ORRAP

Ocean Research & Resources Advisory Panel

A United States Federal Advisory Committee

Ocean Acidification Task Force

Summary of Work Completed and Recommendations for ORRAP to convey to the IWGOA

Presentation to ORRAP, 27 July 2010

Alaska SeaLife Center

Seward, AK

ORRAP

Ocean Research & Resources Advisory Panel

A United States Federal Advisory Committee

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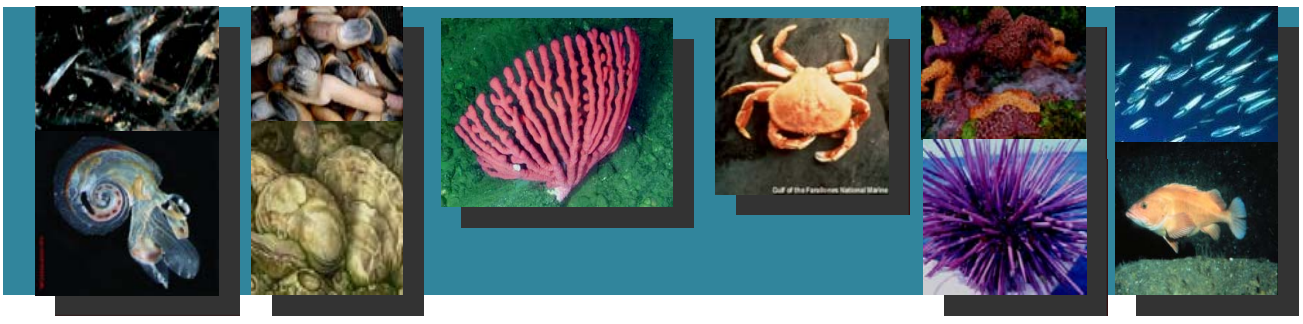

ORRAP
Ocean Research & Resources Advisory Panel
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OATF Background and Timeline

- Recognizing a topic of national priority, and with the objective of assisting the agencies responding to the FOARAM Act, ORRAP worked quickly to stand up an Ocean Acidification Task Force (OATF).

- OATF impaneled on March 15, 2010. Designed to:
  - Develop priorities and review gaps in federal plans
  - Bring perspectives from academic sector *and beyond* (NGO, foundation)
  - Present recommendations to ORRAP

- Conducted inaugural meeting on 22-23 June 2010. Discussed national needs and gaps in federal plans. Developed draft recommendations for ORRAP to consider.
  - Met jointly with IWGOA – previewed the content of the draft recommendations
    - Made sure to preserve the appropriate reporting lines (OATF to ORRAP, not OATF to IWGOA)
  - ORRAP will review OATF recommendations on 27 July 2010

- OATF produced in one meeting what was expected to take 2-3 meetings.
  - Will likely meet a second and final time to finalize recommendations, in response to ORRAP comments

Ocean Acidification Task Force
of the
Ocean Research and Resources Advisory Panel
Consortium for Ocean Leadership, 1201 New York Ave NW, Washington, DC
June 22-23, 2010
Agenda

Objectives:

1) **Gather information: Hear from colleagues; Hear from agencies**
2) **Identify gaps in federal plans**
3) **Develop framework for input/recommendations to IWGOA**

Tuesday, 22 June – Fourth floor conference room

8:30-9:00 Breakfast

9:00-9:15 Welcome *(Betzer)*

- Introductions
- Review of agenda and objectives

9:15-12:30 Ocean Acidification briefings – Two members collaborate on each

- **Open ocean ecosystem calcifiers –** Hutchins and Doney *(via phone)*
- **Coral reef environment –** Kleypas with input from Celia Smith and Jen Smith
- **Hypoxia upwelling environment –** Chan and Hofmann *(via phone)*
- **State chemical instrumentation and in situ sensors** – Byrne and Brewer *(via phone)*

10:30-10:45 Break

- **Human dimensions and economic impact –** Huseby and Doney
- **Role of foundations** – Huseby and Short
- **NRC briefing on their OA report –** Fabry and Kleypas
- **Policy and agency interface** – Caldwell and Cowen
- **Review of federal OA plans –** Representative(s) from IWGOA

12:30-1:00 Lunch

1:00-5:00 Discussion

- **Focus on identifying gaps in federal plans**
- **Develop framework for input/recommendations to IWGOA**

