NOAA Deep-Sea Coral and Sponge Ecosystems Exploration and Research Priorities Workshop for the U.S. West Coast

Portland, Oregon – January 20-21, 2010

Introduction

On January 20-21, 2010, scientists and resource managers met in Portland, Oregon to further define the exploration and research priorities laid out in the *NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems*, and to identify critical information needs for deep-sea coral and sponge ecosystems off the U.S. West Coast. The ultimate goal of the workshop was to identify steps to improve the understanding, conservation, and management of these ecosystems. Workshop participants represented a broad range of stakeholders including the Federal government, the Pacific Fishery Management Council, tribes, academia, private industry, and nongovernmental organizations (See Appendix C for a list of participants).

The NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems

The NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems identifies national-level goals, objectives, and approaches to guide NOAA's research, management, and international cooperation activities on deep-sea coral and sponge ecosystems for 2010 through 2019. The primary goal of the Strategic Plan is to improve the understanding, conservation, and management of deep-sea coral and sponge ecosystems. The Strategic Plan covers deep-sea coral and sponge ecosystems under the jurisdiction of the United States and international cooperation activities undertaken by the United States.

The Strategic Plan is divided into three sections: (I) Exploration and Research, (II) Conservation and Management, and (III) International Cooperation.

> Section I identifies the role of research in management, including NOAA's priorities and objectives for research and exploration of deep-sea coral ecosystems and anticipated products for each objective. The goal of NOAA's exploration and research on deep-sea coral and sponge ecosystems is to provide decision-makers with sound scientific information that will enable effective ecosystem-based management decisions.
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> Section II lays out objectives and approaches that NOAA will undertake to enhance protection of deep-sea coral and sponge ecosystems working with the Regional Fishery Management Councils, National Marine Sanctuaries (NMS), and other Federal agencies and partners. NOAA's strategy for managing deep-sea coral and sponge ecosystems is centered on the authority provided to NOAA through the Magnuson-Stevens Fishery Conservation and Management Act and the National Marine Sanctuaries Act.

Section III describes NOAA's participation in international activities to protect and/or conserve deep-sea coral and sponge ecosystems.

The Strategic Plan provides guidance for all NOAA programs supporting research, management, and international cooperation activities on deep-sea coral and sponge ecosystems. Within NOAA, these activities are coordinated through the Coral Reef Conservation Program (CRCP), a matrix program consisting of four NOAA line offices – the National Ocean Service (NOS); National Marine Fisheries Service (NMFS); National Environmental, Satellite, and Data Information Service (NESDIS); and Office of Oceanic and Atmospheric Research (OAR).

NOAA, through the CRCP, will implement the national Strategic Plan by further refining the objectives and approaches stated therein to address issues at the regional level. This workshop focuses on further refining Section I: Exploration and Research of the Strategic Plan to identify critical information needs for the U.S. West Coast region, which encompasses waters under U.S. jurisdiction off the coast of the States of California, Oregon, and Washington.

About the Workshop

The goal of the workshop was to develop a three-year exploration and research priorities plan, commencing in Fiscal Year (FY) 2010 for deep-sea coral and sponge ecosystems off the U.S. West Coast that address resource management needs. Unfortunately, the timing of the workshop and the need to plan for FY 2010 did not coincide. Thus, the plan developed by the workshop participants will inform only FY 2011-2012. The workshop was organized by NOAA's CRCP and Northwest Fisheries Science Center. A Steering Committee consisting of representatives from NOAA (OAR, NMFS, and NOS) presided over the development of the workshop's goals, objectives, schedule, and final summary.

The workshop consisted of presentations highlighting national and regional plans; breakout groups to identify and refine critical information needs, and plenary discussions (See Appendix A: Workshop Agenda).

National and Regional Plans: To set the context for identifying critical information needs, several presentations were given to provide an overview of national and regional plans. The presentations included an overview of NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation; research priorities identified in the State of the Deep Coral Ecosystems of the United States: 2007; Pacific Fishery Management Council Reports; priorities identified by the National Marine Sanctuaries on the West Coast for research on deep-sea corals; and the NMFS Habitat Assessment Improvement Plan. Additionally, an overview was provided on NOAA FY10 Plans for deep-sea coral and sponge research activities off the West Coast and the academically-driven bamboo corals and paleoclimate research off the U.S. West Coast.

