Snapshot of Decision Makers' Science Needs
Ecosystem and Food Web Impacts Working Group

Introduction

The need for greater understanding of ocean acidification and hypoxia (OAH) along the Pacific West Coast has arisen at multiple levels of government. The scope of decision making audiences for the West Coast Ocean Acidification and Hypoxia Science Panel (the Panel) includes managers, policymakers, and legislators at the state, regional, federal and international levels. This document provides a summary of decision maker information needs which the Panel's Ecosystem and Food Web Impacts Working Group aims to address through their work.

Conversations with Decision Makers

To identify priority information needs related to the issues of OAH, Ocean Science Trust, in collaboration with the Institute for Natural Resources in Oregon, conducted a series of interviews with decision makers across the natural resource management and policy landscape. From these interviews, the Panel gained insight into core information needs relating to impacts of OAH to ecosystems and food webs. Beyond shaping the work of the Panel, the science needs identified here can help focus research and funding priorities for those with an interest in producing policy and management-relevant science to track and address these critical issues going forward.

Core Information Needs

Science needs have been divided by decision making audiences:

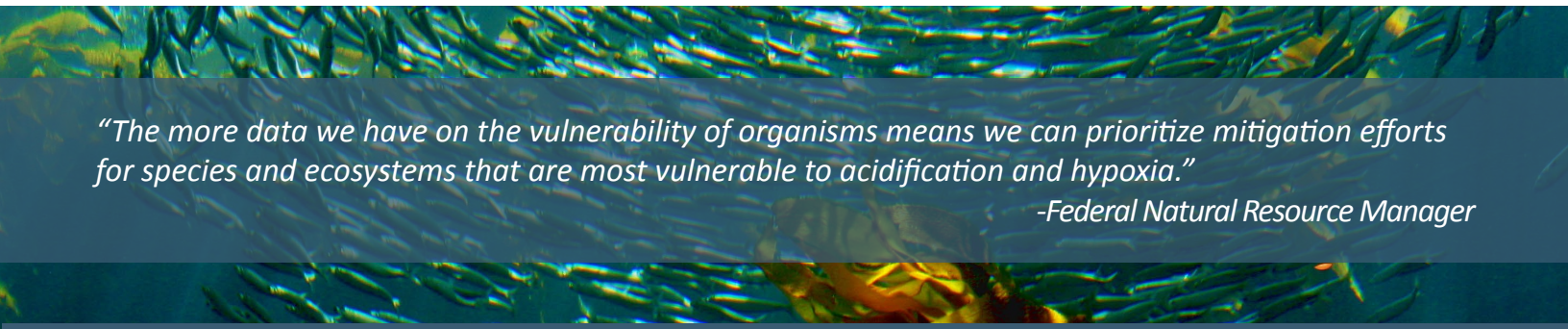
- Water Quality Managers
- Fishery and Wildlife Managers
- Land Use and Park Managers
- Air Quality Managers

Generally, managers recommended that human uses of ecological resources be considered. Key science needs include understanding the vulnerability of fished species, natural variation and species impacts in bays and estuaries, prioritization of ecosystem and species vulnerabilities, species adaptive capacity, and the need to develop predictive modeling tools for species impacts as well as for changes in water chemistry in nearshore and estuarine habitats.

Key Science Needs

- *Impacts to managed species*
- *Species' adaptive capacity*
- *Identification of vulnerable habitats*
- *Impacts on food webs*
- *Species' vulnerability and life histories*
- *Impacts to commercial and recreational managed species*
- *Physiological responses*
- *Impacts to trophic cascades*
- *Nearshore processes in saltmarsh, eelgrass, estuarine communities*

Compiled by California Ocean Science Trust and Institute for Natural Resources on behalf of the West Coast Ocean Acidification and Hypoxia Science Panel



"The more data we have on the vulnerability of organisms means we can prioritize mitigation efforts for species and ecosystems that are most vulnerable to acidification and hypoxia."

-Federal Natural Resource Manager

Water Quality Managers

"It would be informative to parse out the various contributions to acidification and hypoxia. What is the natural signal, the global anthropogenic contribution, and the local anthropogenic contribution?"

- State Water Quality Managers

Impacts to Biology and Ecology

- Biological responses associated with OAH
- Understanding species' adaptive capacity in coastal waters in relation to pelagic/offshore environments
- Qualitative or quantitative impacts to use of marine resources ("beneficial uses") including:
  - » Areas of Special Biological Significance (ASBS), especially those that overlap with marine protected areas
  - » Commercial and sport fishing
  - » Estuarine habitats
  - » Marine habitats, including vegetation such as kelp, fish, shellfish or wildlife
  - » Shellfish harvesting
  - » Fish spawning

Natural Variation and Drivers of OA and Hypoxia

- Identifying a "baseline" for natural conditions as a reference point for future changes
- Advancing tools to monitor and track ocean acidification
- Clarification of the link between OA and hypoxia
- Valuable metrics to monitor in the environment beyond carbon dioxide
- impacts to frequency and/or toxicity of harmful algal bloom events
- Greater understanding of daily, seasonal and geospatial (e.g., bays, shelf, estuaries) variation in pH/oxygen
- Identification of reference conditions or what is considered "natural" variation for a specific region
- Define thresholds or what is an "acceptable" level of pH/oxygen
- Defensible model to predict rate of acidification change
- A budget of various contributors
- Impacts to biogeochemical cycling
- Uncertainty associated with scientific determinations, i.e. is the existing science sufficient to make policy decisions?
- Cost effective research and monitoring