5:00 Wrap-up Discussion / Review Action Items

Wednesday, 23 June – Fourth floor, Pacific Room

9:00-9:30 Breakfast

9:30-12:00 Reconvene *(Betzer)*

- Review previous day's presentations, discussions and action items, and get ready for IWGOA

12:00-1:00 Lunch

1:00-5:00 Joint session with IWGOA (Fountain-level conference room)

Topic for discussion:

- **Gaps in federal plans, for example:**
  - **Geographies that are underrepresented**
  - **Linkage between scientists and industry**

5:00 Adjourn

Executive Summary of OATF Recommendations

1. **Interagency Coordination** – It is critical that the federal agencies participating in the Interagency Working Group on Ocean Acidification (IWGOA) consider the many ways to implement strong interagency coordination of activities and funding in building plans for addressing ocean acidification.

2. **National Program Office** – We support the vision of the National Research Council that calls for establishing a National Ocean Acidification Program Office. This office would not only help maximize communication between agencies and participating scientists but also help avoid duplication.

3. **Foundations, NGOs and Industry** – There is considerable potential value in having several major foundations and NGOs collaborate in supporting research into ocean acidification. We strongly encourage the participating federal agencies to develop linkages with these groups. We also believe there are many opportunities for scientists to advise the marine industrial community and that the IWGOA should encourage productive interactions such as those evolving between marine scientists on the west coast and the Pacific Shellfish Growers Association.

4. **International Collaboration** – The robust research programs involving ocean acidification that are underway internationally offer many opportunities for important collaborations with scientific colleagues in the United States. It is important that the involved federal agencies develop plans that facilitate the participation of U.S. scientists so we capitalize on the substantive investments that are being made abroad.

5. **Communication** – Communication between scientists and education of the public at large is a challenge confronting our society. Indeed, there is growing evidence that the interest in, and appreciation for, science in the United States is extremely low. If we expect our federal legislators to provide substantive long-term support, the IWGOA will need to consider how they can effectively improve communication about Ocean Acidification research and its relevance to society.

6. **Science Needs** – For many decades ocean science has been impeded by the lack of dependable *in situ* sensing systems. Substantial long-term investments are needed to develop (ca. $40M/yr) and then sustainably deploy dependable new sensing systems for physical, chemical and biological variables and this should be integral to the decade-long effort the IWGOA is developing. In addition to NOPP funding, DARPA and HSARPA should be approached to partner in the sensor development effort. An important goal of the observational, experimental and modeling studies being formulated by the IWGOA should include entire food webs and the biogeochemical cycles that support them.

7. **Management Actions and Multiple Stressors** – A host of important management decisions will be made in response to the scientific insights developed during the decade-long investigations involving Ocean Acidification. The Task Force recognizes the particular

challenges presented by the action of multiple stressors in the marine environment but contends they should be made an integral part of management strategies.

8. **Socioeconomic Recommendations** – Social sciences need to be incorporated into the assessment of the impacts of ocean acidification on lives and livelihoods. This could build on existing models – NOAA Climate and Societal Interactions program (CSI) and The U.S. Global Change Research Program (USGCRP) and should include econometric approaches. Risk assessments of ocean acidification, that incorporate low-probability, high-impact events as well as high-probability, low-to-mid impacts need to be considered. Given the global nature of OA, socio-economic impacts must be considered with regard to global security.

9. **National Ocean Acidification Data Management Plan** – There needs to be effective imteragency coordination and data sharing. Information about OA and relevant data are scattered; there needs to be a permanent, national, interagency cyberinfrastructure system that ties together or stores in a few places all relevant data archives relevant to ocean acidification. The IWGOA should also identify opportunities to integrate OA data into the eventual IOOS (Integrated Ocean Observing System) data management scheme.

10. **Federal, Regional, State and Local Interactions** – Local, regional, and state governments can combat the causes of acidification in parallel with the federal government. At the most basic level, any laws useful for preventing acidifying substances – liquid, solid, or gas – from entering the ocean are potential tools for redressing ocean acidification. State, local, and regional governments can act together to mitigate other (non-acidification) stressors on the coastal environment to ensure that synergistic stressors do not worsen acidification's effects. Stormwater management can help ease nonpoint source pollution, and is often controlled at the state level, but may require local measures. State land use planning laws – such as California's SB375 – can help reduce the greenhouse gases that cause ocean acidification. The notions of regional cooperation in ocean observing, and specifically addressing ocean acidification observing, are directly in line with principles approved by the President in his Executive Order 13547 of July 19, 2010.