Breakout Groups: On Day 1, workshop participants were divided into four separate breakout groups (See Appendix B for the Breakout Group Participation List) and tasked with identifying a list of critical information needs based on the NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems, information on the Reauthorized Magnuson-Stevens Fishery Conservation and Management Act that established the Deep Sea Coral Research and Technology Program and the National Marine Sanctuaries Act. Each group then presented their critical information needs list in plenary discussions and agreed on a "Top 10" list of critical information needs.

On Day 2, each breakout group was tasked with further refining the "Top 10" list by identifying and prioritizing activities for the list over the next three years. Two of the four groups assessed the odd numbered items on the "Top 10" list while the other two groups addressed the even numbered items on the "Top 10" list. Breakout groups identified activities based on whether they addressed a critical information need; addressed a management need; were financially feasible; and whether they had the potential for leveraging funds and/or collaborating with other funded programs.

Plenary Discussions: During plenary sessions on Day 1, workshop participants were provided the opportunity to discuss, refine, and prioritize critical information needs identified by the individual breakout groups. The participants narrowed the critical information needs down to ten items and to determine the highest priority, each participant was given four dots and asked to place the dots on (or vote for) the critical information needs that they believed to be the highest priority. The results of the group prioritization exercise are in Table 1.

In plenary discussions on Day 2, workshop participants presented activities for the "Top 10 list. A summary of activities identified by participants is provided below under the NOAA Strategic Plan Objectives.

Table 1. Prioritized needs identified by the participants.

Critical Information Need	**Participants Prioritization (# of votes)**	**Addresses NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems Objective**
1) Identify deep-sea coral species distribution, abundance, densities, and diversity throughout the California Current Large Marine Ecosystem.	33	Locating and characterizing deep-sea coral and sponge ecosystems.
2) Determine the ecological roles of deep-sea corals and sponges (nature of associations between deep-sea corals and sponges and other species (invertebrates and fishes)).	29	Understanding the biodiversity and ecology of deep-sea coral and sponge ecosystems.
3) Understand the basic biology of deep-sea corals, including taxonomy, age structure, growth, gender, population connectivity, and life histories.	22	Understanding the biology and ecology of deep-sea corals and sponges.
4) Understand abiotic and biotic habitat	18	Locating and characterizing deep-

requirements and suitability (e.g., role of methane seeps); geologic context and drivers of deep-sea coral habitat; variables to be used as habitat proxies; and water-column - physical, chemical, and biological parameters of deep-sea coral habitats.		sea coral and sponge ecosystems.
5) Understand anthropogenic and natural impacts on deep-sea coral ecosystems. Develop baseline conditions (indices of health and condition at both species and community level).	17	Understanding the extent and degree of impacts caused by fishing and other human activities. Understand past oceanic conditions and predict the impacts of climate change using deep-sea corals.
6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.	10	Locating and characterizing deep-sea coral and sponge ecosystems. Understanding the biology and ecology of deep-sea corals and sponges. Understanding the biodiversity and ecology of deep-sea coral and sponge ecosystems. Understanding the extent and degree of impacts caused by fishing and other human activities. Understand past oceanic conditions and predict the impacts of climate change using deep-sea corals.
7) Understand deep-sea corals' ability to recover from a variety of stressors.	7	Understanding the extent and degree of impacts caused by fishing and other human activities. Understand past oceanic conditions and predict the impacts of climate change using deep-sea corals.
8) Utilize deep-sea corals to discern past climate conditions.	6	Understand past oceanic conditions and predict the impacts of climate change using deep-sea corals.
9) Evaluate the efficacy of existing management measures.	4	Understanding the extent and degree of impacts caused by fishing and other human activities
10) Improve tools and methods for studying deep-sea corals (develop new technologies and applications for existing technologies in novel ways and develop best practices for deep-sea coral research).	4	Locating and characterizing deep-sea coral and sponge ecosystems. Understanding the extent and degree of impacts caused by fishing and other human activities