Fish and Wildlife Manager

Impacts to Biology and Ecology

- Vulnerability and risk assessments of impacts to important commercial & non-commercial species (e.g., forage fish) and their early life stages (see table at right)
- Potential for trophic cascades or interactions in fisheries and ability to predict stock trends
- Prioritize ecosystem and community vulnerabilities and likely changes to essential habitats
- Defining natural conditions where native communities of shellfish reside: surf zone, sandy beaches, tidal flats, gravel beds, eelgrass beds, kelp forests, shallow subtidal channels
- Understanding the biogeochemical characteristics of OAH in porewater of gravel, sands and mud that are inhabited by popular species of shellfish (i.e., cockles, gaper, butter, and littleneck clams)
- Applicability of scientific findings from commercial shellfish hatcheries to native shellfish in their natural habitats
- Adaptive capacity of commercially harvested shellfish
- Exploring species of oysters that are more tolerant to OAH
- Feasibility of genetically breeding shellfish for tolerance to OAH

Economically valuable species of interest mentioned by West Coast fish and wildlife managers.

	ORGANISMS
Primary producers	Phytoplankton, algal blooms Coralline algae Macroalgae, kelp Estuaries, wetlands
Crustaceans	Dungeness crabs Spiny lobster
Molluscs	Oysters, larvae and adults Clams (cockles, gaper, butter, littleneck, geoduck) Squid Abalone
Echinoderms	Sea Urchin
Vertebrates	Sardines Rockfish Salmon

- Impacts to quality of locally harvested seafood due to OAH impacts on cyanobacteria, methy mercury, and other pollutants
- Potential for offshore shellfish farming
- Impacts to recruitment
- Framework for incorporating impacts of OAH into fishery management plans and stock assessments

Natural Variation and Drivers of OA and Hypoxia

- Defining natural conditions where native communities of shellfish reside: surf zone, sandy beaches, tidal flats, gravel beds, eelgrass beds, kelp forests, shallow subtidal channels
- Understanding the biogeochemical characteristics of OAH in porewater of gravel, sands and mud that are inhabited by popular species of shellfish (i.e., cockles, gaper, butter, and littleneck clams)
- Recommendations for development, infrastructure and operation of a coordinated network of monitoring stations along the Pacific coastline
- Technological advancements necessary to use existing and new data to develop forecasts of impacts to major shellfish growing areas and fishing grounds
- Assessment of regional sensitivities

Land Use and Park Managers

Impacts to Biology and Ecology

- Ability to predict shifts in community structure in major fishing areas
- Impacts to estuaries, saltmarshes, and eelgrass communities and the ability of these regions to buffer erosive wave action on beaches and coastlines
- Direct or indirect effects on recreation

Natural Variation and Drivers of OA and Hypoxia

- Identifying areas more prone to impacts
- Understanding seasonal or episodic events (e.g., El Nino/La Nina, PDO) in contributing to natural variability
- Budget of local vs. global contributors
- Impacts to estuaries

Air Quality Managers

Natural Variation and Drivers of OA and Hypoxia

- An estimate of the cost and benefits of taking mitigating actions
- Of the pollutants potentially contributing to the problem, which ones do you track, or care about?
- Identifying threshold levels of CO_2

Managers are interested in understanding impacts to wild-caught fisheries like Dungeness crab, abalone, and salmon.

"What are the economic impacts? The benefits of acting must vastly outweigh costs of the response."

-State Air Quality Managers

Conclusion

We are moving forward identify the appropriate format and timeline for addressing the science needs identified here. We seek opportunities to align potential Panel products with management and policy processes. All decision makers expressed the need for a product that presents the "state-of-the-knowledge," however they also recognized the need for that product to be dynamic. The products should not only bring together what is known, but provide a path forward to track ocean acidification and hypoxia into the future.

The Panel will:

- **Provide a snapshot of ocean acidification and hypoxia on the west coast** with an eye toward identifying information that is transferable to other regions across the U.S. and more broadly
- **Define research and monitoring priorities** that will address decision makers' needs
- **Strengthen partnerships between the academic community and decision makers**
- **Build a new body of scientific knowledge** from which decision-makers across state, regional, and federal levels may draw to develop more thoughtful management action

For more information on the Science Needs Assessment approach, visit here.
For additional snapshots of decision maker science needs, see also:

Organismal Physiology Working Group
Ocean and Coastal Dynamics Working Group

About the West Coast Ocean Acidification and Hypoxia Panel

The West Coast Ocean Acidification and Hypoxia Panel, convened by California Ocean Science Trust, is funded by the California Ocean Protection Council, Department of the Interior, Coastal Impact Assistance Program, and the California Ocean Science Trust. The Institute for Natural Resources in Oregon, working in collaboration with California, is supported by the Oregon Governor's Office, the Oregon Department of Fish and Wildlife, the Oregon Department of Agriculture, the Oregon Department of Environmental Quality, the Oregon Department of Land Conservation and Development, and the OSU Research Office.