Discussion supporting ORRAP recommendations to IWGOA

FOR DISCUSSION ONLY

1) Interagency Coordination

In an era of limited resources, yet critical scientific needs, it is important to focus on implementing strong interagency coordination of activities and funding so that duplication of activities is minimized and federal investments leveraged. A brief review of federal agency plans for addressing ocean acidification currently reflects reasonable plans *within* individual agencies but limited coordination *between* or *among* agencies. For example, monitoring of coastal waters for changes in pH, pCO_2, DIC and/or A_T, as well as other relevant biological, chemical and physical parameters are often duplicated among agencies, without direct communication and sharing of such data and without a coordinated plan toward a well-conceived and designed overall sampling and management plan. To this end, there needs to be a national plan for developing, deploying and integrating real-time ocean ecological measurements into ongoing observing systems. Moreover, funding of such activities as a national ocean monitoring system should be a focus of all agencies and **coordinated as a single program and perhaps jointly funded through NOPP as a national program**. Similar effective coordination and data sharing activities through creation of a permanent, national, inter-agency cyberinfrastructure system should be a top priority in developing a national plan for addressing ocean acidification.

2) National Program Office

We endorse the NRC vision that there needs to be a National Ocean Acidification (OA) Program Office to develop strategies to coordinate, oversee, and communicate results of national and international OA research. We contend that this office should not reside within any specific agency, but should instead be jointly supported by all of the agencies with interests in OA issues. The logistics of such joint interagency support could be configured on the models of the past JGOFS-GLOBEC programs, or the current Ocean Carbon Biogeochemistry (OCB) program office. This OA program office would provide a number of fundamental advantages over the present system whereby OA research and outreach activities are spread across several agencies. First, an OA program office would obviously be critical to better coordinating and avoiding duplication between the various agencies (see previous bullet). Second, such an office would serve an additional important function by facilitating direct, constructive dialog between the U.S. academic OA community and funding agency representatives, since academic scientists and presumably colleagues from foundations, NGO's and industry would be members of the OA program Scientific Steering Committee. Finally, a national OA program office would fill a major gap by providing a badly needed united forum to represent U.S. OA researchers in communications with the international ocean science community, with any participating foundations (see Item 3), and with related marine industries (see item 3). OA research in the United States has historically lagged behind the more organized and coordinated efforts from other regions such as the European Union, and a formal U.S. OA program office would provide

us with a stronger, more united voice in international OA issues instead of the "many small voices" which are all we now have as individual OA researchers.

3) Foundations, NGOs and Industry

As a follow up to ocean-related discussions that began to surface at COP-15 in Copenhagen in December 2009, a group of foundations decided that they needed to learn more about the broad and critical subject of ocean acidification. Towards that end, they devoted time at a meeting of the Consultative Group on Biological Diversity to provide an introduction to the subject to the member foundations present. The keynote speaker was Dr. Jane Lubchenco, the current administrative head of NOAA. Many of the foundations present acknowledged that they wanted to learn more. A steering committee was created and is currently organizing an educational conference in San Francisco this fall with funders and scientists addressing what is known about the changes in ocean chemistry, about the causes of these changes and about what ocean modelers see in the decades ahead, especially if we continue generating CO_2 according to a "business as usual" scenario.

A member of the Ocean Acidification Task Force of ORRAP, Sven Huseby, is a member of the steering committee referred to above and also a board member of a foundation that has been active in ocean acidification funding. He is working to better understand what the government is planning to fund and the time frames for grants projected for the decade-long study. Sven is also actively engaged with scientists working in the field of ocean acidification so that he can share their views of the highest research priorities with interested foundations.

If our society is to move forward in addressing the ocean acidification challenge, **it is critical that we raise the level of collaboration between the various stakeholders.** In addition to collaborating with foundations, we urge the IWGOA to look closely at the work already being done by NGOs and the fishing industry in their efforts to understand and communicate what is needed to face the challenges of sustainability in our oceans.

An emerging collaboration between ocean scientists and the Pacific Coast Shellfish industry in the Pacific Northwest could well serve as a model for an expanded collaboration between scientists and marine industries. In this case, the Pacific Shellfish Growers Association has worked with NOAA to spearhead the formation of a scientific team with representatives from federal and state agencies, hatchery personnel and growers with a goal of understanding the ocean conditions that may be leading to oyster larval mortality and to develop solutions to the larval problems that are afflicting the industry. Four priorities were identified as part of that initiative, beginning with enhanced monitoring systems up and down the coast, and in the hatcheries, to enable researchers to track ocean conditions to both natural larval spawns and seed survival in the hatcheries. Near-Shore Monitoring stations now stretch from the Whiskey Creek Hatchery in Netarts Bay, Oregon, to Hood Canal, to Lummi Bay in Northern Puget Sound (the Salish Sea). Significantly, the University of Washington, NANOOS and NOAA are also providing additional monitoring stations throughout the Puget Sound area and along the

Washington/Oregon/California Coast to further enhance the understanding of patterns of ocean acidification.