Critical Information Needs

During the two-day workshop, considerable progress was made to identify and prioritize exploration and research information needs. Each participant was placed in one of the four breakout groups. The product from each breakout group consisted of a list of critical exploration and research information needs and activities to be conducted to address those needs. In plenary sessions, workshop participants prioritized the critical information needs and discussed activities (see section on plenary discussions for information on how the prioritization was done). The three highest priorities identified by the participants were:

- Identify deep-sea coral species distribution, abundance, densities, and diversity throughout the California Current Large Marine Ecosystem (LME).
- Determine the ecological roles of deep-sea corals and sponges (nature of associations between deep-sea corals and sponges and other associate species (invertebrates and fishes)).
- Understand the basic biology of deep-sea corals, including taxonomy, age structure, growth, gender, population connectivity, and life histories.

In addition to the list of "Top 10" critical information needs, participants at the workshop recognized during initial group discussions that the inventorying and analysis of existing data was a critical need and in many instances a requirement to adequately address the critical information needs. Participants identified the need for better cooperation in sharing data, the importance of making others aware of the expertise and resources available within the region, suggested steps be taken in order to catalog existing information, and agreed that it was critical for NOAA to have a person with geographical information systems (GIS) and database skills, as well as an understanding of deep-sea corals to assist with the coordination of regional activities. Workshop participants also agreed that climate change and ocean acidification are a serious threat, but lacked the expertise at the workshop to fully address this need.

The following section represents a summary of the critical information needs developed by the participants. The section presents NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems objectives for exploration and research; lists the "Top 10" critical information needs identified by the workshop participants as they relate to that objective to help NOAA meet its overarching goals; and describes activities identified by the workshop participants needed to implement the critical information need.

NOAA Strategic Plan Objective #1: Locating and characterizing deep-sea coral and sponge ecosystems

The Pacific waters off the States of Washington, Oregon, and California are part of the California Current LME. Records of deep-sea corals in the region come from a variety of sources including taxonomic literature, catch records from regional bottom trawl surveys, bycatch data collected by fishery observers and observations from underwater vehicles [i.e. submersibles, remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs)] with varying degrees of reliability. However, only small portions of the coast have been adequately mapped and characterized.

Given the limitations of existing information off the U.S. Pacific coast, it is clear that more targeted data collections and mapping efforts are needed. Because many collections are made from long trawls that can traverse several habitats, it is impossible to determine specifically the habitat from which these species were collected. Therefore, to date, it is difficult to map corals at the regional scale showing the appropriate habitat associations.[1]

Critical Information Needs:

Workshop participants identified the following critical information needs as they relate to this NOAA objective.

- 1) Identify deep-sea coral species distribution, abundance, densities, and diversity throughout the California Current LME.
- 4) Understand abiotic and biotic habitat requirements and suitability (e.g., role of methane seeps); geologic context and drivers of deep-sea coral habitat; variables to be used as habitat proxies; and water-column - physical, chemical, and biological parameters of deep-sea coral habitats.
- 6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.
- 10) Improve tools and methods for studying deep-sea corals (develop new technologies and applications for existing technologies in novel ways and develop best practices for deep-sea coral research).

Activities:

Workshop participants identified the following activities as they relate to this NOAA objective.

[1] Introductory material was taken, with slight modifications, from the Pacific Coast Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

Mapping and site characterization:

1. Document deep-sea coral distribution, abundance, densities, and diversity.
    - Inventory existing data including trawl surveys, observer bycatch data, underwater observations (from submersibles, towed cameras, ROVs and AUVs), museum records, and records from marine debris removal programs.
    - Conduct field surveys.
        - The size of the California Current LME should be broken down into smaller subregions based on oceanographic features to ensure that efforts are spread evenly throughout the LME:
            1. Southern California to Point Conception;
            2. Point Conception to Monterey Bay;
            3. Monterey Bay to Point Arena;
            4. Point Arena to Columbia River; and,
            5. Columbia River to British Columbian border with Washington.
        - Depth range of surveys should cover from 50 meters to 2,000 meters and be further divided by technology limitations into:
            1. Upper shelf slope (including upper parts of canyons); and
            2. Deeper water areas (offshore seamounts)
        - Site selection should consider the following criteria:
            1. Is it within a sanctuary?
            2. Do benthic habitat maps already exist?
            3. Are there known abiotic variables (i.e. substrate types or bottom currents)?
            4. Is it a sensitive area?
            5. Does it have the potential to be a long-term monitoring site?

