ECOSYSTEM VULNERABILITY IN
DAY-TO-DAY PERMIT AND PROJECT REVIEW.

ACCOUNTING *for*
SPECIES DIVERSITY
(in order of priority)

- Identify the numbers and types of **species** impacted by the project
- Identify the numbers and types of **impacts** on species (e.g., anchor, burial, water quality)
- Map and analyze the **spatial distribution** of impacted species (e.g., rare vs. common species, population size, location)
- Evaluate the **duration and frequency** of each impact to species (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to species
 - Assess appropriate levels of duration and frequency of each impact to species
- Analyze the **seasonal characteristics** of the impacted species (e.g., spatial and temporal characteristics of breeding, spawning, and migration)
- Evaluate the **life history characteristics** of the impacted species (e.g., spatial movement of larvae, juveniles, and adults; lifespan; reproductive potential)

ACCOUNTING *for*
HABITAT DIVERSITY *and* HETEROGENEITY
(in order of priority)

- Identify the numbers and types of **habitat** impacted and the role they play in the ecosystem (e.g., nursery, spawning, foundation)
- Identify the numbers and types of **impacts** on habitats (e.g., anchor, burial, water quality)
- Map and analyze the **spatial distribution** of impacted habitats (e.g., rare vs. common habitats, habitat size, location)
- Evaluate the **duration and frequency** of each impact to habitats (e.g., short vs. long term impacts; light vs. heavy impacts)
 - Quantify the duration and frequency of each impact to habitats
 - Assess appropriate levels of duration and frequency of each impact to habitats
- Identify the spatial and temporal characteristics of **dynamic habitats** (e.g., upwelling, fronts) and the role they play in the ecosystem (e.g., nutrient source, aggregation area)



ACCOUNTING *for* CONNECTIVITY *(in order of priority)*

- Identify the approximate **dispersal distance** of larvae of the impacted species (e.g., see MLPA “Size and Spacing” guidelines)
- Evaluate the **circulation patterns** in the project area (e.g., wind, waves, tides, currents, stream flow)
- Identify areas that may be important larval **retention features** (e.g., fronts, eddies, bays, lees of headlands)
- Evaluate overlap between agency jurisdiction and species ranges and consider any **biogeographic boundaries** that occur within the project area
- Assess impacts on **migration patterns**

ADDRESSING *the* RISKS *and* IMPACTS *of* CLIMATE CHANGE *(in order of priority)*

- Identify **potential risks** to the project from climate change (e.g., sea level rise, changes in ocean chemistry, changes in ocean circulation patterns, changes in ocean temperature)
- Identify **actual impacts** on managed species, habitats, and project locations from climate change (e.g., inundation, dissolution of calcareous skeletons, shifts in species range)
- Identify **opportunities for adaptation and/or mitigation** of identified risks and impacts (e.g., increase size of buffer zones, restore degraded habitats, ensure physical sturdiness of project materials)

ACCOUNTING *for* KEY SPECIES *(in order of priority)*

- Identify the impacts to:
 - **Foundation Species** (e.g., kelp, seagrass)
 - **Basal Prey** (e.g., sardines, anchovies, mullet)
 - **Top Predators** (e.g., sharks, tuna, sea lions, elephant seals)
 - **Keystone Species** (e.g., sea otters, sea stars)
- Identify the impacted species' **contributions to ecosystem functioning** (e.g., weigh significance of the impacts)
- Evaluate whether the impacts will cause a **trophic cascade** in the system

CONDUCTING CUMULATIVE IMPACTS ANALYSIS *(in order of priority)*

- Synthesize all **impact types** in one cumulative impacts analysis
- Identify **spatial and temporal overlap** of impacts from all past, present, and probable future projects, regardless of jurisdiction
- Spatially map impacts** to inform analysis
- Categorize and evaluate **impact interactions**:
 - **Additive** (i.e., combination of impacts is equal to the sum of its parts)
 - **Synergistic** (i.e., combination of impacts may be greater than the sum of its parts)
 - **Antagonistic** (i.e., combination of impacts may be less than the sum of its parts)

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