There is little question that collaboration between the public and private sectors in this area would be highly beneficial. If this is to happen, however, we have to develop means of communication around the work that is being done, clarify the sources of funding, and develop detailed maps of the needs that lie ahead. **Sven Huseby will share information about the Ocean Acidification Task Force and the IWGOA in October when a group of foundations meet in San Francisco to discuss ocean acidification.** Hopefully a basis for several major foundations collaborating meaningfully in the realm of ocean acidification will emerge.

In conclusion, we highly encourage the IWGOA to integrate foundations, NGOs and marine industries (fishing, aquaculture, cruise, etc.) into a plan for their respective agencies as they create a strategic program for working with ocean acidification.

4) International Collaboration

In recognition of the fact that ocean acidification is a global issue, the OATF thinks it is important that our federal agencies take leadership in coordinating with the international scientific community. Such international efforts could be targeted towards large scale topics such as the significant effect ocean acidification will have an affect on the food web in the Southern Ocean. Work by McNeil and Matear PNAS (2008) suggests that the southern ocean could become **under-saturated with regard to aragonite by 2030**, which is much sooner than the regions just north of the Polar Front. There are a number of US national agencies participating in Southern Ocean research including the Office of Polar Programs at the National Science Foundation, the U.S. Antarctic Marine Living Resources Program, AMLR in NMFS-NOAA and NASA. Further, a number of international organizations, with which the USA participates, coordinate research and resource management in the Southern Ocean such as SCAR, Scientific Committee on Antarctic Research, and CCAMLR, Convention on the Conservation of Antarctic Marine Living Resources. SCAR is currently considering creation of a formal Working Group on Ocean Acidification.

Substantial international efforts are already underway (e.g., European Project on Ocean Acidification (EPOCA) and SOLAS-IMBER) that support the scientific research that is a key to understanding the evolution of open-ocean and coastal food webs. Building productive interfaces between U.S. scientists and their international colleagues should be made a long-term priority of the decadal plan the IWGOA is formulating.

5) Communication

The scientific community has had significant challenges building trust and convincing the general public and policy makers about the societal challenges related to climate change. In the ocean health realm, the Pew Oceans Commission report had similar muted public and policy response as well. At the root of these issues is the inability for the scientific community to

effectively connect and communicate with the non-scientific community. With these past challenges, the Ocean Acidification Task Force of ORRAP recommends federal agencies focus significant resources, including engaging foundations and other stake holders to provide a robust and effective ocean acidification communications effort. This should be structured in a way to compliment the science, build capacity and further research funding opportunities. These efforts should include feedback metrics to measure effectiveness.

Priority Communication/Marketing Recommendations include:

a. Significant resources must be expended to communicate the scientific and socio-economic findings to policy makers and the general public. This would be provided through a public/private relationship with foundations.

b. Sciences, specifically marine sciences, need to be emphasized throughout the nation's k-12 school curriculums to build a more science-savvy population.

c. Engage and encourage meteorologists and other public spokespeople to provide climate and ocean science background to compliment weather information.[i.e. last earth day Sam Champion of ABC News has provided short stories around ocean acidification that included the collapse of the Whisky Creek Oyster hatchery].

d. Engage conservation psychologists to determine communication and behavioral change strategies.

e. Feedback metrics should be included to measure effectiveness.

6) Science Needs

a. Instrumentation

In situ measurements are one of the most important aspects of the research that scientists will need to address many aspects of ocean acidification. Development of instrumentation is a critically needed enabler for OA research. The OATF suggests that an instrument development program focused on measuring the four principle variables (pH, DIC, AT and pCO2) be made a high priority. Such a program would address what has been a major shortcoming of scientific research on the oceans' carbon dioxide system for decades. Further, the OATF suggests that there should be a sustained investment in sensor system development *and deployment* that will address the need for new biological and biogeochemical metrics of ocean acidification impact, as they become available. We further recommend that the IWGOA **consider using NOPP as a way to focus critical financial resources on this project and also approaching DARPA or HSARPA as possible partners in sensor development and deployment. In the past minimal funding has been applied to sensor development and we strongly recommend adequate funding (ca. $40M/yr) for a long-term multi-agency effort.** Such a program will not only enhance research in the field and laboratory but long-term monitoring as well.