NOAA Strategic Plan Objective #2: Understanding the biology and ecology of deep-sea corals and sponges

Several coral taxa in the region are designated as "habitat forming," meaning they are known to provide vertical structure above the seafloor that can be utilized by other invertebrates or fish. Off the West Coast of the continental U.S. the deep-sea corals known to have the highest overall rating of structural importance and abundance are *Lophelia pertusa, Antipathes dendrochristos, Paragorgia arborea,* and *Primnoa pacifica.* Information on the relative abundance of these coral species were compiled from taxonomic records, in situ photographic surveys, and to a lesser extent bottom trawl surveys. [2]

Critical Information Needs:

Workshop participants identified the following critical information needs as they relate to this NOAA objective.

- 3) Understand the basic biology of deep-sea corals, including taxonomy, age structure, growth, gender, population connectivity, and life histories.
- 6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.

Activities:

Workshop participants identified the following activities as they relate to this NOAA objective.

Biology:

1. Describe the basic biology or life history of structure-forming corals including taxonomy, age structure, growth, reproduction, and population connectivity.
2. Develop taxonomic experts to identify and classify specimen on regional surveys.
3. Standardize surveys and sample collections for comparability.
   - Utilize the NOAA coral collection protocols.
4. Compare the basic biology of West Coast *Lophelia* with that of the Southeast.
5. Conduct genetic analysis of samples.
6. Determine the abiotic and biotic habitat requirements and suitability.
   - Determine variables to be used as deep-sea coral habitat proxies.
   - Identify the physical, chemical, and biological parameters of deep-sea coral habitats.
7. Collect oceanographic conditions with in situ instrumentation (e.g. benthic landers).

[2] Introductory material was taken, with slight modifications, from the Pacific Coast Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

NOAA Strategic Plan Objective #3: Understanding the biodiversity and ecology of deep-sea coral and sponge ecosystems.

Several studies both in the region and elsewhere in the north Pacific report fine-scale associations between demersal fishes, deep-sea corals and other structure-forming invertebrates and some studies have even investigated the nature of those relationships. Because little is known about the nature of relationships between deep-sea corals, other invertebrates and demersal fishes off the Pacific coast, there is a need to quantify those relationships. To date, few studies in the region have examined the nature of relationships between deep-sea corals, other structure-forming invertebrates and fishes, though analysis of recent surveys is ongoing. In order to evaluate the importance of deep-sea corals to their benthic communities, future in situ surveys will need to incorporate a more holistic investigation of species relationships and habitat characteristics. [3]

Critical Information Needs:

Workshop participants identified the following critical information needs as they relate to this NOAA objective.

- 2) Determine the ecological roles of deep-sea corals and sponges (nature of associations between deep-sea corals and sponges and other species (invertebrates and fishes)).
- 6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.

Activities:

Workshop participants identified the following activities as they relate to this NOAA objective.

Ecosystem Function:

1. Determine the ecological roles of deep-sea corals and sponges and their associations with other fish and invertebrates.
    - Conduct laboratory-based experiments, controlled experiments and field research to understand how deep-sea corals function as habitat.

[3] Introductory material was taken, with slight modifications, from the Pacific Coast Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

NOAA Strategic Plan Objective #4: Understanding the extent and degree of impact caused by fishing and other human activities

Compared to other regions in the U.S., the Pacific coast from California to Oregon has a narrow continental shelf, which may result in deep-sea coral communities here being more susceptible to coastal activities. Bottom trawls are the most widely used fishing gear off the U.S. Pacific coast. They are used off Oregon and in federal waters off Washington and California to target numerous species of demersal fishes, shrimp, prawns, sea cucumbers and sea urchins. In addition, sedimentation caused by oil and gas development has been shown to be detrimental to deep-sea corals in the region. Other activities that may adversely affect deep-sea corals include coral harvesting, communication cables, and marine pollution. Unfortunately, the extent of impact from these activities varies and little is known about the potential recovery rates of deep-sea corals. [4]

Critical Information Needs:

Workshop participants identified the following critical information needs as they relate to this NOAA objective.