b. Ocean Acidification and Multiple Stressors

One important gap in the federal ocean acidification agency plans is insufficient emphasis on the

combined impacts of ocean acidification and other anthropogenic stressors. For instance, in many large estuaries with inputs of freshwater, sediments, organic matter, nutrients, and pollutants combined with restricted circulation, the combined impacts of lowered seawater pH and low oxygen concentrations may have a synergistic or compounding impact on marine organisms. The natural and anthropogenic enrichment of nutrients may enhance the production and subsequent remineralization of organic matter leading to hypoxia and low pH waters. The input of "acidified" low pH upwelled water from the ocean combines with this process to produce very low pH conditions. In this case, studies are needed to determine if it will be possible to mitigate the continued development and impacts of corrosive conditions by addressing and reducing the regional-scale anthropogenic stressors that contribute to their formation, such as additional nutrient inputs associated with development and urbanization. Coastal oceans are also extremely complex and dynamic environments where hypoxia, warming and upwelling can compound the stresses related to ocean acidification. There are management actions that can be taken now to address OA and multiple stressors.

c. Ocean acidification and trophic structure

To date most of the research has focused on the effects of OA on organisms that rely on some form of carbonate skeleton (corals, pteropods, coccolithophores, forams etc.) However, there is little information on how changes in the abundance or status of populations of these organisms will affect other components of the food chain. For example, while pteropods are known to be preyed upon by upper trophics levels, their relative importance as a prey item is not well understood. Therefore, we have little understanding of how the loss of pteropods as a prey resource will affect commercially important (fisheries) and protected species (turtles, seabirds and marine mammals). The role of coccolithophores in marine ecosystem interactions is even less clear. Finally, OA is likely to have direct effects on organisms that don't rely on carbonate skeletons. For example, small changes in pH could interfere with respiration and or ion exchange across the gills of many marine organisms. The complexity of the ecosystem responses to acidification of the upper ocean is immense and it will be a daunting task to not only document but to understand the evolution of ocean food webs and nutrient cycles. We need to make sure that an important **goal of our observational, experimental and modeling studies is to consider the entire oceanic food web and the biogeochemical cycles that support it.** This is critical for management of fisheries and other marine resources.

7) Management Actions and Multiple Stressors

Ocean acidification is occurring simultaneously with climate changes associated with rising atmospheric CO_2, such as ocean warming and increased stratification of surface waters, as well as stresses of overfishing and pollution. The combined effects of these multiple stressors on marine organisms and ecosystems will be difficult to assess, and research should be designed to look for broad patterns and unifying concepts, by not only taking advantage of experimental testing, but also modeling (from molecular to ecosystem scales), cross-site field comparisons of organism and ecosystem functioning, and genetic/molecular studies.

Management actions will naturally change over time. In the near-term, an obvious strategy for dealing with the effects of ocean acidification is to reduce those stressors that can be controlled, such as runoff that would further alter ocean chemistry, as well as stressors from overfishing, invasive species, and habitat destruction/degradation. Some management decisions may be simple but effective; for example, seasonal regulation of chemical runoff may prevent additional stress on shellfish larvae during times of recruitment.

Over longer-time periods, management strategies will need to consider new findings regarding multiple stressors, determine which of these can be controlled, and which will need to be considered over the long term as habitats migrate in response to climate change and ocean acidification. For example, while rising temperatures may drive many species poleward, carbonate chemistry conditions most favorable to calcification are contracting equatorward. Such antagonistic changes present a real challenge to management, highlighting the need for research into the effects of multiple stressors on marine organisms and their habitats

8) Socioeconomic Recommendations

The Federal agencies involved in planning and implementing ocean acidification research (i.e., the IWGOA: Department of State, EPA, NASA, NOAA, USFWS, NSF, USGS and BOEMRE) should:

- Engage and support the social sciences to better assess the impacts of ocean acidification on lives and livelihoods. Two models, NOAA **Climate and Societal Interactions program** (CSI) and The U.S. Global Change Research Program (USGCRP) www.usgcrp.gov (specifically the Unified Synthesis Product Global Climate Change in the United States) should be examined for pros and cons as well as best practices.
- Undertake careful risk assessments of ocean acidification to better evaluate how to form policy with regard to low-probability, high-impact events as well as high-probability, low-to-mid impacts.
- With the global nature of OA, federal agencies must engage in international efforts to examine socio-economic impacts in regards to global security.
- Explore using econometric approaches to gauging public concern for ocean acidification impacts (e.g. food security, contingent valuation of species extinctions, connection between livelihoods and deteriorating oceans, understanding of ecosystem services).

9) National OA Data Management Plan

Timely access to quality observational and experimental data sets will play a vital role in accelerating our understanding of the trajectories and impacts of ocean acidification. To enhance important synthesis activities such as biogeochemical and ecological time-series, identifying the spatial distribution of OA risks, meta-analyses of OA impacts across taxonomic and functional groups, coupled models of ocean physics, biogeochemistry and food web change, the OATF recommends the development of a National OA Data Management Plan. Furthermore, OA data

should be integrated into the eventual IOOS data management scheme.

Currently, datasets that inform OA research reside across a multitude of agencies and institutions at the state, regional, national, international levels or are held by individual researchers or research programs. As a result, datasets can vary greatly in quality (in terms of metadata documentation in particular) and accessibility. For researchers, the absence of a lead office for the deposition of OA-relevant datasets and/or uncertainties in the structural relationship between data centers in data replication and cross-linkage can slow the process of data submission. The core objectives of a National OA Data Management Plan will be to ensure the coordinated archiving and standardization of OA-relevant datasets and their effective dissemination to researchers. An additional objective will be to provide public transparency in the source and quality of data that are used to inform the policy decision process.

To meet these objectives, we concur with the recommendation set forth by the NRC report for the creation and support of a National OA Data Management Office that can serve as a single access point for OA data resources. While calls for investments in oceanographic data management are not new, OA is likely to pose new challenges for the current system of data management. For example, OA-relevant data encompasses not only traditional oceanographic measurements that are readily cataloged but also data from manipulative experiments, emerging genomic datasets, as well as socioeconomic data (e.g. fishery) that will be critical for informing OA science and policy. The OATF recognizes that these activities currently fall under the purview of a number of long-standing as well as nascent data management efforts and that the diversity of relevant datasets clearly precludes the use of any single database structure across disciplines. In this regard, a core charge of a National OA Data Management Office will be to develop a mechanism for cataloging and cross-reference OA-relevant data from a diversity of data sources including complimentary international OA-data and metadata (e.g. SOLAS-IMBER, EPOCA) management and rescue efforts (e.g. EPOCA/EUR-OCEANS) that are already underway internationally. This mechanism can take the form of a metadata catalog that facilitates both data access and standardization. For example, entries in an OA metadata catalog will include not only water chemistry profile datasets held by data centers such as the NODC but also microbial genomic data deposited and access through facilities such as the National Center for Biotechnology Information (NCBI) or Community Cyberinfrastructure for Advanced Microbial Ecology Research and Analysis (CAMERA). This approach would allow the National OA Data Management Office to make full use of existing community data standards as well as bio- and eco-informatics infrastructures. Our recommendation also does not preclude the development and/or use of data management capacity at the National OA Data Management Office. In fact, the ability to meet emerging data management needs from expanding areas of OA-research and/or to ensure long-term data archival and access will be important. We further recognize that the National OA Data Management Office does not necessarily require the de novo development of a data management organization. Expansion of an existing data center such as the Biological and Chemical Oceanography Data Management Office (BCO-DMO) may provide an effective means for leveraging ongoing data management expertise and to minimize time lags in implementing a data management plan.

As noted above, ocean research is diverse and by its nature is disparate in information content. Most of the data gathered from remote sensors, ship instrumentation, gliders, buoys, and field samples are captured and stored in ad-hoc formats, at physically separate locations and often hosted on computers not accessible from the internet. The task force was impressed by the need to bring uniformity in data gathering and dissemination to the ocean research community. It is important to note that the Department of Defense has funded research and development programs for the creation of open-standard, open-architecture "platforms" for data management. Specifically, data capture, data fusion, and the translation of data into information are important capabilities of such platforms as well as is their application to virtually any data domain. One such approach uses a service-oriented architecture (SOA) platform that is based on non-proprietary, open standards. An SOA platform creates an open, independent "marketplace" that hosts services (software modules) for collecting, analyzing and disseminating both sensor and non-sensor data to ultimately provide meaningful information to scientists, resource managers and decision makers. An SOA platform also provides an opportunity for the scientific community to integrate heterogeneous data sets in a meaningful way which will encourage and enable holistic analysis rather than traditional independent "point" analysis. The task force suggests that a focused program to transition and implement existing DoD data management capability for the benefit of the ocean research community **be considered** by the IWGOA. Leveraging DoD investments will also promote sharing of information, data standards, and scientific findings that are important to homeland security, our nation's defense and to ocean research while also providing a cost-effect solution for ocean research data management.