- 5) Understand anthropogenic and natural impacts on deep-sea coral ecosystems. Develop baseline conditions (indices of health and condition at both species and community level).
- 6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.
- 7) Understand deep-sea corals' ability to recover from a variety of stressors.
- 9) Evaluate the efficacy of existing management measures.
- 10) Improve tools and methods for studying deep-sea corals (develop new technologies and applications for existing technologies in novel ways and develop best practices for deep-sea coral research).

Activities:

Workshop participants identified the following activities as they relate to this NOAA objective.

Human Impacts:

1. Identify areas with existing baseline information.
2. Determine the footprint of the sources of impact (e.g., trawl fishery).
3. Evaluate the effectiveness of existing management measures.

[4] Introductory material was taken, with slight modifications, from the Pacific Coast Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

    - Investigate recovery rates of deep-sea corals and their habitats from stressors including identification of areas with existing baseline data that have since been closed.
    - Validate closure areas adherence by mapping fishing effort.
    - Develop recovery potential models.
4. Establish baseline conditions and monitor sites.
    - Conduct comparative studies at disturbed and undisturbed sites of deep-sea corals.
5. Improve communication and coordination between federal state, tribes, and local agencies.
    - Define criteria for evaluating the need for management response.

NOAA Strategic Plan Objective #5: Understand the impacts of climate change and past oceanic conditions.

Evidence suggests that global climate change may pose other threats to deep-sea corals. Deep-sea corals are most likely feeding on suspended organic matter that rains down from the surface or is transported by currents. Because many of the organisms that comprise this source of organic material (e.g., coccolithophores, foraminiferans, pteropods) use carbonate to form protective shells, reduced carbonate concentrations (e.g. ocean acidification) may impact nutrient availability for deep-sea corals or their skeletal development. In addition, rising atmospheric carbon dioxide is increasing deep-sea water temperatures and altering salinities, which may in turn cause changes in thermohaline circulation. Because deep-sea corals have evolved in a steady-state, nutrient-rich environments, they may be particularly susceptible to such changes in environmental conditions. [5]

Critical Information Needs:

Workshop participants identified the following critical information needs as they relate to this NOAA objective.

- 5) Understand anthropogenic and natural impacts on deep-sea coral ecosystems. Develop baseline conditions (indices of health and condition at both species and community level).
- 6) Synthesize and understand existing information on deep-sea corals and develop a deep-sea coral data management plan.
- 7) Understand deep-sea corals ability to recover from a variety of stressors.
- 8) Utilize deep-sea corals to discern past climate conditions.

Activities:

Workshop participants identified the following activities as they relate to this NOAA objective.

Past Climate Conditions

1. Collect information on climate conditions that can be derived from deep-sea corals.
    - Provide deep-sea coral samples for analysis.

[5] Introductory material was taken, with slight modifications, from the Pacific Coast Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

Conclusion

The Deep-Sea Coral and Sponge Ecosystems Exploration and Research Priorities Workshop provided an opportunity for scientists and resource managers to identify and prioritize critical information needs to increase our understanding of deep-sea coral and sponge ecosystems in the West Coast region. Workshop participates approached each critical information need and focused on applied research activities that would address current and future management needs.

Participants were mindful of developing activities on an appropriate timescale, building on existing known activities and developing collaborations. They discouraged focusing on manipulative experiments, remarking that those would be better suited for National Science Foundation proposals. In addition, participants agreed that projects should be distributed along the coast to both understand gradients such as north-south, and to include a variety of habitat types. Understanding connectivity and differences among places was also a recurring comment.

Workshop participants were not directed to develop critical information needs directly from NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (although it was provided as a guiding document), the "Top 10" list of critical information needs developed was very consistent with the Plan's Exploration and Research Objectives. Each critical information need correlated directly to at least one of the objectives of the Plan.

The information provided by the participants at the workshop is an initial step that will help to inform future budget allocations for the U.S. West Coast; ensure that research activities address management needs; maximize opportunities to utilize regional expertise; leverage and complement existing regional efforts; and share information on these habitats. The goal for future research activities will be to provide a better understanding on the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats.