10) Federal, regional, state and local interactions

Local, regional, and state governments can combat the causes of acidification in parallel with the federal government. Environmental laws currently in effect provide a network of pathways for intergovernmental cooperation and coordination. Below we list some of the environmental laws relevant for mitigating ocean acidification, and the governmental interactions that these laws trigger.

	Federal	State	Regional/Local
Federal	RCRA[i] CERCLA[ii] NEPA[iii]	Clean Air Act[iv] Clean Water Act[v] FIFRA[vi] CZMA[vii] NEPA Grants and Matching Funds[viii]	Clean Air Act - PSD Clean Water Act - TMDLs (FOARAM) NEPA ESA: HCPs, etc.
State		State Pollution Laws State Stormwater Mgmt. Laws Coastal Mgmt Laws, incl. erosion prevention Little NEPAs	State Pollution Laws State Stormwater Mgmt. Laws Coastal Mgmt Laws, including erosion prevention Little NEPAs
Regional/Local			Land Use Laws and Zoning provisions Habitat conservation and open-space ordinances.

Existing Governmental Interactions that Can Help Address Ocean Acidification Issues – It is crucial that local, regional, and state governments actively address the local causes of ocean acidification.

Federal–State Interactions

At the most basic level, any laws useful for preventing acidifying substances – liquid, solid, or gas – from entering the ocean are potential tools for redressing ocean acidification. The broadest and most influential of these are federal environmental laws that regulate air and water pollutants; control the use, disposal, and cleanup of toxic and hazardous substances; and promote responsible environmental management through planning requirements. Many of these federal laws have state components, requiring state implementation and enshrining some level of vertical interaction between state and federal governments. Similarly, state laws can require local

implementation, and in some cases federal laws reach all the way down to the local level.

State–Local/Regional Interactions

To minimize the impacts of ocean acidification locally, it is imperative that state, local, and regional governments act to mitigate other (non-acidification) stressors on the coastal environment to ensure that synergistic stressors to not worsen acidification's effects. Further, local efforts could reduce or eliminate stressors that might not have any direct connection to ocean acidification, but removal of these stressors could increase the environments tolerance to stress in general, thereby providing a buffer to the direct effects of ocean acidification. Some states, including California, have their own laws that parallel those at the federal level. For example, California's Water Code defines pollutants in such a way that it could include acidification agents. Water Code § 13376, definitions in § 13050. To the extent that this and other state statutes differ from the federal law, they should be used to minimize changes to coastal pH at the local level.

Stormwater management can help ease nonpoint source pollution and is often controlled at the state level, but it may require local measures. Many states have stormwater management programs; see, e.g., F.S. §§403.0891, 403.061(32) (Florida); Environment Article 4 §201.1 and §203 (Maryland). These local measures are key to minimizing runoff that can contribute to acidification.

Lastly, state land use planning laws – such as California's SB375 – can help reduce the greenhouse gases that cause ocean acidification, and these require regional and local participation. Zoning and other planning ordinances may seem remote from a change in ocean pH, but reducing sprawl reduces CO_2 very effectively, and open-space ordinances can create buffer zones that help stop runoff into the ocean.

Federal–Local Interactions

The Clean Water Act is implemented through state programs, and may require local-level stormwater management through the National Pollutant Discharge Elimination System (NPDES) provision. For example, New York's model local law for meeting state and federal guidelines, available at: http://www.dec.ny.gov/docs/water_pdf/localaw06.pdf.

The new Federal Ocean Acidification Research and Monitoring Act (FOARAM), 33 U.S.C. § 3701 et seq., requires the Joint Subcommittee on Ocean Science and Technology to "facilitate communication and outreach opportunities with nongovernmental organizations and members of the stakeholder community with interests in marine resources." 33 U.S.C. § 3703. Local governments and other interested parties should use these opportunities to participate in federal efforts to mitigate ocean acidification. The federal Endangered Species Act (ESA), 16 U.S.C. § 1531 et seq., may also play a local role in the form of Habitat Conservation Plans for listed species, and by influencing local land use decisions to avoid harm to those species. Four marine invertebrate species are listed as endangered or threatened at present, and many more may warrant listing. As ocean acidification increasingly threatens marine invertebrates with calcium carbonate parts, the ESA is bound to play a more prominent role in local measures to mitigate acidification.

Statement of Work

for the

Ocean Acidification Task Force

of the

Ocean Research and Resources Advisory Panel

A. Official Designation

This Task Force will be designated as the Ocean Research and Resources Advisory Panel (ORRAP) Ocean Acidification Task Force (hereinafter referred to as the OATF).

B. Objectives and Scope of Activity

The OATF is convened by the ORRAP to facilitate a means for experts on the topic of ocean acidification to provide their input, views and expertise to ORRAP on issues relating to interagency federal ocean acidification activities.

The OATF shall provide preliminary advice and recommendations to the ORRAP on principles and issues relating to ocean acidification. It is intended that the advice and recommendations will be approved and delivered by the ORRAP to the federal government by way of the Interagency Working Group on Ocean Acidification (IWGOA) of the Joint Subcommittee on Ocean Science and Technology (JSOST).

Working with other allied groups and individuals, the OATF will work to enhance the coordination and implementation of ocean acidification efforts among academic, state, private, federal and other stakeholders.

C. Membership

Membership of the OATF shall be comprised of non-federal individuals that have expertise and/or experience in the field of ocean acidification. Membership shall not exceed the number of ORRAP members at any time. Service on the OATF is voluntary.

D. Workload

In accomplishing its work, it is expected that the OATF will meet in person twice, and no more than three times, over the course of its existence and will communicate between meetings via conference calls and emails. The objectives of the first meeting will include scoping and assignment of work. The objective of the final meeting will be to reach consensus on a final product for delivery to ORRAP. The ORRAP staff will assist the OATF in accomplishing its work.

E. Period of Existence

The OATF will be impaneled effective March 15, 2010, and will terminate effective March 31, 2011, with the option for an extension, if needed, to complete its work.

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ORRAP
Ocean Research & Resources Advisory Panel
A United States Federal Advisory Committee

i The Resource Conservation and Recovery Act regulates many highly acidic substances. *See* 40 C.F.R. § 261.40 et seq. Because the law does not have a significant state component, it is only listed under federal law.

ii The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., provides federal authority to respond to a release of substances that may endanger the environment. As low-pH substances can cause local acidification in the marine environment with potentially catastrophic results for marine life and habitat, state and local authorities should alert the National Response Center and request a remediation in the event of a local release.

iii The National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 et seq., requires any major federal action, which may include state or local actions that use federal funds, to account for the environmental impacts of that action and to consider alternatives to it. Importantly, NEPA can have local and regional interactions via its public notice provisions. State-law equivalents ("little NEPAs") play a similar role and require interactions between state and local governments.

iv 42 U.S.C. § 7401 et seq. Following the federal EPA's finding that CO_2 and other greenhouse gases threaten human health and welfare, states must evaluate their CO_2 emissions under the Clean Air Act's Prevention of Significant Deterioration provision. States should take steps to minimize their CO_2 (and other greenhouse gas) emissions before seeking federal approval for their plans.

v Under the Clean Water Act (CWA), 33 U.S.C. § 1251 et seq., states must prepare a list of impaired waters and Total Maximum Daily Loads. Most relevant to ocean acidification, TMDLs may be required for CO_2. States should ensure they have adequate monitoring to accurately identify which waters are impaired by pH.

vi Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. § 136 et seq., a state may regulate the sale or use of any federally registered pesticide" so long as it does not allow a sale or use prohibited federally. 7 U.S.C. § 136v(c)(1). If a coastal state is aware that a registered pesticide is contributing to acidification along coastal waters, it therefore has the authority to restrict the use of that pesticide.

vii Under the Coastal Zone Management Act (CZMA), 16 U.S.C. § 1451 et seq., states could declare pH to be a factor in maintaining the quality of significant coastal habitat. The states could then use the CZMA to influence local land use policies that negatively impact coastal ocean pH.

viii States should apply for available grants and matching funds under the Coastal Wetlands Planning, Protection and Restoration Act,16 U.S.C. 3951-3956, the CZMA,16 U.S.C. § 1455, and the Clean Water Act (see http://www.epa.gov/owm/cwfinance/ for program details). States should also leverage the National Coastal Monitoring Program (established by 33 U.S.C. §§ 2801-2805) data in order to monitor the pH of their coastal waters closely.