Appendix A: Workshop Agenda

NOAA West Coast Deep-Sea Corals
Exploration and Research Priorities Workshop
January 20-21, 2010
Portland, Oregon
Agenda

GOAL:

- To develop a three year exploration and research priorities plan for deep-sea corals and sponges off the U.S. West Coast that addresses resource management needs.

OBJECTIVES:

- Review and understand existing exploration and research objectives for deep-sea coral and sponge ecosystems.
- Identify critical exploration and research information needs.
- Develop a concise description of priority activities that will address those needs.

DAY 1 – Activities and Objectives

8:00	Registration
8:30	Welcome, Meeting Logistics, and Review of Agenda (Elizabeth Clarke and Katie Watson)
9:00	Presentation on NOAA's Deep-Sea Coral Plan (Kacky Andrews)
9:30	Introduction on Existing Relevant West Coast Plans (Dani Lipski)
9:40	NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (Robert Brock)
10:00	Review of West Coast Science Priority Plans (Elizabeth Clarke, Dani Lipski and Mary Yoklavich)
10:50	Break
11:00	Overview of NOAA 2010 West Coast Deep-Sea Coral and Sponge Research Activities (John Tomczuk)
11:30	Lunch

1:00	Presentation on Bamboo Corals and Paleoclimate Research (Howie Spero)
1:30	Discussion of Criteria for Identifying Critical Information Needs and Activities (Plenary)
2:00	Development of List of Critical Information Needs (Breakout Groups)
3:20	Break
3:30	Breakout Groups Present Critical Information Needs (Plenary)
4:10	Discussion of Prioritization of Information Needs (Plenary)
4:50	Review of Day 1 Accomplishments and Next steps (Plenary)
5:00	End of Day 1

DAY 2 – Activities and Objectives	
8:30	Summarize Day 1 and Review Day 2 Agenda (John Tomczuk)
9:00	Development of Exploration and Research List of Activities (Breakout Groups)
10:45	Break
11:00	Presentation of List of Exploration and Research Activities (Breakout Groups)
12:00	Lunch
1:30	Continued Presentation of List of Exploration and Research Activities (Breakout Groups)
2:30	Refinement of List of Activities (Plenary)
3:15	Break
3:30	Discussion of Refined Activities, Wrap Up and Next Steps (Plenary)
4:30	End of Workshop

Appendix B: Breakout Group Participation List

Group A	
NAME	AFFLIATION
Sandra Brooke	Marine Conservation Biology Institute
Rob Jones	Northwest Indian Fisheries Commission
Jennifer Kunzelman	NOAA Marine Fisheries Service
*Stacey Miller	NOAA Marine Fisheries Service
Jan Roletto	National Ocean Service
Howie Spiro	University of California, Davis
Mary Yoklavich	NOAA Marine Fisheries Service

Group B	
NAME	AFFLIATION
Erica Burton	NOAA Ocean Service
Jena Carter	The Nature Conservancy
Kerry Griffin	Pacific Fisheries Management Council
Lara Henry	University of South Florida
Brad Pettinger	Oregon Trawl Commission
Sean Rooney	Washington State University Vancouver
Joe Schumaker	Quinault Department of Fisheries
*Curt Whitmire	NOAA Marine Fisheries Service

Group C	
NAME	AFFLIATION
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Ed Bowlby	NOAA Ocean Service
Robert Brock	NOAA Marine Fisheries Service
Peter Etnoyer	NOAA Ocean Service
Steve Joner	Makah Tribe
Brendan Roark	Texas A&M University
Steve Ross	University of North Carolina Wilmington
*Fan Tsao	NOAA Marine Fisheries Service

Group D	
NAME	AFFLIATION
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Lisa Etherington	NOAA Ocean Service
Chris Goldfinger	Oregon State University
Jennifer Hagen	Quileute Nation
Brian Tissot	Washington State University Vancouver
Jonathan Warrenchuk	Oceana
Gary Williams	California Academy of Sciences
*Timi Vann	NOAA Marine Fisheries Service

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Appendix C: Participants List

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